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Marine Scotland

Development of a Deep Sea Marine Reserve West of Scotland

SOCIO-ECONOMIC IMPACT ASSESSMENT

September 2019

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Proposed Deep Sea Marine Reserve

Socio-Economic Impact Assessment

September 2019

Report prepared by:

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For:

Scottish Government
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Non-Technical Summary

Introduction

The Scottish Government has made a long-term commitment to ensuring the sustainable management of the marine environment by balancing the competing interests of use and protection of the sea. This has included developing and implementing a coherent network of Marine Protected Areas (MPAs) to benefit the conservation of vulnerable and characteristic marine species and habitats in Scottish waters. The designation of MPAs is a high policy priority and fulfils duties in domestic and European legislation, as well as contributing to wider UK and international networks of protected areas.

The deep seas around Scotland are home to some of the most vulnerable habitats and species on earth[1,2]. A deep sea marine reserve is proposed for designation to prevent the further decline of these globally threatened habitats and species and facilitate their recovery. This will also protect the range of ecosystem services that deep sea ecosystems provide, including nutrient cycling and carbon storage[3]. When designated, the reserve will complement and form part of Scotland's existing MPA network.

Marine Scotland's policy is to provide information on the potential economic, social and environmental impacts of possible marine designations to Ministers before consultation. Evidence of the environmental and socio-economic impacts of designation of conservation sites in the marine environment is required to progress designation of MPAs under the Marine (Scotland) Act 2010 and Marine and Coastal Access Act 2009.

What is Socio-Economic Impact Assessment?

Socio-economic impact assessment (SEIA) aims to identify and assess the potential economic and social effects of a proposed development or policy on the lives and circumstances of people, their families and their communities. The assessment investigates the potential cumulative economic benefits and costs, and associated potential social impacts, of implementing the proposed management scenarios at each individual MPA. It also considers the potential economic benefits and costs, and associated potential social impacts of implementing the suite of measures overall.

The assessment provides Marine Scotland with evidence on economic and social effects to inform a Business and Regulatory Impact Assessment (BRIA) for each MPA, and a Sustainability Appraisal for the suite of proposed measures overall.

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[1] Scottish Government (2011). Scotland's Marine Atlas: Information for The National Marine Plan. Deep Sea Habitats. Available at: https://www2.gov.scot/Publications/2011/03/16182005/49 (accessed 20/11/2018).

[2] JNCC (2012). Nature News Issue 27: Winter 2012. Improving our understanding of deep-sea marine habitats. Available at: http://jncc.defra.gov.uk/page-6038 (accessed 20/11/2018).

[3] Hanley, Nick; Hynes, Stephen; Patterson, David; and Jobstvogt, Niels (2015). "Economic Valuation of Marine and Coastal Ecosystems: Is it currently fit for purpose?" Journal of Ocean and Coastal Economics: Vol. 2, Article 1. DOI: http://dx.doi.org/10.15351/2373-8456.1014

What is the proposed deep sea marine reserve?

Three boundary options for the proposed reserve are being considered by Marine Scotland based on advice from the Joint Nature Conservation Committee. These comprise a north-eastern boundary option (Faroe-Shetland), a western boundary option (West of Scotland) and a combination of both options (Faroe-Shetland and West of Scotland).

The proposed protected features of the sites are shown in Table S1, and a map is provided in Figure 1. The proposed management scenarios seek to reduce risk to and disturbance of the protected features.

Table S1 Proposed Protected Features within each assessed area

Site Name	Proposed Protected Features
Faroe-Shetland Reserve	▪ Burrowed mud (including sea pens) ▪ Deep sea sponge aggregations ▪ Atlantic-influenced offshore deep sea muds ▪ Atlantic-influenced offshore subtidal sands and gravels
West of Scotland Reserve	▪ Burrowed mud (including sea pens) ▪ Coral gardens ▪ Cold-water coral reefs (including *Lophelia pertusa* reefs) ▪ Deep sea sponge aggregations ▪ Atlantic influenced offshore deep sea muds ▪ Atlantic influenced offshore subtidal sands and gravels ▪ Seamount communities ▪ Seamounts ▪ Blue Ling (Molva dypterygia) ▪ Leafscale gulper shark (Centrophorus squamosus) ▪ Gulper shark (Centrophorus granulosus) ▪ Orange roughy (Hoplostethus atlanticus) ▪ Portuguese dogfish (Centroscymnus coelolepis) ▪ Roundnose grenadier (Coryphaenoides rupestris) ▪ Geodiversity features
Faroe-Shetland and West of Scotland Reserve	▪ All features listed above.

How was the Socio-Economic Impact Assessment undertaken?

The SEIA has sought to estimate the effects of the designation and management of the proposed deep sea marine reserve areas in terms of:

- Potential costs to activities;
- Potential social impacts;
- Potential costs to the public sector; and
- Potential environmental impacts.

Lower, intermediate and upper scenarios were developed to assess the potential range of impacts, reflecting a range of possible management options that may be applied to support achievement of site conservation objectives, as developed by Marine Scotland.

The estimates have been developed to help inform the impact assessment and should not be seen as prejudging the outcome of project-level additional assessments at such time as these may be required. The estimates have been used to assess the potential range in impacts associated with designation of the proposed sites.

The potential costs have been assessed for the following activities:

- Commercial Fisheries;
- Military Interests;
- Oil and Gas (including exploration, production, interconnectors, gas storage);
- Power Interconnectors and Transmission Lines;
- Seabed Mining; and
- Telecom Cables.

Other sectors were scoped out of the assessment. There is currently no existing or planned activity for the aquaculture, carbon capture and storage, coastal protection and flood defence, energy generation, marine aggregate extraction, ports and harbours, recreational boating, shipping, tourism or water sports sectors in the areas covered by the potential deep sea marine reserve areas and aviation was not considered to pose a significant risk to any of the site features.

Potential cost impacts have been quantified where possible for each relevant activity and potential deep sea marine reserve area, estimated in terms of additional expenditure that would be incurred and presented as Present Values (PV) over the lifetime of the assessment period (2019 to 2038). Consistent unit costs have been used within marine activity sectors as a basis for estimating these impacts, although it is recognised that the actual costs that may be incurred by specific activities within individual sites may be higher or lower than these ‘average’ values.

For the commercial fisheries sector, where the management options may give rise to economic impacts as a result of changes in output, the potential cost impacts were estimated in terms of impacts to Gross Value Added (GVA). This provides a better representation of the true economic cost to this sector. These impacts were reported as both annual average and in PV terms.

In addition to the quantified cost impacts, it is recognised that there are a number of cost impacts that cannot readily be quantified. These include:

- Costs associated with as yet unplanned development in the oil and gas, power interconnectors and telecom cable sectors;
- Opportunity cost of foregone future activity due to restrictions within the reserve areas;
- The potential cost impacts of delays during the consenting process arising as a result of the designations; and
- The potential deterrent to investment as a result of the designations.

It is recognised that some of these unquantified cost impacts may be at least as great as the quantified cost impacts and for some of the abovementioned sectors, the costs are therefore likely to represent only a partial estimate of costs.

The social impacts generated by the proposed management scenarios will be strongly connected to the nature, scale and distribution of the economic impacts (on both income and employment). Any significant change in employment, for example generated as a result of restrictions on fishing activity, can have significant social impacts (e.g. on health, crime). The distribution of impacts on employment in the fishing sector has focussed on the registered home ports of the vessels affected. The distribution of impacts on the fish processing industry has focussed on the ports of landing of the affected vessels' catches.

Public sector costs were estimated for the following broad areas based on discussions with Marine Scotland and JNCC:

- Preparation of Statutory Instruments;
- De-designation of existing sites;
- Site monitoring;
- Compliance and enforcement;
- Promotion of public understanding; and
- Regulatory and advisory costs associated with licensing decisions.

The biodiversity features of an MPA contribute to the delivery of a range of ecosystem services. The designation and management of the deep sea MPAs may protect the services the sites currently provide, and may improve the quantity and quality of the beneficial services provided, which may increase their value (contribution to economic welfare). Impacts on the value of ecosystem services may occur as a result of the management and/or achievement of the conservation objectives of the MPA.

The ecosystem services analysis provides a qualitative description of the potential changes in ecosystem service provision associated with the implementation of management scenarios to support the achievement of conservation objectives for individual features.

Detailed assessments for each proposed boundary option are presented in Appendix C with an assessment of the combined impact presented in the main report (Section 8).

What are the likely significant economic and social impacts of the proposals?

Impacts to Activities

Potential cost impacts were identified for 6 different human activities within one or more of the proposed boundary options. The costs should be treated as partial as it was not possible to estimate cost impacts for all potential costs, such as costs associated with delays, opportunity costs of future activity foregone, or for impacts on investor confidence. The cost estimates for the intermediate scenario are considered to represent the best available estimate of quantified impacts.

For commercial fisheries, the values presented represent the estimated direct GVA associated with the value of landings that could be affected by the possible management measures and will be overestimates if some of the effort that could be affected is displaced and fishing continues elsewhere or if less damaging gears can continue to be used within the proposed sites.

Given the uncertainties, confidence in the cost estimates is low. It is recognised that the actual costs that may be incurred by specific activities within individual sites may be higher or lower than the 'average' values generated within this assessment.

Table S2 summarises the quantified cost estimates (non-GVA costs) by site[4]. The total quantified cost impacts for the combined reserve (present value over 20-year assessment period at 2019 prices) are estimated to range between £291,000 (lower estimate) and £226,000 (upper estimate). Under the lower estimate, £82,000 is attributable to the Faroe-Shetland reserve, and £23,000 to the West of Scotland reserve. The majority of the costs (£195,000) arise from the national-level assessment (i.e. for Military activities).

The costs for the proposed Faroe-Shetland and West of Scotland reserve are lower than the additive cost of the two individual boundary options because for the Telecoms sector the same telecoms cables cross both parts of the combined reserve area and it is assumed that only one assessment is required.

Quantified costs are lower in the intermediate and upper scenarios, compared to the lower scenario, because some activities no longer take place (and therefore will not incur licensing-related assessment costs, for example). The intermediate and upper scenarios also result in a number of non-quantified (but potentially significant) opportunity costs for sectors that will not be able to operate in the proposed reserve areas (oil and gas, seabed mining).Table S3 summarises the same quantified cost estimates (non-GVA costs) by activity for the proposed Faroe-Shetland and West of Scotland reserve (the combined area). Details by sector for the individual areas are provided in Section 4.

Most cost impacts are minor, but they vary between sectors. Under the intermediate scenario, the largest costs are estimated to be experienced by the Military sector, related to the cost of amending and updating its Marine Environment and Sustainability

[4] Note, for all tables of results, totals may not sum due to rounding.

Assessment Tool (MESAT) and other Ministry of Defence environmental tools, and additions to electronic charting by the Hydrographic Office. This may overestimate the costs to the Military sector, as these updates may be carried out in conjunction with updates required for other proposed MPAs that may be designated at a similar time to the proposed deep sea marine reserve.

Table S2 Present value (PV) in £'000 for quantified cost impacts to human activities by site (costs discounted over assessment period (2019-2038), 2019 prices)

Sector	Lower Estimate	Intermediate Estimate	Upper Estimate
Faroe-Shetland reserve	82	31	31
West of Scotland reserve	23	9	9
Faroe-Shetland and West of Scotland reserve	96	31	31
National-level assessment (Military activities)	195	195	195
Total Faroe-Shetland and West of Scotland reserve + national assessment	**291**	**226**	**226**

PV is calculated by discounting future values using the HM Treasury recommended 3.5% discount rate. Discounting converts future monetary amounts to their equivalent value in today's terms, (based on the premise that people prefer to receive benefits in the present rather than in the future).

Table S3 Present value (PV) in £'000 for quantified national cost impacts to human activities (costs discounted over assessment period (2019-2038), 2019 prices)

Sector	Lower Estimate	Intermediate Estimate	Upper Estimate
Military activities	195	195	195
Oil and gas	63	0	0
Power interconnectors and transmission lines	5	5	5
Seabed mining	3	0	0
Telecom cables	25	25	25
Total	**291**	**226**	**226**

Table S4 summarises estimated GVA impacts for the commercial fisheries sector by site (arising from changes to landings from UK vessels) for the proposed reserves. The ranges presented across the scenarios reflect the possible range of quantified costs depending on which particular management approach is adopted. The impacts under the lower scenario are zero. The impact for the Faroe-Shetland reserve cannot be disclosed for the intermediate scenario, but is negligible. The estimated impact on direct GVA under the intermediate estimate is £1.1 million, rising to £8.8 million under the upper estimate (present value, costs discounted over the 20-year assessment period, 2019 prices). These impacts arise as a result of reduced landings from the proposed reserves where fishing effort would be restricted under the assessed management scenarios. When taking into account the knock-on effects on the supply chain to the commercial fisheries sector, the impacts are £1.6 million under the intermediate scenario and £12.8 million under the upper scenario (present value, costs discounted over the 20-year assessment period, 2019 prices) for the proposed Faroe-Shetland and West of Scotland reserve.

Under the intermediate scenario, impacts are minor and mainly on set nets and demersal trawls, arising almost exclusively from the proposed West of Scotland reserve. Under the upper scenario, the impacts arise from both proposed reserve areas, although still mostly from the proposed West of Scotland reserve, and predominantly affect the pelagic fishery (midwater trawls and surrounding nets), and set nets.

Table S5 summarises the potential employment impacts on the commercial fisheries sector associated with estimated reductions in output. The potential loss of jobs is between 0 and 15 full-time equivalents (direct and indirect, lower to upper scenario), with an intermediate estimate of 2 jobs, related to the change in activity of UK vessels.

Table S4 Impacts on GVA in £'000 for quantified cost impacts to commercial fisheries (Direct and Indirect GVA) (total costs discounted over assessment period (2019 – 2038), 2019 prices)

Site	Direct GVA			Direct + Indirect GVA		
	Lower	Inter-mediate	Upper	Lower	Inter-mediate	Upper
Faroe-Shetland reserve	0	N.D.	3,180	0	N.D.	4,604
West of Scotland reserve	0	1,124	5,646	0	1,628	8,175
Faroe-Shetland and West of Scotland reserve	0	N.D.	8,826	0	N.D.	12,779

N.D. = Value cannot be disclosed, as it relates to the operations of fewer than five vessels. As a result the value for the Faroe-Shetland and West of Scotland reserve also cannot be disclosed.

Table S5 Impacts on employment for commercial fisheries (direct and indirect employment, number of jobs)

Sector	Lower Estimate	Intermediate Estimate	Upper Estimate
Commercial fisheries (direct and indirect employment)	0	2	15

Social Impacts

The proposed Faroe-Shetland reserve has minimal impacts on fisheries in the intermediate scenario. The proposed West of Scotland reserve has low impacts under the intermediate scenario. However, the majority of these arise for vessels registered to North Shields in England. Therefore in Scotland, the estimated social and economic impacts on employment based on vessels' registered home ports are minimal under the intermediate estimate, although this may underestimate impacts from vessels which operate from Scottish ports but are registered outside of Scotland. There is a risk of very small social impacts at several Scottish ports where landings are made in the north-west of Scotland.

Under the upper scenario, there are risks of small social impacts on ports in north-west and north-east Scotland.

Public Sector Costs

Table S6 presents a summary of estimated quantified cost impacts to the public sector.

Table S6 Present value (PV) in £'000 for quantified public sector costs for the proposed combined reserve (costs discounted over assessment period 2019–2038, 2019 prices)

Site Name	Quantified Cost Impact (Present Value of Total Costs, £'000)		
	Lower Estimate	Intermediate Estimate	Upper Estimate
Preparation of statutory instruments	0	4	4
Changes to designations of existing sites	8	8	8
Site monitoring	3,646	3,646	3,646
Regulatory and advisory costs associated with licensing decisions	10	3	3
Total	**3,664**	**3,661**	**3,661**

The main potential costs identified relate to future monitoring costs of designated sites. The majority of the costs are attributed to the proposed West of Scotland reserve, due to the need for both benthic habitat monitoring and deep sea fish surveys. In addition, in the proposed Faroe-Shetland reserve, benthic habitat monitoring costs are reduced on the assumption that benthic habitat monitoring would have been required for the North-East Faroe-Shetland Channel Nature Conservation MPA and only the additional cost for the expanded area is costed. A breakdown per site can be found in section 5.

Costs to the public sector are greater under the lower scenario compared to the intermediate and upper scenarios, due to the additional regulatory and advisory costs associated with licensing decisions – more activities are permitted in the lower scenario, so there are potentially more licence applications.

Ecosystem Services

The potential for ecosystem service benefits and costs to arise on-site or off-site has been considered. On-site benefits are the result of protection of features through the proposed management scenarios. Off-site benefits include spill-over effects, where particular species (including commercial fish or shellfish species, and other protected biodiversity) have healthier populations inside the site, and this supports movement of individuals to areas outside the site. The extent of this effect depends, amongst other things, on the size of site, impact of management measures and mobility and lifecycles of the species concerned. Ecosystem service costs could arise on-site, for example, if alternative fishing activities (using different gears) enter areas where restrictions are introduced on existing fishing activities, but this is considered unlikely. Costs could also arise off-site – if a significant amount of fishing activity is expected to be displaced from the site to other areas there could be a negative effect on ecosystem services outside the site, however this is also considered unlikely due to the relatively minor scale of impacts on commercial fisheries, particularly under the intermediate scenario.

The sites support a range of ecosystem services, but evidence on the baseline condition of the site features, and on the expected impacts of designation in scientific or economic terms, is extremely sparse and, as a result, the assessment of changes in ecosystem services is highly uncertain. The proposed designation and management for the MPAs will protect the supporting and provisioning services, including fish (and shellfish) for human consumption, the sites currently provide.

Uncertainties

All of the estimates of costs and benefits are subject to significant uncertainties. The cost estimates present a partial estimate of costs as it has not been possible to take account of unplanned future activity that will occur in the oil and gas sector. The range of cost impacts varies greatly depending on the management scenarios applied. It is recognised that the actual costs that may be incurred by specific activities within individual sites may be higher or lower than the ‘average’ values generated within this assessment. In addition, the consequential impacts in remote or fragile communities may have the potential to be greater than the estimates presented in this assessment.

The benefits assessment is subject to particular uncertainty and it has only been possible to develop partial and tentative estimates of potential benefits for a limited number of ecosystem services.

How do I respond to the consultation?

Views on the proposed management measures and the findings of the socio-economic impact assessment are now invited.

The consultation questionnaire asks for comments on the proposed deep sea marine reserve options, which includes a question on the economic, social, and environmental assessments of the impact of the management approaches. Please provide any comments on this socio-economic assessment in your responses to the questionnaire, including any comments on general issues or cumulative effects.

Copies of the assessments are available online at https://consult.gov.scot/marine-scotland/deep-sea-marine-reserve. If you require access to a paper copy then please get in touch so that arrangements can be made for you to view them during office hours.

Please send online at https://consult.gov.scot/marine-scotland/deep-sea-marine-reserve. If you are unable to respond online, then please send your response with a completed Respondent Information Form, to:

By email to: marine_conservation@gov.scot or

By post to: Deep Sea Marine Reserve Consultation

Scottish Government

Marine Planning and Policy Division

Area 1-A South

Victoria Quay

Edinburgh EH6 6QQ

If you have any enquiries please send them to: marine_conservation@gov.scot

What happens next?

Following the consultation period, the responses received will be analysed, and the findings will be taken into account in the finalisation of the proposed management measures.

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1 Introduction

1.1 Background

1.1.1 The Scottish Government has made a long-term commitment to ensuring the sustainable management of the marine environment by balancing the competing interests of use and protection of the sea. This has included developing and implementing a coherent network of Marine Protected Areas (MPAs) to benefit the conservation of vulnerable and characteristic marine species and habitats in Scottish waters. The designation of MPAs is a high policy priority and fulfils duties in domestic and European legislation, as well as contributing to wider UK and international networks of protected areas.

1.1.2 The deep seas around Scotland are home to some of the most vulnerable habitats and species on earth[5,6]. A deep sea marine reserve is proposed for designation to prevent the further decline of these globally threatened habitats and species and facilitate their recovery. This will also protect the range of ecosystem services that deep sea ecosystems provide, including nutrient cycling and carbon storage[7]. When designated, the reserve will complement and form part of Scotland's existing MPA network.

1.1.3 The proposal for a deep sea marine reserve is intended to build on the EU Deep Sea Fisheries Regulation 2016/2336[8] which bans deep sea trawling in EU waters at depths greater than 800m. The use of gillnets and entangling nets are also banned at depths greater than 600m and restricted at depths between 200 and 600m, according to EU Regulation 227/2013[9]. These EU Regulations complement other international regulations that ensure emerging extractive activities are appropriately managed in the context of the status of vulnerable habitats and species in deep seas around Scotland.

[5] Scottish Government (2011). Scotland's Marine Atlas: Information for The National Marine Plan. Deep Sea Habitats. Available at: https://www2.gov.scot/Publications/2011/03/16182005/49 (accessed 20/11/2018).

[6] JNCC (2012). Nature News Issue 27: Winter 2012. Improving our understanding of deep-sea marine habitats. Available at: http://jncc.defra.gov.uk/page-6038 (accessed 20/11/2018).

[7] Hanley, Nick; Hynes, Stephen; Patterson, David; and Jobstvogt, Niels (2015). "Economic Valuation of Marine and Coastal Ecosystems: Is it currently fit for purpose?" Journal of Ocean and Coastal Economics: Vol. 2, Article 1. DOI: http://dx.doi.org/10.15351/2373-8456.1014

[8] Regulation (EU) 2016/2336 of the European Parliament and the Council of 14 December 2016 establishing specific conditions for fishing for deep-sea stocks in the north-east Atlantic and provisions for fishing in international waters of the north-east Atlantic and repealing Council Regulation (EC) No 2347/2002. Available at: https://ec.europa.eu/fisheries/better-future-eu-deep-sea_en (accessed 14/11/2018)

[9] Regulation (EU) No 227/2013 of the European Parliament and of the Council of 13 March 2013 amending Council Regulation (EC) No 850/98 for the conservation of fishery resources through technical measures for the protection of juveniles of marine organisms and Council Regulation (EC) No 1434/98 specifying conditions under which herring may be landed for industrial purposes other than direct human consumption. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013R0227 (accessed 21/11/2018)

1.1.4 The proposed location for a deep sea marine reserve has not yet been finalised. Three boundary options for the proposed reserve are being considered by Marine Scotland based on advice from the Joint Nature Conservation Committee (JNCC). These comprise a north-eastern boundary option (Faroe-Shetland), a western boundary option (West of Scotland) and a combination of both options (Faroe-Shetland and West of Scotland). These areas are shown on Figure 1.

1.1.5 It is anticipated that a deep sea reserve would be underpinned by designating it as an MPA under the Marine and Coastal Access Act 2009. Sites designated in this manner are protected by provisions in s125 and 126 of the Act which places legal duties on public authorities not to put protected features at significant risk through their decision making. In addition, s140 provides general protection against intentional or reckless damage or destruction. Although a number of fishing activities are already banned or restricted in deep sea areas by existing EU Regulations, the establishment of an MPA will ensure that vulnerable deep sea habitats and species are protected from other activities that do not currently take place but that may occur in the future (e.g. deep sea mining).

1.1.6 The proposal to designate a deep sea marine reserve as an MPA is the subject of this Social and Economic Impact Assessment Report, produced as part of a Sustainability Appraisal (SA).

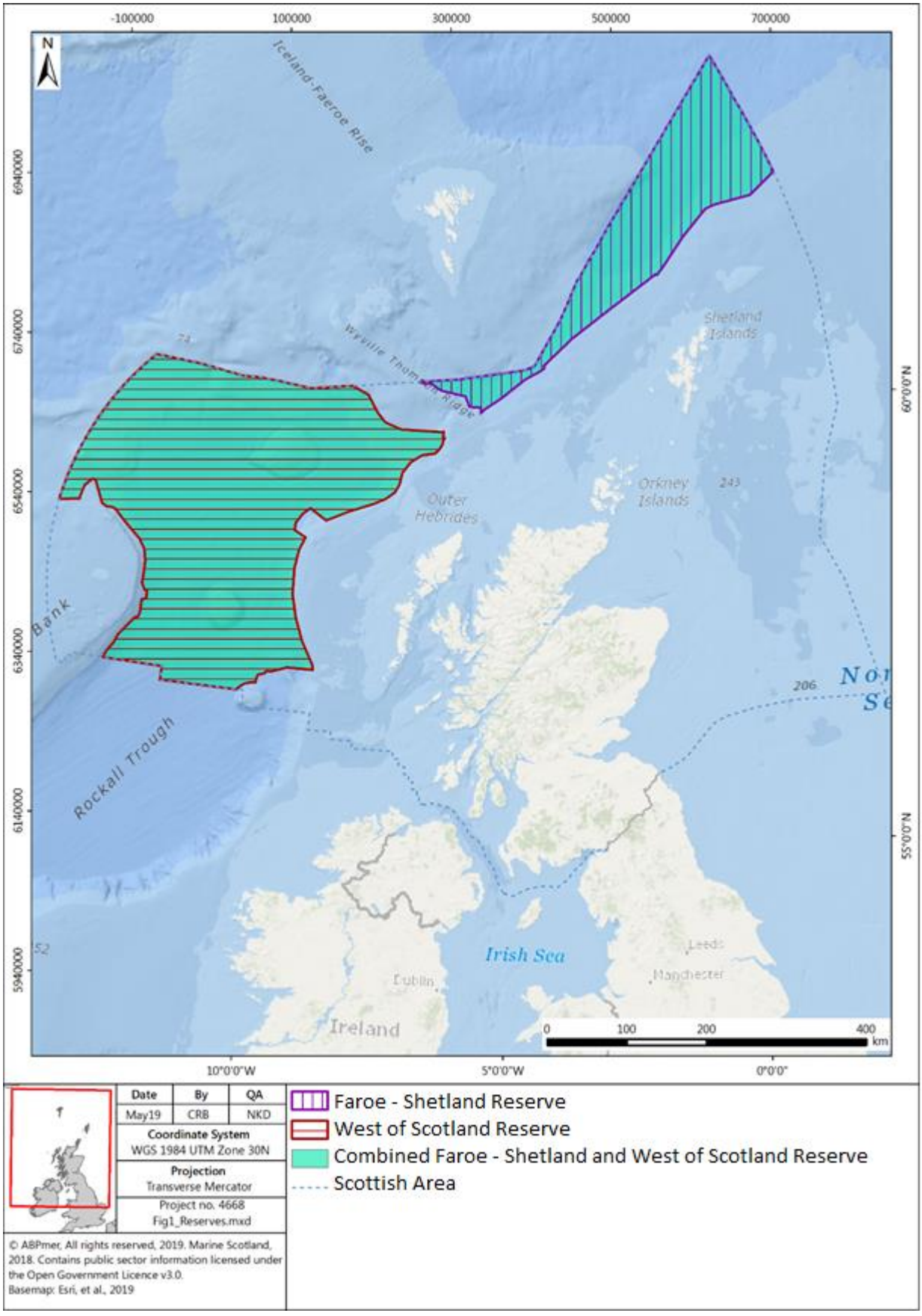

Figure 1 Map of proposed deep sea marine reserve boundary options

1.2 Social and Economic Impact Assessment

1.2.1 The purpose of the SEIA is to identify and assess the potential economic and social effects of a proposed development or policy on the lives and circumstances of people, their families and their communities. It considers the potential economic benefits and costs, and their distribution among different groups, to inform the assessment of potential impacts on individuals, communities and society.

1.2.2 This study aims to assess the potential economic and social effects of the proposed designation and management of three potential deep sea marine reserve areas.

1.2.3 The objectives of the study were, for each potential deep sea marine reserve area:

- Identify the activities taking place, and the activities that could be affected by designation of each proposed site and how;
- Identify and estimate the costs to potentially affected activities, specifically arising from the proposed management scenarios for each pMPA;
- Identify any communities and social groups that may be adversely or positively affected by designation proposals, and quantify the scale and costs of such impacts where possible;
- Estimate the costs to government (public sector costs) associated with the designation and management of the sites;
- Identify, describe and quantify the potential costs and benefits to society as a whole associated with designation of each individual site.

1.2.4 Based on the individual area impact assessments, a combined assessment is also required to estimate the potential aggregate costs of designation and management of the suite of areas as a whole and the combined impact on potentially affected marine activities, communities, social groups and Government. However, since the 'West of Scotland and Faroe Shetland Combined' Deep Sea Marine Reserve represents the combination of the potential Faroe Shetland Deep Sea Marine Reserve with the West of Scotland Deep Sea Marine Reserve, the assessment of 'West of Scotland and Faroe Shetland Combined' represents the combined assessment.

1.2.5 A cumulative assessment is also required to present information on the potential total impact as a result of all MPAs and other planned projects such as renewable energy development to date.

1.2.6 The assessment provides Marine Scotland with evidence on economic and social effects to inform a Business and Regulatory Impact Assessment (BRIA), and a Sustainability Appraisal for the proposals.

1.3 Purpose and Structure of this Report

1.3.1 The purpose of this report is to document the findings of the SEIA. A Strategic Environmental Assessment (SEA) of the proposed management scenarios has also been undertaken and is reported separately. The key findings of both the SEA and the SEIA are summarised in an overall Sustainability Appraisal (SA) document.

1.3.2 The remainder of this Socio-Economic Impact Assessment Report is structured as follows:

- Section 2 provides information on the proposed designation and management of pMPAs and their policy context;
- Section 3 describes the approach to the SEIA and the methods used;
- Section 4 presents the results of the assessment in relation to potential impacts on activities that could be affected by the designation and management of the pMPAs;
- Section 5 presents the potential impacts on the public sector;
- Section 6 presents the distribution of economic costs and consequent social impacts;
- Section 7 presents the potential impacts on ecosystem services;
- Section 8 considers the potential combined impacts of the proposals and the cumulative impacts with other planned projects and proposals; and
- Section 9 presents the limitations and uncertainties in the assessment.

1.3.3 The Non-Technical Summary precedes Section 1. Further detailed information is provided in Appendices as follows:

- Appendix A: Sector context, assumptions and assessment approach;
- Appendix B: Public sector costs;
- Appendix C: Site Assessment Tables (providing detailed assessments for each pMPA); and
- Appendix D: Abbreviations.

2 Proposals for a Deep Sea Marine Reserve

2.1 Background

2.1.1 The deep waters of Scotland support a rich diversity of life[10]. Deep sea habitats occur beyond the continental shelf break at depths typically greater than around 200m. The inaccessibility of these areas means that research is limited[11]. Although knowledge of these habitats is very patchy and limited, it is growing all the time.

2.1.2 Deep sea habitats are found offshore to the north-east and west of Scotland and comprise cold water coral reefs, coral carbonate mounds, submarine canyons, sea mounts and deep sea sediments. Deep sea habitats and species that are listed as Priority Marine Features (PMFs) include seamount communities, carbonate mound communities, coral gardens, deep sea sponge aggregations, offshore deep sea muds and cold-water coral reefs.

2.1.3 Deep sea habitats can provide spawning, nursery and refuge areas for many fish[12], as well as support a wide range of invertebrates[13]. Reefs are slow growing, fragile and easily damaged, and thousands of years of growth can be rapidly destroyed by activities that cause direct physical disturbance of the seabed along with the associated increase in turbidity and subsequent sedimentation. Spawning areas and spawning aggregations of fish present in the deep sea areas of Scotland, for example blue ling, which are vulnerable to targeted fishing[14]. Deep sea fish species for which there is already a zero Total Allowable Catch (TAC), for example Portuguese dogfish, are also vulnerable to bycatch[15].

2.1.4 There is therefore a need to protect these particularly vulnerable habitats and species from activities that currently take place or could take place there in the future, including deep sea mining activities, deep sea oil and gas exploration and development, cables/pipeline laying and deep sea fishing.

2.1.5 The MPA network is intended to benefit the marine environment, historic features, coastal communities, marine industries and recreational users[16]. In

[10] Scottish Government (2011). Scotland's Marine Atlas: Information for The National Marine Plan. Deep Sea Habitats. Available at: https://www2.gov.scot/Publications/2011/03/16182005/49 (accessed 03/12/2018).

[11] JNCC website. Nature News 27. Deep sea marine habitats. Available at: http://jncc.defra.gov.uk/page-6038 (accessed 03/12/2018).

[12] Priede, I.G. (2018) Deep-sea Fishes Literature Review. JNCC Report No. 619. JNCC, Peterborough. ISSN 0963-8091.

[13] SNH website. Cold water coral. Available at: https://www.nature.scot/landscapes-and-habitats/habitat-types/coast-and-seas/marine-habitats/cold-water-coral (accessed 03/12/2018).

[14] Priede, I.G. (2018) Deep-sea Fishes Literature Review. JNCC Report No. 619. JNCC, Peterborough. ISSN 0963-8091.

[15] Ibid.

[16] ibid

total, it consists of 231 sites covering over 22% of Scotland's seas[17]. The network comprises Special Areas of Conservation (SAC), Special Protection Areas (SPAs), Sites of Special Scientific Interest (SSSI) and MPAs (Nature Conservation, Historic and Demonstration and Research)[18].

2.1.6 Nature Conservation MPAs seek to ensure that nationally important marine wildlife, habitats, geology and undersea landforms receive adequate protection against disturbance and degradation. Specifically, they aim to either conserve features or remove pressures in order to allow them to recover. They also contribute to the survival and maintenance of species of international significance by complementing other systems of protection, both spatially and through the alignment of conservation objectives[19]. For example, Scotland's Nature Conservation MPAs form part of the wider OSPAR network of marine protected areas that are found across the North East Atlantic[20]. In addition, they contribute to achieving Good Environmental Status (GES) as set out by the Marine Strategy Framework Directive 2008/56/EC[21].

2.2 Designation of the MPA network to date

2.2.1 The Marine (Scotland) Act 2010[22] and the Marine and Coastal Access Act 2009[23] gave Scottish Ministers powers to designate MPAs in Scottish territorial and offshore waters, respectively. To inform this process, the Scottish MPA Project was established to ensure MPAs are designated in the most appropriate locations for their particular objectives. SNH is responsible for providing advice on Nature Conservation MPAs in Scottish territorial waters, while the Joint Nature Conservation Committee (JNCC) advise on possible designations in the offshore environment, including the proposed deep sea marine reserve that is the topic of this assessment[24].

2.2.2 In 2012, SNH and JNCC submitted advice to the Scottish Government on 33 proposed MPAs in both the inshore and offshore environment, as well as four

[17] Scottish Government (2018) Marine Protected Area Network - 2018 Report to the Scottish Parliament [Online] Available at: https://www.gov.scot/publications/marine-protected-area-network-2018-report-scottish-parliament/

[18] Scottish Government (2017) Marine Protected Areas (MPAs) [online] Available at: http://www.gov.scot/Topics/marine/marine-environment/mpanetwork (accessed 04/11/2018)

[19] Scottish Government (2017) Marine Protected Areas (MPAs) [online] Available at: http://www.gov.scot/Topics/marine/marine-environment/mpanetwork (accessed 04/11/2018)

[20] OSPAR Commission (2015) Marine Protected Areas [online] Available at: https://www.ospar.org/work-areas/bdc/marine-protected-areas (accessed 04/11/2018)

[21] Scottish Government (2011) Marine Protected Areas in Scotland's Seas – Guidelines on the selection of MPAs and development of the MPA network [online] Available at: http://www.gov.scot/resource/doc/295194/0114024.pdf (accessed 04/11/2018)

[22] Scottish Government (2017) Marine (Scotland) Act [online] Available at: http://www.gov.scot/Topics/marine/seamanagement/marineact (accessed 04/11/2018)

[23] Scottish Government (2014) Marine and Coastal Access Act 2009 [online] Available at: http://www.gov.scot/Topics/marine/seamanagement/marineact/ukbill (accessed 04/11/2018)

[24] SNH/JNCC (2012) Commissioned Report No. 547: Advice to the Scottish Government on the selection of Nature Conservation Marine Protected Areas (MPAs) for the development of the Scottish MPA network [online] Available at: http://www.snh.org.uk/pdfs/publications/commissioned_reports/547.pdf (accessed 04/11/2018)

areas of search[25]. The proposals were subject to public consultation in the summer of 2013 as part of Marine Scotland's integrated 'Planning Scotland's Seas' process, which sought views on marine planning, Sectoral Marine Plans for offshore renewable energy, MPAs and Priority Marine Features (PMFs)[26]. An SEA Environmental Report, which looked at the potential environmental effects of the designations, was among the suite of consultation documents made available at this time[27].

2.2.3 Following on from this consultation and additional advice received from SNH and JNCC[28], 30 of the original 33 prospective Nature Conservation MPAs were formally designated by Scottish Ministers in July 2014: 17 in the inshore environment and 13 in the offshore environment.

2.2.4 Draft management measures were subsequently developed and an addendum to the original 2013 Environmental Report was published in November 2014[29]. The Environmental Report addendum and the outputs of additional consultations fed into the finalisation of the first phase of fisheries management measures, which were implemented in early 2016[30].

2.2.5 The SEA of the second phase of management measures commenced in October 2017 and work on both the development of the management measures and the SEA is ongoing. The management measures are expected to come into force in 2020.

2.2.6 In addition to the 30 MPAs designated in 2014, Ministers issued an Order to immediately designate an additional emergency MPA in Loch Carron following damage to the world's largest expanse of flame shell beds from commercial fishing (scallop dredging) in 2017[31]. However, the current designation is temporary and will expire in 2019[32]. This designation was temporary and due to

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[25] ibid

[26] Scottish Government (2015) Planning Scotland's Seas [online] Available at: http://www.gov.scot/Topics/marine/seamanagement/national/marine-consultation (accessed 04/11/2018)

[27] Scottish Government (2013) Planning Scotland's Seas: 2013 - Possible Nature Conservation Marine Protected Areas Consultation Overview - Strategic Environmental Assessment Report [online] Available at: http://www.gov.scot/Publications/2013/08/2591 (accessed 04/11/2018)

[28] SNH (2014) SNH's advice on selected responses to the 2013 Marine Scotland consultation on Nature Conservation Marine Protected Areas (MPAs) [online] Available at: https://www.nature.scot/sites/default/files/2017-07/Publication%202014%20-%20SNH%20Commissioned%20Report%20747%20-%20SNH%27s%20advice%20on%20selected%20responses%20to%20the%202013%20Marine%20Scotland%20consultation%20on%20Nature%20Conservation%20Marine%20Protected%20Areas%20%28MPAs%29.pdf (accessed 04/11/2018)

[29] Scottish Government (2014) MPA/SAC Consultation Environmental Assessment [online] Available at: http://www.gov.scot/Topics/marine/marine-environment/mpanetwork/MPAMGT/consultation2014/ManagementSEA (accessed 04/11/2018)

[30] Scottish Government (2017) Inshore MPAs/SACs [online] Available at: http://www.gov.scot/Topics/marine/marine-environment/mpanetwork/inshorempas (accessed 04/11/2018)

[31] Scottish Government (2018) Protection for world's biggest plan shell bed [online] Available at: https://news.gov.scot/news/protection-for-worlds-biggest-flame-shell-bed (accessed 04/11/2018

[32] SNH (2017) Loch Carron possible MPA [online] Available at: https://www.nature.scot/loch-carron-possible-mpa (accessed 04/11/2018)

expire in 2019[33]. The Loch Carron MPA was permanently designated in May 2019, along with associated fisheries management measures[34], following a public consultation which ran to 13 June 2018[35].

2.2.7 In addition to Nature Conservation MPAs, Fair Isle was designated in 2016 as a Demonstration and Research MPA under the Marine (Scotland) Act 2010[36]. There are also eight historic MPAs (HMPAs) that are designated for nationally important historic assets, predominately shipwrecks[37].

2.2.8 Four additional proposed MPAs (pMPAs) that were initially introduced for consideration as areas of search in 2013 have now been recommended for designation[38]. These pMPAs would extend protection to basking shark, minke whale, Risso's dolphin, burrowed mud, shelf banks and mounds, and shelf deeps. A Sustainability Appraisal, comprising an SEA and SEIA, is currently being consulted on to inform the designation of these four pMPAs[39].

2.3 Proposed deep sea marine reserve

2.3.1 The Scottish Government's Programme for Scotland 2017-18 included a commitment to 'evaluate options to create a deep sea national marine reserve'. The designation of a deep sea reserve would complement the existing MPA network in Scottish waters and provide a legal framework for the protection of additional deep sea marine habitats and species against emerging threats.

2.3.2 Marine Scotland and JNCC have recently undertaken a scoping exercise to identify the deep sea features of interest and evaluate options for creating a deep sea national marine reserve to the north-west and north-east of Scotland in waters deeper than 800 metres[40]. The 'study area' for the potential deep sea marine reserve is divided into two distinct biogeographic areas either side of the Wyville-Thomson Ridge, with different hydrographic and thermal regimes resulting in distinct community types north and south (Figure 1).Numerous

[33] SNH (2017) Loch Carron possible MPA [online] Available at: https://www.nature.scot/loch-carron-possible-mpa (accessed 04/11/2018)

[34] Scottish Government (2019). The Loch Carron Marine Conservation Order 2019, made 20 March 2019, coming into force 19 May 2019 https://www2.gov.scot/Resource/0054/00546857.pdf

[35] Scottish Government (2019) The Loch Carron Nature Conservation Marine Protected Area Order 2019, made 20 March 2019, coming into force 19 May 2019. https://www2.gov.scot/Resource/0054/00546856.pdf

[36] Marine Scotland (2016) Fair Isle Demonstration and Research MPA Consultation [online] Available at: https://www.gov.scot/Topics/marine/marine-environment/mpanetwork/DandRMPAs/FairIsleDRMPA (accessed 17/11/2018)

[37] Historic Environment Scotland (2016). Scotland's Historic Marine Protected Areas 2016.

[38] SNH (2017) Scottish Marine Protected Areas Project [online] Available at: https://www.nature.scot/professional-advice/safeguarding-protected-areas-and-species/protected-areas/national-designations/marine-protected-areas/scottish-marine-protected-0 (accessed 04/11/2018)

[39] Marine Scotland (2019). Four Additional pMPA Consultation [online] Available at: https://consult.gov.scot/marine-scotland/four-new-marine-protected-areas/.

[40] Doggett, M., Baldock, B. & Goudge, H. (2018). A review of the distribution and ecological importance of seabed communities in the deep waters surrounding Scotland. JNCC Report No. 625, JNCC, Peterborough, ISSN 0963-8091.

deep sea habitats and species could be appropriate for spatial protection, many of which are already Priority Marine Features (PMFs) or correlate with existing PMF descriptions. Features of interest include deep sea sedimentary habitats, specifically the PMFs 'offshore deep sea muds' and 'offshore subtidal sands and gravels', and associated biodiversity, specifically the northern feather star (*Leptometra celtica*) and sea pens, including the tall sea pen (*Funiculina quadrangularis*). There are also a number of fish species that are regarded as potential features of designation interest for the proposed large-scale deep sea MPA[41], such as ~~o~~range roughy *(Hoplostethus atlanticus)* and Portuguese dogfish *(Centroscymnus coelolepis)*.

2.3.3 The proposal for a deep sea marine reserve has been informed by the EU Deep Sea Fisheries Regulation 2016/2336[42]. This EU Regulation bans deep sea trawling below 800m depth in EU waters. In addition, the use of gillnets and entangling nets are also banned at depths greater than 600m and restricted at depths between 200 and 600m, according to EU Regulation 227/2013[43]. Further, designation of the reserve as an MPA under the Marine and Coastal Access Act 2009 will safeguard the site against disturbance by any future activities, such as deep sea mining. It should be noted that the MPA designation would include the whole water column and not just the water column below 800m depth.

2.3.4 The proposed designation of a deep sea marine reserve MPA is the subject of this present assessment. The boundary options for a proposed deep sea marine reserve that are being considered by Marine Scotland, informed by advice received from JNCC, are as follows:

- North-eastern boundary option – 'Faroe-Shetland reserve';
- Western boundary option – 'West of Scotland reserve'; and
- A combination of both options – 'Faroe-Shetland and West of Scotland reserve'.

2.3.5 Table 1 below provides a description of the boundary options for a proposed deep sea marine reserve, including proposed protected features and draft conservation objectives. Figure 1 provides a map of the location of the boundary options.

[41] Priede, I.G. (2018) Deep-sea Fishes Literature Review. JNCC Report No. 619. JNCC, Peterborough. ISSN 0963-8091.

[42] Regulation (EU) 2016/2336 of the European Parliament and the Council of 14 December 2016 establishing specific conditions for fishing for deep-sea stocks in the north-east Atlantic and provisions for fishing in international waters of the north-east Atlantic and repealing Council Regulation (EC) No 2347/2002. Available at: https://ec.europa.eu/fisheries/better-future-eu-deep-sea_en (accessed 14/11/2018]).

[43] Regulation (EU) No 227/2013 of the European Parliament and of the Council of 13 March 2013 amending Council Regulation (EC) No 850/98 for the conservation of fishery resources through technical measures for the protection of juveniles of marine organisms and Council Regulation (EC) No 1434/98 specifying conditions under which herring may be landed for industrial purposes other than direct human consumption. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013R0227 (accessed 21/11/2018)

Table 1 Characteristics of the proposed deep sea marine reserve boundary options under assessment

Boundary option	Proposed protected features
Faroe-Shetland reserve	▪ Burrowed mud (including sea pens) ▪ Deep sea sponge aggregations ▪ Atlantic-influenced offshore deep sea muds ▪ Atlantic-influenced offshore subtidal sands and gravels
West of Scotland reserve	▪ Burrowed mud (including sea pens) ▪ Coral gardens ▪ Cold-water coral reefs (including *Lophelia pertusa* reefs) ▪ Deep sea sponge aggregations ▪ Atlantic influenced offshore deep sea muds ▪ Atlantic influenced offshore subtidal sands and gravels ▪ Seamount communities ▪ Seamounts ▪ Blue Ling (Molva dypterygia) ▪ Leafscale gulper shark (Centrophorus squamosus) ▪ Gulper shark (Centrophorus granulosus) ▪ Orange roughy (Hoplostethus atlanticus) ▪ Portuguese dogfish (Centroscymnus coelolepis) ▪ Roundnose grenadier (Coryphaenoides rupestris) ▪ Geodiversity features
Faroe-Shetland and West of Scotland reserve	▪ All features listed above.

3 Approach to the Assessment

3.1 Introduction

3.1.1 The methodology applied has built on previous marine socio-economic assessments for MPAs, particularly the assessment of Scottish Nature Conservation MPAs[44], the assessment of phase 2 fisheries management measures in Nature Conservation MPAs[45], and the assessment of four new Nature Conservation MPAs[46]. It is consistent with Better Regulation Executive guidance on impact assessment, the Green Book methodology[47] for economic assessment and Scottish Government guidance on Business and Regulatory Impact Assessment (BRIA)[48]. An overview of the approach is shown in Figure 2.

3.1.2 The methodology covers:

- General project assumptions;
- Data collation and scoping;
- Establishing a baseline against which impacts can be assessed;
- Assessment of costs and benefits for each site; and
- Combined assessment.

[44] Marine Scotland, 2013. Planning Scotland's Seas: 2013 - The Scottish Marine Protected Area Project – Developing the Evidence Base tor Impact Assessments and the Sustainability Appraisal Final Report.

[45] Marine Scotland, 2018. Proposed Inshore MPA/SAC Fisheries Management Measures – Phase 2. Socio-Economic Impact Assessment. October 2018. Report prepared by ABPmer & eftec for the Scottish Government.

[46] Marine Scotland, 2019. SEIA of Proposed Marine Protected Areas. Socio-Economic Impact Assessment. January 2019. Prepared by ABPmer & eftec for Marine Scotland.

[47] HM Treasury, 2018. The Green Book. Central Government Guidance on Appraisal and Evaluation. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/685903/The_Green_Book.pdf

[48] https://beta.gov.scot/publications/bria-guidance/.

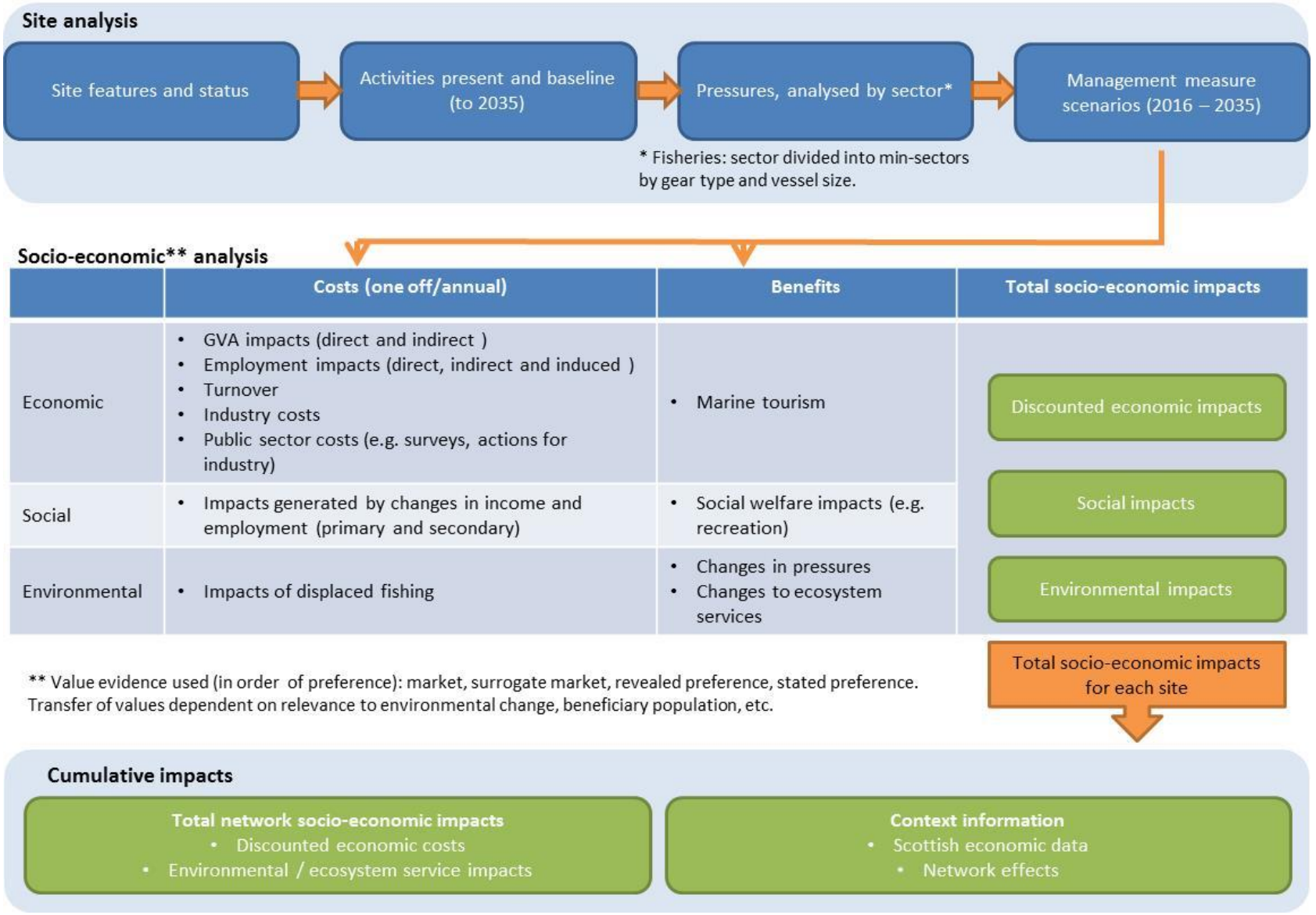

Figure 2 Economic and Social Analysis Process

3.2 General Project Assumptions

3.2.1 A number of key assumptions were developed in consultation with Marine Scotland which have informed the progression of the study.

3.2.2 Lower, intermediate and upper estimates have been developed to assess the potential range of impacts, which reflect a range of possible management options that may be applied. The management scenarios have been developed for the purposes of the assessment by Marine Scotland and are provided in Table 2. They do not anticipate final advice on management measures, nor do they reflect the management measures that may be adopted by the Scottish Government. The assumptions used for each sector and each estimate are documented in Appendix C. Impacts have been assessed for the lower, intermediate and upper scenarios compared to the 'do nothing' option, i.e. not to proceed with the proposed designations.

Table 2 Management Scenarios Assessed

Scenario	Management
Lower	Designation as an MPA with existing fisheries management and consenting as normal.
Intermediate	Designation as an MPA with no extractive activities that affect the seabed (e.g. no demersal fisheries / no consenting oil and gas, etc.).
Upper	Designation as an MPA with no extractive activities that affect the seabed or in the water column.

3.2.3 It has been assumed that sites will be designated in 2019 and costs will be first experienced in 2019. Costs and GVA impacts are expressed in 2019 prices using the latest Gross Domestic Product (GDP) deflator data[49].

3.2.4 An assessment period of 20 years following designation has been selected as providing a reasonable time period within which the main impacts are likely to occur. Beyond this time period, socio-economic effects and environmental impacts become less certain. For socio-economic effects, this is due to technological changes and the ability of industries to adapt (e.g. as capital depreciates and is replaced), amongst other things. For environmental impacts, environmental responses are harder to predict based on current knowledge and due to external influences (e.g. climate change). The assessment period therefore runs from 2019 to 2038.

[49] GDP deflator data from June 2018 includes the forecasted percentage change in GDP deflator for 2018 to 2022. Taken from the Office for Budgetary Responsibility (OBR) forecasts for GDP deflator increases as of March 2018 Economy supplementary tables. http://obr.uk/efo/economic-fiscal-outlook-march-2018/.

3.2.5 Monetary impacts have been discounted over the assessment period using a 3.5% discount rate in line with the Green Book. Employment impacts have not been discounted so that the full impact on employment is clear.

3.2.6 The assessment has sought to ensure consistency between the lower, intermediate and upper estimates used in the SEIA, and the reasonable alternatives assessed in the SEA.

3.3 Data Collation and Scoping

3.3.1 Relevant data on the spatial distribution and intensity of marine activities occurring within and adjacent to the potential deep sea marine reserve areas was collated within ArcGIS. This included the following activities:

- Aquaculture (finfish);
- Aquaculture (shellfish);
- Aviation;
- Carbon Capture and Storage;
- Coast Protection and Flood Defence;
- Commercial Fisheries (including salmon and sea trout);
- Energy Generation;
- Marine Aggregate Extraction;
- Military Interests;
- Oil and Gas (including exploration, production, interconnectors, gas storage);
- Ports and Harbours;
- Power Interconnectors;
- Recreational Boating;
- Seabed mining;
- Shipping;
- Telecom Cables;
- Tourism (including heritage assets); and
- Water sports.

3.3.2 The potential for the proposed deep sea marine reserve options to give rise to social and economic impacts on other activities depends on the nature and scale of interactions between them. The scoping assessment identifies the potential interactions between the deep sea marine reserve option areas, and those interactions with the potential to give rise to significant social and economic impacts.

3.3.3 Scoping took into consideration:

- Whether the activity (or potential future activity) spatially overlaps with the deep sea marine reserve areas;
- Whether management scenarios for the deep sea marine reserve areas have the potential to give rise to a significant interaction with the sector.

3.3.4 The outcome of the scoping assessment is provided in Table 3. The sectors taken forward for assessment were: commercial fisheries; military interests; oil and gas; power interconnectors; seabed mining and telecommunication cables.

Table 3 Outcome of Scoping

Sector	Scoped in?	Comment
Aquaculture (finfish)	×	▪ No overlap with existing or proposed aquaculture sites
Aquaculture (shellfish)	×	▪ No overlap with existing or proposed aquaculture sites
Aviation	×	▪ No management would be required for this sector
Carbon Capture and Storage	×	▪ No overlap with potential CCS locations
Coast Protection and Flood Defence	×	▪ No overlap with coastal protection and flood defence measures
Commercial Fisheries	✓	▪ Overlap with commercial fishing activity
Energy Generation	×	▪ No overlap with wind, wave and tidal Development Plan Options
Marine Aggregate Extraction	×	▪ No current marine aggregate licences or licence applications in Scottish waters
Military Interests	✓	▪ Overlap of danger areas and practice and exercise areas with West of Scotland Reserve
Oil and Gas	✓	▪ Overlap with 29th and 30th Round areas
Ports and Harbours	×	▪ No overlap with ports and harbours or dredge disposal sites
Power Interconnectors	✓	▪ Overlap with planned Icelink interconnector
Recreational Boating	×	▪ No management would be required for this sector
Seabed mining	✓	▪ No seabed mining activity currently, but potential management may preclude future activity of the sector in Scottish waters
Shipping	×	▪ No management would be required for this sector
Telecom Cables	✓	▪ Overlap with existing telecom cables
Tourism (including heritage assets)	×	▪ No management would be required for this sector
Water sports	×	▪ No management would be required for this sector

3.4 Establishing a Baseline

3.4.1 In order to undertake the socio-economic assessment, a range of baseline information is required. Given that the assessment relates to impacts over time, a dynamic baseline is needed which indicates how baseline conditions might change over the time period of the assessment. Assuming designation in 2019 and an assessment covering a 20 year period, a baseline has been created covering the period from 2019 to 2038.

3.4.2 The baseline work has built on the work previously carried out for the Nature Conservation MPA assessment[50] in terms of the types of information required, but has been focussed on the specific geographical areas relating to the areas under consideration, and the activities scoped in to the assessment. In considering potential future development activity, various assumptions have been made and documented in Appendix A.

3.4.3 A range of baseline information was collated, including:

- The distribution of biodiversity features within the potential deep sea marine reserve areas;
- The distribution and intensity (number of locations/volume/value) of human activities within and adjacent to the pMPAs and how this might change over the assessment period (in the absence of the intervention); and
- Information on ecosystem service values associated with the marine environment and how these may change over the assessment period (in the absence of the intervention).

3.4.4 Key data sources included:

- Marine Scotland's NMP Interactive (NMPi);
- Information from The Crown Estate on Lease and Agreement-for-Lease locations;
- Kingfisher Cables;
- Oil and Gas Authority (OGA) Oil and Gas licensing round awards;
- Oil and Gas pipeline data (Common Data Access Ltd, 2018);
- Processed UK commercial fisheries vessel VMS ping data for the five years 2013–2017 broken down by gear type and linked to estimated landings for vessels over 12m in length (provided by Marine Scotland);
- ICES rectangle landings data for fishing vessels 12m and under broken down by gear type;
- Scotmap data for UK fishing vessels under 15m in length;
- Military practice and exercise areas (PEXA) and military establishments from British Crown, Oceanwise and Defence Infrastructure Organisation.

[50] Marine Scotland, 2013. Planning Scotland's Seas: 2013 - The Scottish Marine Protected Area Project – Developing the Evidence Base tor Impact Assessments and the Sustainability Appraisal Final Report.

3.4.5 All data were stored and managed in accordance with good practice.

3.4.6 In addition to baseline data, a range of additional data and information has been required to inform the assessment. In particular, information on licensing costs and the cost of management measures has been required to estimate cost impacts for activities, together with information on enforcement, surveillance and monitoring costs to estimate impacts on the public sector. Such information has been obtained from the Nature Conservation MPA assessment[51] and other Scottish MPA impact assessments[52], Defra's Marine Conservation Zone Impact Assessment[53], and the Impact Assessment that accompanied the Marine (Scotland) Act 2010[54]. Additional information was sought from specific marine sectors where required.

3.5 Assessment of Costs and Benefits

Economic Impacts to Marine Activities

3.5.1 Detailed assessment methods for relevant marine activities scoped in to the assessment are presented in Appendix A.

3.5.2 All the methods generally entail making estimates of the cost of implementing management measures and/or the impact of implementing the management measures on operating revenues. Lower, intermediate and upper scenarios have been assessed, to reflect a range of possible management approaches to the deep sea marine reserve areas, providing a range of potential cost impacts.

3.5.3 Consistent unit costs have been used within most marine activity sectors as a basis for estimating these impacts, although it is recognised that the actual costs that may be incurred by specific activities within individual sites may be higher or lower than these 'average' values.

3.5.4 For some sectors, there may also be impacts associated with delays in consenting as a result of the designations or impacts on investor confidence, and opportunity costs for activity foregone where scenarios preclude the presence of activities within the proposed reserve areas. However, it has not been possible to quantify these potential impacts as it is not possible to predict whether or where they might occur. It is recognised that these costs could potentially be large for some sectors and possibly larger than some of the costs that have been quantified.

3.5.5 Where possible, impacts have been quantified in monetary terms, with these values converted to 2019 prices using the relevant GDP deflators. Where impacts on economic activities have the potential to give rise to a change in the

[51] Marine Scotland, 2013. ibid.

[52] Marine Scotland, 2019. SEIA of Proposed Marine Protected Areas. Socio-Economic Impact Assessment. January 2019. Prepared by ABPmer & eftec for Marine Scotland.

[53] Defra, 2012. Designation of Marine Conservation Zones in English Inshore Waters and English and Welsh Offshore Waters. Impact Assessment. IA No: Defra 1475. December 2012.

[54] Risk & Policy Analysts & ABPmer, 2009. Full Regulatory Impact Assessment: Scottish Marine Bill. Final Report. March, 2009.

level of output, direct and indirect impacts on Gross Value Added (GVA) and employment have been estimated using appropriate multipliers. This is only the case for the fisheries sector, which is the only sector for which the management scenarios have the potential to affect output through loss of landings.

3.5.6 The impacts for all the relevant activities for each site are documented in Tables 3 (cost impacts) and 4 (potential benefits) of Appendix C. Sectors that are unaffected are recorded in Table 5 of the Site Reports in Appendix C.

Social impacts on individuals, communities and society

3.5.7 Social impacts are effects on individuals, communities and society. They can vary in their desirability, scale, extent or duration (temporal and spatial), intensity and severity, as well as the extent to which they affect particular groups or are compounded by cumulative effects.

3.5.8 The social impacts generated by the proposed management scenarios will be strongly connected to the nature, scale and distribution of the economic impacts (on both income and employment). Any significant change in employment, for example generated as a result of restrictions on fishing activity, can have significant social impacts (e.g. on health, crime). Economic and social impacts have been assessed through a distributional analysis.

3.5.9 Employment is recognised as being a particularly important generator of social benefit. It is the key means by which individuals fulfil material wellbeing, as well as being central to social linkages, individual identity, social status and an important contributor to physical and mental health. Conversely, unemployment can be detrimental to physical and mental health and a key cause of deprivation and associated issues of community cohesion.

3.5.10 The distribution of impacts on employment in the fishing sector has focussed on the registered home ports of the vessels affected. The distribution of impacts on the fish processing industry has focussed on the ports of landing of the affected vessels' catches.

3.5.11 The distributional analysis has focussed exclusively on the commercial fishing sector (and the fish processing sector) as the main sector affected. The analysis quantifies the estimated economic costs of management scenarios (on output, GVA and employment).

3.5.12 The focus of the distributional analysis was predominantly on groups in Scotland, as this is where the majority of impacts are expected to occur. This has included impacts on specific locations (including regions, districts and ports) and on specific groups within Scotland's population (including, for example, different age groups, genders, minority groups, and parts of Scotland's income distribution). Table 4 summarises the list of groups that have been considered in the distributional analysis.

Table 4 Groups who may be affected by fisheries management scenarios

Location	Fishing group	Groups distinguished by:			
		Age	Income	Social groups	Gender
Region Port Rural/ urban/ mainland or island	Gear type Vessel size	Children Working age Pensionable age	10% most deprived 10% most affluent Remaining 80%	e.g. Crofters Ethnic minorities With disability or long-term sick	Male Female

3.5.13 The social impact assessment presented in Section 6 identifies the potential social impacts of designating the deep sea marine reserve areas for the commercial fisheries sector, where designation is expected to have GVA and employment impacts. For this sector, the tables identify the potential distribution of economic impacts and are then combined with relevant quantitative (e.g. potential employment impacts) and qualitative information to assess whether social impacts are likely to occur, and if so, their potential significance. Mitigation measures for potentially significant social impacts are also highlighted.

3.5.14 The significance of the social impacts has been assessed using the following definitions:

- xxx/+++: significant negative/positive effect; This is defined as where it is probable that an impact will be noticed and is potentially significant;
- xx/++: possible negative/positive effect This is defined as where it is possible than an impact will be noticed;
- +/-: minimal effect, if any. This is defined as where it is probable than an impact is unlikely to be sufficiently significant so as to be noticeable, but that some possibility exists that a negative/positive impact could occur; and
- 0: no noticeable effect expected.

3.5.15 The social impact assessment is conducted for each deep sea marine reserve area. The results of the social impact assessment for each site are reported in Table 6 of Site Reports in Appendix C.

Impacts on the public sector

3.5.16 Following a decision to designate a deep sea marine reserve, costs may be incurred by the public sector in the following broad areas:

- Preparation of Marine Management Schemes;
- Preparation of Statutory Instruments;
- Site monitoring;
- Compliance and enforcement;
- Promotion of public understanding; and
- Regulatory and advisory costs associated with licensing decisions and review of consents.

3.5.17 Standard assumptions have been developed for the estimation of public sector cost impacts for each site based on information contained within the Final Regulatory Impact Assessment for the Marine (Scotland) Bill[55], information from the Marine Conservation Zones Impact Assessment[56], information from the previous impact assessment of Nature Conservation MPAs[57] and informal discussions with Marine Scotland and JNCC (see Appendix B). These agreed assumptions have then been used to estimate costs to central government for each area.

3.5.18 The estimated public sector cost impacts for each site are documented in Table 7 of Site Reports in Appendix C.

Impacts on ecosystem services

3.5.19 The biodiversity features of an MPA contribute to the delivery of a range of ecosystem services. Management of the pMPAs may improve the quantity and quality of the beneficial services provided, which may increase the value (contribution to economic welfare) of them. Impacts on the value of ecosystem services may occur as a result of the management and/or achievement of the conservation objectives of the pMPA.

3.5.20 The ecosystem services analysis provides a qualitative description of the potential changes in ecosystem service provision associated with the implementation of management scenarios to support the achievement of conservation objectives for individual features. The ecosystem services analysed are based on the list of final ecosystem services used in previous Scottish MPA impact assessments, but updated to reflect the latest evidence and terminology used by SNH (C. Leakey, *pers. comm.*). Those impact assessments do not consider supporting services due to a risk of double counting their value with final services.

3.5.21 For deep sea MPAs, the number of final services that can be quantified is more limited than for other MPAs. This is due to the relatively more limited scientific evidence base relating to them. The benefits of protecting deep sea ecosystems are more long term, due to the slower rate of recovery of such

[55] Scottish Government, 2009. Final Regulatory Impact Assessment for the Marine (Scotland) Bill.

[56] Finding Sanctuary, Irish Seas Conservation Zones, Net Gain and Balanced Seas. 2012. Impact Assessment materials in support of the Regional Marine Conservation Zone Projects' Recommendations.

[57] Marine Scotland, 2013. Planning Scotland's Seas: 2013 - The Scottish Marine Protected Area Project – Developing the Evidence Base tor Impact Assessments and the Sustainability Appraisal Final Report.

ecosystems. They also relate to the role of deep sea ecosystems in supporting the wider marine ecosystem (e.g. for nutrient cycling). For these reasons, this assessment also considers the impacts of the pMPAs on supporting services, with the reporting an interpretation of the results being mindful to avoid double-counting of benefits.

3.5.22 The list of ecosystem services that have been considered is described in Section 7.

3.5.23 The analysis of changes to ecosystem services has considered both on-site and off-site impacts of management scenarios. Off-site impacts could be positive (e.g. by supporting healthier fish stocks in the area) or negative (e.g. due to the impacts of displaced fishing vessels). Examples of these impacts are discussed in Section 7.

3.5.24 In assessing impacts, we have sought to clearly link the management scenarios ('lower' to 'upper') to changes in ecosystem services and the economic value of these. The analysis has been summarised in an assessment table (Tables 9a and 9b in Appendix C), similar to that used in previous impact assessments of MPAs in Scottish, English and UK waters.

3.5.25 In addition to the summary of anticipated ecosystem services benefits under the lower, intermediate and upper estimates, the assessments include four columns of information to clarify understanding of the qualitative changes in ecosystem services arising from the proposed management scenarios (see Tables 9a and 9b in the Site Reports in Appendix C):

- **Relevance**: Relating to the amount of ecosystem good or function arising from site;
- **Value weighting**: Categorisation of how valuable the amount of ecosystem good or function from the site is in providing benefits to human population;
- **Scale of benefits**: Consideration of actual potential to deliver benefits (for example considering location of benefits, delivery to human population, etc.);
- **Confidence**: Level of confidence in our current knowledge of all other categories (in other words, scale of benefit, level of improvement, etc.).

3.5.26 Based on the above categories, an overall level of each ecosystem service has been defined with its own confidence level. An overall level of total benefits has also been defined.

3.5.27 The parameters have been assigned a level for each service from a menu, defined as shown in Table 5.

3.5.28 The approach provides a qualitative summary of the expected ecosystem service benefits to ensure all relevant impacts are captured in the analysis.

Table 5 Definition of ecosystem service levels

Level	Definition
Nil	Not present/none
Minimal	Present at a very low level, unlikely to be large enough to make a noticeable impact on ecosystem services
Low	Present/detectable, may have a small noticeable impact on ecosystem services, but unlikely to cause a meaningful change to site's condition
Moderate	Present/detectable, noticeable incremental change to site's condition
High	Present/detectable order of magnitude impact on sites condition

Valuation of Ecosystem Services

3.5.29 There are limited valuation data for marine ecosystem services provided by MPA features. The National Ecosystem Assessment (NEA)[58] included a synthesis of data available up to 2010 for marine ecosystem services[59], and there have been subsequent reviews by Potts *et al.*[60] and Burdon *et al.*[61], expanding it to encompass additional features.

3.5.30 To gauge the ecosystem services accruing from marine protected areas, relevant valuation literature has been assessed including a review prepared as part of the NEA Follow-On project[62] Marine chapter and Turner and Schaafsma[63]. There is data for market goods (e.g. fish) that allow quantification and valuation of some flows of services. However, monetary valuation evidence for the value of protecting deep sea ecosystems and for many ecosystem services are scarce. These data limitations impose significant constraints on the extent to which changes in ecosystem service provision can be quantified, and necessitate a largely qualitative analysis of ecosystem service impacts.

3.5.31 In addition, there are studies that use economic valuation techniques to assess the impacts of marine conservation measures, such as designation of and implementation of management measures in protected areas. There are a small number of such studies in the UK (e.g. McVittie and Moran[64];

[58] UK National Ecosystem Assessment (2011) The UK National Ecosystem Assessment Technical Report. UNEP-WCMC, Cambridge.

[59] Austen, M., Malcolm, S., Frost, M., Hattam, C., Mangi, S., Stentiford, G., 2011. Marine. In: The UK National Ecosystem Assessment Technical Report. UK National Ecosystem Assessment. Cambridge: UNEP-WCMC.

[60] Potts T, Burdon D, Jackson E, Atkins J, Saunders J, Hastings E, Langmead O., 2014. Do marine protected areas deliver flows of ecosystem services to support human welfare? *Marine Policy* 44; 139–148.

[61] Burdon D, Potts T, Barbone C, Mandera L., 2017. The matrix revisited: A bird's-eye view of marine ecosystem service provision. *Marine Policy* 77; 78–89.

[62] UKNEA-FO (2014) Marine chapter. UNEP-WCMC, Cambridge.

[63] R.K. Turner and M. Schaafsma eds (2015) Coastal Zone Ecosystem Services, ch 6, Springer, Switzerland.

[64] McVittie, A., & Moran, D., 2008. Determining monetary values for use and non-use goods and services: Marine Biodiversity–primary valuation. Final Report to Defra.

Kenter *et al*,[65]), and some further information is available from the NEA Follow-on Project[66] and from eftec *et al.*[67].

3.6 Approach to assessing combined impacts

3.6.1 The proposed Faroe-Shetland and West of Scotland reserve area represents the combined assessment of the other two individual areas. Therefore, the combined assessment summarises this information.

3.6.2 The scale of the sectors affected in Scotland has been used to provide context for assessing the significance of impacts to activities. Information on key sectors has been drawn (where available) from the Scottish Government's Economic Strategy, or from industry data. The significance of impacts has been assessed taking account of the scale of the impacts incurred by different sectors and the relative importance of each sector to the Scottish economy (now and in the future).

3.6.3 Information has also been collated on the total impact as a result of the proposed combined reserve area, other MPAs, and current or planned renewable development to date, to provide context for the estimated impacts of the proposed reserve areas on specific marine activities. Qualitative commentary is provided on whether this context might increase or decrease the significance of the impacts considered within this assessment.

3.6.4 For impacts to the public sector, a top-down approach has been used to assess costs, using national assumptions, applied at site level.

3.6.5 For the social analysis, the assessment of impacts has taken account of the distributional analysis to identify whether specific local communities or groups may be affected by designations. Where there is the potential for multiple impacts, a qualitative assessment of the combined impacts on these communities or groups has been provided. Information has also been presented on the total impact as a result of all MPAs and current or planned renewable developments to date, to provide context for the estimated impacts of the proposed marine reserve areas on specific marine activities. Qualitative commentary is provided on whether this context might increase or decrease the significance of the impacts considered within this assessment.

3.6.6 For the environmental impacts, part of the rationale for an ecologically-coherent network of MPAs is the concept that the value of the network is greater than the sum of its parts. However, scientific understanding of the relationships

[65] Kenter, J.O., Bryce, R., Davies, A., Jobstvogt, N., Watson, V., Ranger, S., Solandt, J.L., Duncan, C., Christie, M., Crump, H., Irvine, K.N., Pinard, M. & Reed, M.S., (2013). The value of potential marine protected areas in the UK to divers and sea anglers. UNEP-WCMC, Cambridge, UK.

[66] UK National Ecosystem Assessment Follow-on, 2014. The UK National Ecosystem Assessment Follow-on: Synthesis of the Key Findings. UNEP-WCMC, LWEC, UK.

[67] eftec, ABPmer & University of Stirling, 2015. Valuing the UK Marine Environment – an Exploratory Study of Benthic Ecosystem Services. Project ME5106.

between deep sea ecosystems and the wider network is limited and it is therefore difficult to provide any quantification of the combined benefits.

3.6.7 The selection of potential deep sea marine reserve areas has been based on the Scottish MPA Selection Guidelines (Box 3, Marine Scotland *et al*[68]). These guidelines include a number of elements that relate to the wider benefits of a network, for example, replication supports resilience and connectivity supports linkages between marine ecosystems. These benefits have been reflected in Table 8 of Site Reports in Appendix C.

3.6.8 Value Transfer techniques have been used to interpret existing valuation data for MPAs and deep sea environments to the proposals to designate the deep sea marine reserve areas. This uses a similar approach to that applied for the Nature Conservation MPA assessment[69] and drawing on further information published as part of the UK NEA Follow-On Project[70].

3.6.9 The ecosystem services impacts have been considered separately for the assessments of the two individual proposed reserve areas, and for the combined area.

Cumulative assessment

3.6.10 A cumulative assessment has given consideration to how the significance of these impacts might vary when taking account of the total impact as a result of all MPAs and current or planned renewable energy generation development to date, particularly where there is overlap or potential for interaction between these and proposed deep sea reserve areas. This analysis has drawn on information contained within:

- the Scottish Nature Conservation MPA assessment[71];
- the socio-economic assessment for the short-term options for offshore wind farms[72];
- the socio-economic assessment for the draft plan for offshore wind, wave and tidal energy[73];

[68] Marine Scotland, JNCC and SNH, 2011. Marine Protected Areas in Scotland's Seas. Guidelines on the selection of MPAs. February, 2011.

[69] Marine Scotland, 2013. Planning Scotland's Seas: 2013 - The Scottish Marine Protected Area Project – Developing the Evidence Base tor Impact Assessments and the Sustainability Appraisal Final Report.

[70] UK National Ecosystem Assessment Follow-On Report (2014) The UK National Ecosystem Assessment Follow-On Technical Report. UNEP-WCMC, Cambridge.

[71] Marine Scotland, 2013. Planning Scotland's Seas: 2013 - The Scottish Marine Protected Area Project – Developing the Evidence Base tor Impact Assessments and the Sustainability Appraisal Final Report.

[72] Marine Scotland, 2011. Blue Seas – Green Energy: A Sectoral Marine Plan for Offshore Wind Energy in Scottish Territorial Waters. Part A – The Plan.

[73] Marine Scotland, 2013. Planning Scotland's Seas: Sectoral Marine Plans for Offshore Wind, Wave and Tidal Energy in Scottish Waters - Consultation Draft, July 2013.

- monitoring of the impact of the implemented phase 1 measures in inshore MPAs[74];
- the SEIA of proposed phase 2 fisheries management measures in inshore MPAs[75]; and
- the SEIA of four additional proposed Marine Protected Areas[76].

3.6.11 This information helps to provide context for the additional impacts estimated to occur as a result of implementation of the proposed deep sea marine reserve, particularly where these additional impacts will affect activities and communities that will or are experiencing impacts as a result of earlier decisions on MPAs or offshore renewables developments. For ecosystem services, the context of the proposed deep sea marine reserve areas in the wider network of MPAs is important, as one benefit of the deep sea marine reserve relates to resilience and supporting services, that help maintain the services provided by the wider network.

[74] Marine Scotland Science, 2017. Scotland Marine Protected Areas Socioeconomic Monitoring. 2016 Report. Marine Analytical Unit, Marine Scotland Science, Scottish Government. Available online at http://www.gov.scot/Resource/0051/00514589.pdf. Accessed 19 April 2018.

[75] Marine Scotland, 2018. Proposed Inshore MPA/SAC Fisheries Management Measures – Phase 2. Socio-Economic Impact Assessment. October 2018. Report prepared by ABPmer & eftec for the Scottish Government.

[76] Marine Scotland, 2019. SEIA of Proposed Marine Protected Areas. Socio-Economic Impact Assessment. January 2019. Prepared by ABPmer & eftec for Marine Scotland.

4 Impacts to Activities

4.1 Introduction

4.1.1 This section summarises the estimated costs and benefits associated with the designation of each deep sea marine reserve area for each sector. Quantified cost estimates are presented in tables for each sector. Where impacts are expected to affect a sector's output, the impact on GVA and employment is also provided. Impacts that are anticipated, but for which cost estimates were not possible, are described qualitatively.

4.2 Commercial Fisheries

4.2.1 The proposed management scenarios could result in impacts on GVA as a result of a reduction in output (loss in value of landings), under the intermediate and upper scenarios. The intermediate scenario prohibits all demersal gear (mobile and static), and the upper scenario prohibits all demersal and pelagic gear (mobile and static). Potential impacts to direct GVA for the commercial fisheries sector are summarised in Table 6. The equivalent figures expressed in terms of potential impacts on the annual value of landings affected are presented in Table 7. These impacts could arise as a result of reduced landings from restrictions to gear types in the proposed deep sea marine reserve under the assessed management options for each area.

4.2.2 The total cost for the combined area of £1.1 million over 20 years (Table 6, intermediate scenario, present value of direct GVA over 20 years at 2019 prices) is relatively small compared to the GVA of the fishing sector (£296 million annually, 2016[77]). This equates to an annual average value for affected landings of £149,000 per year from the West of Scotland reserve (Table 7), compared to £557 million[78] landings for the Scottish fishing sector as a whole in 2016. The impacts in relation to the value of landings affected by home port, and port of landing, are considered in section 6.

4.2.3 The estimated impacts on UK vessels are zero under the lower scenario and minor to moderate under the intermediate and upper scenarios respectively. Under the intermediate scenario, the impacts are mainly related to the proposed West of Scotland reserve (impacts from the Faroe-Shetland reserve cannot be disclosed, but are negligible), primarily relating to set nets (which continue to operate in the shallower waters on Rockall Rise) and demersal trawls (which continue to operate along the shelf edge, where the boundary of

[77] Marine Scotland, 2018. Scotland's Marine Economic Statistics. Published by The Scottish Government, October 2018. 77 pages. Available at: https://www.gov.scot/Resource/0054/00542012.pdf. Accessed 22/10/18.

[78] Scottish Government, 2017. Scottish Sea Fisheries Statistics 2016. Available at: https://www.gov.scot/Topics/Statistics/Browse/Agriculture-Fisheries/PubFisheries. Accessed 22/10/2018.

the proposed reserve crosses into slightly shallower waters above the 800m contour in some places).

4.2.4 Under the upper scenario, the impacts arise from both proposed reserve areas, although still mostly from the proposed West of Scotland reserve. The impact is predominantly on the pelagic fishery (midwater trawls, £602,000 of annual landings affected; and 'other gears' £365,000 of annual landings affected – mostly surrounding nets and set nets). The impact on the pelagic fishery (£850,000 value of annual landings affected) represents 0.5% of the value of annual landings of pelagic species by Scottish vessels to the UK and abroad (£197 million).

Table 6 Potential GVA impacts to the commercial fisheries sector (direct effect and the combined direct and indirect effect) (present value of total GVA impact, £000s)

Site	Estimate (Direct GVA)			Estimate (Direct + Indirect GVA)		
	Lower	Inter-mediate	Upper	Lower	Inter-mediate	Upper
Faroe-Shetland reserve	0	N.D.	3,180	0	N.D	4,604
West of Scotland reserve	0	1,124	5,646	0	1,628	8,175
Faroe-Shetland and West of Scotland reserve	0	N.D.	8,826	0	N.D.	12,779
N.D. = Value cannot be disclosed, as it relates to the operations of fewer than five vessels. As a result the value for the Faroe-Shetland and West of Scotland reserve also cannot be disclosed.						

Table 7 Potential annual average loss in value of landings for the commercial fisheries sector (£000s, 2019 prices)

Site	Estimate		
	Lower	Intermediate	Upper
Faroe-Shetland reserve	0	N.D.	379
West of Scotland reserve	0	149	621
Faroe-Shetland and West of Scotland reserve	0	N.D.	1,000
N.D. = Value cannot be disclosed, as it relates to the operations of fewer than five vessels. As a result the value for the Faroe-Shetland and West of Scotland reserve also cannot be disclosed.			

4.2.5 Potential direct and indirect impacts on employment for the commercial fisheries sector are summarised in Table 8. These impacts arise as a result of

the reduced landings and GVA impacts discussed above, which may have knock-on effects on employment in the catching sector (direct) and the upstream supply chain (indirect).

4.2.6 The total direct and indirect employment impact is between zero and 15 full-time equivalents (FTE), with an expected loss of 2 FTEs under the intermediate scenario. Including induced employment impacts as well, this rises to 2.4 FTEs under the intermediate scenario and 16.4 under the upper scenario.

4.2.7 Impacts mainly arise from the proposed West of Scotland reserve area (2.3 FTE under the intermediate estimate), where the impacts are mostly on set nets followed by demersal trawls, and on vessels registered to North Shields in North East England[79]. Under the upper scenario, the impacts are greater and are split between the West of Scotland and Faroe-Shetland areas, with the majority from the proposed West of Scotland reserve area. These arise from the pelagic sector – midwater trawls and surrounding nets – followed by set nets and demersal trawls, and include greater impacts in Scotland – in the North East and Shetland.

4.2.8 Impacts on non-UK vessels have not been quantified. The nationalities likely to be most affected are Faroese (28 vessels) and Norwegian (8 vessels) in the Faroe-Shetland reserve (with smaller numbers of French, Dutch, German, Greenland, Danish, Irish, Spanish, Polish and Swedish vessels), and Norwegian (60 vessels), Irish (24 vessels), Faroese (23 vessels) and French (12 vessels) in the West of Scotland reserve (with smaller numbers of Dutch, German, Danish, Spanish, Lithuanian and Polish vessels). If these vessels would normally land to ports in Scotland, there may be knock-on effects on the ports and down-stream supply chains.

Table 8 Potential direct and indirect employment impacts to the commercial fisheries sector (full-time equivalents)

Site	Estimate (Direct and Indirect FTEs)			Estimate (Direct, Indirect and Induced FTEs)		
	Lower	Interme-diate	Upper	Lower	Interme-diate	Upper
Faroe-Shetland reserve	0.0	N.D.	5.7	0.0	N.D.	6.2
West of Scotland reserve	0.0	2.3	9.4	0.0	2.4	10.2
Faroe-Shetland and West of Scotland reserve	0.0	N.D.	15.2	0.0	N.D.	16.4

[79] If these vessels are operating from Scottish ports (employing crew from Scotland), then this will cause the impacts to Scotland to be underestimated.

N.D. = Value cannot be disclosed, as it relates to the operations of fewer than five vessels. As a result the value for the Faroe-Shetland and West of Scotland reserve also cannot be disclosed.

4.3 Military Activities

4.3.1 Potential quantified cost impacts to military activities at a national level are summarised in Table 9.

4.3.2 The costs are estimated to be the same in each scenario. The costs relate to the need for the Ministry of Defence (MoD) to amend and update its Marine Environment and Sustainability Assessment Tool (MESAT) (and other MoD environmental tools) together with subsequent costs to maintain and comply with these updates. The assessment has been made at a national level because it is not possible to assign these costs to individual site proposals.

4.3.3 Initial revision of MESAT (and other MoD environmental tools) and additions to electronic charting by the Hydrographic Office are estimated to cost £28,000 (at 2019 prices), and this cost would be incurred in 2020. Consideration of MPAs will be undertaken as part of planning for all MoD maritime activities. It has been estimated that the costs to MoD will be £11,100 per year in the first four years of the assessment period, reducing to £5,600 p.a. from year 5 onwards (at 2019 prices). It may be that these updates can be combined with updates required arising from the designation of other pMPAs at a similar time, and the overall cost may be lower.

Table 9 Potential quantified cost impacts to military activities (present value of total costs over 20 years, £000s)

Site	Estimate		
	Lower	Intermediate	Upper
National assessment	195	195	195
Total	**195**	**195**	**195**

4.4 Oil and Gas

4.4.1 Potential quantified cost impacts to the oil and gas sector are summarised in Table 10. It has only been possible to quantify cost impacts to the oil and gas industry under the lower scenario, which would relate to additional assessment costs for licensing. These costs are minor, at £63,000 (present value over 20 years at 2019 prices), and mostly arise from the proposed Faroe-Shetland reserve area. However, under the intermediate and upper scenarios, no oil and gas activity would be allowed within the proposed reserve areas, resulting in a (potentially significant) opportunity cost that cannot be quantified.

4.4.2 There is also potential for the oil and gas sector to experience other cost impacts which have not been quantified in this assessment. These include cost

impacts associated with any delays in consenting processes and additional costs associated with any future pipeline construction in the proposed reserve areas (under the lower scenario), and deterrent to investment.

Table 10 Potential quantified cost impacts to the oil and gas sector (present value of total costs over 20 years, £000s)

Site	Estimate		
	Lower	Intermediate	Upper
Faroe-Shetland reserve	48	0	0
West of Scotland reserve	14	0	0
Faroe-Shetland and West of Scotland reserve	63	0	0

4.5 Power Interconnectors and Transmission Lines

4.5.1 Potential quantified cost impacts to the power interconnectors and transmission lines sector are summarised in Table 11. Cost impacts are only anticipated to occur in relation to the proposed Faroe-Shetland reserve area, related to the proposed IceLink interconnector. The potential quantified costs are associated with the future additional assessment requirements for MPA features to support planning application. The potential quantified costs associated with all scenarios are considered negligible.

4.5.2 There is also potential for the power interconnectors and transmission lines sector to experience other cost impacts which have not been quantified in this assessment. These include cost impacts associated with future as yet unidentified power cable projects, the impact of any delays in consenting processes or deterrent to investment. These cost impacts have the potential to be greater than the quantified cost impacts identified in this assessment.

Table 11 Potential quantified cost impacts to the power interconnectors and transmission lines sector (present value of total costs over 20 years, £000s)

Site	Estimate		
	Lower	Intermediate	Upper
Faroe-Shetland reserve	5	5	5
West of Scotland reserve	0	0	0
Faroe-Shetland and West of Scotland reserve	5	5	5

4.6 Seabed Mining

4.6.1 Potential quantified cost impacts to the seabed mining sector are summarised in Table 13. It has only been possible to quantify cost impacts to the seabed mining sector under the lower scenario, which would relate to additional assessment costs for licensing. These costs are negligible, at £3,000 (present value over 20 years at 2019 prices), and arise from the proposed Faroe-Shetland reserve area, as the area in which future mineral extraction is more likely. However, under the intermediate and upper scenarios, no seabed mining activity would be allowed within the proposed reserve areas, resulting in an opportunity cost that cannot be quantified, although there is much uncertainty over the potential for the sector to develop commercially within UK waters.

4.6.2 There is also potential for the seabed mining sector to experience other cost impacts which have not been quantified in this assessment. These include cost impacts associated with future as yet unidentified seabed mining projects, the impact of any delays in consenting processes or deterrent to investment. However, it is not likely that there will be substantial development of the sector within the timeframe of the assessment.

Table 12 Potential quantified cost impacts to the seabed mining sector (present value of total costs over 20 years, £000s)

Site	Estimate		
	Lower	Intermediate	Upper
Faroe-Shetland reserve	3	0	0
West of Scotland reserve	0	0	0
Faroe-Shetland and West of Scotland reserve	3	0	0

4.7 Telecom Cables

4.7.1 Potential quantified cost impacts to the telecom cables sector are summarised in Table 13. The identified costs relate to potential replacement of existing telecom cables within the period of IA and the need for assessment of any impacts to protected features.

4.7.2 There is also potential for the telecom cables sector to experience other cost impacts which have not been quantified in this assessment. These include cost impacts associated with future as yet unidentified telecom cable projects, the impact of any delays in consenting processes or deterrent to investment. These cost impacts have the potential to be greater than the quantified cost impacts identified in this assessment.

Table 13 Potential quantified cost impacts to the telecom cables sector (present value of total costs over 20 years, £000s)

Site	Estimate		
	Lower	Intermediate	Upper
Faroe-Shetland reserve	25	25	25
West of Scotland reserve	9	9	9
Faroe-Shetland and West of Scotland reserve	25	25	25

4.7.3 The cost associated with additional assessment is applicable across all three scenarios, and is the same across all three scenarios (£25,000). The telecom cables that cross the proposed West of Scotland reserve also cross the proposed Faroe-Shetland reserve, therefore the impact of the combined area is the same as for the proposed Faroe-Shetland reserve.

5 Impacts to the Public Sector

5.1.1 Estimated costs to the public sector are shown in Table 14, Table 15 and Table 16, for each boundary option. Potential future monitoring costs comprise the majority of the total public sector costs. Additional costs may be associated with the preparation of statutory instruments for management of fishing activity, the de-designation of existing sites (Rosemary Bank Seamount NC MPA) and amendments to boundaries of existing MPAs (North-East Faroe-Shetland Channel NC MPA) and in determining and advising upon licence applications that may affect the proposed sites.

5.1.2 Compliance and enforcement for fisheries, and promotion of public understanding are considered to be part of existing workstreams and extra costs as a result of the MPAs will not apply.

5.1.3 Site monitoring costs are the greatest public sector cost. Costs are relatively higher for the proposed West of Scotland reserve compared to the proposed Faroe-Shetland reserve. There are two reasons for this: West of Scotland reserve requires monitoring of both benthic habitats and deep sea fish communities; and the monitoring costs for benthic habitats in the proposed Faroe-Shetland reserve have been scaled back to account for the fact that two thirds of the site is covered by the North-East Faroe-Shetland Channel NC MPA which would require monitoring of benthic habitats, therefore there is only an additional marginal cost to extend that monitoring to the full area of the proposed Faroe-Shetland reserve. The monitoring proposals for the proposed reserve areas with deep sea fish features (West of Scotland reserve and Faroe-Shetland and West of Scotland reserve) already envisage the implementation of deep sea fish population monitoring in coordination with the existing deep sea fish surveys, with a marginal additional cost for amendments or additions to haul locations to accommodate monitoring needs for the proposed deep sea marine reserve areas.

Table 14 **Potential quantified cost impacts to the public sector by activity (present value of total costs over 20 years, £000s) for proposed Faroe-Shetland reserve**

Activity	Quantified Cost Impact		
	Lower Estimate	Intermediate Estimate	Upper Estimate
Preparation of statutory instruments	0	4	4
Changes to designations of existing sites	4	4	4
Site monitoring	749	749	749
Regulatory and advisory costs associated with licensing decisions	8	3	3
Total	**762**	**761**	**761**

Table 15 **Potential quantified cost impacts to the public sector by activity (present value of total costs over 20 years, £000s) for proposed West of Scotland reserve**

Activity	Quantified Cost Impact		
	Lower Estimate	Intermediate Estimate	Upper Estimate
Preparation of statutory instruments	0	4	4
Changes to designations of existing sites	4	4	4
Site monitoring	2,896	2,896	2,896
Regulatory and advisory costs associated with licensing decisions	2	1	1
Total	**2,903**	**2,906**	**2,906**

Table 16 **Potential quantified cost impacts to the public sector by activity (present value of total costs over 20 years, £000s) for proposed Faroe-Shetland and West of Scotland reserve**

Activity	Quantified Cost Impact		
	Lower Estimate	Intermediate Estimate	Upper Estimate
Preparation of statutory instruments	0	4	4
Changes to designations of existing sites	8	8	8
Site monitoring	3,646	3,646	3,646
Regulatory and advisory costs associated with licensing decisions	10	3	3
Total	**3,664**	**3,661**	**3,661**

6 Distribution of Economic Costs and Consequent Social Impacts

6.1 Overview

6.1.1 The designation of the proposed combined deep sea reserve areas is estimated across three scenarios. The lower scenario is estimated to have no significant economic and social impacts on commercial fisheries, and with impacts and other sectors limited to cost impacts related to additional assessment costs for licence applications and updates to the MoD's systems. The intermediate and upper scenarios are estimated to:

- Reduce the average annual value of output landed by the UK commercial fisheries sector by between £0.1 million and £1 million;
- Reduce GVA (direct and indirect) of the UK commercial fisheries sector over the 20-year assessment period by £1.6 million to £12.8 million (present value); and
- Reduce the average employment (mean number of jobs, direct, indirect and induced) of the UK commercial fisheries sector by between 2 and 16 full time equivalents (FTEs);
- Result in a number of non-quantified opportunity costs for sectors that will not be able to operate in the proposed reserve areas (oil and gas, seabed mining), for which the distribution of economic costs and consequent social impacts are not assessed.

6.1.2 The range reflects the different management options and assumptions assessed across the estimates.

6.1.3 The higher end of these ranges, from the upper scenarios, represent management options that restrict all fishing gears and a worst-case assumption that all economic activity is lost rather than being displaced to alternative fishing grounds. The lower end represents the intermediate scenario, with restrictions to demersal fishing activity (much of which is already restricted by European fishing regulations in the depths encompassed by the proposed deep sea marine reserve areas).

6.1.4 In addition to the impact on the commercial fisheries sector, reductions in the quantity of sea fish landed at Scottish landing ports, would reduce the supply of locally-landed catch to fish processing facilities, and to the hotel/restaurant, retail and wholesale trades. The distributional analysis therefore considers how the impacts on both sectors (commercial fisheries and fish processing) are likely to be distributed across different areas of Scotland and specific groups of people, and assesses the likely significance of these impacts.

6.1.5 The distributional analysis presented in this section considers the distribution of the potential economic (and hence social) costs of all the proposed management scenarios. Impacts have been calculated by applying national multipliers[80] at the site level and regional/ port level to estimate the economic impacts of management scenarios at sites and by region/port. Local and regional multipliers are not available and hence the application of national multipliers may overestimate or underestimate the size and geographical distribution of impacts. A distributional analysis has also been conducted for each site and is presented in the Site Reports in Appendix C.

6.1.6 The different aspects assessed as part of the social impact analysis for each site are:

- The area of social impact associated with the economic impacts identified; Whether any mitigation effects are planned/necessary; and the overall significance of social impacts (all in Table 4a in Appendix C);
- For the fishing sector, Table 4b in Appendix C considers the main vessel sizes, gear types, regions, home ports and ports of landings, and whether ports are rural/urban and mainland or island;
- In Table 4c in Appendix C, the distribution of social impacts is considered by age, income, social group and gender.

6.1.7 The key results of the proposed reserve areas' distributional analysis are summarised in Table 17 and Table 18. For some aspects, the distribution of costs (e.g. across different Scottish regions and ports, and categories of vessel) has been assessed quantitatively. For other aspects (i.e. age, gender, income and social groups), the analysis indicates whether management scenarios are likely to impact on these groups, and if so, whether the impact is anticipated to be minimal, negative, or significantly negative.

6.1.8 The distributional analysis is based on UK fishing vessels only and their affected landings, as no information on the value or location of landings from non-UK vessels was available. If the affected non-UK vessels would normally land to ports in Scotland, there may be knock-on effects on those ports and down-stream supply chains. This may be important for ports which usually receive substantial non-UK landings, such as Kinlochbervie.

[80] Source: http://www.gov.scot/Topics/Statistics/Browse/Economy/Input-Output/Downloads/IO1998-2014Latest

Table 17 Distribution of quantified economic costs for commercial fisheries and fish processors (Intermediate estimate unless otherwise specified) — Location, age, gender

Sector/ Impact	Location			Age			Gender	
	Regions	Port (s)	Rural, Urban, Coastal or Island	Children	Working Age	Pensionable Age	Male	Female
Commercial Fisheries Reduction in landed value, GVA and employment, linked back to home port of vessels	Regional share of total reductions in landings in Scotland: North: 0.1% North East: 22% West: < 0.1% South West: 0.2% Majority of reductions arise in England for intermediate scenario (77%) (Peterhead for upper scenario)	Employment impacts in Scotland negligible under intermediate scenario. Largest absolute employment impact for intermediate estimate is at non-Scottish UK port: 2 FTEs	x Impacts concentrated in coastal areas; urban in North-East.	x Potential negative effect if parent loses job/ becomes unemployed	x	0	x 2 FTE job losses	x Potential negative effect if member of household loses job/ becomes unemployed
Fish Processors Reduction in local landings at landing ports	x North-west region is most significantly affected in Scotland (intermediate scenario), North-east region in upper scenario	In all ports, affected landings represent a very low proportion (up to 0.4%) of total landings to port, or have very low value.	x Impacts concentrated in coastal areas; urban in North-East	x	x	0	x 60% of processors male	x 40% of processors female
Impacts: xxx: significant negative effect; xx: possible negative effects; x: minimal negative effect, if any; 0: no noticeable effect expected.								

Table 18 Distribution of quantified economic costs for commercial fisheries and fish processors (Intermediate estimate unless otherwise specified) — Fishing groups, income groups and social groups

Sector/ Impact	Fishing Groups		Income Group			Social Groups		
	Vessel Category <12 m, >12 m	Gear Types/Sector	10% Most Deprived	Middle 80%	10% Most Affluent	Crofters	Ethnic Minorities	With Disability or Long-Term Sick
Commercial fisheries Reduction in landed value, GVA and employment, linked back to home port of vessels	Under intermediate and upper estimate – impacts on >12 m vessels	Main gear types affected for vessels are set nets. (Impact on pelagic vessels in upper scenario)	x Possible negative impact on 10% most deprived	x Possible negative impact on middle income group	x Possible negative impact on upper income group under upper scenario, but wage data not available to confirm	0	EU/EEA nationals account for 14% of employment on Scottish vessels, and non-EEA nationals 7% (mostly Philippino)[81]	0 No employment data but unlikely to be employed in fishing
Fish Processors Reduction in local landings at landing ports		x Impacts are < 1% of landings at any port.	x	X	0	0	55% of employment in fish processing in Scotland is of EEA nationals, 2% of 'other/ unknown'[82]	No breakdown of fish processing employment data around disability or long-term sick
Impacts: xxx: significant negative effect; xx: possible negative effects; x: minimal negative effect, if any; 0: no noticeable effect expected								

[81] Seafish, 2019. 2018 Employment in the UK Fishing Fleet. Available online at https://www.seafish.org/media/publications/Seafish_2018_employment_in_fleet_FINAL.pdf. Accessed 27 March 2019.

[82] Seafish, 2018. Seafish Economic Analysis – UK Seafood Processing Sector Labour 2018. Available online at https://www.seafish.org/media/2018_seafood_processing_sector_labour_report.pdf. Accessed 27 March 2019.

6.2 Distribution of Economic Costs – Location

6.2.1 The following assessment is mainly based on the intermediate estimate. Significant impacts under the upper estimate are also highlighted, as they represent a worst-case prediction of impacts for decision-makers to be aware of.

6.2.2 Table 19 presents the annual loss of landings affected by region and home port of the vessels affected, providing an indication of where employment impacts may fall. It covers all vessels greater than 12 metres in length. All of the impacts are on over-12m vessels in both the intermediate and upper scenarios. There are no estimated impacts for under-12 m vessels, and no impacts under the lower scenario.

6.2.3 Table 19 shows that:

- In the intermediate scenario, the expected costs of the proposed management scenarios are predominantly on other (non-Scottish) UK ports. It is estimated that over 77% of the total landings lost would be from vessels registered to UK ports outside of Scotland. Losses of landings from vessels registered at Fraserburgh are about 22% of the landings affected under the scenario. Note these totals are not the percentage of landings lost at the respective ports.
- Under the upper scenario, the majority of impacts are felt in the North East region of Scotland (88%), with most losses from vessels registered at Peterhead (49% of total losses under the upper scenario), followed by Fraserburgh (21%) and Lerwick. North Shields accounts for the remainder.

6.2.4 While these ports may bear the greater proportion of the total effects, the significance of impacts depend on their scale relative to the size of the affected port. The impacts per port are calculated as relative to total landings per port, provided by Marine Scotland. The impact on landings is small across all Scottish ports under the intermediate estimate. The highest is Fraserburgh which has less than 0.5% of total landings potentially affected. The employment impacts vary across ports, although they are generally low as a percentage of total employment. In the intermediate scenario, the value of landings potentially lost as a result of the proposed management scenarios represents a very small proportion of total landings by home port for all of Scotland's districts and ports affected. The majority of the impacts on employment under the upper scenario are at Fraserburgh and Peterhead (based on landings affected by registered home port of the vessels). An estimated 10 jobs would be affected in total at these ports, which is 0.5% of the local fishing workforce in Fraserburgh, and 2.1% (7 jobs) in Peterhead.

Table 19 Annual average value (£000) of landings affected by region and home port of vessels affected, 2019 prices

Home Fishing Region/Port		Scenarios	
		Intermediate	Upper
		Total value of landings affected at port	
North	**North Total:**	**<1**	**<1**
North East	Fraserburgh	N.D.	211
	Peterhead	N.D.	488
	Other	<1	187
	North East Total:	**34**	**885**
West	**West Total:**	**<1**	**<1**
Other UK Ports	**Other UK Ports Total:**	**115**	**115**
	Total	**149**	**1,000**

N.D. = Value cannot be disclosed, as it relates to the operations of fewer than five vessels.

6.3 Distribution of Economic Costs – Fishing Groups

6.3.1 Table 20 presents the annual average loss of the value of landings by gear type and vessel length. Due to disclosure issues this is only presented for the combined site (FWC). Under the intermediate estimate, the majority of impacts are on set nets, followed by demersal trawls and seines. In the upper estimate, midwater trawls and surrounding nets, followed by set nets, are the most significantly affected gear types.

Table 20 Annual Average Loss of Landings by Gear Type and by Site £'000

Gear	Proposed Faroe-Shetland and West of Scotland reserve	
	Intermediate Scenario	Upper Scenario
Demersal seines & demersal trawls	33.6	33.6
Midwater trawls	0.0	601.8
Other gears combined (hooks and lines, set nets, surrounding nets)	115.6	365.0
TOTAL	**149.2**	**1,000.5**

6.4 Fish Processing Industry

6.4.1 In the Scottish fish processing industry, there were 111 businesses processing sea fish in 2016[83]. It is clear from Table 21 that processing activity is concentrated in the north-east of Scotland (Grampian) with more modest levels

[83] All marine fish including shellfish (excludes salmon and trout). SeaFish 2016. Seafood processing industry report. Available at: http://www.seafish.org/research-economics/industry-economics/processing-sector-statistics.

of processing activity in “Other Scotland” and in the Highlands and Islands (where processing is on a smaller scale). 50% of processing units are located in Grampian and together they account for over 70% of total employment in the fish processing industry in Scotland.

Table 21 Number of Sea fish processing units in Scotland and industry employment, 2016.

Area	Sea Fish Processing Units	Industry FTE Employment
North East (Grampian)	56	3,439
Other Scotland	38	888
Highland and Islands	17	446
Total	**111**	**4,774**

Source: SeaFish, 2016[84]

6.4.2 No management measures are anticipated for wild salmon and sea trout fisheries, and these processing units would predominantly be processing farmed salmon. No impacts are expected, therefore, on the Scottish salmon processing industry.

6.4.3 Management scenarios are, however, anticipated to restrict commercial fishing activity, and have the potential to reduce the quantity and quality of seafish landed locally at Scottish landing ports. This could reduce the supply of locally-landed catch to fish processing facilities and the hotel/restaurant, retail and wholesale trades, and/or reduce confidence and hence investment in these sectors, in particular, the fish processing industry. The significance of the economic impact will depend upon various factors, including:

- The extent to which the landings of different species are affected (i.e. pelagic, demersal, shellfish) and the dependency of different processing units on these species;
- The distribution of affected landings across landing ports/regions and the dependency of landing ports on the affected landings; and

  The dependency of fish processing units in these regions/ports on processing locally landed catch, and their ability to offset reductions in local landings with landings that would have gone to ports where impacts are lower, and/or with imported fish.

6.4.4 The MPA socio-economic monitoring report[85] found little evidence of these effects from existing management measures in designated sites. However, it

[84] SeaFish 2016. Seafood processing industry report. Available at: http://www.seafish.org/research-economics/industry-economics/processing-sector-statistics.

[85] Marine Scotland Science, 2017. Scotland Marine Protected Areas Socioeconomic Monitoring. 2016 Report. Marine Analytical Unit, Marine Scotland Science, Scottish Government. Available online at http://www.gov.scot/Resource/0051/00514589.pdf. Accessed 19 April 2018.

should be noted that further effects may become evident over a longer time period.

6.4.5 The size of the impact on these ports depends on the relative importance of the landings affected within the total landings to the port. The landings affected as a percentage of the total landings at each port cannot be published for reasons of anonymity (fewer than five vessels involved in each case), except for Peterhead under the upper scenario.

6.4.6 Under the upper estimate, impacts at Peterhead are 0.6% of total landings at the port, while Fraserburgh, Kinlochbervie and Ullapool all have less than 0.5% of landings at the port affected. For the other Scottish ports affected (Lerwick, Scrabster and Scalloway and Isles), the landings affected as a percentage of total landings to the port are even lower in percentage terms, and in actual value. Under the intermediate scenario, the impacts are similar or less, with no impacts at Lerwick or Peterhead.

6.4.7 At several of these locations identified under the intermediate and upper estimates, the impacts are unlikely to have noticeable effects on local fish processing businesses, due to the small scale of the landings affected.

6.4.8 Under the intermediate scenario, the majority of the affected landings from the proposed reserve areas were made to Ullapool, followed by Kinlochbervie. Under the upper scenario, due to the greater impact on the pelagic fleet, the majority of the affected landings from the proposed reserve areas were made to Peterhead (74%), followed by Fraserburgh . Ullapool, Kinlochbervie and Lerwick each have between 4-5% of the impacts.

Impact on Incomes

6.4.9 The average wages for employees in fish processing and fishing are shown in Table 22 and Table 23. They show the lower wages per employee in the fishing industry, and therefore the potential for management scenarios to have a greater impact on lower income groups, as identified in Table 18.

Table 22 Gross wages and salaries per employee for the processing and preserving of fish, crustaceans and molluscs, 2014-16

Scotland: Processing and Preserving Fish, Crustaceans and Molluscs (SIC 10.2)	2014	2015	2016
Gross Wages & Salaries per employee (£)	20,939	23,564	21,208

Source: Scottish Government, 2018[86]

[86] Scottish government. (2018, p.272). Scottish Annual Business Statistics 2016. Available at: https://www2.gov.scot/Topics/Statistics/Browse/Business/SABS

Table 23 Gross wages and salaries per employee in the Scottish fishing industry, 2014-16

Scottish Fishing (SIC 03.1)	2014	2015	2016
Gross Wages & Salaries per employee (£)	11,426	17,747	10,310

Source: Scottish Government, 2018[87]

Economic Importance of the Commercial Fishing Sector to the Scottish Economy and Sustainable Economic Growth

6.4.10 Scotland's sea-fishing industry is estimated to contribute approximately 0.19% to total Scottish GVA[88] and 0.30% of GVA when the indirect and induced effects throughout the Scottish economy are added. Total employment in the sea-fishing industry was 4,799 in 2017[89], which is 0.2% of the labour force in Scotland[90]. The total effect on employment (taking account of indirect and induced effects) is estimated to be 2 full time equivalent (FTE) jobs under the intermediate estimate, which is 0.05% of sea-fishing industry employment in Scotland. It should be noted that some of those employed may work part-time, so 2 FTE may translate into more than 2 employees. The fact that most of the fish catching industry in Scotland is concentrated in coastal areas and islands means it has an important role to play in ensuring that these parts of Scotland contribute to, and share in, future economic growth.

6.4.11 The most recent sea fisheries statistics[91] show that the value of fish landed by Scottish vessels decreased by 1% in real terms from 2016 to 2017. In 2017, 465,000 tonnes of fish and shellfish were landed by Scottish vessels with a value of £560 million.

6.4.12 The commercial fishing sector contributes to Scotland's economic growth, and makes an important contribution in terms of ensuring that all parts of Scotland share in that growth. In 2017, although Scotland had only 8.2% of the UK population[92], it landed 64% of the total value of fish landed at UK ports[93]. The industry is therefore of much greater economic (and social and cultural) importance to Scotland than to the rest of the UK.

[87] Ibid.

[88] £251m of GVA out of Total Scottish GVA is estimated at £134 billion (Scottish Parliament, 2018, p.6).

[89] Scottish Government (2018, p.272). Scottish Annual Business Statistics 2016. Available at: https://www2.gov.scot/Topics/Statistics/Browse/Business/SABS

[90] Scottish labour force is estimated to be around 2.4 million.

[91] Scottish Government (2018). Scottish Sea Fisheries Statistics 2017. Available at: https://www.gov.scot/publications/scottish-sea-fisheries-statistics-2017/

[92] Office for National Statistics (2018). Population estimates for the UK, England and Wales, Scotland and Northern Ireland: mid-2017. Available at: https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/bulletins/annualmidyearpopulationestimates/mid2017

[93] Marine Management Organisation (2018). UK Sea Fisheries Statistics 2017. Available at: https://www.gov.uk/government/statistics/uk-sea-fisheries-annual-statistics-report-2017.

6.4.13 Table 24 presents the impact which the management scenarios (under lower, intermediate and upper estimates) could have on the GVA generated by the fishing sector in Scotland and GVA generated by the fishing sector and its supply chain.

6.4.14 Table 24 shows that over the study period, the potential direct impact is a reduction in GVA of between £1.1 million (intermediate estimate) and £8.8 million (upper estimate). The potential direct and indirect impact on GVA is a reduction between £1.6 million (intermediate estimate) and £12.8 million (upper estimate). The annual impacts represent approximately 0.06% to 0.8% of the sector's annual GVA[94].

Table 24 Impact on GVA for the Commercial Fishing Sector (Direct Impact and Direct plus Indirect Impact) over the 20 year assessment period, Present Value, 2019 prices, £'000s.

Site Name	Quantified GVA Impact over Assessment Period (Present Value of Total Costs, £'000)			
	Intermediate		Upper	
	Direct	Direct + Indirect	Direct	Direct + Indirect
Faroe-Shetland reserve	N.D.	N.D.	3,180	4,604
West of Scotland reserve	1,124	1,628	5,646	8,175
Faroe-Shetland and West of Scotland reserve	N.D.	N.D.	8,826	12,779
N.D. = Value cannot be disclosed, as it relates to the operations of fewer than five vessels. As a result the value for the Faroe-Shetland and West of Scotland reserve also cannot be disclosed.				

6.4.15 As indicated in Table 25, the impacts of the intermediate and upper scenarios are estimated to lead to between 2 and 15 full-time equivalent jobs being lost directly and indirectly throughout the Scottish Economy, across the estimates. This represents between 0.06% to 0.4% of total full-time jobs created directly and indirectly by the Scottish fishing industry[95].

6.4.16 Table 25 shows the number of direct, indirect and induced jobs affected, per site where management measures are proposed. Management scenarios proposed for the proposed West of Scotland reserve account for much of the employment impact – nearly 100% of the employment impacts under the intermediate estimate, when compared to the proposed Faroe-Shetland and West of Scotland reserve. This also holds true under the upper estimate, where the proposed West of Scotland reserve accounts for 62% of employment impacts.

[94] GVA for Scottish fishing industry is estimated at £251 million per year.

[95] In 2017, the number of fishers regularly employed on Scottish registered vessels was 3,932 (Scottish Government, 2018, p.51).

6.4.17 An important consideration is whether ports will be affected by a combination of impacts on commercial fishing (assessed by impact on landings by vessels' home port) and on fish processing (assessed by impact on landings by port of landing). Under the intermediate estimate, there are no ports in Scotland at risk of this. Under the upper estimate, the impacts on Fraserburgh and Peterhead increase (to 3.2 and 7.4 jobs respectively and up to 1% of landings), but are still small. They are not considered likely to result in noticeable social or economic impacts.

Table 25 Average (mean) Number of Direct, Indirect and Induced Jobs Affected, year-on-year over 2019-2038, FTEs

Site Name	Estimated Employment Impact (Number of Direct & Indirect Jobs)		Estimated Employment Impact (Number of Direct, Indirect & Induced Jobs)	
	Intermediate	Upper	Intermediate	Upper
Faroe-Shetland reserve	N.D.	5.7	N.D.	6.2
West of Scotland reserve	2.3	9.4	2.4	10.2
Faroe-Shetland and West of Scotland reserve	N.D.	15.2	N.D.	16.4
N.D. = Value cannot be disclosed, as it relates to the operations of fewer than five vessels. As a result the value for the Faroe-Shetland and West of Scotland reserve also cannot be disclosed.				

6.4.18 Under the intermediate scenario, the estimated loss of GVA would clearly have a negligible effect. Under the upper estimate, the impact is higher, but still represents less than 1% of the sector's GVA and employment, so impacts at the Scottish economy and sectoral level are minor. Furthermore, these estimates are considered to overestimate the likely impacts as they assume that all fishing effort and associated landings is lost rather than being displaced (even though some displacement is likely).

6.4.19 The employment impacts also assume that reductions in GVA will automatically translate into job losses. In reality, vessels are likely to be able to absorb some small reductions in turnover and hence profit without that having any impact on employment. Further, even where the reductions in GVA are significant enough to affect employment, vessel owners have a number of alternative options before having to make fishermen redundant (e.g. reduction in wages, reduction in hours).

6.4.20 The point at which reductions in profits starts to impact on employment issues will be different for the owners of different vessels. Rather than apply an arbitrary estimate of the threshold below which businesses would be able to absorb costs, it has been assumed that all losses in GVA translate directly into lost employment. The estimates presented above, therefore are considered likely to over-estimate the economic impacts generated by the proposals.

6.4.21 Although the GVA and employment impacts are relatively small at the Scottish economy and sectoral level, they could have more significant economic and social consequences for the specific locations, individuals and communities that are affected. The scale and significance of impacts will depend on who bears the costs and the relative vulnerability of the local economies, fishing sectors and social groups upon which they fall. A distributional analysis has therefore been undertaken and is presented in Section 6.5.

6.5 Distribution of Economic Costs – Groups

6.5.1 The following sections relate to overall activity connected to fishing – the commercial fishing sector, upstream supply chain and downstream supply chain, including fish processing.

Age and Gender

6.5.2 The proposed management scenarios have the potential to put between 2 and 15 FTE jobs at risk in the commercial fishing sector and its supply chain. These impacts are most likely to fall on those of working age, and on men who make up the vast majority of those employed in commercial sea fishing. There could be further employment impacts in downstream activities like fish processing, which are likely to be more evenly distributed between men and women.

6.5.3 These impacts could generate economic and social costs for the individuals concerned and for their families (including children) at the upper levels. However, some displacement of fishing activity is likely to occur and hence the impacts on employment are likely to be lower than the maximum estimate.

Income

6.5.4 The gross wages and salaries of fishermen are likely to have considerable variation across fleets and roles in the sector, and include individuals in the lowest-paid 10% of the Scottish economy's workforce (see Table 23). It is likely, therefore, that the proposed management scenarios at the sites could mainly impact on income groups falling into the lowest paid 10% and the middle 80% of workers. It is possible that, under the upper scenario due to the impacts on the pelagic fleet, the top 10% may also be affected. Although wages in this sector are thought to be higher than other sectors, there are no published data on wages for the pelagic sector.

Social Groups

6.5.5 Approximately a fifth of employment on Scottish fishing vessels is of non-UK nationals (mostly from the EU)[96]. There is no information to our knowledge that provides information on the ethnic origin of Scottish fishermen employed on Scottish-based vessels. The majority (55%) of employees in fish processing

[96] Seafish, 2019. 2018 Employment in the UK Fishing Fleet. Available online at https://www.seafish.org/media/publications/Seafish_2018_employment_in_fleet_FINAL.pdf. Accessed 27 March 2019.

are non-UK EEA nationals[97]. It is not anticipated, however, that there would be any significant impacts on crofters, ethnic minorities, people with disabilities or other social groups.

6.6 Consequential Social Impacts

6.6.1 Further potential social impacts in the local communities affected, such as on culture, heritage, crime, health education access to services, or changes to the local environment are not considered likely to occur.

6.7 Conclusions

6.7.1 For the management options assessed for the proposed deep sea marine reserve areas, the estimated economic impacts on ports likely to have their fishing fleets or landings affected, are negligible under the intermediate estimate. There are exceptions to this for ports in north-east Scotland in the upper scenario where there is a low risk of minor impacts.

[97] Seafish, 2018. Seafish Economic Analysis – UK Seafood Processing Sector Labour 2018. Available online at https://www.seafish.org/media/2018_seafood_processing_sector_labour_report.pdf. Accessed 27 March 2019.

7 Impacts to Ecosystem Services

7.1 Approach

7.1.1 This section considers the range of benefits that could arise from the designation and management of a proposed deep sea marine reserve. These benefits are assessed based on the implementation of a range of assessment scenarios used to consider the likely costs in previous sections (lower, intermediate, upper).

7.1.2 Deep sea MPAs are focussed on protecting particular features of interest and the wider ecosystem of the deep sea marine environment. Those features can be geological, habitats or species. They are identified on conservation grounds, and therefore are subject to moral and philosophical arguments about the appropriateness and benefits of their protection. This analysis focuses on the economic arguments for their protection, which are regarded as separate from, but not superior to, moral or other arguments.

7.1.3 This analysis of benefits adopts an ecosystem services approach. It is important to note that it aims to assess the expected changes in ecosystem services as a result of implementing management scenarios – it is not an assessment of the total ecosystem services arising from the sites. The change in ecosystem services is assessed relative to the baseline of the expected condition of the sites in the absence of additional management. However, this baseline, and the change due to designation and management, are poorly understood for deep sea environments. As a result, this is a source of uncertainty, as the extent and condition of the features of the proposed sites, and their response to existing management measures, are not always well understood.

7.1.4 A qualitative approach has been adopted to assessing the potential benefits within each site (see individual Site Reports presented in Table 6a of Appendix C). Table 6b considers whether there are any negative *changes* (costs) to ecosystem services as a result of the proposed management scenarios.

7.1.5 Both ecosystem service benefits and costs could arise on-site or off-site. On-site benefits are the result of management protections of features. Off-site benefits include spill-over effects, where maintaining health populations of particular species (including commercial fish or shellfish species, and other protected biodiversity) inside the site supports populations outside the site. The extent of this effect depends, amongst other things, on the size of site, impact of management measures and mobility and lifecycles of the species concerned.

7.1.6 Ecosystem service costs that could arise on-site, for example if alternative fishing activities (using different gears), enter areas where restrictions are introduced on existing fishing activities. Costs could also arise off-site.

7.1.7 The on-site/off-site distinction in Tables 9a and 9b of the Site Reports in Appendix C reflect the ecosystem providing the services analysed. It does not relate to the location of people benefiting from the services.

7.1.8 This section firstly considers the ecosystem services likely to be affected by the proposed management scenarios. It then discusses the overall benefits of the proposed measures across the sites, and any synergies (or network effects) arising from their collective implementation.

7.2 Marine Ecosystem Services

7.2.1 A healthy marine environment provides a large number of benefits to people. The benefits and the beneficiaries are not uniform and cover a wide range of ecosystem functions and interdependencies. The concept of 'ecosystem services' is used to capture the benefits provided. Ecosystem services are the outcomes from ecosystems that directly lead to good(s) that are valued by people[98]. The deep sea (> 200 metres below sea level) is known to support vitally important ecosystem services[99].

7.2.2 The ecosystem service concept provides a framework to identify the range and type of benefits provided by an ecosystem. This section uses the terminology from the UK National Ecosystem Assessment (2010, first used in the Millennium Ecosystem Assessment, 2005), which is applied in subsequent UK analysis of MPAs (e.g. Burdon *et al*.[100]). It splits the benefits provided by UK environments into the following services:

- Provisioning Services – the tangible goods and associated benefits produced by an ecosystem;
- Regulating Services – the benefits from the regulation of ecosystem processes;
- Cultural Services – the non-tangible ecosystem benefits either from experience of the ecosystem or knowledge of its existence;
- Supporting Services – those services whose function underlie all other ecosystem service provision.

7.2.3 The ecosystem services considered in Tables 9a and 9b are a subset of those relevant to the Scottish marine environment. In most assessments, supporting services are not measured separately in economic analysis. This is because their contribution is reflected in final services and benefits and to include their values separately would involve double-counting. Accordingly, the economic

[98] Natural Capital Committee, 2013. State of Natural Capital Report. Natural Capital Committee, Defra.

[99] Jobstvogt, N., Townsend, M., Witte, U., & Hanley, N. (2014). How can we identify and communicate the ecological value of deep-sea ecosystem services?. PloS one, 9(7), e100646.

[100] Burdon D, Potts T, Barbone C, Mandera L., 2017. The matrix revisited: A bird's-eye view of marine ecosystem service provision. *Marine Policy* 77; 78–89.

valuation framework set out in Bateman *et al*[101] and UK NEA[102] only counts final impacts on human wellbeing as economic benefits, to avoid double counting, and separates the contribution of ecosystem services to benefits from the contributions of other resource, capital and labour inputs needed for their production. The CICES (2018) framework[103] avoids the term supporting services altogether, regarding these elements rather as structures, processes and functions.

7.2.4 However, in the specific context of the deep sea, "most ecosystem services are removed in time and space from humans, and hence very many services are of the supporting type"[104]. The problem in this situation is that many of the services supported by deep sea functions and processes risk being overlooked if they are not explicitly accounted for. This depends on the boundaries of the assessment, but if the boundaries are restricted to the deep sea reserve area, there is a good case for accounting for supporting services. Consequently, deep sea service typologies commonly include supporting or intermediate services (e.g. Armstrong *et al*.[105]; Jobstvogt *et al.*[106]; Fletcher *et al.*[107]).

7.2.5 Therefore, the fact that a deep sea valuation study focuses on habitat and supporting services does not necessarily imply that the values should be excluded to avoid double-counting, because it is quite likely that the services supported fall outside the boundaries of the assessment.

7.2.6 In practical terms, methods for valuing these services would generally be limited to stated preference valuations or in some case production function methods. But as Hanley *et al.*[108] argue, the linkages between supporting and final services "are often across ecosystems, and many linkages may be as yet unknown", creating "a risk that the value of supporting services is systematically under-represented in current economic valuation studies", because we do not have the data/knowledge to construct production functions or to include full information in stated preference surveys.

7.2.7 The links from deep sea ecosystems to ecosystem services are illustrated in Figure 3.

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[101] Natural Capital Committee, 2013, State of Natural Capital Report. Natural Capital Committee, Defra

[102] UK National Ecosystem Assessment (2011) The UK National Ecosystem Assessment Technical Report. UNEP-WCMC, Cambridge

[103] Haines-young, R. and M.B. Potschin (2018) Common International Classification of Ecosystem Services (CICES) V5.1 and Guidance on the Application of the Revised Structure.

[104] Armstrong, C. W., Kahui, V., Vondolia, G. K., Aanesen, M., & Czajkowski, M. (2017). Use and non-use values in an applied bioeconomic model of fisheries and habitat connections. Marine resource economics, 32(4), 351-369.

[105] Armstrong, C. W., Foley, N. S., Tinch, R., & van den Hove, S. (2012). Services from the deep: Steps towards valuation of deep sea goods and services. *Ecosystem Services*, *2*, 2-13.

[106] Jobstvogt, N., Townsend, M., Witte, U., & Hanley, N. (2014). How can we identify and communicate the ecological value of deep-sea ecosystem services?. PloS one, 9(7), e100646.

[107] Fletcher S, Saunders J, Herbert R. Description of the ecosystem services provided by broad-scale habitats and features of conservation importance that are likely to be protected by Marine Protected Areas in the Marine Conservation Zone Project area. Natural England; 2011.

[108] Hanley, N., Hynes, S., Patterson, D., & Jobstvogt, N. (2015). Economic valuation of marine and coastal ecosystems: is it currently fit for purpose?. *Journal of Ocean and Coastal Economics*.

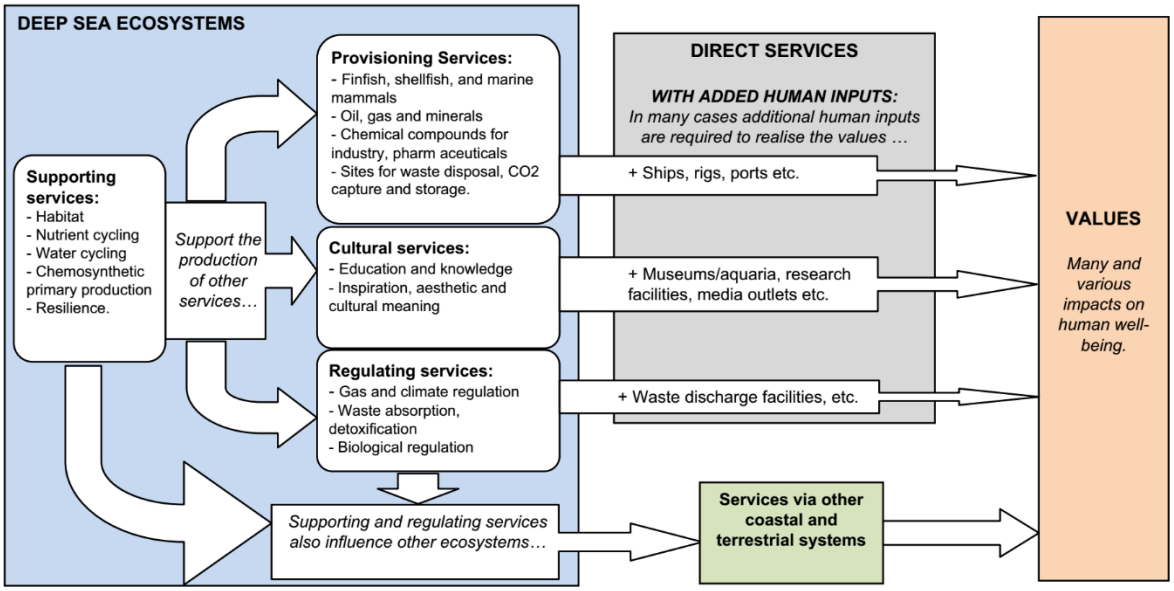

Figure 3 Services of deep sea ecosystems (source: Armstrong et al 2012)

7.2.8 The typology in Table 26 has been used to identify the services for analysis in relation to the sites' proposed management scenarios.

7.2.9 The definitions of the services identified in Table 26 are defined by SNH as follows:

- Regulating services:
  - Carbon storage & climate regulation – storage or sequestration of organic or inorganic carbon within biomass or sediment or geological material;
  - Waste breakdown & detoxification of water & sediment – physical or chemical change to organic or inorganic contamination levels of water or sediment by species/habitats that remove contaminants through consumption or filtering, or otherwise help lock contaminants in to substrate.

  Provisioning services:

  - Fish & shellfish stocks – harvestable wild fish and shellfish for commercial market or personal use / recreational fishing;
  - Genetic resources – species with potential use in, for example, biomedicine, food/nutrition or cosmetics, whether as raw material or isolation of genetic properties; and
- Cultural services:
  - Socially valued places – Locations which society or parts of society (i.e. communities of place or interest) place some value upon, regardless of whether or not they actively use or enjoy the natural assets at that location (i.e. people can acquire a level of well-being from their knowledge of the natural environment and its health);

- Seascape – the aesthetic qualities and character (visual and sense of place) of areas of sea or coast with which human society has a connection; and
- Wildlife – species and habitats which people enjoy, study or observe.

7.2.10 The typology in Table 26 has been used to identify the services for analysis in relation to the sites' proposed management scenarios. Changes in the levels of the supporting services cannot easily be quantified or assessed individually, so they are assessed under a collective heading in Table 9a.

Table 26 Typology of Scottish marine final ecosystem services, and resulting goods and benefits

	Supporting	Provisioning	Regulating	Cultural
Ecosystem services	Biomass production Larval/gamete supply Nutrient cycling Water cycling Formation of: Species habitat Physical barrier	Fish & shellfish Genetic resources	Climate regulation Waste breakdown / detoxification	Socially valued places Wildlife
Goods/ benefits		Food Fish feed Fertiliser Medicine, cosmetics & biotech	Healthy climate Clean water & sediments Immobilisation of pollutants	Nature watching Spiritual/cultural well-being Aesthetic benefits Knowledge (science & education)

Source: SNH

7.2.1 Knowledge of deep sea ecosystem services is poor. In terms of the natural science knowledge, Börger *et al*.[109] state that "*the relationship between ecosystem services and underlying marine ecosystem processes and biodiversity is still not well established and largely theoretical. There is little directly relevant evidence or data to validate current theory and models*." This is especially true of the deep seas.

7.2.2 Consequently, the ways in which ecosystem service provision depend on biodiversity and ecosystem processes are poorly understood. The ability to link

[109] Börger, T., Beaumont, N.J., Pendleton, L., Boyle, K.J., Cooper, P., Fletcher, S., Haab, T., Hanemann, M., Hooper, T.L., Hussain, S.S., Portela, R., Stithou, M., Stockill, J., Taylor, T. and Austen, M.C. (2014) Incorporating ecosystem services in marine planning: The role of valuation. Marine Policy, 46. pp. 161-170. ISSN 0308-597X

changes in systems management to changes in ecosystem service values is therefore extremely limited (see Figure 4). Hanley *et al*. state that scientific knowledge "*does not permit a full parameterisation of the links between changing the management of deep-sea ecosystems (such as banning deep-sea fishing, or allowing deep-sea mining) and their functioning …or the linkage between deep sea functions and ES supplies in near and distance ecosystems*".

Services/Ecosystems and habitats		Cold water corals	Open slopes and basins	Canyons	Sea-mounts	Chemo-synthetic	Water column	Sub-seabed
Supporting	Nutrient cycling	?	+	?	?	+	+	0
services	Habitat	+	+	+	+	+	+	0
	Resilience	?	?	?	?	?	?	0
	Primary production	?	?	?	?	+	+	0
	Biodiversity	+	+	+	+	+	+	?
	Water circulation and exchange	0	+	+	?	0	+	0
Provisioning	Carbon capture and storage (artificial)	0	0	0	0	0	+	€
services	Finfish, shellfish, marine mammals	+	+	+	+	+	€	0
	Energy: Oil, gas, minerals	?	?	0	?	?	0	€
	Chemicals compounds—industrial/ pharmaceutical	+	?	?	?	+	?	?
	Waste disposal sites	0	+	+	0	0	0	+
Regulat-ing	Gas and climate regulation	0	?	+	0	+	+	+
Service	Waste absorption and detoxification	0	+	+	0	0	+	0
	Biological regulation	?	+	?	?	+	+	0
Cultural services	Educational	+	+	+	+	+	+	+
	Scientific	+	+	+	+	+	+	+
	Aesthetic	+	?	?	?	+	+	0
	Existence/Bequest	+	?	?	?	?	+	?

Figure 4 Knowledge of deep sea service values (source: Armstrong et al 2012) Key: blue=good knowledge; green=some knowledge; yellow=little knowledge; grey=no knowledge; white=irrelevant). Value is defined as being; present (+); not present (0); unknown (?); monetarily known (€)

7.3 Ecosystem Services from Marine Protected Areas

7.3.1 Previous work[110] linked the features in the proposed Scottish MPAs to different ecosystem services to provide a guide to the levels of ecosystem services that may be provided by the sites. This needs to be combined with understanding of the status and threats to site features, and the extent of the proposed management scenarios for the designated area, in order to predict possible changes in associated ecosystem services. Deep sea ecosystems are often highly interconnected with other ecosystems, so looking at them in isolation may consistently underestimate the entire suite of extended benefits that could be lost due to damage (van Dover *et al.*)[111].

[110] ABPmer & eftec, 2015. The Scottish Marine Protected Area Project Second Iteration of Site Proposals – Developing the Evidence Base for Impact Assessments: Final Report. Report to Marine Scotland, September, 2015.

[111] Van Dover, C. L., Aronson, J., Pendleton, L., Smith, S., Arnaud-Haond, S., Moreno-Mateos, D., ... & Edwards, A. 2014. Ecological restoration in the deep sea: Desiderata. *Marine Policy*, *44*, 98-106.

7.3.2 The timing of ecosystem service benefits is also uncertain. Experiences in temperate marine ecosystems indicate that recovery of seabed habitats following impacts from human pressures can occur over a range of time scales from less than one year to many years, depending on the features affected. Recovery of fish populations has also been observed over a range of time scales, depending on the scale of impact and the life cycles of the species affected.

7.3.3 Damage to deep sea benthic habitats can be especially long term. In shelf seas, recovery of seafloor communities from benthic trawling can take less than a decade depending on the substrate (Hiddink *et al*.[112]), but decades to centuries are needed in deepwater habitats (Huvenne *et al*.[113]). Epifauna within track areas from experimental deep sea nodule mining show no recovery after 20 years compared to undisturbed nodule/no nodule areas, and it is thought that the soft sediment seafloor could take many decades to hundreds of years to recover from the disturbance caused by nodule removal (Boetius & Haeckel[114]).

7.3.4 Boetius & Haeckel[115] report that dark, cold, energy-poor deep sea ecosystems are particularly vulnerable to mechanical disruption of the surface seafloor, which contains most of the food and microbial communities on which benthic fauna depend. Sköld *et al*.[116] note that chronic bottom trawling reduces diversity and may boost the abundances of species resistant to bottom trawling. Rogers[117] reports that deep sea ecosystems are likely to be highly sensitive to changes in food supply and the physical environment driven by global climate change.

7.3.5 These results emphasise the potential importance of food web effects and cumulative effects with climate change when assessing the impact of bottom trawling. However It is a matter of urgency that baselines are established for diversity, abundance, and biomass of deep sea ecosystems, particularly for the pelagic realm and that a mechanistic understanding is developed of how food supply and physical parameters affect community structure and function.

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[112] Hiddink, J.G., Jennings, S., Sciberras, M., Szostek, C.L., Hughes, K.M., Ellis, N., Rijnsdorp, A.D., McConnaughey, R.A., Mazor, T., Hilborn, R. and Collie, J.S., 2017. Global analysis of depletion and recovery of seabed biota after bottom trawling disturbance. Proceedings of the National Academy of Sciences, 114(31), pp.8301-8306.

[113] Huvenne, V. A. I., Bett, B. J., Masson, D. G., Le Bas, T. P., & Wheeler, A. J. 2016. Effectiveness of a deep-sea cold-water coral Marine Protected Area, following eight years of fisheries closure. *Biological Conservation*, *200*, 60-69.

[114] Boetius, A., & Haeckel, M. 2018. Mind the seafloor. *Science*, *359*(6371), 34-36.

[115] Boetius, A., & Haeckel, M. 2018. Ibid.

[116] Sköld, M., Göransson, P., Jonsson, P., Bastardie, F., Blomqvist, M., Agrenius, S., Hiddink, J.G., Nilsson, H.C. and Bartolino, V., 2018. Effects of chronic bottom trawling on soft-seafloor macrofauna in the Kattegat. Marine Ecology Progress Series, 586, pp.41-55.

[117] Rogers, A.D., 2015. Environmental change in the deep ocean. Annual Review of Environment and Resources, 40, pp.1-38.

7.3.6 Hiddink *et al.* report that trawl gears removed 6–41% of faunal biomass per pass, and recovery times post-trawling were 1.9–6.4 years depending on fisheries and environmental context. Otter trawls (OT) caused the least depletion, removing 6% of biota per pass and penetrating the seabed on average down to 2.4 cm, whereas hydraulic dredges (HD) caused the most depletion, removing 41% of biota and penetrating the seabed on average 16.1 cm.

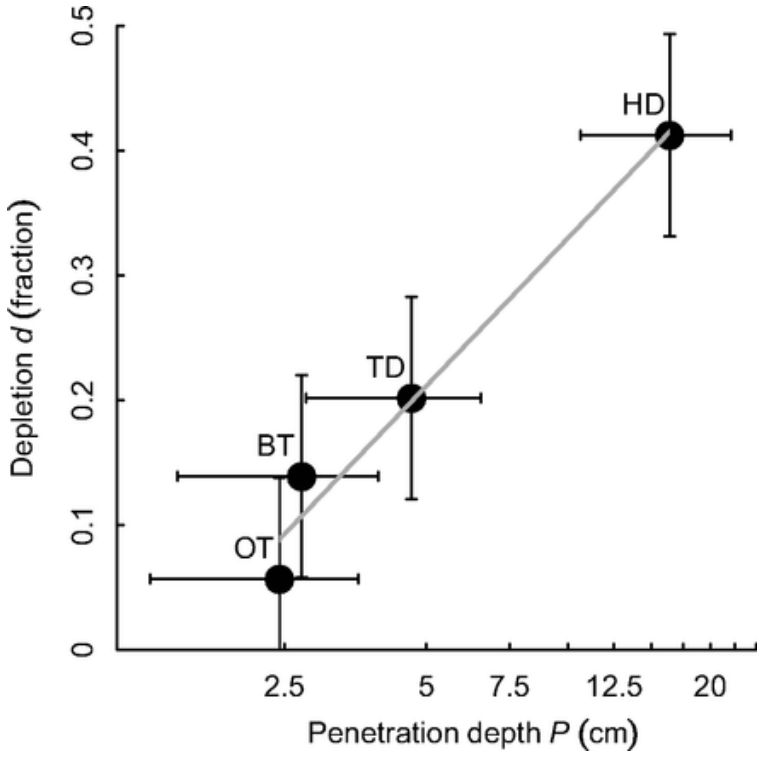

Figure 5 The relationship between the penetration depth *P* and depletion *d* of macrofaunal community biomass and numbers caused by a single trawl pass for different trawl gears[118] (means ± SD). Source: Hiddink et al[119]

7.3.7 This information set remains subject to considerable uncertainty. As identified by Potts *et al.*[120] "Underlying the use of the ecosystem services approach to inform MPA designation is the paucity of data. The availability of data on the functioning (i.e. what ecological configurations and levels of biodiversity provide what services) and value of those services to society is a major obstacle to the implementation of policy".

[118] Bottom trawls [here defined as any towed bottom-fishing gear, including otter trawls (OTs), beam trawls (BTs), towed (scallop) dredges (TDs), and hydraulic dredges (HDs)]

[119] Hiddink, J.G., Jennings, S., Sciberras, M., Szostek, C.L., Hughes, K.M., Ellis, N., Rijnsdorp, A.D., McConnaughey, R.A., Mazor, T., Hilborn, R. and Collie, J.S., 2017. Global analysis of depletion and recovery of seabed biota after bottom trawling disturbance. Proceedings of the National Academy of Sciences, 114(31), pp.8301-8306.

[120] Potts T, Burdon D, Jackson E, Atkins J, Saunders J, Hastings E, Langmead O., 2014. Do marine protected areas deliver flows of ecosystem services to support human welfare? *Marine Policy* 44; 139–148.

7.3.8 Values can be latent or unrealised. For example, there may be limited current use for deep sea fish harvests from the proposed MPAs, but we cannot assume these have no value; rather, there is a latent value that may be classified either as a future use value (we plan to use the resource in future) or as an option value (we do not plan to use it, but value keeping the option open).

7.3.9 Subsequent work has added to the evidence base (e.g. Burdon *et al.*[121] on seabirds) but not resolved this data gap on ecosystem service flows and goods/ benefits from habitats and species. Schratzberger *et al.*[122] identified that in contrast to the ecological evidence surrounding highly protected marine areas, systematic reviews and quantitative meta-analyses of the socio-economic effects of these areas relative to other types of MPA are not available at present.

7.3.10 In addition to a partial evidence base, the benefits analysis is mainly based on consideration of ecosystem services from protected features (due to the available information). In reality, MPAs are likely to contain marine biodiversity features that are not designated features but which give higher levels of ecosystem services as a result of protection under site management measures.

7.3.11 As a result of these uncertainties, a key part of the ecosystem services analysis for each site is that the level of confidence in each assessment is explicitly recorded. In general, confidence is only moderate or high for ecosystem services which are not expected to change significantly at a site. For most potential positive impacts at individual sites, the analysis of ecosystem services changes has low confidence.

7.3.12 Several of the services in Table 26 are hard to quantify and measure at a site level, and/or lack evidence as to how they could change as a result of management measures. For this reason, some services (such as Genetic resources, and Spiritual/cultural well-being) are not included in the site-level analysis.

7.3.13 Other services are not considered relevant to the site management measures. For example, management of fisheries impacts on benthic communities such as reefs will not have an impact on natural coastal protection. These services are also not included in the ecosystem services considered at a site level.

7.3.14 The list of ecosystem services included reflects those covered in ABPmer & eftec[123], but the wording of these has been updated to reflect the typology in Table 26. Specifically, this has led to the adjustments shown in Table 27.

[121] Burdon D, Potts T, Barbone C, Mandera L., 2017. The matrix revisited: A bird's-eye view of marine ecosystem service provision. *Marine Policy* 77; 78–89.

[122] Schratzberger M, Paltriguera L, Neville S, Weston K, Painting S, 2016, Review of Highly Protected Marine Areas. Final Report.

[123] ABPmer & eftec, 2015. The Scottish Marine Protected Area Project Second Iteration of Site Proposals – Developing the Evidence Base for Impact Assessments: Final Report. Report to Marine Scotland, September, 2015.

Table 27. Adjustments to ecosystem services terminology

ABPmer and eftec (2015)	This Report
Fish for human consumption	Fish and shellfish for human consumption
Fish for non-human consumption	Fish and shellfish for non-human consumption
Gas and climate regulation	Climate regulation
Regulation of pollution	Waste breakdown/detoxification

7.3.15 It is noted that the list of ecosystem services used contains both final services and goods/benefits to people from Table 26. This reflects the practicalities of being able to identify evidence for services or goods/ benefits, and a desire to retain consistency with the previous typology used to assess impacts of MPA designation and management in Scottish waters. The list does not contain overlaps between services and goods/benefits, so there is no risk of double-counting.

7.3.16 Some key issues in the assessment of levels of different ecosystem services in the site assessments are discussed below.

Provisioning Services

7.3.17 The proposed management scenarios for the MPAs could increase the level of provisioning services. The most significant provisioning service is of fish (and shellfish) for human consumption. While the status of commercial fish stocks in UK waters are variable and not fully known, the assessment is based on the fact that UK populations of several important commercial species are at suboptimal levels. It is assumed that protected areas can potentially help with stock recovery.

7.3.18 This can result from reduction of fishing pressures, and in particular from protection of key stages (e.g. spawning, nursery grounds) in species' life cycles. Providing spatial or species protection, has been shown to boost populations, which potentially can have a benefit on fishery yields.

7.3.19 Gubbay[124] found some evidence of positive species community effects in shallower seas, such as greater complexity of food webs and increased primary and secondary productivity in MPAs as a consequence of protection. Fernández-Chacón *et al.*[125] identified that a partially protected area off the coast of Norway increased survival and stimulated movement of Atlantic cod (*Gadus morhua*) to surrounding areas.

7.3.20 For mobile fish species spillover benefits are complex, and the benefits of the management measures will depend on several factors, in particular the

[124] Gubbay, S., 2006. Marine Protected Areas. A review of their use for delivering marine biodiversity benefits. English Nature Research Reports, No 688.

[125] Fernández-Chacón, A., Moland, E., Espeland, S. & Olsen, E. (2015). Demographic effects of full vs. partial protection from harvesting: inference from an empirical before-after control-impact study on Atlantic cod. *J Appl Ecol*, 52, 1206–1215DOI:10.1111/1365-2664.12477

implementation of CFP reforms and UK and Scottish fisheries policies post-Brexit, which remain uncertain. The actual impact of protected areas on fish stocks is known to depend on many factors including the size of the MPA, its position in an MPA network, the size of that network, the mobility of the species, the distribution of fishing effort and so on. Detailed modelling of these issues is beyond the scope of this work.

Regulating Services

7.3.21 Two regulating services are considered in the analysis. Carbon sequestration is more significant where there is primary productivity from benthic vegetation in a site.

7.3.22 Through a natural carbon sequestration and storage process, the deep sea provides a climate regulation service. Carbon is fixed into Particulate Organic Carbon (POC) via photosynthesis only in the euphotic zone, up to a depth of about 100m (Boscolo-Galazzo *et al.*[126]). Carbon sequestration in deep sea sediments is driven by the 'Ocean biological pump', a series of biologically-mediated processes that transport organic material (carbon and other nutrients) from the ocean surface to deeper layers that "plays a decisive role in the Earth's carbon cycle" (Thomsen *et al*.[127]). There are two main components: the organic carbon pump; and the calcium carbonate pump (Passow and Carlson[128]). The organic carbon pump is the more 'efficient' (Hülse *et al.*[129]).

7.3.23 The biological pump recycles nutrients and provides food for deep-dwelling species. It also plays an important role in the Earth's carbon cycle, carrying carbon away from the atmosphere and upper ocean layers. Marine organisms act as a reserve or sink for carbon in living tissue and by facilitating burial of carbon in seabed sediments. Agustí *et al*.[130] report "the ubiquitous presence of healthy photosynthetic cells, dominated by diatoms, down to 4,000 m in the deep dark ocean" which confirms that fast-sinking mechanisms inject fresh organic carbon into the deep sea, playing a key role in the global carbon cycle.

7.3.24 The pump displays complex relationships involving for example convective mixing, nutrient uplifting, and algal/diatom blooms. These processes are partly driven by atmospheric processes (Pedrosa-Pàmies *et al*.[131]). These processes

[126] Boscolo-Galazzo, F., Crichton, K. A., Barker, S., & Pearson, P. N. (2018). Temperature dependency of metabolic rates in the upper ocean: A positive feedback to global climate change?. *Global and planetary change*.

[127] Thomsen, L., Aguzzi, J., Costa, C., De Leo, F., Ogston, A., & Purser, A. (2017). The oceanic biological pump: rapid carbon transfer to depth at continental margins during winter. Scientific reports, 7(1), 10763.

[128] Passow and Carlson, 2012. The biological pump in a high CO_2 world. Mar Ecol Prog Ser 470:249-271. https://doi.org/10.3354/meps09985

[129] Hülse, D., Arndt, S., Wilson, J. D., Munhoven, G., & Ridgwell, A. (2017). Understanding the causes and consequences of past marine carbon cycling variability through models. Earth-science reviews, 171, 349-382.

[130] Agustí, S., González-Gordillo, J. I., Vaqué, D., Estrada, M., Cerezo, M. I., Salazar, G., ... & Duarte, C. M. (2015). Ubiquitous healthy diatoms in the deep sea confirm deep carbon injection by the biological pump. Nature communications, 6, 7608.

[131] Pedrosa-Pàmies, R., Sanchez-Vidal, A., Canals, M., Lampadariou, N., Velaoras, D., Gogou, A., ... & Calafat, A. (2016). Enhanced carbon export to the abyssal depths driven by atmosphere dynamics. *Geophysical Research Letters*, *43*(16), 8626-8636.

may experience feedback from climate change and associated aspects of ocean biology, chemistry and structure, though at present the details of possible relationships are poorly understood (Boscolo-Galazzo *et al*.[132]). Evidence from modelling studies[133] indicates that the export of primary production off the North West European Shelf into deeper waters is an important mechanism for carbon sequestration, although this process is physically driven rather than biologically driven and therefore may not be influenced by management measures within deep sea MPA options.

7.3.25 Luisetti *et al*.[134] report the importance of shelf sediments for carbon storage. They analyse storage only down to a depth of 200 metres and therefore do not provide data directly relevant to the deep sea areas. Changes observed include altering the depth and rate of organic carbon burial and changing the seabed communities involved in bioturbation and bio-irrigation (Duplisea *et al*.[135]).

7.3.26 Pusceddu *et al*.[136] review evidence on the impacts of deep sea trawling, and present evidence on biodiversity and ecosystem function impacts from trawled versus untrawled areas in deep waters of the Mediterranean. There are two main sources of impact: sediment disturbance and removal of organic carbon, and destruction of habitat complexity. Carbon removal can represent as much as 60–100% of the input flux, which can have substantial impacts on ecosystem processes, causing "the degradation of deep sea sedimentary habitats and an infaunal depauparation" and "the collapse of benthic biodiversity and ecosystem functions, with potential consequences on the biogeochemical cycles". Compared with untrawled areas, trawled deep sea sediments have lower organic carbon turnover and are significantly depleted in organic matter content, meiofauna abundance and biodiversity, and nematode species richness and individual biomass.

7.3.27 From the above evidence we can conclude that some of the deep sediments in the proposed deep sea marine reserve areas are likely to play important roles in storing carbon, and that disturbance of the sediments could negatively impact this service. However, it is unlikely that such impacts will result in released carbon reaching surface layers and any organic carbon remobilised is likely to resettle elsewhere in the deep sea environment. As identified by Wakelin *et al*., the main processes governing carbon sequestration off the

[132] Boscolo-Galazzo, F., Crichton, K. A., Barker, S., & Pearson, P. N. (2018). Temperature dependency of metabolic rates in the upper ocean: A positive feedback to global climate change?. *Global and planetary change*.

[133] Wakelin, S. L., Holt, J. T., Blackford, J. C., Allen, J. I., Butenschön, M., Artioli, Y. 2012. Modelling the carbon fluxes of the northwest European continental shelf: Validation and budgets. Journal of Geophysical Research Vol 117, Issue C5.

[134] Luisetti, T., Turner, R.K., Andrews, J.E., Jickells, T.D., Kröger, S., Diesing, M., Paltriguera, L., Johnson, M.T., Parker, E.R., Bakker, D.C. and Weston, K., 2019. Quantifying and valuing carbon flows and stores in coastal and shelf ecosystems in the UK. Ecosystem services, 35, pp.67-76.

[135] Duplisea, D. E., Jennings, S., Malcolm, S. J., Parker, R., & Sivyer, D. B. (2001). Modelling potential impacts of bottom trawl fisheries on soft sediment biogeochemistry in the North Sea. *Geochemical Transactions*, *2*(1), 112.

[136] Pusceddu, A., Bianchelli, S., Martín, J., Puig, P., Palanques, A., Masqué, P., Danovaro, R., 2014. Chronic and intensive bottom trawling impairs deep-sea biodiversity and ecosystem functioning. PNAS 111, 8861–8866.

North West European shelf edge are physically driven and management measures within the MPA option areas is unlikely to affect these processes.

7.3.28 There is at present only limited demersal fishing pressure in the West of Scotland part of the area and existing regulations ban trawling below 800 metres (EU Deep Sea Fisheries Regulation 2016/2336) thus we can assume that the proposed management will not result in significant changes in these regulating processes. However, the management could protect against possible future damages if regulations were to change, or new activities that disturbed benthic carbon stores emerged (e.g. deep sea mining).

7.3.29 An additional climate regulation service is provided by methanotrophic microbes in the ocean floor and waters (Armstrong *et al*.[137]). These consume almost all of the methane entering the oceans through various processes such as coastal runoff, diffusion from organic-rich anoxic sediments, or through seeps, vents, and mud volcanoes emitting methane-rich fluids or methane-rich bubbles (Glover and Smith[138]). Hence these microbial systems provide an important gas regulation service by maintaining most of the ocean volume in a state of undersaturation in methane compared to the atmosphere (Knittel and Boetius[139]; Boetius and Knittel[140]). Again, we would not expect the current flows of this service to change as a direct result of the management measures, but they could prevent future reductions in service under hypothetical future fishing or other pressures.

7.3.30 Overall therefore the available evidence does not suggest the impacts of the site management scenarios on the stock of stored carbon or on the flows of regulating services will have a significant value in relation to the overall costs and benefits of site designation and management. However, this should be kept under review as further research is ongoing in this area.

Cultural Services

7.3.31 Cultural services are the least well-understood group of final ecosystem services from the marine environment. The significance of the management scenarios has been assessed for research and education, recreation activities, and non-use benefits. It can be argued that the sites produce a range of other cultural values. These include direct use values such as the maintenance of traditional fishing communities. The typology in Table 26 also includes more indirect values such as meaningful places or socially valued landscapes, symbolic benefits (aesthetic, heritage, spiritual), and philosophical, inspiration

[137] Armstrong, C. W., Foley, N. S., Tinch, R., & van den Hove, S. (2012). Services from the deep: Steps towards valuation of deep sea goods and services. *Ecosystem Services*, *2*, 2-13.

[138] Glover, A.G., Smith, C.R., 2003. The deep-sea floor ecosystem: current status and prospects of anthropogenic change by the year 2025. Environmental Conservation 30 (03), 219–241.

[139] Knittel, K., Boetius, A., 2009. The anaerobic oxidation of methane—progress with an unknown process. Annual Reviews of Microbiology 63, 311–334.

[140] Boetius, A., Knittel, K., 2010. Habitats of anaerobic methane oxidisers. In: Timmith, K. (Ed.), Handbook of Hydrocarbon and Lipid Microbiology. Springer, pp. 2193–2199.

values. However, there is little conclusive evidence on the likely impacts of management measures on these issues.

7.3.32 Deep sea sites have essentially no direct recreational activities, however these habitats can support animal populations that are important for recreation, for example whale watching, or fish caught recreationally in shallower waters. While the value of these activities could be enhanced by designation and management if this would result in higher levels of biodiversity and environmental quality for these activities, the proposed changes are not considered likely to have a significant impact on current flows in this respect. They could however protect against future losses. The value of non-use benefits is considered further under the valuation evidence below.

Supporting Services

7.3.33 MPAs provide a significant number of supporting services. These services are the foundation for all other ecosystem services. This includes notably the support that these services provide for provisioning services such as the protection of features which provide habitats for larval and juvenile life stages of marine species. Broadscale marine habitats provide important intermediate (supporting and regulating) services such as the formation of species habitat and physical barriers[141].

Ecosystem Services Costs

7.3.34 The above discussion relates to Table 9a in the Site Reports in Appendix C, which considers ecosystem service benefits. Table 9b considers ecosystem service costs that might arise from displacement of fishing effort (off-site) and use of alternative fishing gears (on-site). Displacement is only considered under the lower scenario for consistency with SEIAs of other proposed MPA management measures. As the lower scenario does not include any changes to existing fisheries management, it is not considered explicitly in the assessment. If displacement of fishing effort to other areas does occur under the intermediate and upper scenarios, this would result in additional landings that would offset the loss of landings from the pMPA areas, and therefore reduce the size of the impact on the fishing sector. The intermediate and upper estimates are assumed to have no displacement, and hence higher direct impacts on the fishing sector.

7.3.35 If fishing effort is displaced rather than lost, it could have detrimental effects on the ecosystem services provided by the areas it is displaced to. However, these effects would be expected to be less than the benefits in the sites because:

[141] Potts T, Burdon D, Jackson E, Atkins J, Saunders J, Hastings E, Langmead O., 2014. Do marine protected areas deliver flows of ecosystem services to support human welfare? *Marine Policy* 44; 139–148.

- The areas displaced to would overall be expected to have less sensitive and/or significant marine conservation features, as this should be the basis for site identification.
- Protection of the pMPAs from fishing pressure may be expected to increase fish populations and reproductive output, potentially improving fisheries elsewhere whether through direct export of fish or through greater larval output and settlement elsewhere. It is not possible to quantify these potential impacts, but in any case the existing demersal fishing pressure is low so we can assume that both these impacts, and the threat of displacement, are limited.
- In the "upper" scenario, the additional exclusion of all pelagic gear could lead to a more substantial displacement, although even in this scenario the estimated lost revenue is approximately £1 million which is a very small fraction of the Scottish pelagic fishing industry.

7.4 Values of Benefits from Designation and Management in MPAs

7.4.1 As discussed above, the proposed management changes could influence some ecosystem services thereby creating changes in a variety of benefits to people. An attempt can be made to identify the economic value of these benefits. However, much of the valuation evidence available is highly uncertain, and the evidence base has very significant gaps. When combined with the uncertainties over the levels of ecosystem services changes, this makes accurate valuation of the full benefits of the management scenarios impossible. The timing of realisation of benefits is also uncertain.

7.4.2 Four requirements for the economic framework to be applied can be identified[142]:

i. Methods to identify and paramaterise direct and indirect links between human welfare and the functionality and extent of ecosystems;
ii. Methods to estimate how ecosystem service supply will change when there is a change in the functionality and/or extent of the ecosystem;
iii. Methods to identify how this change in ecosystem service supply will affect the flow of direct and indirect benefits, once behavioural responses to the change in ecosystem service have been taken into account; and
iv. Methods for measuring the monetary value of this change in benefits (Bateman *et al*.[143]).

7.4.3 To date, scientists still know relatively little about the deep sea and "safe limits" for resource exploitation are either unknown or very uncertain[142]. Many knowledge gaps remain around the overall functioning of deep sea ecosystems

[142] Hanley, N., Hynes, S., Patterson, D., & Jobstvogt, N. 2015. Economic valuation of marine and coastal ecosystems: is it currently fit for purpose? *Journal of Ocean and Coastal Economics*.

[143] Natural Capital Committee, 2013, State of Natural Capital Report. Natural Capital Committee, Defra

(Armstrong *et al*.[144]). The lack of ecological knowledge means that we know very little about the economic value of protecting the deep sea[142].

7.4.4 From a natural sciences perspective, the relationship between ecosystem services and underlying marine ecosystem processes and biodiversity is still not well established and largely theoretical. There is little directly relevant evidence or data to validate current theory and models. Thus the reliance of ecosystem service provision on biodiversity and ecosystem processes is also poorly understood[145]. Jobstvogt *et al*.[146] report that because the available information on deep sea ecosystem services is mostly of a descriptive nature, "*the majority of experts would be reluctant to put numbers on the ES changes that we have to expect in the future*."

7.4.5 There are two main options for valuing deep sea systems and their services. These are

i. production function methods, linking deep sea functions and services to the delivery of final services that can be valued;
ii. stated preference methods relating to protection of the deep sea habitat and its associated functions.

7.4.6 Gaps in scientific knowledge make it hard to predict the effects of changes in deep sea ecosystem management on the delivery of intermediate and final ecosystem services. This makes the use of production function methods for economic valuation difficult[142].

7.4.7 Lack of knowledge about the nature of the deep sea – and in particular an almost-complete lack of experience with and understanding of deep sea ecosystems on the part of the general public – complicates the use of stated preference methods. Jobstvogt *et al*. even argue that the unfamiliarity of the general public with the deep sea environment is the biggest challenge of attaching economic values to the deep sea. This unfamiliarity does not invalidate stated preference methods, but does imply that they suffer from problems of incomplete and poorly-informed preferences and may not be able to satisfy end-users' demands for accuracy and precision in cost benefit analysis[142].

7.4.8 Folkersen *et al*.[147] present a meta-analysis of the limited (they identify 15 studies) deep sea valuation literature. They report that "*the studies included in this systematic review are so varied that it is impossible with any confidence to*

[144] Armstrong, C. W., Foley, N. S., Tinch, R., & van den Hove, S. (2012). Services from the deep: Steps towards valuation of deep sea goods and services. *Ecosystem Services*, *2*, 2-13.

[145] Börger, T., Beaumont, N.J., Pendleton, L., Boyle, K.J., Cooper, P., Fletcher, S., Haab, T., Hanemann, M., Hooper, T.L., Hussain, S.S., Portela, R., Stithou, M., Stockill, J., Taylor, T. and Austen, M.C. (2014) Incorporating ecosystem services in marine planning: The role of valuation. Marine Policy, 46. pp. 161-170. ISSN 0308-597X

[146] Jobstvogt, N., Hanley, N., Hynes, S., Kenter, J., & Witte, U. (2014). Twenty thousand sterling under the sea: estimating the value of protecting deep-sea biodiversity. *Ecological Economics*, *97*, 10-19.

[147] Folkersen, M. V., Fleming, C. M., & Hasan, S. (2018). The economic value of the deep sea: A systematic review and meta-analysis. *Marine Policy*, *94*, 71-80.

estimate the (total) value of the deep sea in monetary terms, let alone determine how much (or how little) is known about the economic value of the deep sea as an ecosystem."

Provisioning Services

7.4.9 By their very nature provisioning services are those services most closely tied to the market economy. Goods (fish, shellfish, oil, gas) from marine ecosystems are sold in existing markets and so have a market value: the total value of Scottish fish landings was £560 million in 2017[148]. Such market values do not include the externalities of extracting the good from the ecosystem.

7.4.10 Protection by the proposed management scenarios of features in MPAs that are important for fish and shellfish lifecycles could increase the health and size of stocks. This could benefit commercial fisheries in surrounding areas. However, the actual level of demersal fishing in the proposed deep sea marine reserve areas is very limited and it appears reasonable to assume that the direct impact of protection on current flows of provisioning services would be correspondingly minor.

7.4.11 Other provisioning services are also difficult to quantify. For example, Potts *et al.*[149] identified medicines and blue biotechnology as an important marine service. However, apart from horse mussels, they could only cite expert opinion on the importance of a range of habitats and species for this benefit.

Regulating Services

7.4.12 Marine regulating ecosystem services provide some essential functions. For example, carbon sequestration and storage in the marine environment helps regulate the global climate. Marine regulating services are generally difficult to quantify in scientific terms and therefore are difficult to value in monetary terms.

7.4.13 As discussed above, we lack the data needed to establish any link between changes in management arising from the designation and changes in the regulating services. Some changes could occur, and would likely be positive, through reduced disturbance of sediments and enhanced habitat protection generally. However, this impact is likely to be limited, in light of the currently low demersal fishing pressures in the areas.

7.4.14 The benefits of protecting the areas against potential future fishing pressures could be significant, but this hypothetical future fishing is speculative.

7.4.15 Consequently, although the UK has official unit values with which we could value carbon sequestration services[150] we lack the physical data to estimate

[148] Scottish Government (2018). Scottish Sea Fisheries Statistics 2017. Available at: https://www.gov.scot/publications/scottish-sea-fisheries-statistics-2017/

[149] Potts T, Burdon D, Jackson E, Atkins J, Saunders J, Hastings E, Langmead O., 2014. Do marine protected areas deliver flows of ecosystem services to support human welfare? *Marine Policy* 44; 139–148.

[150] HMT, 2018. [full ref to be added]

any change in the rate of flow of these services arising as a result of the designation.

Cultural Services

7.4.16 The majority of cultural services from the marine environment are dependent on the quality of the marine environment, which is likely to be enhanced (or is less likely to be degraded) by the proposed management scenarios. However, the extent of this improvement is very hard to predict.

7.4.17 Cultural services and non-use values are classified in different ways in different marine ecosystem services studies. The main evidence available relates to non-use value for biodiversity (see below) and use values for recreation, therefore the following analysis looks at these two areas in detail. Other cultural services, such as the value of research and education, are hard to quantify or value either in total or in terms of the expected changes from management measures. However, they could be significant if sites are subject to long-term research studies.

Recreation and Tourism

7.4.18 The remote, deep nature of the areas under consideration means there are no direct impacts on recreation values. There could be indirect impacts, to the extent that the changes in management might enhance populations of animals that support recreation services – notably whales and dolphins, and perhaps some fish species that could be caught recreationally in shallower waters. The extent of any marginal impact arising from the designation is however likely to be very small.

7.4.19 It should be noted that any socio-economic benefits associated with recreation and tourism will occur in coastal, often remote communities. These communities may be the same as those where many of the costs identified in Section 6 occur.

Supporting Services

7.4.20 Supporting services are perhaps the most critical set of services provided by features in MPAs. Supporting services underpin all other ecosystem services, and therefore few studies are able to extract the contribution and therefore value of each ecosystem process. Valuing supporting ecosystem services in general brings a significant risk of double-counting, as they support the provisioning, regulating and cultural services from MPA sites discussed above.

7.4.21 However, as noted above, not valuing supporting services also brings a risk of under-valuing benefits if MPA management measures increase supporting services that give rise to final ecosystem services outside site boundaries, and these values are not captured because the available evidence is applied only to changes in final services inside the boundaries. For example, the support to whale, dolphin and fish populations noted in the previous section, or the provision of habitat and refugia for fish and fish larvae potentially supporting fisheries elsewhere.

7.4.22 Furthermore, since the data are lacking for estimating production functions, in fact there is little risk of double-counting, since we are not able to determine the links between the deep sea and final services with the exception of the direct fisheries service from fishing in the area. This is extremely limited for demersal fishing. It is larger, though still small in the context of fisheries services in general, for pelagic fishing, though the link from this to the sea bed is uncertain and the catches are prevented only in the "upper" protection scenario.

Total Economic Value

7.4.23 For the deep sea, there is very limited evidence on the individual value of different ecosystem services, other than for fisheries. There are, partly as a consequence of the lack of physical data, a few studies that attempt to estimate the total value of the protection of the marine environment. These mostly relate to the whole value of protecting the marine environment via some form of proposed protection measures over a specific area and are therefore in principle rather well suited to the case of designating a MPA and/or excluding damaging activities from all or part of an area.

7.4.24 An international study by Brander *et al.*[151] concluded that the benefits to people of expanding MPAs generally outweighed the costs. They considered the benefits of protection based on a meta-analysis of values. Their meta-analysis function could be used to estimate the benefits of the Scottish MPA network, but not of the proposed management scenarios being assessed.

7.4.25 A study by Gubbay[152] reviewed the evidence for benefits of MPAs set up for the conservation of marine biodiversity. It found that some direct evidence that MPAs can protect and enhance ecosystem services comes from situations where habitats and species protected by MPAs are known to provide specific services. It concluded that highly protected MPAs lead to overwhelming positive effects on biodiversity (i.e. higher densities, biomass, size and diversity of certain species or groups of species). There is some evidence of positive species community effects such as greater complexity of food webs and increased primary and secondary productivity in MPAs as a consequence of protection.

7.4.26 McVittie and Moran[153] derived a primary estimate of benefits from the implementation of the nature conservation measures in the draft Marine Bill, specifically, Marine Conservation Zones (MCZs). They identified UK households' aggregate willingness to pay (WTP) of £487 million to £698 million per year. This figure represents a total economic valuation for the MCZ provisions. Due to the nature of the MCZ outcomes, it is suggested that a high

[151] Brander *et al.,* 2015. The benefits to people of expanding Marine Protected Areas. IVM Institute for Environmental Studies.

[152] Gubbay, S., 2006. Marine Protected Areas. A review of their use for delivering marine biodiversity benefits. English Nature Research Reports, No 688.

[153] McVittie, A., & Moran, D., 2008. Determining monetary values for use and non-use goods and services: Marine Biodiversity–primary valuation. Final Report to Defra.

proportion of this value will be non-use value. However, the data did not allow the study to categorically isolate this component of value.

7.4.27 A median value for halting the loss of marine biodiversity (which includes, but is a wider objective than MCZ provisions) had an aggregate UK value of £1,171 million per year. This value is based on median estimates, and is recommended as it avoids the influence of extreme values and represents the amount that 50% of respondents would be willing to pay.

7.4.28 The values generated within this research were based on the best *ex ante* assessment of the anticipated environmental gains from the UK Marine Bill Marine Nature Conservation Zones, using a hypothetical network scenario. Because of uncertainty, there is potential for disparity between the policy benefits estimates presented here and what is actually realised as the policy is implemented. It is also important to note that no assumption has been made for the timescale over which these benefits arise.

7.4.29 It is interesting to note that the average values per household for halting loss of, or increasing, UK marine biodiversity in the McVittie and Moran study were lower in Scotland than in England or Wales. Nevertheless, the average household values in Scotland were significant and positive. Also, these values relate to average country household values for all UK waters, implying that English and Welsh households will value improvements in biodiversity in Scottish waters. There is also more general economic evidence of the Scottish populations' positive willingness to pay to conserve designated marine sites[154].

7.4.30 The extent to which the non-use values identified in the McVittie and Moran study are relevant to the proposed management scenarios in MPAs is related to the contribution that the measures will make to halting marine biodiversity loss.

7.4.31 Wattage *et al*.[155] found that the public in Ireland is willing to pay up to €10 per person to protect deep sea corals from trawling based on the corals providing genetic material for the biomedical industry, essential fish habitats and carbon sinks.

7.4.32 Ressurreição *et al*.[156] report that visitors to and residents of the Azores were willing to pay €405–605 per person to prevent 10–25% reductions in marine species richness in open waters, including the deep sea.

[154] Jacobs, 2004. An Economic Assessment of the Costs and Benefits of Natura 2000 Sites in Scotland. Report to Scottish Government.

[155] Wattage P, Glenn H, Mardle S, Van Rensburg T, Grehan A, Foley N. Economic value of conserving deep-sea corals in Irish waters: A choice experiment study on marine protected areas. Fisheries Research 2011; 107(1–3): 59-67.

[156] Ressurreicão A, Gibbons J, Dentinho TP, Kaiser M, Santos RS, Edward-Jones G. 24 Economic valuation of species loss in the open sea. Ecological Economics 2011; 70(4): 25 729-739.

7.4.33 Jobstvogt *et al*. [157]; used choice modelling to estimate the WTP of the Scottish public for protecting biodiversity in Scottish waters by restricting fishing and/or oil and gas activities. Results showed that Scottish participants supported the idea of deep sea protection and despite limited knowledge, were able to participate in the valuation process. WTP results were similar for the option value of finding products with pharmaceutical applications and for the protection (non-use value) of deep sea species, with a combined WTP of £70-£77 on average. However, Hanley *et al*. [158] note that "*there was no examination of how much people understood what kinds of wildlife they were bidding to protect, nor the consequences of not protecting it*".

7.4.34 Aanesen *et al*.[159] estimate the WTP of the Norwegian public for the protection of cold-water corals around the coastline. Respondents were willing to pay €53 for extending the protected area from the current 2445 km² to 5000 km², and €66 for an extension from 2,445 to 10,000 km² – again displaying a non-linear response to increased protected area.

7.4.35 Respondents were WTP more for protection where the area was deemed attractive for the oil/gas industry (+€39) or the fisheries industry (+€16), demonstrating sensitivity to the level of threat – that is, people were expressing their WTP to prevent damage.

7.4.36 Börger *et al*.[160] found that respondents were willing to pay £4.19 (£5.70 in the conditional logit) per year on average for a 10% increase in species diversity from excluding trawling from 25% on the Dogger Bank. Their average WTP for a 25% increase from excluding on 50% was £7.76 (£7.22 in the conditional logit). This illustrates that the UK public hold significant values for environmental benefits generated by conservation measures in an offshore location, but at a declining rate. Values for the protection of charismatic species exceed those for general species diversity.

7.4.37 As noted above, the lack of public familiarity with deep sea systems and their services is a serious challenge for conducting and in particular interpreting the results of stated preference surveys. Van den Hove[161] argues that environmental issues characterised by complexity, uncertainty, large temporal and spatial scales, irreversibility and unfamiliarity – such as deep sea ecosystems – may favour deliberative methods that allow for greater

[157] Jobstvogt, N., Townsend, M., Witte, U., & Hanley, N. (2014). How can we identify and communicate the ecological value of deep-sea ecosystem services?. PloS one, 9(7), e100646.

[158] Hanley, N., Hynes, S., Patterson, D., & Jobstvogt, N. (2015). Economic valuation of marine and coastal ecosystems: is it currently fit for purpose?. *Journal of Ocean and Coastal Economics*.

[159] Aanesen, M., C.W. Armstrong, M.Czajkowski, J.Falk-Petersen, N.Hanley, and S. Navrud. 2015. "Willingness to Pay for Unfamiliar Public Goods: Preserving Cold-Water Coral in Norway." Ecological Economics 112(0):53-67.

[160] Börger et al 2014b Valuing conservation benefits of an offshore marine protected area Ecological Economics 108 (2014) 229–241

[161] Van den Hove 2000. Participatory approaches to environmental policy-making: the European Commission Climate Policy Process as a case study. Ecological Economics 33 (2000) 457–472

clarification and interaction. This could go some way towards partly addressing issues of unfamiliarity and uncertain/ill-formed preferences.

7.4.38 Falk-Andersson *et al*.[162] examine individual and group methods for valuing cold-water coral protection. Use-values, particularly habitat supporting fish production, dominated the focus group discussions, while non-use and intrinsic values were emphasised in the questionnaire responses. Respondents rejected the use of the precautionary measure of temporary closures to gain information on cold water coral presence. Reasons were costs to fishers, and the rejection of the premise that precautionary closures would prevent further damage. While use-values were emphasised in the discussions, participants favoured non-use and intrinsic values of CWC in the questionnaires.

7.4.39 Falk-Andersson *et al*. conclude that individual questionnaires resulted in a focus on personal considerations in terms of environmental values and beliefs, while in groups people acted like policy analysts evaluating side costs and benefits, feasibility and efficiency of implementation. This lends support to the idea that the valuation results from stated preference surveys and group valuation exercises could be quite different.

7.4.40 Overall there is no way to transfer any of the above figures directly to the current case, other than to observe that they do suggest that the Scottish population hold significant non-use values associated with protection of remote, deep sea environments. This is not based on full understanding of the systems and their services. The values include components of non-use value and of option values for protecting services against uncertain future damage.

7.4.41 In large part, this conclusion is due to the uncertainties in how ecosystem services will change with respect to management measures. The assessment of benefits has focussed on the changes to ecosystem services that are expected to result from the proposed management scenarios. While the sites undoubtedly support a considerable range and value of ecosystem services, evidence on the baseline contribution of the site features to these ecosystem services, and on the expected nature of these changes in scientific or economic terms, is extremely sparse. As a result, the assessment of changes in ecosystem services at individual sites (see Table 9a in Site Reports, Appendix C) is uncertain.

7.5 Conclusions

7.5.1 The assessment of benefits has focussed on a review of the limited evidence that is available for deep sea ecosystems and services. While the sites undoubtedly support a considerable range and value of ecosystem services, evidence on the expected changes to ecosystem services is extremely sparse.

[162] Falk-Andersson *et al*. 2015. A deliberative approach to valuation and precautionary management of cold water corals in Norway. Maritime Studies 201514:7.

As a result, any assessment of changes in ecosystem services associated with designation and management of the deep sea MPA options is highly uncertain.

7.5.2 The range of valuation evidence reviewed above gives indications of which ecosystem services that are impacted by management measures may be valuable to society. The important potential changes include fisheries services, both direct and indirect, climate regulation, and non-use values.

7.5.3 Consideration of different groups of services does not produce any valuation data that can be used with confidence to value the changes expected from sites. The uncertainty associated with the quantification of ecosystem services, as reflected in the evidence reviewed above, reinforces the necessity for a largely qualitative approach to the assessments of benefits at a site level.

7.5.4 That said, the evidence does suggest that members of the public are likely to hold non-use values for deep sea protection, associated with the protection of vulnerable species and habitats. While we do not place any particular credence on specific values estimated in the literature, they are nevertheless a clear indication that some such values exist. In this context it is worth considering that the estimated cost to fisheries, limited to approximately £1 million per year in the upper scenario and much less in the others, represents a very small amount per household in Scotland. Without seeking to be specific, it nevertheless seems highly likely that the average WTP for conservation of the large deep sea areas under consideration would be greater, and possibly substantially greater, than this figure.

8 Combined and Cumulative Impacts

8.1 Marine Activities

Combined Non-GVA (Cost) Impacts

8.1.1 The proposed Faroe-Shetland and West of Scotland reserve represents the combined impact of the proposed Faroe-Shetland reserve and the proposed West of Scotland reserve. The combined quantified impacts on operating costs (costs which are not expected to affect output and thus not affect GVA) and GVA impacts (impacts which could affect GVA) are presented in Section 4 by activity.

8.1.2 The potential total quantified increases in operating costs (non-GVA costs) for the combined reserve (present value over 20-year assessment period at 2019 prices) are estimated to range between £291,000 (lower estimate) and £225,000 (upper estimate) (Table 28). Quantified costs are less in the upper scenario because some activities no longer take place, but there is also an unquantified (potentially significant) opportunity cost.

8.1.3 It has not been possible to quantify a range of other potential cost impacts, such as the cost of uncertainty and delays in the licensing process, and the figures presented therefore represent a partial assessment of cost impacts. In particular, the potential opportunity cost for sectors that would not be able to operate within the proposed reserve areas (oil and gas, seabed mining) under the intermediate and upper scenarios has not been quantified — this results in the intermediate and upper scenarios having a lower cost impact than the lower scenario. The cost impacts of the lower scenario relate to additional assessment costs for marine licences, but in the intermediate and upper scenarios, some activities will not be permitted (e.g. oil and gas exploration, seabed mining), meaning that no licences will be applied for and no additional costs will be incurred.

8.1.4 Most cost impacts are minor, but they vary between sectors. Under the intermediate scenario, the largest costs are estimated to be experienced by the Military sector, related to the cost of amending and updating its Marine Environment and Sustainability Assessment Tool (MESAT) and other Ministry of Defence environmental tools, and additions to electronic charting by the Hydrographic Office. This may overestimate the costs to the Military sector, as these updates may be carried out in conjunction with updates required for other proposed MPAs that may be designated at a similar time to the proposed deep sea marine reserve.

Table 28 Potential total quantified cost impacts by sector (present value of total costs over 20 years, £000s, 2019 prices)

Site	Estimate		
	Lower	Intermediate	Upper
Military activities	195	195	195
Oil and Gas	63	0	0
Power interconnectors and transmission lines	5	5	5
Seabed mining	3	0	0
Telecom cables	25	25	25
Total	**291**	**225**	**225**

Combined GVA Impacts

8.1.5 Table 29 presents information on potential direct and indirect GVA impacts for commercial fisheries, where a change in the value of output (landings) may occur for the commercial fisheries sector. The estimated combined impact on direct GVA for the proposed combined reserve for the commercial fisheries sector varies from £0 (lower estimate), £1.1 million (intermediate estimate) and £8.8 million (upper estimate) (present value, costs discounted over the 20-year assessment period, 2019 prices). These impacts arise as a result of reduced landings from the proposed reserves where fishing effort would be restricted under the assessed management scenarios.

8.1.6 Considering direct and indirect GVA impacts, the total impacts for the proposed combined reserve is a reduction between £0 (lower estimate), £1.6 million (intermediate estimate) and £12.8 million (upper estimate) over the study period. Again, these values are the present value of total impacts over 20 years, and relate to the impacts on commercial fisheries as well as the knock-on impacts on their supply chains (boat building, maintenance etc).

8.1.7 These impacts correspond to a potential loss of jobs of between 0 and 16 full-time equivalents (direct, indirect and induced, lower to upper scenario), with an intermediate estimate of 2 jobs.

Table 29 Potential total GVA impacts by for commercial fisheries (present value of total direct and indirect GVA impact over 20 years, £000s, 2019 prices)

GVA	Estimate		
	Lower	Intermediate*	Upper
Direct GVA	0	1,124	8,826
Direct + Indirect GVA	0	1,628	12,779
* Values for intermediate scenario are those for the West of Scotland reserve only, as the values for Faroe-Shetland cannot be disclosed as they relate to the operations of fewer than five vessels.			

Significance of Combined and Cumulative Impacts on Marine Activities and Regions

8.1.8 This section considers the significance of economic impacts to marine activities and geographic areas taking account of the relative scale of the impacts both on their own and in combination with other marine initiatives, in particular:

- Development of offshore wind farms based on the currently proposed, consented, contracted and under construction wind farms163;
- Potential future offshore renewables development under the draft plan for wave and tidal energy developments in Scottish waters164, and the current Areas of Search (AoS) for offshore wind (noting that these will be superseded by new Draft Plan Options during 2019);
- The 30 Nature Conservation MPAs designated in 2014165;
- Offshore SACs;
- The implemented phase 1 measures in inshore MPAs and SACs166,167;
- The impact assessment of the draft (now proposed) SPAs;
- The SEIA of proposed phase 2 fisheries management measures in inshore MPAs and SACs168; and
- The SEIA of four proposed MPAs for mobile and benthic features (North-East Lewis, Sea of Hebrides, Shiant East Bank and Southern Trench).

8.1.9 The assessment of management measures for priority marine features (PMFs) is ongoing and is yet to be fully consulted upon. In consequence, it is not possible at this stage to determine whether there may be cumulative effects arising from interactions between the designation of a proposed deep sea marine reserve and PMFs, although the first phase of implementation is for inshore PMFs, so interaction is unlikely. This possibility will be assessed by the forthcoming SEIA for the PMF fisheries management measures.

8.1.10 For many of the marine activities, the potential quantified cost impacts associated with the designation of the proposed deep sea marine reserve are minor and will not be significant in their own right or in combination with other initiatives. Commercial fisheries may experience more significant impacts under the upper scenario as a result of designation of the proposed deep sea

[163] Marine Scotland, 2011. Blue Seas – Green Energy: A Sectoral Marine Plan for Offshore Wind Energy in Scottish Territorial Waters. Part A – The Plan.

[164] Marine Scotland, 2013. Planning Scotland's Seas: Sectoral Marine Plans for Offshore Wind, Wave and Tidal Energy in Scottish Waters - Consultation Draft, July 2013.

[165] Marine Scotland, 2013. Planning Scotland's Seas: 2013 - The Scottish Marine Protected Area Project – Developing the Evidence Base tor Impact Assessments and the Sustainability Appraisal Final Report.

[166] It is recognised that the data used (2012-2016) do not fully take account of changes to fishing patterns as a result of phase 1 MPA measures, therefore it is included in this in-combination assessment and not considered a sunken cost. Due to this the assessment may, therefore under/overestimate impacts.

[167] Marine Scotland Science, 2017. Scotland Marine Protected Areas Socioeconomic Monitoring. 2016 Report. Marine Analytical Unit, Marine Scotland Science, Scottish Government. Available online at http://www.gov.scot/Resource/0051/00514589.pdf. Accessed 19 April 2018.

[168] Marine Scotland, 2018. Proposed Inshore MPA/SAC Fisheries Management Measures – Phase 2. Socio-Economic Impact Assessment. October 2018. Report prepared by ABPmer & eftec for the Scottish Government.

marine reserve and the cumulative and in-combination impacts for this sector is therefore considered in more detail.

8.1.11 There is potential for cumulative effects on commercial fisheries, particularly with the management of other designations and the potential for restriction on fishing areas due to potential offshore wind Areas of Search and wave Draft Plan Option areas north and east of Lewis, and north of Shetland (Figure 6).

8.1.12 There is potential additional impact on commercial fisheries as a result of management measures in Nature Conservation MPAs and SACs that lie within the proposed deep sea marine reserve area. Any additional impact on UK vessels is expected to be minor.

8.1.13 The Nature Conservation MPAs and SACs that lie adjacent to or in proximity to the proposed deep sea marine reserve area have the potential to result in in-combination impacts on commercial fisheries, however due to the existing restrictions on trawling and netting in deep water, additional impacts are expected to be minor under the intermediate scenario. Under the upper scenario, the impact is mainly on the pelagic sector, and no management measures are anticipated for the pelagic sector in the other designations, therefore there is no in-combination impact.

8.1.14 The Seas off St Kilda and Seas off Foula pSPAs are located on the shelf in proximity to the proposed deep sea marine reserve. No management measures have yet been defined for the pSPAs therefore it is not possible to assess the potential for in-combination impacts.

8.1.15 The offshore wind Areas of Search[169] are early proposals and likely to be updated in the near future to Development Plan Option areas. The scenarios being considered are for 2, 4 and 8GW of offshore wind to be developed at national level, whilst the Areas of Search have the capacity to accommodate around 130GW. There is therefore considerable uncertainty in the location, scale and timing of development within these areas; some areas may not be developed at all, and it is unlikely that large areas within the Areas of Search will be developed during the study period.

8.1.16 Therefore, whilst there is potential for in-combination effects on fisheries, this is considered to be minor.

[169] Marine Scotland Science, 2018. Scoping 'Areas of Search' Study for offshore wind energy in Scottish Waters, 2018. Available at https://www.gov.scot/binaries/content/documents/govscot/publications/consultation-paper/2018/06/scoping-areas-search-study-offshore-wind-energy-scottish-waters-2018/documents/00536637-pdf/00536637-pdf/govscot%3Adocument.

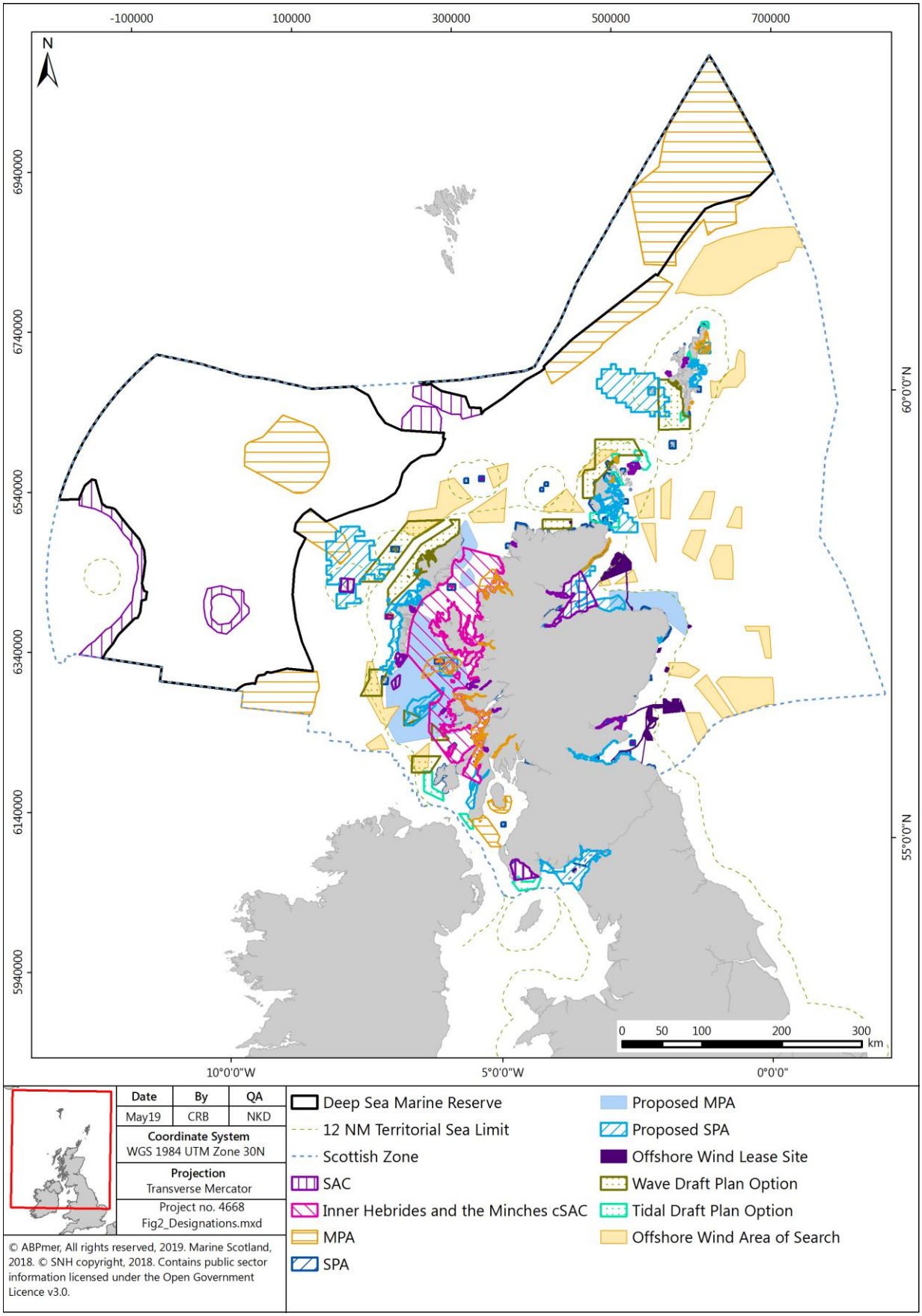

Figure 6 **Spatial information on MPAs, SACs and SPAs and sectors with potential for cumulative effects on commercial fisheries**

8.2 Social Impacts (commercial fisheries)

8.2.1 The two sites (WSR and FSR) are not expected to have significant social impacts, and therefore the combined and cumulative impacts of the FWC site will be similar to the sum of the two sites' impacts. The social impacts are assessed as low.

8.3 Public sector

8.3.1 The estimated total costs to the public sector, currently assumed to be centralised and therefore mostly attributed to JNCC and MS, are presented in Table 16. Potential future monitoring costs comprise the majority of the total public-sector costs. Additional costs may be associated with the preparation of Management Schemes and in determining and advising upon licence applications within or near to the proposed sites.

8.3.2 The total public sector costs under the intermediate scenario were estimated at around £3.2 million (present value over 20 years (2019 to 2038) at 2019 prices), of which approximately 80% was associated with future monitoring costs of pMPA features.

8.3.3 Should more local management of the sites be pursued, this is considered unlikely to materially change the costs to the public sector but would redistribute costs across a wider range of regulators and authorities.

8.4 Potential Benefits

8.4.1 Treating marine protected areas as a collection of individual and separate features providing separate ecosystem services potentially ignores any network effects that could occur from a set of MPAs. A number of adjacent marine reserves may demonstrate network effects, i.e. the benefit from the networks may be greater (or less) than the sum of the benefits from the individual MPAs. Some MPAs will protect replicates of habitats and features, and they may be connected through larval dispersal, thus making the MPA network more resilient to impacts. These effects are potentially of great importance in assessing the benefits of management measures in marine protected areas because of the lack of barriers and mobility of species.

8.4.2 A comparison can be made between the values for designation and management and commercial fisheries costs. The assessment of benefits has focussed on a review of the limited evidence that is available for deep sea ecosystems and services. While the sites undoubtedly support a considerable range and value of ecosystem services, evidence is extremely sparse, and so any assessment of changes in ecosystem services as a result of designation and management of the deep sea marine reserve options is highly uncertain.

8.4.3 The range of valuation evidence available gives indications of which ecosystem services that are impacted by management measures may be valuable to society. The important potential changes include fisheries services, both direct and indirect, climate regulation, and non-use values. The available evidence does suggest that members of the public are likely to hold non-use values for deep sea protection, associated with the protection of vulnerable species and habitats. The literature does not provide specific value estimates, but do indicate that such values exist and are significant (see section 7). It seems highly likely that the average WTP per household for conservation of the large deep sea areas under consideration would be greater, and possibly substantially greater, than the estimated cost to fisheries, which at approximately £1 million per year in the upper scenario and much less in the others, represents a very small amount per household in Scotland.

9 Limitations and Uncertainties

9.1 Overview

9.1.1 All of the estimates of costs and benefits are subject to significant uncertainties. Limitations and uncertainties in relation to marine activities, social impacts, public sector costs and environmental impacts are described below.

9.2 Marine Activities

9.2.1 Uncertainties in the location and nature of future activity in the marine environment also introduce an uncertainty in the estimation of costs and benefits. For example, for oil and gas, the location and scale of future development is particularly uncertain and the assessment has focussed on areas where potential for development has been identified. Similar uncertainties relate to future trends in ongoing activities such as commercial fishing (assumed landings values remain constant over the assessment period). Such assessments are therefore based on a significant degree of speculation about future levels of activity and are thus inherently uncertain.

9.2.2 As identified in section 3 and Appendix C, it has not been possible to estimate the cost of potential consequential impacts associated with designation, for example, the costs of delays to consenting processes or costs associated with reduced investor confidence. In addition, the potential opportunity costs for oil and gas and seabed mining under the intermediate and upper scenarios are not quantified. It is recognised that these costs, where they occur, may be significant.

9.2.3 It is recognised that the actual costs that may be incurred by specific activities within individual sites may be higher or lower than the 'average' values generated within this assessment. In addition, the consequential impacts in remote or fragile communities may have the potential to be greater than the estimates presented in this assessment.

9.2.4 VMS pings occur at least every two hours, and therefore do not provide a complete picture of fishing activity. However, by using data over a five-year period this limitation is minimised. The process of averaging landings data across pings may result in landings values being over- or under-estimated for individual pings. Data on the spatial distribution of under-12m vessels' activity is more limited, as they are not required to use VMS. Scotmap data is dated (2007-2011) and only captures a proportion of the fleet. It has been assumed that under-12m vessels are not affected by the proposed deep sea marine reserve, due to the distance from land and the physical characteristics of the waters in the proposed reserve areas.

9.2.5 The extent to which displacement of fishing activity will occur (rather than loss of the value of landings), and the nature of displacement (areas or gear types

to which effort might be displaced) is uncertain. The knock-on impacts in terms of environmental impacts, impacts on vessels affected and impacts on other vessels, are also uncertain. For the intermediate and upper estimates, it has been assumed that the value of landings affected is lost. However, in practice it is likely that at least part of the effort would be displaced, and this could result in additional environmental impacts, impacts on the vessels displaced, and on other vessels.

9.2.6 As the value of future landings cannot be forecast, it is assumed that the value of landings is constant over time. The average value of landings per year estimated for each site is therefore assumed to be the same in each of the 20 years covered by the impact assessment. In reality, it is likely that the value of landings in each site would fluctuate over time, depending on regulations, quotas, and environmental influences, and hence the estimated loss in landings may underestimate or overestimate the true future value of landings. As the GVA and employment estimates are based on the value of affected landings the same limitation applies.

9.2.7 Fishing patterns may have changed compared to the period from which data were used for the assessment (2013–2017). In particular, demersal trawling has been banned in waters below 800m. This has been taken account of in the assessment, and only demersal trawl data for 2017 has been included in the assessment, however this means the pattern of activity is based on only a single year of data and fishing patterns may vary between years.

9.2.8 The multipliers used to estimate the indirect GVA impacts and the direct plus indirect employment effect, that could be generated from the estimated reduction in the value of landings, relate to ‘Marine Fishing and Freshwater Fishing’ and not the specific gear types affected. They may, therefore, underestimate or overestimate the impacts. The multipliers – which are national multipliers – have been applied at the site level and regional/port level to estimate the economic impacts by site and by region/port. Local and regional multipliers are not available and hence the application of national multipliers may overestimate or underestimate the size and geographical distribution of impacts. Finally, application of the multipliers also assumes that a reduction in output is similar to a change in final demand and that there is no rise in the price of fish to offset the reductions in the value of landings.

9.2.9 Within this study, combined effects have been assessed as the sum of the individual impacts on the two sites, which in this case relates to the proposed combined reserve area. The assessment of combined benefits is subject to the same limitations as those identified for the site assessments. However, at this scale, additional evidence on the network value of MPAs is relevant. Due to the unique deep sea ecosystems protected, there are expected to be additional impacts from designation. Furthermore, the sites can cumulatively contribute to the resilience of marine ecosystem services in a way that is greater than the sum of the parts of the network, but there is little if any quantified evidence available to support this.

9.3 Social Impacts

9.3.1 The main potential social impacts identified within the assessment relate to impacts on the commercial fishing sector. Given the range of the economic impacts on commercial fishing identified across the scenarios analysed, the social consequences of the proposed management scenarios are also similarly uncertain.

9.3.2 However, the worst-case impacts identified under the upper scenario are relatively small, and are considered unlikely to have significant social effects. While there are uncertainties in the exact extent of these impacts, there is reasonable confidence in the general conclusion that they are unlikely to be economically or socially significant.

9.4 Public Sector

9.4.1 Costs on the public sector are uncertain and may be higher or lower than estimated. The scope, scale and frequency of monitoring requirements may significantly affect the estimates of public sector costs for monitoring. The costs include additional regulatory and advisory costs associated with licensing decisions are dependent on the number of licence applications that are brought forward, and this is subject to the same uncertainties as the cost impacts on relevant marine activities.

9.5 Environmental Impacts

9.5.1 In general, there is moderate uncertainty on the extent of ecosystem service impacts, although this varies across services. There is high uncertainty in the monetary valuation of these benefits, and robust values are not available to support cost-benefit analysis. See Section 7 for more detail.

Appendix A Sector Context, Assumptions and Assessment Methods

See separate document: Appendix A - Sector context

Appendix B Public Sector Costs

This appendix provides the assumptions used to assess the impacts of the designation of the proposed deep sea marine reserve areas on the public sector. The assumptions are reviewed in groupings of costs, as follows:

- Management schemes;
- Statutory instruments;
- Site monitoring;
- Compliance and enforcement;
- Promoting public understanding; and
- Regulatory and advisory costs associated with licensing decisions.

A.1 Marine Management Schemes

As part of the process of designation, 'Conservation Objectives and Advice to Support Management' documents are developed for new MPAs. Amongst other things, these set out the preferred management option and how this could be delivered. These documents represent a sunk cost as the work will largely be completed ahead of the decision to designate. The document is likely to provide a sufficient basis for coordinating management efforts and it is not expected that a more formal Marine Management Scheme would be required.

A.2 Statutory Instruments

Several different mechanisms may be used to restrict or regulate works or activities potentially affecting the proposed deep sea marine reserve areas. These factors are discussed in more detail in the following paragraphs:

- Fisheries management measures beyond 12 NM;
- Changes to existing MPA designations and management.

Fisheries management measures beyond 12nm

Currently, fisheries management measures in offshore waters need to be pursued through the Common Fisheries Policy (CFP), in consultation with the European Commission. Such measures would control the activities of all fishing vessels. The measures could introduce spatial restrictions on gear types, the targeting of particular species and the time periods for which such prohibitions would apply.

Outside the European Union, the UK will have powers to manage fisheries out to 200 NM. The Fisheries Bill, which will establish these powers, is currently progressing through Parliament. There is considerable uncertainty over the future relationship of the UK with the European Union, including with regards to the CFP, and when any changes to the relationship might come into force. Therefore, the standard cost for implementing a Statutory Instrument has been assumed to be £4,200 in 2019 prices, being the uprated cost of the mid-range of the estimate for a Marine Conservation Order provided

in RPA & ABPmer[170] (£3,500 at 2009 prices). In addition, the Sea Fish Licensing (Foreign Vessels) (EU Exit) (Scotland) Order 2019[171] prohibits foreign fishing boats from fishing within the Scottish zone without first obtaining a licence from the Scottish Ministers, and will come into force on exit day.

Changes to existing MPA designation and management

If the proposed Faroe-Shetland reserve, or the proposed Faroe-Shetland and West of Scotland reserve, is designated, the North-East Faroe-Shetland Channel Nature Conservation MPA would be de-designated and the protection afforded by this MPA would be subsumed within the proposed deep sea marine reserve.

Similarly, if the proposed West of Scotland reserve, or the proposed Faroe-Shetland and West of Scotland reserve, is designated, the Rosemary Bank Seamount Nature Conservation MPA would be de-designated and the protection afforded by this MPA would be subsumed within the proposed deep sea marine reserve. The cost associated with this is assumed to be £4,200 at 2019 prices in each case.

A.3 Site Monitoring

The costs of site surveys to characterise the proposed deep sea marine reserve areas in advance of designation have been treated as sunk costs because the expenditure has already occurred or has been budgeted. Following designation, there will be an ongoing requirement to undertake monitoring, both to improve understanding of the distribution of features and to monitor the condition of features to assess achievement of the feature-specific conservation objectives.

The costs of monitoring individual MPAs will vary depending on the locations of the sites and types of features for which the sites are designated. Offshore sites generally incur higher costs, owing to the requirement for larger vessels. As an example, the cost of the North-east Faroe-Shetland Channel survey doubled from expected costs to £700,000 (JNCC, pers. comm.).

There are already several designated sites within the deep sea marine reserve. Site condition monitoring is yet to take place in Anton Dohrn[172] but has occurred in various other designated sites that lie within in the proposed deep sea marine reserve areas[173]. Future monitoring will aim to assess the condition of site features; assess the degree to which management measures are effective in achieving conservation objectives; identify priorities for future management; and fulfil the government's MPA national and international assessment and reporting commitments and identify where further action is required[174]. These monitoring procedures are required as per the UK Marine and Coastal Access Act 2009, which requires the JNCC to report to ministers on the degree to which the conservation objectives of the protected features of Nature Conservation MPAs have been achieved[175]. The area of Anton Dohrn SAC is 1,429 km^2, which is

[171] http://www.legislation.gov.uk/ssi/2019/87/made

[172] JNCC. 2017. Anton Dohrn Seamount MPA. Available at: http://jncc.defra.gov.uk/page-6527. [Accessed on 07/02/2019].

[173] JNCC. 2018. JNCC Marine Survey Update. Available at: http://jnccoffshoresurvey.blogspot.com/search/label/Offshore%20Seabed%20Surveys. [Accessed on 11/02/2019]

[174] JNCC. 2017. North-East Faroe-Shetland Channel MPA. Available at: http://jncc.defra.gov.uk/page-6483. [Accessed on 07/02/2019]

[175] JNCC. 2017. North-East Faroe-Shetland Channel MPA. Available at: http://jncc.defra.gov.uk/page-6483. [Accessed on 07/02/2019]

located in the proposed West of Scotland reserve (107,773 km^2). The area of the North-East Faroe-Shetland Channel MPA is 23,682 km^2, which is in the proposed Faroe-Shetland reserve (area 36,226 km^2).

- For the purposes of this assessment, the following assumptions have been applied:
- A 30-day seabed habitat survey is estimated to cost £1.5 million[176]. This includes vessel, equipment and personnel costs, survey planning and management, analysis and reporting. Additional value could be added to the monitoring through cooperation with the research community to collect data to enhance understanding of ecology, genetics, ocean processes and interactions. Surveys would be carried out every 12 years, starting in 2022.
- A survey of deep water fish communities is estimated to cost £450,000 per survey. This includes vessel time, staff and equipment. Surveys are undertaken by JNCC and a long time-series of data is available, providing a picture of the fish community for the purposes of fishery management but that could also inform status assessments and the deep sea marine reserve monitoring programme. Given that these surveys are already undertaken, it is assumed that an additional cost of £100,000 is incurred to make amendments or additions to haul locations to accommodate monitoring needs for the proposed deep sea marine reserve areas. Surveys would be carried out every 2 years (in line with current surveys), with the first survey in 2021.
- For the proposed Faroe-Shetland reserve, monitoring would be of benthic features and seabed habitats. Two thirds of the proposed reserve is already designated as the North-East Faroe-Shetland Channel Nature Conservation MPA. Therefore the additional monitoring costs have been assumed as 33% of the costs of a 30-day seabed habitat survey.
- For the proposed West of Scotland reserve, monitoring would be of both seabed habitats and deep water fish communities. For the proposed Faroe-Shetland and West of Scotland reserve, it is assumed that the survey costs for benthic habitats in the proposed Faroe-Shetland reserve and in the proposed West of Scotland reserve are additive.

The monitoring cost assumptions are indicative and will depend on monitoring priorities and frequency of surveys determined under the Scottish MPA Monitoring Strategy.

A.4 Compliance and Enforcement

Where management measures are necessary to support the achievement of conservation objectives for individual features within the proposed deep sea marine reserve, a level of compliance and enforcement activity may be required. For licensable activities, this is likely to primarily entail scrutiny of monitoring returns provided by operators in fulfilment of conditions in their licences and in most cases is likely to impose only a minimal administrative burden on regulators.

[176] Pers. comm., JNCC.

For unlicensed activity, some additional site-based monitoring could be required. For commercial fishing activity, Vessel Monitoring System (VMS) data will provide a good source of information on spatial activity for vessels over 12 metres in length, and available data indicate that vessels under 12 metres in length do not fish in the deep sea marine reserve areas. However, since the intermediate scenario restricts certain gear types but not all gear types, some additional inspection activity may be required.

In the future, remote sensing technologies or high frequency VMS technologies may be able to be used to indicate gear types being deployed. Marine Scotland Compliance have three Marine Protection Vessels (MPV), two light aircraft that are deployed on fisheries enforcement activities in Scottish inshore and offshore waters[177]. Compliance and inspection monitoring for fisheries will be necessary as part of general fisheries enforcement, and therefore it is assumed that there will be no additional enforcement costs.

A.5 Promoting Public Understanding

Once designated, a level of promotion of the MPAs and their management plans will be undertaken. This may take a variety of forms including provision of information via the internet, including within Marine Scotland Interactive. The costs associated with these activities are generally considered to be part of normal corporate activity for Marine Scotland and SNH and for the purposes of this assessment it has therefore been assumed that no additional costs will be incurred.

A.6 Regulatory and Advisory Costs Associated with Licensing Decisions

Where licensed development is proposed in the vicinity of the proposed deep sea marine reserve areas, developers may be required to provide an assessment of the potential impacts of the development on those features as part of their overall development application to meet legislative requirements.

For MPAs, under the Marine (Scotland) Act 2010 and Marine and Coastal Access Act 2009, where it is concluded that a proposed development is capable of affecting other than insignificantly a protected feature of an MPA, a more detailed assessment of the potential impact is required. This will entail additional review effort by regulators and their advisors (e.g. JNCC[178]). To consider this extra cost to regulators, 10% of the cost of additional assessment requirements for sectors to prepare submissions relating to MPAs has been added[179].

The main areas identified where additional costs may be incurred in reviewing licensing and consent applications include oil and gas, power interconnectors, telecommunication cables and seabed mining.

The cost impacts identified above will fall on the lead regulators for the relevant licensing regimes but also on JNCC, the statutory nature conservation body.

[177] Marine Scotland. 2017. Fleet & Aircraft. Available at: https://www2.gov.scot/Topics/marine/Compliance/resources/ [Accessed on 04/02/2019]

[178] In accordance with the Section 127 of The Marine & Coastal Access Act (2009), the JNCC have a statutory responsibility to advise the regulator on any proposal that may be capable of affecting the site's features or may hinder the achievement of the sites conservation objectives. JNCC, 2017. North East Faroe Shetland Channel MPA. Available at: http://jncc.defra.gov.uk/page 6483. Accessed on 07/02/2019.

[179] RPA & ABPmer (2009). Full Regulatory Impact Assessment: Scottish Marine Bill.

Appendix C Site Assessments

See separate document: Appendix C - Site Assessment Tables

Appendix D Abbreviations

AA	Appropriate Assessment
ABNJ	Areas Beyond National Jurisdiction
AoS	Area of Search
bbl	Per barrel
BEIS	Department for Business, Energy and Industrial Strategy
BGS	British Geological Survey
BMSY	The biomass that would provide maximum sustainable yield of a fish stock
boe	Barrels of oil equivalent
boepd	Barrels of oil equivalent per day
BRIA	Business and Regulatory Impact Assessment
CCS	Carbon capture and storage
CFP	Common Fisheries Policy
cSAC	Candidate SAC
DASA	Defence Analytical Services and Advice
EC	European Commission
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
ENSG	Electricity Networks Strategy Group
ES	Ecosystem Services
ESCA	European Subsea Cables Association
EU	European Union
FeAST	Feature Activity Sensitivity Tool
FWC	Faroe-Shetland and West of Scotland reserve
FSR	Faroe-Shetland reserve
FTE	Full-Time Equivalent
GDP	Gross Domestic Product
GVA	Gross Value Added
HM	Her Majesty's
HMNB	Her Majesty’s Naval Base
IA	Impact Assessment
ICES	International Council for the Exploration of the Sea
ISA	International Seabed Authority

ISLES	Irish Scottish links on energy study
JNCC	Joint Nature Conservation Committee
KIS-ORCA	Kingfisher Information Service - Offshore Renewable & Cable Awareness
MarLIN	Marine Life Information Network
MCCIP	Marine Climate Change Impacts Partnership
MCO	Marine Conservation Order
MCZ	Marine Conservation Zone
MESAT	Marine Environment and Sustainability Assessment Tool
MMO	Marine Management Organisation
MoD	Ministry of Defence
MPA	Marine Protected Area
MSY	Maximum Sustainable Yield
mtoe	Million tonnes of oil equivalent
MW	Megawatt
N.D.	Non disclosive
NATO	North Atlantic Treaty Organization
NCMPA	Nature Conservation Marine Protected Area
NEA	National Ecosystem Assessment
NGL	Natural gas liquids
NM	Nautical mile
NMPi	National Marine Plan interactive
NOAA	National Oceanographic and Atmospheric Administration
Ofgem	Office of the Gas and Electricity Markets
OGA	Oil and Gas Authority
OSPAR	Oslo-Paris Agreement
PEXA	Practice and Exercise Areas
PMF	Priority Marine Feature
pMPA	Proposed Marine Protected Area
pSPA	Potential Special Protection Area
PV	Present Value
RAF	Royal Air Force
WSR	West of Scotland reserve
SA	Sustainability Appraisal
SAC	Special Area of Conservation

Appendix D: Abbreviations

SEA	Strategic Environmental Assessment
SEIA	Social and Economic Impact Assessment
SEPA	Scottish Environmental Protection Agency
SPA	Special Protection Area
STECF	Social, Technical and Economic Committee on Fisheries
TAC	Total Allowable Catch
UK	United Kingdom
UKCS	UK Continental Shelf
UKHO	UK Hydrographic Office
UKMMAS	United Kingdom Marine Monitoring and Assessment Strategy
UNCLOS	United Nations Convention on the Law of the Sea
VME	Vulnerable Marine Ecosystem
VMS	Vessel Monitoring System