NFFO & SFF

# Spatial Squeeze in Fisheries

Final Report

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Innovative Thinking - Sustainable Solutions

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## Final Report

June 2022

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## Notice



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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

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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.

## Past (2000)

SACs and NMRs designated, but MCZs, NCMPAs and most offshore SACs not yet designated, nor management measures implemented. Offshore renewable energy is small-scale, experimental sites. Fishing could not take place in deep water (>800 m depth) due to technical constraints, nor over rocky seabed, or in uneconomical areas. Aquaculture, aggregates, cables and oil and gas installations as they were in 2000.

## Present

MCZs and NCMPAs designated, as well as current SACs, some with management measures to protect the most sensitive features from trawling and dredging. 10.4 GW offshore wind installed and commissioned across 40 wind farms. Tide and wave energy only small projects. Trawling banned from waters >800 m depth, and on vulnerable marine ecosystems >400 m, and technical constraints to trawling over rocky seabed. Aquaculture, aggregates, cables and oil and gas installations as they were in 2020/21.

# Scenarios

## Future 1 (2030)

Trawling banned across 80% of offshore SACs (for benthic features), MCZs and NCMPAs, and across whole sites for HPMAs. 40 GW offshore wind deployed in UK waters, based on existing areas and Round 3 OWF areas. Wave and tidal energy develops in line with sector plans and trends. Aquaculture, aggregates, cables and oil and gas development in line with sector growth aspirations. Oil and gas platforms not yet decommissioned.

## Future 2 (2050)

Trawling banned across 80% of offshore SACs (for benthic features), MCZs and NCMPAs, and across whole sites for HPMAs. 115 GW offshore wind deployed in UK waters, based on existing areas, Rounds 3 and 4, ScotWind areas and Celtic Sea zones. Wave and tidal energy develops in line with sector plans and trends. Aquaculture, aggregates, cables and oil and gas development in line with sector growth aspirations. Some oil and gas platforms decommissioned but others remain.

## Future 3 (Worst Case)

As for Future 2, but assuming trawling is banned across all SACs (for benthic features), MCZs, NCMPAs and HPMAs. No trawling within offshore wind farms. No trawling or dredging over cables including a 0.25 nautical mile buffer either side. All oil and gas platforms remain.

**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.

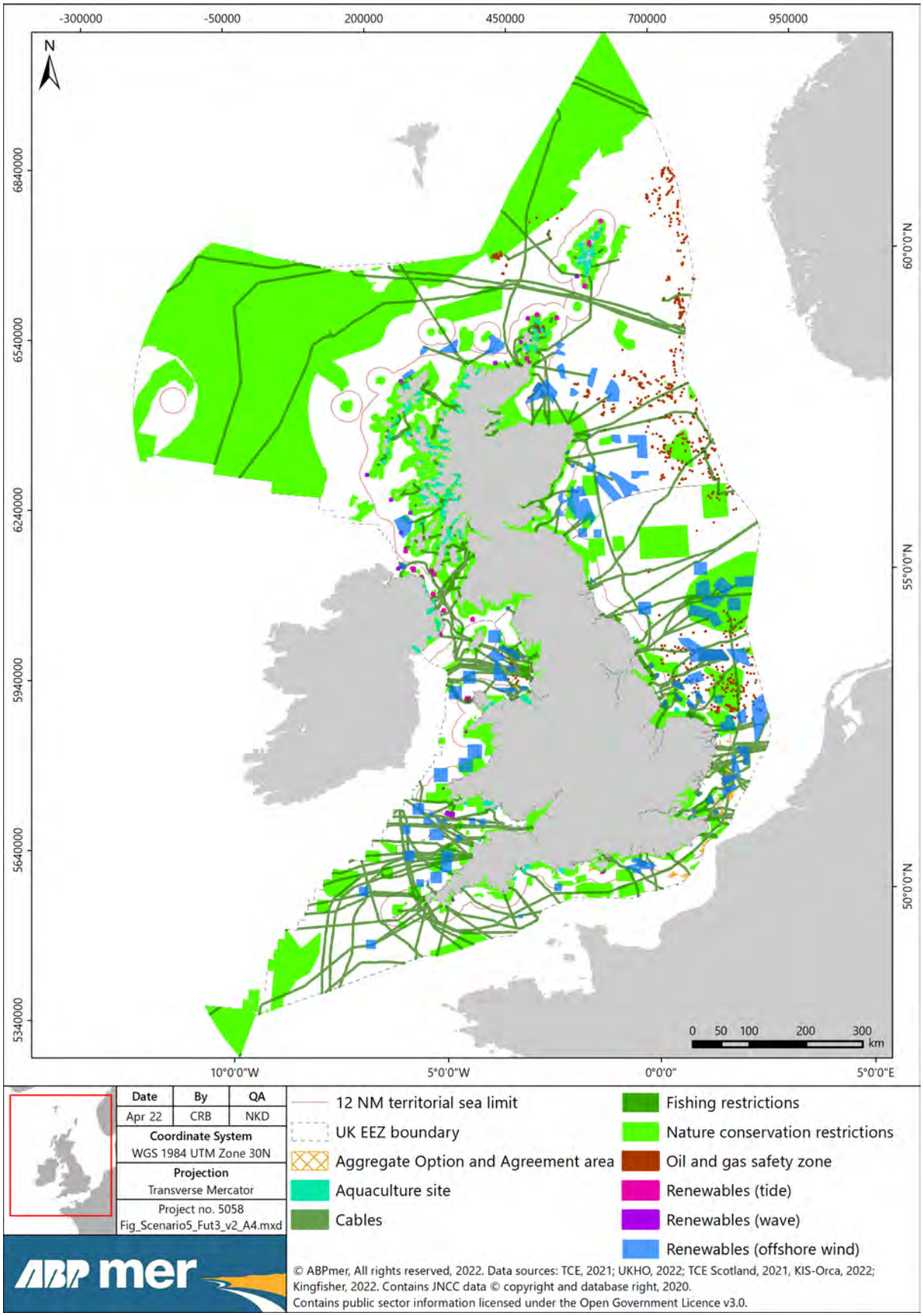
## Scenario Results

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$^2$ (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$^2$, 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$^2$ 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$^2$ 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$^2$ of space if a 0.25 nautical mile no-trawling buffer is applied to cables.




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

**Figure ES2. Future 3 scenario, all sectors**

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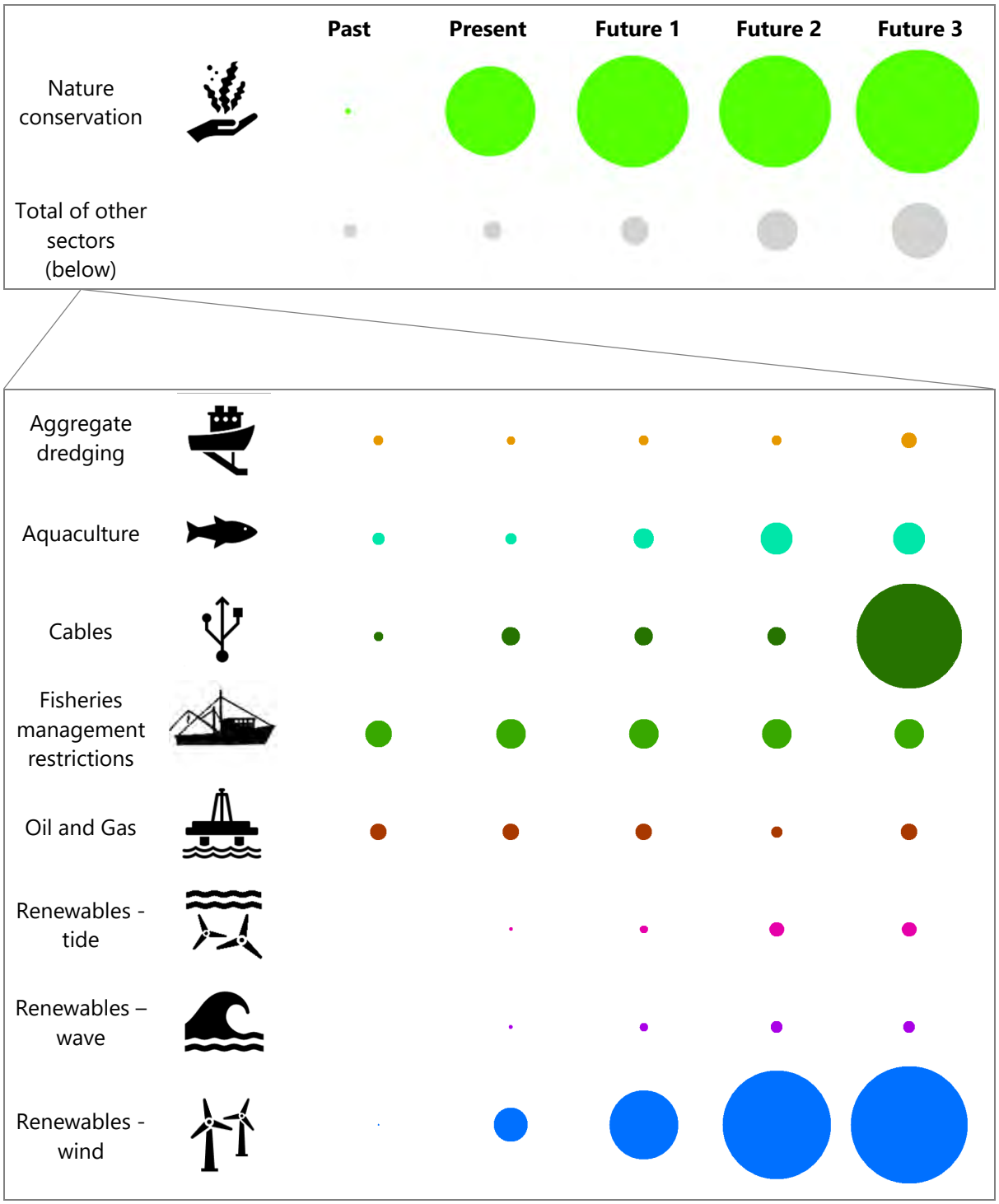


**Figure ES3. Relative area of each sector under each scenario**

# 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[1], 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 – HPMAs 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

[1] 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 HPMAs, 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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# 1 Introduction

The development of the blue economy[2] 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.

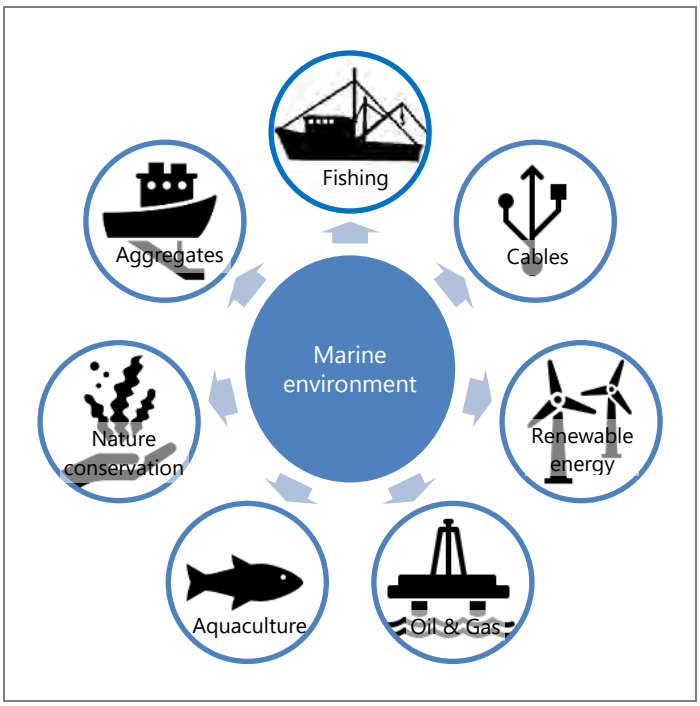



**Figure 1. Example sectors present in the marine environment**

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).

[2] The sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of ocean ecosystems.

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$^2$ 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).

| | Past 2000 | Present 2020/21 | Future 1 2030 | Future 2 2050 | Future 3 2050 (worst-case) |
|---|---|---|---|---|---|
| **Fishing** | ▪ Fisheries restrictions (year-round prohibitions on trawling) as in 2000.<br>▪ Technical and economic constraints to fishing in some areas. | ▪ Fisheries restrictions (year-round prohibitions on trawling) as in 2021.<br>▪ Technical and economic constraints to fishing in some areas. | ▪ Fisheries restrictions (year-round prohibitions on trawling) as in 2021.<br>▪ Technical and economic constraints to fishing in some areas. | ▪ Fisheries restrictions (year-round prohibitions on trawling) as in 2021.<br>▪ Technical and economic constraints to fishing in some areas. | ▪ Fisheries restrictions (year-round prohibitions on trawling) as in 2021.<br>▪ Technical and economic constraints to fishing in some areas. |
| **Nature Conservation** | ▪ SACs designated, but no management measures. MCZs, NCMPAs and most offshore SACs not yet designated.<br>▪ National Nature Reserves with fishing restrictions. | ▪ MCZ, NCMPAs and SACs designated, some with management measures. | ▪ Existing and proposed management measures.<br>▪ At least 80% of offshore sites protected from trawling.<br>▪ HPMAs in England (based on Reference Areas) and Scotland (additional 5% of offshore waters and 10% of inshore waters). | ▪ Existing and proposed management measures.<br>▪ At least 80% of offshore sites protected from trawling.<br>▪ HPMAs in England (based on Reference Areas) and Scotland (additional 5% of offshore waters and 10% of inshore waters).<br>▪ 3 NM zone around Scotland with an effort cap. | ▪ Trawling banned across all SACs, NCMPAs and MCZs.<br>▪ HPMAs in England (based on Reference Areas) and Scotland (additional 5% of offshore waters and 10% of inshore waters).<br>▪ 3 NM zone around Scotland excludes trawling. |
| **Offshore renewables – Wind** | ▪ One windfarm with two turbines at Blyth. | ▪ 10.4 GW offshore wind capacity installed across 40 wind farms. | ▪ At least 40 GW offshore wind capacity deployed in UK waters[1], based on existing pipeline and Round 3 OWF areas.<br>▪ Fixed turbines with lower capacity density allow some (25%) trawling within arrays. Floating arrays exclude all trawling. | ▪ 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.<br>▪ Fixed turbines with lower capacity density allow some (25%) trawling. Floating arrays exclude all trawling. | ▪ 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.<br>▪ No trawling within any OWF arrays. |
| **Offshore renewables – Wave** | ▪ No wave energy projects. | ▪ Small, demonstration projects.<br>▪ No trawling within arrays. | ▪ 182 MW installed capacity, based on active and pre-planning application lease areas.<br>▪ No trawling within arrays. | ▪ 1 GW installed capacity, based on sector projections.<br>▪ No trawling within arrays. | ▪ 1 GW installed capacity, based on sector projections.<br>▪ No trawling within arrays. |
| **Offshore renewables – Tidal** | ▪ No tidal energy projects. | ▪ Small, demonstration projects.<br>▪ No trawling within arrays. | ▪ 0.55 GW installed capacity, based on active and pre-planning application lease areas.<br>▪ No trawling within arrays. | ▪ 2.5 GW installed capacity, based on sector projections.<br>▪ No trawling within arrays. | ▪ 2.5 GW installed capacity, based on sector projections.<br>▪ No trawling within arrays. |

| | Past 2000 | Present 2020/21 | Future 1 2030 | Future 2 2050 | Future 3 2050 (worst-case) |
|---|---|---|---|---|---|
| **Aggregates** | ▪ Aggregate extraction from Active Dredge Zones (179 km$^2$) within licensed areas in 2000. | ▪ Aggregate extraction from Active Dredge Zones (101 km$^2$) within licensed areas in 2020, producing 18 million tonnes aggregate. | ▪ Aggregate production of 29 million tonnes based on sector projections, requiring 162 km$^2$ seabed to be dredged, representing 18% of Licence, Exploration and Option Areas. | ▪ Aggregate production of 29 million tonnes based on sector projections, requiring 162 km$^2$ seabed to be dredged, representing 35% of Exploration and Option Areas. | ▪ Aggregate production of 29 million tonnes based on sector projections, requiring 162 km$^2$ seabed to be dredged, representing 35% of Exploration and Option Areas. |
| **Aquaculture** | ▪ Aquaculture production, particularly in Scotland, for salmon and shellfish.<br>▪ No seaweed production. | ▪ Aquaculture production based on current sites.<br>▪ Small-scale and experimental seaweed cultivation. | ▪ Aquaculture production increases based on sector aspirations and growth rates in the four devolved administrations for finfish, shellfish and seaweed. | ▪ Aquaculture production increases based on sector aspirations and growth rates in the four devolved administrations for finfish, shellfish and seaweed. | ▪ Aquaculture production increases based on sector aspirations and growth rates in the four devolved administrations for finfish, shellfish and seaweed. |
| **Cables** | ▪ Telecom cables that were present in 2000, and Blyth windfarm export cable.<br>▪ Trawling can take place over cables laid in soft substrate and waters <200 m deep. | ▪ Telecom, power cables and OWF export cables.<br>▪ Trawling can take place over cables laid in soft substrate and waters <200 m deep. | ▪ Telecom, power cables, proposed cables and OWF export cables.<br>▪ Trawling can take place over cables laid in soft substrate and waters <200 m deep. | ▪ Telecom, power cables, proposed cables and OWF export cables.<br>▪ Trawling can take place over cables laid in soft substrate and waters <200 m deep. | ▪ Telecom, power cables, proposed cables and OWF export cables.<br>▪ No trawling or dredging over full length of cables including a 0.25 NM buffer either side. |
| **Oil and Gas** | ▪ Oil and gas installations with surface and subsea safety zones (500 m). | ▪ Oil and gas installations with surface and subsea safety zones (500 m). | ▪ Oil and gas installations with surface and subsea safety zones (500 m). | ▪ Some decommissioning of oil and gas installations, representing 41% reduction in area of safety zones. | ▪ Oil and gas decommissioning does not result in change of footprint, existing surface and subsea safety zones (500 m) maintained. |

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.

**Figure 2. Summary of scenarios for each sector**

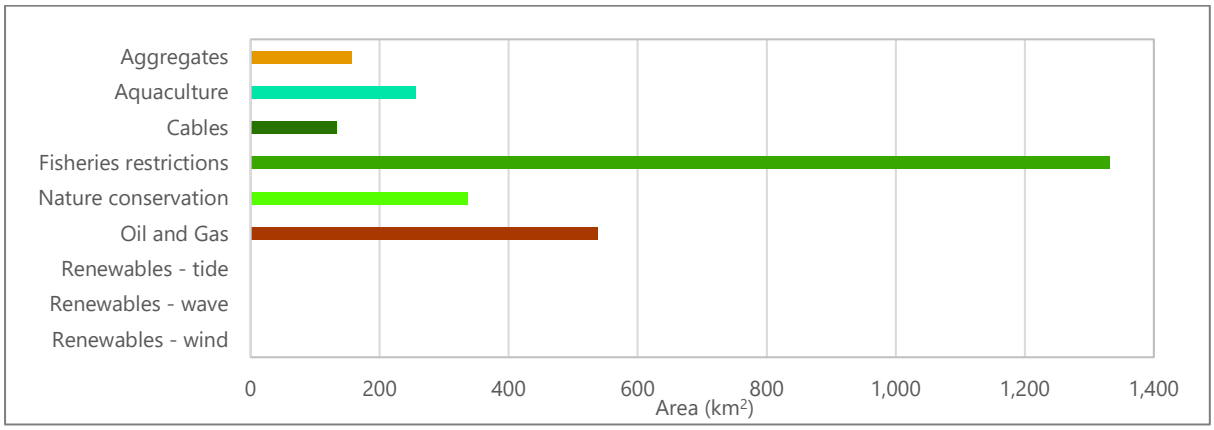
# 3 Past Scenario (2000)

In 2000, fishing was relatively unconstrained in where it could operate across the UK EEZ. The Oil and Gas sector was well established[3]. 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$^2$ 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$^2$) | 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% |
| **Total** | **2,712** | **0.37%** |
| 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**

[3] 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.

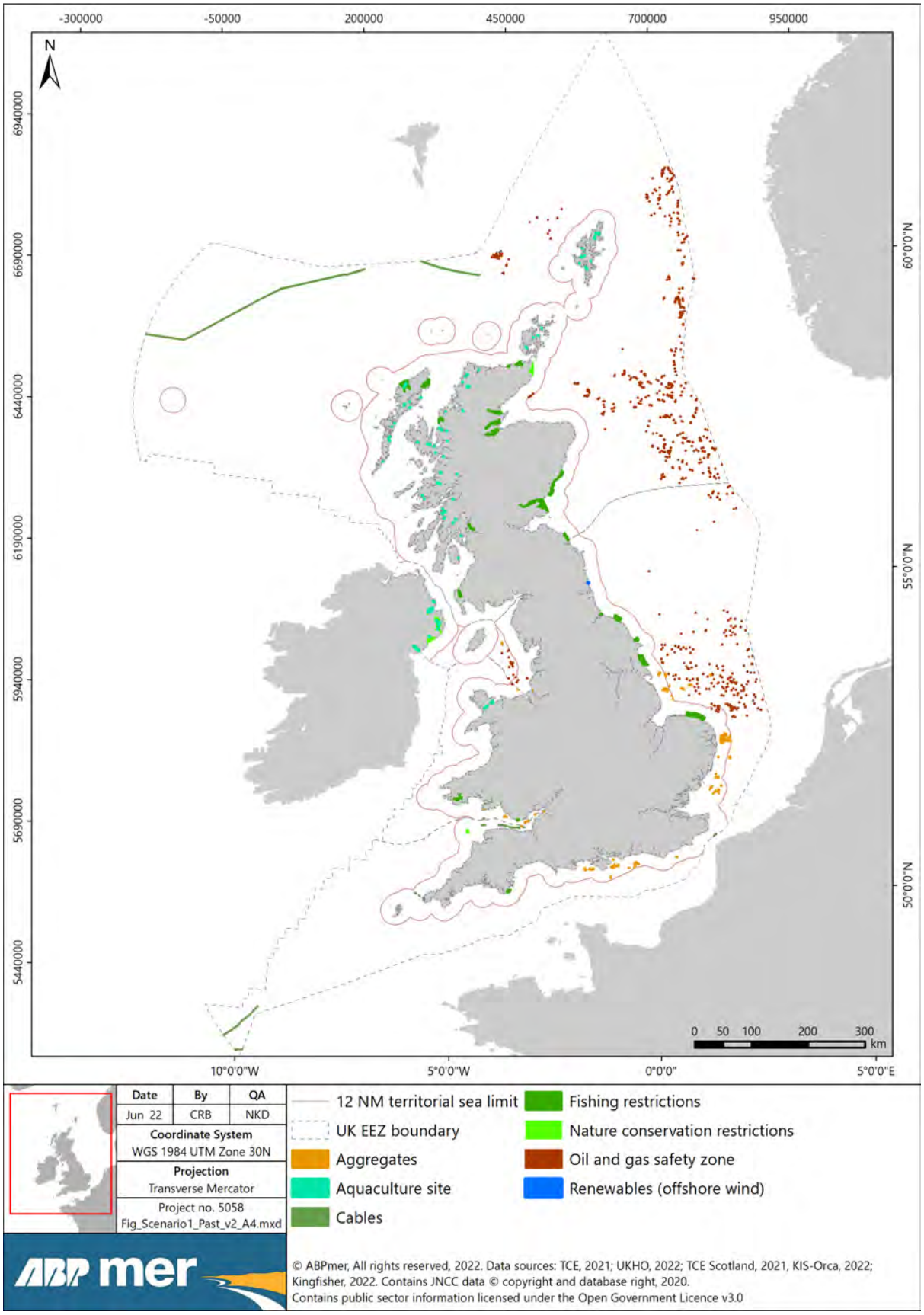



**Figure 4. Past scenario, all sectors**

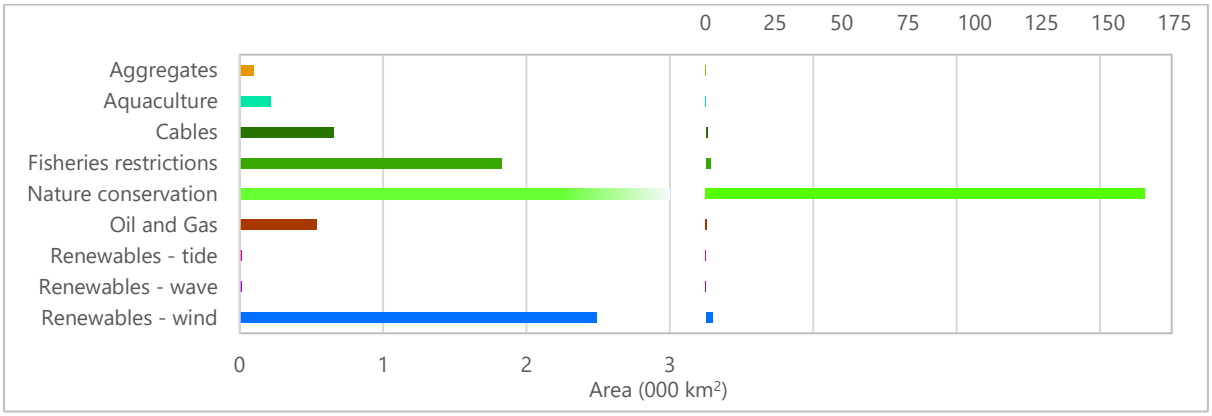
# 4 Present Scenario (2020/2021)

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$^2$ 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$^2$) | 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% |
| **Total** | **169,966** | **23.13%** |
| Note: These area calculations take account of overlaps between different sectors. | | |




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

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

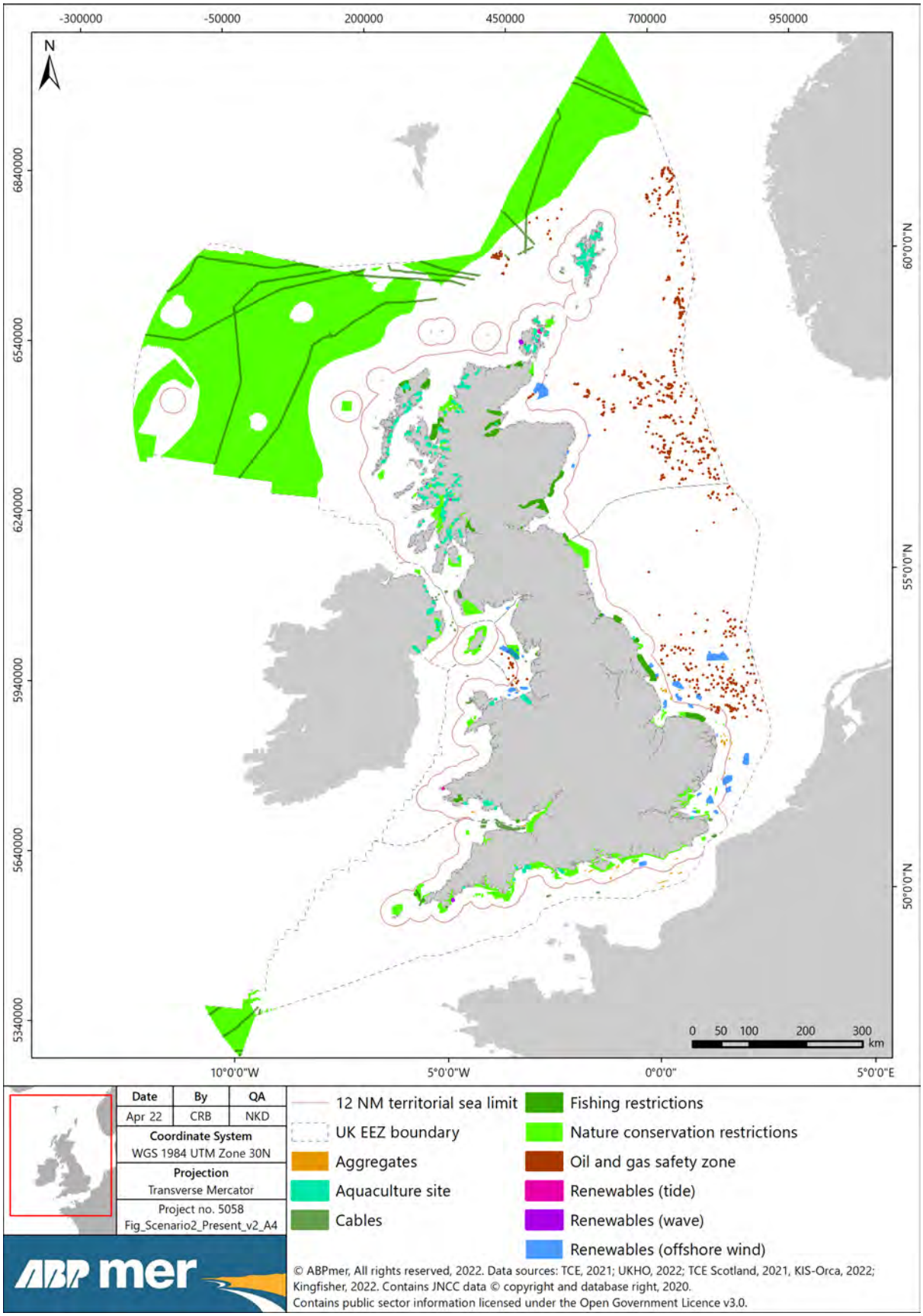



**Figure 6. Present scenario, all sectors**

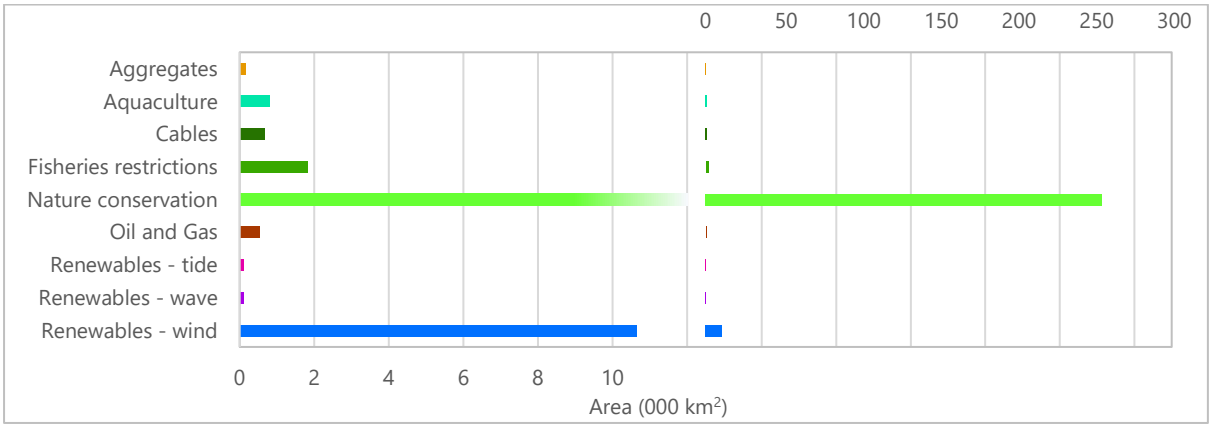
# 5 Future 1 Scenario (2030)

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$^2$ 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$^2$) | 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% |
| **Total** | **266,457** | **36.26%** |
| Note: These area calculations take account of overlaps between different sectors. | | |




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

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

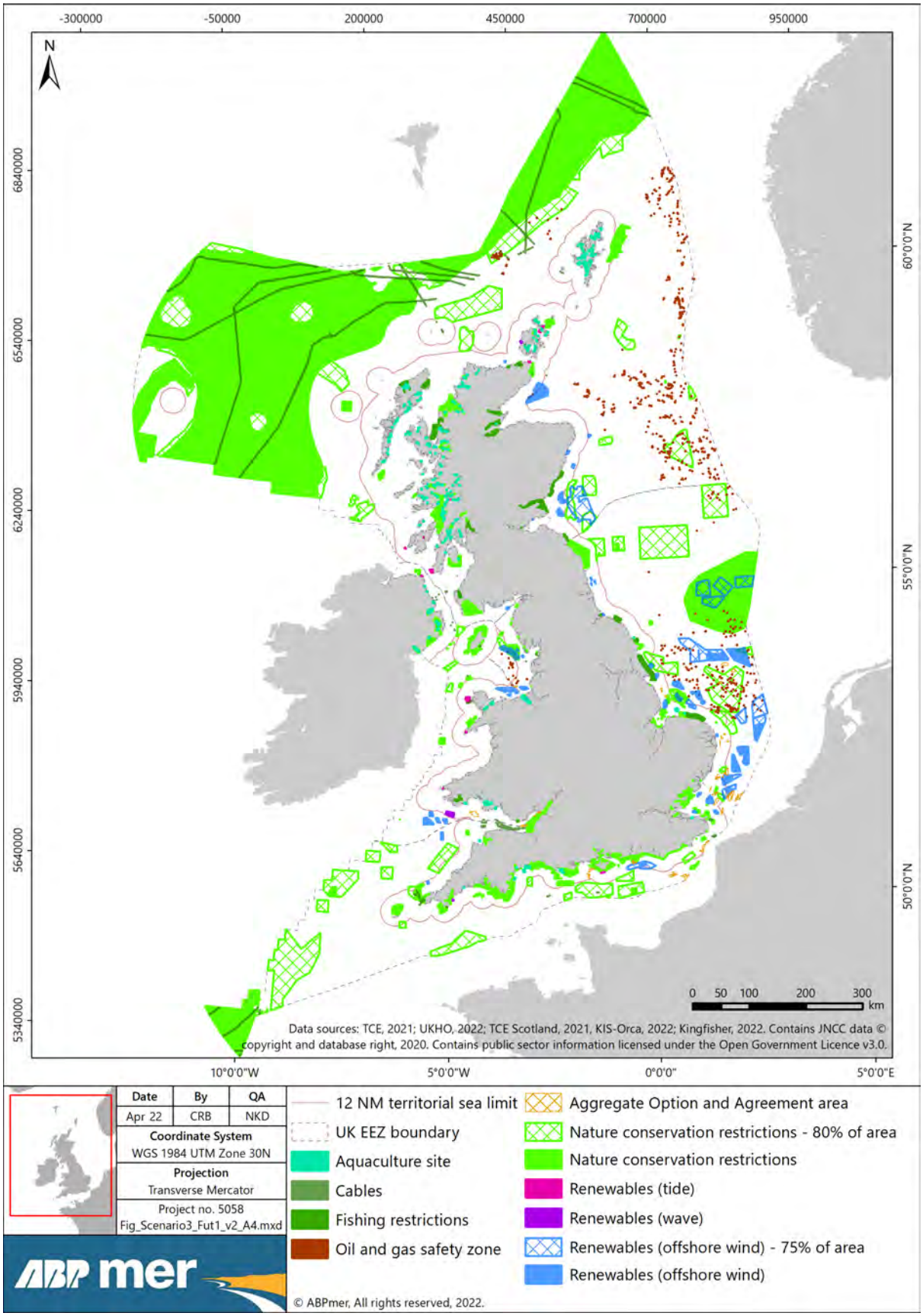



**Figure 8. Future 1 scenario, all sectors**

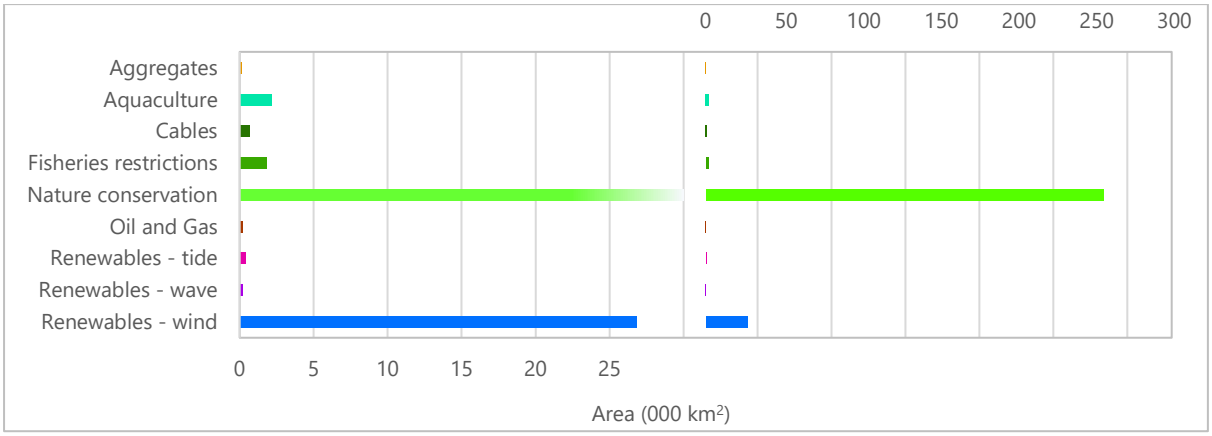
# 6 Future 2 Scenario (2050)

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[4]. 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$^2$ 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$^2$) | 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% |
| **Total** | **276,713** | **37.66%** |
| Note: These area calculations take account of overlaps between different sectors. | | |




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

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

[4] 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.

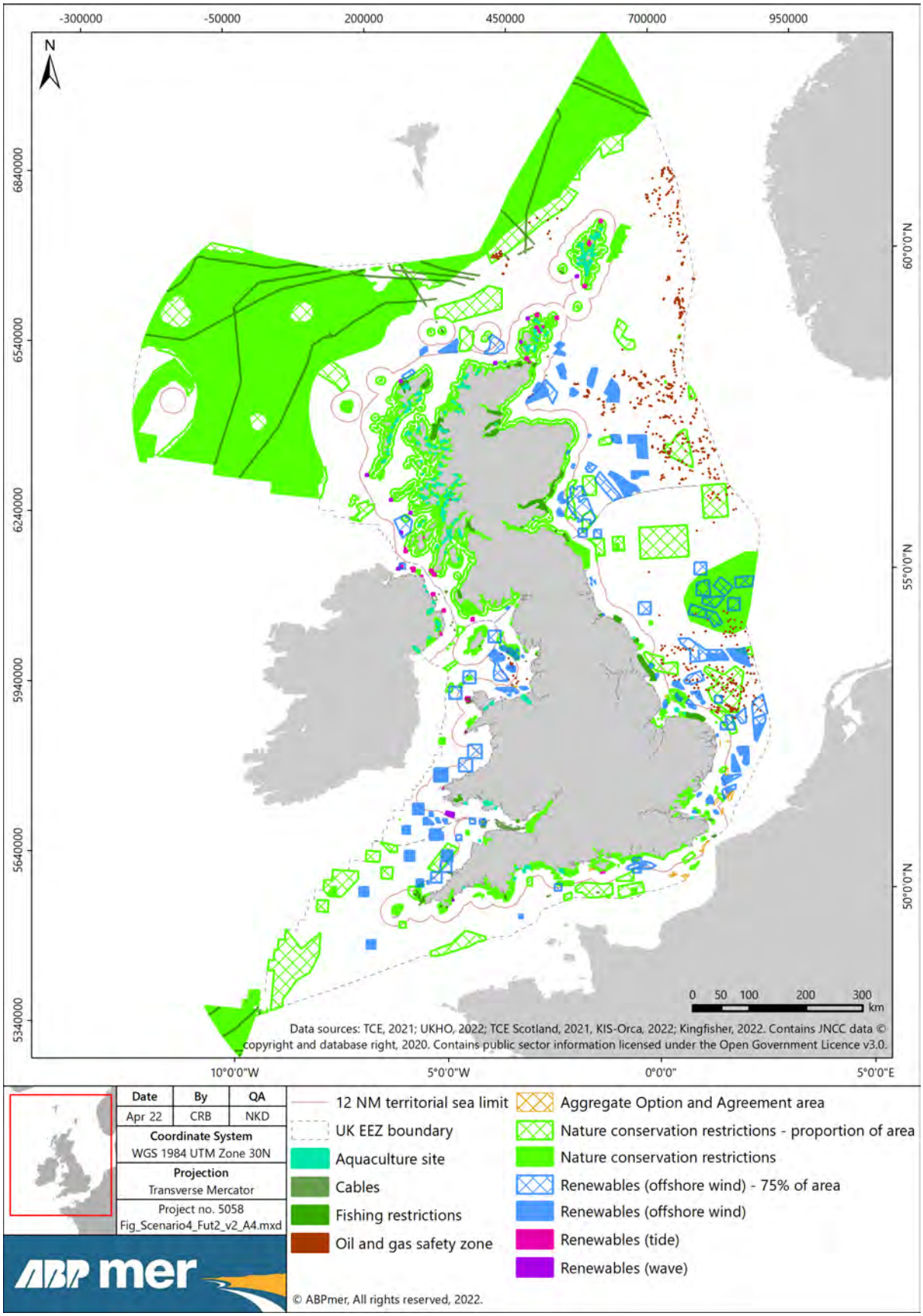



**Figure 10. Future 2 scenario, all sectors**

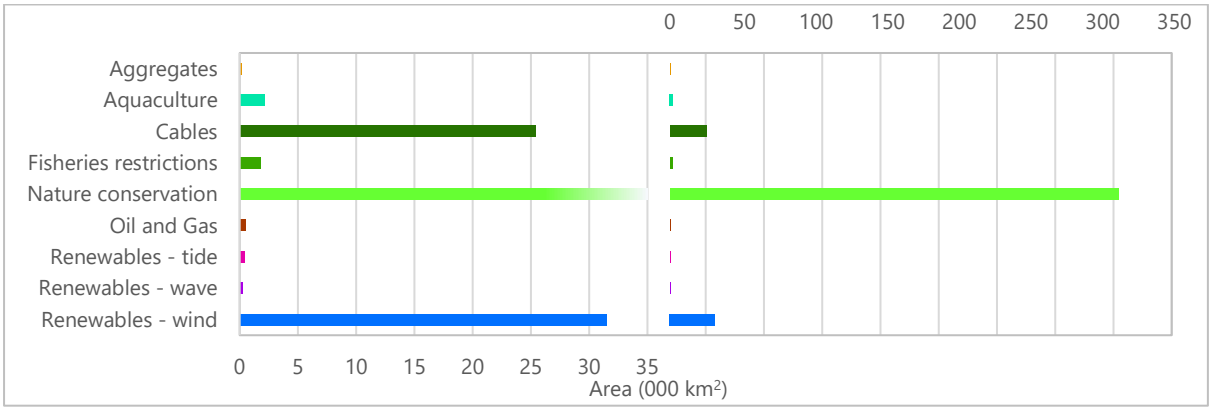
# 7 Future 3 Scenario (2050)

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$^2$ 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[5]. 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$^2$ 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$^2$) | 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% |
| **Total** | **356,834** | **48.56%** |
| Note: These area calculations take account of overlaps between different sectors. | | |




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

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

[5] 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.

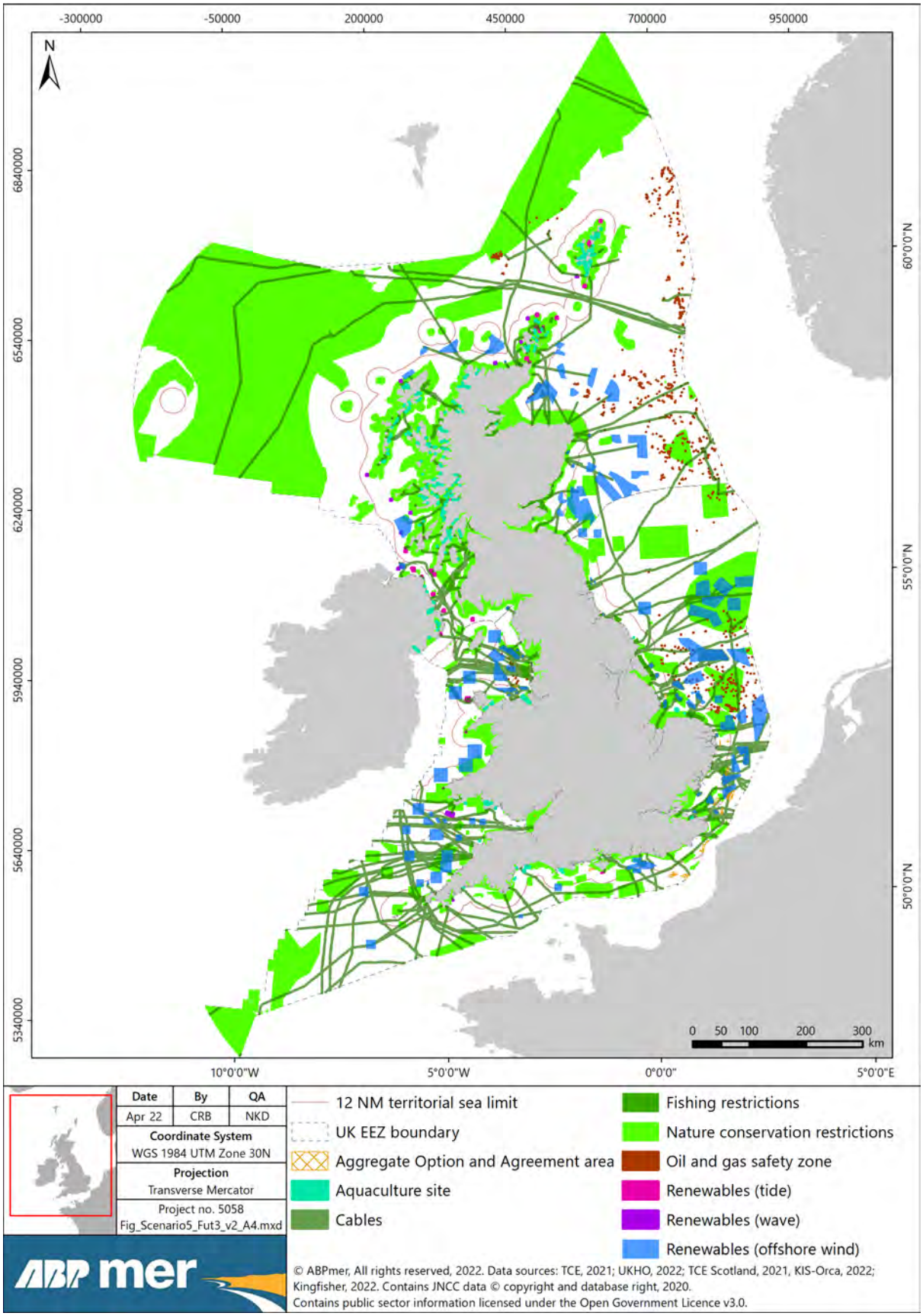



**Figure 12. Future 3 scenario, all sectors**

# 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 Westermost 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 $km^2$ 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.

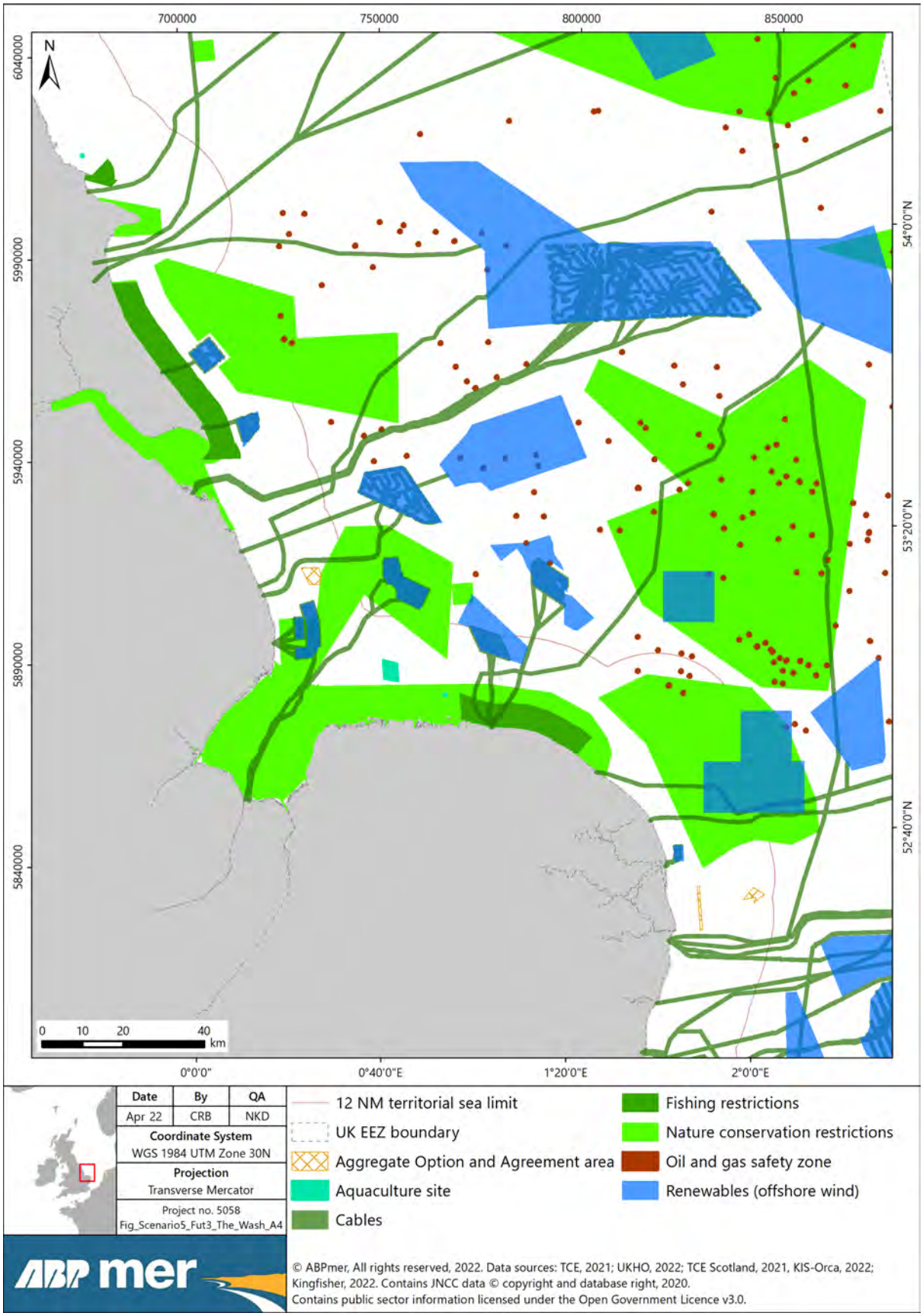



**Figure 13. Local case study: The Wash and off the Humber Estuary – Future 3 scenario**

## 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 as 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.

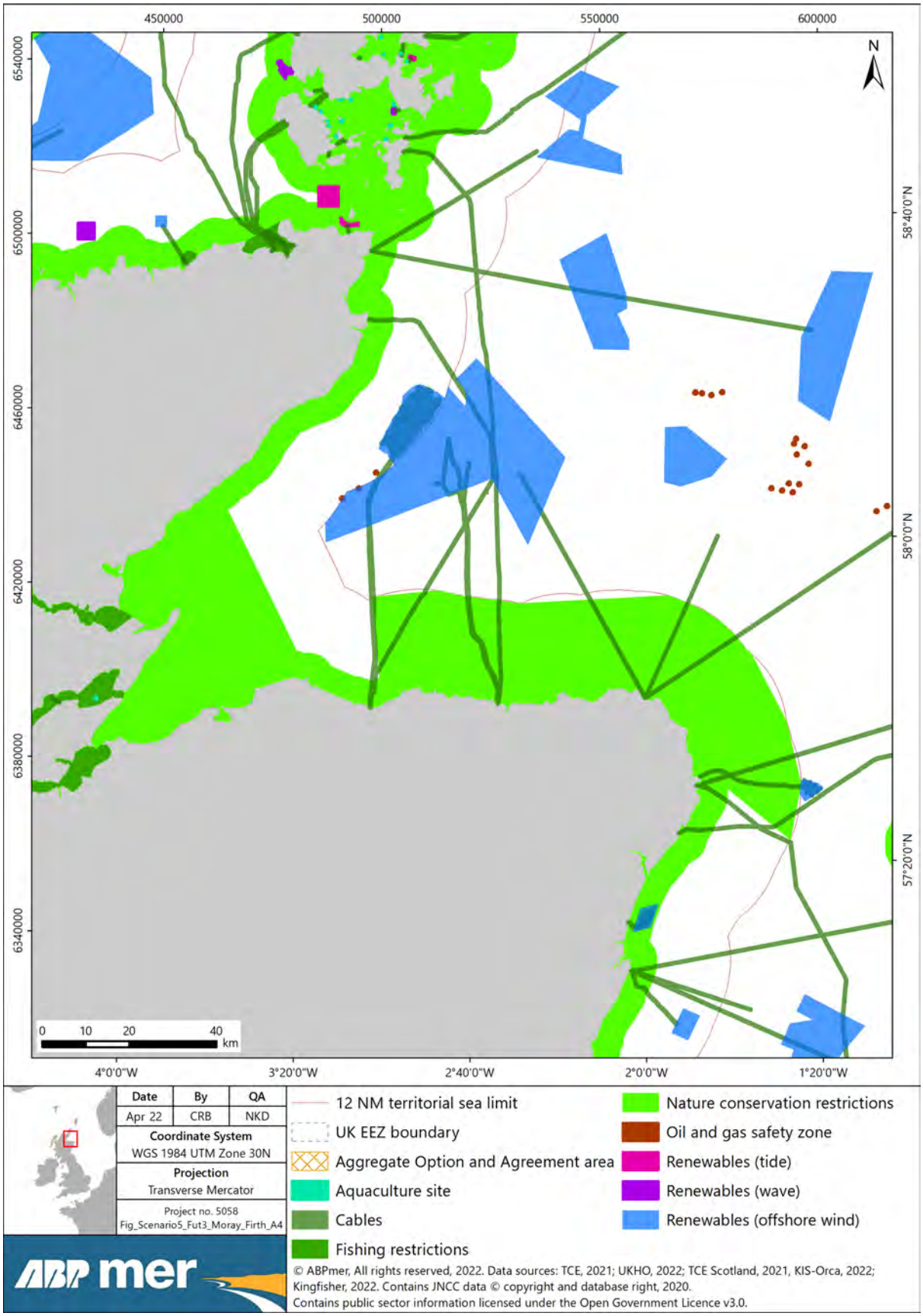



**Figure 14. Local case study: Moray Firth – Future 3 scenario**

# 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.

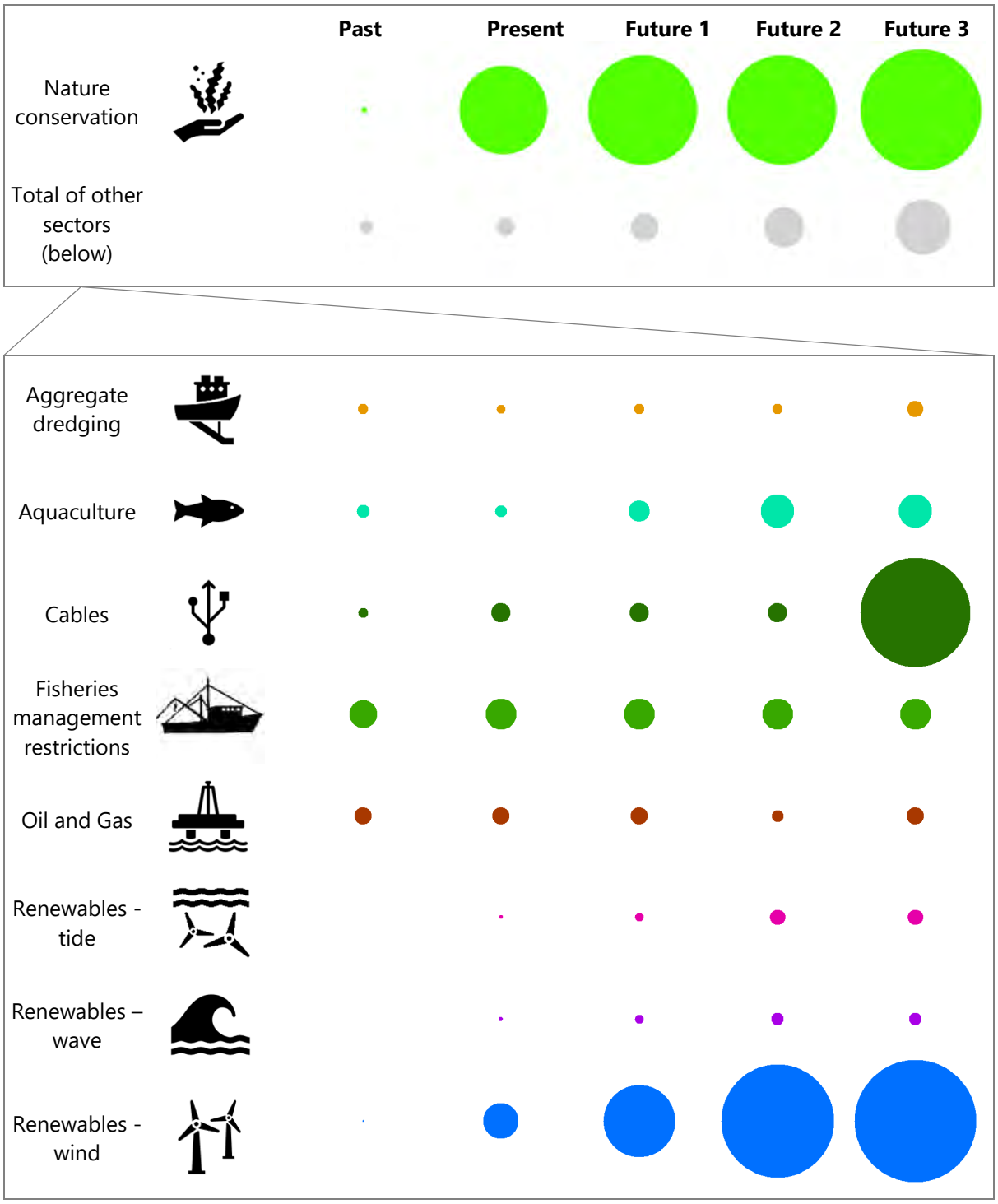



**Figure 15. Relative area of each sector under each scenario**

Nature conservation (MPAs[6], 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[7]. 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,

6 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.

7 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 HPMAs, 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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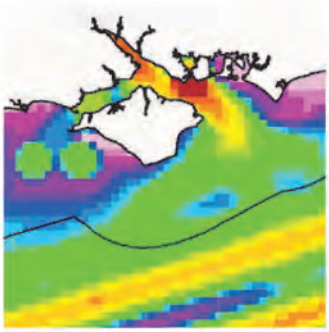
# 11 Abbreviations/Acronyms

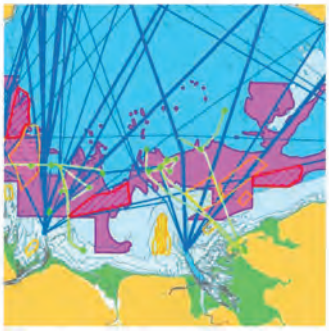
| | |
|---|---|
| BEIS | Department for Business, Energy & Industrial Strategy |
| BUTEC | British Underwater Test and Evaluation Centre |
| Cefas | Centre for Environment, Fisheries and Aquaculture Science |
| CEO | Chief Executive Officer |
| ECSA | European Subsea Cables Association |
| EEC | European 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.

# Appendices



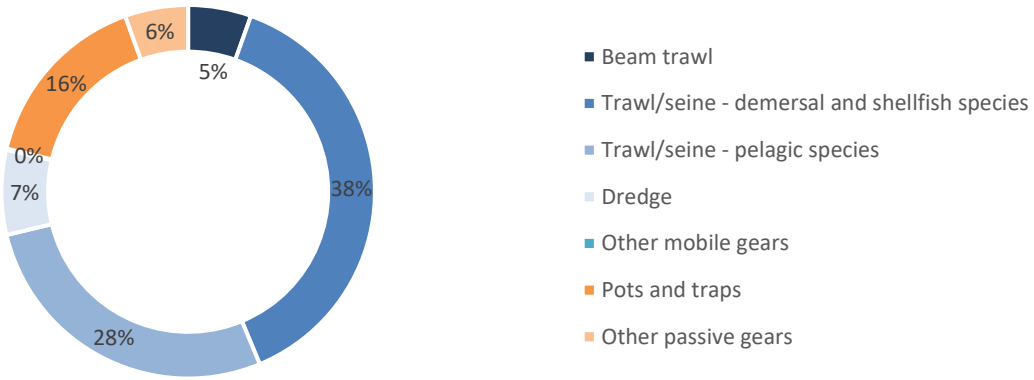

Innovative Thinking - Sustainable Solutions

ABP mer

# A Fishing Sector Assumptions and Scenarios

## A.1 Assumptions

Restrictions exist for different gear types, vessel sizes, engine powers or seasons, and will affect individual fleet segments differently (positively and negatively). For example, restrictions on mobile demersal gears may provide new opportunities for static gear fisheries. The mobile gear sector (dredges, trawls and seines) makes up 79% of UK landings by value, and the majority of this is from trawls and seines. Trawls may be deployed on the seabed (demersal trawl) or in the water column (mid-water or pelagic trawl). Trawls and seines landing demersal and shellfish species make up the largest proportion of UK landings by value (38%) (Figure A1). For this reason, the analysis focusses on restrictions on demersal trawling. In many cases, where demersal trawls are restricted, beam trawls and dredges are also restricted – together these represent 50% of UK landings by value. 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. There are additional areas where trawling is restricted for certain vessel size classes or at certain times of the year, but these areas have not been included in the analysis, as trawling is permitted during some months and for some vessels.




Source: Calculated from MMO 2017, 2018, 2019, 2020, 2021.

**Figure A1. Proportion of UK landings by value, by gear type (average 2016-2020)**

Restrictions on fishing activity can be put in place for fisheries management purposes (e.g. to reduce gear conflict, or for stock management). Many of these are seasonal or related to technical gear specifications, particular species or restrictions on vessel sizes or engine power. These restrictions are included in the spatial mapping for the fishing sector. The mapping for fishing sector also includes other restrictions on fishing that are not for nature conservation purposes, e.g. military, food safety or harbour/navigation restrictions. Restrictions for conservation purposes are included in the 'Marine Protected Areas and Nature Conservation' sector. Differences between the past scenario and other scenarios are: inclusion of BUTEC restrictions, Loch Torridon and the Northern Inner Sound restriction, small areas around harbours or FEPA closures, and exclusion of the Start Bay trawling restrictions (which are subsequently incorporated in the nature conservation scenarios).

Assumptions for the fishing sector are provided in Table A1, and spatial data for each scenario are shown in Figure A2 to Figure A3.

**Table A1. Fishing assumptions**

| Sector | Scenario | Assumptions and Rationale | Limitations |
|---|---|---|---|
| Fishing | Past | ▪ Restrictions on trawling (permanent, year-round, exclusions established through regulation rather than voluntary arrangements) for fisheries management or gear conflict purposes, based on Kingfisher data and consideration of the timing and purpose of each restriction (fisheries management vs nature conservation). | ▪ Identification of areas for the past scenario is difficult as older legislation is not available online. BUTEC and Clyde (Faslane) areas uncertain, but these are minor importance overall. |
| | Present | | |
| | Future 1 | | |
| | Future 2 | | |
| | Future 3 | | |

## A.2 Areas by Scenario

The areas of fisheries management restrictions, for each scenario, and in relation to the UK EEZ, are shown in Table A2.

**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**

| Scenario | Area ($km^2$) | As % of EEZ |
|---|---|---|
| Past | 1,332 | 0.18% |
| Present | 1,829 | 0.25% |
| Future 1 | 1,829 | 0.25% |
| Future 2 | 1,829 | 0.25% |
| Future 3 | 1,829 | 0.25% |

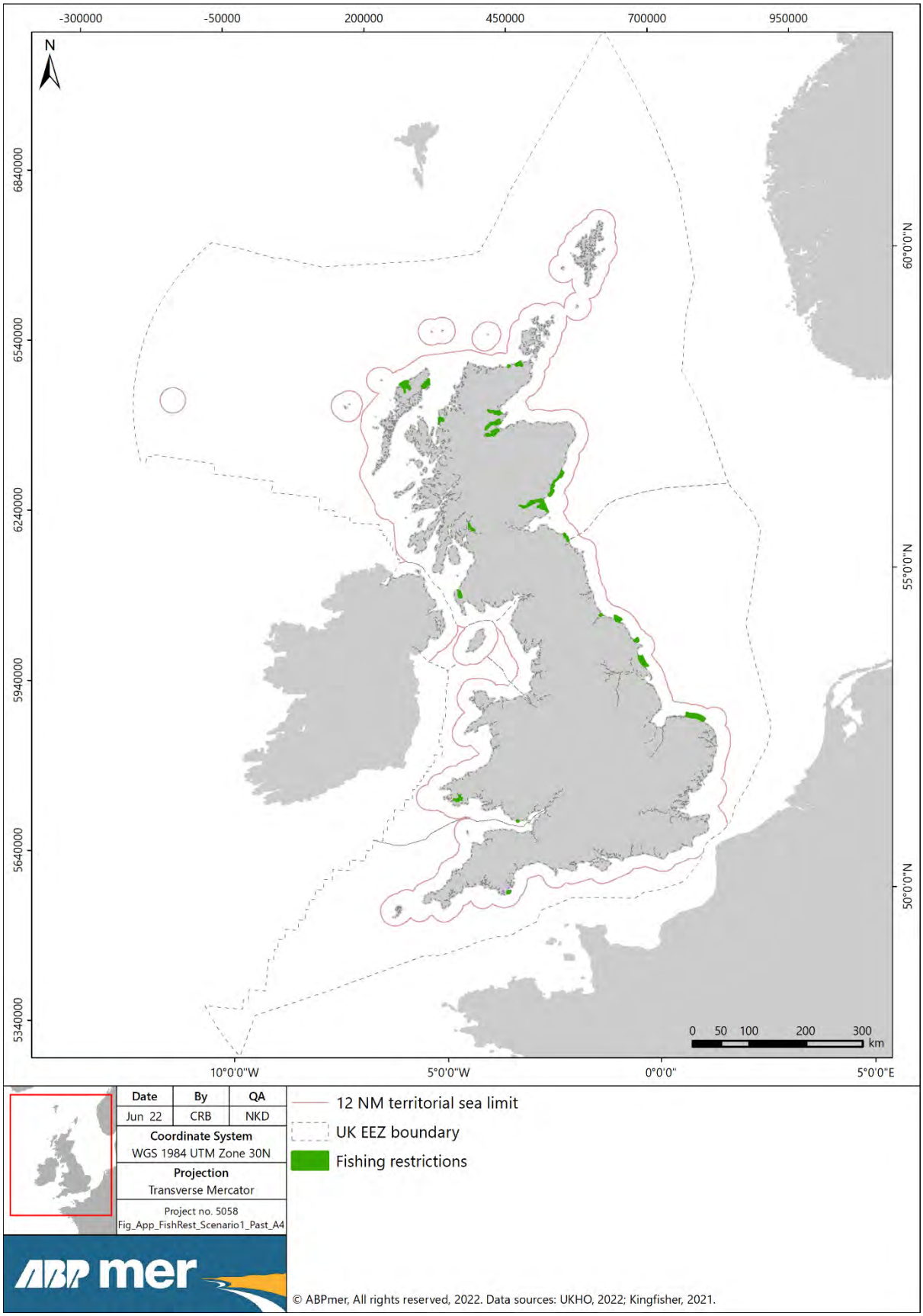



**Figure A2. Fishing restrictions – Past scenario**

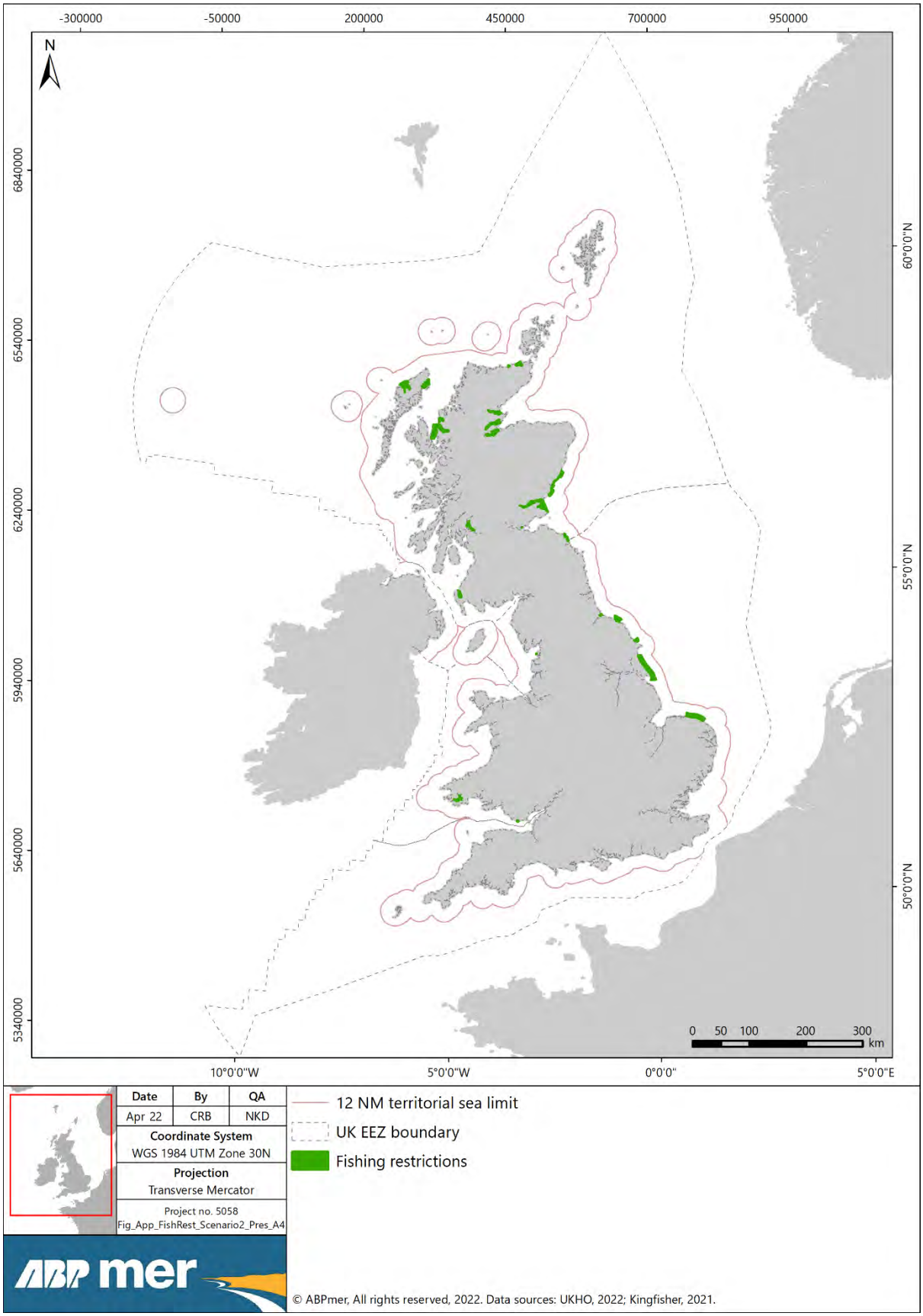



**Figure A3. Fishing restrictions – Present scenario**

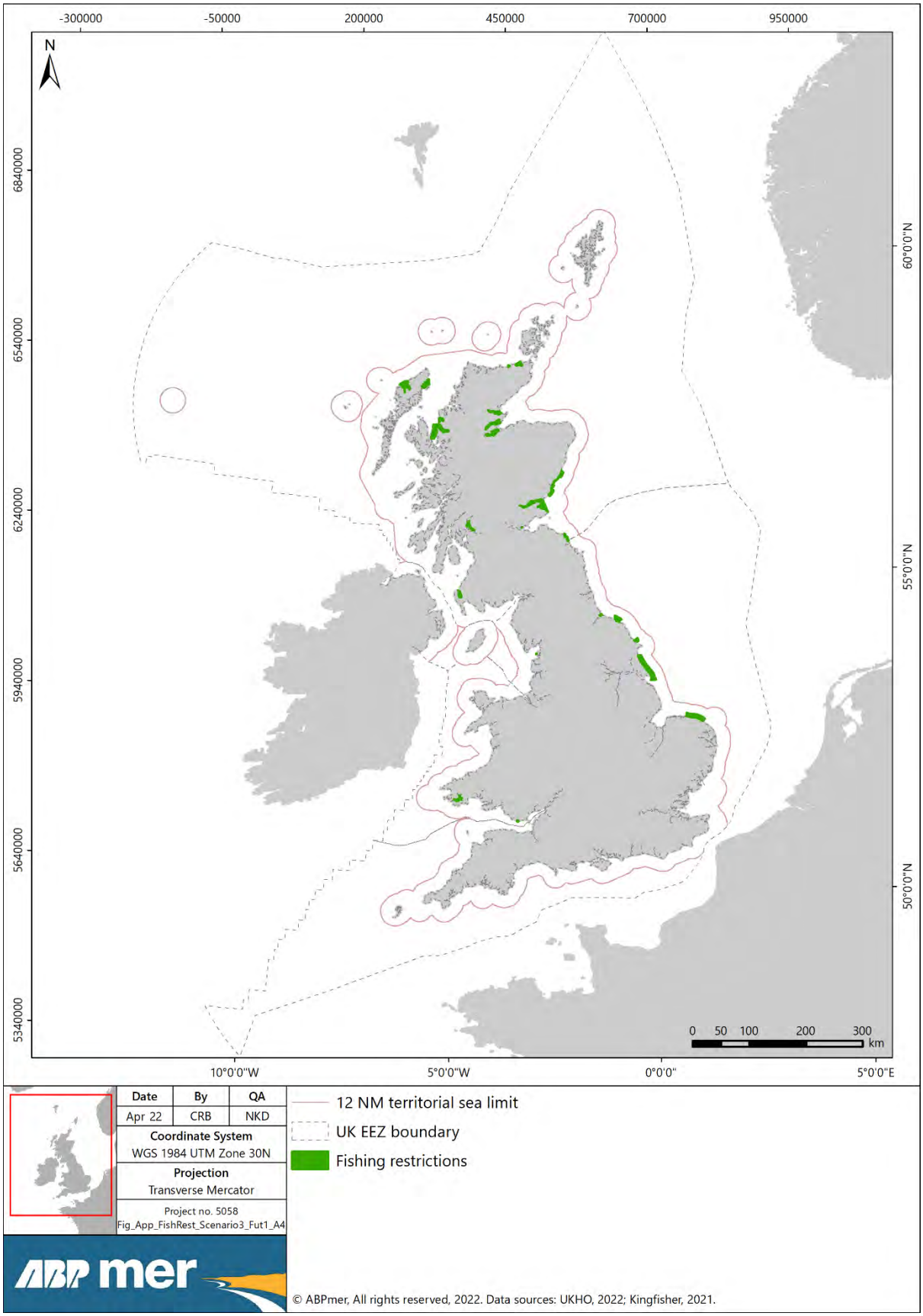



**Figure A4. Fishing restrictions – Future 1 scenario**

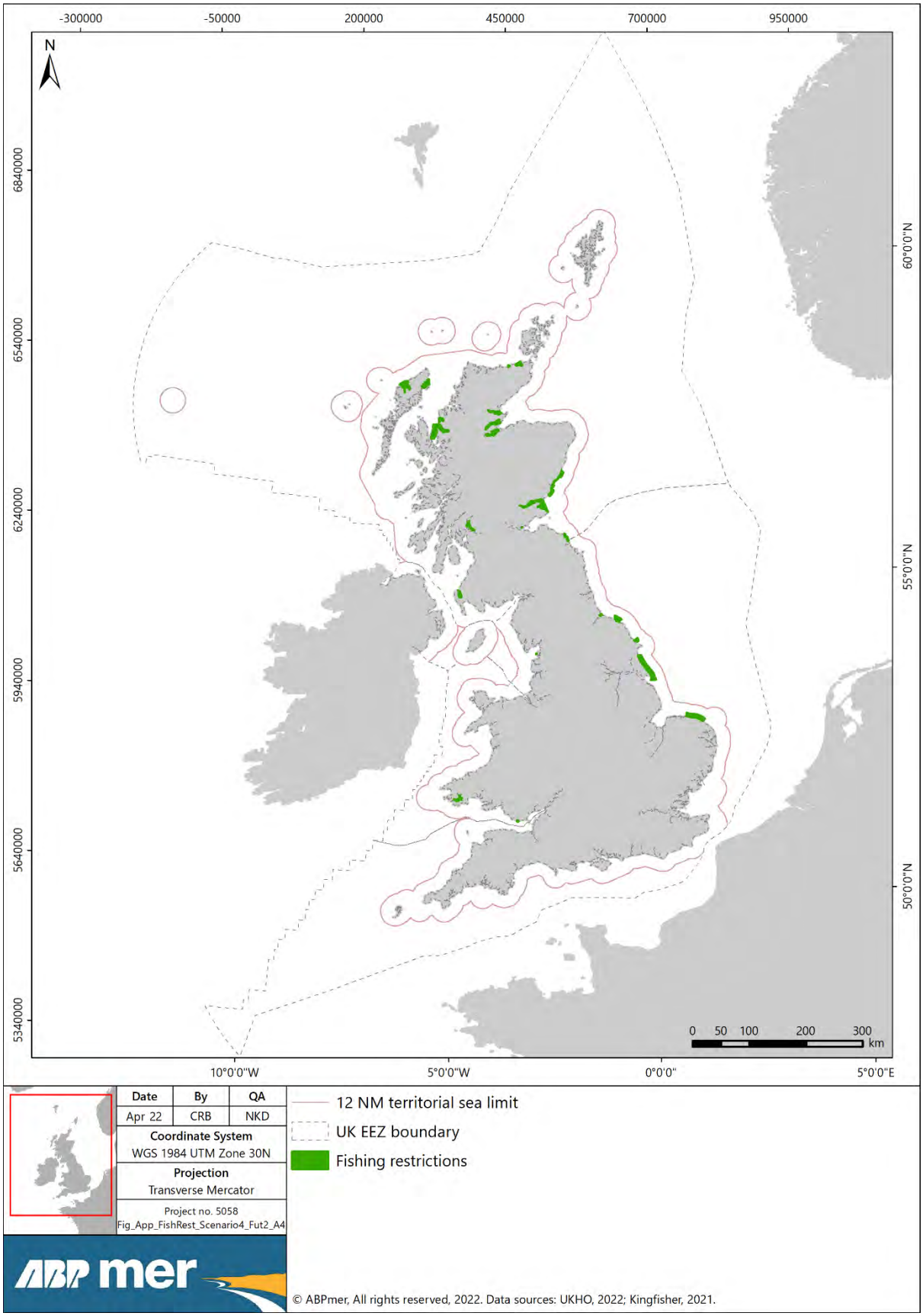



**Figure A5. Fishing restrictions – Future 2 scenario**

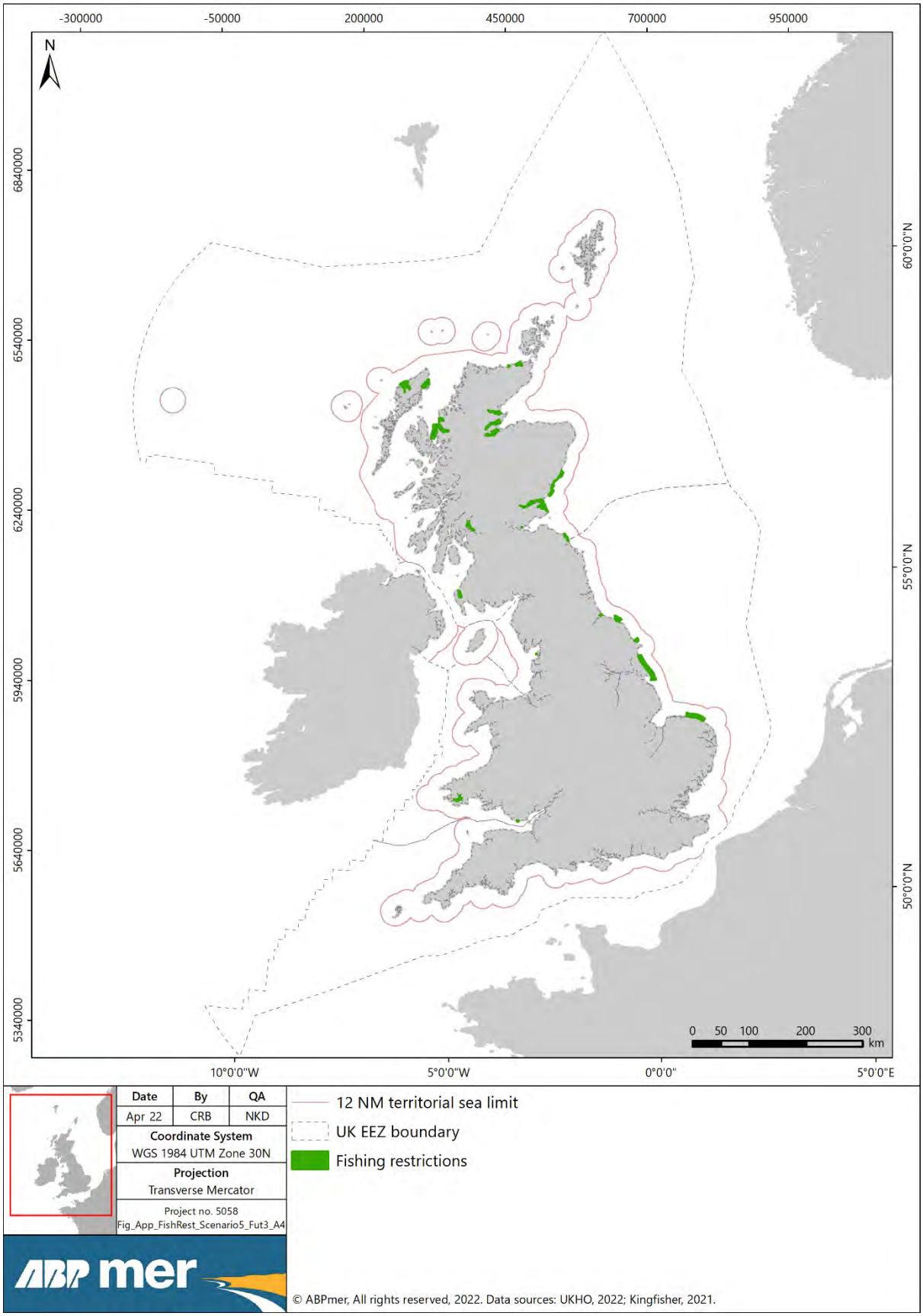



**Figure A6. Fishing restrictions – Future 3 scenario**

# B Marine Protected Areas and Nature Conservation Assumptions and Scenarios

## B.1 Assumptions

Marine areas are increasingly being designated to protect the diverse species and habitats in the marine environment around the UK. Various different designations are made according to the legislation and administration in which they occur, which together form a network of protected sites. Special Areas of Conservation (SACs) are designated to protect seabed habitats and some mobile species, originally under the EU Habitats Directive (Council Directive 92/43/EEC). Marine Conservation Zones (MCZs) have been designated in English waters to protect a range of nationally important, rare or threatened habitats and species. In Scottish inshore and offshore waters, Nature Conservation Marine Protected Areas (NCMPAs) have been designated to protect a range of nationally important habitats and species, and the Scottish Government is considering protection measures for Priority Marine Features (PMFs) and the introduction of Highly Protected Marine Areas (HPMAs). Restrictions on fishing activity have begun to be introduced in these sites, first those in inshore waters, and subsequent to the UK leaving the European Union, restrictions in offshore sites are also being considered. There are also restrictions on fishing activity, brought in under fisheries legislation, but which have a nature conservation purpose, such as protections for spawning grounds and deep-water habitats. These are also included in this sector. Special Protection Areas (SPAs) have not been included in the analysis, as to date they have not resulted in restrictions to demersal trawling, although this may change in future.

The restrictions on fishing for nature conservation included in this analysis are those where demersal trawling is prohibited for all vessel sizes and engine powers, all year round. There are additional areas where trawling is restricted for certain vessel size classes or at certain times of the year, but these areas have not been included in the analysis, as trawling is permitted during some months and for some vessels.

Assumptions for the marine protected areas and conservation sector are provided in Table B1 and spatial data for each scenario are shown in Figure B1 to Figure B5. The focus is on where there are permanent, year-round exclusions of trawling. For future scenarios, we assume that 80% of the area of offshore sites (that do not currently have restrictions in place) will have trawling restrictions introduced, and in Future 3 we assume trawling is banned across all sites.

**Table B1. Marine protected areas and conservation sector assumptions**

| Sector | Scenario | Assumptions and Rationale | Limitations |
|---|---|---|---|
| MPAs and Nature Conservation | Past | ▪ Areas of coastal/marine waters with year-round trawling bans in 2000 for nature conservation purposes, using Kingfisher (2021) data and informed by Cefas (1997). | |
| | Present | ▪ Areas of coastal/marine waters with year-round trawling bans in 2020/21, for nature conservation purposes, using Kingfisher data and consideration of the purpose of each restriction (fisheries management vs nature conservation). | |

| Sector | Scenario | Assumptions and Rationale | Limitations |
|---|---|---|---|
| | Future 1 | ▪ Trawl restrictions for nature conservation purposes within 12 NM as they are in 2021 (broadly, those within SACs, NCMPAs and MCZs), and proposed offshore restrictions being consulted on as of November 2021 (6 sites in English waters). Assumes that within 12 NM gear-feature interactions have been sufficiently addressed and further management measures are not needed.<br>▪ For other SACs for benthic features, NCMPAs and MCZs beyond 12 NM, trawl bans are implemented across 80% of their area (based on the average proportion for sites where trawl bans are proposed – the average is 82%).<br>▪ Designation of Highly Protected Marine Areas (HPMAs) and ban on mobile demersal gear (and all gears) within them (Benyon Review, Defra 2019). Reference Areas are used as a proxy for locations in English waters. Scottish Government has committed to protecting 10% of waters as HPMAs, split between inshore and offshore waters. 2.7% of inshore waters are currently protected; so we assume an additional 10% of inshore waters are designated as HPMAs. 42.6% of offshore waters are currently protected but there is likely to be a desire to show designation of new areas, so we assume an additional 5% of offshore waters are designated as HPMAs. Priority Marine Features (PMFs) in Scotland have not been explicitly considered but protections may be incorporated within existing sites and HPMA areas.<br>▪ It is assumed that trawling restrictions are not introduced in SPAs. | ▪ No information on location of HPMAs in Welsh, Scottish or NI waters – not possible to include spatially. HPMAs in Scotland have been incorporated into area calculations but not mapped. Candidate HPMAs in England are likely to be announced soon and may differ from the Reference Areas mapped.<br>▪ Uncertainty over potential for trawling restrictions in SPAs. |
| | Future 2 | ▪ As for Future 1, and a 3 NM zone around Scotland is introduced. This is assumed to be a cap on effort (in line with current proposals) rather than a spatial restriction. | ▪ As for Future 1. |

| Sector | Scenario | Assumptions and Rationale | Limitations |
|---|---|---|---|
| | Future 3 | ▪ Prohibition of bottom trawling across the full extent of all NCMPAs, SACs, MCZs (for benthic features) (but not SPAs), and 3 NM zone around Scotland - Government strategy to protect and recover 30% of seas by 2030, and calls from various NGOs to restrict bottom trawling in all MPAs (Greenpeace, MCS, NEF, Oceana), and within 3 NM zone around Scotland. The 3 NM zone also corresponds to proposals for protection of PMFs.<br>▪ HPMAs as in Future 1. | ▪ As for Future 1. |

## B.2 Areas by Scenario

The areas of nature conservation restrictions, for each scenario, and in relation to the UK EEZ, are shown in Table B2. The extent of the potential impact, 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 increase the spatial extent of nature conservation measures assessed in these scenarios.

**Table B2. Areas of nature conservation restrictions on trawling by scenario, and as a percentage of UK EEZ**

| Scenario | Area ($km^2$) | As % of EEZ |
|---|---|---|
| Past | 337 | 0.05% |
| Present | 164,947 | 22.45% |
| Future 1 | 254,998 | 34.70% |
| Future 2 | 256,204 | 34.87% |
| Future 3 | 312,785 | 42.57% |

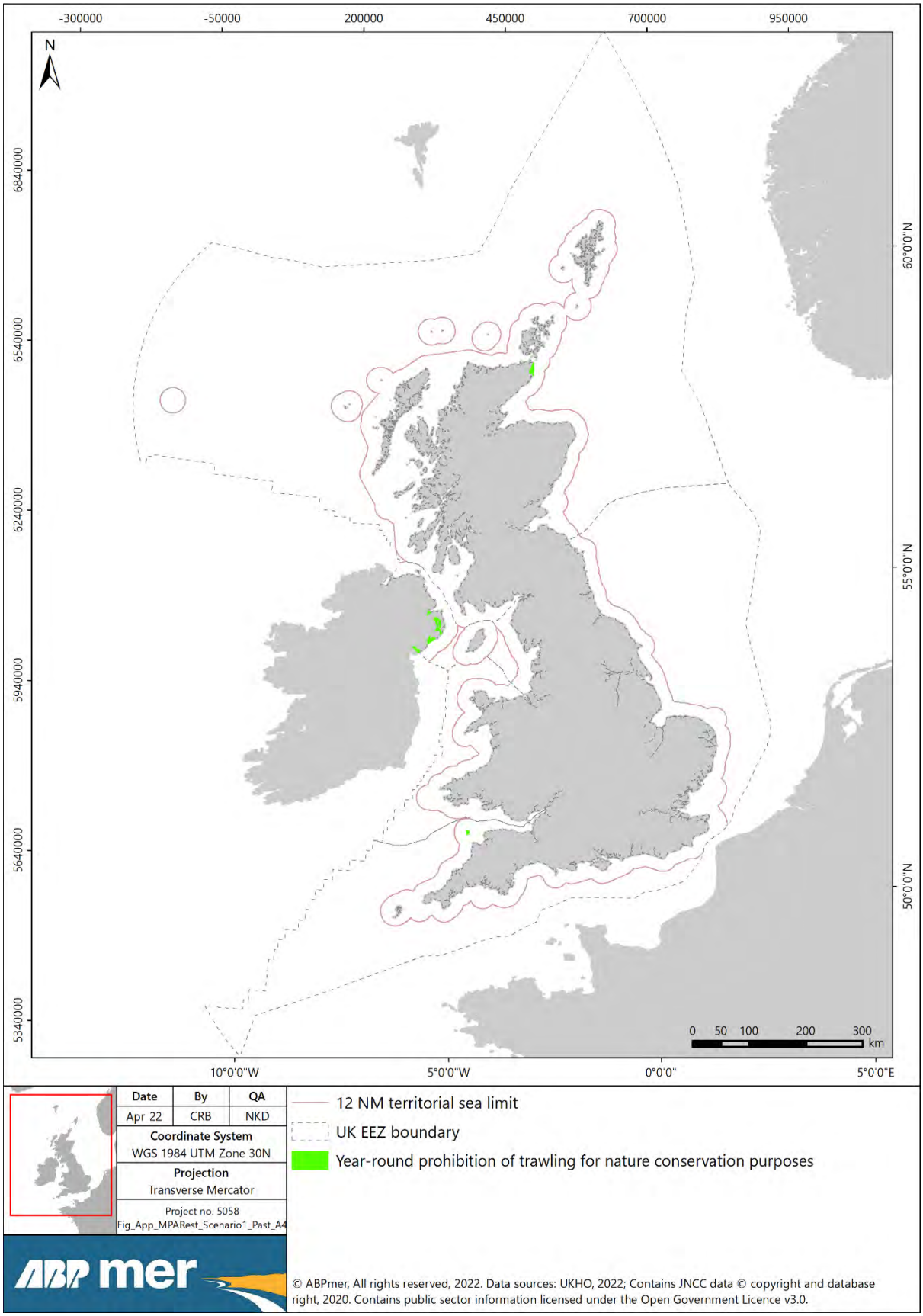



**Figure B1. Nature Conservation – Past scenario**

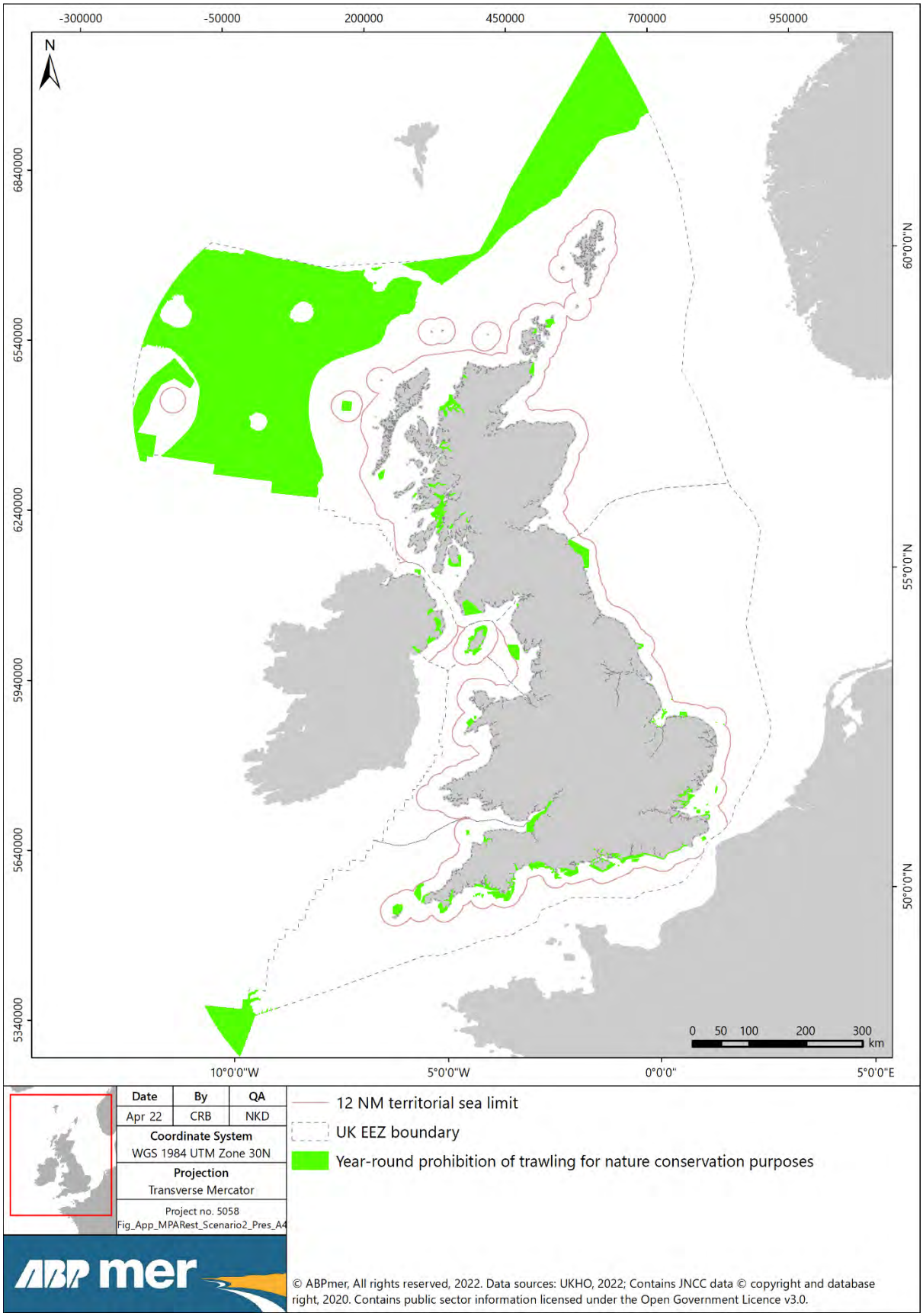



**Figure B2. Nature conservation – Present scenario**

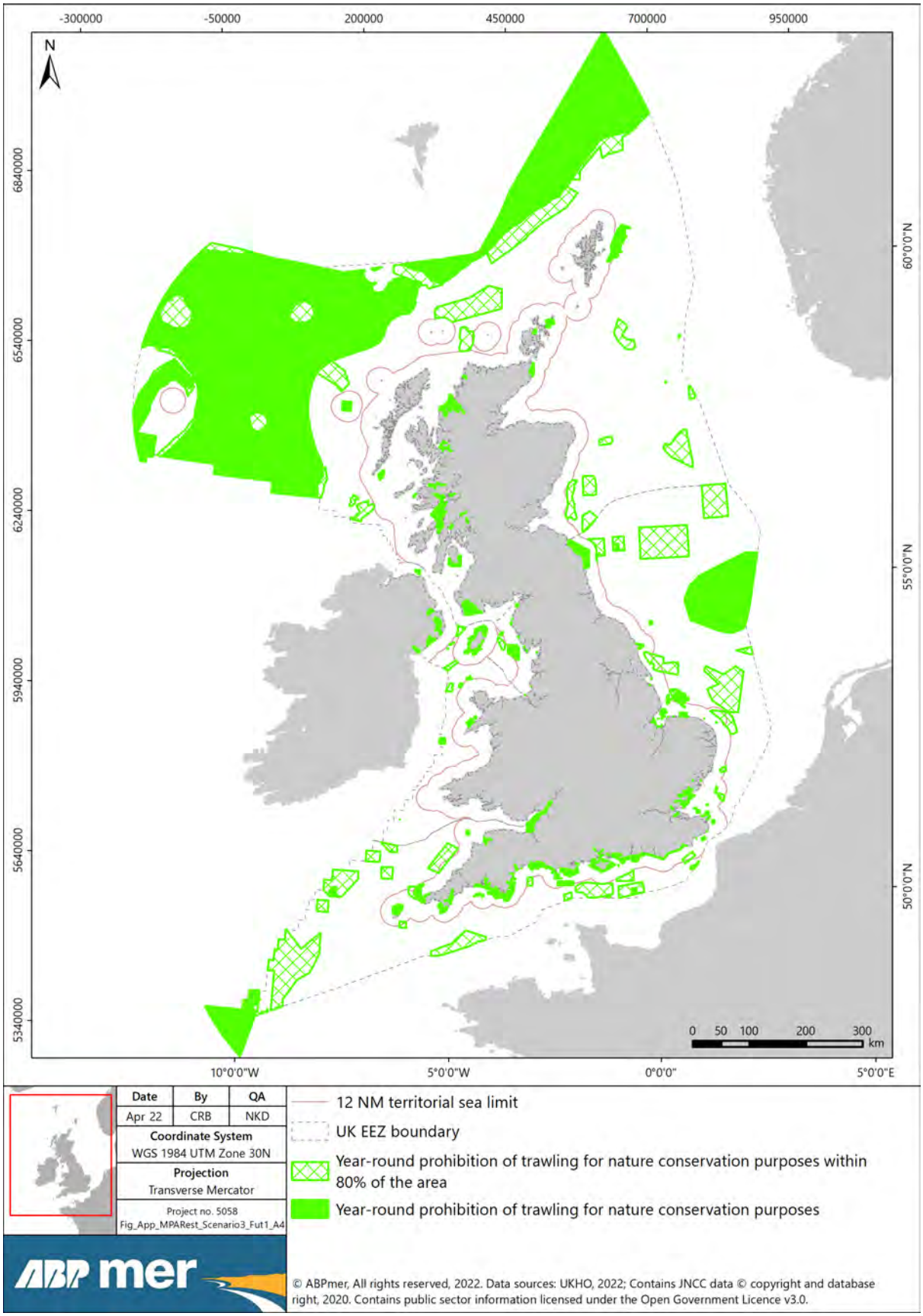



**Figure B3. Nature conservation – Future 1 scenario**

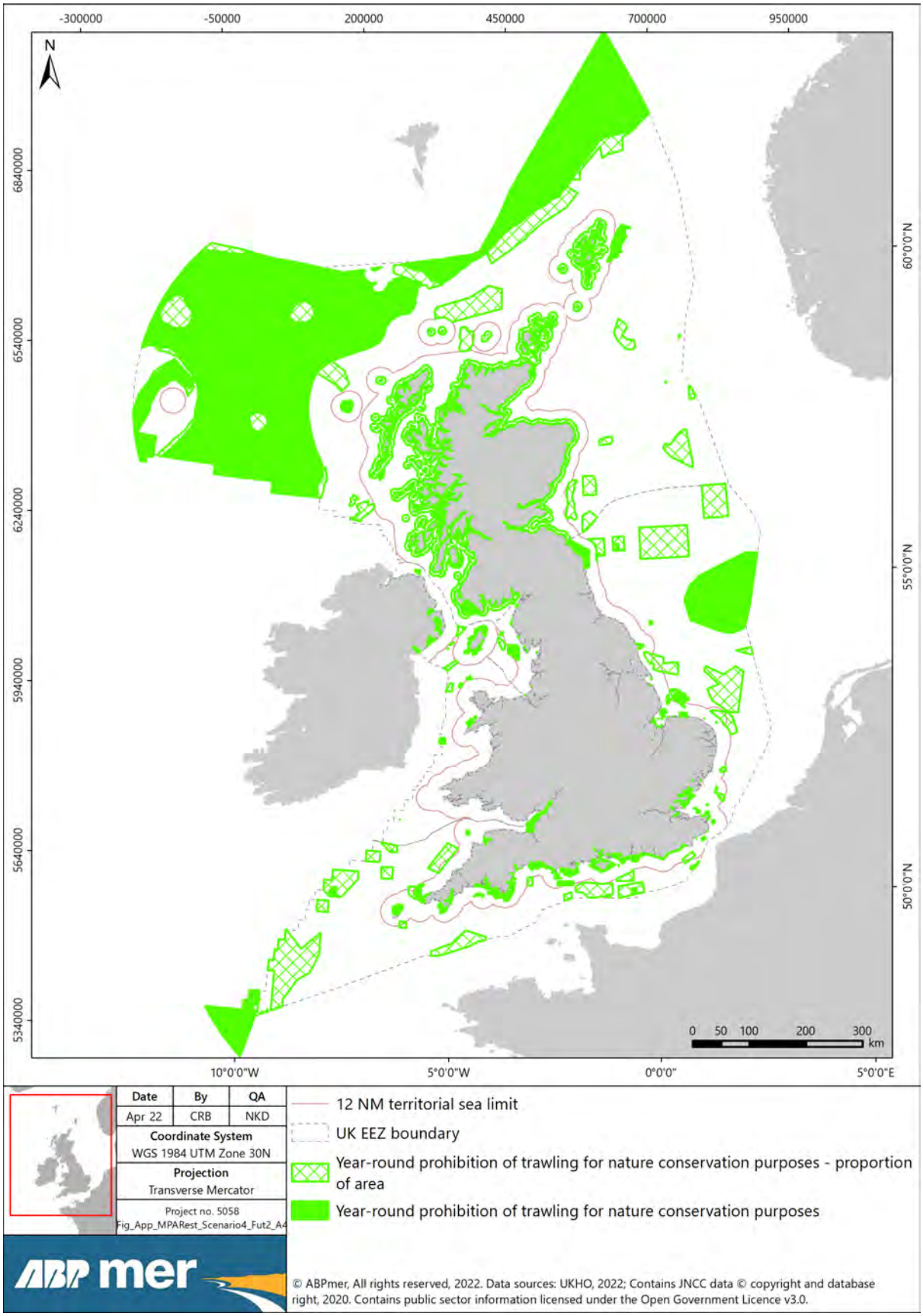



**Figure B4. Nature conservation – Future 2 scenario**

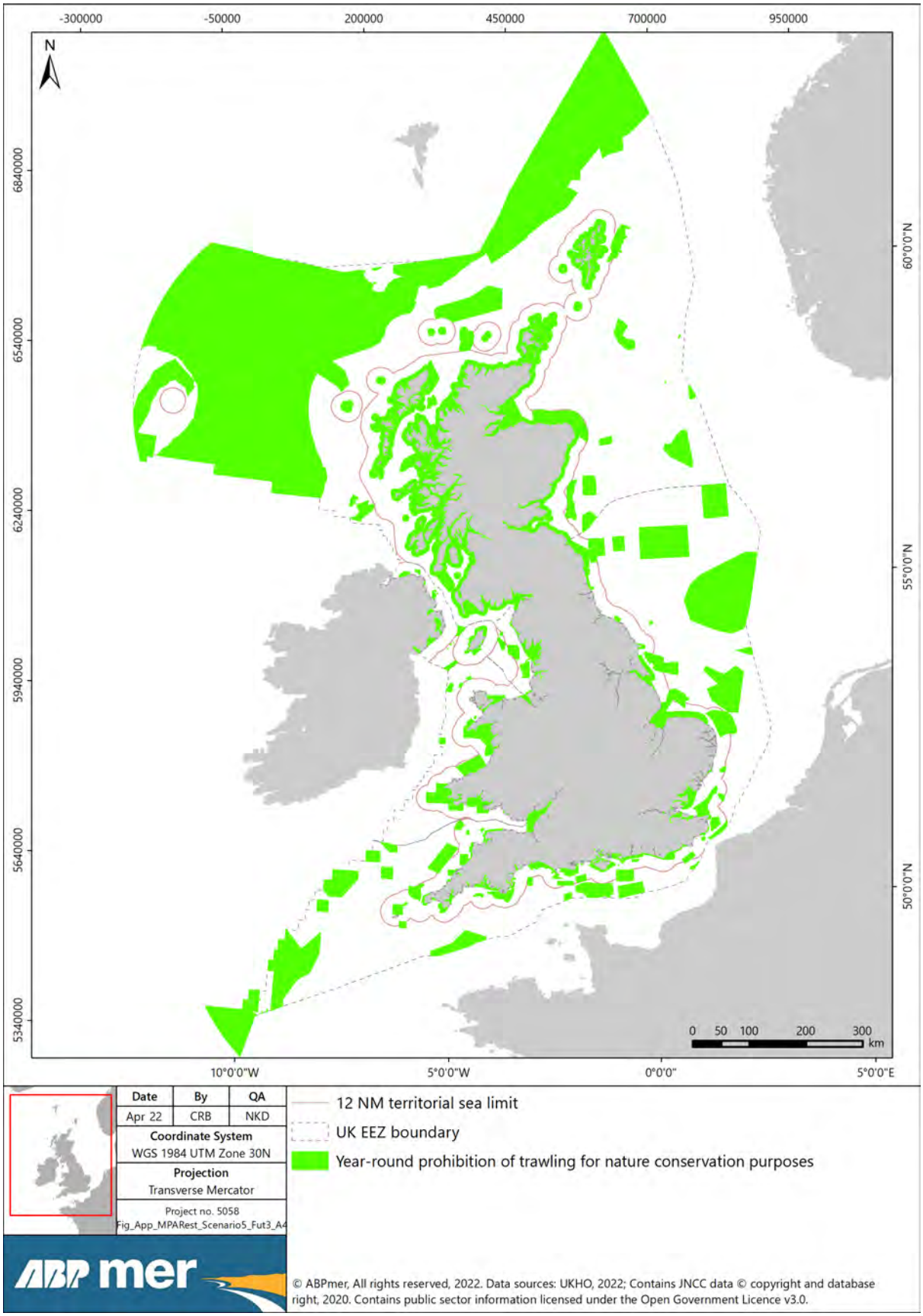



**Figure B5. Nature conservation – Future 3 scenario**

# C Offshore Renewables Sector Assumptions and Scenarios

Offshore renewable energy involves the generation of energy from wind, wave or tidal power in the marine environment. Each subsector is addressed separately below.

## C.1 Wind

### C.1.1 Assumptions

Generation of energy from offshore wind involves the installation of turbines in the marine environment. Turbines within an array are linked together with inter-array cables and connected to one or more substations. Electricity is exported from the substations to shore through subsea export cables. Turbines in shallow water (up to c. 50 m depth) usually have fixed foundations in the seabed (e.g. monopiles or jackets). There is potential for some fishing activity to continue within the arrays, although data shows that trawling activity has been significantly reduced within existing fixed arrays in the UK[8]. Floating offshore wind turbines are beginning to be deployed and have the potential to be installed in much deeper waters than fixed turbines. These use different kinds of anchoring systems to secure the turbine to the seabed. The anchoring and cable systems mean that fishing within floating arrays could be extremely hazardous, depending on the type of tethering system used, and may be excluded completely.

As of March 2021, the UK had 10.4 GW of installed and commissioned offshore wind capacity across 40 wind farms (RenewableUK, 2021). There is 18 GW of offshore wind currently in construction and consented around the UK. The Government's goal is to have of 40 GW by 2030, and be on a path to 65-125 GW by 2050' (CCC, 2020). Similarly, National Grid (2021) developed four scenarios for the pathway to Net Zero, which involved between 31 and 47 GW of offshore wind being connected by 2030, and 113 GW by 2050 in the 'Consumer Transformation' pathway. A higher pathway, 'Widespread Innovation' included up to 140 GW of offshore wind by 2050.

The average turbine size is 4.5 MW (10,415 MW capacity from 2,292 turbines in 39 projects) and current capacity density is 6 MW/km$^2$ (European MSP Platform, 2018). However, there is a move towards larger turbines, which are more widely spaced (recent planned OWF have an average capacity density of 3.2 MW/km$^2$, data from BEIS). Where these used fixed foundations, there is potential for this to facilitate the continuation of fishing activity within arrays.

Assumptions for the offshore wind sector are provided in Table C1, and spatial data for each scenario are shown in Figure C1 to Figure C5. We assume there will be 115 GW of OWF by 2050, in line with CCC (2020) and National Grid (2021). To allocate this spatially in Future 2 and 3 scenarios, beyond existing defined sites, we have created new polygons for OWF, based on work recently carried out for BEIS (2022a) looking at future OWF scenarios for achieving Net Zero. We selected the scenario that takes some constraints into account (i.e. does not minimise the levelized cost of energy regardless of other societal constraints).

[8] Analysis of VMS data at a resolution of 1/200th of an ICES rectangle, undertaken for this report, for five wind farms for which sufficient time series of data pre- and post-installation were available (Beatrice, East Anglia One, Greater Gabbard, Hywind 2 and Rampion) indicated a 100% reduction in mobile gear activity after wind farm construction.

**Table C1. Offshore renewables assumptions – wind**

| Sector | Scenario | Assumptions and Rationale | Limitations |
|---|---|---|---|
| Offshore renewables – Wind | Past | ▪ Wind farms that were operational or under construction in 2000 – this was only Blyth offshore wind farm. | |
| | Present | ▪ UK has 10.4 GW of operational offshore wind capacity across 40 wind farms (RenewableUK, 2021), an additional 6.6 GW are under construction across 10 sites (BEIS, 2021).<br>▪ Average capacity density is 6 MW/km$^2$ (European MSP Platform, 2018).<br>▪ Include windfarms that were constructed or under construction in 2020. These cover 12 GW capacity[9].<br>▪ Analysis of trawling activity pre- and post-construction for five windfarms (Beatrice, East Anglia 1, Galloper, Greater Gabbard, Rampion 1) demonstrated a loss of 100% of trawling activity post construction across all sites. On this basis, we assume there is no trawling within (fixed) offshore wind farm arrays, and no trawling within floating arrays, due to technical/safety issues. | ▪ Offshore construction for Neart na Gaoithe and Hornsea 2 started in mid/late 2020. Not included in this scenario but may already be affecting fishing. |
| | Future 1 | ▪ Minimum of 40 GW of offshore wind, based on the Government's goal of achieving this by 2030 (CCC, 2020), and National Grid's (2021) four scenarios with connections of between 31 and 47 GW by 2030.<br>▪ UK has 9.86 GW awaiting construction and 2.14 GW with planning applications submitted (BEIS, 2021). This makes a total of 29 GW operational, under construction, awaiting construction and with applications submitted.<br>▪ Include windfarms in 'present' scenario, those in the planning system and with lease options | |

[9] The difference with the 10.4 GW operational and 6.6 GW under construction that BEIS report is that the BEIS figure includes sites where construction has started onshore only, whereas the scenario only includes sites once offshore construction is underway.

| Sector | Scenario | Assumptions and Rationale | Limitations |
|---|---|---|---|
| | | where construction has not yet started, and plans in development (e.g. Berwick Bank, Erebus & Valorus, Celtic Sea Arrays, Hornsea 4, Dogger Bank). These cover 42.6 GW capacity.<br>▪ For future OWF, larger turbines, more widely spaced (average of recent applications is 3.2 MW per km$^2$) may enable some fishing to continue within arrays. Assume trawling is reduced by 75% within future fixed offshore wind farm arrays with a capacity per km$^2$ under 3.5 MW (this is shown by hatching in figures, and relevant areas will be calculated for the report). For floating arrays, assume all trawling effort is excluded. | |
| | Future 2 | ▪ 115 GW of offshore wind, based on the average of 'Balanced Pathway' and 'Widespread innovation' scenarios in CCC (2020), and in line with National Grid (2021) 'Consumer Transformation' which foresees '…further increases through the 2030s to reach 80 GW by 2040 and 113 GW by 2050'.<br>▪ As for Future 1, assume fishing is excluded from sites in the Present scenario, and from floating arrays, and reduced by 75% from future fixed arrays with capacity per km$^2$ <3.5 MW.<br>▪ Spatial allocation – building on the 42 GW in Future 1:<br>○ 8 GW is attributed to the relevant Round 4 sites;<br>○ ScotWind sites are included as in the leasing outcomes published on 17 January 2022, for 25 GW (CES, 2022);<br>○ 4 GW was applied to Celtic Sea zones (ORE Catapult, 2020), pro-rata based on area, after taking account of existing known projects (Erebus, Valorus, Llyr1, Llyr2, White Cross and Wave Hub); | ▪ Location of future OWF is uncertain and areas identified do not represent potential development areas. |

| Sector | Scenario | Assumptions and Rationale | Limitations |
|---|---|---|---|
| | | ○ The remaining 26 GW capacity needed to reach 115 GW was applied based on future scenario planning for BEIS (2022b) and assuming 3.2 MW/km². | |
| | Future 3 | ▪ As for Future 2, but with no trawling within all fixed and floating offshore wind farm arrays. | ▪ As for Future 2. |

## C.1.2 Areas by Scenario

The areas of offshore wind developments that restrict trawling, for each scenario, and in relation to the UK EEZ, are shown in Table C2.

**Table C2. Areas of offshore wind develoments that restrict trawling by scenario, and as a percentage of UK EEZ**

| Scenario | Area (km²) | As % of EEZ |
|---|---|---|
| Past | 0.4 | <0.00% |
| Present | 2,488 | 0.34% |
| Future 1 | 10,664 | 1.45% |
| Future 2 | 26,815 | 3.65% |
| Future 3 | 31,483 | 4.28% |

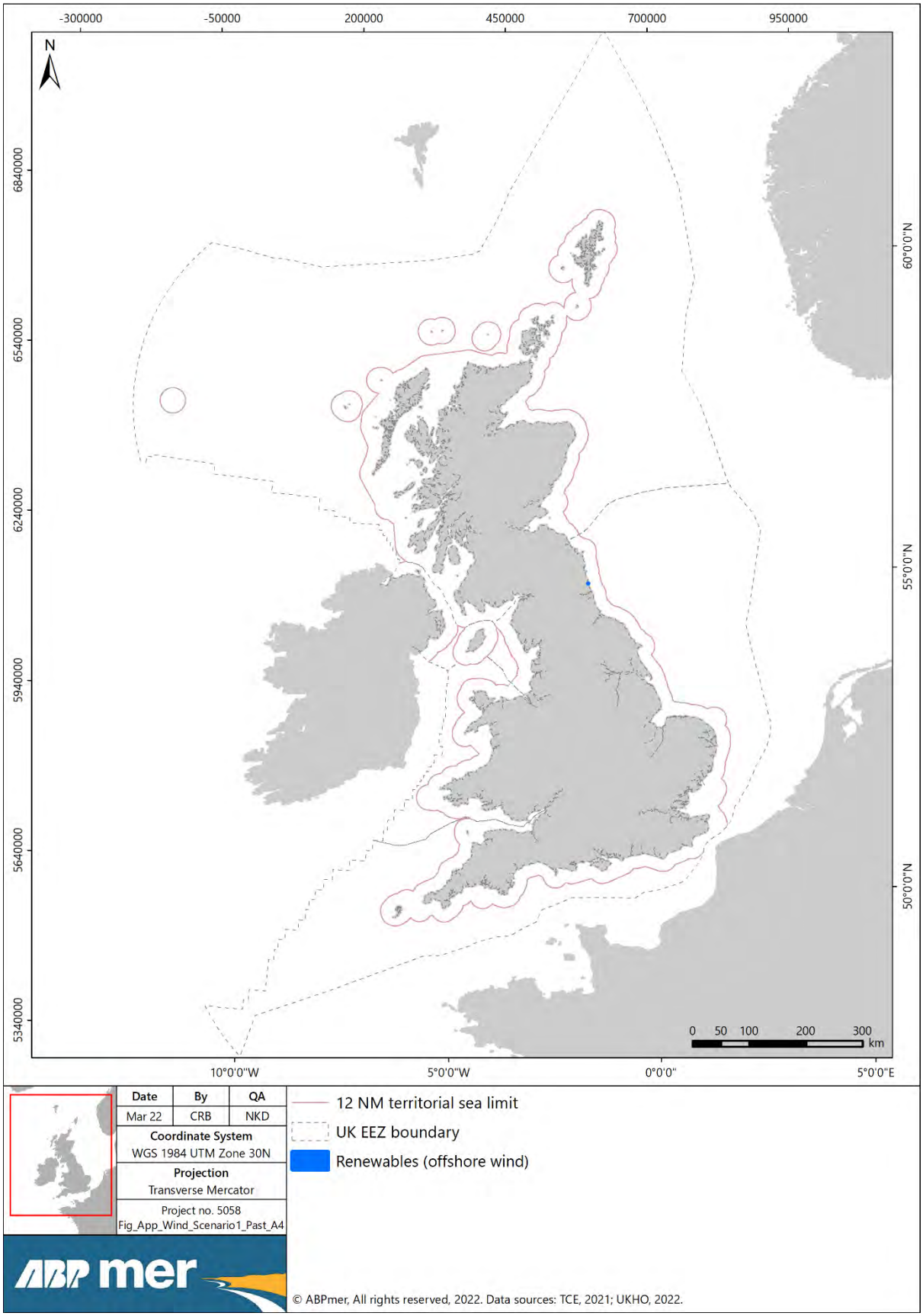



**Figure C1. Offshore wind – Past scenario**

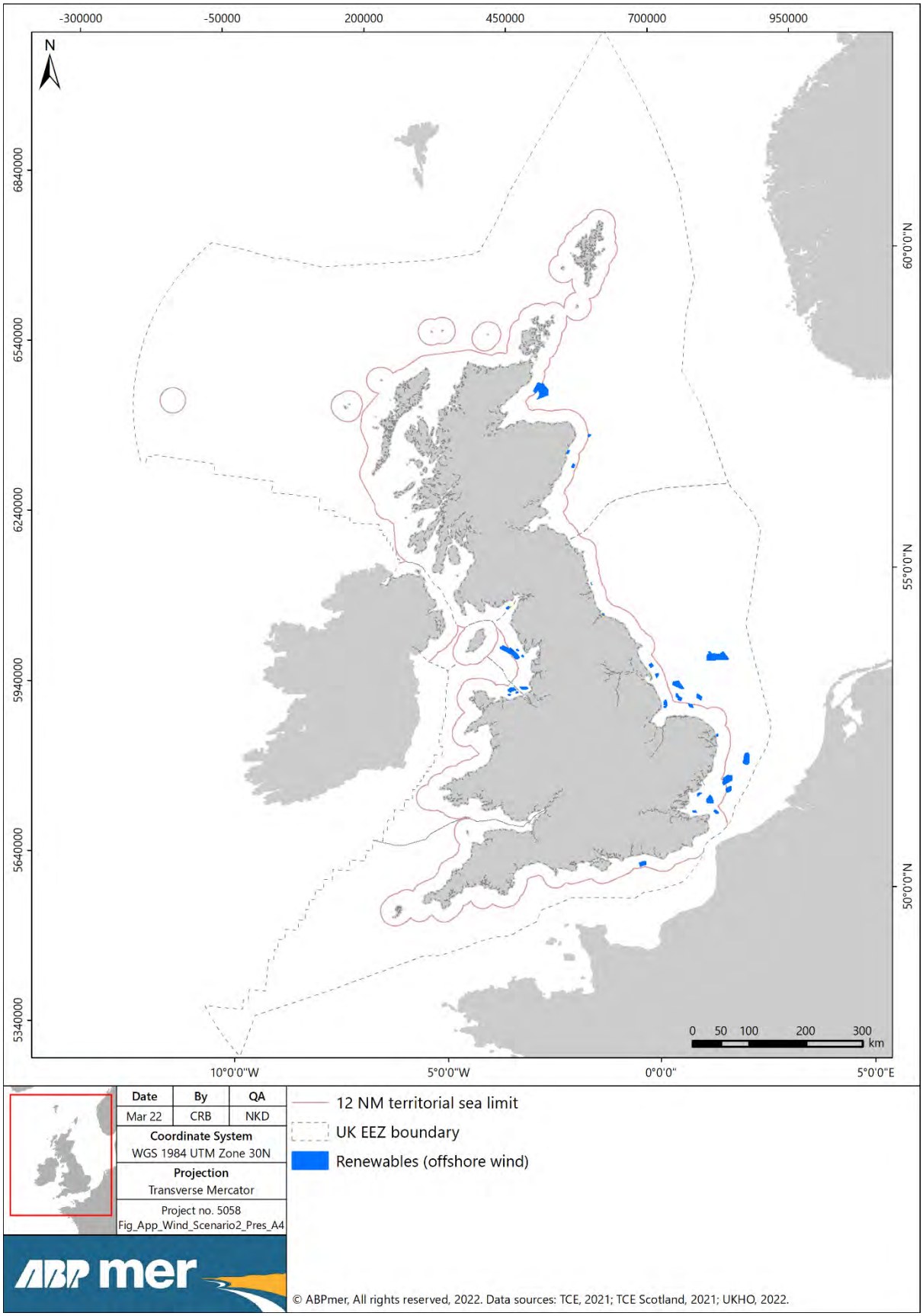



**Figure C2 Offshore wind – Present scenario**

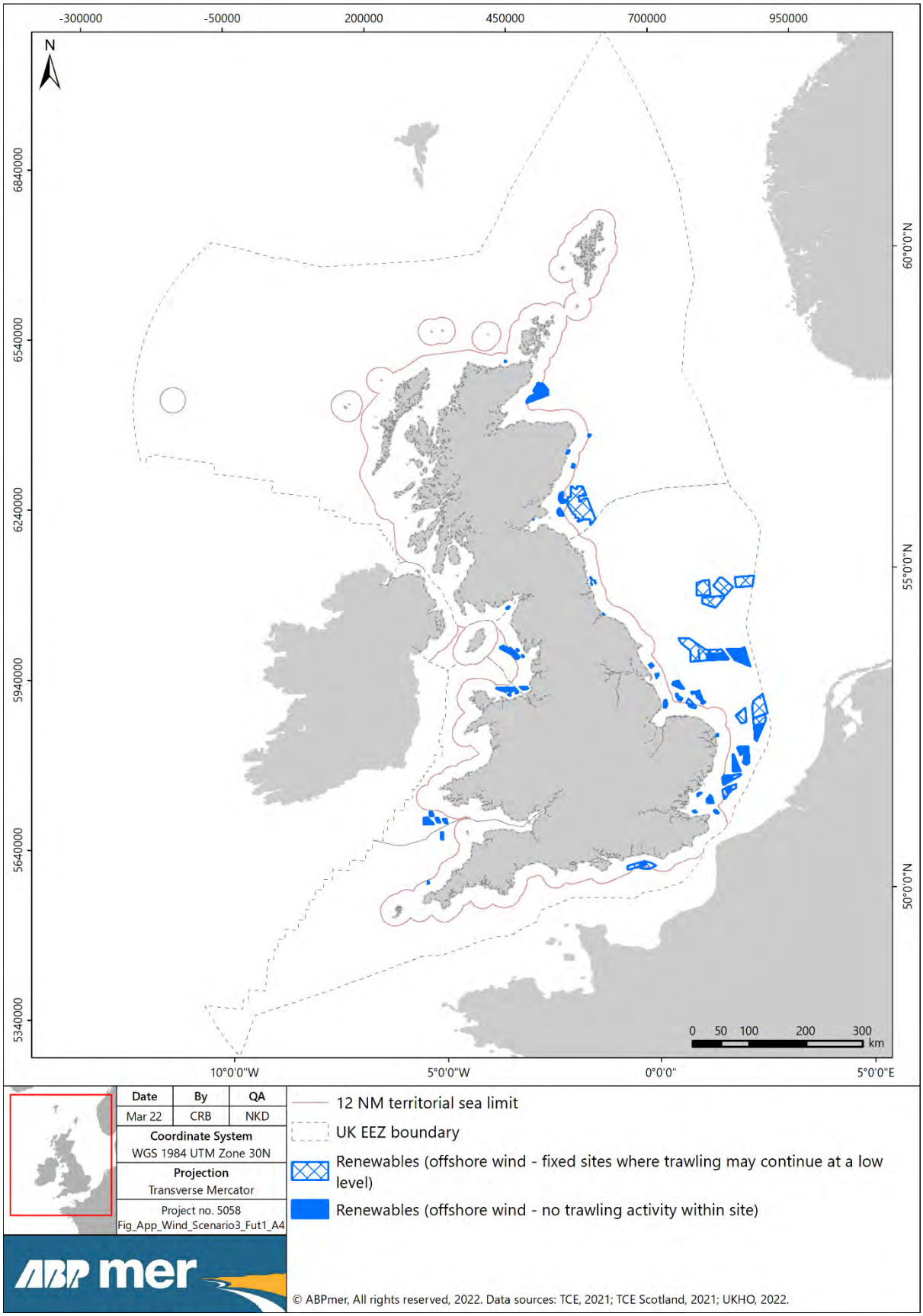



**Figure C3. Offshore wind – Future 1 scenario**

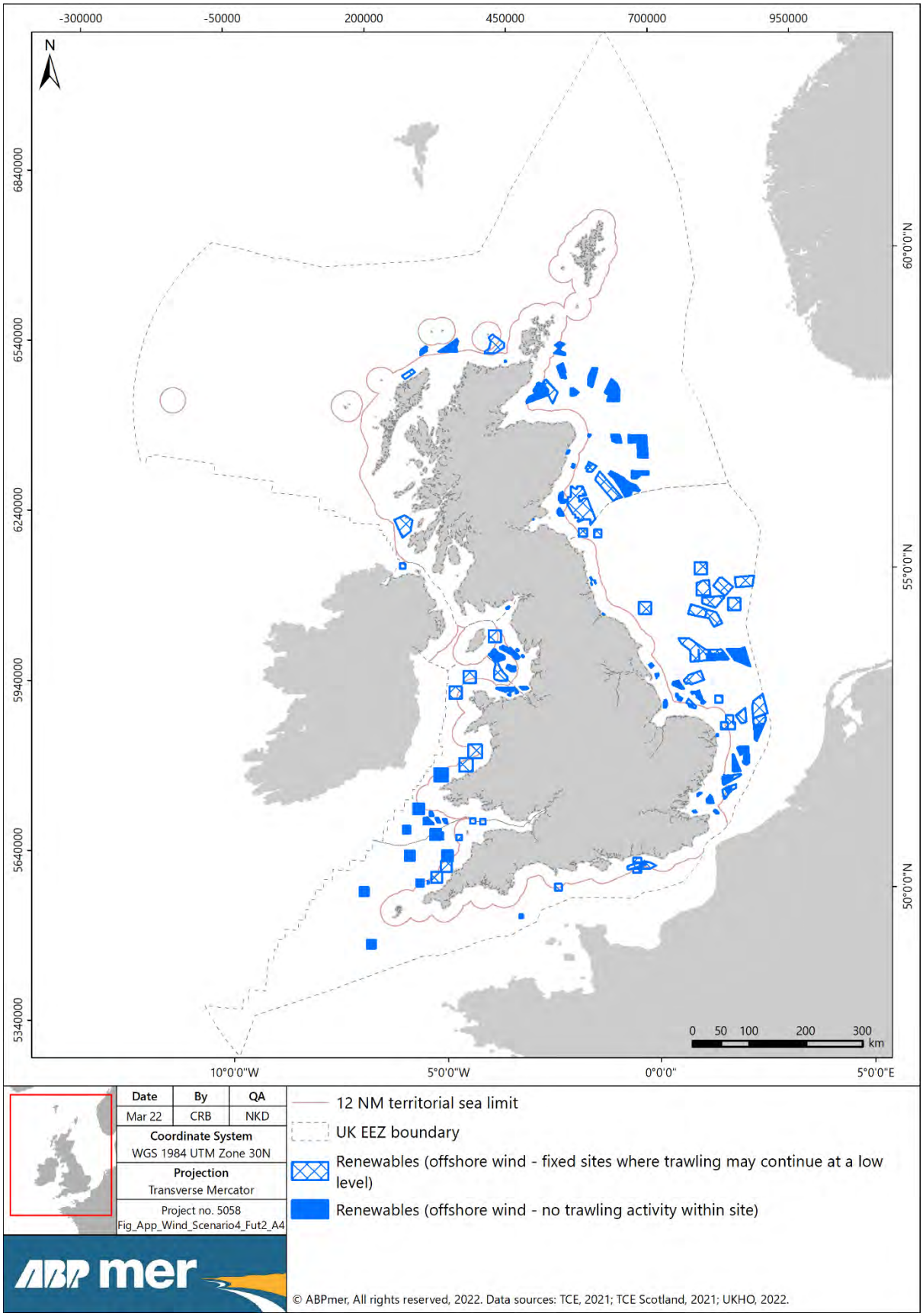



**Figure C4. Offshore wind – Future 2 scenario**

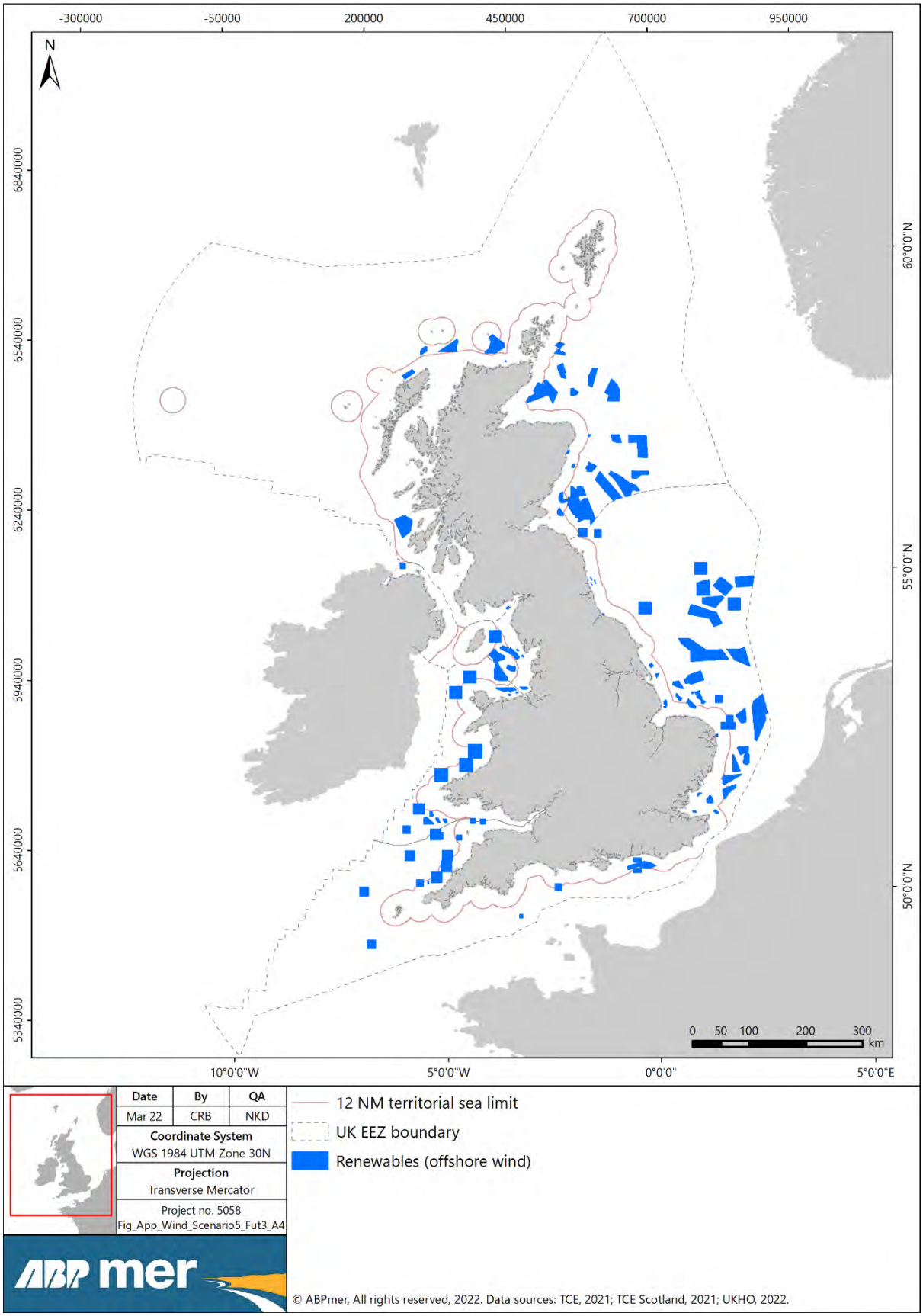



**Figure C5. Offshore wind – Future 3 scenario**

# C.2 Wave

## C.2.1 Assumptions

Wave energy is captured using a range of different wave energy converter devices, which are usually floating and tethered to the seabed. Some demonstration sites have been established but wave energy has yet to be deployed commercially on a large scale. Current sites and those in the planning system are shown in Table C3.

Assumptions for the wave renewable energy sector are provided in Table C4, and spatial data for each scenario are shown in Figure C6 to Figure C9.

**Table C3. Wave energy sites – operational and in the planning system**

| Site name | Development Status | Installed capacity (MW) | Date under Construction |
|---|---|---|---|
| Wello Penguin Device (Billia Croo – EMEC) | Operational | 1.0 | (operational 27/05/2008) |
| Hayle Wave Hub (Test Site) | Operational | 23.0 | 01/06/2010 |
| Milford Haven Wave Dragon Pre-Commercial Demonstrator | Planning application submitted | 7.0 | |
| Billia Croo Wave Test Site (Extension) | Planning application submitted | 20.0 | |

Source: BEIS (2021)

**Table C4. Offshore renewables assumptions – wave**

| Sector | Scenario | Assumptions and Rationale | Limitations |
|---|---|---|---|
| Offshore renewables – Wave | Past | ▪ None. | |
| | Present | ▪ Active wave lease areas from Crown Estate and Crown Estate Scotland datasets. These are mostly test sites. | |
| | Future 1 | ▪ Active and pre-planning application lease areas for wave energy from Crown Estate and Crown Estate Scotland datasets (assume that only sites currently in the planning system are developed by 2030).<br>▪ Potential for 182 MW installed capacity by 2030, based on the above. This compares to a projection for 1 GW installed capacity by 2040 (ORE Catapult, 2018); previous projections for the sector have proved over-optimistic. | |

| Sector | Scenario | Assumptions and Rationale | Limitations |
|---|---|---|---|
| | Future 2 | ▪ Assume 1 GW installed capacity (ORE Catapult, 2018).<br>▪ Spatial allocation – to existing sites in the planning system, and additional capacity allocated to Scottish Draft Plan Option areas, and Northern Ireland wave 'future renewable energy zones', assuming 6 MW/km$^2$ (based on capacity per unit area for existing and planned tidal sites). On this basis, 1 GW wave energy would occupy 137 km$^2$ sea space. | ▪ Future scale and location of development of wave energy is uncertain.<br>▪ Future capacity per km$^2$ for wave energy is uncertain. Assumptions are based on estimates from current data for the tidal sector. These are conservative compared to assumptions used in the 2013 socio-economic impact assessment for offshore renewable energy in Scotland, which was 25 MW/km$^2$ (AEA Technology and Hartley Anderson 2011). |
| | Future 3 | ▪ As for Future 2. | ▪ As for Future 2. |

## C.2.1 Areas by Scenario

The areas of wave energy developments, for each scenario, and in relation to the UK EEZ, are shown in Table C5.

**Table C5. Areas of wave energy developments by scenario, and as a percentage of UK EEZ**

| Scenario | Area (km$^2$) | As % of EEZ |
|---|---|---|
| Past | 0.0 | 0.00% |
| Present | 12.3 | <0.00% |
| Future 1 | 102.7 | 0.01% |
| Future 2 | 240.2 | 0.03% |
| Future 3 | 240.2 | 0.03% |

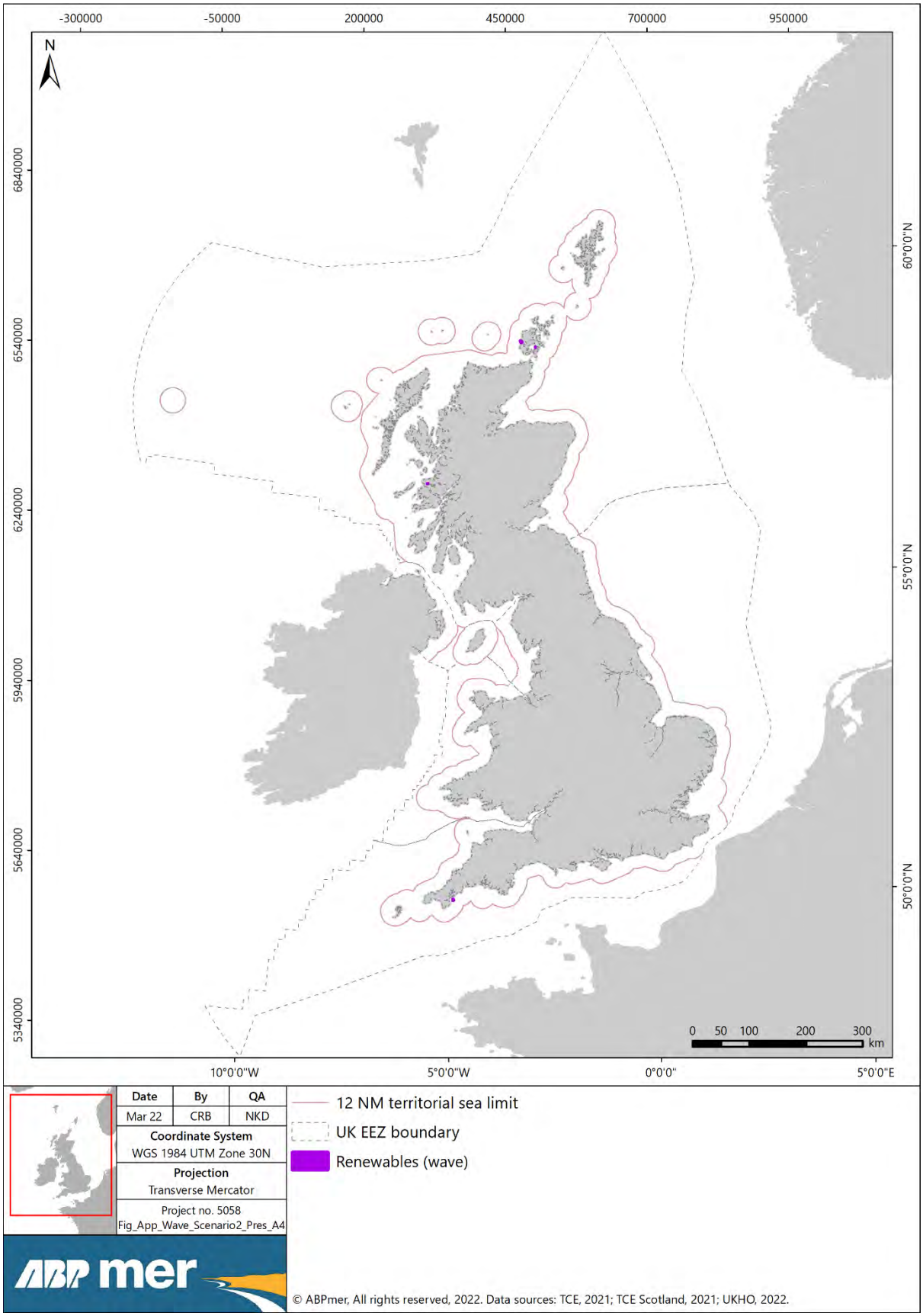



**Figure C6. Wave energy – Present scenario**

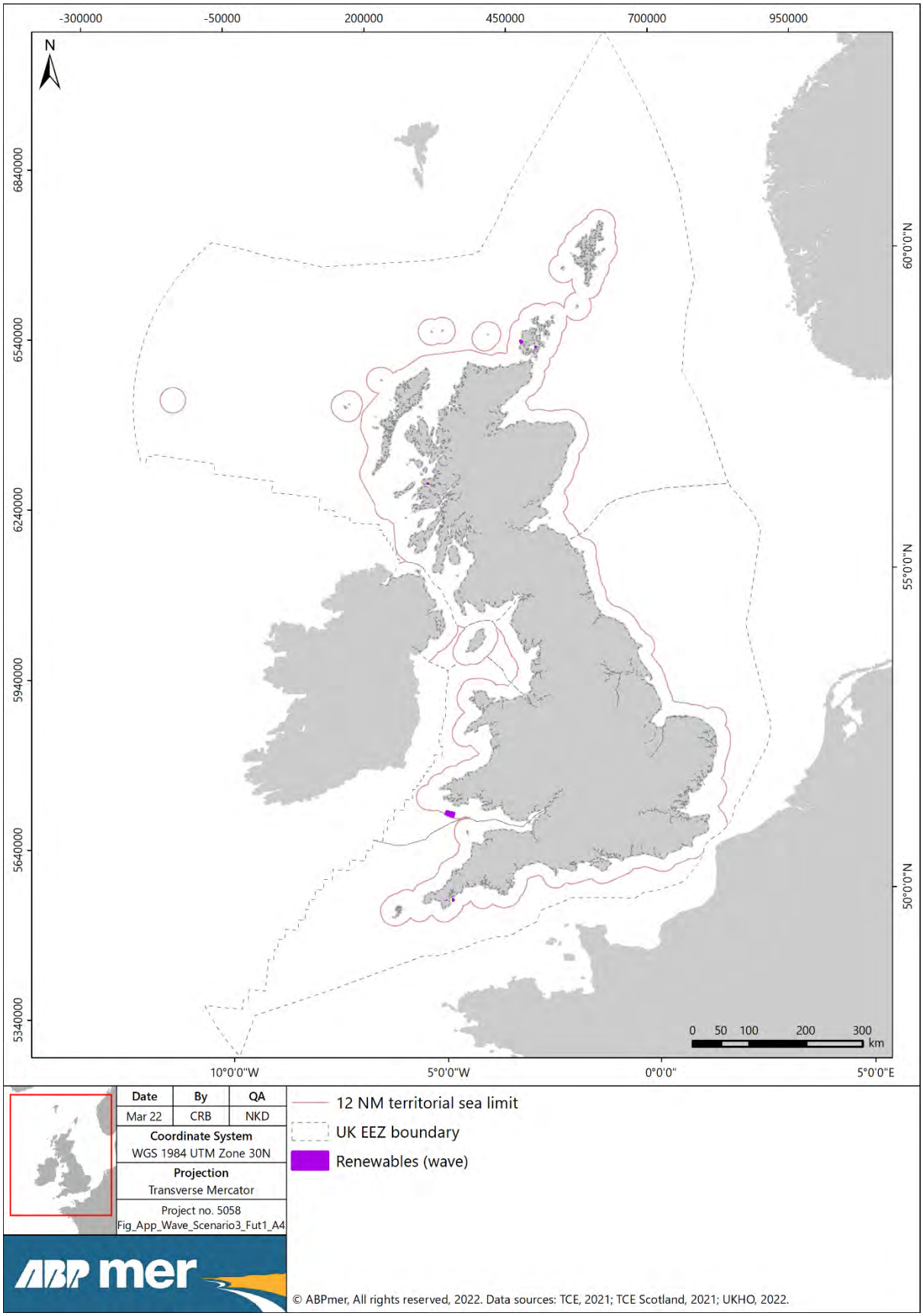



**Figure C7. Wave energy – Future 1 scenario**

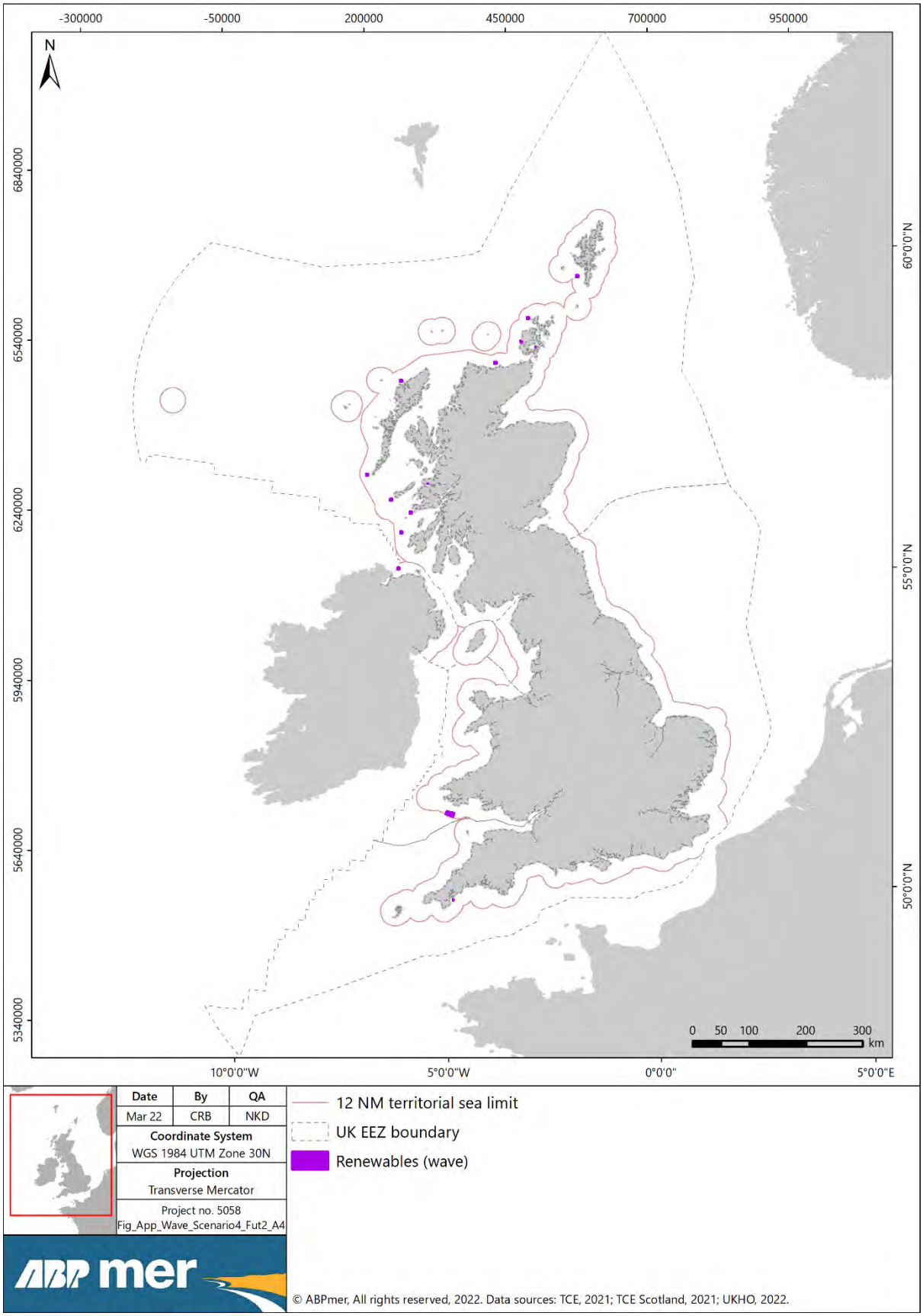



**Figure C8. Wave energy – Future 2 scenario**

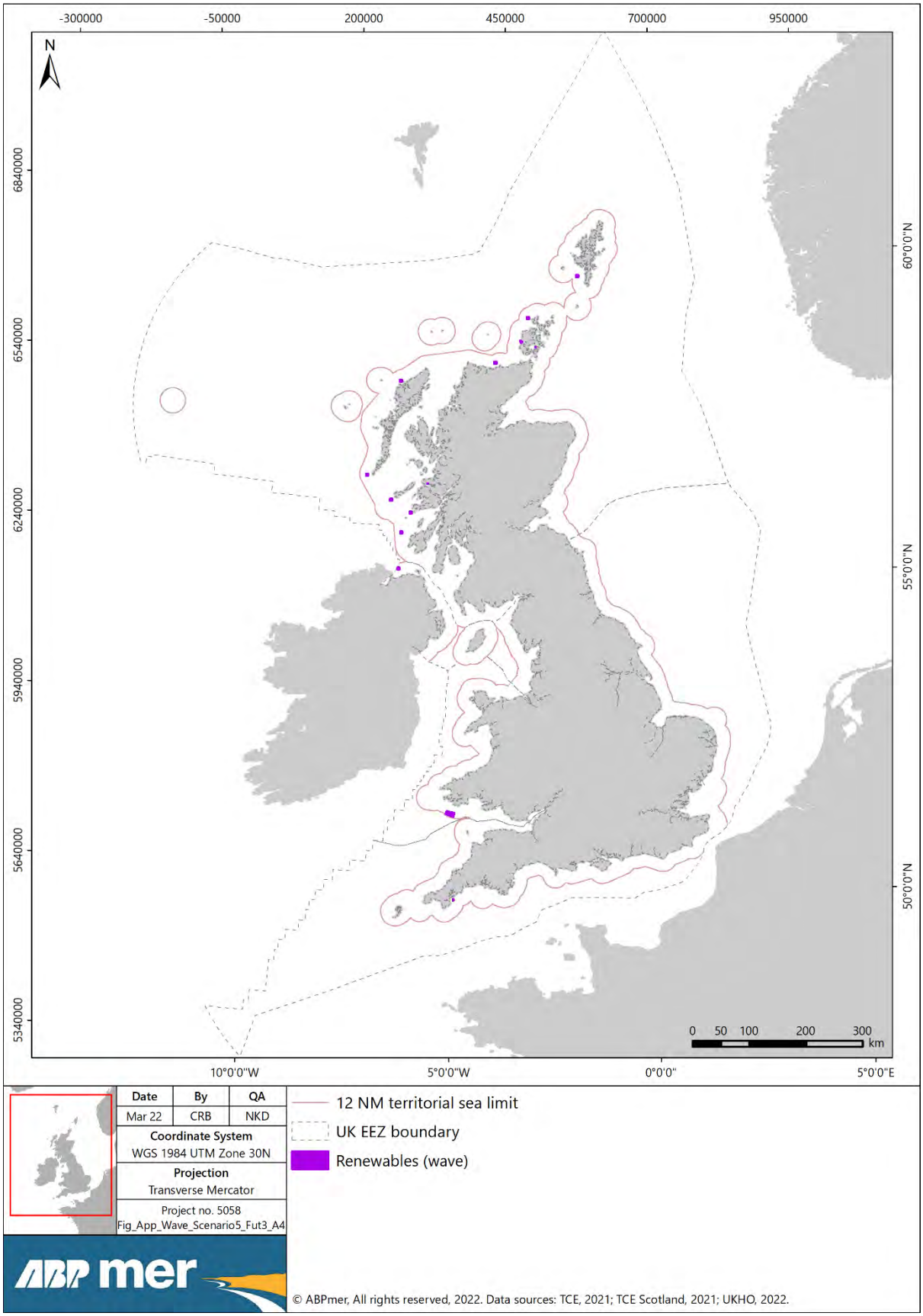



**Figure C9. Wave energy – Future 3 scenario**

# C.3 Tidal

## C.3.1 Assumptions

Tidal energy can be captured through tidal stream devices, which generate energy from the movement of currents and tides in the water column, and tidal range, where the incoming tide is held within a lagoon and then released through turbines when required. There are a number of small-scale and demonstration tidal stream sites in operation, and others in the planning system (Table C6). Projections and ambition for the tidal energy sector are that an estimated 1 GW of tidal stream will be deployed by 2030, and the UK's 'practical resource' has been estimated at 15 GW (ORE Catapult, 2018).

Assumptions for the tidal renewable energy sector are provided in Table C7, and spatial data for each scenario are shown in Figure C10 to Figure C13.

**Table C6. Tidal energy sites – operational and in the planning system**

| Site Name | UK Administration | Development Status | Area ($km^2$) | Installed Capacity (MW) |
|---|---|---|---|---|
| EMEC Fall of Warness | Scotland | Operational | 9.10 | |
| EMEC Shapinsay Sound | Scotland | Operational | 1.41 | |
| Nova Innovation Ltd | Scotland | Operational | 0.8 | 1.9 |
| Sustainable Marine Energy Ltd | Scotland | Operational | 0.4 | 0.28 |
| Ramsey Sound | Northern Ireland | Operational | 0.60 | 1 |
| Strangford Lough | Northern Ireland | Operational | 0.08 | 1.2 |
| Sound of Islay | Scotland | Agreement/option for lease | 0.35 | 10 |
| Isle of Islay | Scotland | Agreement/option for lease | 2.28 | 30 |
| Mull of Kintyre | Scotland | Agreement/option for lease | 25.72 | 3 |
| Lashy Sound | Scotland | Agreement/option for lease | 4.19 | 30 |
| Inner Sound | Scotland | Lease | 3.27 | 92 |
| Holyhead Deep | England/Wales | Agreement/option for lease | 9.17 | 10 |
| Perpetuus Tidal Energy Centre (PTEC) | England/Wales | Agreement/option for lease | 5.02 | 30 |
| West Anglesey Demonstration Zone | England/Wales | Lease – pre-planning application | 35.01 | 240 |
| Bardsey Sound | England/Wales | Agreement/option for lease | 3.33 | 2 |
| Fair Head | Northern Ireland | Agreement/option for lease | 3.33 | 100 |
| N.B. Swansea Bay Tidal Lagoon (320 MW) removed from the list, as project has not progressed, and the footprint of tidal range projects will be very small compared with other activities and is therefore not material in terms of spatial needs. | | | | |

Source: BEIS (2021), Crown Estate, Crown Estate Scotland.

**Table C7. Offshore renewables assumptions – tidal**

| Sector | Scenario | Assumptions and Rationale | Limitations |
|---|---|---|---|
| Offshore renewables – Tidal | Past | ▪ None. | |
| | Present | ▪ Active tidal lease areas from Crown Estate and Crown Estate Scotland datasets. | |
| | Future 1 | ▪ Active and pre-planning application lease areas for tidal energy from Crown Estate and Crown Estate Scotland datasets, with the exception of those known to have been withdrawn (Torr Head, Northern Ireland) (i.e. assume that only sites currently in the planning system are developed by 2030).<br>▪ Potential for 0.55 GW installed capacity by 2030 based on the above. This compares to a projection of 1 GW deployed by 2030 (ORE Catapult, 2018), however projections for the sector have been over-optimistic in the past. | |
| | Future 2 | ▪ Assume 2.5 GW installed capacity by 2050, based on deployment of 100 MW per year from 2030-2050 in line with ORE Catapult (2018) projections.<br>▪ Spatial allocation – to existing sites in the planning system, and additional capacity allocated to Scottish Draft Plan Option areas, and Northern Ireland tidal 'future renewable energy zones', assuming 6 MW/km$^2$ (based on capacity per unit area for existing and planned tidal sites). On this basis, 2.5 GW would occupy 419 km$^2$ sea space. | ▪ Future scale and location of development of tidal energy is uncertain.<br>▪ Future capacity per km$^2$ for tidal energy is uncertain. Assumptions are based on current data for active lease areas and applications. These are conservative compared to assumptions used in the 2013 socio-economic impact assessment for offshore renewable energy in Scotland, which was 25 MW/km$^2$ (AEA Technology and Hartley Anderson 2011). |
| | Future 3 | ▪ As for Future 2. | ▪ As for Future 2. |

## C.3.2 Areas by Scenario

The areas of tidal energy developments, for each scenario, and in relation to the UK EEZ, are shown in Table C8.

**Table C8. Areas of tidal energy develoments that restrict trawling by scenario, and as a percentage of UK EEZ**

| Scenario | Area ($km^2$) | As % of EEZ |
|---|---|---|
| Past | 0.0 | 0.00% |
| Present | 11.3 | <0.00% |
| Future 1 | 103.0 | 0.01% |
| Future 2 | 427.1 | 0.06% |
| Future 3 | 427.1 | 0.06% |

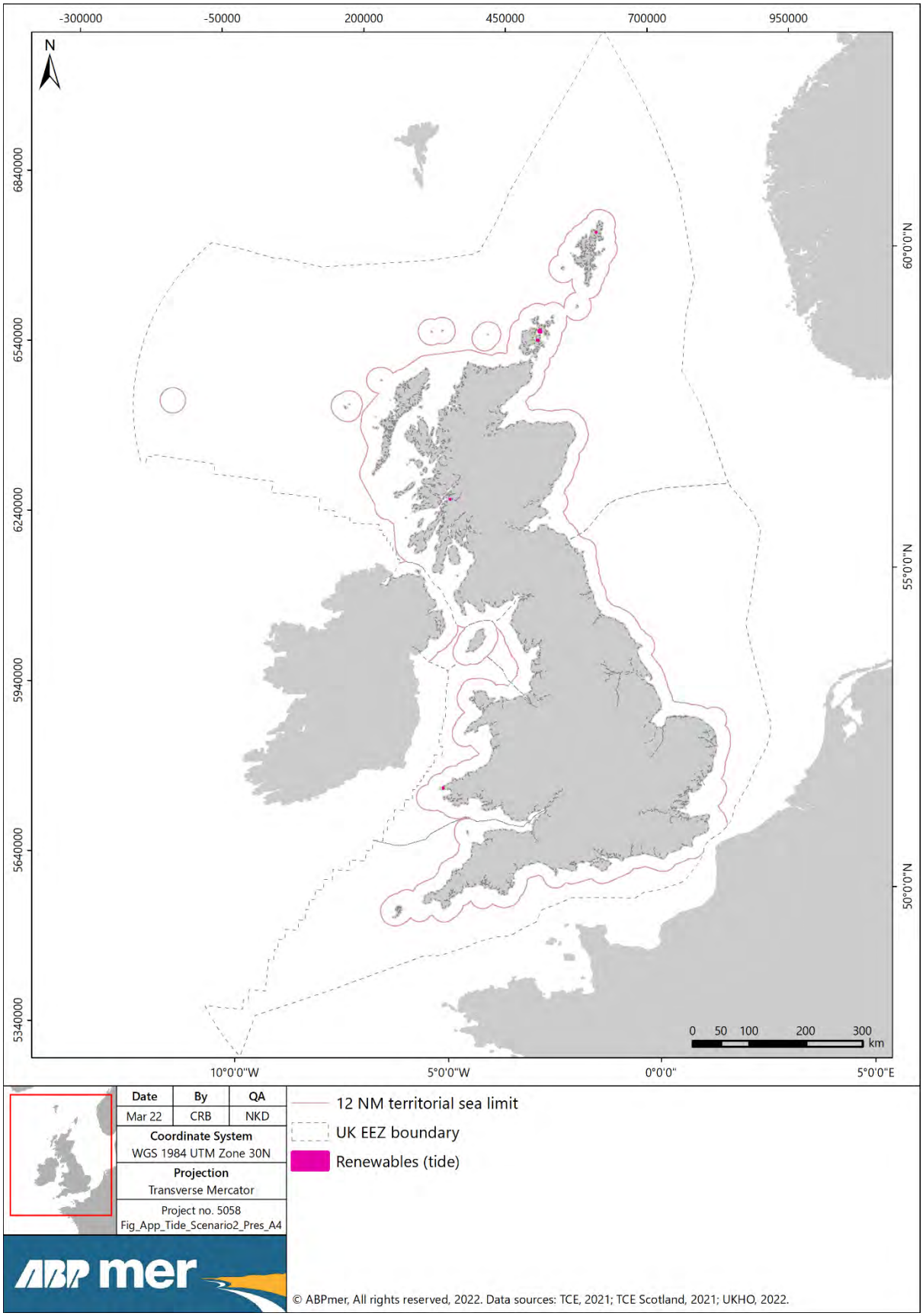



**Figure C10. Tidal energy – Present scenario**

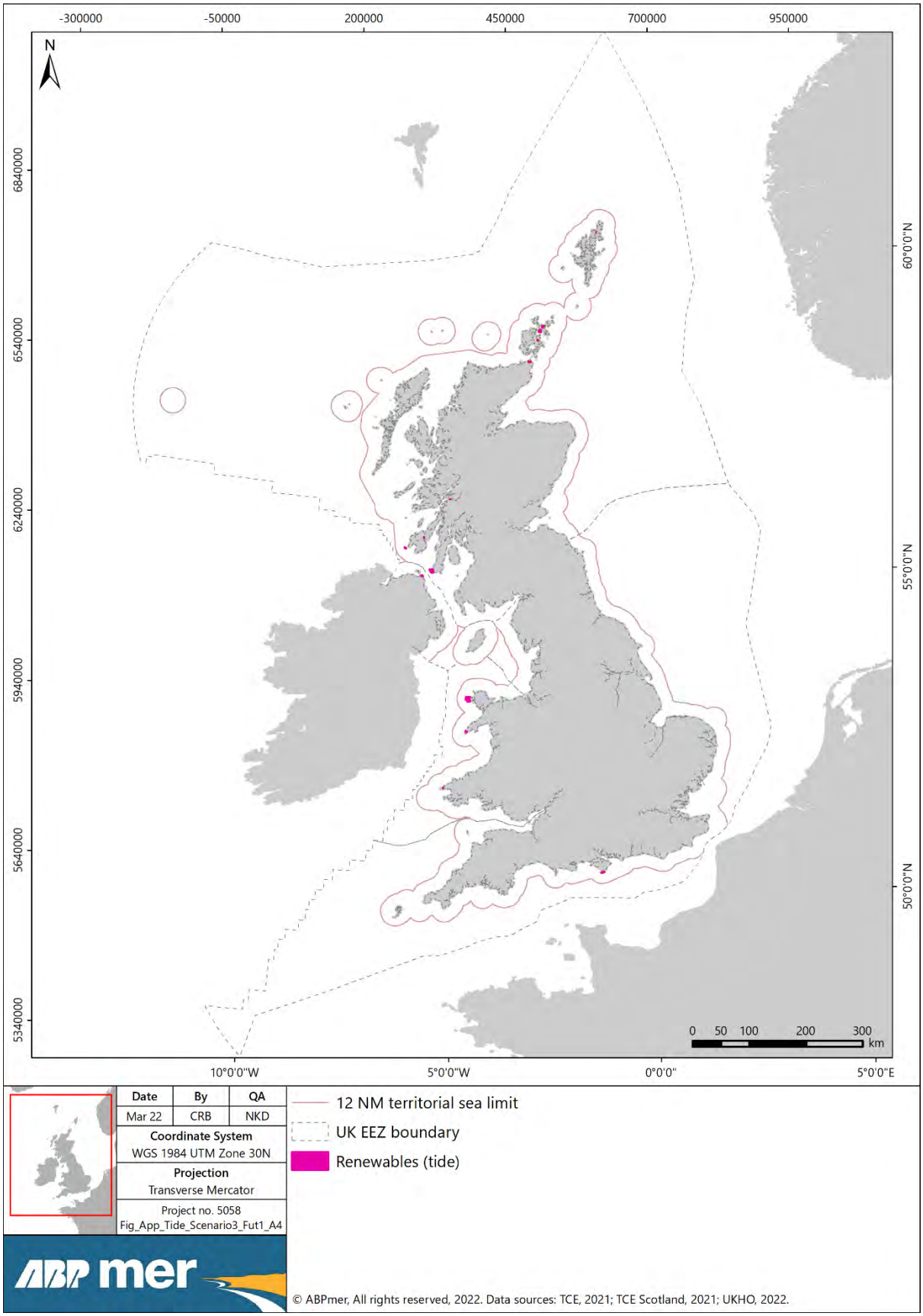



**Figure C11. Tidal energy – Future 1 scenario**

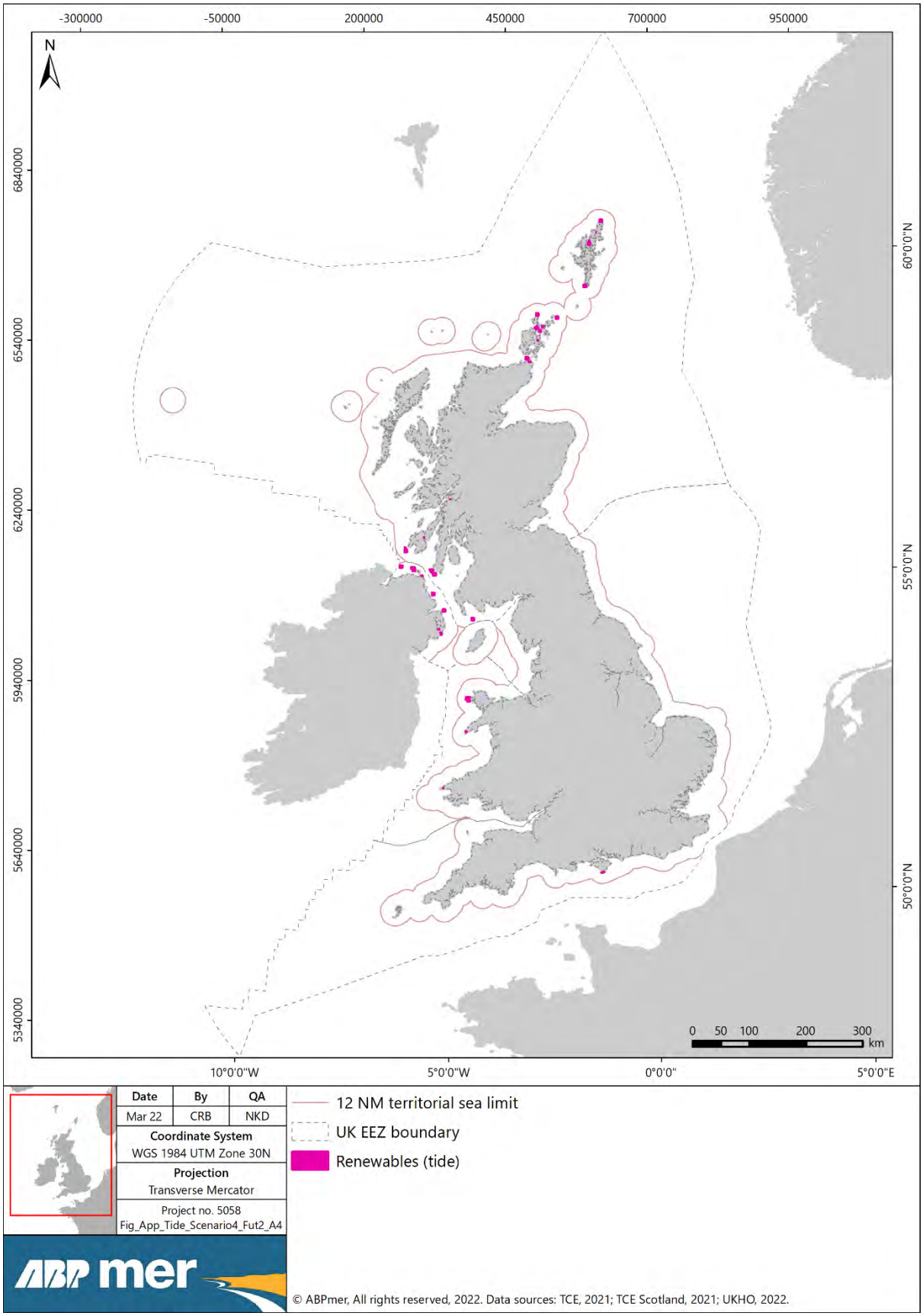



**Figure C12. Tidal energy – Future 2 scenario**

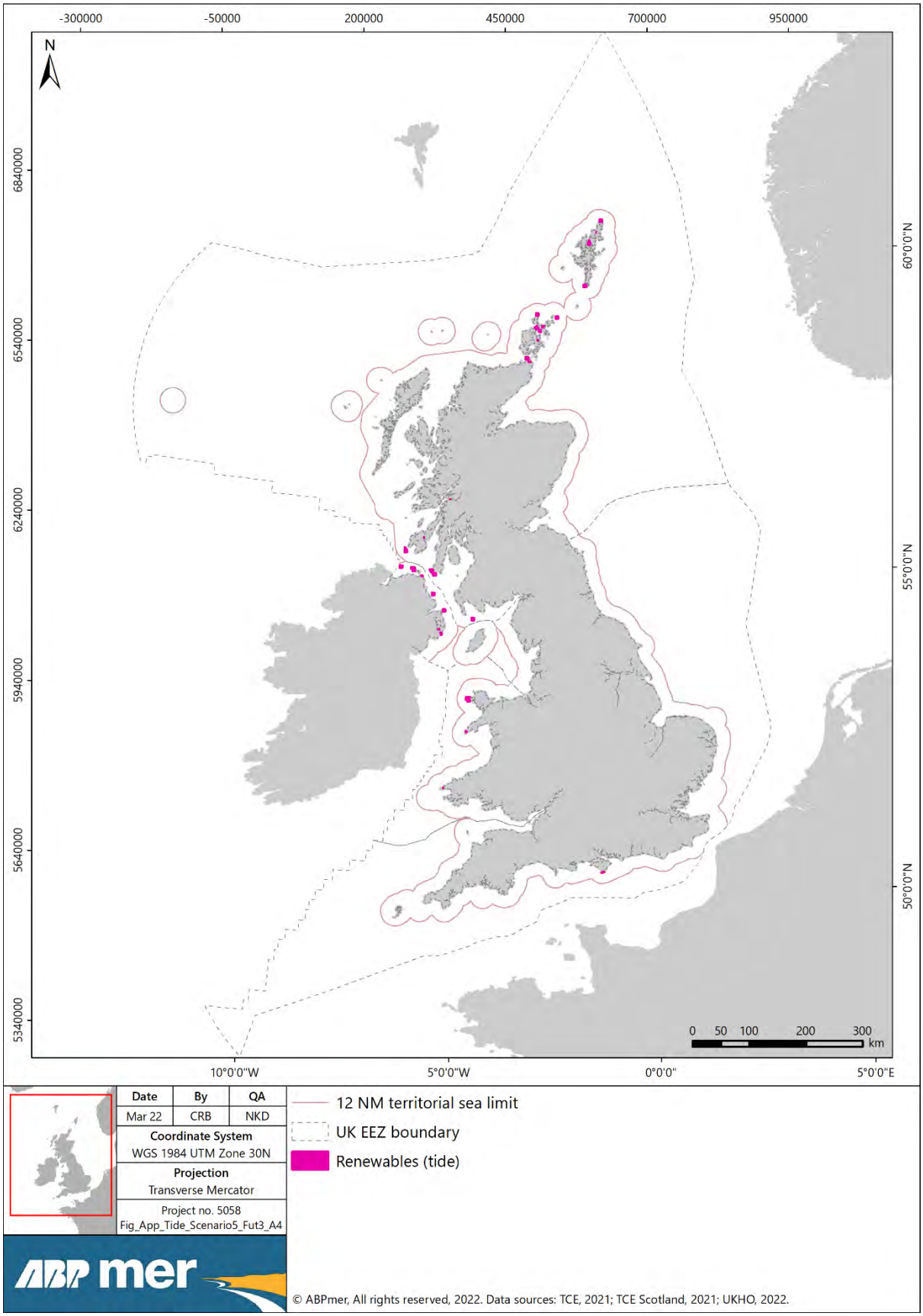



**Figure C13. Tidal energy – Future 3 scenario**

# D Aggregates

## D.1 Assumptions

Marine aggregates are deposits of sand or gravel that may be dredged from the seabed and often used in the construction and other industries. Licence Areas are areas from which aggregate may be dredged by a particular company, and have a defined lifespan. In any one year the dredge footprint, known as the 'Active Dredge Zone', only occupies a small proportion of the Licence Area. In addition, Exploration and Option Areas are awarded to companies for survey and exploration work to identify the quantities and type of aggregate available in an area, to inform applications for future Licence Areas.

Assumptions for the aggregates sector are provided in Table D1, and spatial data are shown in Figure D1 to Figure D5.

**Table D1. Aggregates assumptions**

| Sector | Scenario | Assumptions and Rationale | Limitations |
|---|---|---|---|
| Aggregates | Past | ▪ 179 km$^2$ seabed dredged in 2000 (BMAPA, 2001).<br>▪ Map using Dredged Area for 2000. | |
| | Present | ▪ 101 km$^2$ seabed dredged in 2020, producing 18 m tonnes of sand and gravel (BMAPA, 2021).<br>▪ Map using Dredged Area in 2020. | |
| | Future 1 | ▪ Demand increases to 29 m tonnes by 2030 (TCE, 2019). Based on production per km$^2$ in 2020, this level of production would require 162 km$^2$ of seabed to be dredged.<br>▪ Spatial – apply area required for future tonnage to current licensed areas which extend to 2030 or beyond, and Exploration and Option Areas. For mapping, Licence and Exploration and Option Areas will be shown with hatching, and the area dredged is calculated separately. | ▪ Not possible to determine the areas that will be dredged within the Licence areas (Production Agreement Areas) and the Exploration and Option Areas, so the maps show a larger area than where restrictions will actually be. This is shown by hatching rather than solid colour, and the area affected is calculated separately. |
| | Future 2 | ▪ No sector aspirations/projections available beyond 2030, assume 29 m tonnes demand in 2050. Based on production per km$^2$ in 2020, this level of production would require 162 km$^2$ of seabed to be dredged.<br>▪ Spatial – apply area required for future tonnage to Exploration and Option Areas. For mapping, Exploration and Option Areas are shown with hatching, and the area | ▪ As for Future 1.<br>▪ Future aspirations/ projections to 2050 for the sector are not available. |

| Sector | Scenario | Assumptions and Rationale | Limitations |
|---|---|---|---|
| | | dredged will be calculated separately. | |
| | Future 3 | ▪ As for Future 2. | ▪ As for Future 2. |

## D.2 Areas by Scenario

The areas of aggregate extraction, for each scenario, and in relation to the UK EEZ, are shown in Table D2.

**Table D2. Areas of aggregate extraction by scenario, and as a percentage of UK EEZ**

| Scenario | Area ($km^2$) | As % of UK EEZ |
|---|---|---|
| Past | 156 | 0.02% |
| Present | 101 | 0.01% |
| Future 1 | 158 | 0.02% |
| Future 2 | 161 | 0.02% |
| Future 3 | 165 | 0.02% |

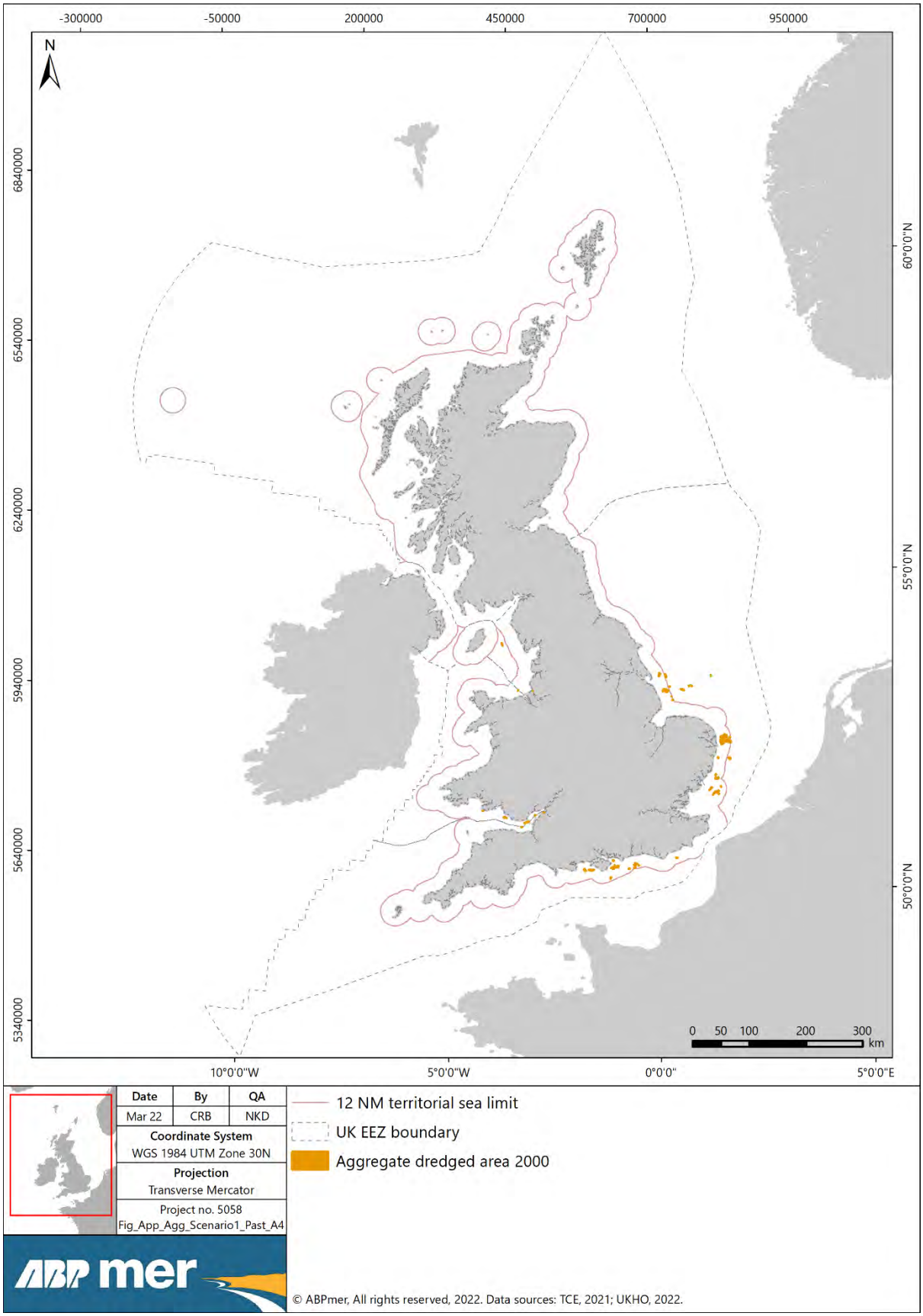



**Figure D1. Aggregates – Past scenario**

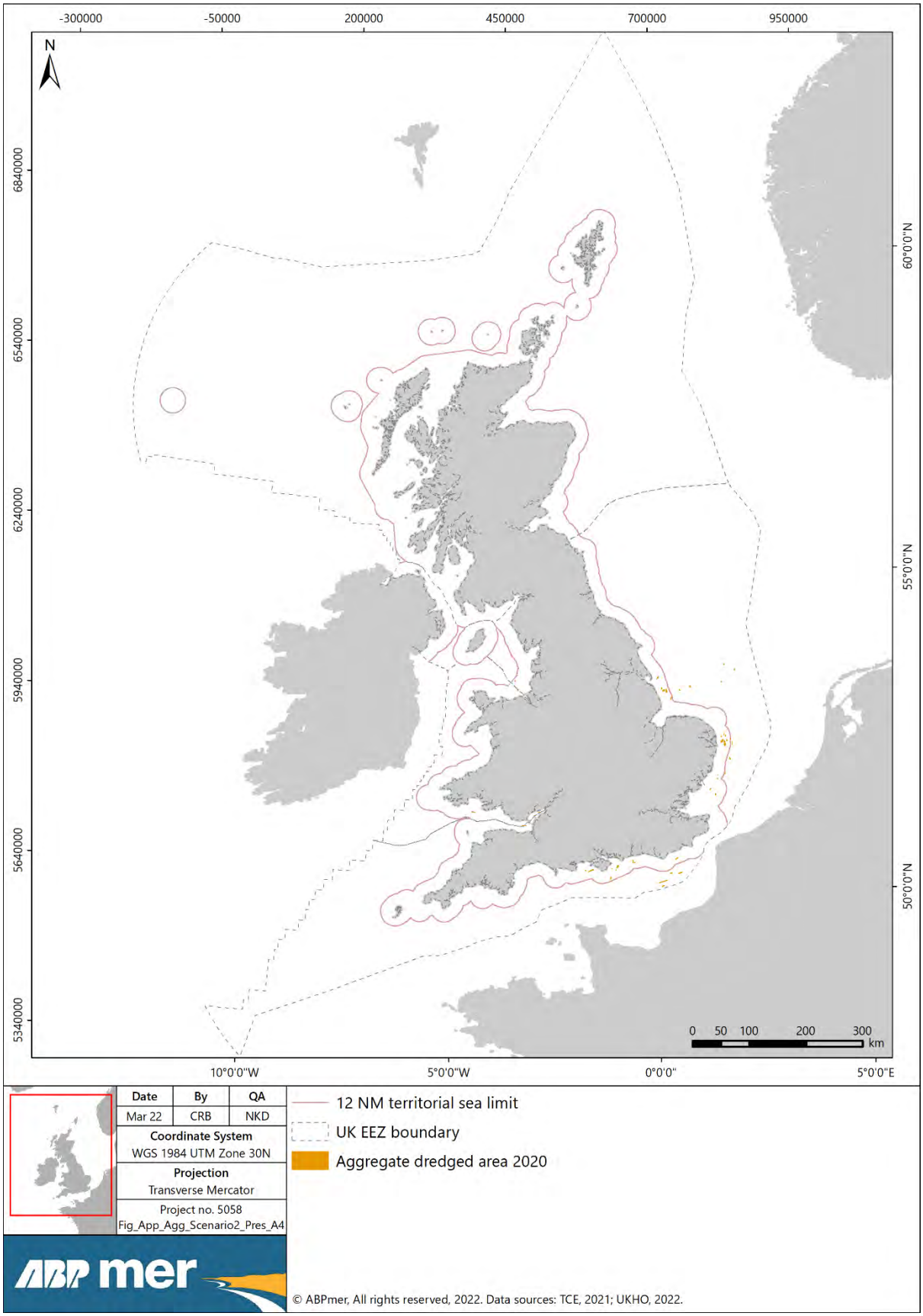



**Figure D2. Aggregates – Present scenario**

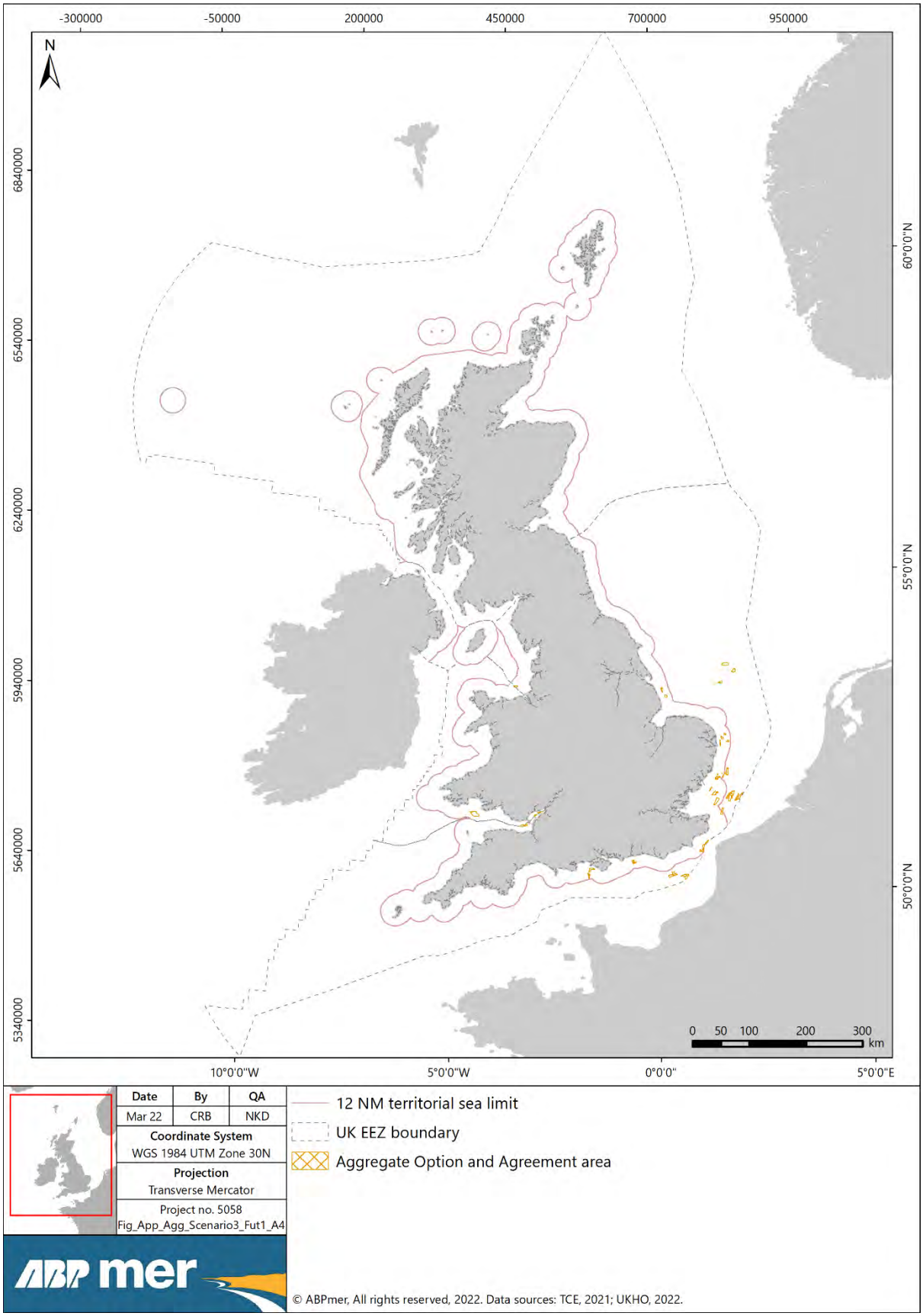



**Figure D3. Aggregates – Future 1 scenario**

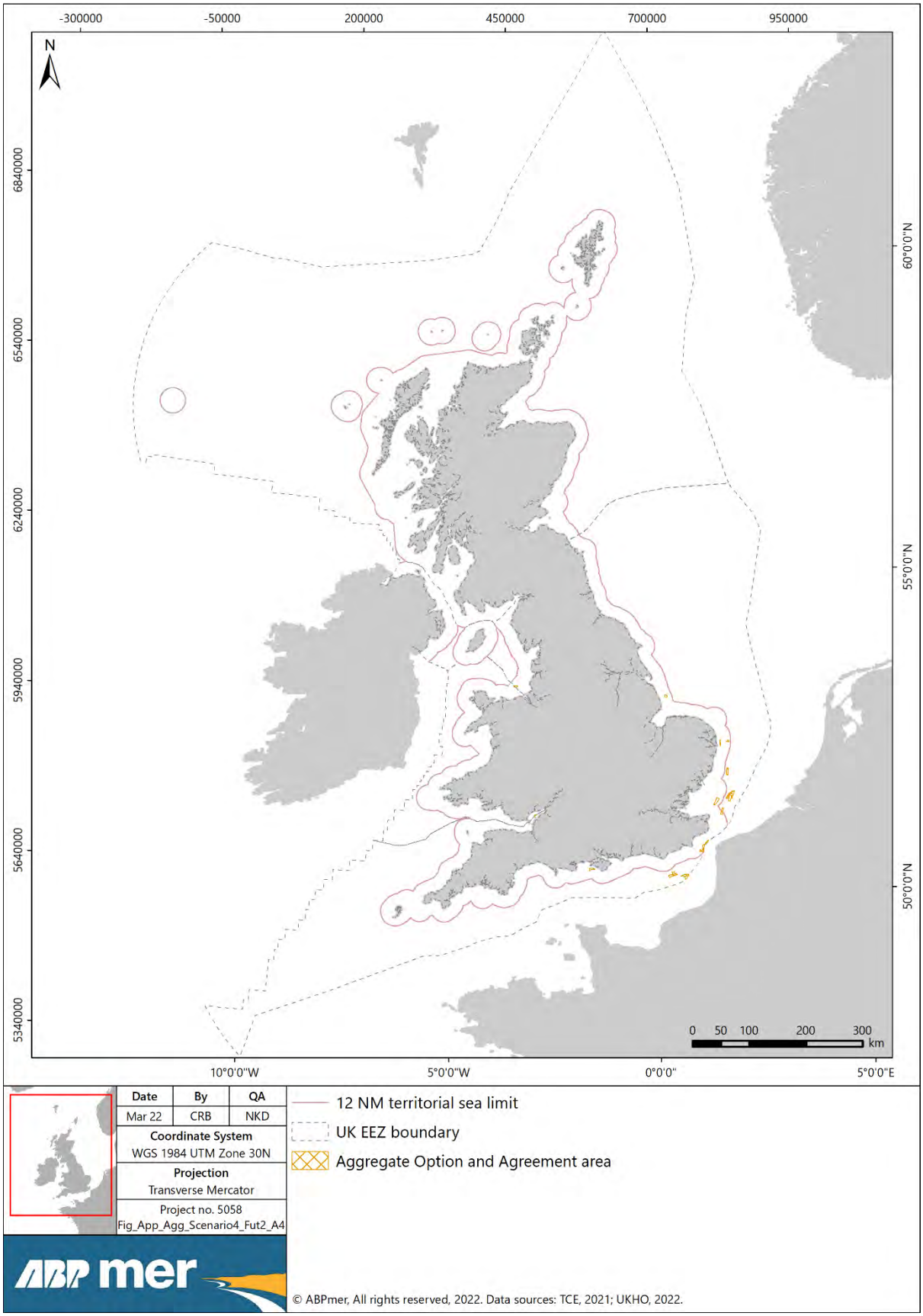



**Figure D4. Aggregates – Future 2 scenario**

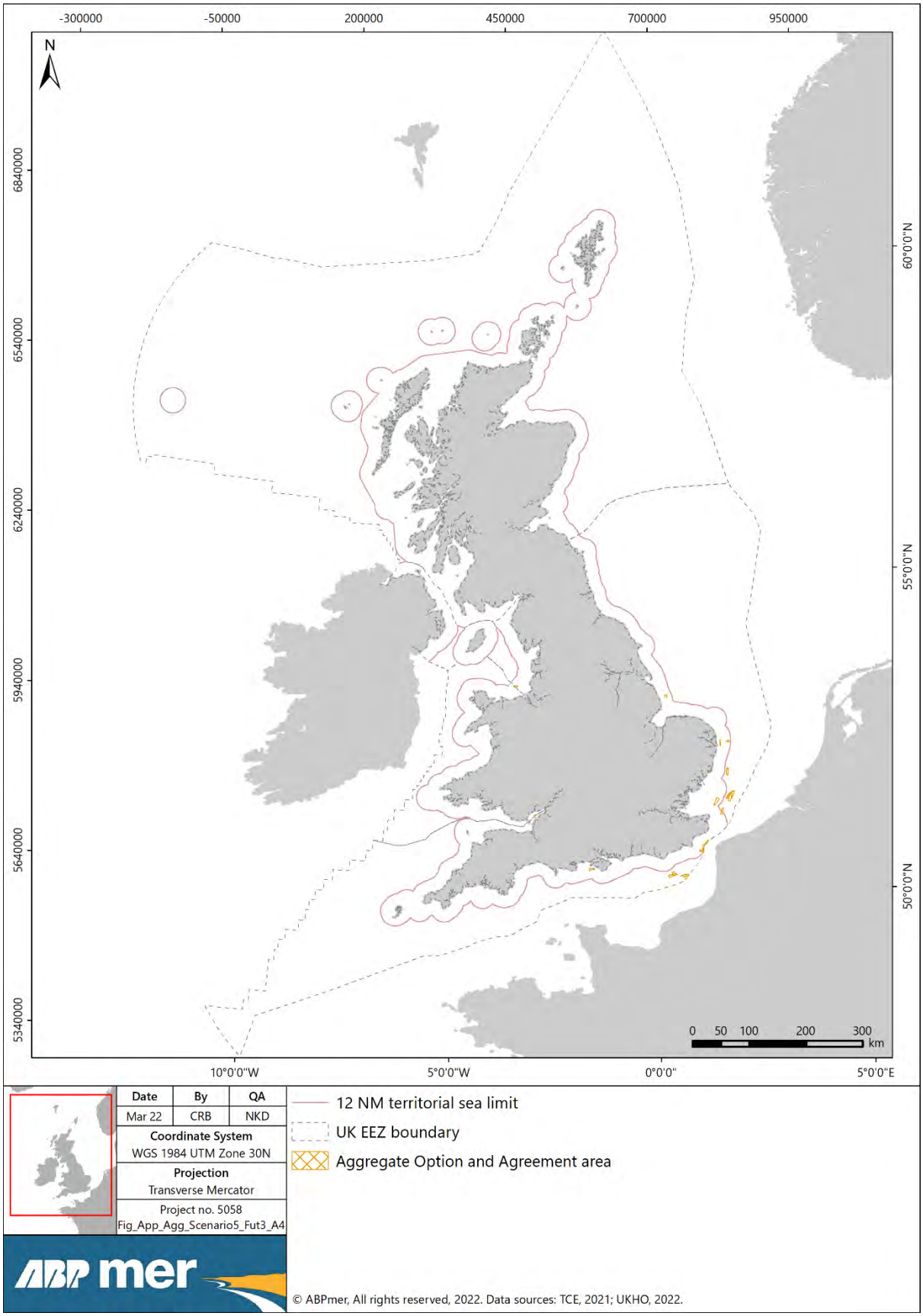



**Figure D5. Aggregates – Future 3 scenario**

# E Aquaculture

## E.1 Assumptions

Aquaculture involves the cultivation of finfish, shellfish and seaweed in the marine environment, and may use ropes, buoys, trestles, nets and cages as growing or containment mechanisms. These represent an obstacle to navigation and fishing.

Assumptions for the aquaculture sector are provided in Table E1 (finfish), Table E2 (shellfish) and Table E3 (seaweed), and spatial data are shown in to Figure E1 to Figure E5. A summary of the assumptions on production for each aquaculture type in each devolved administration is shown in Table E4, and the corresponding areas of sea space for each scenario are shown in Table E5.

**Table E1. Aquaculture assumptions – Finfish**

| Sector | Scenario | Assumptions and Rationale | Limitations |
|---|---|---|---|
| Aquaculture – finfish | Past | ▪ Scotland: in 2000, 128,919 tonnes of salmon were produced from 184 active sites (FRS, 2001a). Map historical sites from 2000, identified from a point dataset from Crown Estate Scotland, matched with current lease area polygons either by lease reference or spatial location.<br>▪ England: It is assumed there was no marine-based production in 2000. In 2010, only 8 tonnes of marine finfish were produced per year (Huntingdon & Cappell, 2020). This would require 0.002 km$^2$ space, based on salmon production in Scotland.<br>▪ Wales: None.<br>▪ Northern Ireland: None. | ▪ Historical spatial data are not available. In Scotland, the areas mapped (10.1 km$^2$) are an underrepresentation of the area required to produce the reported tonnage (38.7 km$^2$). |
| | Present | ▪ Scotland: in 2020, 192,129 tonnes of salmon were produced at 232 sites (MSS, 2021a). 58.2 km$^2$ of sea space is within aquaculture finfish lease areas. This equates to production of 3,313 tonnes per km$^2$. Map current licence areas.<br>▪ England: In 2020, only 17 tonnes of trout were produced in cages in the South-west. This would require 0.005 km$^2$ space, based on salmon production in Scotland. The location of these cages is not clear and they may be in transitional waters. Therefore, no areas are mapped. | ▪ England – spatial data on aquaculture lease areas are not available. |

| Sector | Scenario | Assumptions and Rationale | Limitations |
|---|---|---|---|
| | | ▪ Wales: None.<br>▪ Northern Ireland: 2 marine finfish sites. 1,109 tonnes of finfish (salmon and trout) produced in 2018, from 33 sites (only 2 marine). This equates to roughly 67 tonnes from the marine sites (assuming pro-rata production). Map current licence areas. | |
| | Future 1 | ▪ Scotland: Ambition to grow production to 350,000 tonnes by 2030 (SAIC, 2017). This is considered optimistic (an increase of over 150,000 tonnes), based on the historical increase of only 60,000 tonnes over the last 20 years. In addition, constraints on inshore space, sea lice choke points and social licence are likely to limit significant expansion inshore, and engineering constraints and economic costs are likely to limit offshore expansion. Based on 1.5% annual growth rate, production in 2030 is assumed to be 225,000 tonnes, requiring 67.5 km² of space (based on production per unit area at 2020 levels). Map current licence areas, noting this may underestimate area involved – area calculated separately.<br>▪ England: The English Aquaculture Strategy anticipates 1,176 tonnes of sea-grown trout in 2030 (Huntingdon & Cappell, 2020). If 10% of this (12 tonnes) is produced in sea cages this would require 0.004 km² space, based on salmon production in Scotland. No licence areas are in the planning system – area calculated separately.<br>▪ Wales: Finfish production unlikely.<br>▪ Northern Ireland: No growth in sea-based finfish production is anticipated (DAERA, 2021). Map current licence areas. | ▪ Future projections uncertain.<br>▪ Not possible to map where future production might take place outside of existing lease areas. Areas mapped likely to be an underestimate of future production areas, therefore the additional area required for production projections has been calculated but not mapped. |
| | Future 2 | ▪ Scotland: Production reaches 350,000 tonnes (the ambition for the sector stated in SAIC, 2017). This requires 105 km² of sea space (based on production per unit area | ▪ As for Future 1. |

| Sector | Scenario | Assumptions and Rationale | Limitations |
|---|---|---|---|
| | | at 2020 levels). Map current licence areas, noting this may underestimate area involved – area calculated separately.<br>▪ England: The English Aquaculture Strategy foresees 5,905 tonnes of trout grown in sea water by 2040. If 10% of this (59 tonnes) is grown in sea cages, this would require 0.02 km² space. Map current and future licence areas, noting this may underestimate area involved – area calculated separately.<br>▪ Wales: Finfish production unlikely.<br>▪ Northern Ireland: No growth in sea-based finfish production is anticipated in the short term (DAERA, 2021) and no further information is available for the long-term. Therefore no growth is assumed. Map current licence areas. | |
| | Future 3 | ▪ As for Future 2. | ▪ As for Future 2. |

**Table E2. Aquaculture assumptions – Shellfish**

| Sector | Scenario | Assumptions and Rationale | Limitations |
|---|---|---|---|
| Aquaculture – shellfish | Past | ▪ Scotland: Production of shellfish in 2000 was 2,003 tonnes of mussels and 247 tonnes of oysters (FRS, 2001b). Map historical sites from 2000, identified from a point dataset from Crown Estate Scotland, matched with current lease area polygons either by lease reference or spatial location.<br>▪ England: 3,994 tonnes of shellfish (mostly mussels) produced in 2010 (Huntingdon & Cappell, 2020). This would require 7.0 km² of sea space based on production per unit area in Scotland but assuming one harvest per year rather than one harvest every two years as in Scotland.<br>▪ Wales: Production approximately 5,000 tonnes. Precise figure not available; estimated from Cefas (2012). This would require 185 km² space based on current Welsh production per unit area. Map past licence areas. | ▪ Historical spatial data are not available. In Scotland, the areas mapped (3.2 km²) are an underrepresentation of the area required to produce the reported tonnage (7.9 km²).<br>▪ Date information not available for NI lease areas. |

| Sector | Scenario | Assumptions and Rationale | Limitations |
|---|---|---|---|
| | | ▪ Northern Ireland: Production approximately 1,000 tonnes. Precise figure not available; estimated from Cefas (2012). This would require 6.5 km² space based on current shellfish production per unit area in Northern Ireland. Map current licence areas. | |
| | Present | ▪ Scotland: 5,661 tonnes of mussels were produced in 2020 (MSS, 2021b). 19.9 km² of sea space is within shellfish lease areas. This equates to production of 284.5 tonnes per km².<br>▪ England: 3,511 tonnes of shellfish produced (mostly mussels) (Huntingdon & Cappell, 2020). This would require 7.3 km² of sea space based on production per unit area in Scotland but assuming one harvest per year rather than one harvest every two years as in Scotland. Map current licence areas.<br>▪ Wales: 2,946 tonnes (mostly mussels) produced in 2019 (data from Cefas). An area of 108.7 km² is within aquaculture licence areas. Map current licence areas.<br>▪ Northern Ireland: 2,969 tonnes shellfish produced in 2019. An area of 19.2 km² is within shellfish licence areas. Map current licence areas. | ▪ Spatial data on licence areas in England are not available, but sites have been digitised based on sector knowledge. |
| | Future 1 | ▪ Scotland: Ambition to grow production to 21,000 tonnes by 2030 (SFD, 2016). This is considered optimistic based on 2000-2020 growth. Production is assumed to be 10,000 tonnes in 2030, requiring 35 km² of space (based on production per unit area at 2020 levels). Map current licence areas, noting this may underestimate area involved – area calculated separately.<br>▪ England: Ambition for 10,493 tonnes shellfish by 2030 (Huntingdon & Cappell, 2020). Offshore Shellfish Ltd site will contribute to this (target of 10,000 tonnes production from the site), so overall target is realistic. There are also projects in the | ▪ Future projections uncertain.<br>▪ Not possible to map where future production might take place outside of existing lease areas, although some future sites in England have been digitised based on applications in the MMO Marine Case Management System. The additional area required for production projections has been calculated but not mapped. |

| Sector | Scenario | Assumptions and Rationale | Limitations |
|---|---|---|---|
| | | pipeline (licence applications) for scallop and oyster. This would require 18.4 km² of sea space based on production per unit area in Scotland but assuming one harvest per year rather than one harvest every two years as in Scotland. Map current licence areas and licence areas in the planning system.<br>▪ Wales: Assume 8,000 tonnes production. This would require 295 km² space based on current Welsh production per unit area. An ambition to grow production from 8,000 tonnes to 16,000 tonnes was articulated in the Wales Development Strategy (ACIG, 2020), but given 2019 production level was lower than the starting point, this is not considered realistic. Map current and future licence areas.<br>▪ Northern Ireland: Assume production returns to previous level, around 5,000 tonnes. This would require 32 km² based on current production per unit area in Northern Ireland. Map current licence areas. | |
| | Future 2 | ▪ Scotland: Production reaches 21,000 tonnes (the ambition for the sector stated in SFD, 2016). This requires 73.5 km² of space (based on production per unit area at 2020 levels). Map current licence areas, noting this may underestimate area involved – area calculated separately.<br>▪ England: Assume 37,287 tonnes shellfish production by 2040 (Huntingdon & Cappell, 2020). This would require 65.3 km² of sea space based on production per unit area in Scotland but assuming one harvest per year rather than one harvest every two years as in Scotland. Map current licence areas and licence areas in the planning system.<br>▪ Wales: Assume production reaches 16,000 tonnes in line with sector aspiration (ACIG, 2020). This would require 590 km² space based on current Welsh production per unit | ▪ As for Future 1. |

| Sector | Scenario | Assumptions and Rationale | Limitations |
|---|---|---|---|
| | | area. Map current and future licence areas.<br>▪ Northern Ireland: Assume 5,000 tonnes production. This would require 32 km² based on current production per unit area in Northern Ireland. Map current licence areas. | |
| | Future 3 | ▪ As for Future 2. | ▪ As for Future 2. |

**Table E3. Aquaculture assumptions – Seaweed**

| Sector | Scenario | Assumptions and Rationale | Limitations |
|---|---|---|---|
| Aquaculture – seaweed | Past | ▪ Scotland: None.<br>▪ England: None.<br>▪ Wales: None.<br>▪ Northern Ireland: None. | |
| | Present | ▪ Scotland: Research and small-scale operations in place. Map seaweed cultivation lease areas (excluding those for seaweed harvesting from the foreshore). 0.93 km² of sea space is within seaweed lease areas.<br>▪ England: Production starting from initial sites, no data available on tonnages. Map approved licence applications for seaweed (one known of in Scarborough, 25 ha).<br>▪ Wales: None.<br>▪ Northern Ireland: None. | |
| | Future 1 | ▪ Scotland: Cultivated seaweed production expands to 12,000 tonnes by 2030 (half of the growth foreseen to 2040 in ABPmer & RPA, in prep). Based on production of 38 tonnes per km² (ABPmer & Maritek, in prep), 325 km² of space is required. Map current licence areas, noting this may underestimate area involved – area calculated separately.<br>▪ England: Production increases to 1,736 tonnes in line with 2030 aspirations (Huntingdon & Cappell, 2020). This would require 45.6 km² space (based on ABPmer & Maritek, in prep). Map current areas and licence applications in the planning system. | ▪ Future projections are uncertain, particularly for this emerging sector.<br>▪ Not possible to map where all future production might take place, although some future sites in England have been digitised based on applications in the MMO Marine Case Management System. The additional area required for production projections has been calculated but not mapped. |

| Sector | Scenario | Assumptions and Rationale | Limitations |
|---|---|---|---|
| | | ▪ Wales: No information available. Some development may occur, but this is unlikely to be at a material scale at national level.<br>▪ Northern Ireland: No information available. Some development may occur, but this is unlikely to be at a material scale at national level. | |
| | Future 2 | ▪ Scotland: Cultivated seaweed production expands to 24,000 tonnes by 2040 (ABPmer & RPA, in prep), and it is assumed the same growth rate continues to 2050 (i.e. 36,000 tonnes). Based on production of 38 tonnes per km$^2$ (ABPmer & Maritek, in prep), 945 km$^2$ of space is required. Map current licence areas, noting this may underestimate area involved – area calculated separately.<br>▪ England: Production increases to 13,066 tonnes in line with 2040 aspirations (Huntingdon & Cappell, 2020). This would require 343.0 km$^2$ space (based on ABPmer & Maritek, in prep). Map current areas and licence applications in the planning system, noting this may underestimate area involved – area calculated separately.<br>▪ Wales: No information available. Some development may occur, but this is unlikely to be at a material scale at national level.<br>▪ Northern Ireland: No information available. Some development may occur, but this is unlikely to be at a material scale at national level. | ▪ As for Future 1. |
| | Future 3 | ▪ As for Future 2. | ▪ As for Future 2. |

**Table E4. Assumptions on aquaculture production (tonnes) by aquaculture type and devolved administration for each scenario**

| Devolved Administration | Aquaculture Type | Past | Present | Future 1 | Future 2 | Future 3 |
|---|---|---|---|---|---|---|
| Scotland | Fish | 128,959 | 192,129 | 225,000 | 350,000 | 350,000 |
| Scotland | Shellfish | 2,250 | 5,661 | 10,000 | 21,000 | 21,000 |
| Scotland | Seaweed | 0 | no data | 12,000 | 36,000 | 36,000 |
| England | Fish | 8 | 17 | 12 | 59 | 59 |
| England | Shellfish | 3,994 | 4,182 | 10,493 | 37,287 | 37,287 |
| England | Seaweed | 0 | no data | 1,736 | 13,066 | 13,066 |
| Wales | Fish | 0 | 0 | 0 | 0 | 0 |
| Wales | Shellfish | 5,000 | 2,946 | 8,000 | 16,000 | 16,000 |
| Wales | Seaweed | 0 | 0 | 0 | 0 | 0 |
| Northern Ireland | Fish | 0 | 67 | 67 | 67 | 67 |
| Northern Ireland | Shellfish | 1,000 | 2,969 | 5,000 | 5,000 | 5,000 |
| Northern Ireland | Seaweed | 0 | 0 | 0 | 0 | 0 |

**Table E5. Areas involved in aquaculture ($km^2$) by aquaculture type and devolved administration for each scenario**

| Devolved Administration | Aquaculture Type | Past | Present | Future 1 | Future 2 | Future 3 |
|---|---|---|---|---|---|---|
| Scotland | Fish | 38.7 | 55.1 | 67.5 | 105.0 | 105.0 |
| Scotland | Shellfish | 7.9 | 18.0 | 35.0 | 73.5 | 73.5 |
| Scotland | Seaweed | 0.0 | 0.8 | 315.0 | 945.0 | 945.0 |
| England | Fish | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| England | Shellfish | 7.0 | 20.4 | 21.4 | 65.2 | 65.2 |
| England | Seaweed | 0.0 | 0.3 | 45.6 | 343.0 | 343.0 |
| Wales | Fish | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Wales | Shellfish | 184.5 | 103.7 | 295.2 | 590.5 | 590.5 |
| Wales | Seaweed | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Northern Ireland | Fish | 0.0 | 1.2 | 1.2 | 1.2 | 1.2 |
| Northern Ireland | Shellfish | 18.1 | 18.1 | 32.4 | 32.4 | 32.4 |
| Northern Ireland | Seaweed | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **UK (total)** | **Fish** | **38.7** | **56.3** | **68.7** | **106.2** | **106.2** |
| **UK (total)** | **Shellfish** | **217.5** | **160.2** | **384.0** | **761.6** | **761.6** |
| **UK (total)** | **Seaweed** | **0.0** | **1.1** | **360.6** | **1,287.9** | **1,287.9** |

## E.2 Areas by Scenario

The areas of aquaculture, for each scenario, and in relation to the UK EEZ, are shown in Table E6.

**Table E6. Areas of aquaculture by scenario, and as a percentage of UK EEZ**

| Scenario | Area ($km^2$) | As % of UK EEZ |
|---|---|---|
| **Finfish** | | |
| Past | 38.7 | 0.01% |
| Present | 56.3 | 0.01% |
| Future 1 | 68.7 | 0.01% |
| Future 2 | 106.2 | 0.01% |
| Future 3 | 106.2 | 0.01% |
| **Shellfish** | | |
| Past | 217.5 | 0.03% |
| Present | 160.1 | 0.02% |
| Future 1 | 383.9 | 0.05% |
| Future 2 | 761.4 | 0.10% |
| Future 3 | 761.4 | 0.10% |
| **Seaweed** | | |
| Past | 0.0 | 0.00% |
| Present | 0.8 | 0.00% |
| Future 1 | 360.4 | 0.05% |
| Future 2 | 1,287.8 | 0.18% |
| Future 3 | 1,287.8 | 0.18% |
| **Shellfish and Seaweed** | | |
| Past | 0.0 | 0.00% |
| Present | 0.3 | 0.00% |
| Future 1 | 0.3 | 0.00% |
| Future 2 | 0.3 | 0.00% |
| Future 3 | 0.3 | 0.00% |
| **Total** | | |
| Past | 256 | 0.03% |
| Present | 217 | 0.03% |
| Future 1 | 813 | 0.11% |
| Future 2 | 2,156 | 0.29% |
| Future 3 | 2,156 | 0.29% |

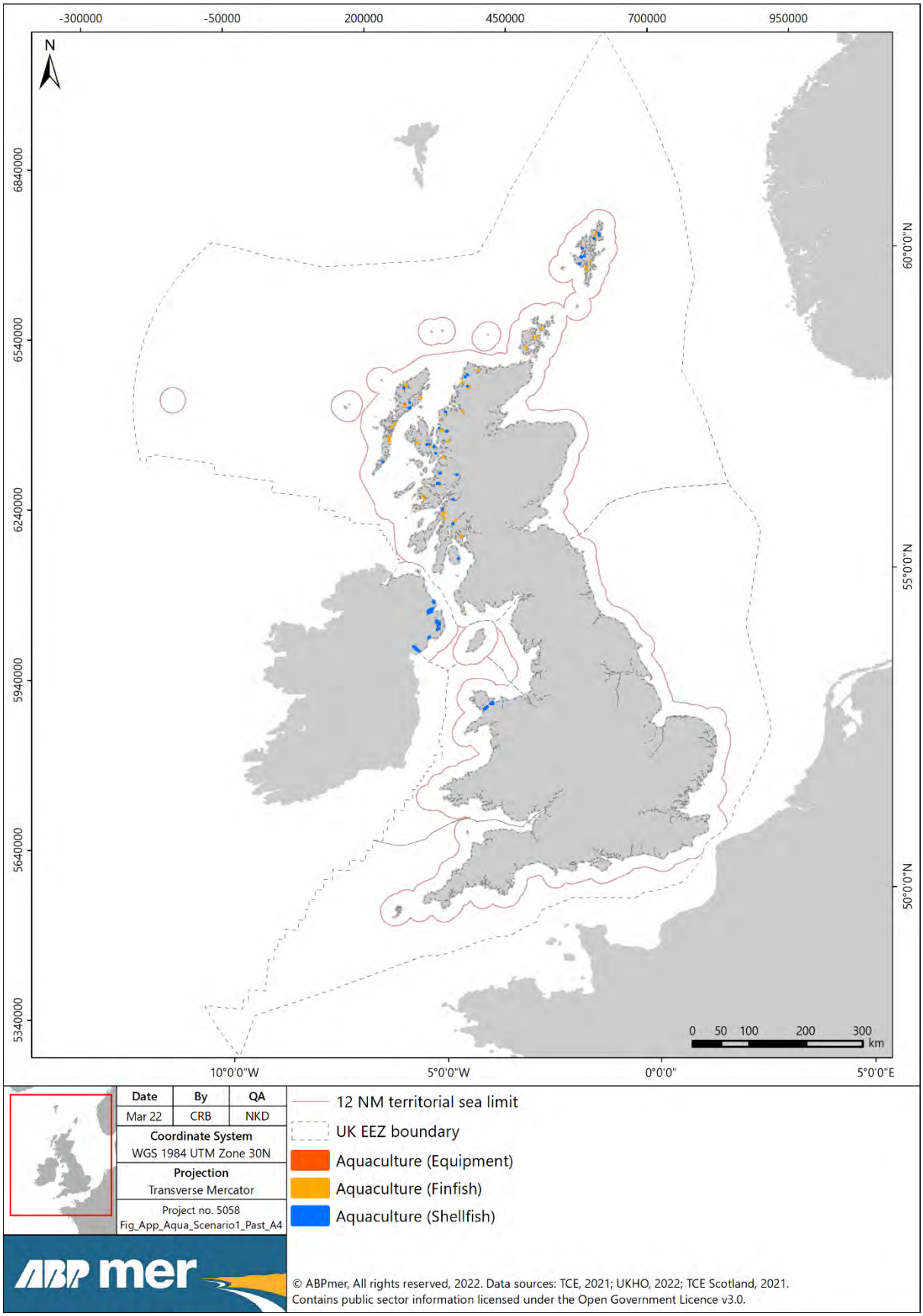



**Figure E1. Aquaculture – Past scenario**

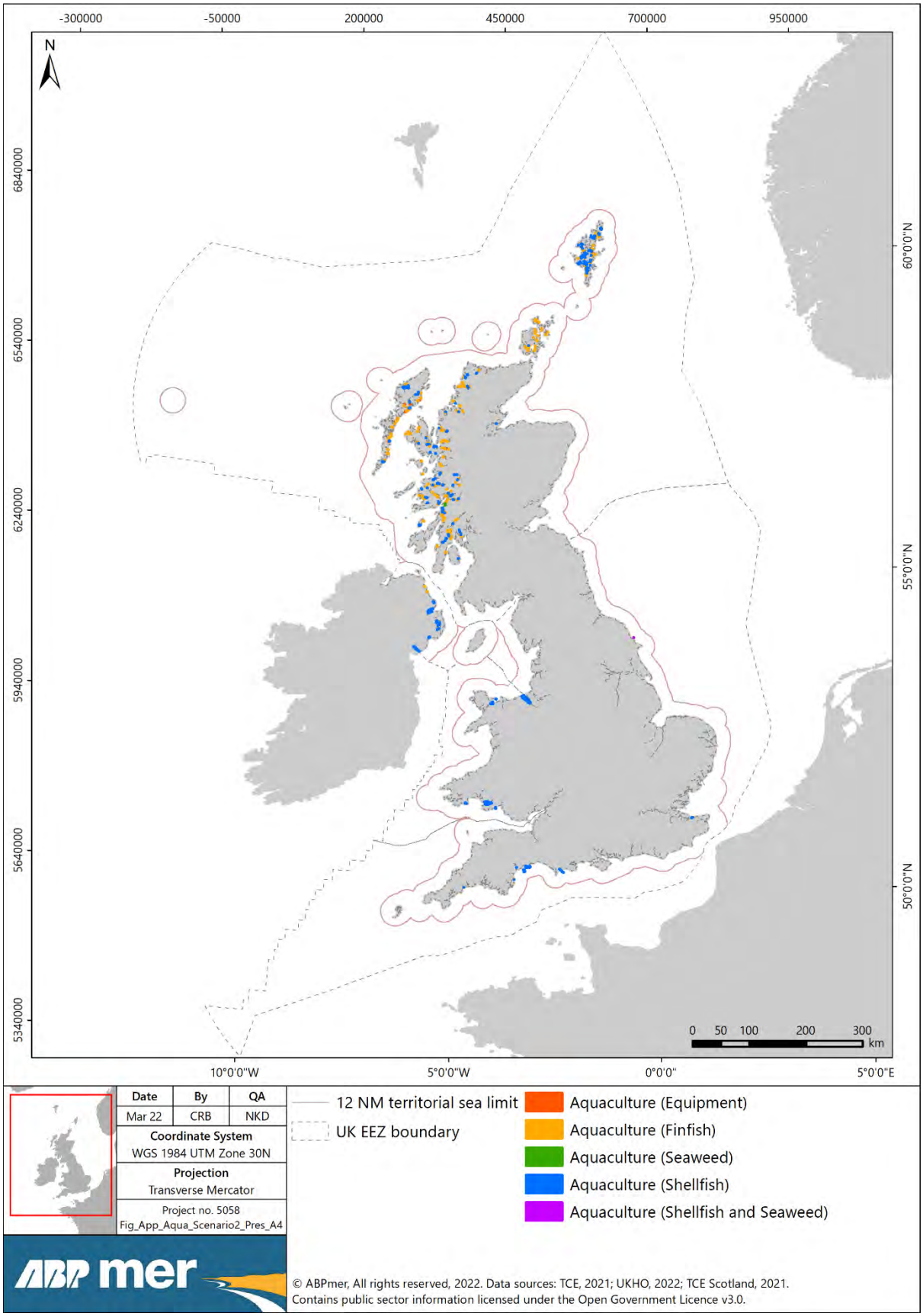
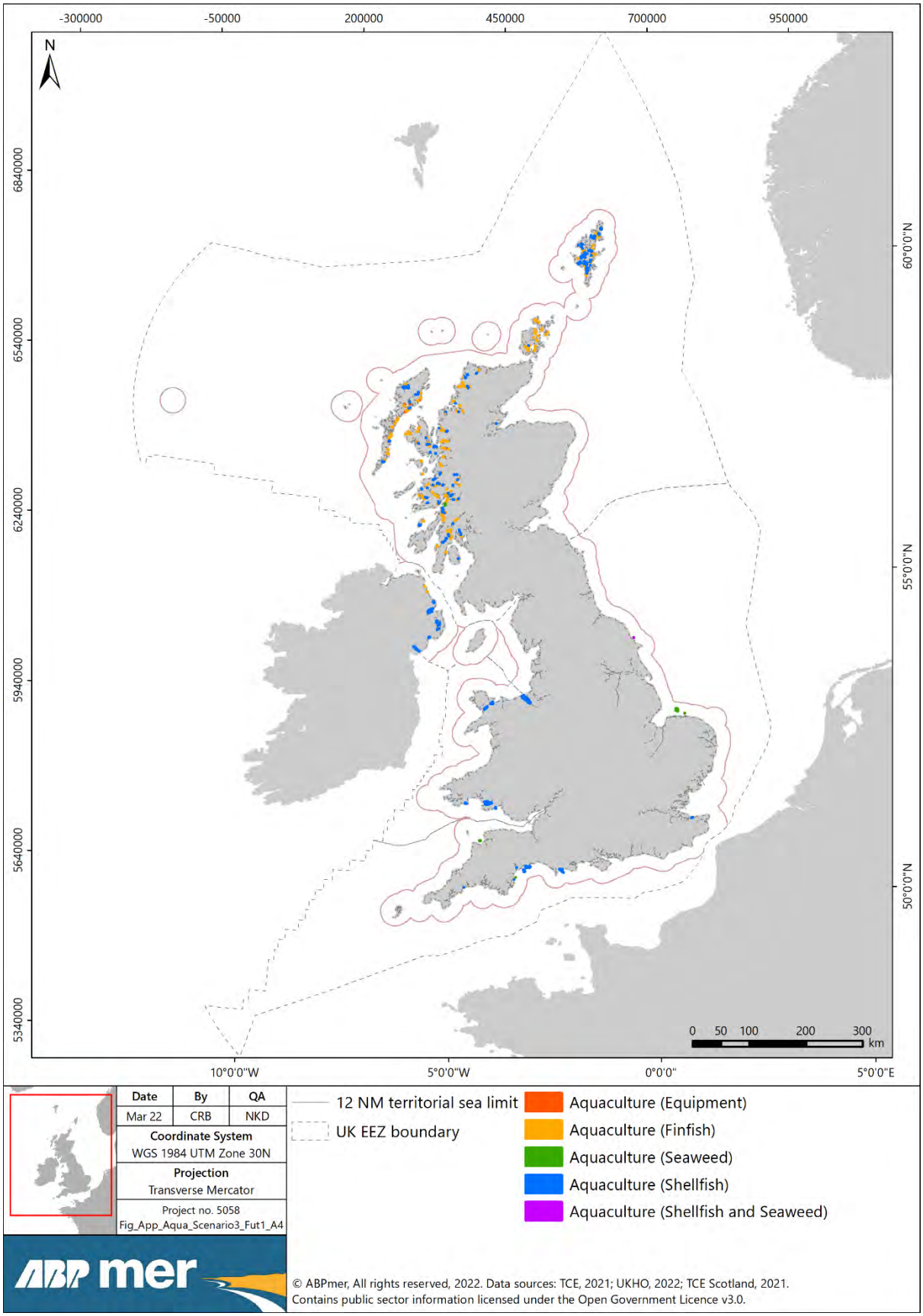
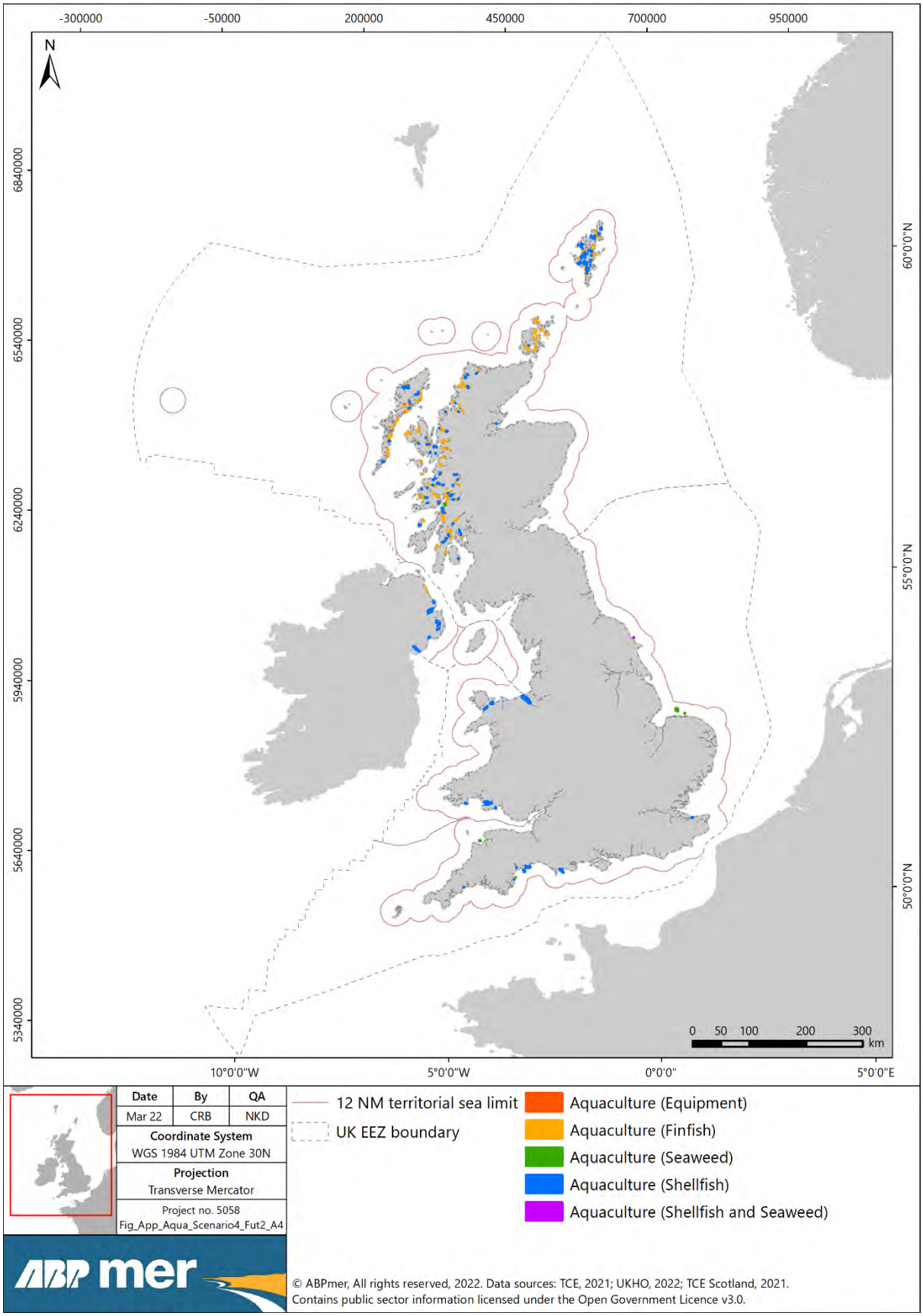



**Figure E2. Aquaculture – Present scenario**



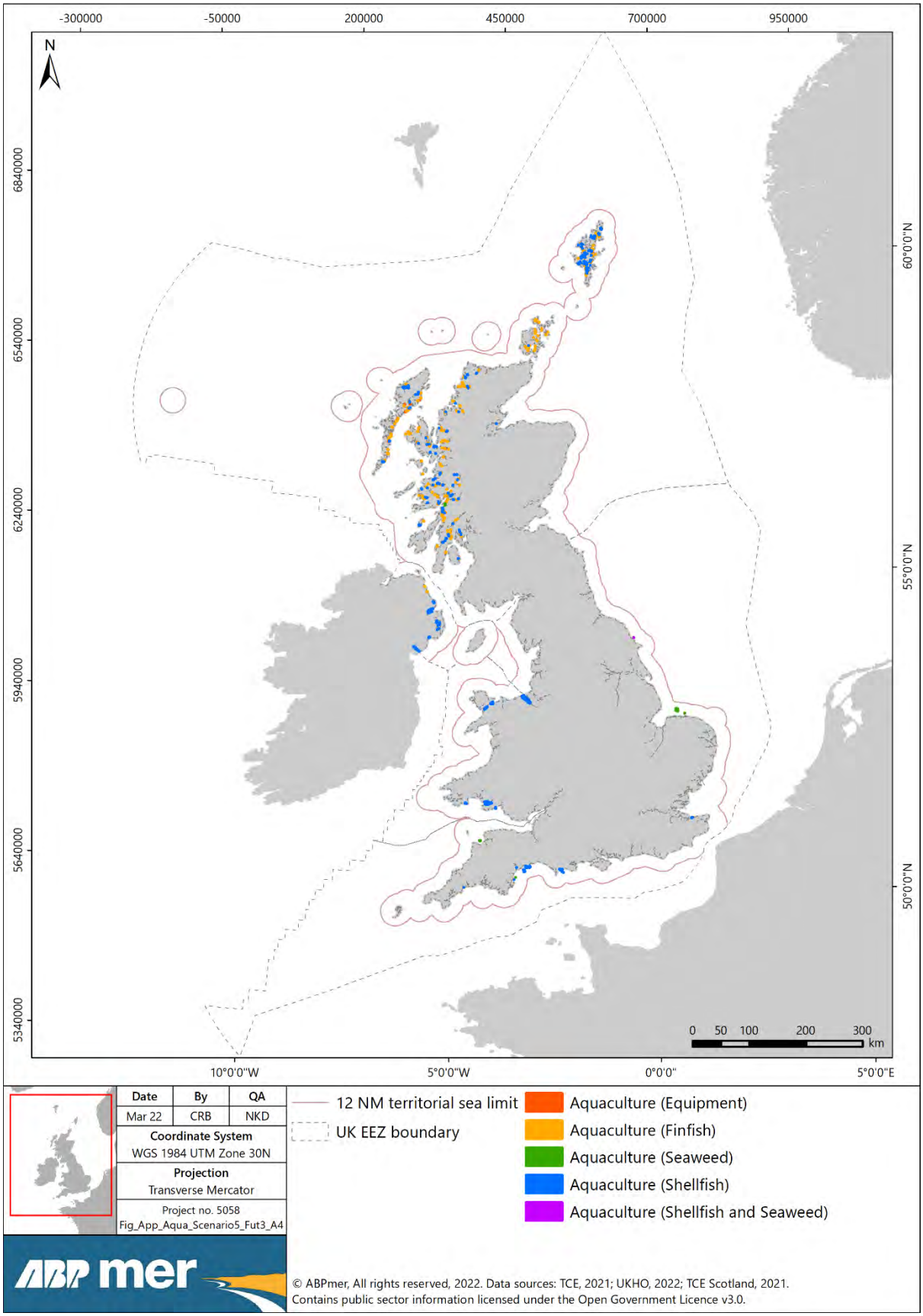

Note: Full extent of future areas is not mapped spatially

**Figure E3. Aquaculture – Future 1 scenario**




Note: Full extent of future areas is not mapped spatially

**Figure E4. Aquaculture – Future 2 scenario**




Note: Full extent of future areas is not mapped spatially

**Figure E5. Aquaculture – Future 3 scenario**

# F Cables

## F.1 Assumptions

Subsea cables represent a potential hazard for fouling of mobile demersal gear, and the European Subsea Cable Association (ECSA) recommends observing a 0.25 NM no-fishing zone either side of cables. However, this is not a legal requirement and fishing does take place over cables. Cables may be buried in soft sediment (mud, sand, gravel), although in areas where the seabed is mobile (e.g. large moving sand waves), cables can become exposed and present a snagging hazard. Cables are usually surface-laid over hard substrates (rock) and in deep waters. Cables include telecom cables, power cables, and OWF export cables.

Assumptions for the cables sector are provided in Table F1, and spatial data are shown in Figure F1 to Figure F5. A number of cable routes had to be digitised for the future scenarios, as many proposed cables were not available in KIS-Orca data (Table F2). Offshore wind farm (OWF) export cables are included in the 'cables' sector for mapping purposes.

**Table F1. Cables assumptions**

| Sector | Scenario | Assumptions and Rationale | Limitations |
|---|---|---|---|
| Cables | Past | ▪ Include 'out-of-use' cables, Blyth OWF export cable, and telecom cables with a 'date of issue' prior to 2001.<br>▪ Assume cables will be buried in soft substrates and fishing can take place over them. Only cables that overlap with 'Rock and boulders' substrate and cables in deeper waters (>200 m) (as these will not be buried), are assumed to restrict fishing activity, with a buffer of 100 m either side of the cable. | ▪ Cables may not always remain buried and can cause issues for fishing, scenario map likely to underestimate the impact of cables on fishing. |
| | Present | ▪ Include 'out-of-use' cables, export cables for OWF in present scenario, and current telecoms and power cables with a status of 'active' or 'disused/inactive'.<br>▪ Constraints to fishing activity, as in past scenario. | ▪ As for Past.<br>▪ Some active power cables do not have a 'date of issue' in the spatial data (Western HVDC link, Jersey-Guernsey1, Normandy 1, 2 and 3). These are included in the present and future scenarios. |
| | Future 1 | ▪ Include 'out-of-use' cables, export cables for OWF in Future 1 scenario, power cables with a status of 'active', 'disused/inactive' or 'under construction', telecoms cables with a status of 'active' or 'proposed', proposed cables from KIS-Orca, and additional proposed | ▪ As for Past.<br>▪ Future cables do not always have a defined route, therefore routes shown are indicative. |

| Sector | Scenario | Assumptions and Rationale | Limitations |
|---|---|---|---|
| | | cables that are not in the spatial data (Table F2).<br>▪ For constraints to fishing activity, as in Past scenario. | |
| | Future 2 | ▪ Include 'out-of-use' cables, export cables for OWF in Future 2 scenario, power cables with a status of 'active', 'disused/inactive' or 'under construction', telecoms cables with a status of 'active' or 'proposed', proposed cables from KIS-Orca, and additional proposed cables that are not in the spatial data (Table F2).<br>▪ For constraints to fishing activity, as in Past scenario. | ▪ As for Future 1. |
| | Future 3 | ▪ Include cables as in Future 2.<br>▪ Apply 0.25 NM (463 m) no-trawling buffer either side of all cables, except for disused/out-of-use cables, regardless of substrate. | ▪ As for Future 1. |

**Table F2. Proposed cables, routes, and whether they are already included in KIS-Orca data**

| Proposed Cable | Route | Included in KIS-Orca 'Proposed Cables' Data? |
|---|---|---|
| **Power Interconnectors** | | |
| Nemo Link Interconnector | UK–Belgium | ✓ |
| Aquind | UK (south coast)–France (Normandy) | digitised |
| Celtic Link | Ireland–France, through UK waters | digitised |
| Eastern HVDC | Scotland (Peterhead)–England (Drax) | digitised |
| ElecLink | | digitised |
| EuroLink | UK–Netherlands | digitised |
| Fablink | UK–France via Alderney | digitised |
| Greenlink | Ireland (Wexford)–Wales (Pembrokeshire) | digitised |
| Icelink | Scotland–Iceland | digitised |
| LirIC | Scotland (Kilmarnock South)–Northern Ireland (Kilroot) | digitised |
| Nautilus | UK–Belgium | digitised |
| NeuConnect | UK–Germany | digitised |
| North Connect | Scotland (Peterhead)–Norway | digitised |
| Viking | UK–Denmark | digitised |
| Western Isles interconnector | Scotland mainland (Dundonnell)–Western Isles (Stornoway) | digitised |

| Proposed Cable | Route | Included in KIS-Orca 'Proposed Cables' Data? |
|---|---|---|
| **Telecom cables** | | |
| Channel Crossing | UK–France | digitised |
| Ireland-France Cable-1 (IFC-1) | Ireland–France (through UK waters) | digitised |
| Northern Ireland-Scotland telecom cable (Scot-NI 3 and 4) | Northern Ireland (Larne & Donaghadee)–Scotland (Girvan & Portpatrick) | ✓ |
| Rockabill | Ireland (Portraine)–UK (Southport) | ✓ |

## F.2 Areas by Scenario

The areas of cables restricting trawling, for each scenario, and in relation to the UK EEZ, are shown in Table F3.

**Table F3. Areas of cables restricting trawling by scenario, and as a percentage of UK EEZ**

| Scenario | Area ($km^2$) | As % of UK EEZ |
|---|---|---|
| Past | 134 | 0.02% |
| Present | 656 | 0.09% |
| Future 1 | 677 | 0.09% |
| Future 2 | 687 | 0.09% |
| Future 3 | 25,453 | 3.46% |

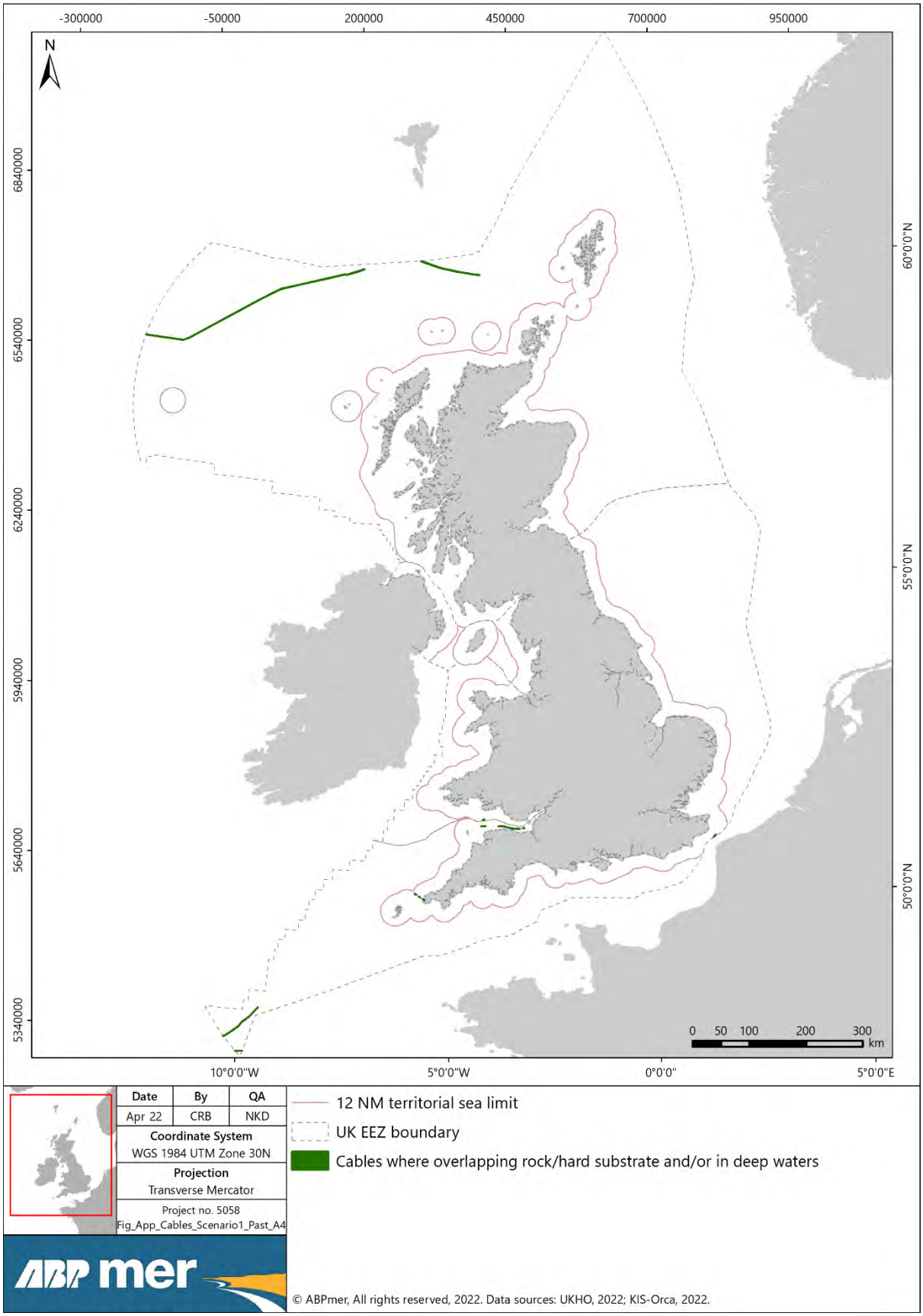



**Figure F1. Cables – Past scenario (over hard substrate and in water >200 m depth, 100 m buffer)**

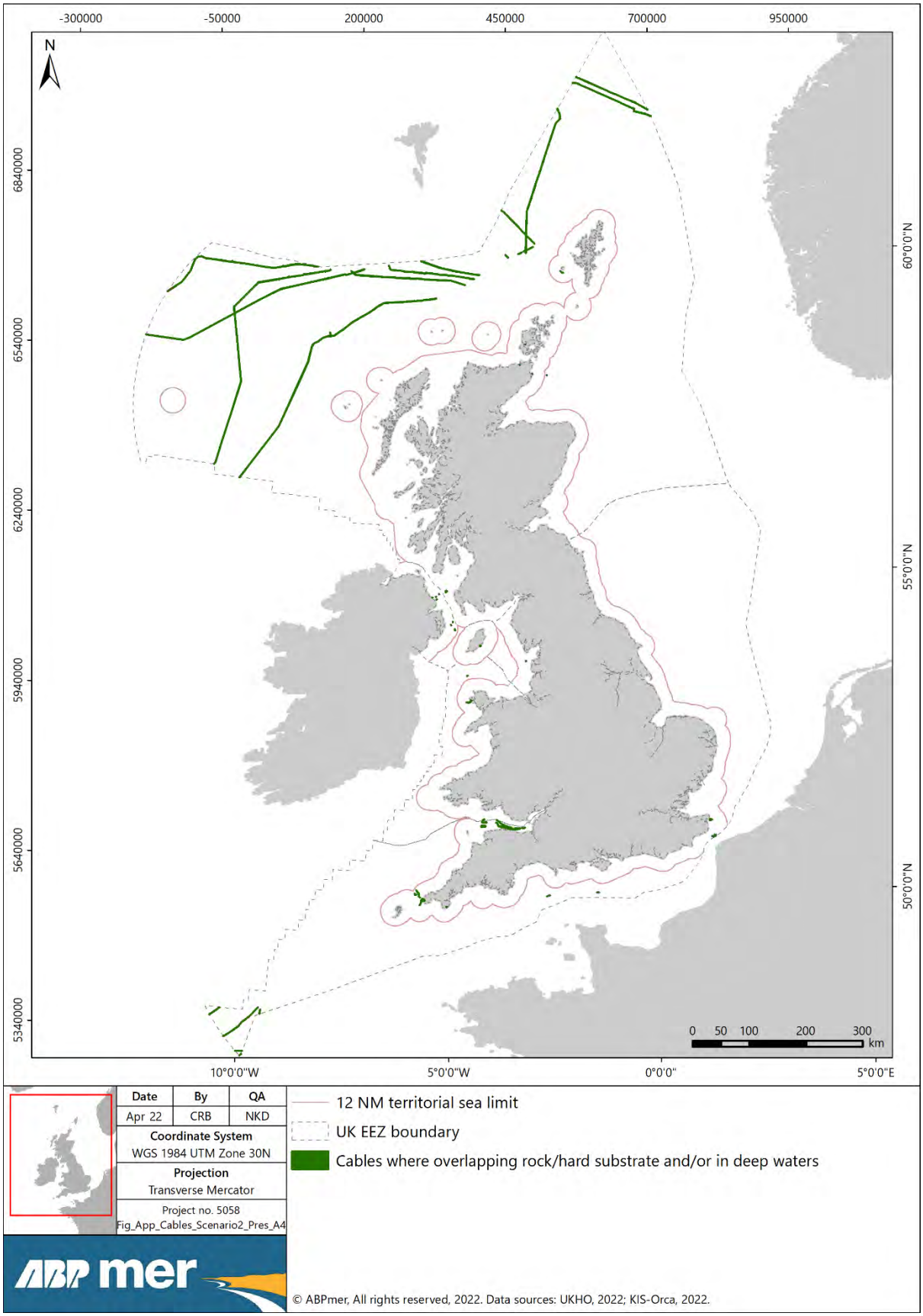



**Figure F2.** **Cables – Present scenario (over hard substrate and in water >200 m depth, 100 m buffer)**

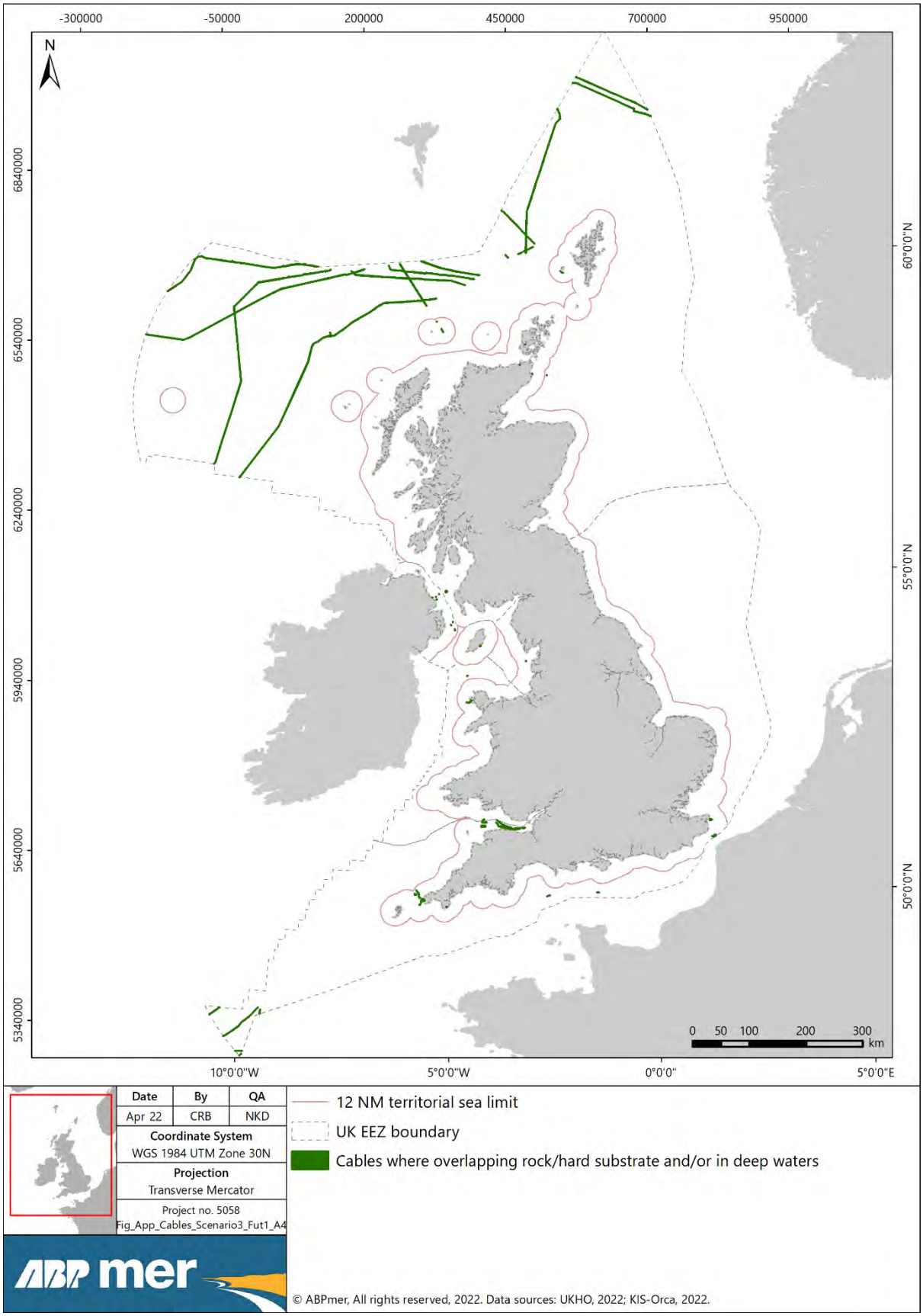



**Figure F3.** **Cables – Future 1 scenario (over hard substrate and in water >200 m depth, 100 m buffer)**

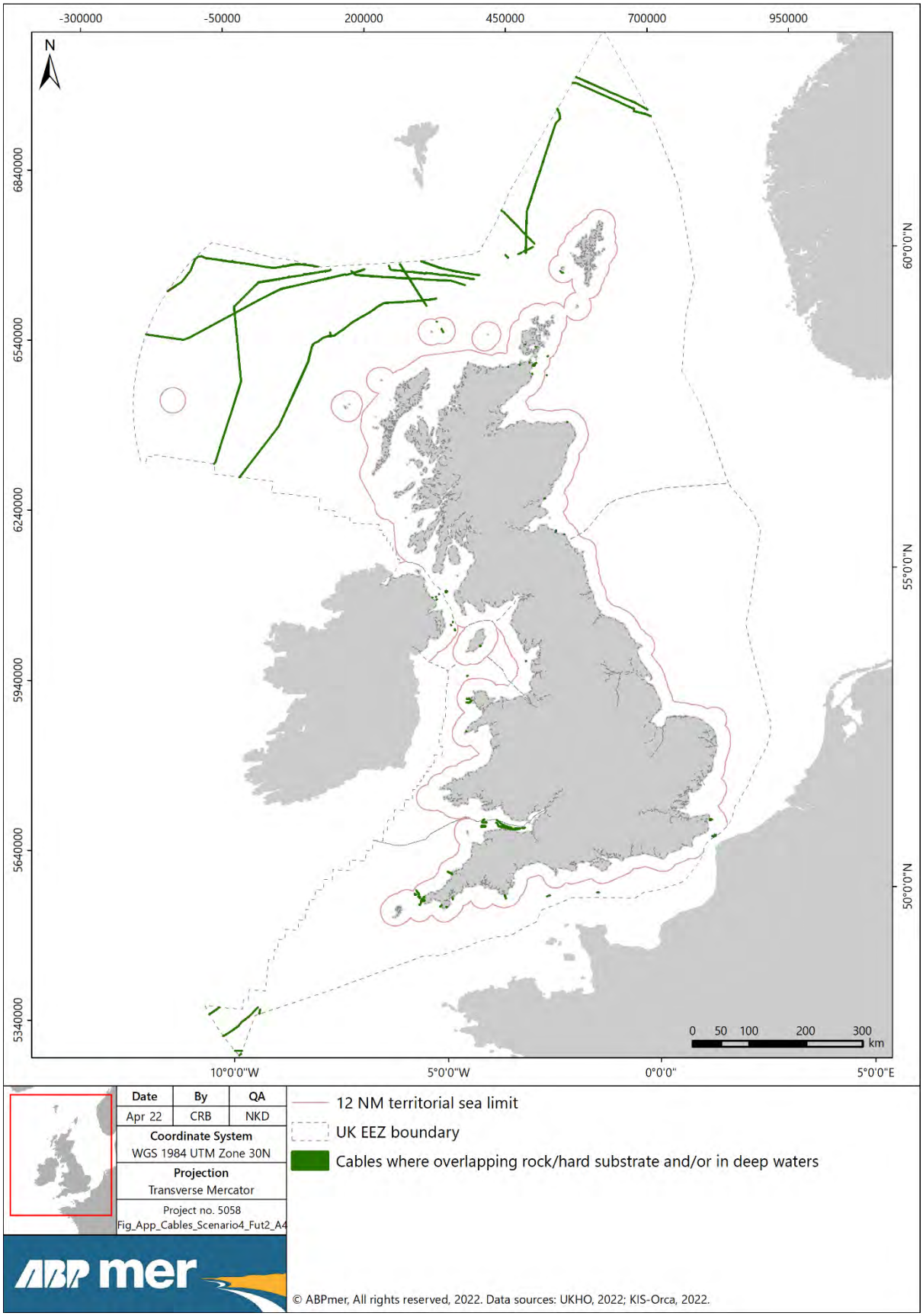



**Figure F4.** **Cables – Future 2 scenario (over hard substrate and in water >200 m depth, 100 m buffer)**

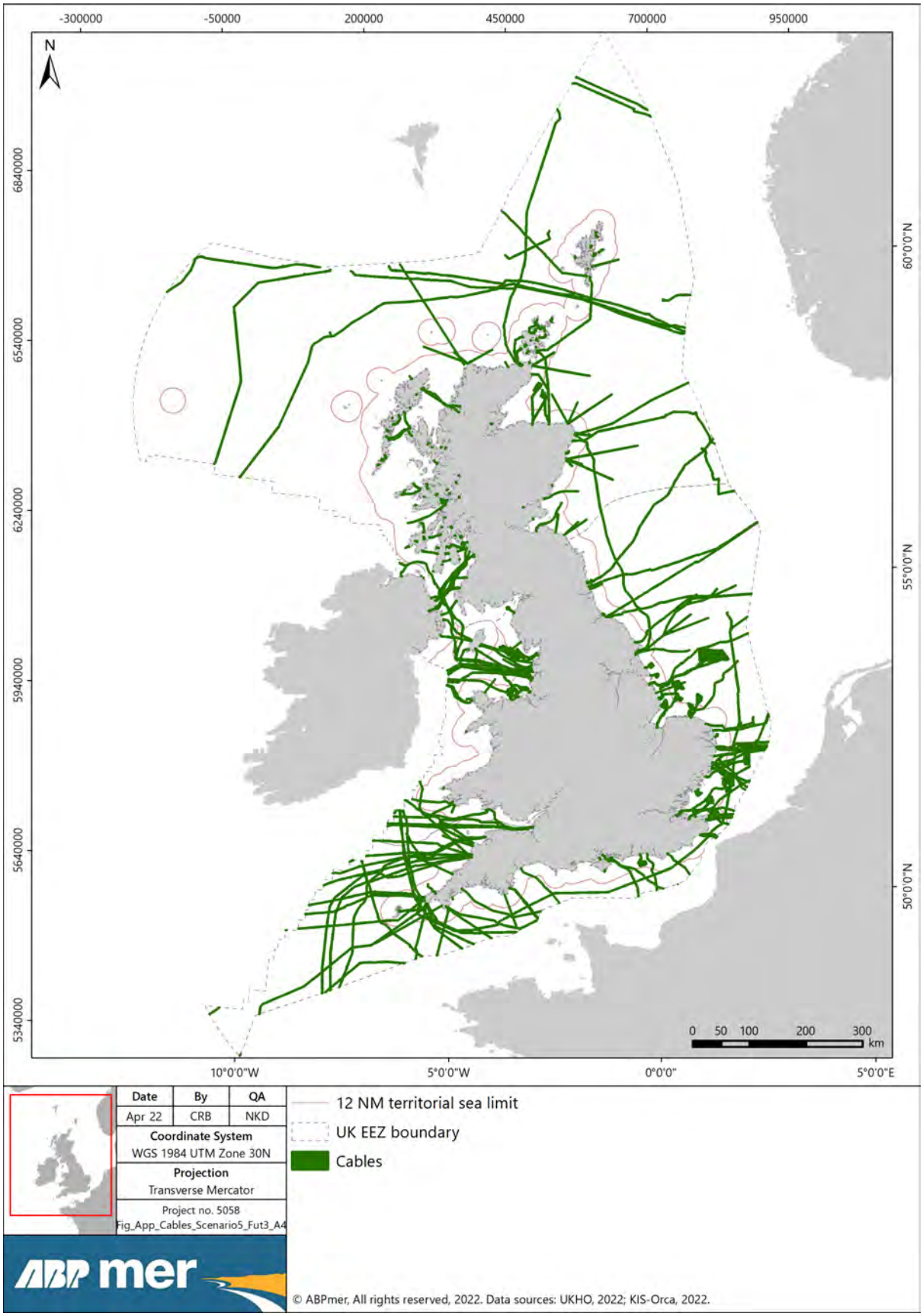



**Figure F5.** **Cables – Future 3 scenario (all cables regardless of substrate and with 0.25 NM buffer)**

# G Oil and Gas

## G.1 Assumptions

Extraction of oil and gas involves the drilling of exploration wells to identify oil and gas deposits, and establishment of platforms for extraction of oil and gas. Pipelines or tankers then take the oil and gas back to shore. Disused exploration and extraction wells may be plugged and cut below the surface of the seabed, or plugged and capped, allowing potential re-entry (DTI, 2001). Safety zones of 500 m are established around surface platforms and some subsea infrastructure (under the Petroleum Act 1987), which prohibit fishing from taking place within it.

The oil and gas sector is anticipated to undergo decommissioning over the next few decades, although the extent of this is uncertain. BEIS (2018) decommissioning guidance cites OSPAR Decision 98/3 which provides a requirement that all installations should be completely removed unless a derogation is granted. The policy is to achieve a clear seabed. However, BEIS acknowledge that this will not always be achievable, and consider decommissioning as the last option after re-use of the facilities for energy or other projects has been ruled out. This indicates that many of the structures could remain in place for some time. Despite this, the latest information on decommissioning plans (OPRED, 2021) does show that many appear to be planning to remove and recycle infrastructure, although some plan to leave footings *in situ*. Pipelines are considered on a case-by-case basis (DTI, 2001). The Oil & Gas Authority confirms that decommissioning is the most likely immediate pathway for most infrastructure (OGA, 2021). Decommissioning has been incorporated into the Future 2 and 3 scenarios by reducing the size of the Safety Zones pro-rata according to the proportion of wells expected to be decommissioned (Table G1).

**Table G1. Oil and Gas decommissioning plans by region**

| Well Type | Northern North Sea and West of Shetland | Central North Sea | Southern North Sea and Irish Sea |
|---|---|---|---|
| Platform Wells | 328 | 283 | 371 |
| Subsea Wells | 204 | 303 | 47 |
| Subsea E&A Wells | 20 | 29 | 31 |

Source: OGUK, 2020.

Assumptions for the Oil and Gas sector are provided in Table G2, and spatial data are shown in Figure G1 to Figure G5.

**Table G2. Oil and Gas assumptions**

| Sector | Scenario | Assumptions and Rationale | Limitations |
|---|---|---|---|
| Oil and Gas | Past | ▪ Surface and subsurface safety zones (Petroleum Act 1987) in 2021.<br>▪ Fishing can take place over pipelines. | ▪ Date information is not complete in OGUK data, and not available in the Kingfisher data used, therefore may not correctly capture installations at 2000. |
| | Present | ▪ Surface and subsea safety zones in 2021.<br>▪ Fishing can take place over pipelines. | |

| Sector | Scenario | Assumptions and Rationale | Limitations |
|---|---|---|---|
| | Future 1 | ▪ Although some decommissioning may take place to 2030, we assume surface and subsea safety zones remain as in the Present scenario.<br>▪ Fishing can take place over pipelines. | ▪ Decommissioning plans uncertain, and some infrastructure may be decommissioned to 2030. |
| | Future 2 | ▪ Decommissioning is currently projected to be substantially complete by 2050. Numbers of wells to be decommissioned (OGUK, 2020), compared with the number of 'completed (operating)', 'completed (shut in)' and 'drilling' wells in the OGUK spatial dataset, indicates that 59% of wells will be decommissioned.<br>▪ Spatial allocation: reduce existing safety zones by 59% to reflect the decommissioning of 59% of wells.<br>▪ Fishing can take place over pipelines. | ▪ Decommissioning plans are difficult to map as spatial information not available. In practice, some platforms may be entirely removed and fishing can resume in the area, some may leave footings in place leaving a safety hazard, others may not be decommissioned.<br>▪ A detailed analysis of decommissioning plans and linking to spatial data is not possible within the scope of the project. Therefore existing safety zones are reduced pro-rata to reflect extent of anticipated decommissioning. |
| | Future 3 | ▪ Assume all safety zones remain in place.<br>▪ Fishing can take place over pipelines. | |

## G.2 Areas by Scenario

The areas of oil and gas, for each scenario, and in relation to the UK EEZ, are shown in Table G3.

**Table G3. Areas of oil and gas by scenario, and as a percentage of UK EEZ**

| Scenario | Area ($km^2$) | As % of UK EEZ |
|---|---|---|
| Past | 538 | 0.07% |
| Present | 538 | 0.07% |
| Future 1 | 538 | 0.07% |
| Future 2 | 225 | 0.03% |
| Future 3 | 538 | 0.07% |

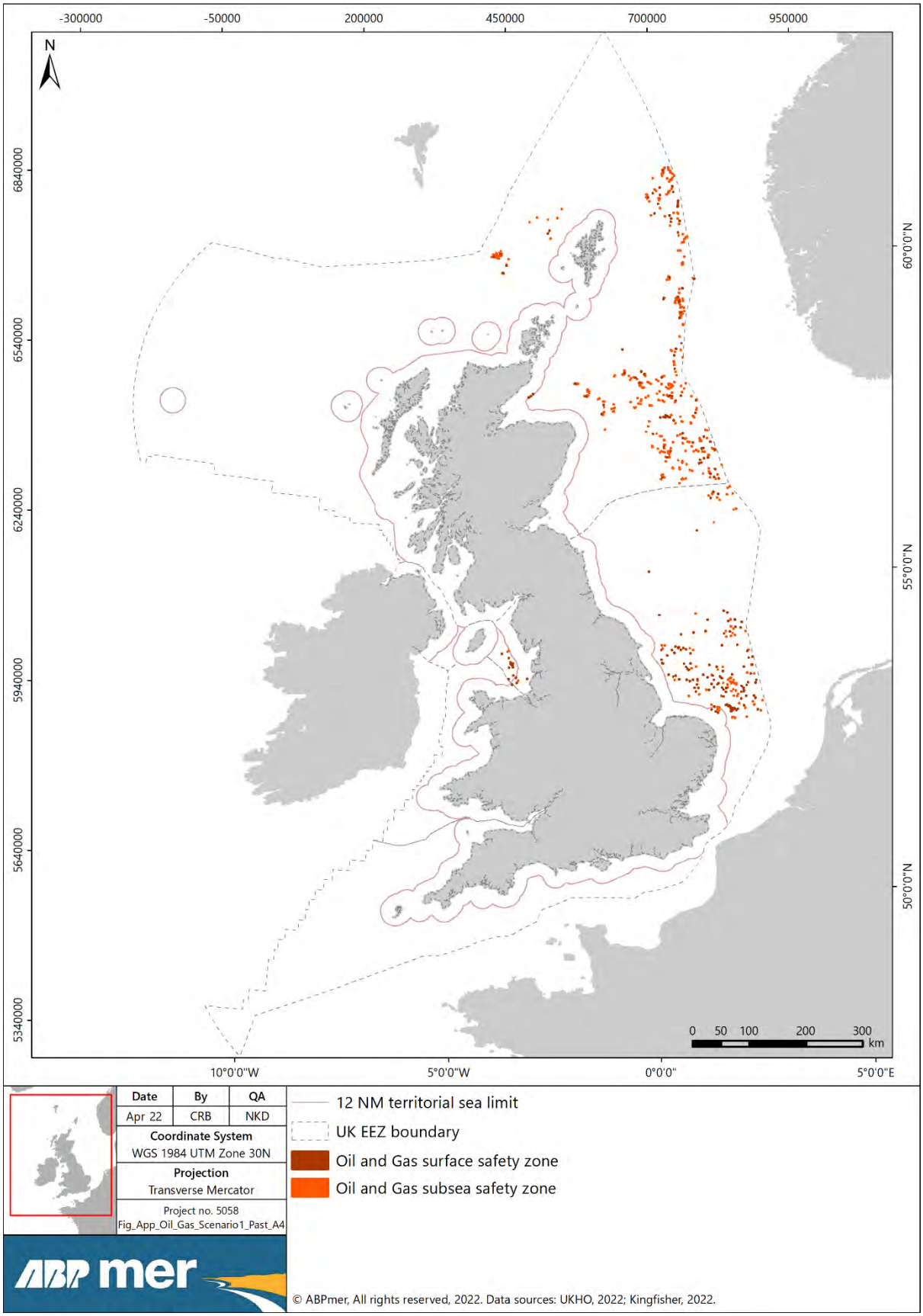



**Figure G1. Oil and Gas – Past scenario**

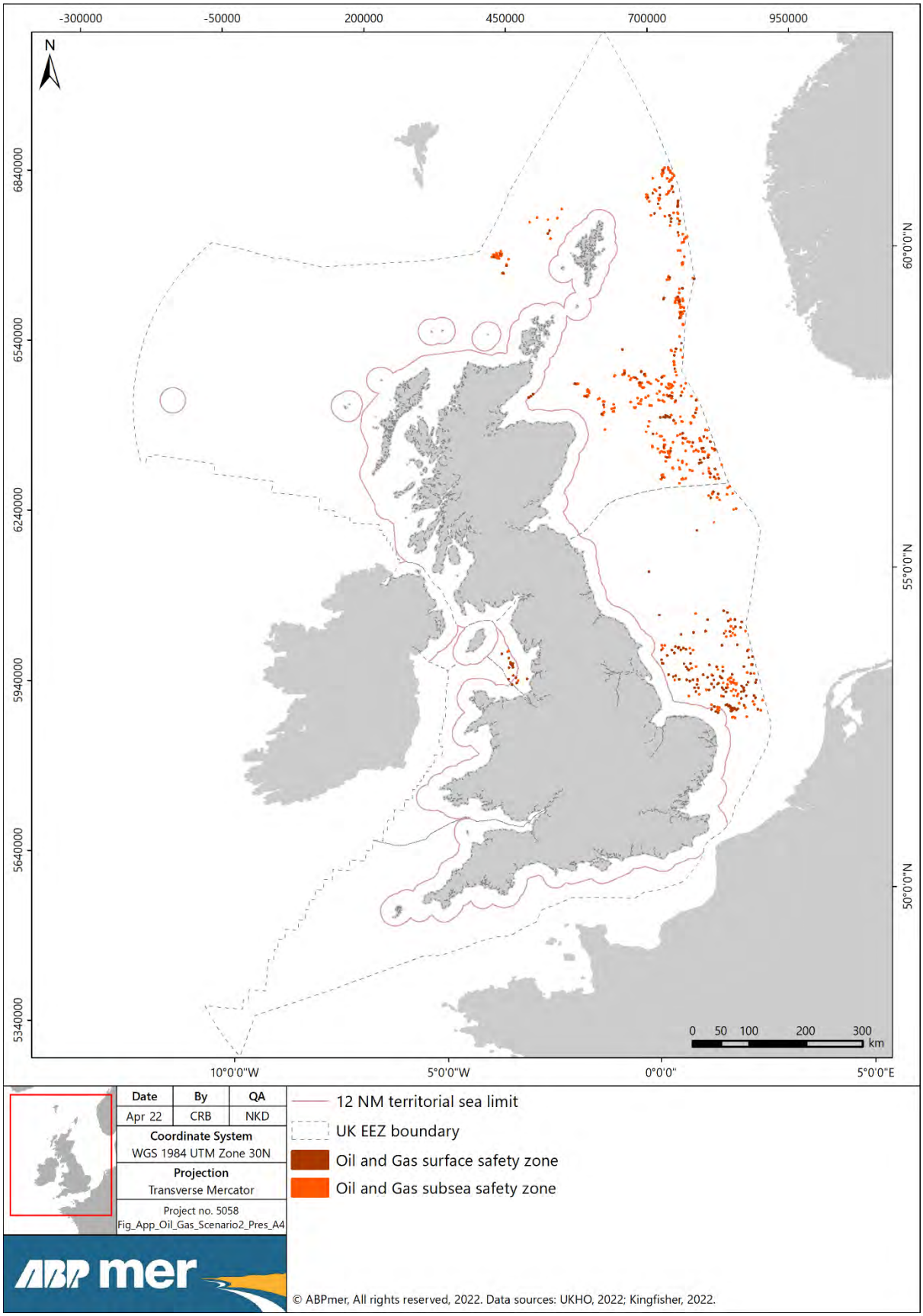



**Figure G2. Oil and Gas – Present scenario**

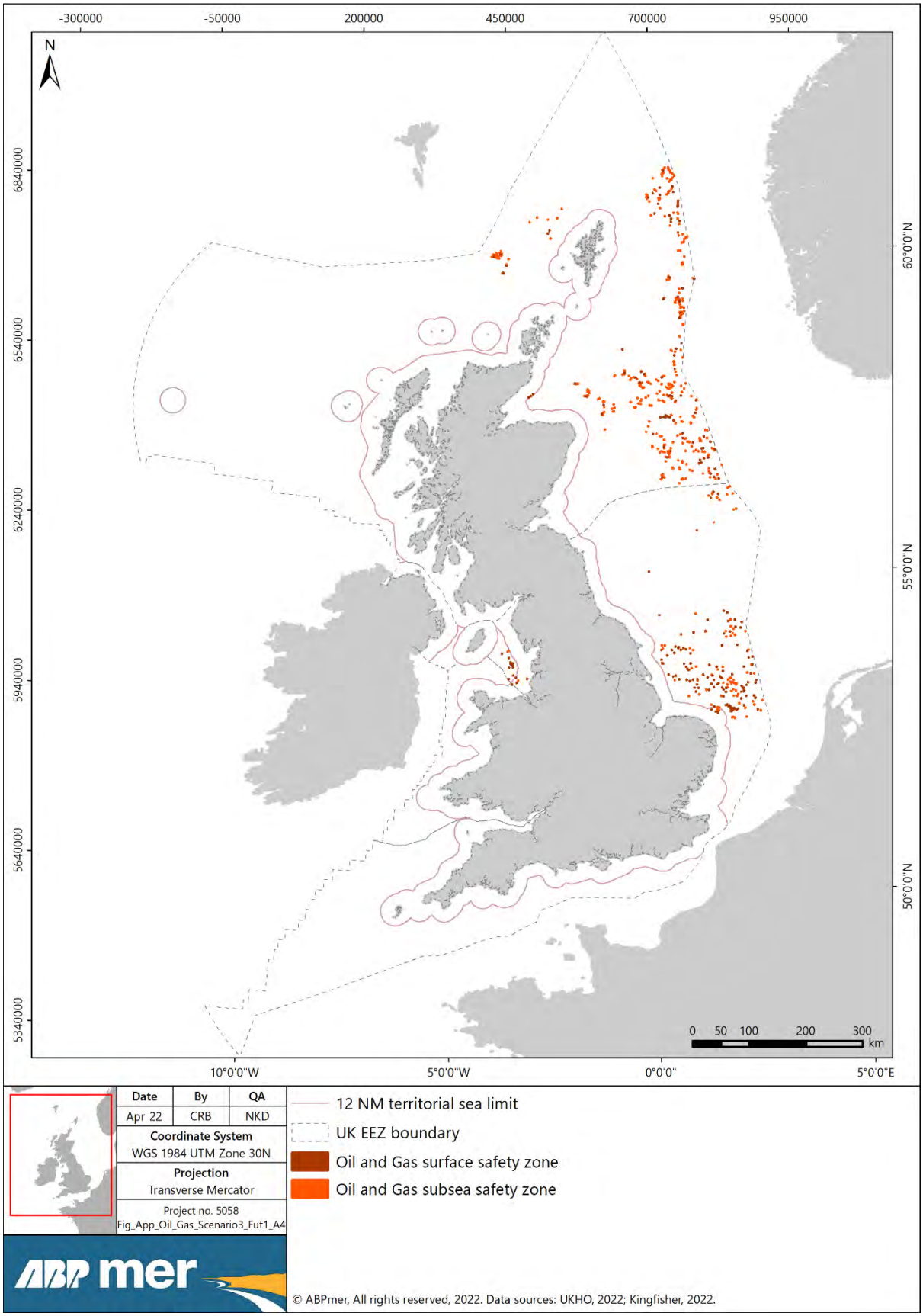



**Figure G3. Oil and Gas – Future 1 scenario**

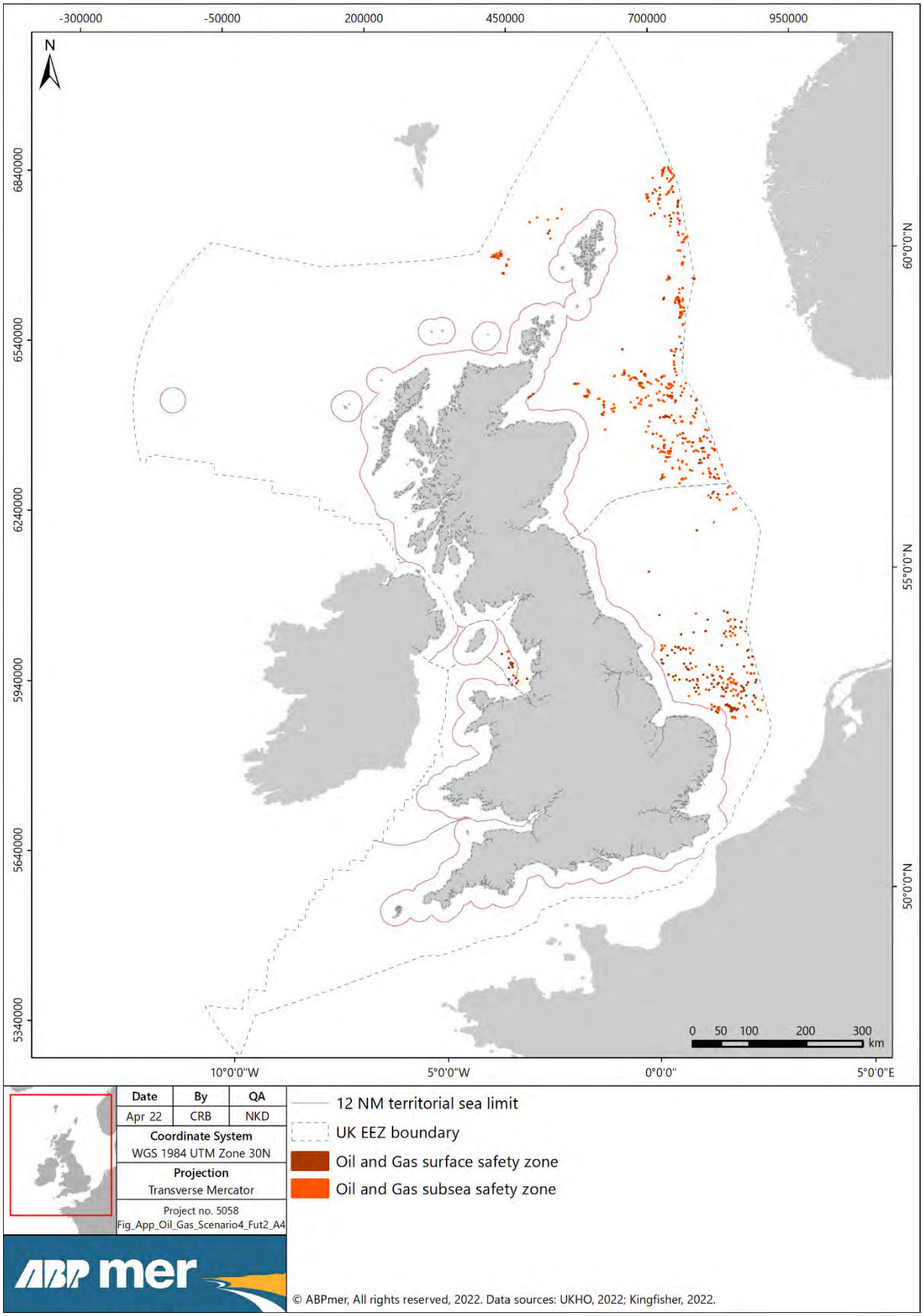



**Figure G4.** **Oil and Gas – Future 2 scenario (reduced safety zone to reflect reduction in area through decommissioning)**

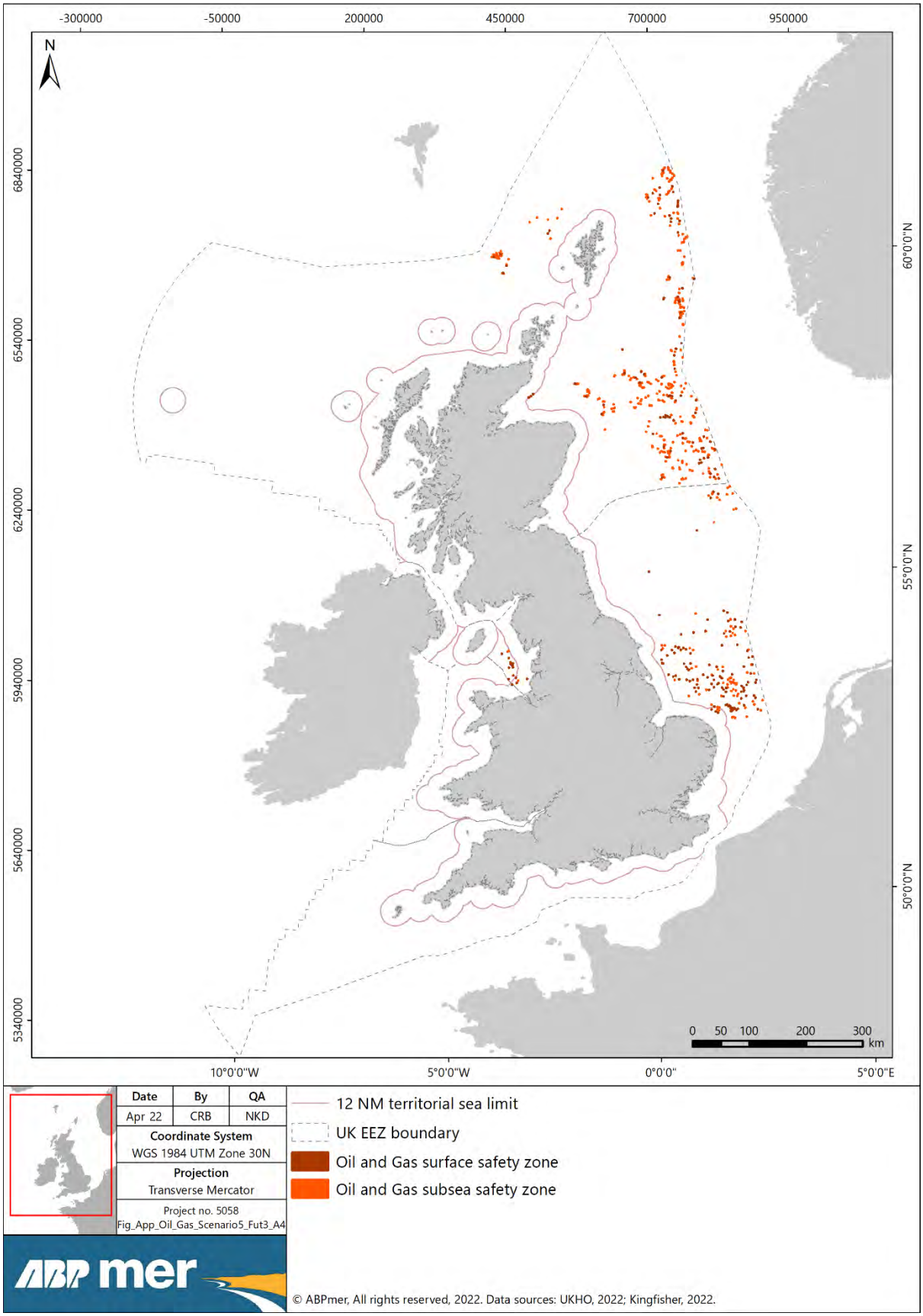



**Figure G5. Oil and Gas – Future 3 scenario**

# H Sector Statistics by Devolved Administration

This Appendix presents the area of each sector under each scenario by Devolved Administration. The UK EEZ area, split by Devolved Administration, is shown in Figure H1, with area calculations in Table H1. Area calculations for each scenario are presented in the sections that follow.

**Table H1. UK EEZ area, by Devolved Administration**

| Devolved Administration | UK EEZ ($km^2$) |
|---|---|
| England | 230,391 |
| Isle of Man | 3,949 |
| Northern Ireland | 6,792 |
| Scotland | 462,880 |
| Wales | 30,759 |
| **Total** | **734,770** |

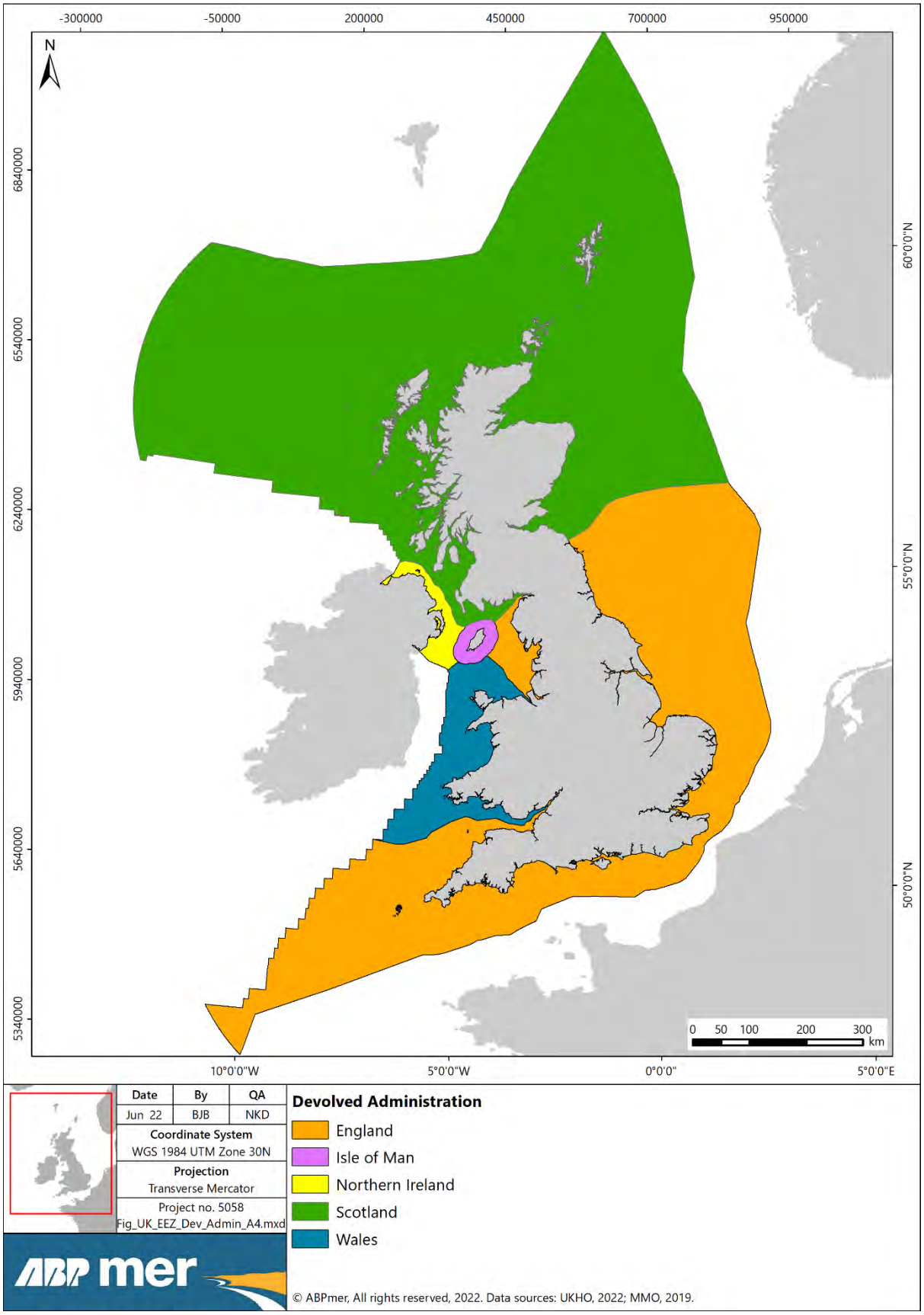



**Figure H1. UK EEZ split by Devolved Administration**

## H.1 Past Scenario

The areas of each sector under the Past scenario, by Devolved Administration, are shown in Table H2.

**Table H2. Areas for each sector, by Devolved Administration, for the Past scenario**

| Sector | England | Isle of Man | Northern Ireland | Scotland | Wales | Total |
|---|---|---|---|---|---|---|
| Aggregates | 144.7 | 0.0 | 0.0 | 0.0 | 11.6 | **156.4** |
| Aquaculture - Finfish | 0.0 | 0.0 | 0.0 | 38.7 | 0.0 | **38.7** |
| Aquaculture - Seaweed | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **0.0** |
| Aquaculture - Shellfish | 7.0 | 0.0 | 18.1 | 7.9 | 184.5 | **217.5** |
| Cables | 29.6 | 0.0 | 0.0 | 103.8 | 0.6 | **133.9** |
| Fisheries restrictions | 446.7 | 0.0 | 0.0 | 862.8 | 22.5 | **1,332.0** |
| Nature conservation | 30.1 | 0.0 | 214.7 | 92.6 | 0.0 | **337.5** |
| Oil and Gas | 187.6 | 0.0 | 0.0 | 349.8 | 1.0 | **538.4** |
| Renewables - tide | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **0.0** |
| Renewables – wave | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **0.0** |
| Renewables - wind | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | **0.4** |
| Note: Some sectors may overlap spatially, therefore the sum of the areas here may be greater than the overall area for the Past scenario in section 3, which takes account of these overlaps. | | | | | | |

## H.2 Present Scenario

The areas of each sector under the Present scenario, by Devolved Administration, are shown in Table H3.

**Table H3. Areas for each sector, by Devolved Administration, for the Present scenario**

| Sector | England | Isle of Man | Northern Ireland | Scotland | Wales | Total |
|---|---|---|---|---|---|---|
| Aggregates | 94.0 | 0.0 | 0.0 | 0.0 | 7.2 | **101.2** |
| Aquaculture - Finfish | 0.0 | 0.0 | 1.2 | 55.1 | 0.0 | **56.3** |
| Aquaculture - Seaweed | 0.0 | 0.0 | 0.0 | 0.8 | 0.0 | **0.8** |
| Aquaculture - Shellfish | 20.4 | 0.0 | 18.1 | 18.0 | 103.7 | **160.1** |
| Aquaculture - Shellfish and Seaweed | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | **0.3** |
| Cables | 78.2 | 0.5 | 1.1 | 572.8 | 3.1 | **655.7** |
| Fisheries restrictions | 599.8 | 0.0 | 0.0 | 1,206.6 | 22.5 | **1,828.8** |
| Nature conservation | 8,730.0 | 409.5 | 311.1 | 155,391.4 | 105.3 | **164,947.2** |
| Oil and Gas | 187.6 | 0.0 | 0.0 | 349.8 | 1.0 | **538.4** |
| Renewables - tide | 0.0 | 0.0 | 0.1 | 10.6 | 0.6 | **11.3** |
| Renewables - wave | 2.8 | 0.0 | 0.0 | 9.4 | 0.0 | **12.3** |
| Renewables - wind | 1,897.9 | 0.0 | 0.0 | 502.9 | 87.3 | **2,488.2** |
| Note: Some sectors may overlap spatially, therefore the sum of the areas here may be greater than the overall area for the Present scenario in section 4, which takes account of these overlaps. | | | | | | |

## H.3 Future 1 Scenario

The areas of each sector under the Future 1 scenario, by Devolved Administration, are shown in Table H4.

**Table H4. Areas for each sector, by Devolved Administration, for the Future 1 scenario**

| Sector | England | Isle of Man | Northern Ireland | Scotland | Wales | Total |
|---|---|---|---|---|---|---|
| Aggregates | 137.0 | 0.0 | 0.0 | 0.0 | 21.4 | **158.4** |
| Aquaculture - Finfish | 0.0 | 0.0 | 1.2 | 67.5 | 0.0 | **68.7** |
| Aquaculture - Seaweed | 45.4 | 0.0 | 0.0 | 315.0 | 0.0 | **360.4** |
| Aquaculture - Shellfish | 21.3 | 0.0 | 32.4 | 35.0 | 295.2 | **383.9** |
| Aquaculture - Shellfish and Seaweed | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | **0.3** |
| Cables | 80.1 | 0.5 | 1.1 | 591.8 | 3.1 | **676.5** |
| Fisheries restrictions | 599.8 | 0.0 | 0.0 | 1,206.6 | 22.5 | **1,828.8** |
| Nature conservation | 46,955.9 | 409.8 | 577.4 | 206,678.6 | 375.8 | **254,997.6** |
| Oil and Gas | 187.6 | 0.0 | 0.0 | 349.8 | 1.0 | **538.4** |
| Renewables - tide | 5.0 | 0.0 | 3.4 | 46.4 | 48.1 | **103.0** |
| Renewables - wave | 2.8 | 0.0 | 0.0 | 9.4 | 90.4 | **102.7** |
| Renewables - wind | 7,828.6 | 0.0 | 0.0 | 2,359.6 | 475.9 | **10,664.1** |

Note: Some sectors may overlap spatially, therefore the sum of the areas here may be greater than the overall area for the Future 1 scenario in section 5, which takes account of these overlaps.

## H.4 Future 2 Scenario

The areas of each sector under the Future 2 scenario, by Devolved Administration, are shown in Table H5.

**Table H5. Areas for each sector, by Devolved Administration, for the Future 2 scenario**

| Sector | England | Isle of Man | Northern Ireland | Scotland | Wales | Total |
|---|---|---|---|---|---|---|
| Aggregates | 159.4 | 0.0 | 0.0 | 0.0 | 1.5 | **160.9** |
| Aquaculture - Finfish | 0.0 | 0.0 | 1.2 | 105.0 | 0.0 | **106.2** |
| Aquaculture - Seaweed | 342.8 | 0.0 | 0.0 | 945.0 | 0.0 | **1,287.8** |
| Aquaculture - Shellfish | 65.1 | 0.0 | 32.4 | 73.5 | 590.5 | **761.4** |
| Aquaculture - Shellfish and Seaweed | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | **0.3** |
| Cables | 85.1 | 0.5 | 1.1 | 595.8 | 4.2 | **686.7** |
| Fisheries restrictions | 599.8 | 0.0 | 0.0 | 1,206.6 | 22.5 | **1,828.8** |
| Nature conservation | 46,956.1 | 409.8 | 577.4 | 207,884.5 | 375.8 | **256,203.7** |
| Oil and Gas | 78.5 | 0.0 | 0.0 | 145.8 | 0.4 | **224.8** |
| Renewables - tide | 5.0 | 0.0 | 112.6 | 261.3 | 48.1 | **427.1** |
| Renewables - wave | 2.8 | 0.0 | 15.3 | 131.7 | 90.4 | **240.2** |
| Renewables - wind | 13,911.1 | 255.1 | 68.0 | 9,004.0 | 3,576.7 | **26,814.9** |

Note: Some sectors may overlap spatially, therefore the sum of the areas here may be greater than the overall area for the Future 2 scenario in section 6, which takes account of these overlaps.

## H.5 Future 3 Scenario

The areas of each sector under the Future 3 scenario, by Devolved Administration, are shown in Table H6.

**Table H6. Areas for each sector, by Devolved Administration, for the Future 3 scenario**

| Sector | England | Isle of Man | Northern Ireland | Scotland | Wales | Total |
|---|---|---|---|---|---|---|
| Aggregates | 159.8 | 0.0 | 0.0 | 0.0 | 4.9 | **164.7** |
| Aquaculture - Finfish | 0.0 | 0.0 | 1.2 | 105.0 | 0.0 | **106.2** |
| Aquaculture - Seaweed | 342.8 | 0.0 | 0.0 | 945.0 | 0.0 | **1,287.8** |
| Aquaculture - Shellfish | 65.1 | 0.0 | 32.4 | 73.5 | 590.5 | **761.4** |
| Aquaculture - Shellfish and Seaweed | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | **0.3** |
| Cables | 14,758.1 | 329.8 | 453.5 | 7,985.2 | 1,926.1 | **25,452.6** |
| Fisheries restrictions | 599.8 | 0.0 | 0.0 | 1,206.6 | 22.5 | **1,828.8** |
| Nature conservation | 61,031.8 | 409.8 | 829.6 | 245,231.7 | 5,282.6 | **312,785.5** |
| Oil and Gas | 187.6 | 0.0 | 0.0 | 349.8 | 1.0 | **538.3** |
| Renewables - tide | 5.0 | 0.0 | 112.6 | 261.3 | 48.1 | **427.1** |
| Renewables - wave | 2.8 | 0.0 | 15.3 | 131.7 | 90.4 | **240.2** |
| Renewables - wind | 16,591.7 | 340.2 | 90.7 | 10,245.1 | 4,215.7 | **31,483.3** |

Note: Some sectors may overlap spatially, therefore the sum of the areas here may be greater than the overall area for the Future 3 scenario in section 7, which takes account of these overlaps.

# I Local Case Study Maps

This Appendix provides detailed maps for the Present, Future 1, Future 2 and Future 3 scenarios for the following local areas:

- I.1 Islay
- I.2 Moray Firth
- I.3 Orkney
- I.4 Outer Thames Estuary
- I.5 The Wash and off the Humber Estuary

Future areas mapped for some sectors are indicative and may not represent plans or proposals for developments.

## I.1 Islay

Maps for Islay are shown for Present, Future 1, Future 2 and Future 3 scenarios in Figure I1 to Figure I4.

Future areas mapped for some sectors are indicative and may not represent plans or proposals for developments.

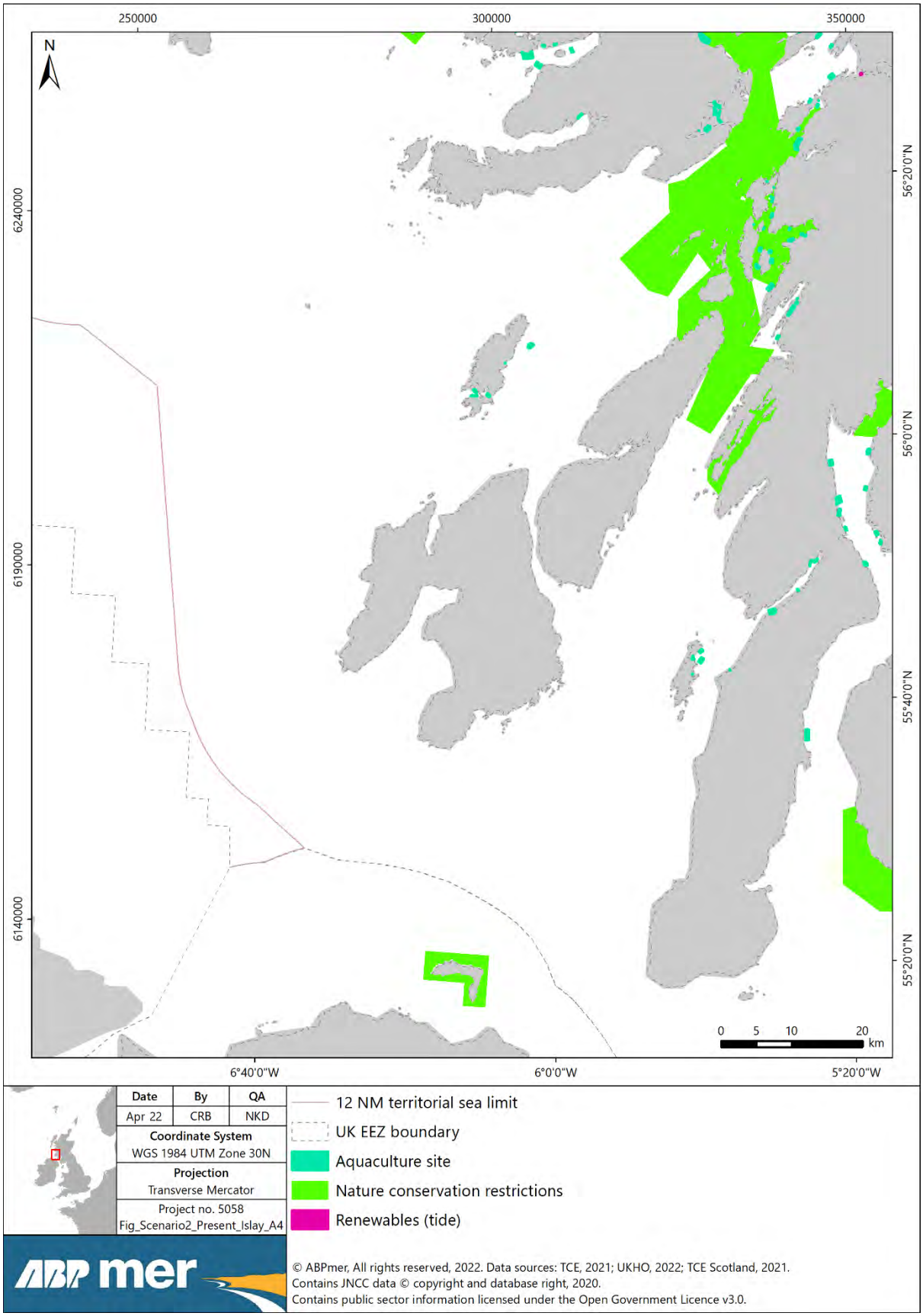



**Figure I1. Local case study: Islay – Present scenario**

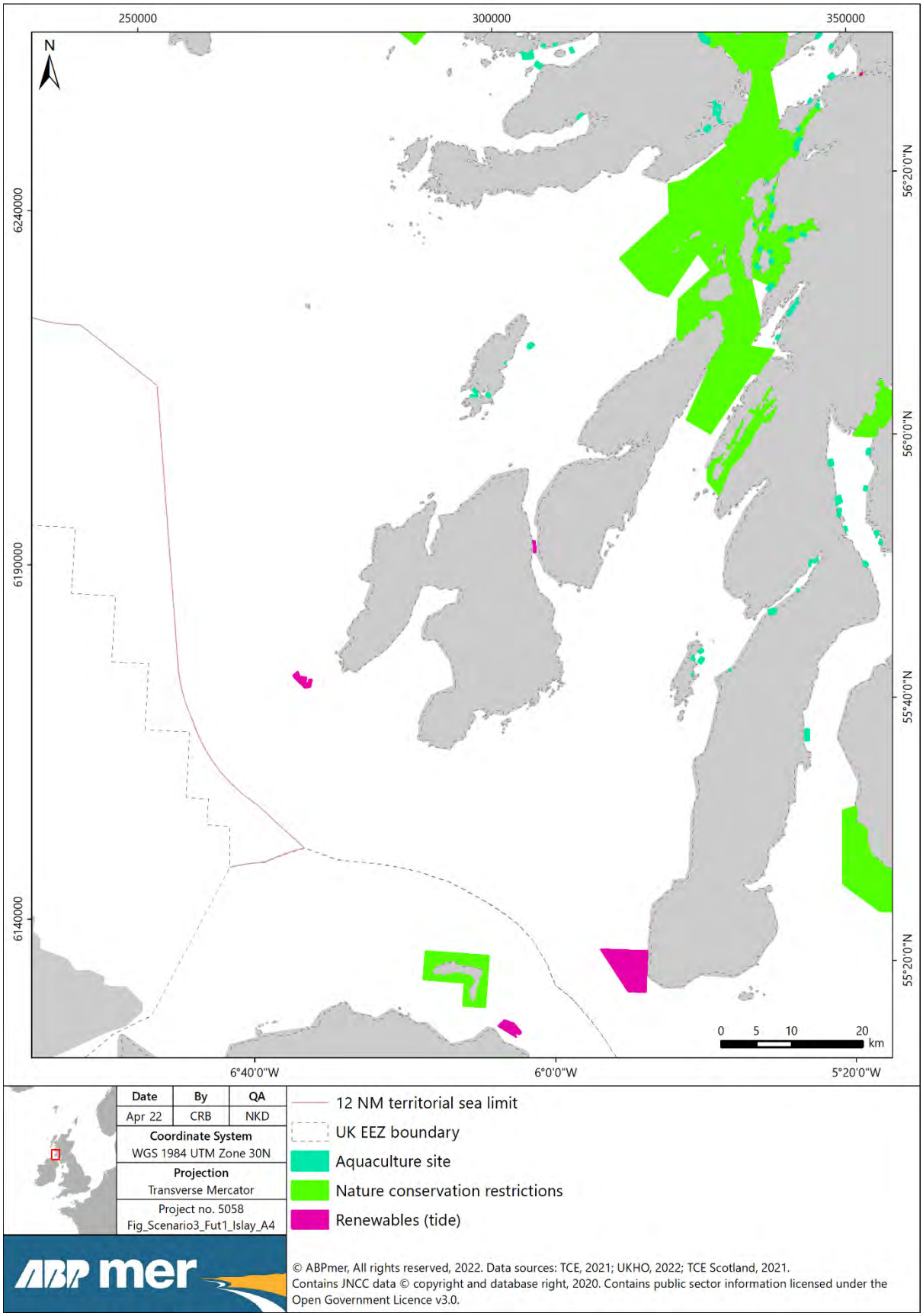



**Figure I2. Local case study: Islay – Future 1 scenario**

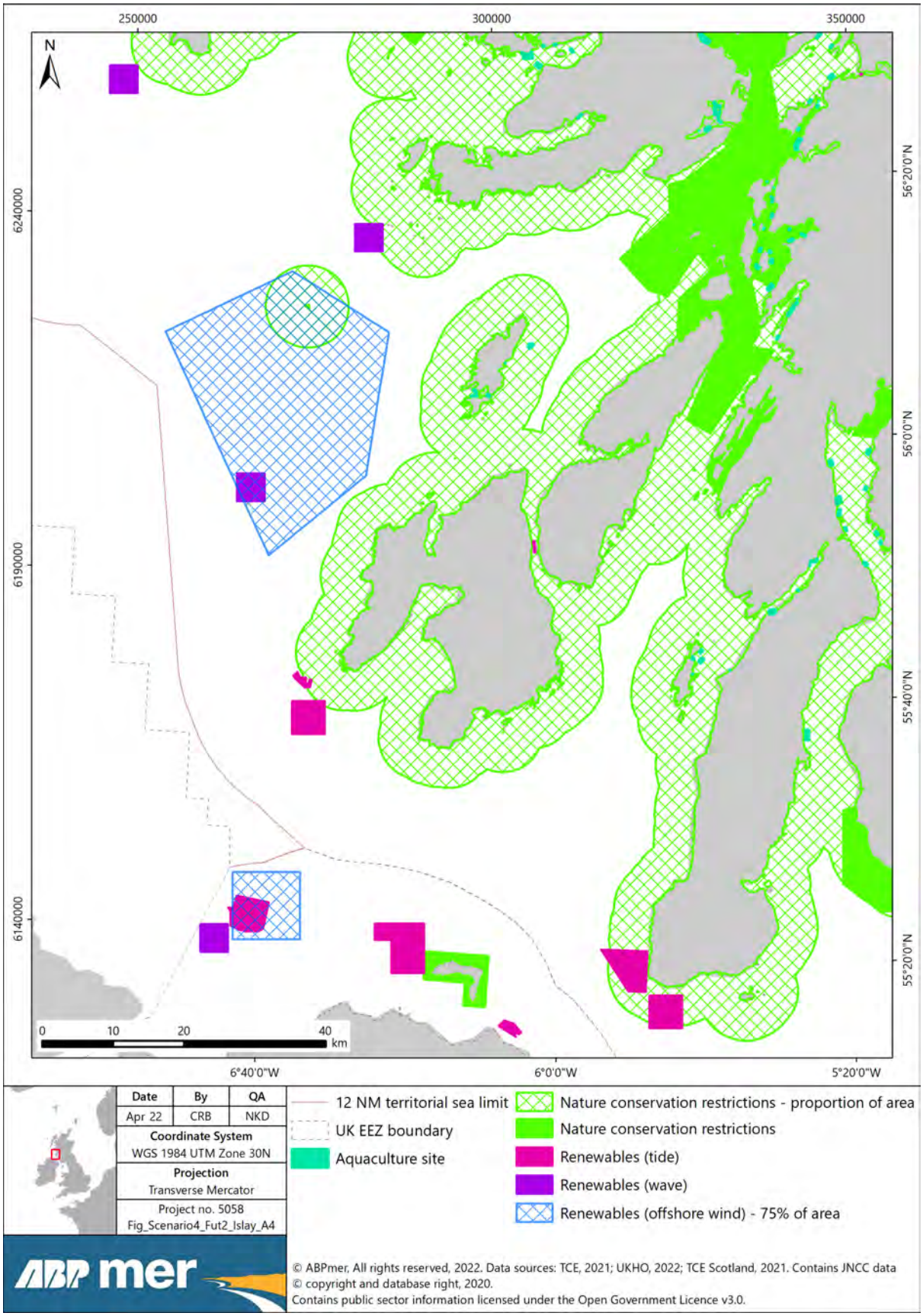



**Figure I3. Local case study: Islay – Future 2 scenario**

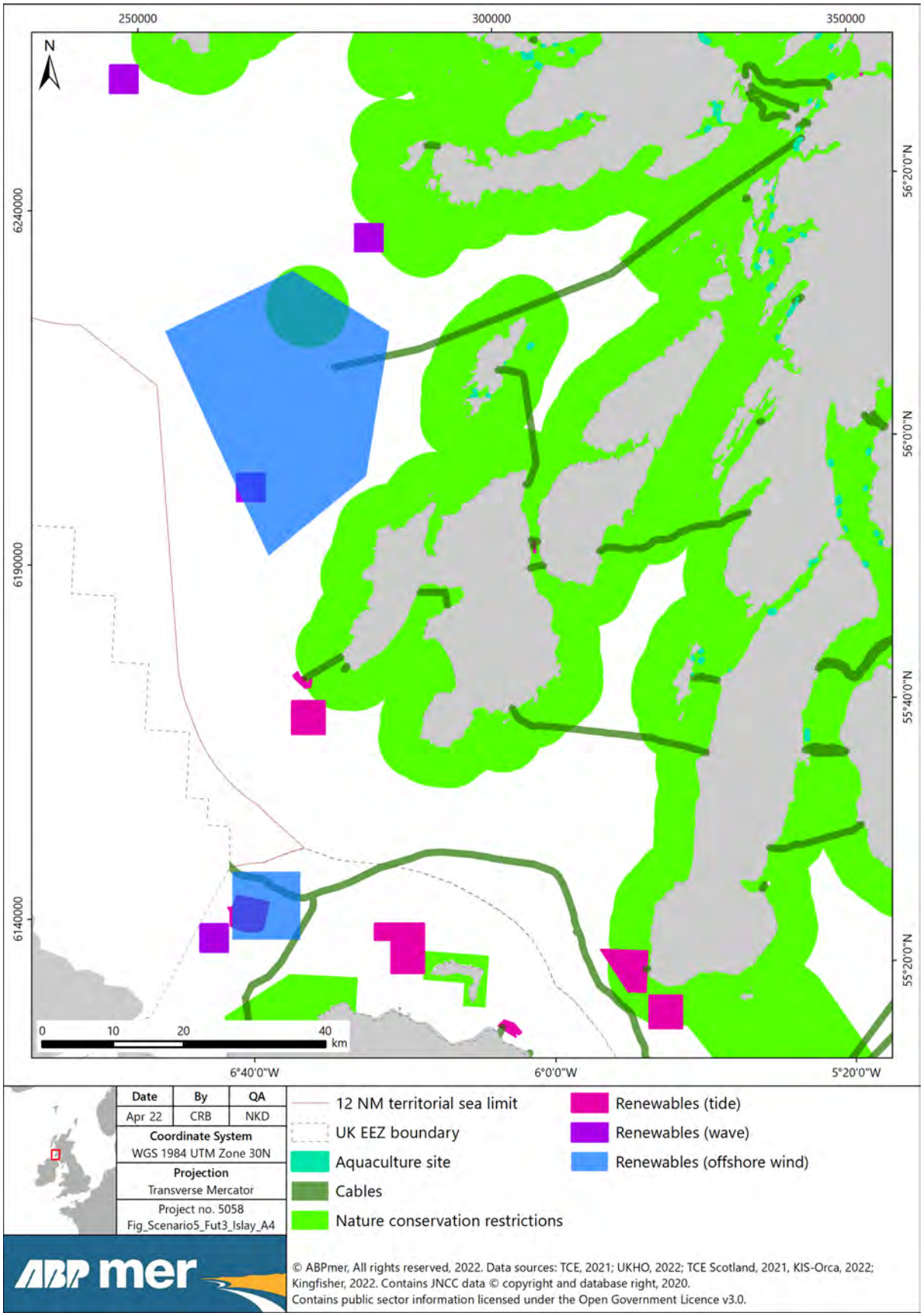



**Figure I4. Local case study: Islay – Future 3 scenario**

## I.2 Moray Firth

Maps for the Moray Firth are shown for Present, Future 1, Future 2 and Future 3 scenarios in Figure I5 to Figure I8.

Future areas mapped for some sectors are indicative and may not represent plans or proposals for developments.

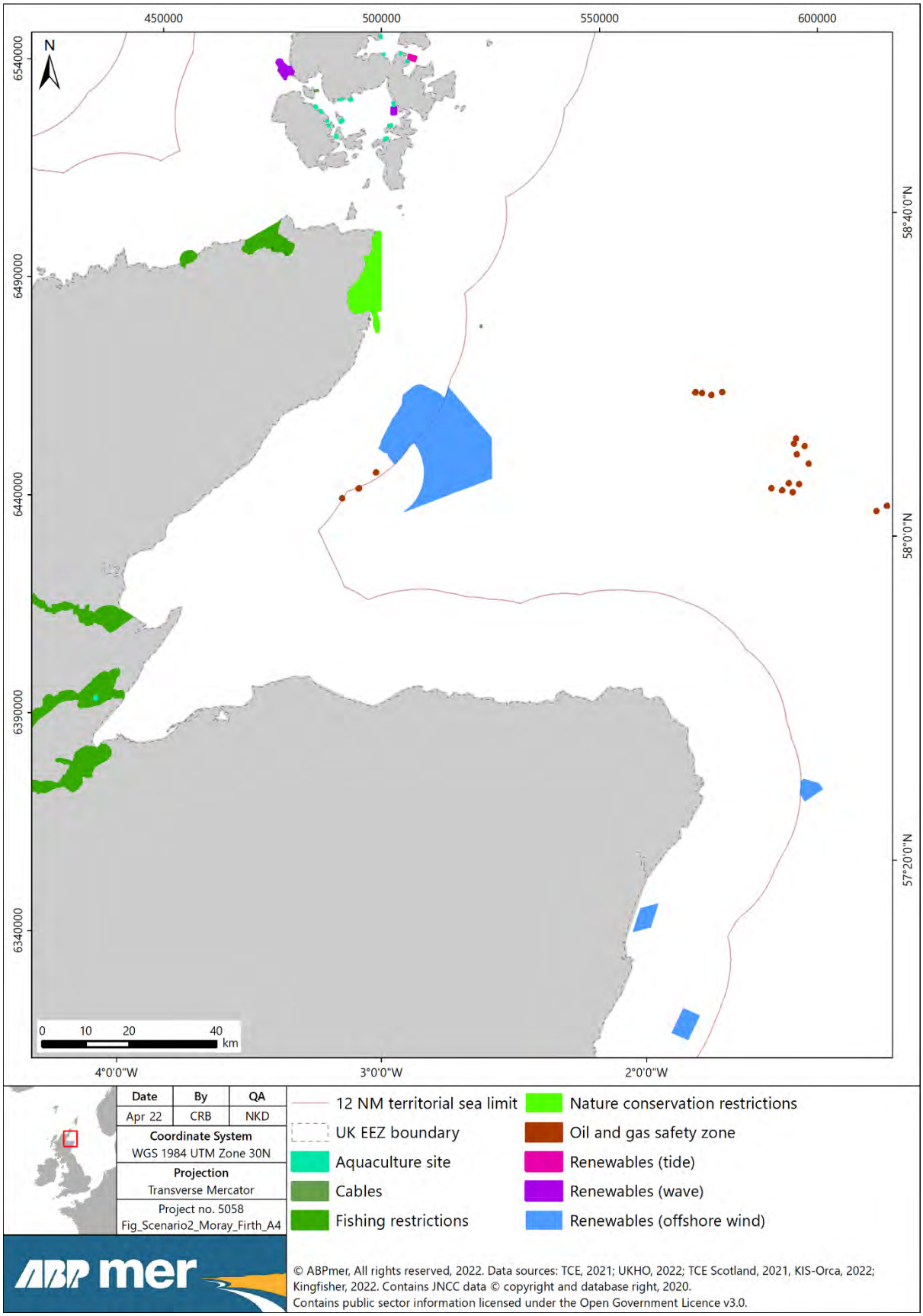



**Figure I5. Local case study: Moray Firth – Present scenario**

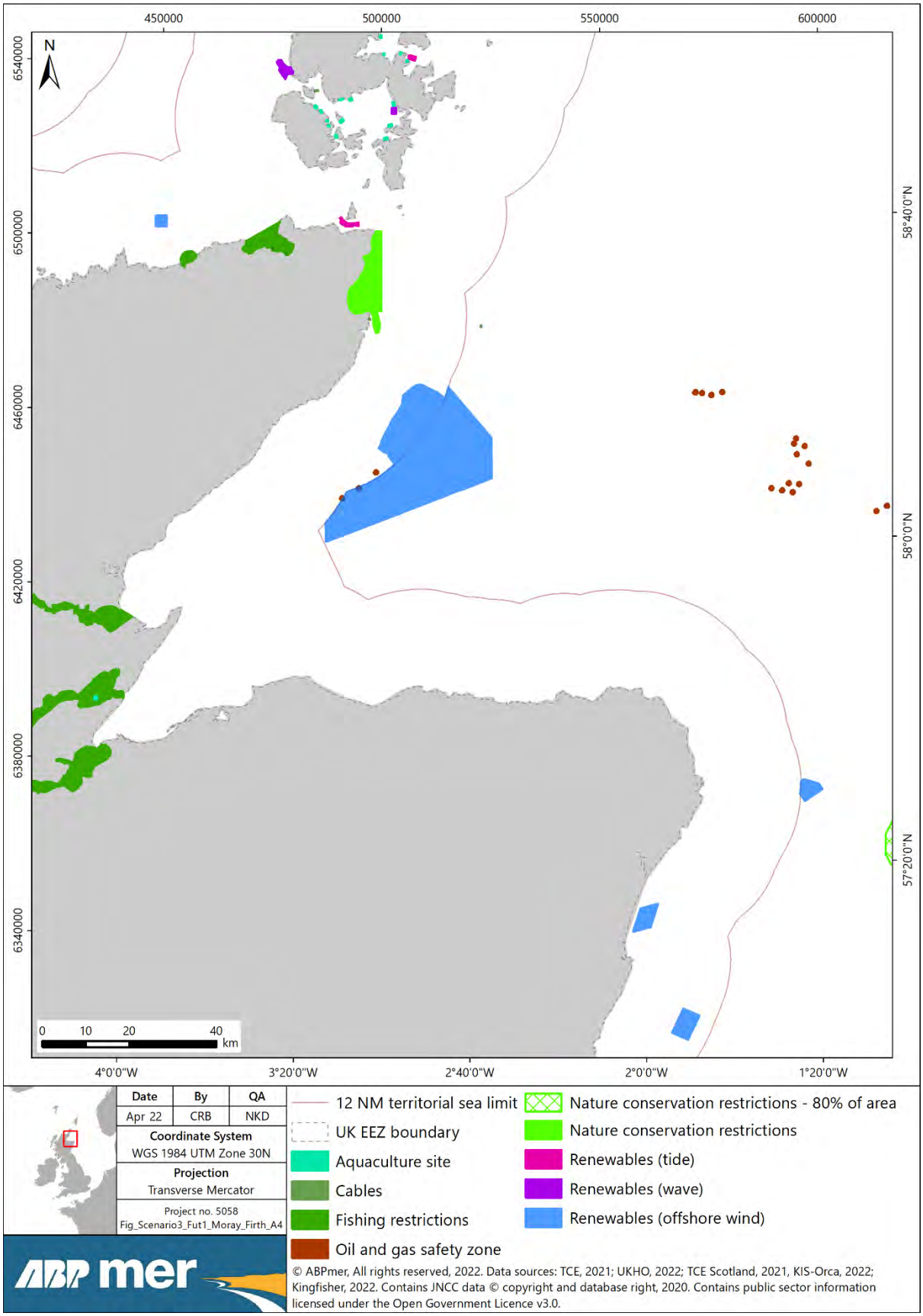



**Figure I6. Local case study: Moray Firth – Future 1 scenario**

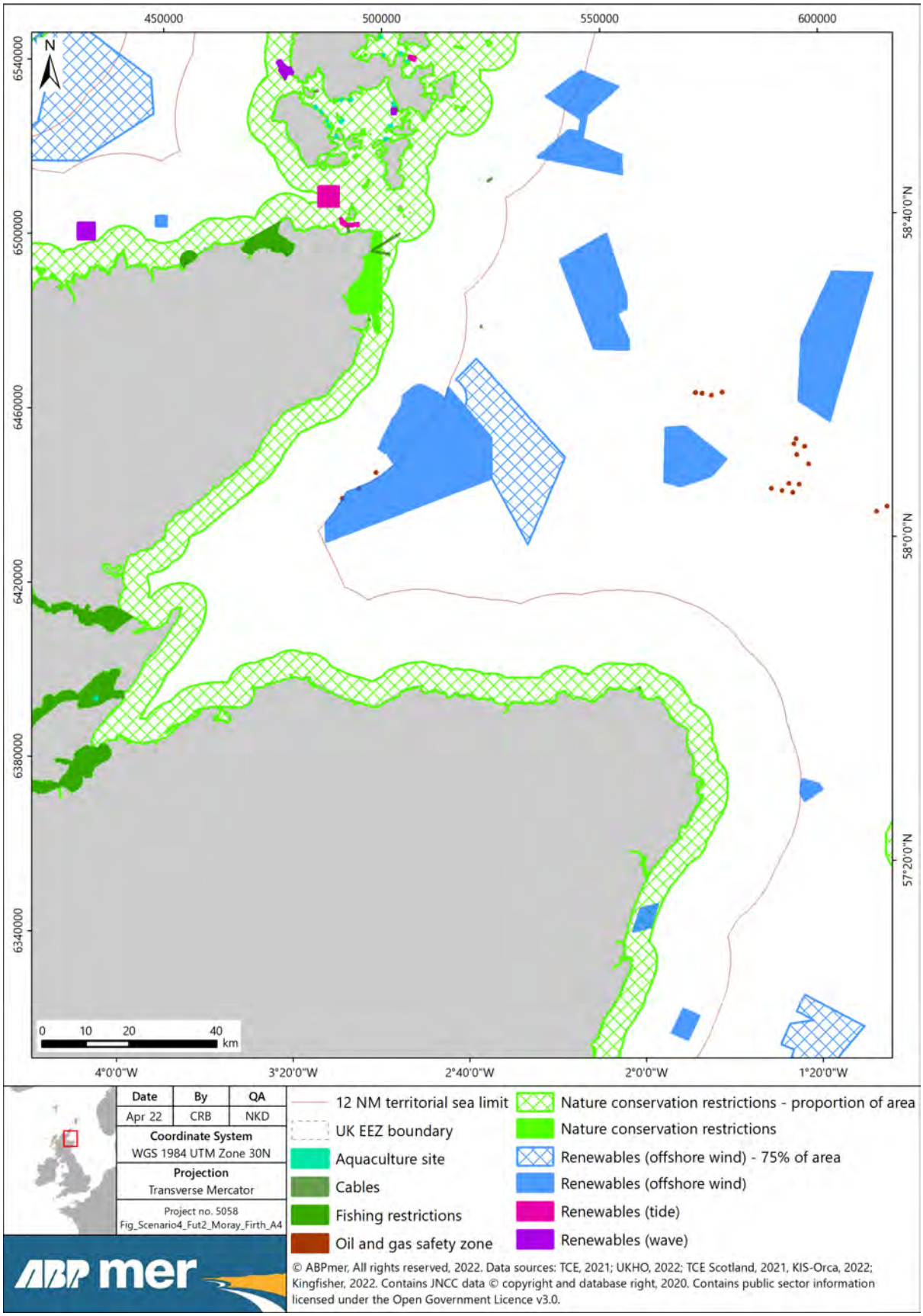



**Figure I7. Local case study: Moray Firth – Future 2 scenario**

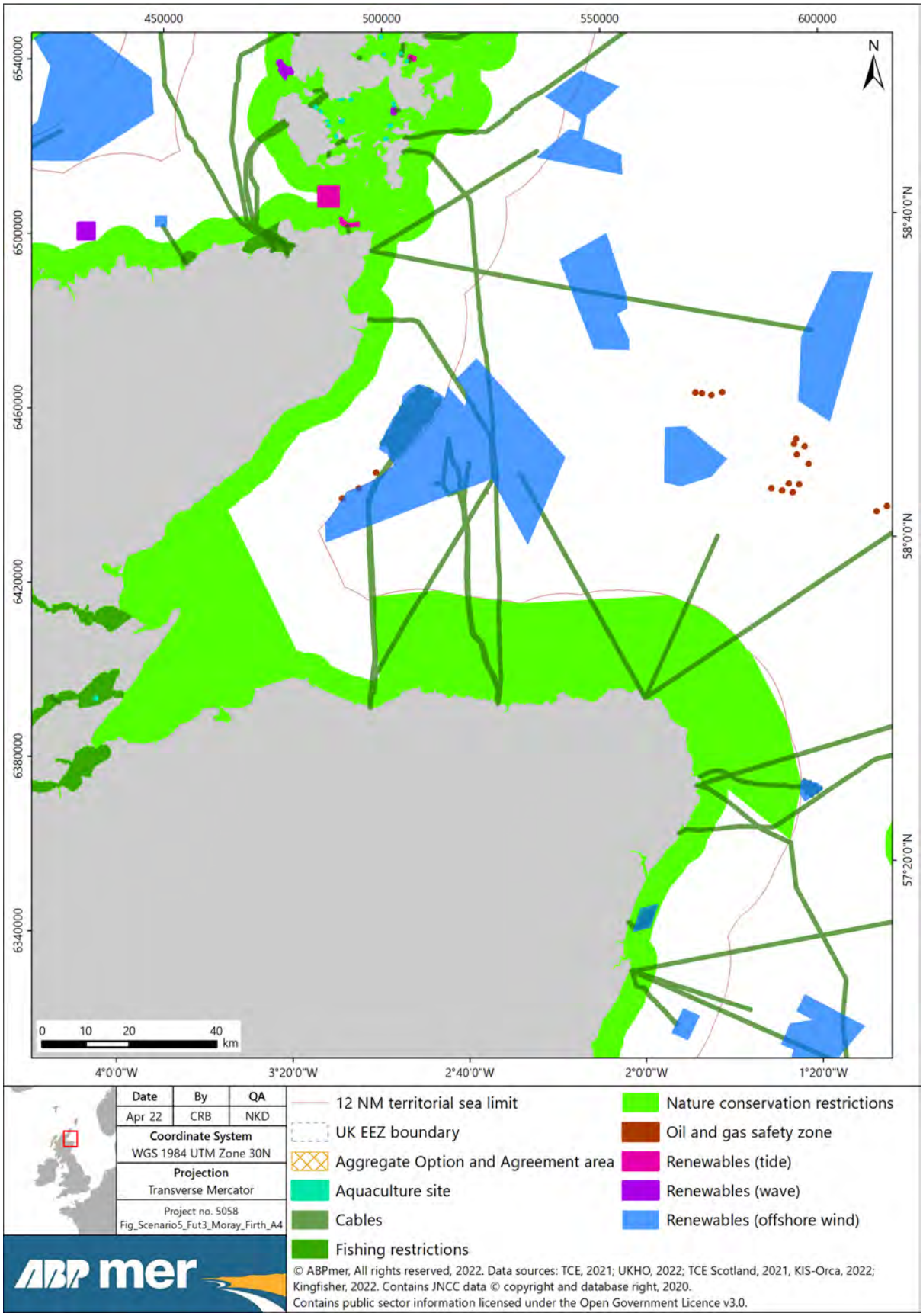



**Figure I8. Local case study: Moray Firth – Future 3 scenario**

## I.3 Orkney

Maps for Orkney are shown for Present, Future 1, Future 2 and Future 3 scenarios in Figure I9 to Figure I12.

Future areas mapped for some sectors are indicative and may not represent plans or proposals for developments.

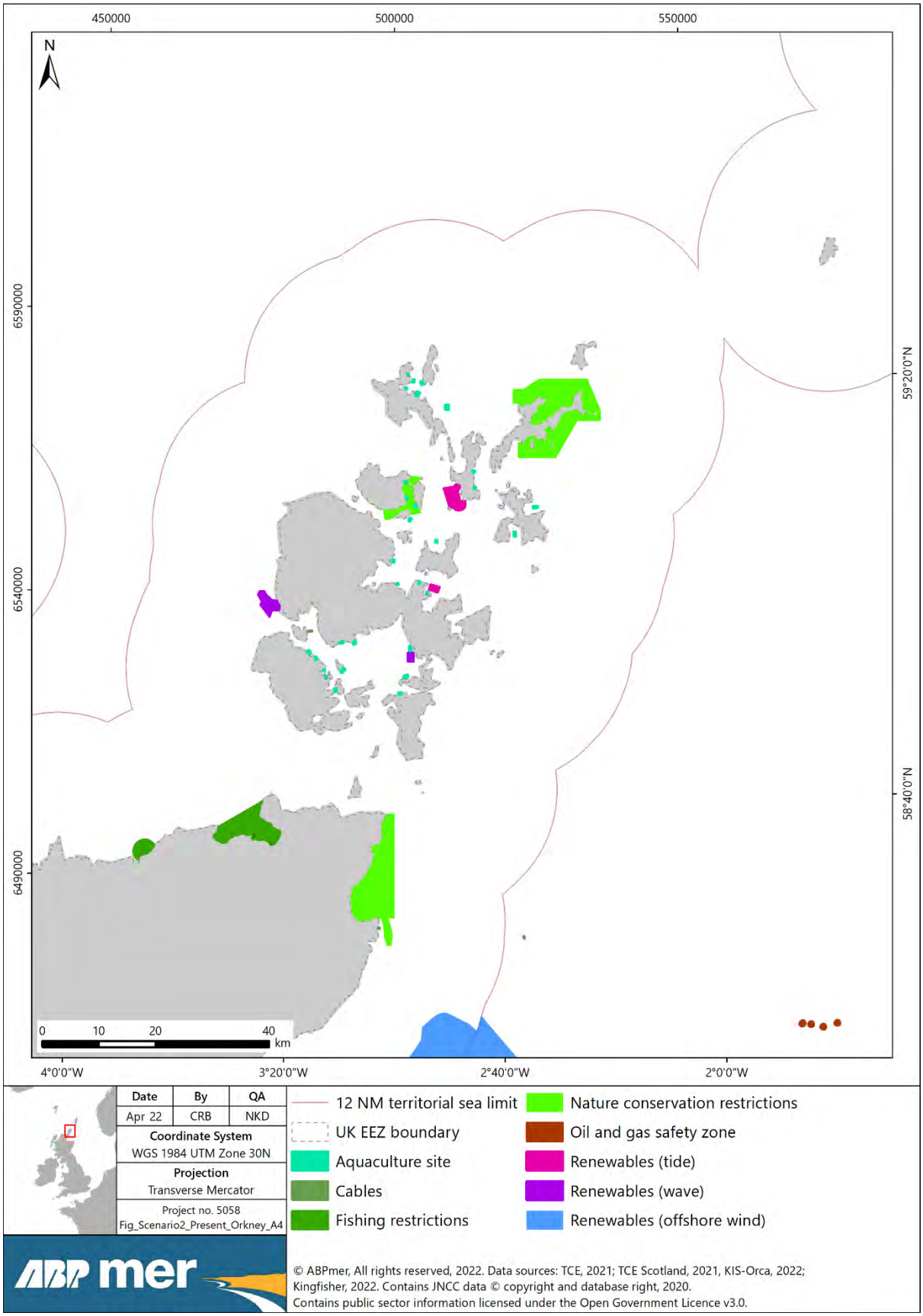



**Figure I9. Local case study: Orkney – Present scenario**

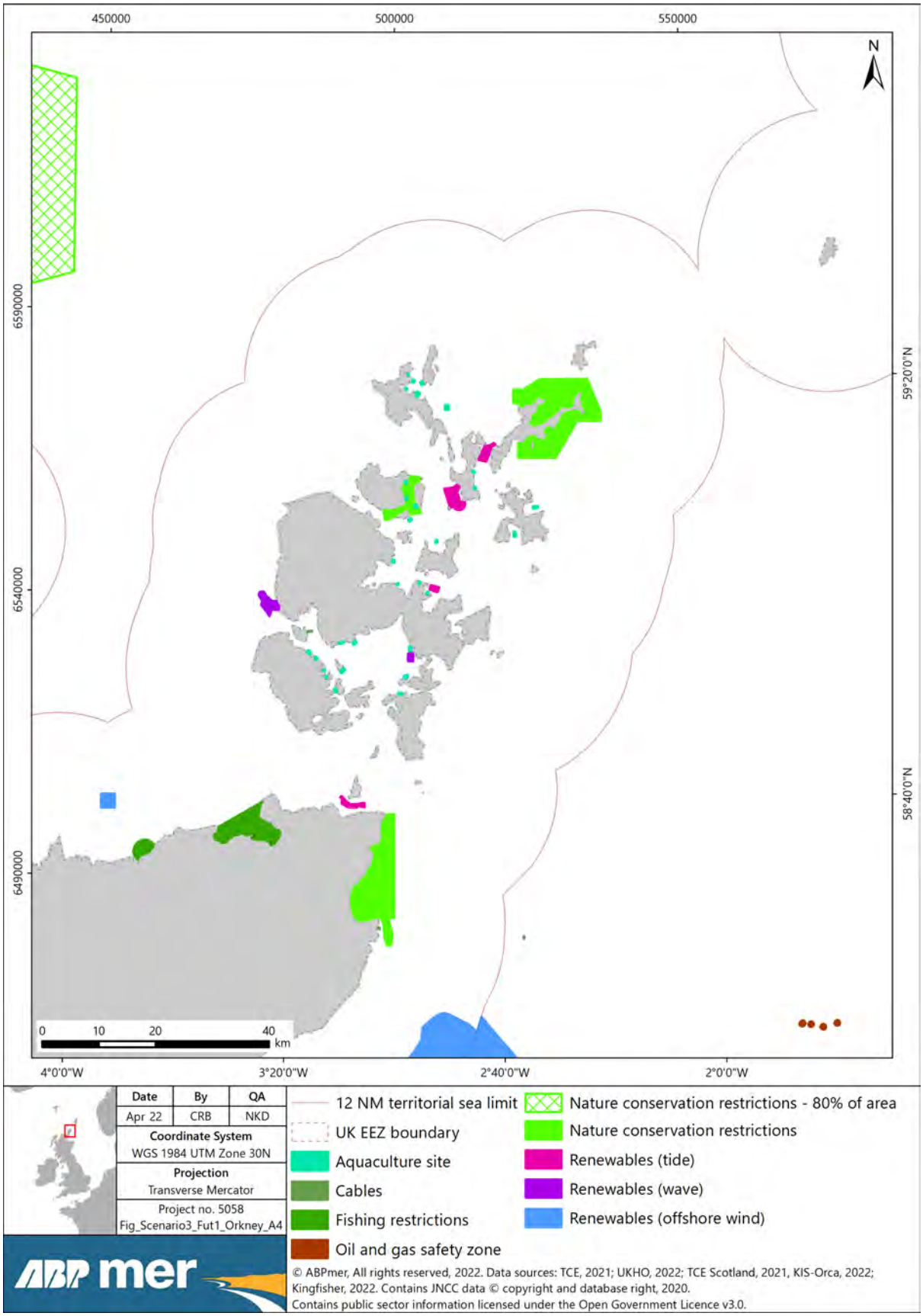



**Figure I10. Local case study: Orkney – Future 1 scenario**

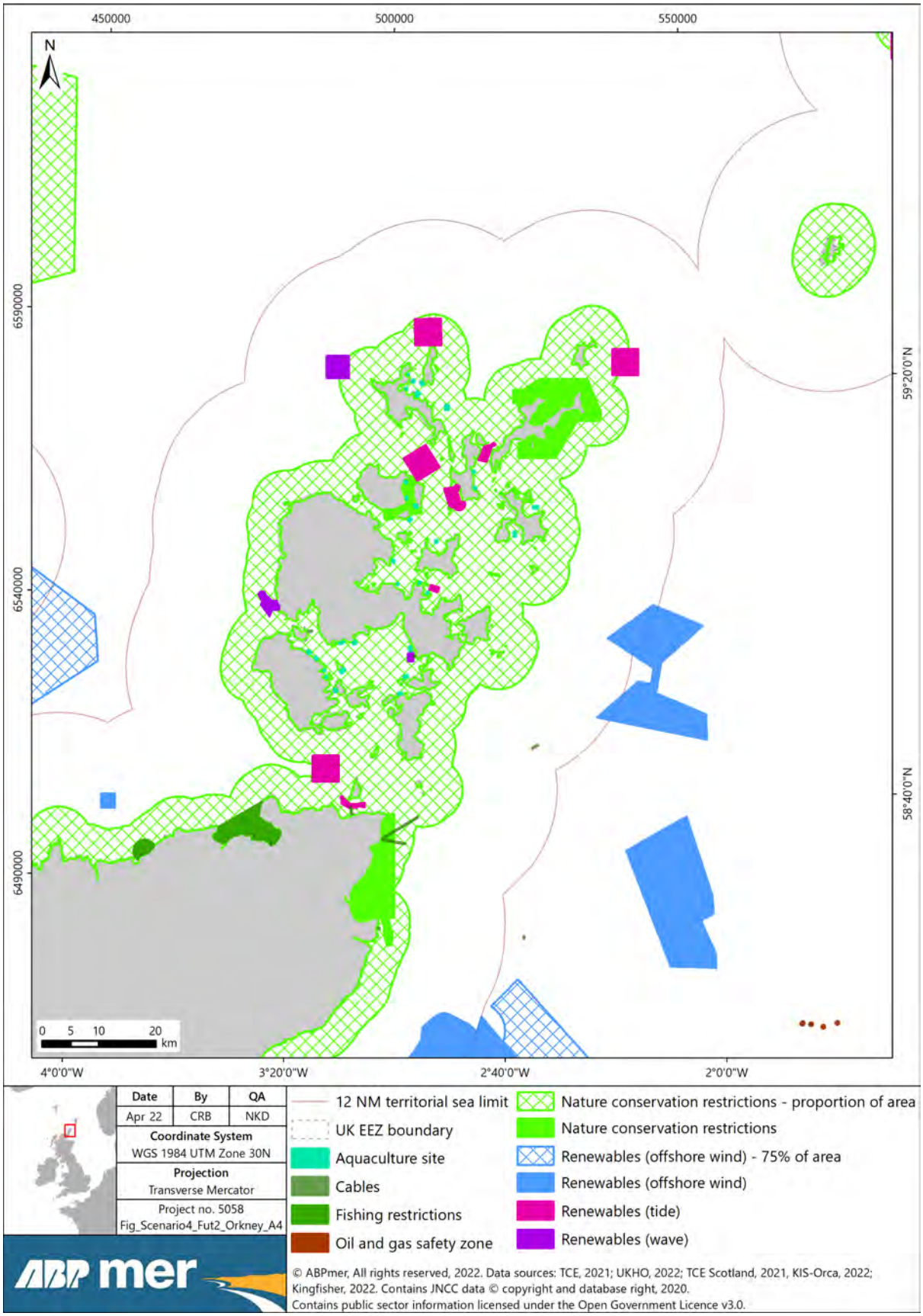



**Figure I11. Local case study: Orkney – Future 2 scenario**

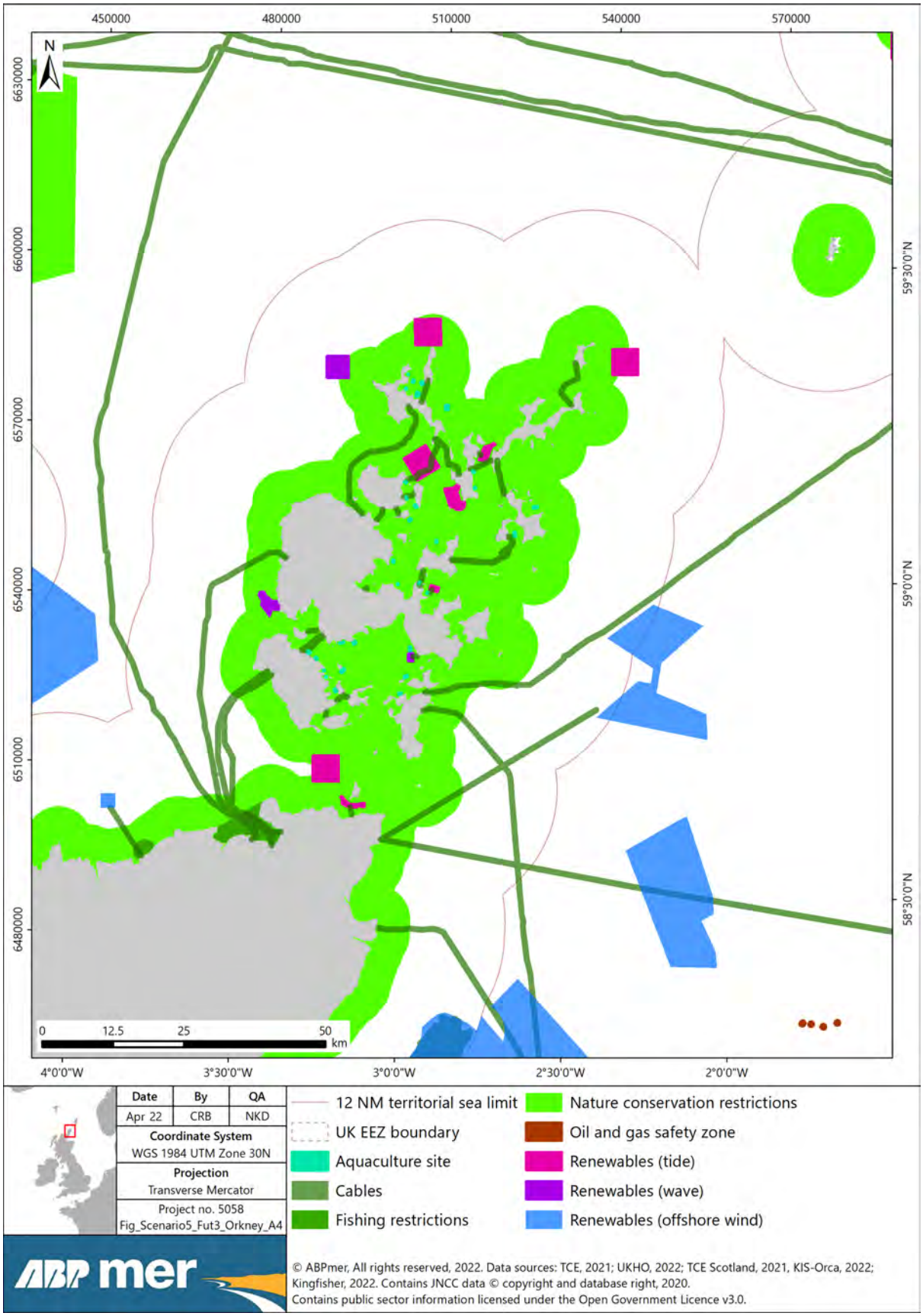



**Figure I12. Local case study: Orkney – Future 3 scenario**

## I.4 Outer Thames Estuary

Maps for the Outer Thames Estuary are shown for Present, Future 1, Future 2 and Future 3 scenarios in Figure I13 to Figure I16.

Future areas mapped for some sectors are indicative and may not represent plans or proposals for developments.

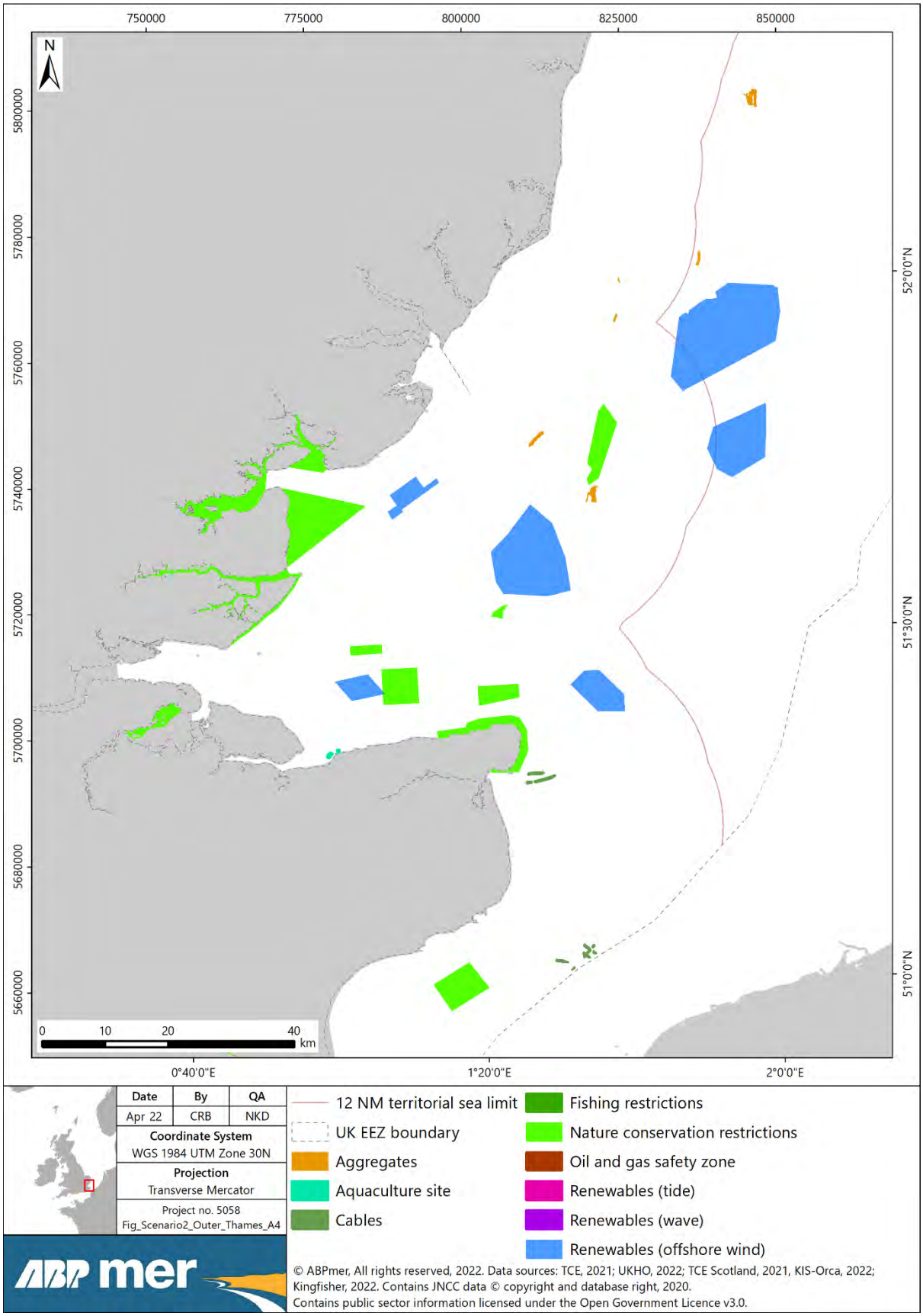



**Figure I13. Local case study: Outer Thames Estuary – Present scenario**

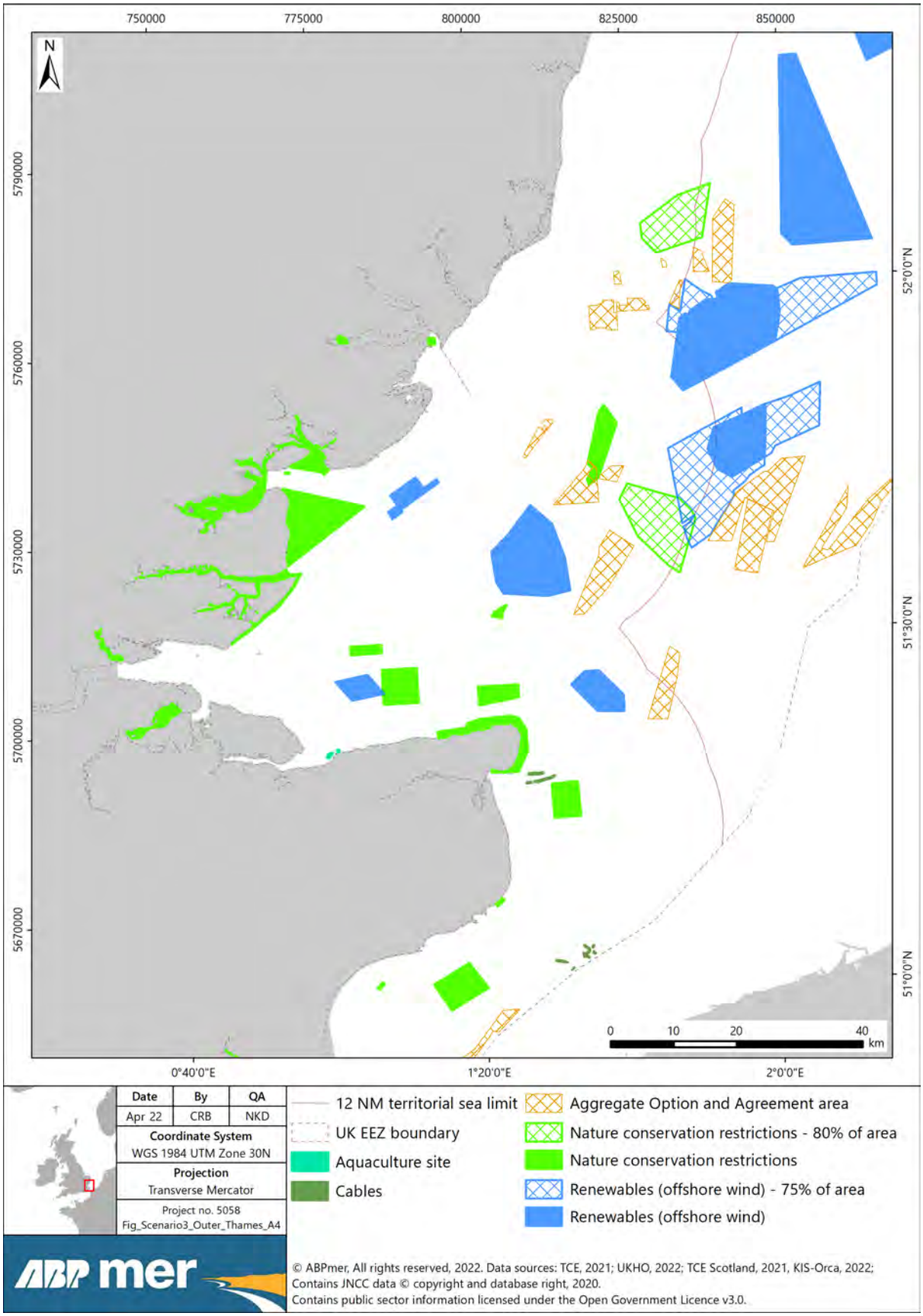



**Figure I14. Local case study: Outer Thames Estuary – Future 1 scenario**

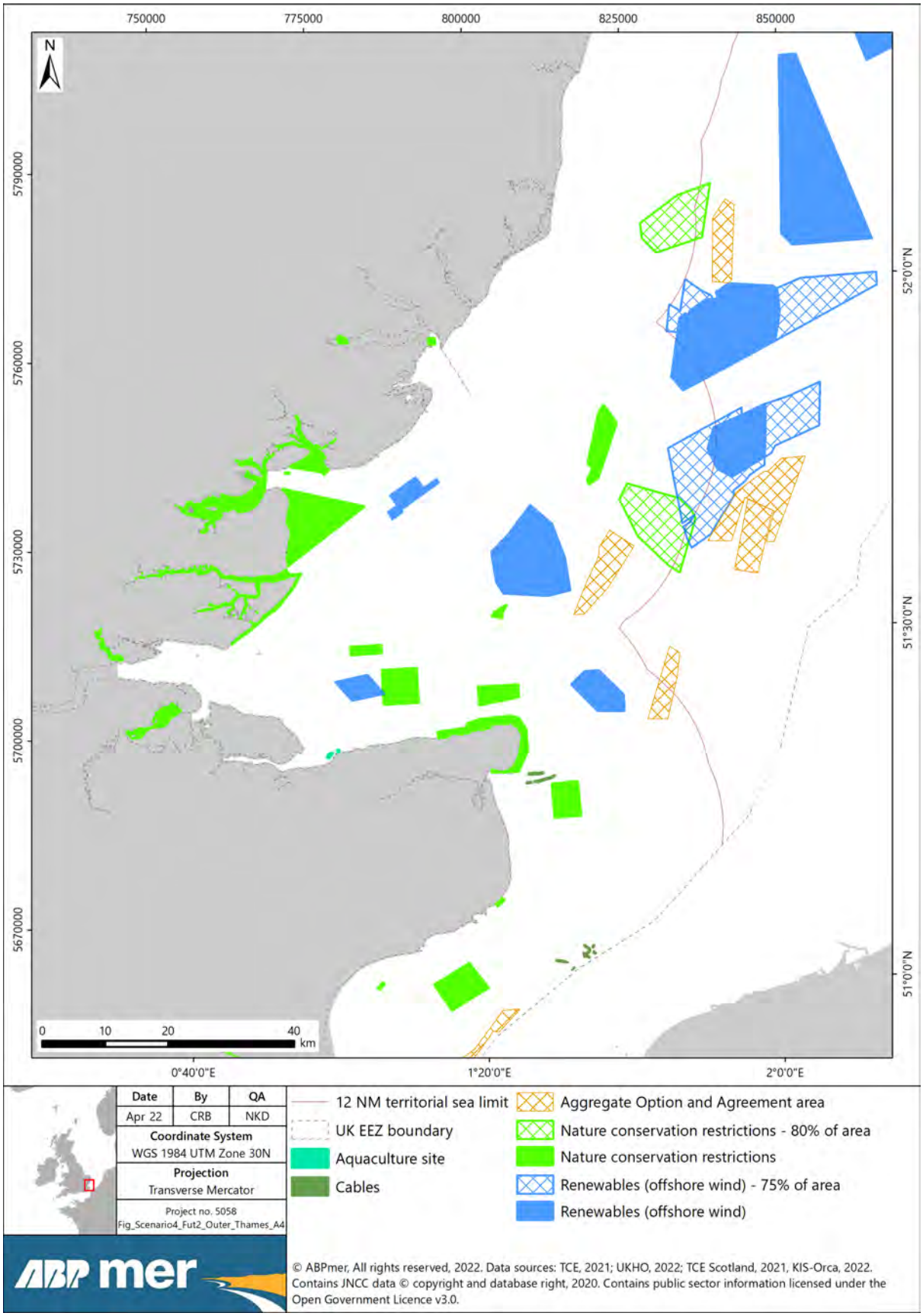



**Figure I15. Local case study: Outer Thames Estuary – Future 2 scenario**

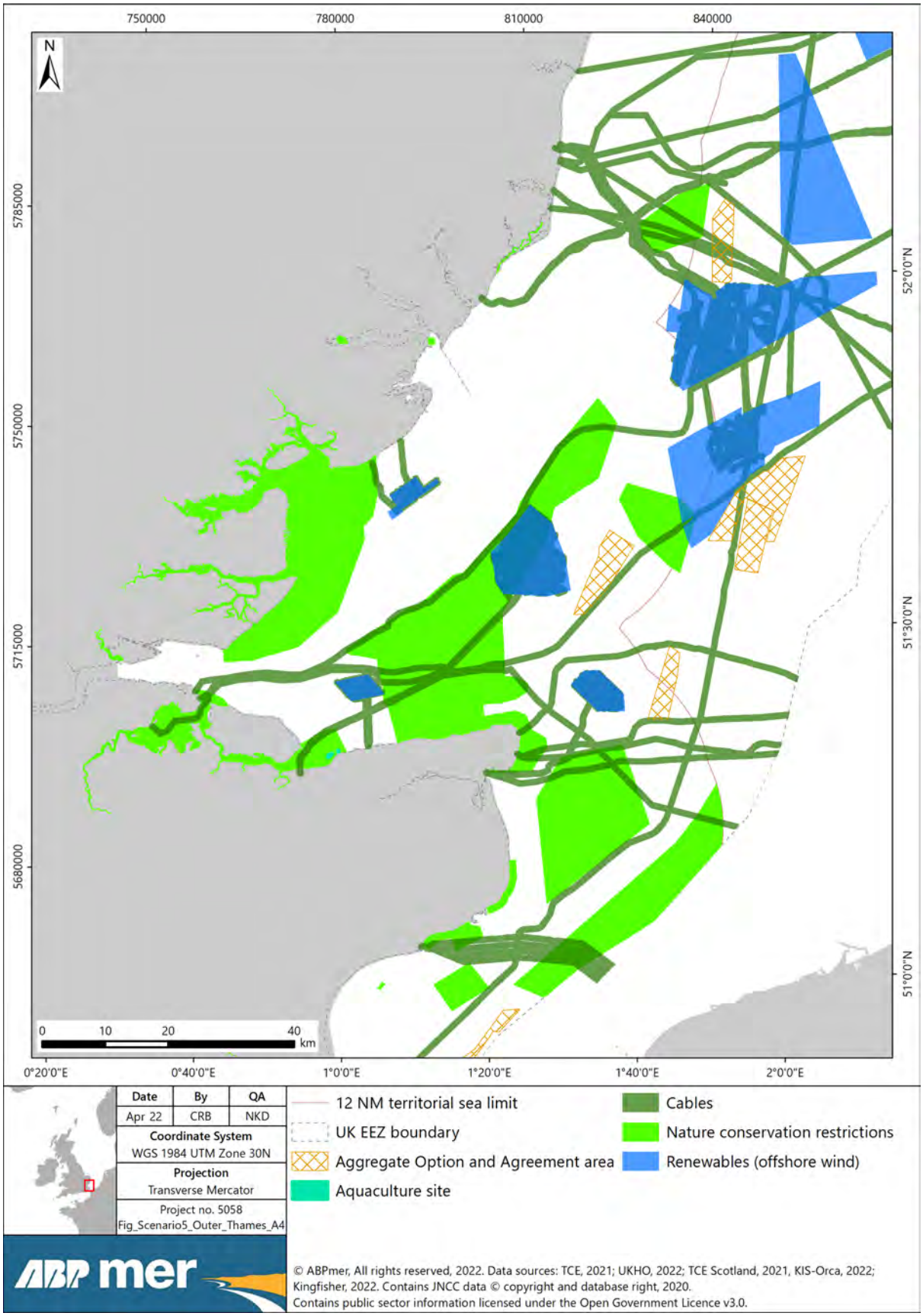



**Figure I16. Local case study: Outer Thames Estuary – Future 3 scenario**

## I.5 The Wash and off the Humber Estuary

Maps for The Wash and off the Humber Estuary are shown for Present, Future 1, Future 2 and Future 3 scenarios in Figure I17 to Figure I20.

Future areas mapped for some sectors are indicative and may not represent plans or proposals for developments.

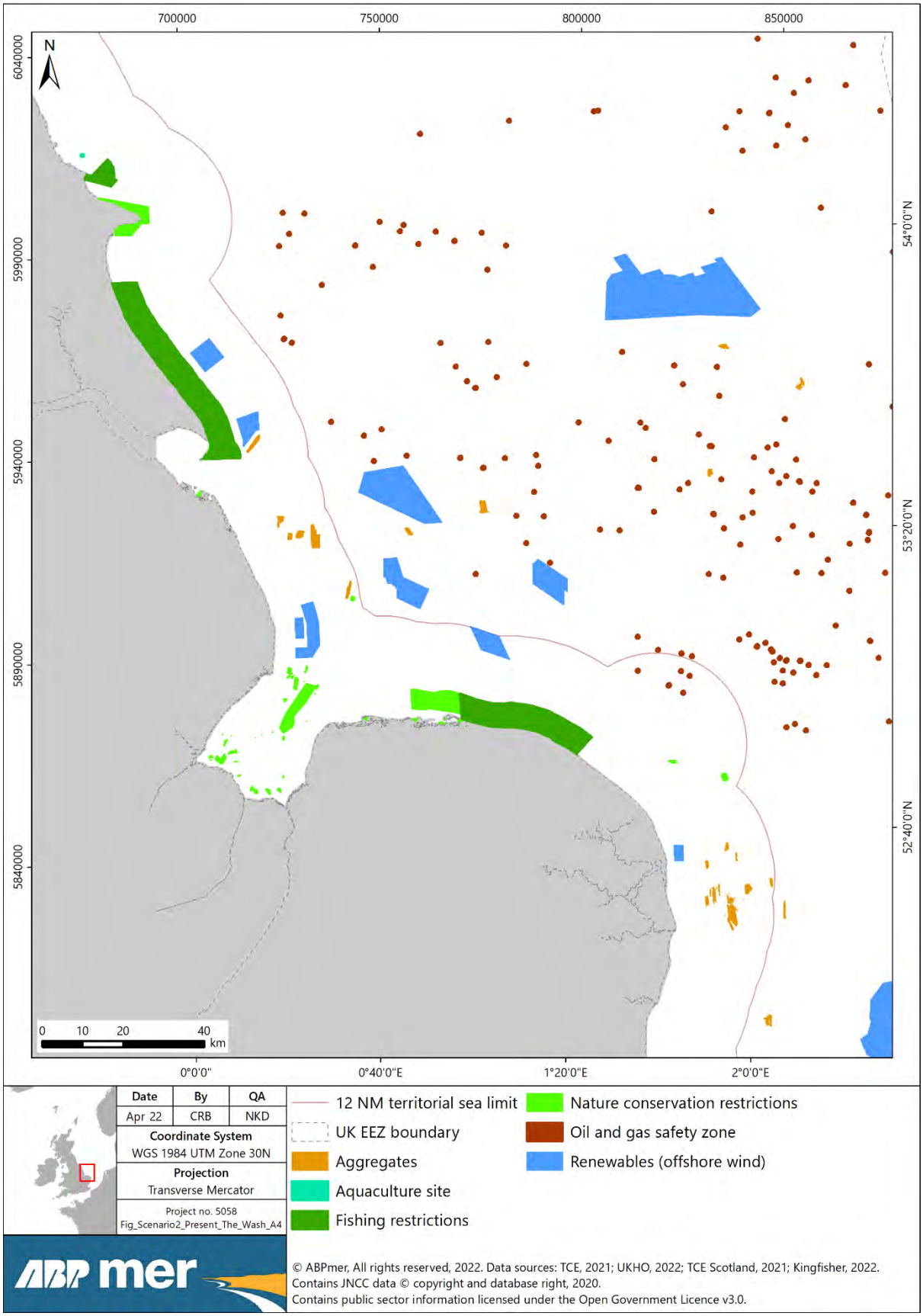



**Figure I17. Local case study: The Wash and off the Humber Estuary – Present scenario**

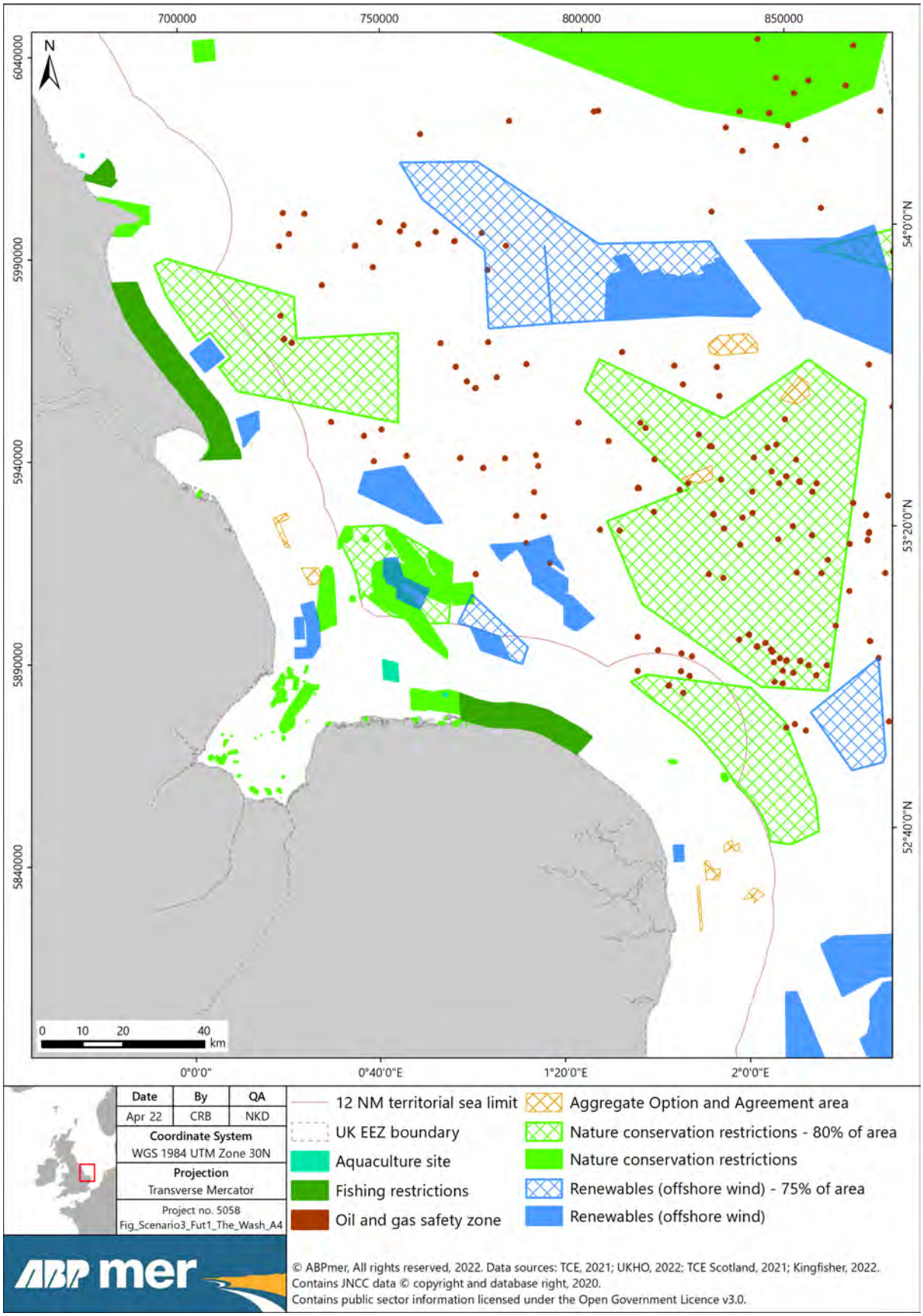



**Figure I18. Local case study: The Wash and off the Humber Estuary – Future 1 scenario**

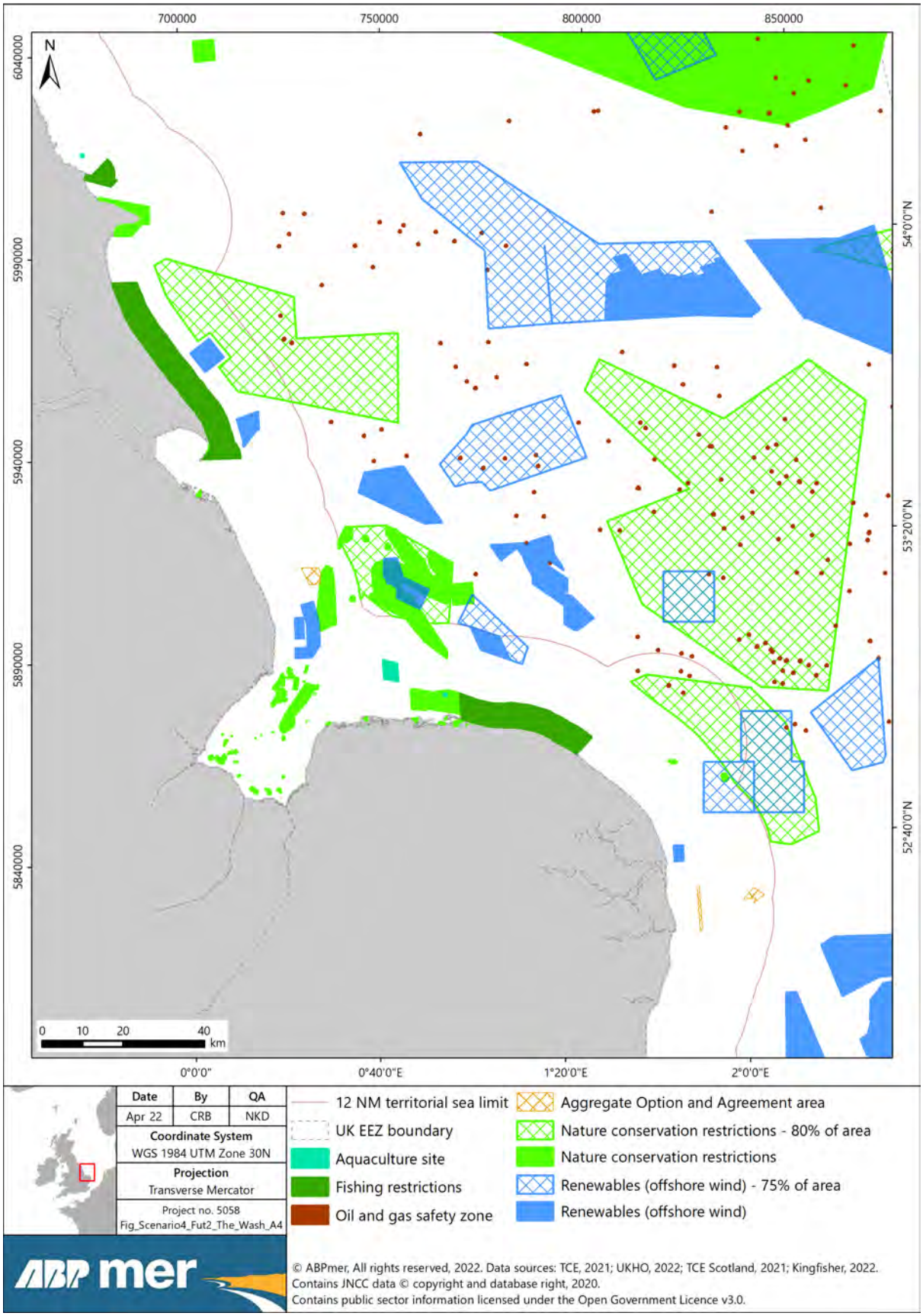



**Figure I19. Local case study: The Wash and off the Humber Estuary – Future 2 scenario**

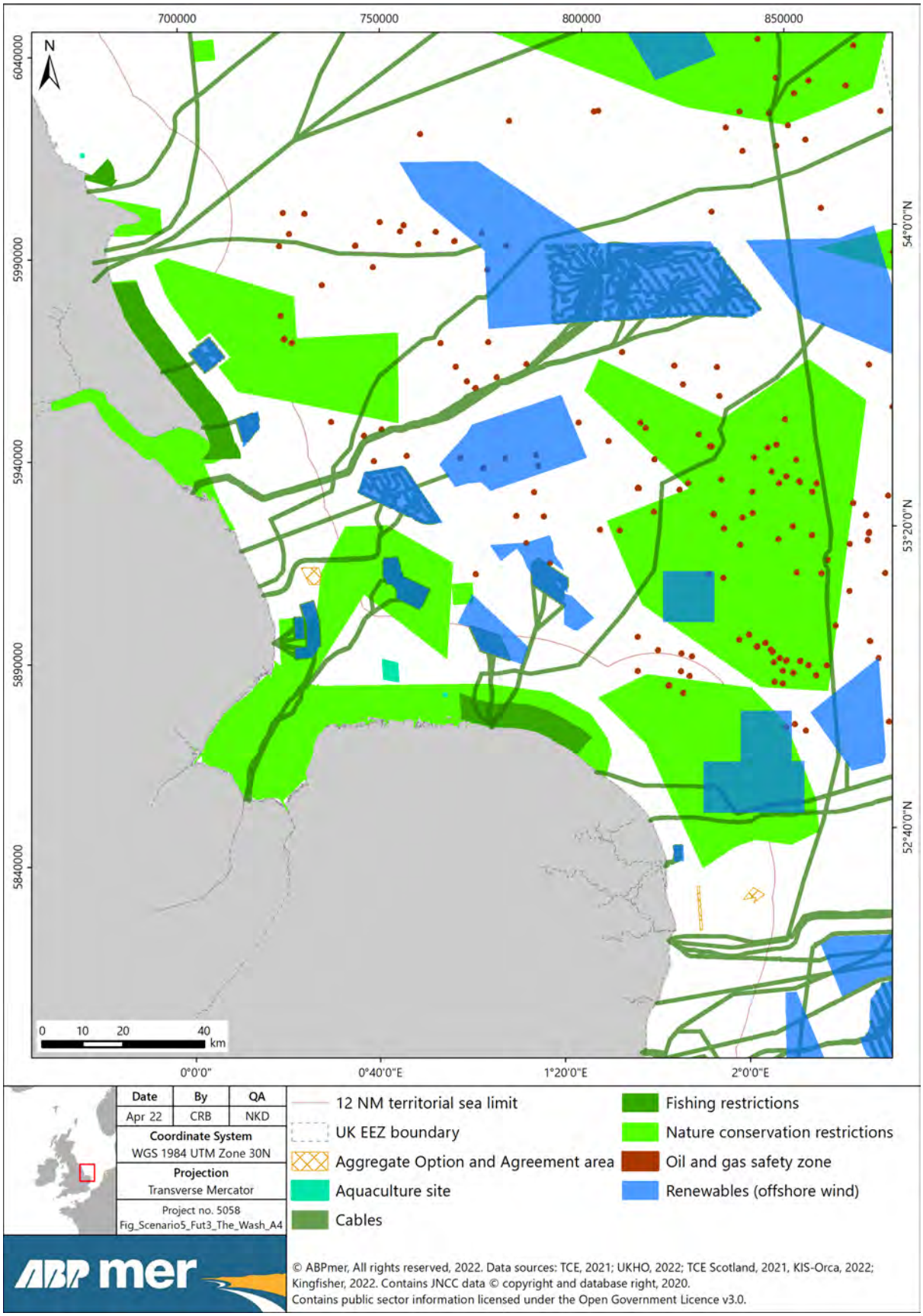



**Figure I20. Local case study: The Wash and off the Humber Estuary – Future 3 scenario**

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