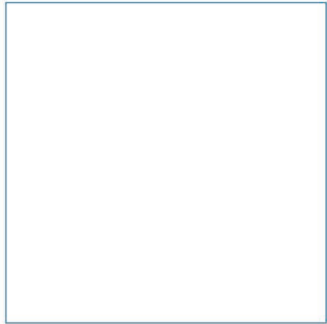
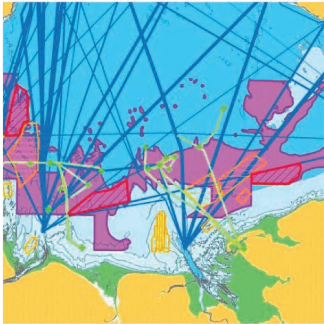
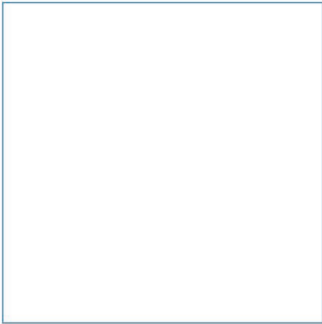
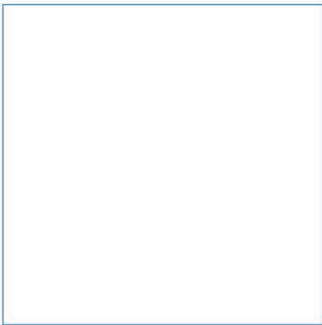
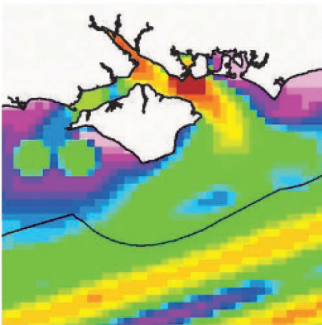


**NFFO & SFF**

# **Spatial Squeeze in Fisheries**

Final Report

June 2022



Innovative Thinking - Sustainable Solutions

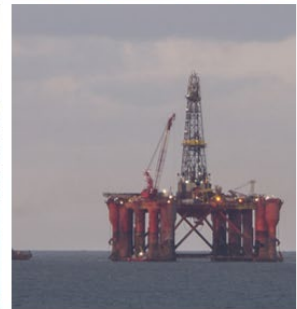
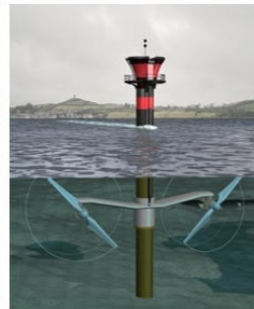


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# Spatial Squeeze in Fisheries




## Final Report

June 2022



# Document Information

Document History and Authorisation		
<b>Title</b>	Spatial Squeeze in Fisheries	
	Final Report	
<b>Commissioned by</b>	NFFO & SFF	
<b>Issue date</b>	June 2022	
<b>Document ref</b>	R.3900	
<b>Project no</b>	R/5058/1	
Date	Version	Revision Details
11/04/2022	1	Issue for client review
23/06/2022	2	Issue for client use

Prepared (PM)	Approved (QM)	Authorised (PD)
S.F. Walmsley	N.J. Frost	S.C. Hull
		

## Suggested Citation

ABPmer, (2022). Spatial Squeeze in Fisheries, Final Report, ABPmer Report No. R.3900.  
A report produced by ABPmer for NFFO & SFF, June 2022.

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## Acknowledgements

The authors thank Kingfisher for providing spatial data on fisheries restrictions by gear type and oil and gas safety zones, The Crown Estate for providing active dredge zone data, and the Crown Estate Scotland for providing historical aquaculture lease data.

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# Preface

The genesis of this report, by a respected and authoritative consultancy, lies in the mounting concerns within the fishing industry across the UK about the loss of fishing grounds to an array of competing spatial pressures of which offshore wind and marine protected areas top the list.

Unlike agriculture, fishermen do not hold property rights over their production areas, and this means there is almost limitless scope for displacement. We are already seeing its effects. This report shows that the outlook ahead is truly frightening.

As fishing is regarded as a soft parameter (rather than a hard constraint) when siting wind farms, and marine protected areas have a statutory basis, marine spatial planning has not provided, to date, any kind of effective safeguard for fishing. With governments' proposed substitution of balance for prioritisation as the guiding principle in marine spatial planning, our concerns have only intensified. Net zero and biodiversity loss will be prioritised over and above fishing, despite fishing's value in producing low carbon, healthy and sustainable food, contributing to our food security and supporting our coastal communities. But it is possible to minimise the impact on fishing considerably through better planning and through the design and implementation process.

A strategic approach to understanding and dealing with the potential for displacement is needed and requires:

- An understanding of the cumulative impact on fishing of all aspects of the spatial squeeze;
- A robust analysis of displacement effects including unintended consequences; and
- The design and implementation of mitigation measures to minimise impacts on fishing businesses and fishing communities.

It is the first of these bullets that this report *begins* to address. We say *begins*, because we are aware of its limitations. The report has undertaken a detailed and evidence-based analysis of future scenarios across a range of maritime sectors and the implications for fisheries. However, this is the start, not the conclusion, of our attempts to understand and deal with what may lie ahead for the fishing industry:

- The report focuses on mobile bottom trawling because this is the fleet sector where most data are available and is already being impacted by displacement from MPAs and offshore wind farms, but others will rapidly follow.
- Direct and indirect displacement effects will, however, also impact heavily on pelagic fishing and on static gears and it is of paramount importance that the consequences for these sectors are understood and avoided or mitigated.
- Importantly, we need to assess the impact of displacement not just on the UK fleet, but on all fleets that fish in the UK's waters – primarily the EU who have unfettered access to the UK EEZ at least in the short term, and also those fleets that secure access on an annual basis, such as Norway. Displacement effects on these vessels will be a very important factor and as these fleets are also facing displacement in their own waters, so the effect on our UK fleet becomes further amplified.
- Finally, the choice of baseline against which displacement is measured is significant – choice of baseline year, and what potential displacement looks like under different scenarios – this is something that requires further investigation.
- Clearly, the farther ahead in time we look, the more assumptions have to be made about future scenarios – these will need to be refined as policies develop and more definitive information becomes available.

- We make no apologies for making evidence-based assumptions about the future – it is imperative that we can consider the cumulative impact not just at present but looking ahead to a range of scenarios, as we must avoid the effects of displacement being seen too late that changes are irreversible.

This report should therefore be seen as an important starting point and call for action, rather than a final definitive analysis of where we are heading. But it sends very clear signals about the risks for fishing from the spatial squeeze in our increasingly crowded seas, with major consequential impacts on our ability to continue to produce low-carbon food safely and efficiently.

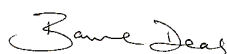
Indeed, the fact that the displacement outcomes under the different scenarios presented are so varied provides every reason for those involved – including governments, fishing industry, offshore developers, science institutes, statutory advisors – to develop strategies to minimise the impact on fishing. The war in Ukraine have emphasised how vulnerable our food security can be to external shocks. If this report stimulates a serious debate on how to safeguard priority food production, it will have done its job.

In many ways the most significant statistics generated by this report are those that illustrate the difference between the best-case scenario and the worst-case scenario. We are unlikely to have much influence over some of the major drivers behind the spatial squeeze. But we don't have to fatalistically accept that fishers, the original sea-bed users, should be expelled from their grounds. We can – and indeed must – ensure that there are meaningful and effective policy solutions to minimise and mitigate against displacement outcomes, and especially the most extreme ones.

Planning and design decisions and government policy choices can make a huge difference. Above all there is an urgent need to understand what the impact of displacement means. We already have marine plans. They say the right things about protecting fishing but fall down in how they are implemented and don't give sufficient protection to our industry. Governments need to look at existing plans and the tools and mechanisms within them to bring the balance that our marine planning systems currently lack.

We need more holistic planning systems that value and protect a legitimate, sustainable and long-established industry that remains at the core of many of our coastal communities and contributes to both our national food security as well as our international trade. A good place to start would be to grant the main fishing federations the status of statutory consultees. It is monstrous that fishing businesses and fishing communities are denied an equal say when we are the sector likely to feel the most significant impact.

Finally, we are grateful to the Honourable Fishmongers Company for financial support in the production of the report.



Barrie Deas  
CEO, National Federation of Fishermen's  
Organisations



Elspeth Macdonald  
CEO, Scottish Fishermen's Federation

# Executive Summary

The marine environment is an important resource. It contributes to economic growth and livelihoods as well as playing an important role in climate change mitigation. Increasing activity levels from a range of sectors, as well as the need to ensure protection of marine habitats and species, is leading to increasing spatial demands in our seas. The commercial fishing sector is experiencing 'spatial squeeze', with its traditional fishing grounds under increasing competition from other sectors and policies looking to expand in the marine environment.

Established sectors such as fishing, aquaculture, extraction of marine aggregates, oil and gas production, and ports and shipping, now exist alongside new and emerging sectors such as renewable energy (wind, wave and tidal). The target to achieve Net Zero by 2050 – and by 2045 in Scotland – together with recent disruptions to other energy supplies, provides an incentive for increased deployment of marine renewable energy technologies. In addition, the need to ensure protection of marine habitats and species and targets to protect 30% of the marine environment by 2030 are leading to increased designation of protected areas and associated restrictions on activities.

The competition for marine space needs to be carefully managed, to ensure that new industries can establish, co-existence can occur where feasible, and existing sectors are able to thrive.

## Approach

This report explores past, present and future scenarios for a selection of key sectors, to quantify and visualise the spatial demands of existing and forthcoming projects, plans and policies, and their potential implications for the areas available to commercial fishing. Five scenarios were developed and mapped using best available evidence. The future scenarios are based on sector projections and growth rates and aim to represent a realistic future development pathway for each sector (Figure ES1). The scenarios were:

- Past (2000);
- Present (2020/2021, depending on latest year of data available for each sector);
- Future 1 (2030);
- Future 2 (2050);
- Future 3 (2050, with worst-case assumptions in relation to compatibility with fishing activity).

The following sectors were considered:

- Fishing and fisheries management-related restrictions;
- Nature conservation such as restrictions on fishing in protected areas; and
- Offshore renewable energy development (wind, wave and tidal).
- Aggregate dredging;
- Aquaculture (finfish, shellfish and seaweed);
- Cables (including power interconnectors, offshore power distribution network cables, power cables to and from offshore infrastructure and telecom cables); and
- Oil and gas infrastructure.

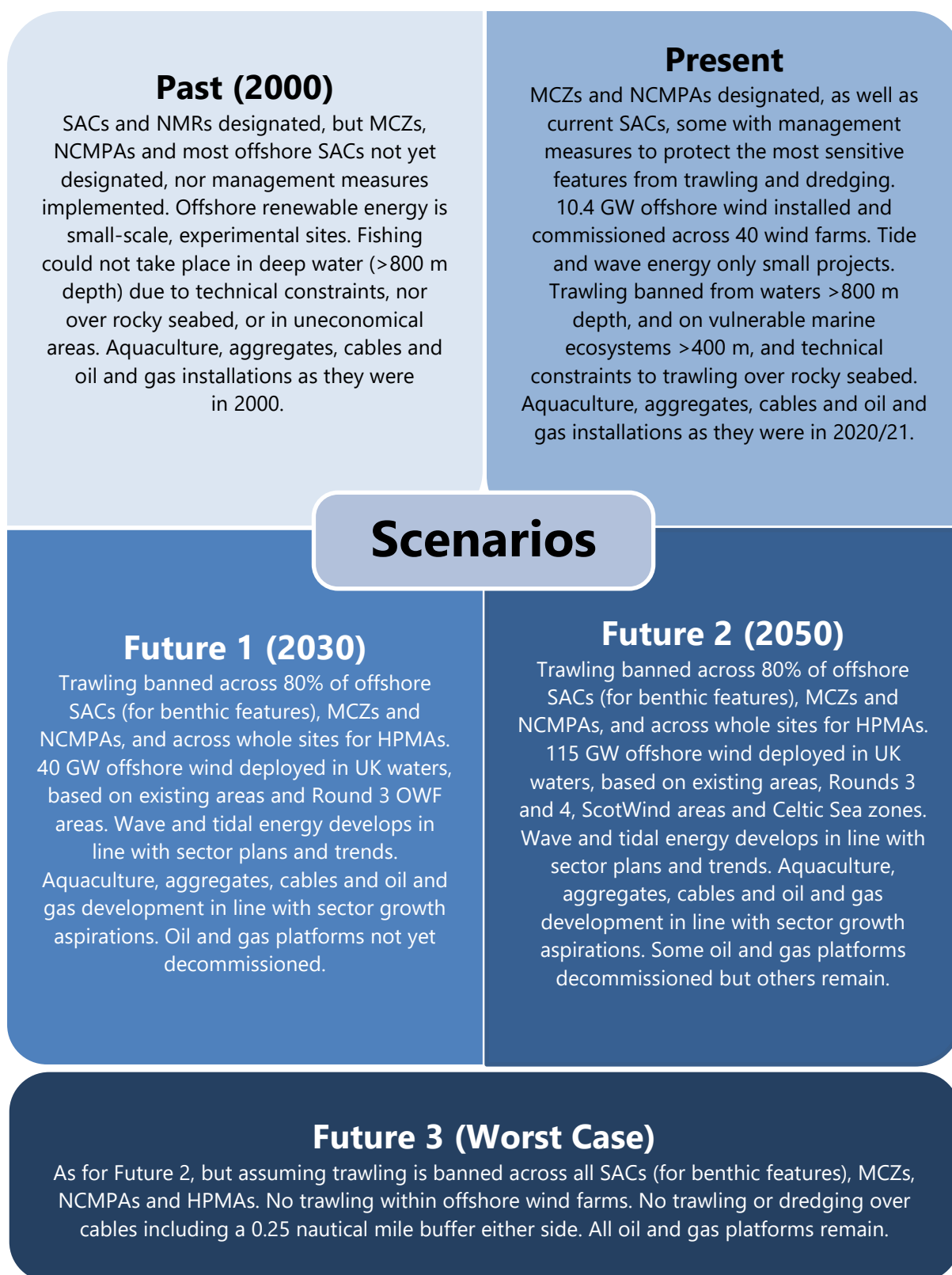


Figure ES1. Summary of Scenarios

The fishing industry is diverse, ranging from small inshore vessels to ocean-going vessels over-70 m in length. A range of gear types are used, including static gears (pots, nets, lines) and mobile gears (demersal and pelagic trawls, seines and dredges) to catch a diversity of fish and shellfish. The UK's fishing and fish processing industries employ 24,000 people and contribute £1.4 billion to the UK economy. The industry is particularly important at a local level in coastal and island communities and contributes to food security through the provision of healthy, nutritious climate-smart protein.

This report focusses on demersal trawling activity, and potential restrictions on it. The mobile gear sector (dredges, trawls and seines) makes up 79% of UK landings by value, and trawls and seines landing demersal and shellfish species make up the largest proportion of UK landings by value for any gear category (38%). Further work could investigate spatial squeeze on other gear types, which may be affected differently, and the effects of displacement on non-UK fleets that are facing similar spatial pressures, adding to the squeeze faced by the UK fleet.

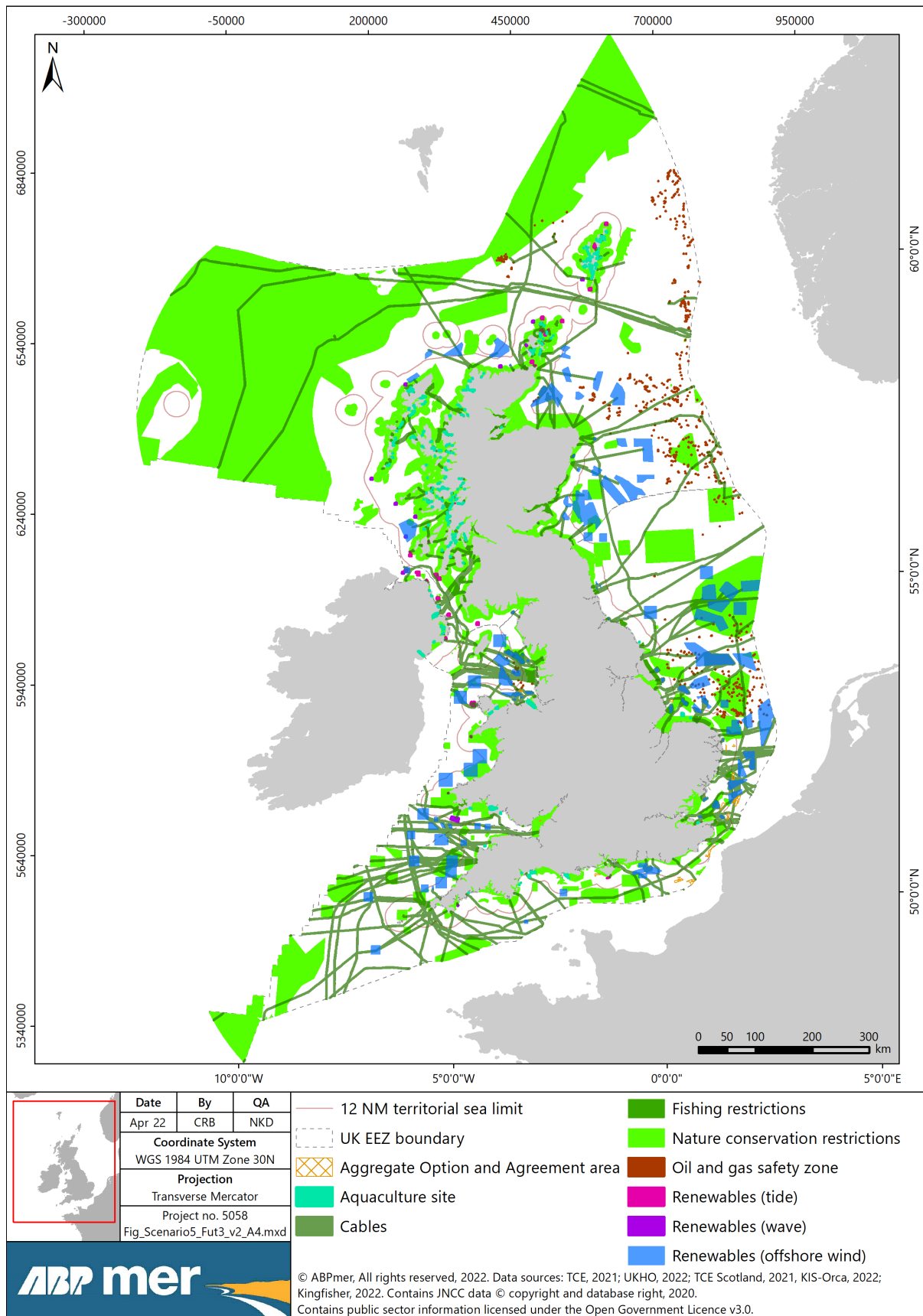
## Scenario Results

The scenarios demonstrate a significant increase in activity and demand for space from a range of sectors. In the Past scenario, fishing was relatively unconstrained in where it could operate across the UK EEZ, with only 2,887 km<sup>2</sup> (0.39% of the EEZ) having restrictions on trawling activity.

Substantial progress has been made in implementing fisheries measures in inshore MPAs, and in the development and roll-out of offshore wind. In the Present scenario, the overall spatial footprint of activities or policies that spatially constrain trawling is 169,966 km<sup>2</sup>, representing 23 % of the UK EEZ. To date, this has been achieved with a relatively minor impact on fishing overall, reflected in the ability of the UK fleet to maintain the quantity and value of landings, but at a more local scale, the magnitude of impact can be much more significant.

In contrast, by 2050, potentially 356,834 km<sup>2</sup> of the UK EEZ could be subject to trawling restrictions under the worst-case future Scenario 3, representing 49 % of the EEZ (Figure ES2). The spatial footprint in 2050 arises predominantly from (Figure ES3):

- Implementation of fisheries management measures in marine protected areas (MPAs) and the introduction of Highly Protected Marine Areas (HPMAs);
- Offshore wind, with Net Zero targets resulting in an estimated 115 GW of offshore wind capacity by 2050, occupying 31,500 km<sup>2</sup> of sea space;
- Cables (including power interconnectors, offshore power distribution network cables, power cables to and from offshore infrastructure and telecom cables), affecting 25,500 km<sup>2</sup> of space if a 0.25 nautical mile no-trawling buffer is applied to cables.



Note: Does not include spatial representation of HPMA in Scotland, or new aquaculture sites

Figure ES2. Future 3 scenario, all sectors

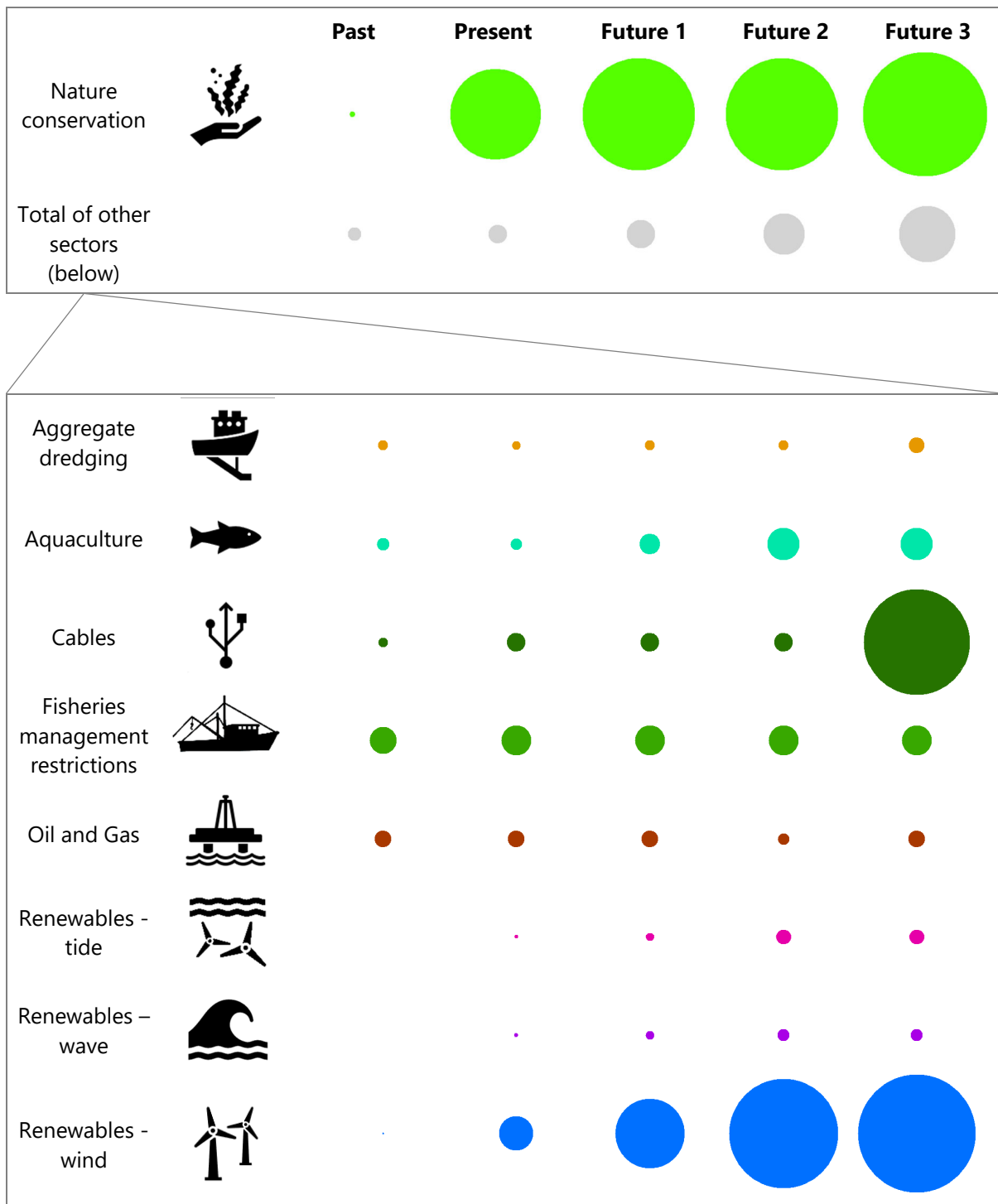


Figure ES3. Relative area of each sector under each scenario

## Conclusions

UK seas are at a critical juncture, with the demand for marine space projected to increase substantially over the next 10-30 years (Figure ES3). Nature conservation (MPAs<sup>1</sup>, SACs, MCZs and HPMAs and associated restrictions on fisheries) and the development of offshore wind have particularly large future spatial footprints which are likely to restrict access for mobile fishing gears.

This is not just a marginal or incremental change. The extent of these likely restrictions on fishing activity are of a scale not previously seen before and will have significant implications for fisheries and their future viability.

At a local or regional level, fisheries may be impacted even more severely, particularly for local inshore fleets with limited operational range. Increasing restrictions associated with the footprint of other uses can result in significant spatial squeeze on local fishing grounds, which is explored in the report through local case studies.

Some aspects of the future scenarios were not possible to map spatially due to lack of information on potential location – HPMA in Scotland, and future aquaculture sites, particularly for seaweed cultivation. The implementation of these, depending on where they are located, has the potential to also cause substantial impacts on fishing, affecting all gear types.

The displacement of fishing activity under these future scenarios could be significant, and of a magnitude that cannot be absorbed by the remaining fishing grounds. This could lead to reductions in output and job losses in the fishing industry, and upstream and downstream impacts on associated land-based industries, with particular effects in coastal communities. The spatial displacement of fishing from existing fishing grounds will also have knock-on effects on the areas to which effort is displaced to, leading to conflict with other fleet segments and greater environmental impacts at these locations.

Fishing tends to be concentrated in core areas that account for the majority of effort, with extensive margins. It is important that new developments and nature conservation policies and regulations in the marine area take this into account and seek to minimise displacement of fishing effort. Where there is no alternative, then priority should be given to avoiding displacing fishing from key fishing grounds, intensively fished core areas and areas where fishing activities are sensitive to displacement.

The future scenarios highlight the importance of enabling co-existence and co-location. This could be achieved by co-locating OWF with MPAs in appropriate circumstances and enabling coexistence with fishing in the vicinity of cables, within wind farm arrays and in MPAs, where feasible.

Different fisheries (gear type, target species) have different spatial footprints, and different inter-annual variability in their fishing footprints. This study has focussed on restrictions to demersal trawling, but other gear types (e.g. dredges, demersal seines, pelagic gears, nets, pots and traps) should also be considered. In addition, climate change pressures are resulting in changes to the distribution of fish stocks (ICES, 2017), and fisheries need the spatial flexibility to adapt to these changes.

The ability of the fishing industry to continue to produce healthy protein and contribute to food security and coastal communities depends on its future viability. This in turn will require close collaboration and cooperation with other sectors that are increasing their spatial footprint in the marine area, to ensure

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<sup>1</sup> Priority Marine Features (PMFs) in Scotland have not been explicitly included in the analysis, although the implementation of a 3 NM trawling exclusion zone in the Future 3 scenario (and a 3 NM zone with an effort cap in the Future 2 scenario) may coincide with potential management measures for PMFs.

that such developments and nature conservation restrictions occur in a way that is compatible with the continuation of fishing activity and the viability of fishing businesses.

Key measures to facilitate this include:

- Recognition of the importance of fishing for both food production and livelihoods, and its effective integration and prioritisation into the marine spatial planning and decision-making systems. This should be based on genuine co-management of our seas that involves those whose lives and livelihoods are at stake, and who may have limited or no alternative means to pursue their legitimate and long-standing activity.
- Regulators and regulatory systems (including licensing and consenting) should be accountable for decisions and their consequences, applying a hierarchy for spatial decision-making to minimise conflict, i.e. avoid, minimise, mitigate.
- An improved evidence base for fisheries in marine spatial planning, including identification of key fishing grounds for different gear types and fleet segments, improved information on where fishing occurs particularly for smaller vessels, and dependencies on specific areas. This would help facilitate the identification and protection of key fishing grounds, and those identified as sensitive to displacement impacts through marine spatial planning, whilst building in flexibility to accommodate future changes in species' distributions.
- Key fishing industry representatives should be given a stronger and more effective voice in the planning process, at both and plan and project level, to ensure that the potential impact on the fishing industry of proposed activities are adequately expressed and considered. This includes early and effective engagement of stakeholders at local, national and international level. Involvement in the decision-making process can help to minimise impacts on key fishing grounds, and to maximise potential for co-existence through technology choice, design and siting (for developments) and mitigation, innovation and management (for nature conservation).
- Partnership working and a strategic approach to future nature conservation measures, including HPMA's, that maximise the conservation benefits whilst minimising impacts on the fishing industry, taking into account scientific advice.
- Financial support to the fishing industry to enable adjustment to new measures and restrictions, where impacts cannot be avoided.

# Contents

1	Introduction.....	1
2	Scenarios and Approach.....	3
3	Past Scenario (2000).....	7
4	Present Scenario (2020/2021).....	9
5	Future 1 Scenario (2030).....	11
6	Future 2 Scenario (2050).....	13
7	Future 3 Scenario (2050).....	15
8	Local Case Studies.....	17
	8.1 The Wash and off the Humber Estuary.....	17
	8.2 Moray Firth.....	19
9	Conclusions.....	22
10	References.....	25
11	Abbreviations/Acronyms.....	29

## Appendices

A	Fishing Sector Assumptions and Scenarios.....	31
	A.1 Assumptions.....	31
	A.2 Areas by Scenario.....	32
B	Marine Protected Areas and Nature Conservation Assumptions and Scenarios.....	38
	B.1 Assumptions.....	38
	B.2 Areas by Scenario.....	40
C	Offshore Renewables Sector Assumptions and Scenarios.....	46
	C.1 Wind.....	46
	C.2 Wave.....	55
	C.3 Tidal.....	61
D	Aggregates.....	68
	D.1 Assumptions.....	68
	D.2 Areas by Scenario.....	69
E	Aquaculture.....	75
	E.1 Assumptions.....	75
	E.2 Areas by Scenario.....	83
F	Cables.....	89
	F.1 Assumptions.....	89
	F.2 Areas by Scenario.....	91

G	Oil and Gas.....	97
G.1	Assumptions.....	97
G.2	Areas by Scenario.....	98
H	Sector Statistics by Devolved Administration .....	104
H.1	Past Scenario.....	106
H.2	Present Scenario.....	106
H.3	Future 1 Scenario .....	107
H.4	Future 2 Scenario .....	107
H.5	Future 3 Scenario .....	108
I	Local Case Study Maps.....	109
I.1	Islay.....	109
I.2	Moray Firth .....	114
I.3	Orkney.....	119
I.4	Outer Thames Estuary.....	124
I.5	The Wash and off the Humber Estuary .....	129

## Tables

Table 1.	Areas restricted to trawling in the Past scenario.....	7
Table 2.	Areas restricted to trawling in the Present scenario .....	9
Table 3.	Areas restricted to trawling in the Future 1 scenario.....	11
Table 4.	Areas restricted to trawling in the Future 2 scenario.....	13
Table 5.	Areas restricted to trawling in the Future 3 scenario.....	15
Table A1.	Fishing assumptions.....	32
Table A2.	Areas of fisheries management measures (year-round restrictions on trawling) by scenario (including some restrictions for military and food safety purposes), and as a percentage of UK EEZ.....	32
Table B1.	Marine protected areas and conservation sector assumptions.....	38
Table B2.	Areas of nature conservation restrictions on trawling by scenario, and as a percentage of UK EEZ.....	40
Table C1.	Offshore renewables assumptions – wind .....	47
Table C2.	Areas of offshore wind developments that restrict trawling by scenario, and as a percentage of UK EEZ.....	49
Table C3.	Wave energy sites – operational and in the planning system .....	55
Table C4.	Offshore renewables assumptions – wave.....	55
Table C5.	Areas of wave energy developments by scenario, and as a percentage of UK EEZ .....	56
Table C6.	Tidal energy sites – operational and in the planning system.....	61
Table C7.	Offshore renewables assumptions – tidal .....	62
Table C8.	Areas of tidal energy developments that restrict trawling by scenario, and as a percentage of UK EEZ.....	63
Table D1.	Aggregates assumptions .....	68
Table D2.	Areas of aggregate extraction by scenario, and as a percentage of UK EEZ .....	69

Table E1.	Aquaculture assumptions – Finfish .....	75
Table E2.	Aquaculture assumptions – Shellfish .....	77
Table E3.	Aquaculture assumptions – Seaweed .....	80
Table E4.	Assumptions on aquaculture production (tonnes) by aquaculture type and devolved administration for each scenario.....	82
Table E5.	Areas involved in aquaculture (km <sup>2</sup> ) by aquaculture type and devolved administration for each scenario .....	82
Table E6.	Areas of aquaculture by scenario, and as a percentage of UK EEZ.....	83
Table F1.	Cables assumptions.....	89
Table F2.	Proposed cables, routes, and whether they are already included in KIS-Orca data .....	90
Table F3.	Areas of cables restricting trawling by scenario, and as a percentage of UK EEZ.....	91
Table G1.	Oil and Gas decommissioning plans by region .....	97
Table G2.	Oil and Gas assumptions.....	97
Table G3.	Areas of oil and gas by scenario, and as a percentage of UK EEZ.....	98
Table H1.	UK EEZ area, by Devolved Administration .....	104
Table H2.	Areas for each sector, by Devolved Administration, for the Past scenario .....	106
Table H3.	Areas for each sector, by Devolved Administration, for the Present scenario .....	106
Table H4.	Areas for each sector, by Devolved Administration, for the Future 1 scenario.....	107
Table H5.	Areas for each sector, by Devolved Administration, for the Future 2 scenario.....	107
Table H6.	Areas for each sector, by Devolved Administration, for the Future 3 scenario.....	108

## Figures

Figure ES1.	Summary of Scenarios .....	v
Figure ES2.	Future 3 scenario, all sectors .....	vii
Figure ES3.	Relative area of each sector under each scenario.....	viii
Figure 1.	Example sectors present in the marine environment .....	1
Figure 2.	Summary of scenarios for each sector .....	6
Figure 3.	Area occupied by each sector in the Past scenario .....	7
Figure 4.	Past scenario, all sectors.....	8
Figure 5.	Area occupied by each sector in the Present scenario .....	9
Figure 6.	Present scenario, all sectors.....	10
Figure 7.	Area occupied by each sector in the Future 1 scenario.....	11
Figure 8.	Future 1 scenario, all sectors .....	12
Figure 9.	Area occupied by each sector in the Future 2 scenario.....	13
Figure 10.	Future 2 scenario, all sectors .....	14
Figure 11.	Area occupied by each sector in the Future 3 scenario.....	15
Figure 12.	Future 3 scenario, all sectors .....	16
Figure 13.	Local case study: The Wash and off the Humber Estuary – Future 3 scenario.....	18
Figure 14.	Local case study: Moray Firth – Future 3 scenario .....	21
Figure 15.	Relative area of each sector under each scenario.....	22
Figure A1.	Proportion of UK landings by value, by gear type (average 2016-2020) .....	31
Figure A2.	Fishing restrictions – Past scenario .....	33
Figure A3.	Fishing restrictions – Present scenario .....	34
Figure A4.	Fishing restrictions – Future 1 scenario.....	35

Figure A5.	Fishing restrictions – Future 2 scenario.....	36
Figure A6.	Fishing restrictions – Future 3 scenario.....	37
Figure B1.	Nature Conservation – Past scenario.....	41
Figure B2.	Nature conservation – Present scenario.....	42
Figure B3.	Nature conservation – Future 1 scenario.....	43
Figure B4.	Nature conservation – Future 2 scenario.....	44
Figure B5.	Nature conservation – Future 3 scenario.....	45
Figure C1.	Offshore wind – Past scenario.....	50
Figure C2.	Offshore wind – Present scenario.....	51
Figure C3.	Offshore wind – Future 1 scenario.....	52
Figure C4.	Offshore wind – Future 2 scenario.....	53
Figure C5.	Offshore wind – Future 3 scenario.....	54
Figure C6.	Wave energy – Present scenario.....	57
Figure C7.	Wave energy – Future 1 scenario.....	58
Figure C8.	Wave energy – Future 2 scenario.....	59
Figure C9.	Wave energy – Future 3 scenario.....	60
Figure C10.	Tidal energy – Present scenario.....	64
Figure C11.	Tidal energy – Future 1 scenario.....	65
Figure C12.	Tidal energy – Future 2 scenario.....	66
Figure C13.	Tidal energy – Future 3 scenario.....	67
Figure D1.	Aggregates – Past scenario.....	70
Figure D2.	Aggregates – Present scenario.....	71
Figure D3.	Aggregates – Future 1 scenario.....	72
Figure D4.	Aggregates – Future 2 scenario.....	73
Figure D5.	Aggregates – Future 3 scenario.....	74
Figure E1.	Aquaculture – Past scenario.....	84
Figure E2.	Aquaculture – Present scenario.....	85
Figure E3.	Aquaculture – Future 1 scenario.....	86
Figure E4.	Aquaculture – Future 2 scenario.....	87
Figure E5.	Aquaculture – Future 3 scenario.....	88
Figure F1.	Cables – Past scenario (over hard substrate and in water >200 m depth, 100 m buffer).....	92
Figure F2.	Cables – Present scenario (over hard substrate and in water >200 m depth, 100 m buffer).....	93
Figure F3.	Cables – Future 1 scenario (over hard substrate and in water >200 m depth, 100 m buffer).....	94
Figure F4.	Cables – Future 2 scenario (over hard substrate and in water >200 m depth, 100 m buffer).....	95
Figure F5.	Cables – Future 3 scenario (all cables regardless of substrate and with 0.25 NM buffer).....	96
Figure G1.	Oil and Gas – Past scenario.....	99
Figure G2.	Oil and Gas – Present scenario.....	100
Figure G3.	Oil and Gas – Future 1 scenario.....	101
Figure G4.	Oil and Gas – Future 2 scenario (reduced safety zone to reflect reduction in area through decommissioning).....	102
Figure G5.	Oil and Gas – Future 3 scenario.....	103

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Figure H1.	UK EEZ split by Devolved Administration.....	105
Figure I1.	Local case study: Islay – Present scenario .....	110
Figure I2.	Local case study: Islay – Future 1 scenario.....	111
Figure I3.	Local case study: Islay – Future 2 scenario.....	112
Figure I4.	Local case study: Islay – Future 3 scenario.....	113
Figure I5.	Local case study: Moray Firth – Present scenario.....	115
Figure I6.	Local case study: Moray Firth – Future 1 scenario .....	116
Figure I7.	Local case study: Moray Firth – Future 2 scenario .....	117
Figure I8.	Local case study: Moray Firth – Future 3 scenario .....	118
Figure I9.	Local case study: Orkney – Present scenario.....	120
Figure I10.	Local case study: Orkney – Future 1 scenario .....	121
Figure I11.	Local case study: Orkney – Future 2 scenario.....	122
Figure I12.	Local case study: Orkney – Future 3 scenario .....	123
Figure I13.	Local case study: Outer Thames Estuary – Present scenario.....	125
Figure I14.	Local case study: Outer Thames Estuary – Future 1 scenario.....	126
Figure I15.	Local case study: Outer Thames Estuary – Future 2 scenario.....	127
Figure I16.	Local case study: Outer Thames Estuary – Future 3 scenario.....	128
Figure I17.	Local case study: The Wash and off the Humber Estuary – Present scenario.....	130
Figure I18.	Local case study: The Wash and off the Humber Estuary – Future 1 scenario.....	131
Figure I19.	Local case study: The Wash and off the Humber Estuary – Future 2 scenario.....	132
Figure I20.	Local case study: The Wash and off the Humber Estuary – Future 3 scenario.....	133

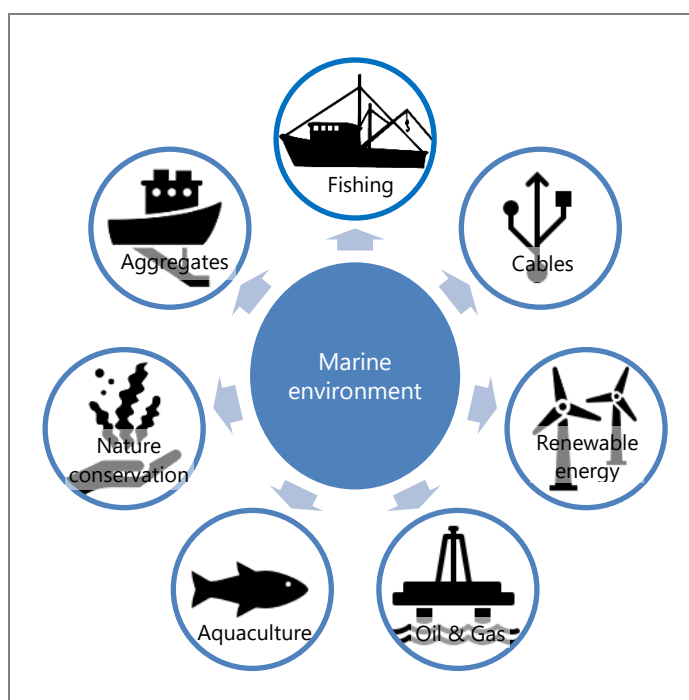
# 1 Introduction

The development of the blue economy<sup>2</sup> and realisation of the potential of the marine environment to contribute to economic growth, livelihoods, and climate change objectives, is resulting in increasing activity from a range of different sectors in the marine environment (Figure 1). Sectors active in the marine space includes established sectors such as fishing, aquaculture, extraction of marine aggregates, oil and gas production, and ports and shipping, as well as new and emerging sectors such as renewable energy (wind, wave and tidal). The need to ensure protection of marine habitats and species and targets to protect 30% of the marine environment by 2030 are leading to increased designation of protected areas and associated restrictions on activity. The target to achieve Net Zero by 2050, together with recent disruptions to other energy supplies, provides an incentive for increased deployment of marine renewable energy technologies.

These spatial demands on the marine environment are resulting in 'spatial squeeze' of established sectors, particularly fishing, which finds its traditional grounds under increasing competition from other sectors. This is likely to increase significantly in the coming decades, as various projects already in the pipeline are realised, and new projects are developed.

The competition for marine space needs to be carefully managed, to ensure that co-existence can occur where feasible, and existing sectors are able to maintain financial viability.

This report explores past, present and future scenarios for a selection of key sectors, to quantify and help visualise the implications of forthcoming projects, plans and policies.



**Figure 1. Example sectors present in the marine environment**

Spatial squeeze on the fishing industry arises from a number of different sectors and regulations, including fisheries management-related measures and closed areas. Those with the largest spatial footprint are:

- Nature conservation such as restrictions on fishing in protected areas; and
- Offshore renewable energy development (particularly offshore wind).

<sup>2</sup> The sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of ocean ecosystems.

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Other activities also impose spatial constraints on where fishing activity can occur – albeit to a lesser extent than those activities above – but which can affect the coherence of fishing activities locally. Those considered in this report are:

- Aggregate dredging areas;
- Aquaculture (finfish, shellfish and seaweed);
- Cables (including power interconnectors, offshore power distribution network cables, power cables to and from offshore infrastructure and telecom cables) (although the effect on fishing activity depends on whether and how cables are buried and their monitoring and maintenance); and
- Oil and gas infrastructure.

Other activities not included in this report are ports and harbours (which are often long-established, and much fishing activity takes place further away from the shore), shipping, tourism and recreation, and maritime defence and security. These latter activities may present an obstacle to fishing activity but do not usually preclude it.

## 2 Scenarios and Approach

To quantify and communicate the extent of spatial squeeze in fisheries currently, and in the future, five scenarios were set out:

- Past (2000);
- Present (2020/2021, depending on latest year of data available for each sector);
- Future 1 (2030);
- Future 2 (2050);
- Future 3 (2050, with worst-case assumptions).



The assumptions for each sector under each scenario are summarised in Figure 2 and described in detail in Appendices A to G. Future scenarios are based on sector projections and growth rates and represent a realistic future development pathway for each sector.

Spatial data were sourced for each sector and imported into a Geographical information System (GIS) database. Individual records were queried and allocated to relevant scenarios (i.e. whether each entry was relevant to the past, present or future scenarios). For some sectors, areas were digitised to represent potential future locations of activity. This was the case where the spatial data available did not account for the extent of projected sector growth under the future scenarios (e.g. offshore wind), or where future spatial zones were far larger than the areas required for projected sector growth (e.g. offshore wave and tidal energy).

The fishing industry is diverse, ranging from small inshore vessels to ocean-going vessels over-70 m in length. A range of gear types are used, including static gears (pots, nets, lines) and mobile gears (demersal and pelagic trawls, seines and dredges) to catch a diversity of fish and shellfish. The UK's fishing and fish processing industries employ 24,000 people and contribute £1.4 billion to the UK economy (House of Commons, 2017). The industry is particularly important at a local level in coastal and island communities and contributes to food security through the provision of healthy, nutritious climate-smart protein.

Fishing does not take place uniformly across the marine environment (Eigaard *et al.*, 2017; Amoroso *et al.*, 2018); some areas are unsuitable for fishing, or fishing is not permitted, and some areas are more profitable than others. Furthermore, the fishing sector is diverse, with different gear types often operating in different areas. For the purposes of this report, the focus was on restrictions on trawling, as this is the most widespread mobile demersal gear in the UK fleet (see Appendix B). The restrictions on fishing included in this analysis are those where demersal trawling is prohibited for all vessel sizes and engine powers, all year round. Further analysis could be undertaken to explore the implications of the scenarios on the fished area for individual gear types and including both UK and non-UK activity.

Individual sector maps for each scenario were developed and are available in Appendices A to G. For the future scenarios, it is not always possible to identify spatially where restrictions will be. Where trawling may be excluded from a portion of the area mapped, but not the whole area, this is shown with hatching. These areas have been calculated separately and are shown with hatching on the scenario maps:

-  Areas shown in solid colour indicate that trawling is excluded from the whole area.
-  Areas shown with hatching indicate that trawling is excluded from a proportion of the area.

This is the case for:

- Future fixed-foundation offshore wind farms, where larger and more widely spaced turbines (with a density below 3.5 MW/km<sup>2</sup> installed capacity) may allow some fishing to continue within arrays;
- Designated offshore conservation sites that do not currently have proposed management measures, where an estimated 80% of sites may be protected from trawling (based on the average from recent proposals for fisheries measures in offshore sites) in Future 1 and 2 scenarios; and,
- Aggregate dredging areas where only a proportion of the licence area will be dredged to produce the projected tonnage of aggregate in the future.

In addition, it was not possible to map future aquaculture sites, or Highly Protected Marine Areas (HPMAs) in Scotland, due to lack of information on where future activity may take place. For these, areas have been calculated without being represented on the spatial maps. Candidate HPMAs in England are likely to be announced soon and may differ from the areas mapped (Reference Areas).

The spatial data for all sectors for each scenario were brought together into overall scenario maps, presented in sections 4 to 7. In each scenario, some sectors overlap each other. The overall area affected in each scenario was calculated, taking into account sector overlaps and hatched areas (where trawling is restricted in only a proportion of the area).

	<b>Past</b> 2000	<b>Present</b> 2020/21	<b>Future 1</b> 2030	<b>Future 2</b> 2050	<b>Future 3</b> 2050 (worst-case)
<b>Fishing</b>	<ul style="list-style-type: none"> <li>▪ Fisheries restrictions (year-round prohibitions on trawling) as in 2000.</li> <li>▪ Technical and economic constraints to fishing in some areas.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Fisheries restrictions (year-round prohibitions on trawling) as in 2021.</li> <li>▪ Technical and economic constraints to fishing in some areas.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Fisheries restrictions (year-round prohibitions on trawling) as in 2021.</li> <li>▪ Technical and economic constraints to fishing in some areas.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Fisheries restrictions (year-round prohibitions on trawling) as in 2021.</li> <li>▪ Technical and economic constraints to fishing in some areas.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Fisheries restrictions (year-round prohibitions on trawling) as in 2021.</li> <li>▪ Technical and economic constraints to fishing in some areas.</li> </ul>
<b>Nature Conservation</b>	<ul style="list-style-type: none"> <li>▪ SACs designated, but no management measures. MCZs, NCMPAs and most offshore SACs not yet designated.</li> <li>▪ National Nature Reserves with fishing restrictions.</li> </ul>	<ul style="list-style-type: none"> <li>▪ MCZ, NCMPAs and SACs designated, some with management measures.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Existing and proposed management measures.</li> <li>▪ At least 80% of offshore sites protected from trawling.</li> <li>▪ HPMA in England (based on Reference Areas) and Scotland (additional 5% of offshore waters and 10% of inshore waters).</li> </ul>	<ul style="list-style-type: none"> <li>▪ Existing and proposed management measures.</li> <li>▪ At least 80% of offshore sites protected from trawling.</li> <li>▪ HPMA in England (based on Reference Areas) and Scotland (additional 5% of offshore waters and 10% of inshore waters).</li> <li>▪ 3 NM zone around Scotland with an effort cap.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Trawling banned across all SACs, NCMPAs and MCZs.</li> <li>▪ HPMA in England (based on Reference Areas) and Scotland (additional 5% of offshore waters and 10% of inshore waters).</li> <li>▪ 3 NM zone around Scotland excludes trawling.</li> </ul>
<b>Offshore renewables – Wind</b>	<ul style="list-style-type: none"> <li>▪ One windfarm with two turbines at Blyth.</li> </ul>	<ul style="list-style-type: none"> <li>▪ 10.4 GW offshore wind capacity installed across 40 wind farms.</li> </ul>	<ul style="list-style-type: none"> <li>▪ At least 40 GW offshore wind capacity deployed in UK waters<sup>1</sup>, based on existing pipeline and Round 3 OWF areas.</li> <li>▪ Fixed turbines with lower capacity density allow some (25%) trawling within arrays. Floating arrays exclude all trawling.</li> </ul>	<ul style="list-style-type: none"> <li>▪ 115 GW offshore wind capacity deployed in UK waters, based on existing areas, Round 3 and 4, ScotWind areas and Celtic Sea zones, and additional areas.</li> <li>▪ Fixed turbines with lower capacity density allow some (25%) trawling. Floating arrays exclude all trawling.</li> </ul>	<ul style="list-style-type: none"> <li>▪ 115 GW offshore wind capacity deployed in UK waters, based on existing areas, Round 3 and 4, ScotWind areas and Celtic Sea zones, and additional areas.</li> <li>▪ No trawling within any OWF arrays.</li> </ul>
<b>Offshore renewables – Wave</b>	<ul style="list-style-type: none"> <li>▪ No wave energy projects.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Small, demonstration projects.</li> <li>▪ No trawling within arrays.</li> </ul>	<ul style="list-style-type: none"> <li>▪ 182 MW installed capacity, based on active and pre-planning application lease areas.</li> <li>▪ No trawling within arrays.</li> </ul>	<ul style="list-style-type: none"> <li>▪ 1 GW installed capacity, based on sector projections.</li> <li>▪ No trawling within arrays.</li> </ul>	<ul style="list-style-type: none"> <li>▪ 1 GW installed capacity, based on sector projections.</li> <li>▪ No trawling within arrays.</li> </ul>
<b>Offshore renewables – Tidal</b>	<ul style="list-style-type: none"> <li>▪ No tidal energy projects.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Small, demonstration projects.</li> <li>▪ No trawling within arrays.</li> </ul>	<ul style="list-style-type: none"> <li>▪ 0.55 GW installed capacity, based on active and pre-planning application lease areas.</li> <li>▪ No trawling within arrays.</li> </ul>	<ul style="list-style-type: none"> <li>▪ 2.5 GW installed capacity, based on sector projections.</li> <li>▪ No trawling within arrays.</li> </ul>	<ul style="list-style-type: none"> <li>▪ 2.5 GW installed capacity, based on sector projections.</li> <li>▪ No trawling within arrays.</li> </ul>

	<b>Past</b> 2000	<b>Present</b> 2020/21	<b>Future 1</b> 2030	<b>Future 2</b> 2050	<b>Future 3</b> 2050 (worst-case)
<b>Aggregates</b>	<ul style="list-style-type: none"> <li>Aggregate extraction from Active Dredge Zones (179 km<sup>2</sup>) within licensed areas in 2000.</li> </ul>	<ul style="list-style-type: none"> <li>Aggregate extraction from Active Dredge Zones (101 km<sup>2</sup>) within licensed areas in 2020, producing 18 million tonnes aggregate.</li> </ul>	<ul style="list-style-type: none"> <li>Aggregate production of 29 million tonnes based on sector projections, requiring 162 km<sup>2</sup> seabed to be dredged, representing 18% of Licence, Exploration and Option Areas.</li> </ul>	<ul style="list-style-type: none"> <li>Aggregate production of 29 million tonnes based on sector projections, requiring 162 km<sup>2</sup> seabed to be dredged, representing 35% of Exploration and Option Areas.</li> </ul>	<ul style="list-style-type: none"> <li>Aggregate production of 29 million tonnes based on sector projections, requiring 162 km<sup>2</sup> seabed to be dredged, representing 35% of Exploration and Option Areas.</li> </ul>
<b>Aquaculture</b>	<ul style="list-style-type: none"> <li>Aquaculture production, particularly in Scotland, for salmon and shellfish.</li> <li>No seaweed production.</li> </ul>	<ul style="list-style-type: none"> <li>Aquaculture production based on current sites.</li> <li>Small-scale and experimental seaweed cultivation.</li> </ul>	<ul style="list-style-type: none"> <li>Aquaculture production increases based on sector aspirations and growth rates in the four devolved administrations for finfish, shellfish and seaweed.</li> </ul>	<ul style="list-style-type: none"> <li>Aquaculture production increases based on sector aspirations and growth rates in the four devolved administrations for finfish, shellfish and seaweed.</li> </ul>	<ul style="list-style-type: none"> <li>Aquaculture production increases based on sector aspirations and growth rates in the four devolved administrations for finfish, shellfish and seaweed.</li> </ul>
<b>Cables</b>	<ul style="list-style-type: none"> <li>Telecom cables that were present in 2000, and Blyth windfarm export cable.</li> <li>Trawling can take place over cables laid in soft substrate and waters &lt;200 m deep.</li> </ul>	<ul style="list-style-type: none"> <li>Telecom, power cables and OWF export cables.</li> <li>Trawling can take place over cables laid in soft substrate and waters &lt;200 m deep.</li> </ul>	<ul style="list-style-type: none"> <li>Telecom, power cables, proposed cables and OWF export cables.</li> <li>Trawling can take place over cables laid in soft substrate and waters &lt;200 m deep.</li> </ul>	<ul style="list-style-type: none"> <li>Telecom, power cables, proposed cables and OWF export cables.</li> <li>Trawling can take place over cables laid in soft substrate and waters &lt;200 m deep.</li> </ul>	<ul style="list-style-type: none"> <li>Telecom, power cables, proposed cables and OWF export cables.</li> <li>No trawling or dredging over full length of cables including a 0.25 NM buffer either side.</li> </ul>
<b>Oil and Gas</b>	<ul style="list-style-type: none"> <li>Oil and gas installations with surface and subsea safety zones (500 m).</li> </ul>	<ul style="list-style-type: none"> <li>Oil and gas installations with surface and subsea safety zones (500 m).</li> </ul>	<ul style="list-style-type: none"> <li>Oil and gas installations with surface and subsea safety zones (500 m).</li> </ul>	<ul style="list-style-type: none"> <li>Some decommissioning of oil and gas installations, representing 41% reduction in area of safety zones.</li> </ul>	<ul style="list-style-type: none"> <li>Oil and gas decommissioning does not result in change of footprint, existing surface and subsea safety zones (500 m) maintained.</li> </ul>
<p>1. BEIS (2022) recently set a target for 'up to 50 GW [of offshore wind] by 2030'. Future 1 is in line with this, assessing 42 GW that is already in the planning system and which can realistically be taken forward by 2030.</p>					

Figure 2. Summary of scenarios for each sector

### 3 Past Scenario (2000)

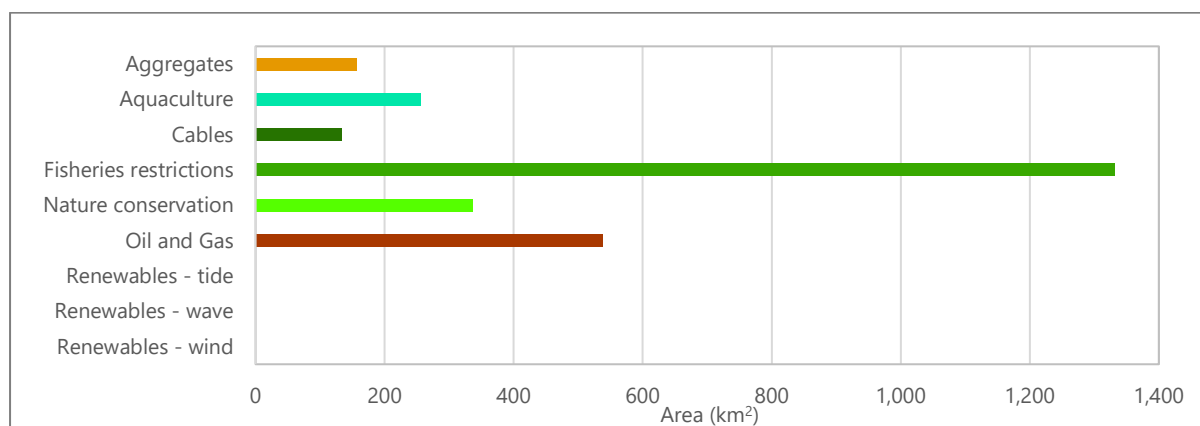
In 2000, fishing was relatively unconstrained in where it could operate across the UK EEZ. The Oil and Gas sector was well established<sup>3</sup>. Aquaculture was also well-established, with a number of sites in inshore waters in Scotland, Wales and Northern Ireland. Aggregate dredging took place in English and Welsh waters. There were some areas which restricted fishing (trawling) for fisheries management purposes (e.g. to protect spawning and nursery grounds, or to reduce gear conflict), but only small areas restricted trawling for nature conservation purposes (Lundy National Nature Reserve, Noss Head and Sinclair Bay protected area in Scotland, and inshore areas in Northern Ireland (Strangford Lough, Belfast Lough, Carlingford Lough and Dundrum Bay). Offshore wind was in its infancy, with the first offshore wind farm test site, consisting of two turbines, located off Blyth in north-east England.

In total, 2,887 km<sup>2</sup> of the UK EEZ was restricted to trawling in the Past scenario, representing 0.39 % of the EEZ. The majority of this was from fisheries restrictions (Figure 3). Full details of the area occupied by individual sectors is provided in Appendices A to G.

**Table 1. Areas restricted to trawling in the Past scenario**

Area	Area Restricted within UK EEZ (km <sup>2</sup> )	As a Percentage of EEZ
England	827	0.36%
Isle of Man	0	0.00%
Northern Ireland	222	3.27%
Scotland	1,444	0.31%
Wales	220	0.72%
<b>Total</b>	<b>2,712</b>	<b>0.37%</b>

Note: These area calculations take account of overlaps between different sectors.



Note: These areas do not take account of overlaps between different sectors.

**Figure 3. Area occupied by each sector in the Past scenario**

<sup>3</sup> Note that mapped areas correspond to 2021, due to lack of historical data availability. The overall spatial footprint is likely to be similar, although many areas west of Shetland had not been developed in 2000.

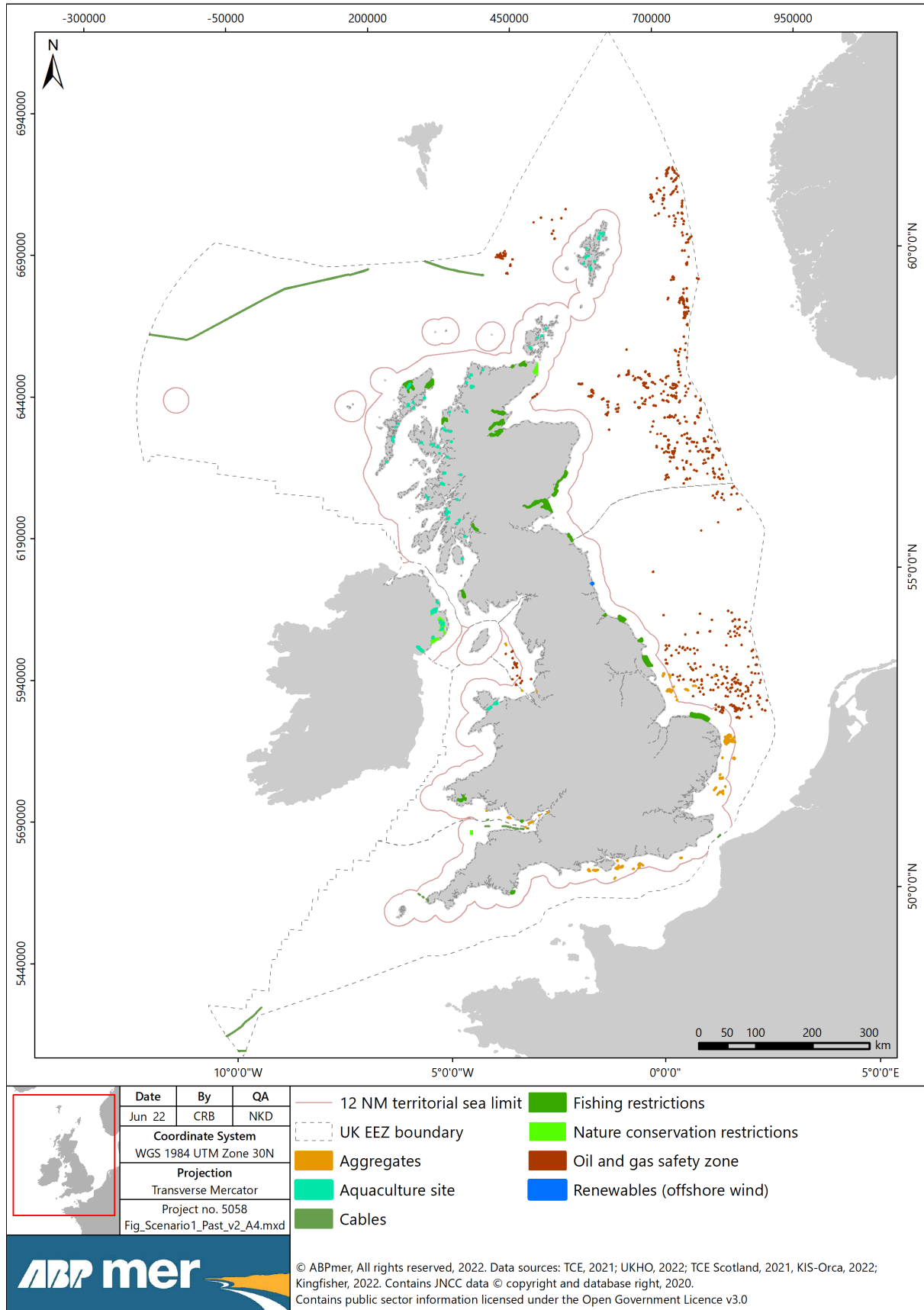


Figure 4. Past scenario, all sectors

## 4 Present Scenario (2020/2021)

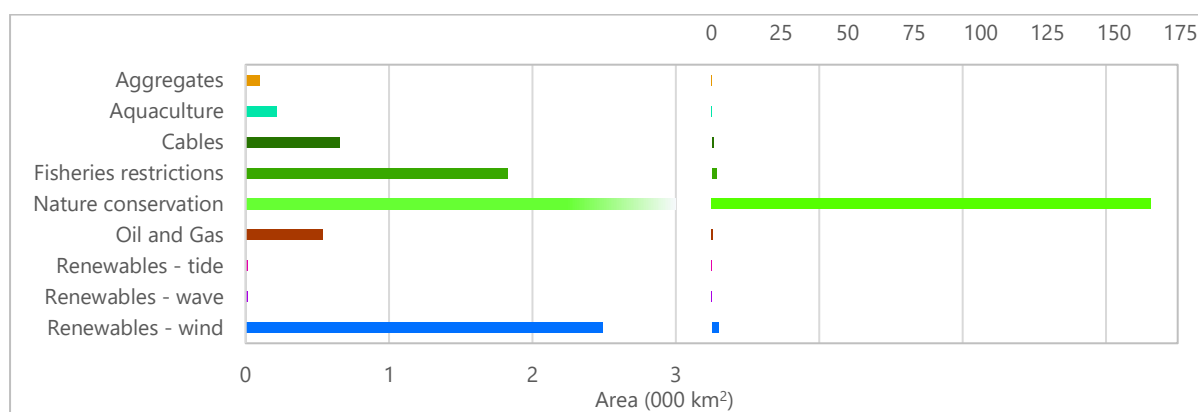
In the Present scenario, spatial restrictions on trawling have begun to be more apparent. This is particularly the case with nature conservation restrictions in inshore waters, and with the roll-out of offshore wind farms in inshore and offshore areas, particularly around the Outer Thames estuary, The Wash and the Humber estuaries, and the Irish Sea. The Oil and Gas sector is well established. There are numerous aquaculture sites in inshore waters in Scotland, Wales and Northern Ireland, and sites beginning to be developed in England. Seaweed farming is also starting, with small-scale trial sites present in Scotland. Aggregate dredging took place in English and Welsh waters. There are some test sites for wave and tidal energy, but these sectors are still small-scale.

In total, 169,966 km<sup>2</sup> of the UK EEZ was restricted to trawling in the Present scenario, representing 23 % of the EEZ. Nature conservation restrictions are responsible for the majority of this footprint (Figure 5). Full details of the area occupied by individual sectors is provided in Appendices A to G. At this early stage of expansion of other marine sectors, it has been possible to avoid some of the areas most important to trawling. This is seen in the location of windfarms in east and south-east England, which are in areas that were not previously intensively trawled. The large increase in area restricted to trawling between the Past and Present scenarios is predominantly due to management measures which restrict bottom trawling in waters deeper than 800 m, to protect deep-sea habitats. The large extent of these restrictions, in an area that was not previously intensively fished, mean that a large proportion of the EEZ (particularly in Scottish waters) has been protected.

**Table 2. Areas restricted to trawling in the Present scenario**

Area	Area Restricted within UK EEZ (km <sup>2</sup> )	As a Percentage of UK EEZ
England	11,385	4.94%
Isle of Man	410	10.37%
Northern Ireland	314	4.62%
Scotland	157,526	34.03%
Wales	331	1.07%
<b>Total</b>	<b>169,966</b>	<b>23.13%</b>

Note: These area calculations take account of overlaps between different sectors.



**Figure 5. Area occupied by each sector in the Present scenario**

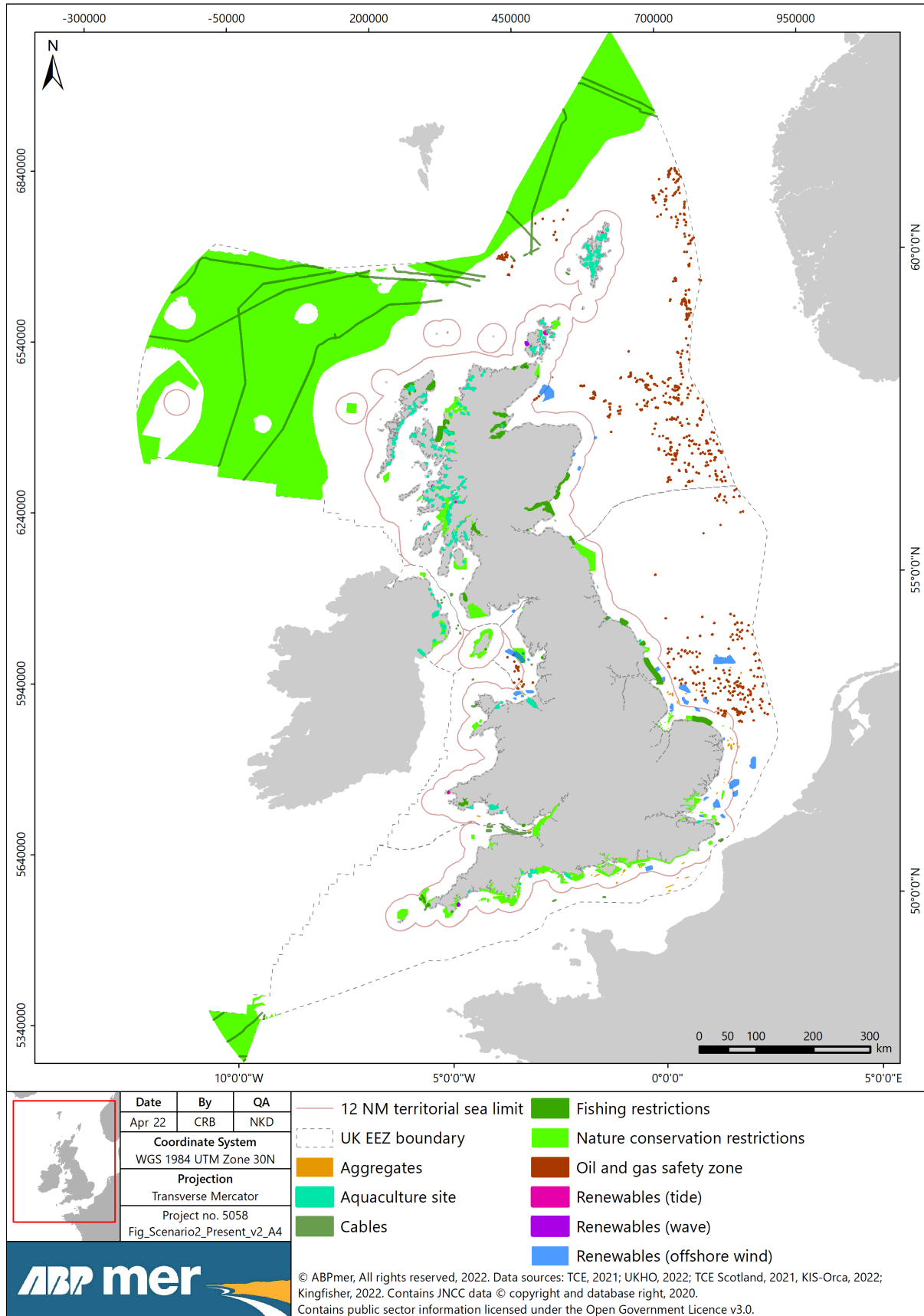


Figure 6. Present scenario, all sectors

## 5 Future 1 Scenario (2030)

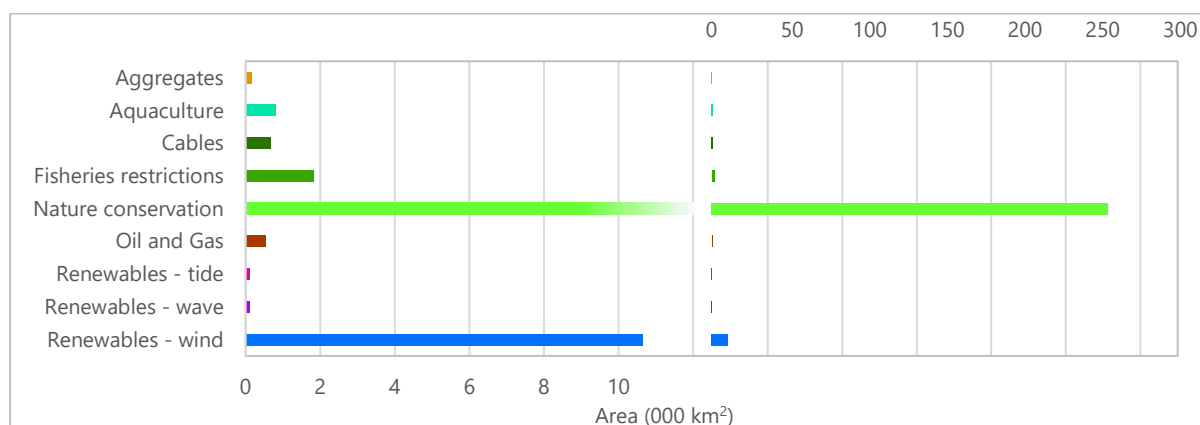
In 2030, spatial restrictions on trawling are projected to increase further. The roll-out of offshore wind increases the areas where fishing is restricted, particularly in the east of England, and the Moray Firth and off the Firth of Forth in Scotland. The implementation of trawling restrictions in offshore MPAs, MCZs and SACs (which are assumed to cover 80% of offshore sites where measures are not yet proposed or in place) also increases significantly to 2030. In addition, the implementation of HPMAs will result in further areas of inshore and offshore waters being restricted. The Oil and Gas sector maintains its current footprint. There is expansion of aquaculture in all jurisdictions, and seaweed farming is developing commercial-scale sites in England and Scotland. Aggregate dredging continues in English and Welsh waters, with an increased footprint compared to the Present scenario.

In total, 266,457 km<sup>2</sup> of the UK EEZ is restricted to trawling in the Future 1 scenario, representing 36 % of the UK EEZ. Nature conservation restrictions are responsible for the majority of this footprint, followed by offshore wind (Figure 7). Full details of the area occupied by individual sectors is provided in Appendices A to G.

**Table 3. Areas restricted to trawling in the Future 1 scenario**

Area	Area Restricted within UK EEZ (km <sup>2</sup> )	As a Percentage of UK EEZ
England	53,628	23.28%
Isle of Man	410	10.38%
Northern Ireland	598	8.81%
Scotland	210,488	45.47%
Wales	1,333	4.34%
<b>Total</b>	<b>266,457</b>	<b>36.26%</b>

Note: These area calculations take account of overlaps between different sectors.



**Figure 7. Area occupied by each sector in the Future 1 scenario**

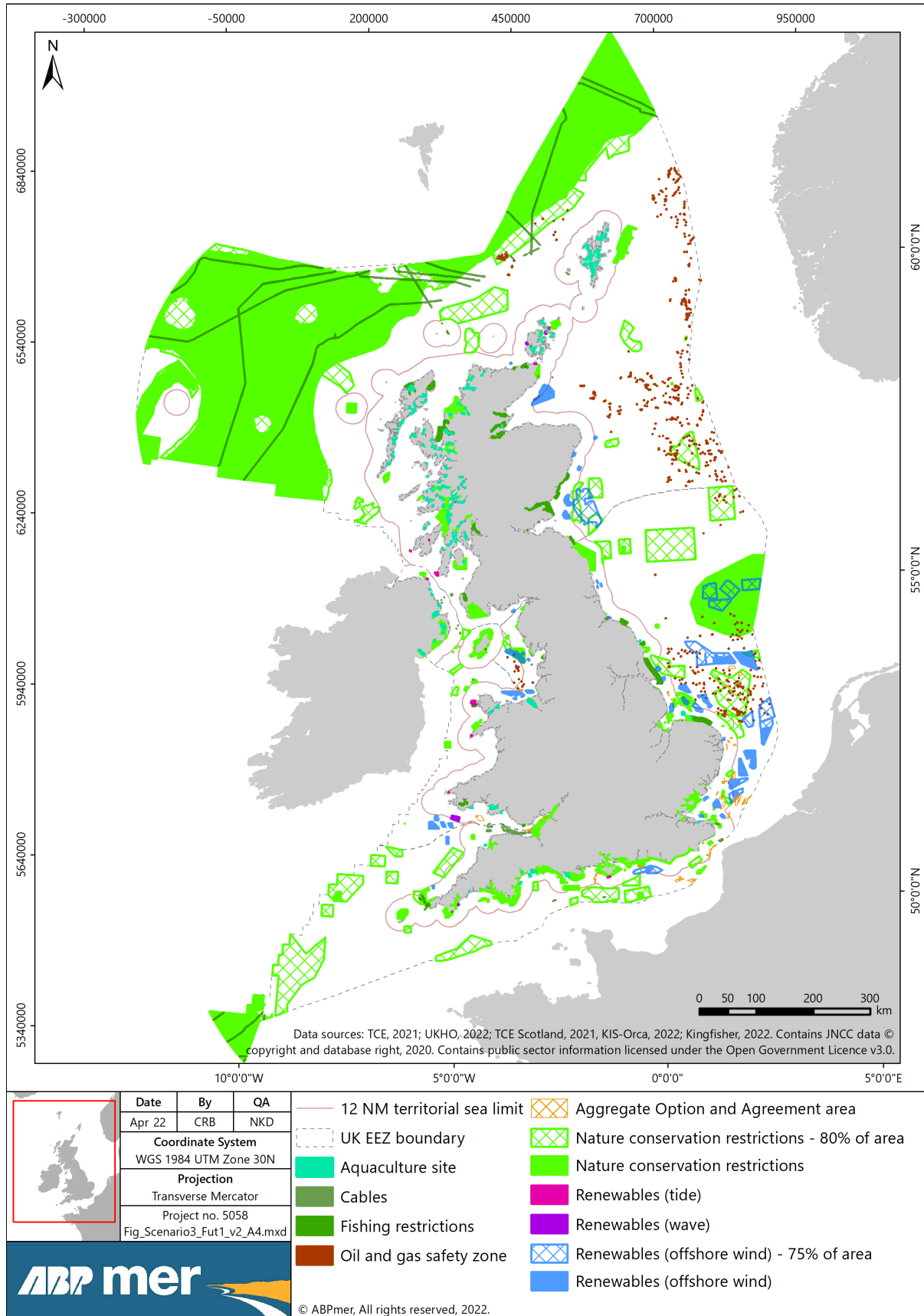


Figure 8. Future 1 scenario, all sectors

## 6 Future 2 Scenario (2050)

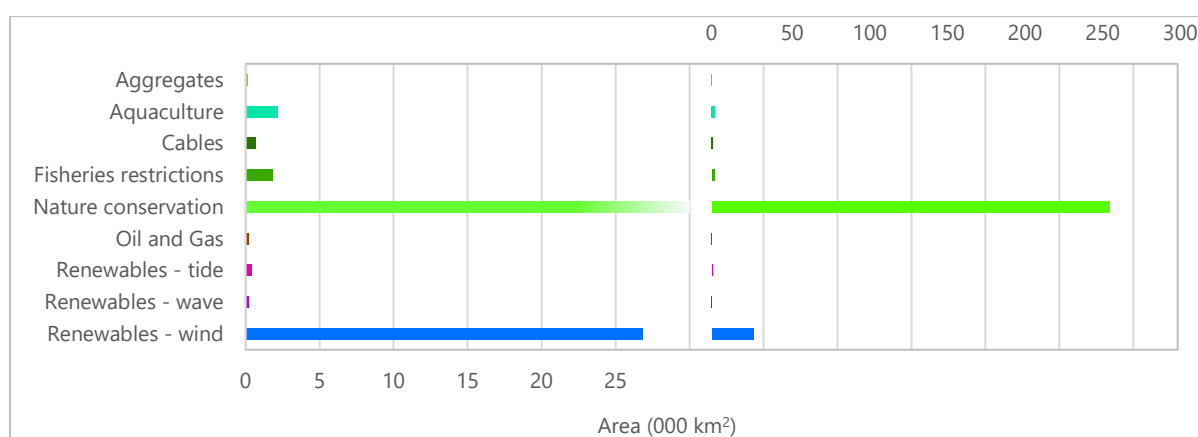
In the Future 2 scenario (2050), spatial restrictions on trawling are projected to intensify further. Nature conservation restrictions are of a similar magnitude to Future 1. The continued roll-out of offshore wind, reaching 115 GW capacity by 2050, results in a spatial footprint of this sector that is ten times that of the Present scenario. The location of around 36 GW is uncertain, and actual locations may differ from those mapped. Wave and tidal energy technologies have been rolled out to more locations, particularly around the Shetland and Orkney islands, west of Scotland and Northern Ireland. The Oil and Gas sector has undergone some decommissioning<sup>4</sup>. Aquaculture continues to expand, with seaweed farming resulting in the largest footprint of the three subsectors (which also include finfish and shellfish). Aggregate dredging continues at similar levels to 2030.

In total, 276,713 km<sup>2</sup> of the UK EEZ is restricted to trawling in the Future 2 scenario, representing 38 % of the UK EEZ. As in Future 1, nature conservation restrictions are responsible for the majority of this footprint, followed by offshore wind, although the latter on a much larger scale than before (more than 2.5 times the area of Future 1 and ten times the area of the Present scenario) (Figure 9). Seaweed farming also takes up a much larger area of seabed than previously. Full details of the area occupied by individual sectors is provided in Appendices A to G.

**Table 4. Areas restricted to trawling in the Future 2 scenario**

Area	Area Restricted within UK EEZ (km <sup>2</sup> )	As a Percentage of UK EEZ
England	58,083	25.21%
Isle of Man	665	16.84%
Northern Ireland	771	11.36%
Scotland	212,548	45.92%
Wales	4,645	15.10%
<b>Total</b>	<b>276,713</b>	<b>37.66%</b>

Note: These area calculations take account of overlaps between different sectors.



**Figure 9. Area occupied by each sector in the Future 2 scenario**

<sup>4</sup> Safety zones have been reduced to reflect potential decommissioning, although with the Government's recent British Energy Security Strategy (BEIS, 2022a), a reduction in spatial footprint of Oil and Gas may not occur.

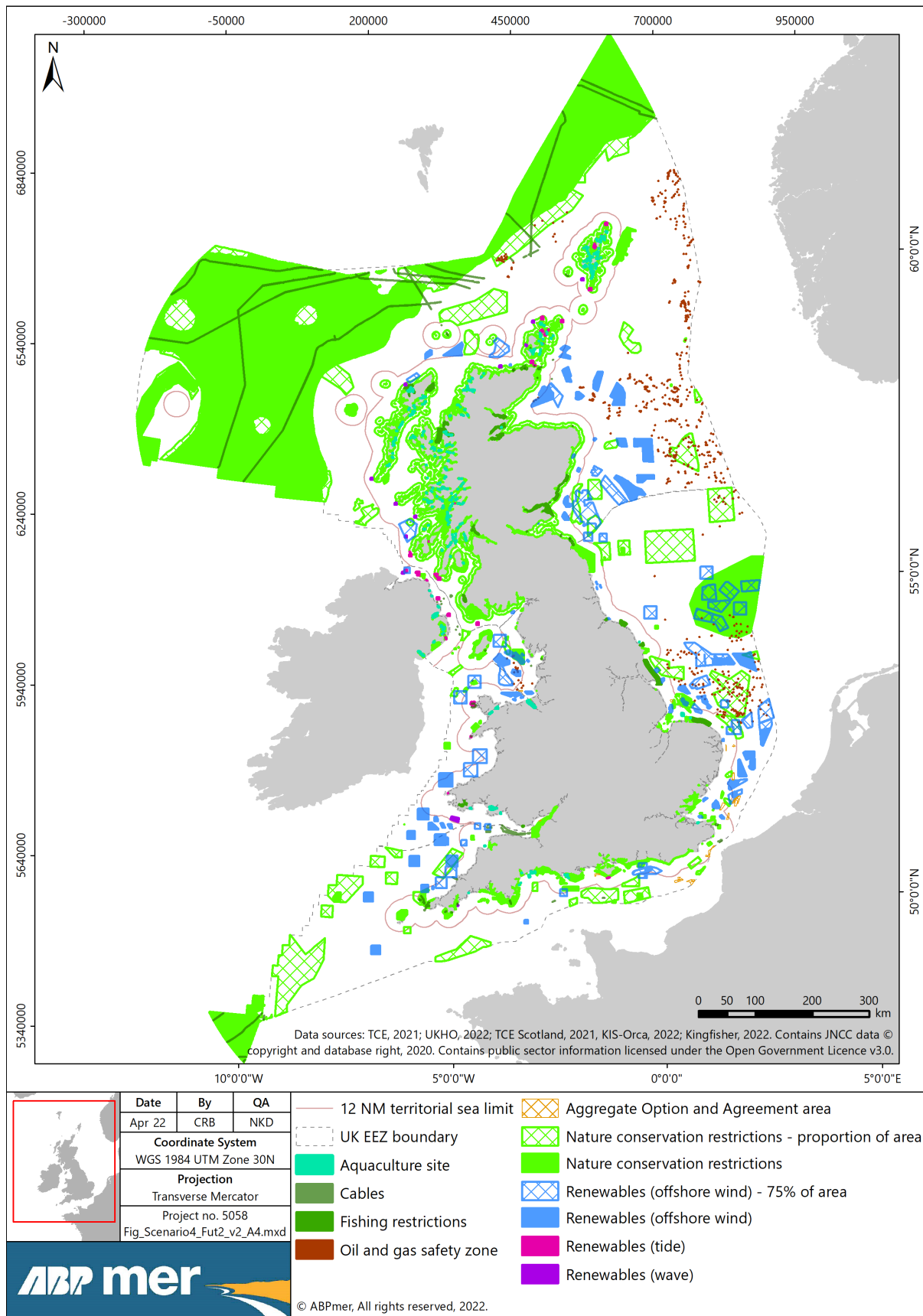


Figure 10. Future 2 scenario, all sectors

## 7 Future 3 Scenario (2050)

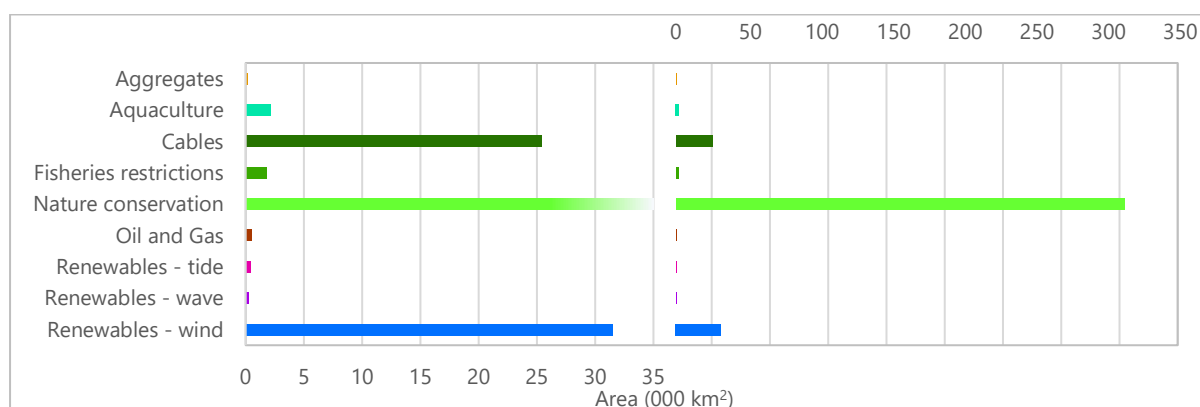
The Future 3 scenario captures the same timeframe as Future 2 (2050), with worst-case assumptions for the different sectors, e.g. that all trawling is restricted from within windfarms and nature conservation areas, and a 0.25 NM exclusion zone extends either side of the full length of cables. In this scenario, spatial restrictions on trawling are intense, with many fishing grounds subject to spatial pressures from a range of other sectors. Exclusion of trawling from offshore wind arrays, which reach 115 GW capacity by 2050, affects 31,500 km<sup>2</sup> of seabed. Wave and tidal energy technologies have been rolled out to more locations, particularly around the Shetland and Orkney islands, west of Scotland and Northern Ireland, as in Future 2. Any decommissioning of the Oil and Gas sector does not result in significant removal of infrastructure, maintaining the same spatial footprint as in the Present scenario<sup>5</sup>. As in Future 2, aquaculture continues to expand, with seaweed farming resulting in the largest footprint of the three subsectors (which also include finfish and shellfish). Aggregate dredging continues at similar levels to 2030, although the spatial areas mapped include the whole of the Option and Exploration Areas, resulting in an increased footprint compared to Future 2. The implementation of a 3 NM trawling exclusion zone around Scotland results in further displacement of trawling from inshore Scottish waters, which could have a substantial impact on fishing communities.

In total, 356,834 km<sup>2</sup> of the UK EEZ is restricted to trawling in the Future 3 scenario, representing 49 % of the EEZ. Nature conservation restrictions are responsible for the majority of this footprint, with offshore wind and cables also representing a significant part (Figure 11). Full details of the area occupied by individual sectors is provided in Appendices A to G.

**Table 5. Areas restricted to trawling in the Future 3 scenario**

Area	Area Restricted within UK EEZ (km <sup>2</sup> )	As a Percentage of UK EEZ
England	82,952	36.00%
Isle of Man	1,055	26.71%
Northern Ireland	1,405	20.68%
Scotland	260,341	56.24%
Wales	11,081	36.03%
<b>Total</b>	<b>356,834</b>	<b>48.56%</b>

Note: These area calculations take account of overlaps between different sectors.



**Figure 11. Area occupied by each sector in the Future 3 scenario**

<sup>5</sup> The Government's recent British Energy Security Strategy (BEIS, 2022a) indicates the need to 'fully utilise our great North Sea reserve', in order 'to reduce our reliance on imported fossil fuels', with another licensing round in autumn 2022.

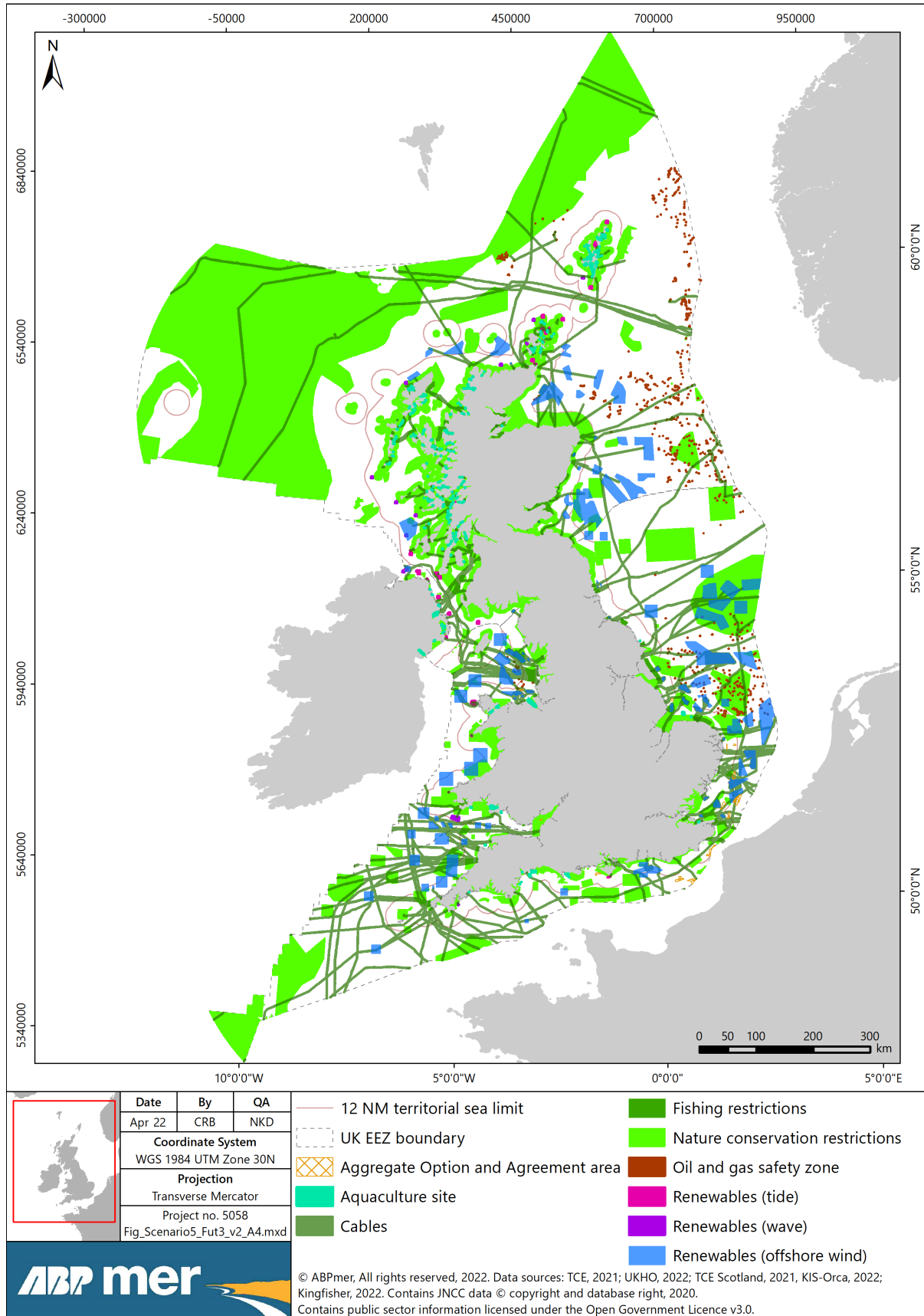


Figure 12. Future 3 scenario, all sectors

## 8 Local Case Studies

The impact of spatial restrictions on fisheries can have a significant impact at a local level, particularly where small-scale inshore fleets are more constrained in their ability to change location, due to a limited operational range. Two local case studies are presented here that illustrate the extent of spatial pressures at a local level in The Wash and off the Humber Estuary, England (Figure 13), and the Moray Firth, Scotland (Figure 14). Figures are shown for the Future 3 scenario. Maps of these areas for the other scenarios, and additional local case study maps are provided in Appendix I.

### 8.1 The Wash and off the Humber Estuary

Commercial fishermen have worked around the Humber since the middle ages. Today, one of the most valuable static gear shellfish fisheries in Europe operates from the towns of Bridlington, Hornsea and Withernsea. Further out to sea, larger nomadic boats target scallops and some whitefish with mobile gear.

Offshore development began to impinge on these fishing grounds in the 1960s, with the first rigs exploiting the Southern North Sea gas fields. Fifty years later, wind farm construction began and now fishing boats must contend with the presence of the Humber Gateway, Westernmost Rough, Race Bank, Sheringham Shoal, Dudgeon, Triton Knoll, Sofia, Creyke Beck, Dogger Bank South West, Dogger Bank South East and Hornsea 1, 2, 3 and 4 arrays – all currently at various stages between planning and operation.

Different developments have had different effects. Fishing continues in the inshore Westernmost Rough wind farm, but only two boats now occasionally visit the once extensively fished Humber Gateway site. Turbine numbers, density and alignment have combined to make that area almost completely unviable. Displaced inshore fishermen are left to choose between increasing fishing pressure on inshore grounds or travelling ever further out to sea in their small boats, in search of room to fish. Meanwhile, the larger offshore wind farms are likely to push mobile gear vessels south and west, towards traditional static gear grounds.

Conservation designations may contribute further to displacement and concentration of fishing effort. The Holderness Inshore and Holderness Offshore MCZs cover 1,485 km<sup>2</sup> between them, almost all historically fished. Uncertainty over the management measures that might be applied to these areas is an ongoing source of concern for local fishermen.

The problems are similar on the North Norfolk coast, where mainly under 10 m vessels from Wells-next-the-Sea, East and West Runton and Cromer fish for crab and lobster. As in East Yorkshire, the need to relocate pots for survey and construction activities associated with wind farms, cables and pipelines is a continual problem, with lost fishing time exacerbating the associated lost access to grounds. In The Wash and neighbouring areas, under-15 m vessels from Boston and Kings Lynn trawl for brown shrimp and pot for whelks, while cockles are hand-worked. The topography of The Wash constrains the local fleet's ability to adapt to displacement.

Wind farm cable exposures and protection measures and management measures for two local SACs are incrementally reducing access to the available grounds. Spatial restrictions have removed access to a historic pink shrimp fishery and seed mussel grounds, removing the supply for mussel cultivation that has witnessed a demise in recent years. Regulatory squeeze has exacerbated spatial squeeze: management measures have capped effort in the shrimp fishery and in 2022 a closure of the cockle fishery is proposed due to poor stock recruitment. Effort displacement into the remaining fisheries therefore risks becoming unsustainable, and businesses are increasingly vulnerable to any downturns.

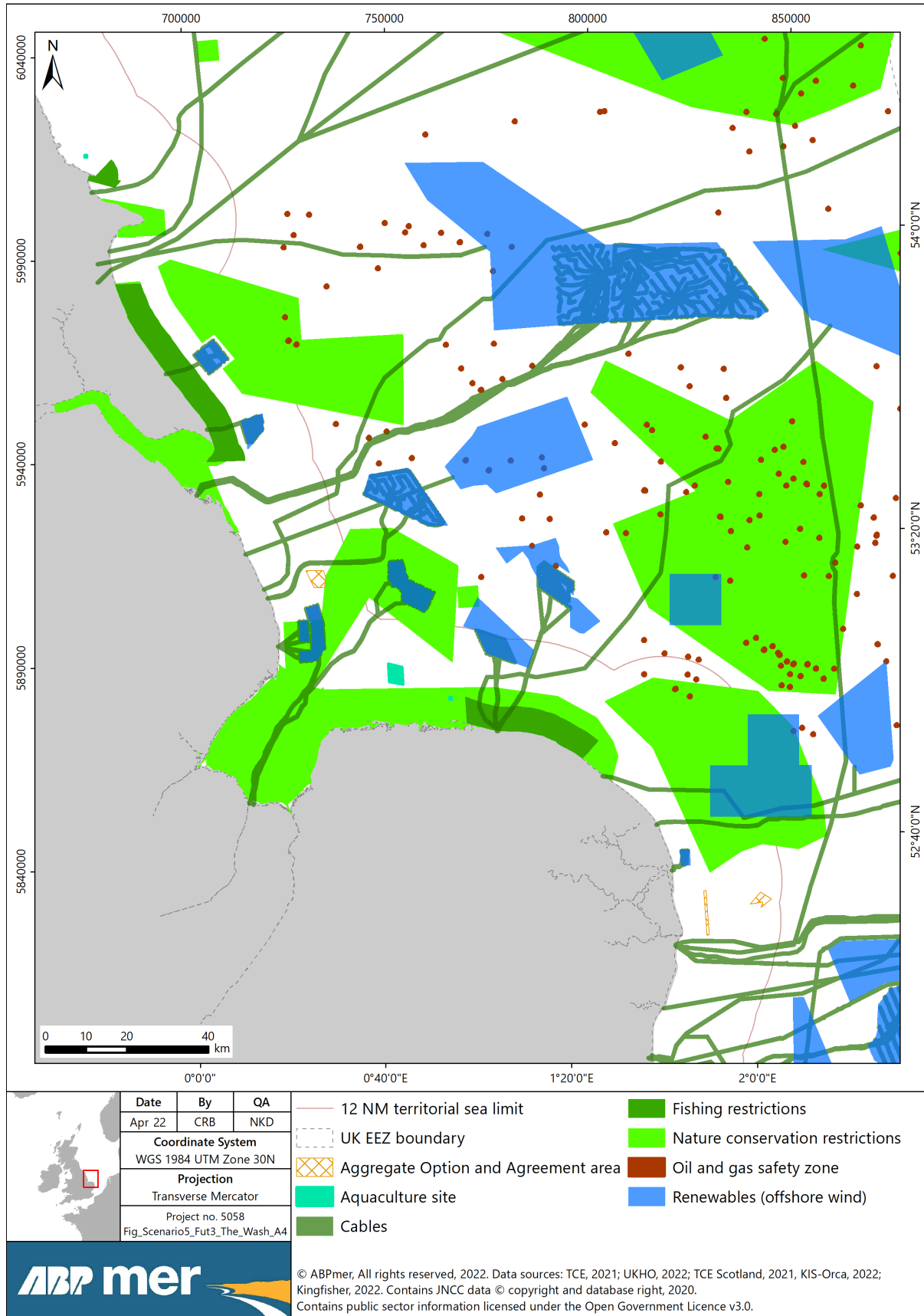


Figure 13. Local case study: The Wash and off the Humber Estuary – Future 3 scenario

## 8.2 Moray Firth

The Moray Firth is a triangular-shaped inlet (firth) on the Scottish North Sea coast, extending north and east of Inverness. It is the largest firth in Scotland and its sheltered nature makes it ideal for a range of fishing activities and provides a safe haven for fishing vessels in search of calmer waters during periods of adverse weather conditions. The varied composition of the seabed makes the Firth the ideal place for a range of fishing activities:

- Directed seasonal squid fisheries;
- Nephrops trawling;
- Scallop dredging;
- Scottish seine netting; and
- Creeling and hand-lining.

This report focusses on the impact of the spatial squeeze on trawls. But all of these fishing activities that currently take place in the Firth will be impacted by the increasing competition for space. If the spatial pressures are not prevented, some fishing activities may have to cease completely and those that survive will be displaced with a greater risk of gear conflict and increased pressure through displacement on localised fish and shellfish resources.

As shown in the various scenario maps, an example of this may be the introduction and enforcement of management measures within the Southern Trench MPA (Figure 14) which have the potential to impact the Nephrops fleet in particular. Offshore wind has already begun to develop in the area and the expansion of offshore wind farms beyond the present scenario will also likely be a major spatial pressure. The Beatrice wind farm was one of the first to be consented, and has been extended by the Moray (East) wind farm. Further wind farms are planned, including Moray (West), as well as offers under the ScotWind leasing round for Falck Renewables and Ocean Winds. Windfarms currently operational and under construction in the Moray Firth have already had an impact on scallop dredging and seine netting in the north, as well as causing displacement of creels. Offshore wind farms currently under construction will both have direct impacts on Nephrops and squid fisheries. The associated export cables are planned to travel ashore on almost parallel routes and will affect in order from north to south: squid, scallops and Nephrops fisheries.

Looking at just these two sources of squeeze – management measures in MPAs and offshore wind – a pattern of cumulative effect emerges, showing that even the mobile fishing fleet will be very constrained in its scope to relocate somewhere else within the Firth. Mobility is already limited to some extent by the fleets' dependence on specific fishing grounds, but this will be greatly exacerbated by it becoming impossible to relocate elsewhere when this "elsewhere" is in future occupied by another activity or is designated as inaccessible to fishing.

Furthermore, it is inevitable – though not yet quantifiable – that offshore wind farms will lead to increased maritime traffic out of ports such as Nigg and Invergordon, and pick-up points will be needed for components transported by barge to the turbine sites. Wick, Buckie and Fraserburgh will also likely see increased traffic in and out of the harbours as these are where marine coordination centres for the wind farms are located.

Other spatial pressures identified are the existing pipelines into St. Fergus that affect the operation of scallop dredgers. The same is happening into Cruden Bay that, despite being at the edge of the Moray Firth will be affected and provoke some spill-over of traffic in the area.

The report notes that some expected spatial pressures cannot yet be quantified or mapped as they are still evolving and planning and development are still at an early stage. One that may be relevant here is seaweed cultivation – currently a very small part of Scotland’s aquaculture industry, but one where there are clear objectives for growth and where a licensing scheme separate from fish farm licensing seems to be emerging.

As indicated in the Future 3 ‘Worst Case’ scenario (Figure 10, Figure 14), there would be a major spatial pressure if a three-mile limit on mobile fishing were ever to be introduced. Whilst there is currently no policy proposal for such a measure, it is subject of intense lobbying pressure and campaigning by several Scottish eNGOs and is a manifesto commitment of the Scottish Green Party, hence has been included in the worst-case scenario.

Finally, while voluntary agreements are currently effective in allowing larger and smaller fishing vessels to co-exist in the area, increased spatial pressures will put this effective co-existence at risk as there will be less space to co-exist in. As the spatial pressures continue to grow and co-existence between different fleet sectors becomes harder, there is an increased risk to fishing as a whole if spatial pressures become such that fishing collectively struggles to co-exist with the other activities and policies that will either partially or completely exclude fishing.

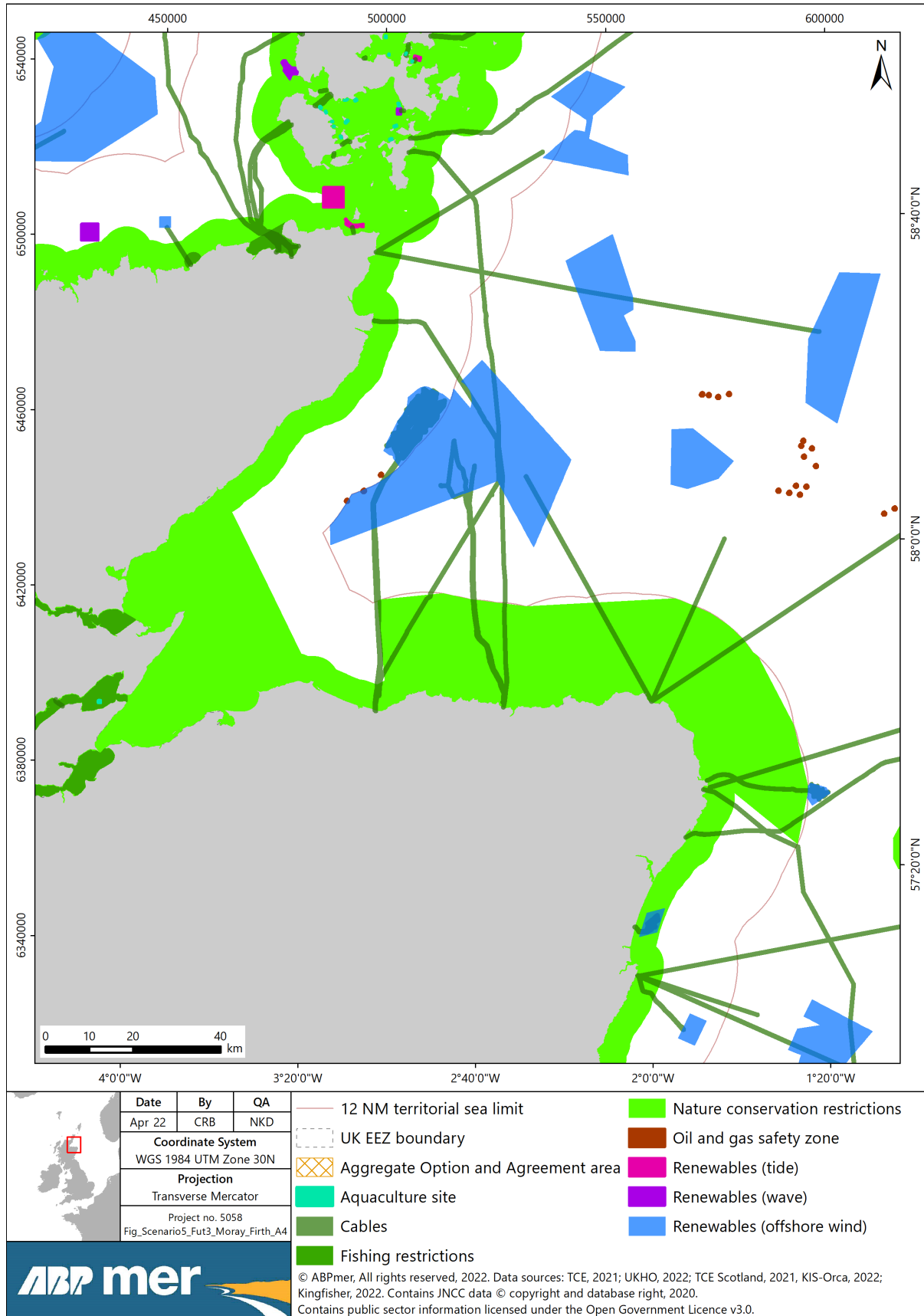


Figure 14. Local case study: Moray Firth – Future 3 scenario

# 9 Conclusions

The development of blue economy sectors (including nature conservation) to date has had a relatively minor impact on fishing. This is reflected in the ability of the UK fishing fleet to maintain the quantity and value of landings thus far. However, the demand for marine space from competing activities is projected to increase significantly over the next 10-30 years (Figure 15), to a scale not previously seen before, with significant implications for fisheries.

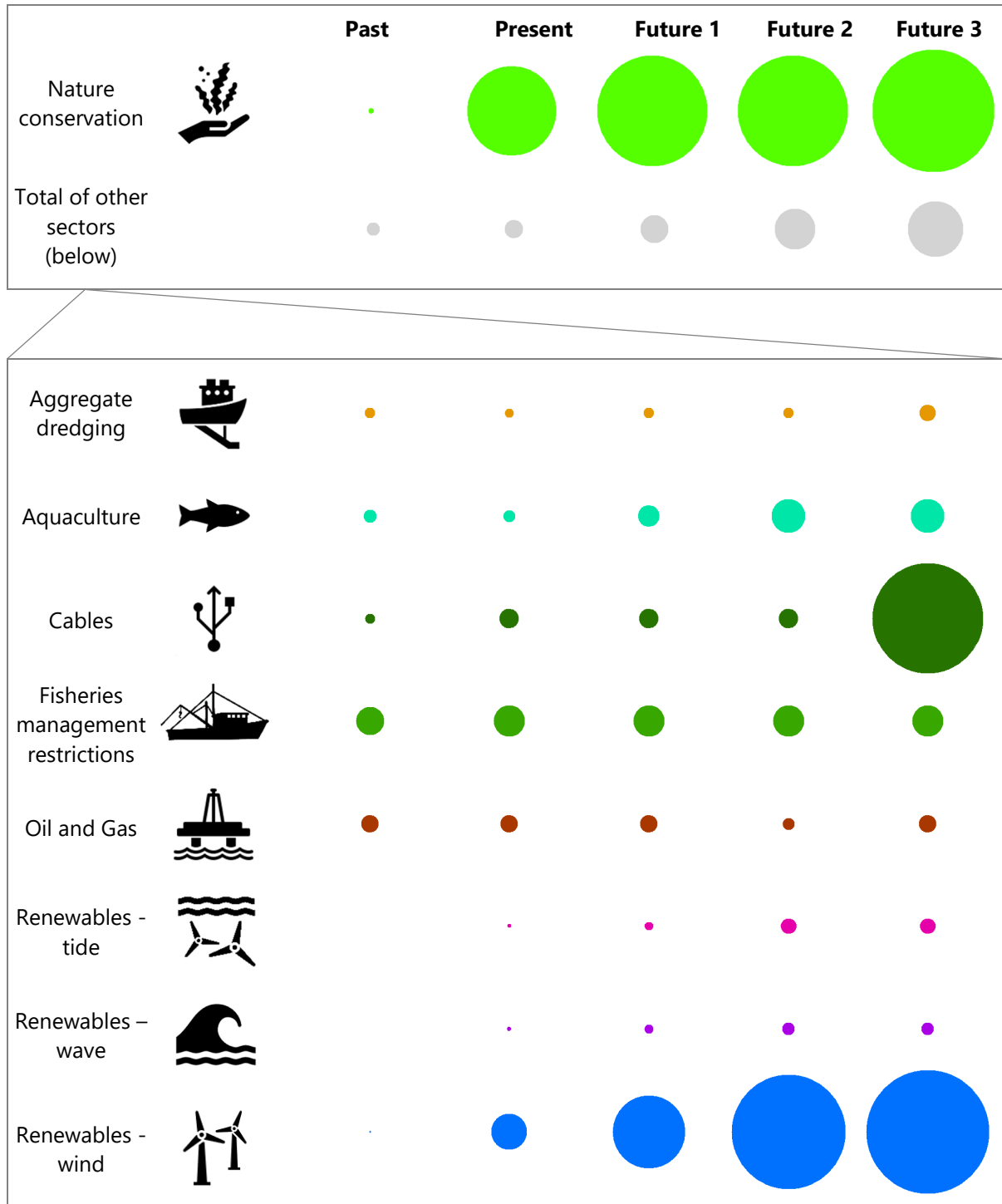


Figure 15. Relative area of each sector under each scenario

Nature conservation (MPAs<sup>6</sup>, SACs, MCZs and HPMAs and associated restrictions on fisheries) and the development of offshore wind farms have the greatest future spatial footprints. The build-out of offshore wind farms increases its footprint to ten times its current level by 2050, and may increase further than this if more ambitious targets are established<sup>7</sup>. However, the extent of the potential impact of nature conservation measures, particularly HPMAs in Scotland, is particularly large; increasing from 22% of the EEZ in the Present scenario (of which a large part is in deep water that was previously not extensively trawled), to 43% of the EEZ in the Future 3 scenario (of which a large part is likely to be in areas that are currently fished by both UK and non-UK fleets). The roll-out of HPMAs in England, and potential measures in Special Protection Areas (not considered in the scenarios), could further exacerbate the spatial squeeze assessed in these scenarios.

The expansion of other marine sectors' activity has significant implications for fisheries and their future viability. Spatial pressures in future scenarios have the potential to overlap significantly with existing fishing grounds, severely impacting business viability for the fishing industry.

The displacement of fishing activity under these scenarios could be significant, and of an order of magnitude that cannot be absorbed by the remaining fishing grounds. This could lead to reductions in output and job losses in the fishing industry, and upstream and downstream impacts on associated land-based industries, with particular effects in coastal communities.

The spatial displacement of fishing from existing fishing grounds also has knock-on effects on the areas to which effort is displaced to (Seafish & UKFEN, 2012; Natural England, 2017). This can increase conflict with other fleet segments (e.g. moving trawling activity into areas that were previously used by static gears), changing costs/earnings profile (as grounds to which effort is displaced are unlikely to be as productive as current fishing grounds), and potentially increasing environmental impacts as reduced catch per unit effort means more fishing effort is required to maintain the same level of catches.

In addition to these macro impacts at UK-level, fisheries at local or regional scale can be impacted even more severely, particularly for local inshore fleets with limited operational range. The increasing footprint of other industries can result in significant spatial squeeze on local fishing grounds, exemplified by the local case studies.

The differences between Future 2 and Future 3 scenarios (both 2050, with the latter employing worst-case assumptions) illustrate the potential scope for policy and implementation to mediate the worst of the impacts. Policies that facilitate and enable co-existence and co-location should be promoted where feasible to minimise the impacts on fisheries. This includes co-locating offshore wind farms with MPAs in appropriate circumstances and enabling co-existence with fishing in the vicinity of cables, within wind farm arrays and in MPAs, where feasible.

We are at a critical juncture, with the spatial requirements of other sectors that are due to materialise in the next ten years resulting in substantial impacts by 2030 which are further amplified by 2050. Fishing tends to be concentrated in core areas that account for the majority of effort, with extensive margins (Jennings & Lee, 2011; Jennings *et al.*, 2012). While bottom trawling is currently the main physical pressure exerted on the seabed, ICES (2021) advise that it can be compatible with achieving seabed conservation objectives. It is therefore important that new developments and nature conservation policies and regulations in the marine area take this into account and seek to minimise displacement of fishing effort. Where there is no alternative, then avoiding displacing fishing from key fishing grounds,

<sup>6</sup> Priority Marine Features (PMFs) in Scotland have not been explicitly included in the analysis, although the implementation of a 3 NM trawling exclusion zone in the Future 3 scenario (and a 3 NM zone with an effort cap in the Future 2 scenario) may coincide with potential management measures for PMFs.

<sup>7</sup> CCC (2020) includes a high scenario for offshore wind ('Widespread Innovation') of 140 GW – exceeding the 115 GW assessed in this report.

intensively fished core areas and areas where fishing activities are sensitive to displacement impacts should be the objective.

Different fisheries (gear type, target species) have different spatial footprints, and different inter-annual variability in their fishing footprints. This study has focussed on restrictions to demersal trawling, but other gear types (e.g. dredges, demersal seines, pelagic gears, nets, pots and traps) should also be considered. In addition, climate change pressures are resulting in changes to the distribution of fish stocks (ICES, 2017), and fisheries need the spatial flexibility to adapt to these changes.

The ability of the fishing industry to continue to produce healthy protein and contribute to food security and coastal communities depends on its future viability. This in turn will require close collaboration and cooperation with other sectors that are looking to develop an increased spatial footprint in the marine area, to ensure that such developments and nature conservation restrictions occur in a way that is compatible with the continuation of fishing activity and the viability of fishing businesses.

Key measures to facilitate this include:

- Recognition of the importance of fishing for both food production and livelihoods, and its effective integration and prioritisation into the marine spatial planning and decision-making systems. This should be based on genuine co-management of our seas that involves those whose lives and livelihoods are at stake, and who may have limited, or no alternative means to pursue their legitimate and long-standing activity.
- Regulators and regulatory systems (including licensing and consenting) should be accountable for decisions and their consequences, applying a hierarchy for spatial decision-making to minimise conflict, i.e. avoid, minimise, mitigate.
- An improved evidence base for fisheries in marine spatial planning, including identification of key fishing grounds for different gear types and fleet segments, improved information on where fishing occurs particularly for smaller vessels, and dependencies on specific areas. This would help facilitate the identification and protection of key fishing grounds, and those identified as sensitive to displacement impacts through marine spatial planning, whilst building in flexibility to accommodate future changes in species' distributions.
- Key fishing industry representatives should be given a stronger and more effective voice in the planning process, at both and plan and project level, to ensure that the potential impact on the fishing industry of proposed activities are adequately expressed and considered. This includes early and effective engagement of stakeholders at local, national and international level. Involvement in the decision-making process can help to minimise impacts on key fishing grounds, and to maximise potential for co-existence through technology choice, design and siting (for developments) and mitigation, innovation and management (for nature conservation).
- Partnership working and a strategic approach to future nature conservation measures, including HPMA's, that maximise the conservation benefits whilst minimising impacts on the fishing industry, taking into account scientific advice.
- Financial support to the fishing industry to enable adjustment to new measures and restrictions, where impacts cannot be avoided.

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# 11 Abbreviations/Acronyms

BEIS	Department for Business, Energy & Industrial Strategy
BUTEC	British Underwater Test and Evaluation Centre
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CEO	Chief Executive Officer
ECSA	European Subsea Cables Association
EEC	European Economic Community
EEZ	Exclusive Economic Zone
EMEC	European Marine Energy Centre
eNGO	environmental Non-Governmental Organisation
EU	European Union
FEPA	Food and Environment Protection Act
GIS	Geographical information System
GW	Gigawatt
HPMA	Highly Protected Marine Area
ICES	International Council for the Exploration of the Sea
KIS-Orca	Kingfisher Information Service – Offshore Renewable & Cable Awareness
MCS	Marine Conservation Society
MCZ	Marine Conservation Zone
MMO	Marine Management Organisation
MPA	Marine Protected Area
MSP	Marine Spatial Planning
MW	Megawatt
NCMPA	Nature Conservation Marine Protected Areas
NEF	New Economics Foundation
NFFO	National Federation of Fishermen's Organisations
NGO	Non-Governmental Organisation
NI	Northern Ireland
NM	Nautical Mile
NMRs	National Marine Reserves
OGUK	Oil & Gas UK (now Offshore Energies UK)
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
OWF	Offshore Wind Farm
PMFs	Priority Marine Features
PTEC	Perpetuus Tidal Energy Centre
SAC	Special Area of Conservation
ScotWind	Lease Programme for Offshore Wind Farm Developments Around Scotland
SFF	Scottish Fishermen's Federation
SPA	Special Protection Area
UK	United Kingdom
UTM	Universal Transverse Mercator
VMS	Vessel Monitoring System
WGS	World Geodetic System

Cardinal points/directions are used unless otherwise stated.

SI units are used unless otherwise stated.