The Crown Estate

Marine Conservation Zone Network Options

Date: September 2010

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Project Manager:	J E Saunders		22-9-10
Quality Manager:	C E Brown		22-9-10
Project Director:	S C Hull		22-9-10

ABP Marine Environmental Research Ltd
Suite B, Waterside House
Town Quay
SOUTHAMPTON
Hampshire
SO14 2AQ

Tel: +44(0)23 8071 1840
Fax: +44(0)23 8071 1841
Web: www.abpmer.co.uk
Email: enquiries@abpmer.co.uk

Summary

This report documents the methodology and results of a study to explore options for the development of a network of Marine Conservation Zones (MCZ) in the four English MCZ Regions.

The objectives of the study were:

- To develop and apply a number of alternative scenarios for the identification of a network of MCZ in the four English Regional MCZ areas taking account of socio-economic criteria;
- To evaluate the alternative scenarios in terms of the potential scope for overlap with The Crown Estate's (TCE) current leases and areas of future potential interest;
- To identify possible trade-offs that might need to be made between the achievement of ecological objectives and TCE current leases and areas of future potential interest; and
- To enable TCE to develop its views on the challenges and opportunities posed by the MCZ designation process.

Seven MCZ planning scenarios were evaluated using an MPA network planning tool - Marxan. The scenarios included pure ecological networks (with and without Special Areas of Conservation (SACs) locked into network design) and networks that sought to avoid a range of key socio-economic interests, including oil & gas, aggregates and windfarms. In addition, where available, the Regional Project first iterations have also been included as an eighth scenario.

Where particular areas are already designated as SACs (including the recently designated inshore SACs), it is possible that the measures required to support achievement of the conservation objectives in these areas will also support achievement of MCZ objectives[1], should MCZs be co-located in these areas. Assuming this is the case, the relative cost of the management measures that industry might be required to take to support achievement of MCZ conservation is likely to be proportional to the spatial extent of MCZ designated outside of existing/recently designated SACs. Thus, a key element of the study has been to explore the scope for minimising spatial overlap between MCZ and socio-economic interests in areas outside of existing/recently designated SACs.

The performance of each of the scenarios was tested to assess:

- The extent to which they met the ecological criteria specified by JNCC and Natural England for the MCZ networks (where these could be coded and/or assessed); and
- The extent of spatial overlap between the MCZ networks and a range of key socio-economic interests relevant to TCE in areas both inside and outside of existing/recently designated SACs.

A number of limitations of the study need to be recognised, in particular, weaknesses in the underlying spatial data layers, particularly in relation to the distribution of ecological features. At the time of the analysis, no comprehensive data layer for intertidal habitats was available and this was therefore excluded from the analysis. The habitat and species FOCI layers used within the study are also known to be incomplete. Not all of the ecological criteria could be coded within Marxan, for example, no

[1] This assumes that some level of multiple use will be permitted within most MCZ. The study has not considered the requirements for 'reference areas' within MCZ networks where bed disturbing activities may be prohibited.

assessment of performance has been made in relation to the following criteria: overall diversity, important areas for key life cycle stages of species, high natural pelagic productivity or reference areas.

The extent of spatial overlap between socio-economic interests and the MCZ networks is taken as an indication of the potential relative costs of management measures that industry may incur to support achievement of conservation objectives for the MCZ. The actual costs incurred will depend on the form of the conservation objectives for each site and decisions on the need for specific management measures. Notwithstanding these limitations, the general findings of the study are considered to be robust in terms of the potential relative costs of the different network options. However, given the study limitations the specific network options developed should be treated as indicative and further work would need to be undertaken to develop specific network proposals.

The key findings from the study are:

- The Marxan tool can minimize the space required to meet the ecological criteria. This is also likely to contribute towards minimizing socio-economic costs, which are a function of network size;
- All the modelled scenarios largely met the ecological criteria against which they were assessed and to the extent possible, with only minor non-conformances, reflecting the limitations of the Marxan tool to code some of the more minor ecological criteria;
- There was no diminution in performance against the ecological criteria against which the scenarios were assessed with increasing application of socio-economic criteria;
- There are wide choices in the location of MCZs while still meeting the ecological criteria against which the networks were assessed;
- The performance of the 1st iteration network proposals against the ecological criteria was variable. The Balanced Seas and Finding Sanctuary first iteration networks performed well against the broad-scale habitat and habitat FOCI criteria but performed less well in relation to the species FOCI criteria (based on an evaluation against point layer data). The Irish Sea first iteration network performed poorly against all of the criteria;
- All the scenarios required some level of spatial overlap with socio-economic interests and it is unlikely to be possible to completely avoid socio-economic interests while still meeting the ecological criteria;
- Locking in existing and recently designated SACs reduced the spatial overlap between MCZ networks and socio-economic interests by up to 50% in areas outside of SACs; such co-location may therefore provide an efficient approach to minimising socio-economic impacts, assuming that the measures already required in SACs will also support achievement of MCZ objectives where these are comparable. However, this assumption does not take account of the likely requirement for stricter management measires in reference areas and it is currently unclear whether locking SACs in to network design may help or hinder the minimization of costs for reference areas;
- Steering site selection away from socio-economic interests also reduced the spatial overlap between MCZ networks and socio-economic interests by between 10-50%;
- Locking out marine aggregate and offshore wind farm areas outside of SACs reduced the extent of spatial overlap with these activities. However, this resulted in increases in spatial overlap for other socio-economic interests and produced less efficient overall socio-economic solutions (in terms of the extent of spatial overlap);

- Overall, and subject to the limitations of this study, the combination of locking in SACs and using cost layers to steer site selection away from socio-economic interests was able to reduce the overlap between the networks and socio-economic interests by up to between 23 and 67% in areas outside of SACs compared to a pure ecological network scenario and depending on Region;
- For English MCZ Regions as a whole, the maximum spatial overlap for TCE's 9 main marine business areas ranged between 12-90%[2] depending on the scenario. Minimum levels of spatial overlap were generally below 10%. For activities that are planned at a national level such as renewable energy, oil & gas, gas storage and carbon capture and storage, it would be helpful to evaluate the implications of such overlap for future plans and programmes;
- The first iteration networks tended to have a greater spatial overlap with socio-economic interests, in some cases substantially so. The first iteration networks also affected some individual sectors disproportionately compared to others. The use of cost layers, which seek to steer site selection away from all key socio-economic interests, appears to be more effective at minimising spatial overlap compared to the bottom-up approach adopted for the first iteration networks. Furthermore, the cost layers also give a more equitable outcome compared to the first iteration networks which disproportionately impact some key activities; and
- The results from this study suggest that, through careful network design, there is substantial scope to minimise spatial overlap with socio-economic interests within English MCZ Regions while still meeting ecological criteria.

While the extent of spatial overlap is unlikely to be perfectly correlated with the cost of potential management measures that industry may need to implement to support achievement of MCZ conservation objectives, other studies have shown this to be a very important factor. Thus, developing MCZ network solutions that minimise spatial overlap with socio-economic interests is likely to be a useful way of minimising the overall cost of management measures for specific industries and for industry as a whole.

In this study, the locking in of existing SACs into network design has been shown to contribute to minimizing the total area of networks and minimising spatial overlap in areas outside of SACs. The locking-in of SACs may therefore make a useful contribution to reducing potential socio-economic costs. However, the benefits of this approach depend on whether it helps or hinders in minimizing the cost of meeting the requirements for reference areas.

The network options developed through this study are illustrative. They do not represent firm proposals for the location of MCZs. They have been used solely to identify some of the interactions between ecological criteria and a limited set of socio-economic factors. They are subject to the limitations and assumptions described within the report.

[2] This is based on an assessment of selected aspects of each marine business area – see section 3.6 for full details of the activities assessed.

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We are grateful for permission from The Crown Estate for access to the future use layers for marine activities and to DECC and UK DEAL for spatial data on oil & gas infrastructure.

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1. Introduction

This report has been prepared for The Crown Estate by ABPmer. It documents the methodology and findings of a study to explore options for the development of networks of Marine Conservation Zones (MCZ) in the four English MCZ Regions (See Figures 1, 9, 18 and 27).

1.1 Background

The Marine & Coastal Access Act (MCAA) 2009 provides for the identification and designation of Marine Conservation Zones (MCZ) within English territorial and offshore waters. In England, the process of identifying these MCZs is being taken forward through four regional projects. Ecological Network Guidance (ENG) guidance has been published for the development of the MCZ networks (JNCC and Natural England (2010)). The guidance establishes selection criteria for three types of feature, for which the principal requirements are as follows:

- Broad-scale habitats - the network is to include approximately 15-40% of the total area of each of these habitats with a minimum of 2 areas within each MCZ region. The minimum diameter of these areas should be 5km with an average diameter of 10-20km;
- Habitat features of conservation importance (FOCI) - the network is to include a minimum of 3 discrete areas for each habitat FOCI which must be of a minimum size (which varies depending on the particular habitat); and
- Species features of conservation importance (FOCI) - the network is to include a minimum of 3 discrete patches for each species FOCI which must be of a minimum size (which varies depending on the particular species).

There are also a range of further criteria, including distance between broad-scale habitat features, overall diversity, important areas for key life cycle stages of species and high natural pelagic productivity. In addition, the guidance also requires the identification of at least one reference area within each Region for each broad-scale habitat, habitat FOCI and species FOCI within which it is assumed that no bed disturbing activities will be allowed.

While the MCAA provides for social and economic factors to be taken into account during the site selection process, there is currently no clear process in place through which this might be achieved.

For the English Regional Projects, network design is being taken forward in three phases. Each Regional Project was required to submit initial proposals for MCZ networks in June 2010. These will be further refined through a process of iteration with subsequent revisions due in October 2010 and March 2011. The first iteration network proposals for Balanced Seas, Finding Sanctuary and the Irish Sea have been included for assessment in this study. The first iteration network for Net Gain area was considered to be preliminary and as therefore not included in the assessment.

1.2 Study Objectives

The objectives of the study are:

- To develop and apply a number of alternative scenarios for the identification of a network of MCZ in the four English Regional MCZ areas taking account of socio-economic criteria;
- To evaluate the alternative scenarios in terms of the potential scope for conflict with TCE current leases and areas of future potential interest;
- To identify possible trade-offs that might need to be made between the achievement of ecological objectives and TCE current leases and areas of future potential interest; and
- To enable TCE to develop its views on the challenges and opportunities posed by the MCZ designation process.

2. Methodology

2.1 Introduction

The development and testing of scenarios has been undertaken using an MPA network planning tool - Marxan Optimised Version 2.1.1 - within a GIS environment (ArcGIS 9.3). Marxan enables the user to specify various objectives for MPA networks in terms of number, proportion and area of particular conservation features to be included within a network. It has been used in this study to encode the main ENG criteria where possible (primarily the criteria for percentage area and number of areas) and to apply these criteria to gridded (2km x 2km grid) data layers representing the spatial distribution of relevant conservation features. Marxan then uses optimisation algorithms to identify grid cells which best meet the selection criteria. Additional functionality within Marxan enables users to select clusters of cells (to enable the selection of distinct sites) and to steer site selection towards particular areas (by locking them in to network design) or away from particular areas (by imposing a relative cost penalty on the selection of particular cells/locations or locking them out of network design completely).

For this study relative cost layers have been developed based on the locations of key socio-economic activities, including oil & gas, and judgements on the relative weightings to be applied to these layers. These judgements were informed by the assumptions used by the statutory nature conservation agencies in preparing the impact assessments for inshore and offshore Special Areas of Conservation (SACs) on the basis that outside of MCZ reference areas, the conservation objectives for MCZ (and thus the management regimes and mitigation measures) are likely to be similar to those for SACs. For example, where the inshore SAC impact assessments suggest that an activity may need to implement additional mitigation measures to support achievement of site conservation objectives, the activity has been given a greater weight in the cost layer compared to activities for which the assessments assumed no additional measures would be required. Two cost layers were developed - a 'low cost' layer which assumes relatively low levels of incompatibility between socio-economic activities and MCZ conservation objectives and a 'high cost' layer which assumes a greater level of

incompatibility. The cost layers have been used in Marxan to develop alternative network designs that have lower levels of spatial overlap with socio-economic interests.

The outputs from Marxan have been assessed both in terms of the extent to which network designs meet the relevant ecological criteria and in relation to the spatial overlap with key socio-economic interests (using functionality in ArcGIS). The extent of spatial overlap has been used as a proxy for the relative cost of management measures that socio-economic sectors may incur to support achievement of MCZ conservation objectives. The actual costs incurred will depend on the form of the conservation objectives for each site and decisions on the need for specific management measures. While it is possible to infer likely objectives and the situations in which management measures might be required, there is a high level of uncertainty in seeking to quantify these costs, for example the Inshore SAC impact assessments prepared by Natural England and JNCC gave wide ranges of costs for possible measures to support achievement of the conservation objectives in those sites. Previous work (ABPmer *et al*, 2007) has shown a good correlation between network size and socio-economic cost. On the basis the assessment of spatial overlap provides a good indication of the likely relative cost of the different scenarios.

A description of the Marxan tool is provided in Appendix A, with a summary of the key steps in the assessment process provided below. The limitations of the methodology and results are presented in Section 4.

Step1: Defining Planning Scenarios

Seven planning scenarios were defined for English waters as follows:

1. Pure ecological network meeting minimum ecological requirements for broad-scale habitat features and habitat and species FOCI;
2. As scenario 1 but with existing and recently designated SACs locked in to the network;
3. As 1 but with 'cost' layer for existing and possible future use activities assuming minimum restrictions are required (based on assumptions used in JNCC/Natural England Inshore SAC impact assessments);
4. As 3 but assuming maximum restrictions are required (based on assumptions used in JNCC/Natural England Inshore SAC impact assessments);
5.. As 2 but with 'cost' layer for existing and possible future use activities assuming minimum restrictions are required (based on assumptions used in JNCC/Natural England Inshore SAC impact assessments);
6. As 5 but assuming maximum restrictions are required (based on assumptions used in JNCC/Natural England Inshore SAC impact assessments); and
7. As 6 but with existing marine aggregate licensed areas and application areas and R1,R2 and R3 offshore wind farm areas locked out of the network. (Where these areas overlap with existing and recently designated SACs, the SACs have been given priority and the areas have remained locked in.).

Step 2: Defining Spatial Information Requirements.

The following information is needed to undertake the analysis:

- Determination of grid size for study - a 2km x 2km grid was selected as a balance between spatial resolution, the ease with which cells might be clustered to form sites and scenario processing times
- Distribution of MCZ features;
- Location of oil & gas infrastructure;
- Assumptions about future oil & gas activity (including decommissioning); and
- Locations of other key socio-economic activities.

Step 3: Collation of Spatial Datalayers within ArcGIS

The following information has been collated within ArcGIS (see Appendices B and C for full data listings used in the study):

- Distribution of the broad-scale habitats, habitat and species FOCI for which MCZ will be designated within the study area (NB there are a total of 73 features but not all of these features occur within the study area). This information has been developed through the Defra-funded MPA datalayers project (MB0102) and was accessed via the relevant Data Archive Centres (DACs); At the time of this study, no data layer was available from the MCZ project on the distribution of intertidal habitats and intertidal areas were therefore excluded from the analysis;
- Collation of data within ArcGIS on existing, planned and potential locations of key socio-economic interests within the study area (including marine aggregate extraction windfarms, wet renewables, carbon capture and storage and gas storage; existing telecom and power cables; areas maintained for navigation and dredged material disposal sites and key fishing grounds).

Step 4: Coding of Relevant Ecological Network Criteria within Marxan

Where possible, the ecological network criteria (JNCC & NE, 2010) were coded within Marxan including criteria for the selection of the minimum proportion and number of broad-scale habitats, the number and size of habitat FOCI and the number of species FOCI patches where relevant. The Marxan tool seeks to identify network options that meet the ecological criteria at 'minimum cost'. Thus for each scenario, the network solutions largely meet the criteria that have been coded within Marxan.

For habitat FOCI, the analysis used the habitat FOCI polygon layer in preference to the habitat FOCI point layer. This has meant that not all areas for each habitat FOCI were included in the analysis, for example, the results suggest that there is no subtidal chalk in Net Gain area as this was only represented by point data and therefore not included in the analysis.

For species FOCI, point layer data was used as this had more comprehensive coverage than the current polygon data. However, it is recognised that the point layer data does not fully represent the mapped distribution of species FOCI.

Step 5: Development of 'Low' and 'High' Cost Layers in ArcGIS

Appendix D provides details of the layers and weightings used to compile the cost layers. The weightings were applied to the socio-economic elements contained within the data layers. The total scores within each 2x2km grid cell were then calculated.

Step 6: Creation of Network Design Outputs for Different Scenarios in Marxan

The Marxan model was run for around 1000 times to generate a stable 'best' network solution for each scenario. The Boundary Length Modifier (BLM) within Marxan was used to select clusters of cells to form a limited number of sites of appropriate size and shape. Each scenario was run with a range of different Boundary Length Modifiers (ranging from 01 to 1000) and the BLM providing the most appropriate output was selected for further analysis. Broadly, for each scenario in English waters the study sought to identify networks of between 40 to 80 sites with a reasonably compact shape. For scenarios that did not lock SACs into network design, a BLM of 100 generally provided the most suitable outputs. For scenarios that locked SACs in, the most suitable BLM proved to be either 01 or 1.

Step 7: Assessment of Network Design Outputs

The performance of each network was assessed as follows:

- Performance of networks against the ecological criteria using ArcGIS based on a spatial analysis of ecological features captured within each network; and
- Calculation and evaluation of spatial overlap between the ecological networks and socio-economic features using spatial analysis tools in ArcGIS. The assessment evaluated the total overlap between each socio-economic interest and MCZ network. It also evaluated the total overlap outside of areas already designated/recently designated as SACs (on the broad assumption that MCZs (with the exception of reference areas) would have generally similar conservation objectives to SACs and thus designation was unlikely to lead to a requirement for additional measures in these areas).

The analysis particularly focused on the key business areas of interest to TCE:

- Marine aggregates;
- Oil & gas pipelines;
- Offshore wind – existing lease areas and potential future interest areas;
- Wet renewables – existing lease areas and wave and tidal interest areas;
- Telecom and power cables;
- Gas storage;
- Carbon capture and storage;
- Aquaculture – this is currently limited to shellfish aquaculture interests in England; and
- Coastal business – this includes moorings and marinas but also areas leased to port & harbour authorities within which construction, dredging and disposal activities take place.

For the Balanced Seas, Finding Sanctuary and Irish Sea areas, the first iteration network designs were also evaluated in this step.

3. Results

3.1 Introduction

The results for each MCZ region are discussed in sections 3.2 to 3.5 below.

3.2 Net Gain Area

3.2.1 Introduction

Figures 2 to 8 illustrate the MCZ networks generated for each scenario. Summary information for each scenario is presented in Table 1. The performance of each scenario against MCZ ecological criteria is summarised in Tables 2 - 5. The extent of overlap with socio-economic interests is presented in Table 6. The total extent for the Net Gain area is 112,303 km^2.

The number of sites within the different scenarios varied between 41-73 and covered areas ranging between 19,746 - 30,576 km^2 (Table 1). This equates to 18-27% of the Net Gain area.

3.2.2 Conformance with Ecological Criteria

The Marxan tool seeks to identify network options that meet the ecological criteria at 'minimum cost'. Thus for each scenario, the network solutions largely meet the criteria that have been coded within Marxan.

No assessment of performance has been made in relation to the following criteria: overall diversity, important areas for key life cycle stages of species, high natural pelagic productivity or reference areas.

3.2.2.1 Broad-scale habitats

All of the scenarios meet the minimum percentage area requirements for broad-scale habitats except for A6 Deep-Sea bed which had no area targets (Table 2). The minimum number of areas (2) was not met for A3.3 Low Energy Infralittoral Rock, A4.1 High Energy Circalittoral Rock, A4.3 Low Energy Circalittoral Rock and A6 Deep-Sea bed in some scenarios. The minimum diameter requirements for broad-scale habitats could not be coded within Marxan. However, the great majority of habitats met the minimum diameter requirements where possible (cells shaded green or orange). For A4.3 Low Energy Circalittoral Rock the minimum diameter requirements were met for only one of the six scenarios. No Deep-Sea bed habitats were selected in scenarios 3 to 7.

The criterion relating to the connectivity of EUNIS level 2 habitats could not be coded within Marxan but performance against the criterion has been assessed manually (Table 3). Only one patch of A6 habitat (Deep Sea Bed) was present within the region therefore connectivity could not be assessed. Connectivity was met for A5 habitats (Sublittoral Sediment), however a

proportion of A3 (Infralittoral Rock and other hard substrata) and A4 (Circalittoral Rock and other hard substrata) habitats did not meet the connectivity target in some scenarios due to the spread of habitat patches selected within the scenarios.

3.2.2.2 Habitat FOCI

All the scenarios met the minimum requirement for the number of habitat FOCI areas (Table 4).

It is not possible to directly code the minimum diameter requirements for habitat areas within Marxan although performance against this criterion has still been assessed. The criterion was not met for *Sabellaria spinulosa* reefs in Scenario 3 and seagrass beds in the majority of scenarios (red cells in Table 4). It is of note that for many of the habitat FOCI, the available patches for the relevant habitat FOCI within the Net Gain region do not meet the minimum criteria and thus it is physically not possible to meet these requirements. Where cells are shaded orange in Table 4, this indicates that the network has performed as well as could be expected, given the availability of habitat patches meeting the minimum criteria.

3.2.2.3 Species FOCI

For the species FOCI, the greatest proportion of data is represented within the respective point layers rather than the polygon layers. The point layer was therefore used in preference to the polygon layer, although the polygon layer includes some areas not represented in the point layer. In using the point layer data it has therefore not been possible to assess whether the minimum patch diameters have been met. The evaluation has been limited to an assessment of whether the required number of patches has been captured within the network. Table 5 indicates that for most of the species, there were too few patches present in Net Gain area to ever meet the minimum requirement (3 patches). However, the networks selected generally included the available patches (cells coloured orange in Table 5). For *Arctica islandica* there were a large number of species points and compliance with the minimum patch requirements was therefore easily met. For one species *Alkmaria romijni* - the tentacled lagoon worm (which inhabits saline lagoons) - the network generally performed better when SACs were locked in although it still failed to meet targets.

Table 1. Summary of Scenario Performance - Net Gain Area

Scenario	Network Area (Km²)	No of Sites	Extent to Which Ecological Criteria are Met	Overlap With Socio-Economic Interests - Area (km²)[1]	Overlap With Socio-Economic Interests - Length (km)[2]	Overlap With Socio-Economic Interests Outside SAC - Area (km²)[1]	Overlap With Socio-Economic Interests Outside SAC - Length (km)[2]
1. Pure ecological network (BLM = 100)	30576	42	All criteria were met where the minimum criteria were present within the region with the exception of: Broad-scale habitat A4.3 (number) & A6 (minimum diameter); Broad-scale habitat A3 (connectivity >80Km); Habitat FOCI 'seagrass beds' (minimum diameter) and Species FOCI *A. romijni* (Number).	53632	3439	47511	3084
2 Pure ecological network with SACs locked in (BLM = 0.1)	20527	41	All criteria were met where the minimum criteria were present within the region with the exception of: Broad-scale habitat A4.3 (number); & A6 (minimum diameter); Broad-scale habitats A3 & A4 (connectivity >80Km). Species FOCI *A. romijni* (number).	48307	4432	28153	2264
3. As 1 but with low cost avoidance (BLM = 100)	19657	44	All criteria were met where the minimum criteria were present within the region with the exception of: Broad-scale habitat A3.3, A4.1, A4.3, A5.3 & A6 (number); Broad-scale habitat A3 & A4 (connectivity >80Km). Habitat FOCI 'seagrass beds' & '*S. spinulosa*' reefs (minimum diameter) and Species FOCI *A. romijni* (no of points).	25436	2444	Not assessed	Not assessed
4. As 2 but with low cost avoidance (BLM = 0.1)	19746	73	All criteria were met where the minimum criteria were present within the region with the exception of: Broad-scale habitat A4.1, A6 (number) & A4.3 (minimum diameter); Broad-scale habitats A3 & A4 (connectivity >80Km); Habitat FOCI 'seagrass beds' (minimum diameter) & Species FOCI *A. romijni* (no of points).	46141	3762	25987	1817
5. As 1 but with high cost avoidance (BLM = 10)	20701	43	All criteria were met where the minimum criteria were present within the region with the exception of: Broad-scale habitat A3.3, A5.3, A6 (number), A4.3 (minimum diameter); Habitat FOCI 'seagrass beds' (minimum diameter) & Species FOCI *A. romijni* (no of points).	52779	2200	Not assessed	Not assessed
6. As 2 but with high cost avoidance (BLM = 0.1)	18659	73	All criteria were met where the minimum criteria were present within the region with the exception of: Broad-scale habitat A4.1, A4.3, A6 (number); Broad-scale habitats A4 (connectivity >80Km). Habitat FOCI 'seagrass beds' (minimum diameter) & Species FOCI *A. romijni* (no of points).	35875	2984	15722	1039
7 As 6 but with aggregate and wind farm areas locked out (BLM = 10)	19544	58	All criteria were met where the minimum criteria were present within the region with the exception of: Broad-scale habitat A4.1, A4.3, A6 (number); Broad-scale habitats A3 & A4 (connectivity >80Km); Habitat FOCI 'seagrass beds' (minimum diameter) & Species FOCI *A. romijni* (no of points).	39225	3283	19072	1338

[1] For activities represented by polygon data - e.g. aggregates sites, aggregate application areas, offshore wind farms, dredge material disposal sites, gas storage sites, hydrocarbon fields, shellfishing areas etc. The total area of overlap exceeds the total area of the network, because activities can overlap, for example, the potential future use areas for marine aggregates and offshore wind overlap with existing uses and with each other.

[2] For activities represented by linear features - e.g. cables and pipelines

Table 2. Scenario Performance for Broadscale Habitats (EUNIS Level 3) – Net Gain

Broadscale Habitat	EUNIS Level 3 Code	Net Gain Region		Targets				Scenario 1: Pure Ecological Network				Scenario 2: Pure Ecological Network with SACs Locked In				Scenario 3: Pure Ecological Network with Low Cost Avoidance				Scenario 4: Pure Ecological Network with SACs Locked In and Low Cost Avoidance				Scenario 5: Pure Ecological Network with High Cost Avoidance				Scenario 6: Pure Ecological Network with SACs Locked In and High Cost Avoidance				Scenario 7: Pure Ecological Network with SACs Locked In, High Cost Avoidance and Aggregate and Wind Farm Areas Locked Out			
		Extent of Features	Number in Region	Area		Number	Min Dia	Extent Captured		Number	No Meeting Min Dia	Extent Captured		Number	No Meeting Min Dia	Extent Captured		Number	No Meeting Min Dia	Extent Captured		Number	No Meeting Min Dia	Extent Captured		Number	No Meeting Min Dia	Extent Captured		Number	No Meeting Min Dia	Extent Captured		Number	No Meeting Min Dia
		(ha)		(ha)	%		(km)	Area (ha)	%			Area (ha)	%			Area (ha)	%			Area (ha)	%			Area (ha)	%			Area (ha)	%			Area (ha)	%		
High Energy Intertidal Rock	A1.1	Not assessed																																	
Moderate Energy Intertidal Rock	A1.2	Not assessed																																	
Low Energy Intertidal Rock	A1.3	Not assessed																																	
Intertidal Coarse Sediment	A2.1	Not assessed																																	
Intertidal Sand and Muddy Sand	A2.2	Not assessed																																	
Intertidal Mud	A2.3	Not assessed																																	
Intertidal Mixed Sediments	A2.4	Not assessed																																	
Coastal Saltmarshes and Saline Reedbeds	A2.5	Not assessed																																	
Interitidal Sediments Dominated by Aquatic angiosperms	A2.6	Not assessed																																	
Intertidal Biogenic Reefs	A2.7	Not assessed																																	
High Energy Infralittoral Rock	A3.1	34788	>2	5219	15 – 31	2	5	5239	15	>2	>2	18029	52	>2	>2	5274	15	>2	>2	18075	52	>2	>2	5224	15	>2	2	17860	51	>2	>2	17759	51	>2	>2
Moderate Energy Infralittoral Rock	A3.2	59118	>2	10050	17 – 32	2	5	12254	21	>2	>2	40864	69	>2	>2	23394	40	>2	2	23706	40	>2	>2	21388	36	>2	2	35434	60	>2	>2	36028	61	>2	>2
Low Energy Infralittoral Rock	A3.3	26	>2	4	16 – 32	2	5	23	89	2	0	26	100	>2	0	23	89	1	0	26	100	2	0	23	89	1	0	26	100	2	0	26	100	2	0
High Energy Circalittoral Rock	A4.1	139	>2	15	11 - 25	2	5	50	36	>2	0	119	86	>2	0	50	36	1	0	119	86	1	0	63	45	2	0	119	86	1	0	119	86	1	0
Moderate Energy Circalittoral Rock	A4.2	502580	>2	65341	13 - 28	2	5	195520	39	>2	>2	97660	19	>2	>2	160764	32	>2	>2	65774	13	>2	>2	143872	29	>2	>2	65445	13	>2	>2	103439	21	>2	>2
Low Energy Circalittoral Rock	A4.3	2009	2	321	16 - 32	2	5	1212	60	1	1	323	16	1	0	362	18	1	0	364	18	2	0	380	19	2	0	389	19	0	0	525	26	1	0
Subtidal Coarse Sediment	A5.1	2257368	>2	383774	17 - 32	2	5	790353	35	>2	>2	553540	25	>2	>2	467563	21	>2	>2	555009	25	>2	>2	484062	21	>2	>2	448790	20	>2	>2	442709	20	>2	>2
Subtidal Sand	A5.2	8104856	>2	1216113	15 - 30	2	5	2042579	25	>2	>2	1221218	15	>2	>2	1269742	16	>2	>2	1216134	15	>2	>2	1383336	17	>2	>2	1216143	15	>2	>2	1261454	16	>2	>2
Subtidal Mud	A5.3	79288	>2	11899	15 - 30	2	5	19834	25	>2	>2	51620	65	>2	>2	17838	22	1	1	17455	22	>2	>2	11907	15	1	1	12019	15	>2	>2	27007	34	>2	>2
Subtidal Mixed Sediments	A5.4	108062	>2	17291	16 - 32	2	5	29075	27	>2	>2	21063	19	>2	>2	17292	16	>2	>2	30151	28	>2	>2	17293	16	>2	>2	22090	20	>2	>2	17584	16	>2	>2
Subtidal Macrophyte-dominated Sediment	A5.5	Not present																																	
Subtidal Biogenic Reefs	A5.6	Not assessed																																	
Deep-Sea Bed	A6	643	1			2	5	267	42	1	0	195	30	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3. Scenario Performance for Connectivity of EUNIS Level 2 Habitats – Net Gain

EUNIS Level 2	Target	Scenario 1: Pure Ecological Network	Scenario 2: Pure Ecological Network with SACs Locked In	Scenario 3: Pure Ecological Network with Low Cost Avoidance	Scenario 4: Pure Ecological Network with SACs Locked In and Low Cost Avoidance	Scenario 5: Pure Ecological Network with High Cost Avoidance	Scenario 6: Pure Ecological Network with SACs Locked In and High Cost Avoidance	Scenario 7: Pure Ecological Network with SACs Locked In, High Cost Avoidance and Aggregate and Wind Farm Areas Locked Out
	(km)	(km)	(km)	(km)	(km)	(km)	(km)	(km)
A3	<80	12 - 200	26-150	81-105	23-96	63-74	38-64	39-190
A4	<80	6-30	26-150	5-110	36-175	63-74	14-130	16-180
A5	<80	6-50	20 - 50	5-46	8-35	10-41	2-56	15-65
A6	<80	0	0	0	0	0	0	0

Table 4. Scenario Performance for Habitat FOCI – Net Gain

Habitat FOCI	Net Gain Region			Targets		Scenario 1: Pure Ecological Network			Scenario 2: Pure Ecological Network with SACs Locked In			Scenario 3: Pure Ecological Network with Low Cost Avoidance			Scenario 4: Pure Ecological Network with SACs Locked In and Low Cost Avoidance			Scenario 5: Pure Ecological Network with High Cost Avoidance			Scenario 6: Pure Ecological Network with SACs Locked In and High Cost Avoidance			Scenario 7: Pure Ecological Network with SACs Locked In, High Cost Avoidance and Aggregate and Wind Farm Areas Locked Out		
	Area (ha)	Number of Sites	Number Patches Meeting Min Diameter	Number	Min Dia (km)	Extent Captured Area (ha)	Number	No Meeting Min Dia	Extent Captured Area (ha)	Number	No Meeting Min Dia	Extent Captured Area (ha)	Number	No Meeting Min Dia	Extent Captured Area (ha)	Number	No Meeting Min Dia	Extent Captured Area (ha)	Number	No Meeting Min Dia	Extent Captured Area (ha)	Number	No Meeting Min Dia	Extent Captured Area (ha)	Number	No Meeting Min Dia
Blue Mussel Beds	166.345	9	0	3	5	60	4	0	92	6	0	75	4	0	75	4	0	99	3	0	75	4	0	75	4	0
Cold-water Coral Reefs		Not present																								
Coral Gardens		Not present																								
Deep-Sea Sponge Aggregations		Not present																								
Estuarine Rocky Habitats	10.134	7	0	3	5	9	5	0	10	7	0	6	3	0	10	7	0	7	3	0	10	7	0	10	7	0
File Shell Beds																										
Fragile Sponge and anthozoan communities on subtidal rocky habitats		Not present																								
Intertidal Underboulder communities		Not present																								
Littoral Chalk Communities		Not assessed																								
Maerl Beds		Not assessed																								
Horse Mussel (Modiolus modiolus) beds		Not present																								
Mud Habitat in Deep Water		Not assessed																								
Sea-pen and burrowing megafauna communities		Not assessed																								
Native Oyster (Ostrea edulis) beds		Not present																								
Peat and Clay Exposures	10.444	Not present	0	3	5	10	3	0	10	3	0	10	3	0	10	3	0	10	3	0	10	3	0	10	3	0
Honeycomb Worm (Sabellaroa alveolata) Reefs		Not present																								
Ross Worm (Sabellaria spinulosa) Reefs	46046.323	717	>3	3	5	15682	210	>3	45999	713	>3	3715	88	1	40163	656	>3	18193	196	>3	40433	662	>3	38061	633	>3
Seagrass Beds	1298.613	133	1	3	5	41	18	0	999	101	1	445	35	0	999	101	1	3	4	0	999	101	1	999	101	1
Sheltered Muddy Gravels	204.481	6	0	3	5	157	5	0	177	4	0	45	3	0	45	3	0	101	3	0	56	3	0	73	3	0
Subtidal Chalk		Not assessed																								
Subtidal Sands and Gravels	261325.028	3664	>3	3	5	92756	1025	>3	155273	2865	>3	14919	380	>3	128992	2659	>3	126106	954	>3	123546	2484	>3	110654	2454	>3
Tide-Swept Channels	2377.091	222	0	3	5	162	23	0	1314	123	0	285	26	0	1624	138	0	73	5	0	1329	126	0	1329	126	0

Table 5. Scenario Performance for Species FOCI – Net Gain

Species FOCI		Net Gain Region		Targets	Scenario 1: Pure Ecological Network		Scenario 2: Pure Ecological Network with SACs Locked In		Scenario 3: Pure Ecological Network with Low Cost Avoidance		Scenario 4: Pure Ecological Network with SACs Locked In and Low Cost Avoidance		Scenario 5: Pure Ecological Network with High Cost Avoidance		Scenario 6: Pure Ecological Network with SACs Locked In and High Cost Avoidance		Scenario 7: Pure Ecological Network with SACs Locked In, High Cost Avoidance and Aggregate and Wind Farm Areas Locked Out	
Latin Name	Common Name	Number of Points	Number of Patches	Number of Patches	No of Points Captured	Number of Patches Captured	No of Points Captured	Number of Patches Captured	No of Points Captured	Number of Patches Captured	No of Points Captured	Number of Patches Captured	No of Points Captured	Number of Patches Captured	No of Points Captured	Number of Patches Captured	No of Points Captured	Number of Patches Captured
Padina pavonica	Peacocks Tail							Not present										
Cruoria cruiriaeformis	Burgundy maerl paint weed	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Grateloupia montagnei	Grateloups little-lobed weed							Not present										
Lithothamnion corallioides	Coral maerl							Not present										
Phymatolithon calcareum	Common Maerl							Not present										
Alkmaria romijni	Tentacled lagoon worm	4	3	3	0	0	2	2	0	0	2	2	0	0	2	2	2	2
Armandia cirrhosa	Lagoon Sandworm							Not present										
Gobius cobitis	Giant Goby							Not present										
Gobius couchi	Couch's Goby							Not present										
Hippocampus guttulatus	Long snouted Seahorse							Not present										
Hippocampus hippocampus	Short snouted Seahorse							Not present										
Victorella pavida	Trembling Sea Matt							Not present										
Amphianthus dohrnii	Sea-fan Anemone							Not present										
Eunicella verrucosa	Pink Sea fan							Not present										
Haliclystus auricula	Stalked Jellyfish	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Leptopsammia pruvoti	Sunset Cup Coral							Not present										
Lucernariopsis campanulata	Stalked Jellyfish							Not present										
Lucernariopsis cruxmelitensis	Stalked Jellyfish							Not present										
Nematostella vectensis	Starlet Sea Anemone							Not present										
Gammarus insensibilis	Lagoon Sand Shrimp							Not present										
Gitanopsis bispinosa	Amphipod Shrimp	4	2	3	3	2	4	2	4	2	4	2	4	1	4	2	4	2
Pollicipes pollicepes	Gooseneck barnacle							Not present										
Palinurus elephas	Spiny Lobster	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Arctica islandia	Ocean Quahog	191	3	3	122	>3	43	>3	32	>3	35	>3	20	>3	14	>3	50	>3
Atrinia pectinata	Fan Mussel							Not present										
Caecum armoricum	Defolin's Lagoon Snail							Not present										
Ostrea edulis	Native Oyster	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Paludinella littorina	Sea Snail							Not present										
Tenellia adspersa	Lagoon Sea Slug							Not present										
Osmerus eperlanus	Smelt							Not assessed										
Anguilla anguilla	European Eel							Not assessed										
Raja undulata	Undulate Ray							Not assessed										

Table 6. Overlap Between MCZ Networks and Socio-economic Interests – Net Gain

Sector	Activity/Element	GIS Layer	Units	Total Extent in Net Gain Region	Scenario 1: Pure Ecological Network		Scenario 2: Pure Ecological Network with SAC Locked In		Scenario 3: Pure Ecological Network with Low Cost Avoidance	Scenario 4: Pure Ecological Network with SACs Locked In with Low Cost Avoidance		Scenario 5: Pure Ecological Network with High Cost Avoidance	Scenario 6: Pure Ecological Network with SACs Locked In with High Cost Avoidance		Scenario 7: SACs Locked In, Wind Farms and Marine Aggregate Activities Locked Out	
					Total Overlap	Overlap Minus SAC	Total Overlap	Overlap Minus SAC	Total Overlap	Total Overlap	Overlap Minus SAC	Total Overlap	Total Overlap	Overlap Minus SAC	Total Overlap	Overlap Minus SAC
Aggregates	Existing licence areas	Dredging Licence Areas	km²	744	327	327	343	289	73	178	124	279	140	86	99	45
	Application areas	Dredging Application areas	km²	774	151	151	159	103	127	139	83	247	76	20	68	11
		Aggregates Prospecting Layer	km²	1258	136	135	572	260	99	449	137	326	409	97	362	50
	Potential future interest use areas	Potential Future Aggregate Resource Medium	km²	44651	13901	12056	12352	6885	6884	13255	7788	10336	8952	3486	9068	3602
		Potential Future Aggregate Resource High	km²	42173	9074	7220	11855	5983	5207	11240	5368	5767	8471	2599	8322	2450
Oil & Gas	Existing structures – surface + subsurface platforms, pipelines, cables	Surface installations	Count	190	49	49	105	36	29	92	23	44	79	10	89	20
		Active Exploration Wells	Count	1308	465	383	670	226	200	608	164	274	505	61	607	163
		Active Pipelines	km	6679	2173	1880	3143	1544	1307	2909	1311	1205	2233	634	2630	1032
Offshore Wind	Existing and consented (not yet built) wind farms (apply to R1/R2 sites)	Wind Farms Round 1 & 2	km²	910	513	453	290	139	244	321	169	327	263	111	166	15
	Cables for R1/R2 sites	Wind Farm Export Cables	km	45	0	0	36	10	0	33	6	0	33	6	33	6
	Application areas (R2.5 and R3 sites)	Wind Farms Round 3	km²	19137	5041	4927	2721	2435	2495	2025	1739	2748	572	287	322	36
	Cable routes for R3 sites	Digitised R3 cable routes	km	2157	347	330	242	110	358	294	162	383	188	57	141	10
	Potential future interest use areas	Floating interest future use Medium	km²	7956	1462	1462	234	234	1082	89	89	445	760	760	1365	1365
		Floating interest future use High	km²	2039	773	773	277	277	712	30	30	140	3	3	68	68
		Fixed foundation future use Medium	km²	8182	2459	1982	2045	912	1732	2488	1355	1899	1904	771	1995	863
		Fixed foundation future use High	km²	2351	296	277	241	163	309	306	228	50	119	41	115	37
	Possible future cable routes	Future Cable Routes	km	1205	123	108	403	180	14	0	0	4	0	0	0	0
		Wind Demonstration Sites	Count	21	0	0	0	0	0	0	0	0	0	0	0	0
Wet Renewables	Existing leased areas and option areas	Pentland Firth Round 1 Lease Option Areas (Tidal). Ramsey sound, Wave hub etc														
	Potential future interest use areas	Tide Future Interest (High)														
		Tide Future Interest (Medium)	km²	0	0	0	0	0	0	0	0	0	0	0	0	0
		Wave Future interest (High)	km²	15	1.3	1.3	6.7	4.8	0.0	6.7	4.8	0.0	6.7	4.9	5.5	3.6
		Wave Future Interest (Medium)	km²	39274	12407	11397	7056	4277	0	7959	5179	23719	6021	3242	8130	5351
Cables	Existing cables (live telecom cables, power interconnectors)	Telecom_cables	km	3035	674	645	527	339	671	518	330	514	479	291	377	188
	Future cables (proposed telecom cables and proposed power interconnectors/ power grid)	brit-ned, anglo scot hvdc link,	km	637	7	7	0	0								
CCS/Gas Storage	Existing lease areas/option areas	Hydrocarbon Fields	km²	1109	562	562	83	83	129	134	134	94	45	45	7	7
		Gas Storage Leases	Count	23	4	4	0	0	0	0	0	0	0	0	0	0
	Potential future use areas	Gas Potential Sites	km²		0	0	0	0	0	0	0	0	0	0	0	0
		CCS Potential Sites	km²	128	16	0	119	41	1	126	49	1	121	43	126	49
	Future pipeline	Proposed pipelines	km	556	114	114	81	81	94	9	9	95	52	52	102	102
Dredging and disposal	Existing maintained areas	Maintained Dredge Areas	km²	15	5	5	3	2	2	5	4	4	3	2	3	2
	Existing disposal areas	Disposal Sites Open	km²	248	12	12	39	24	2	58	43	23	26	12	33	19
	New capital dredge areas	No information available														
Commercial Fisheries	Fisheries values	VMS Data	Cost £	21204586	7,159,350	7,019,472	4,096,743	3,178,495	5,671,452	4064165	3145917	5115477	2638938	1720690	3404286	2486038
		Number of VMS cells overlapping greater than £5000	Count	1197	415	409	247	205	302	228	186	268	135	93	174	132
	Shellfish Values	Commercial Shellfish Areas (MB106)	km²	28429	6481	5772	9742	6041	6324	7164	3463	6364	7814	4113	8799	5098
Aquaculture	Finfish aquaculture	No Finfish Aquaculture within the area														
	Shellfish aquaculture installations	Shellfish aquaculture sites	km²	187	14	0	170	0	15	170	0	8	170	0	170	0
		Total overlap (km²)	KM²	199579	53632	47511	48307	28153	25436	46141	25987	52779	35875	15722	39225	19072
		Total overlap (km)	KM	14314	3439	3084	4432	2264	2444	3762	1817	2200	2984	1039	3283	1338

3.2.3 Overlap with Socio-economic Interests

Table 6 summarises the extent of overlap between the various socio-economic interest layers and the individual network scenarios. Information is also provided on the extent of overlap between the networks and socio-economic interests in areas that are not already designated as SACs. If an assumption is made that the existing management measures implemented under the Habitats Directive are generally sufficient to meet MCZ objectives, then the *additional* cost to industry of MCZ designation will largely arise from new measures applied to areas outside already designated or recently designated SACs.

The total extent of socio-economic interests in Net Gain area (excluding commercial fin fishing) is around 200,000 km^2 and 14,000 km (for pipelines and cables) (Table 6). Between 13 to 27% of this total socio-economic area of interest is captured within the individual scenarios.

There is large variation in spatial overlap with socio-economic interests between scenarios, for example, there is approximately a 47% difference in the total area of overlap between scenario 1 (pure ecological network) and scenario 3 (same but with low cost avoidance) (Table 6). Furthermore, there is large variation in the extent of spatial overlap outside of existing/recently designated SACs, for example, the overlap for scenario 6 is around a third of the overlap for scenario 1 (Table 6).

The inclusion of cost layers to steer site selection away from areas of socio-economic interest had little consistent influence on total spatial overlap (Table 6 compare scenarios 1, 3 and 5), although for some scenarios spatial overlap using cost layers as reduced by up to 50%. The locking-in of SACs into the network reduced the area of overlap with socio-economic interests by up to 30% (Table 6 compare scenarios 1 and 2, 3 and 4, 5 and 6).

The locking out of marine aggregate areas and offshore windfarms outside of SACs reduced spatial overlap with these activities but the overall overlap with socio-economic activities increased (Table 1, scenarios 6 and 7).

It is important to note that this overlap is not spread evenly among sectoral interests with some impacted more than others and that the performance of scenarios was not consistent for sectors or even individual sector layers; e.g. they were worse for some sectors but better for others. These patterns are summarised below for each individual TCE business activity that is present within the region.

3.2.3.1 Marine aggregates

There are approximately 744 km^2 of existing licensed areas and 774 km^2 of application areas within the Net Gain Region. Spatial overlap ranged from 10% to 46% for existing licences and 9% to 32% for application areas across the various scenarios. The extent of spatial overlap with aggregate prospecting areas and high and medium aggregate potential areas also varied considerably across scenarios, affecting up to 45% of these potential resource areas in worst case scenarios. Locking in SACs (Scenario 2) reduced the overlap with existing licensed areas outside of SACs by around 10% compared to Scenario 1. The locking out of existing licence

and application areas (scenario 7) minimised spatial overlap, particularly in areas outside of SACs.

3.2.3.2 Oil & Gas

There are 190 surface installations (these are mostly gas platforms with a handful of metocean monitoring buoys), 1308 active gas production wells and 6,679 km of pipelines in the Net Gain Region. The percentage of installations captured under the scenarios ranges from 15 - 55%, wells range from 15 - 51% and pipelines from 18 - 47%. As much of the activity is offshore, locking in SACs has very little effect on reducing the total amount of activity captured by the network (compare blue columns scenario 1 with 2, 4 and 6) although the amount outside SACs is substantially less (compare yellow columns). Incorporating the cost layers further reduced the level of overlap (compare scenario 1 with 3 and 5 and compare 2 with 4 and 6).

3.2.3.3 Offshore wind

There are 910 km^2 of R1/R2 sites and 19,137 km^2 of R3 sites within the Net Gain Region. Spatial overlap was the lowest for scenario 7 that locked these areas out with only 18% of R1/R2 and 2% of R3 sites captured. However, the amount of potential future interest area that was captured was higher compared to some other scenarios (up to 24%). The scenario with the next lowest overlap was scenario 6 that locked in SACs with high cost avoidance; 29% of R1, 3% of R2/R3 and up to 10% of potential future interest sites. Scenario 1 had the highest levels of overlap for almost all layers of offshore wind business; 56% of R1, 25% of R2/R3 and up to 38% of potential future interest sites.

3.2.3.4 Wet renewables

There are no significant existing or potential future interest tidal areas in the Net Gain Region, although there is a tidal demonstration project in the Humber Estuary. There are some areas of potential high interest for future wave deployments (15 km^2). Between 0 and 45% of these potential interest areas are captured within the different network scenarios. There are some larger areas of medium wave resource (39,274 km^2). Between 0 and 45% of these interest areas are captured within the different network scenarios. Unusually scenario 5 that had high cost avoidance captured the largest area of this resource compared to other scenarios (60%). This relates to the relatively low weighting applied to potential future activities compared to existing ones. The other scenarios range from 0 to 32%

3.2.3.5 Telecom and power cables

There are 3035 km of existing live cable and 637 km of planned cable within the Net Gain Region. Spatial overlap ranged from 377 to 674 km for existing cables and 0 to 7 km for planned cable across the different scenarios. Significantly lower levels of overlap were achieved for scenarios incorporating socio-economic factors.

3.2.3.6 Gas storage and carbon capture and storage

There are 23 km^2 of existing or proposed gas storage areas identified in the Net Gain Region and 128 km^2 potential CCS storage areas (seabed surface not sub-surface) and 556 km of

associated pipelines with the future activity. Spatial overlap ranged from 0 to 4 km^2 for existing or proposed gas storage areas, 1 to 126 km^2 for potential CCS sites and 9 to 114 km for planned pipeline across the different scenarios. Some of the socio-economic scenarios had greater overlap with potential CCS sites and pipelines owing to the lower weight attached to future interest layers in the cost layer.

3.2.3.7 Coastal business

The socio-economic assessment has included limited information on activities relevant to TCE's coastal business. There are only 15 km^2 of maintained navigation channel and 248 km^2 of licensed dredged material disposal site within the Net Gain Region. Spatial overlap ranged from 2 to 5 km^2 for maintained navigation channels and 2 to 58 km^2 for dredged material disposal sites across the different scenarios.

3.2.3.8 Aquaculture

There is approximately 187 km^2 of waterbody containing shellfish aquaculture sites[3] in the Net Gain Region and no finfish aquaculture. Spatial overlap ranged from 8 to 170 km^2 across the different scenarios. Most of this area is within existing/recently designated SACs.

3.3 Balanced Seas Area

3.3.1 Introduction

Figures 9 to 17 illustrate the MCZ networks generated for each scenario. Summary information for each scenario is presented in Table 7. The performance of each scenario against MCZ ecological criteria is summarised in Tables 8 - 12. The extent of overlap with socio-economic interests is presented in Table 7. The total extent for the Balanced Seas area is 18,708km^2.

The number of sites within the different scenarios varied between 15-27 and covered areas ranging between 2764 - 4275km^2 (Table 7). This equates to 15-23% of the Balanced Seas area.

3.3.2 Conformance with Ecological Criteria

The Marxan tool seeks to identify network options that meet the ecological criteria at 'minimum cost'. Thus for each scenario, the network solutions largely meet the criteria that have been coded within Marxan.

No assessment of performance has been made in relation to the following criteria: overall diversity, important areas for key life cycle stages of species, high natural pelagic productivity or reference areas.

[3] The location of individual shellfish aquaculture installations in England is commercially sensitive. The available data layer simply identifies waterbodies which contain shellfish aquaculture installations. For example, the Wash is identified as a waterbody containing shellfish aquaculture installations.

3.3.2.1 Broad-scale habitats

All of the scenarios meet the minimum percentage area requirements for the subtidal broad-scale habitats present within the Balanced Seas Region, with the exception of the Balanced Seas 1st iteration network which missed the target for high energy infralittoral rock (11% versus minimum target of 15%) (Table 8). The minimum number of areas was also met for all broad-scale habitats in all of the scenarios (Table 8). The minimum diameter requirements for broad-scale habitats could not be coded within Marxan. However, the great majority of habitats met the minimum diameter requirements where possible (cells shaded green or orange). For some of the scenarios the minimum diameter for subtidal mud habitat was not met. Scenario 7 did not fully meet the minimum diameter requirements for high and moderate energy circalittoral rock habitats.

The criterion relating to the connectivity of EUNIS level 2 habitats could not be coded within Marxan but performance against the criterion has still been assessed. Only one patch of A6 habitat (Deep Sea Bed) was present within the region, therefore connectivity could not be assessed. Connectivity was met for A5 habitats (Sublittoral Sediment), however a proportion of A3 (Infralittoral Rock and other hard substrata) and A4 (Circalittoral Rock and other hard substrata) habitats did not met the connectivity target in some scenarios due to the spread of habitat patches selected within the region (Table 9).

3.3.2.2 Habitat FOCI

The scenarios fully met the minimum requirement for the number of habitat FOCI areas (Table 10) with the exception of blue mussel beds (two scenarios) and peat and clay exposures (6 scenarios).

For most of the habitat FOCI, none of the patch diameters in the region meet the minimum requirements and thus it was not possible to comply with the ecological criteria for minimum diameter (cells shaded orange in Table 10). For subtidal sand & gravel habitat, there were a large number of patches meeting the minimum diameter requirements in the Region. Consequently all the scenarios easily met the minimum diameter requirements for this FOCI.

3.3.2.3 Species FOCI

For the species FOCI, the greatest proportion of data is represented within the respective point layers rather than the polygon layers. The point layer was therefore used in preference to the polygon layer, although the polygon layer includes some areas not represented in the point layer. In using the point layer data it has therefore not been possible to assess whether the minimum patch diameters have been met. The evaluation has been limited to an assessment of whether the required number of patches has been captured within the network.

Table 11 indicates that for most scenarios the minimum number of patches was achieved, where there were sufficient patches in the Region from which to select. The Balanced Seas 1st iteration network failed to meet the minimum number of patches for most of the species with the exception of native oyster, based on a comparison against the point data layers.

3.3.3 Overlap with Socio-economic Interests

Table 12 summarises the extent of overlap between the various socio-economic interest layers and the individual network scenarios. Information is also provided on the extent of overlap between the networks and socio-economic interests in areas that are not already designated as SACs.

The total extent of socio-economic interests in the Balanced Seas area (excluding commercial fin fishing) is around 46462km^2 and 626km (for pipelines and cables) (Table 12). Between 17 to 25% of this total socio-economic interest is captured within the individual scenarios.

There is significant variation in spatial overlap with socio-economic interests between scenarios, for example, there is approximately a 30% difference in the total area of overlap between scenario 1 (pure ecological network) and scenario 5 (SACs locked in and high cost avoidance) (Table 7). Furthermore, there is also significant variation in the extent of spatial overlap outside of existing/recently designated SACs, for example, the overlap for scenario 7 is around half of the overlap for scenario 1 (Table 7).

The inclusion of cost layers to steer site selection away from areas of socio-economic interest reduces total spatial overlap with socio-economic interests by around 30% (Table 7 compare scenarios 1, 3 and 5). The locking-in of SACs into the network also has the potential to significantly reduce the area of overlap with socio-economic interests outside of existing/recently designated SACs, for example, the area of overlap outside of SACs is reduced by a factor of two when SACs are locked in (Table 7 compare scenarios 1 and 2).

The locking out of marine aggregate and offshore wind farm areas resulted in marginal reductions in overall spatial overlap (Table 7, compare scenarios 6 and 7).

The scenario which resulted in the least spatial overlap between MCZ and socio-economic interests outside of SACs was scenario 7 (overlap around 50% of that for scenario 1).

The 1st iteration network from the Balanced Seas Regional Project resulted in a level of total spatial overlap with socio-economic interests broadly comparable with some of the modelled scenarios, suggesting that the stakeholder process being pursued is, to some extent, effective in reducing potential socio-economic conflict. However, some of the modelled scenarios are significantly more effective in minimising spatial overlap, particularly in areas outside of existing/recently designated SACs (e.g. Table 7, scenarios 6 and 7). Furthermore, the potential impact of the Balanced Seas first iteration network on socio-economic interests varies considerably. For example, while the network has a low spatial overlap with existing marine aggregate areas, the overlap with aggregate application areas is higher than for any of the other scenarios by a factor of 10. Similarly, the network potentially impacts disproportionately on future potential high interest areas for fixed foundation offshore wind and future potential high interest area for wave devices. It also has a disproportionate impact on commercial fishing interests. The modelled scenarios, which seek to steer site selection away from all key socio-economic interests, generally produce more equitable solutions.

Table 7. Summary of Scenario Performance - Balanced Seas Area

Scenario	Network Area (Km²)	No of Sites	Extent to Which Ecological Criteria are Met	Overlap With Socio-Economic Interests - Area (km²)[1]	Overlap With Socio-Economic Interests - Length (km)[2]	Overlap With Socio-Economic Interests Outside SAC - Area (km²)[1]	Overlap With Socio-Economic Interests Outside SAC - Length (km)[2]
1. Pure ecological network (BLM = 0.1)	3289	25	All criteria were met where the minimum criteria were present within the region with the exception of: Broad-scale habitat 'subtidal mud' (minimum diameter); Broad-scale habitat A3 & A4 (connectivity >80Km); Habitat FOCI 'blue mussel beds' (number)	11622	24	11153	24
2. Pure ecological network with SACs locked in (BLM = 0.1)	4275	15	All criteria were met where the minimum criteria were present within the region with the exception of:: Broad-scale habitats A3 & A4 (connectivity >80Km); Habitat FOCI 'peat and clay exposures' (number)	9843	407	7520	209
3. As 1 but with low cost avoidance (BLM = 0.1)	3242	20	All criteria were met where the minimum criteria were present within the region with the exception of: Broad-scale habitat 'subtidal mud' (minimum diameter); Broad-scale habitat A3 & A4 (connectivity >80Km). Habitat FOCI 'peat and clay exposures' (number)	8416	128	Not assessed	Not assessed
4. As 2 but with low cost avoidance (BLM = 0.1)	4080	15	All criteria were met where the minimum criteria were present within the region with the exception of: Broad-scale habitat 'subtidal mud' (minimum diameter); Habitat FOCI 'peat and clay exposures' (number)	8446	391	7337	194
5. As 1 but with high cost avoidance (BLM = 0.1)	2764	31	All criteria were met where the minimum criteria were present within the region with the exception of: Broad-scale habitat 'subtidal mud' (minimum diameter); Broad-scale habitat A3 & A4 (connectivity >80Km). Habitat FOCI 'peat and clay exposures' (number)	7868	0	7712	0
6. As 2 but with high cost avoidance (BLM = 0.1)	4051	15	All criteria were met where the minimum criteria were present within the region with the exception of: Habitat FOCI 'peat and clay exposures' (number)	8176	309	5853	112
7. As 6 but with aggregate and wind farm areas locked out (BLM = 0.1)	3882	15	All criteria were met where the minimum criteria were present within the region with the exception of: Broad-scale habitats 'high and moderate energy circalittoral rock' (minimum diameter) Broad-scale habitats A3 & A4 (connectivity >80Km); Habitat FOCI 'peat and clay exposures' (number)	7999	265	5676	68
8. 1st iteration network	3446	27	All broad-scale and habitat FOCI criteria were met where the minimum criteria were present within the region with the exception of: Broad-scale habitat 'high energy infralittoral rock' (proportion) Most of the species FOCI were not met in relation to points or patches captured.	8019	17	7648	17

1 For activities represented by polygon data - e.g. aggregates sites, aggregate application areas, offshore wind farms, dredge material disposal sites, gas storage sites, hydrocarbon fields, shellfishing areas etc. The total area of overlap exceeds the total area of the network, because activities can overlap, for example, the potential future use areas for marine aggregates and offshore wind overlap with existing uses and with each other.

2 For activities represented by linear features - e.g. cables and pipelines

Table 8. Scenario Performance for Broadscale Habitats (EUNIS Level 3) - Balanced Seas

Broadscale Habitat	EUNIS Level 3 Code	Balanced Seas Region		Targets				Scenario 1: Pure Ecological Network				Scenario 2: Pure Ecological Network with SACs Locked In				Scenario 3: Pure Ecological Network with Low Cost Avoidance				Scenario 4: Pure Ecological Network with SACs Locked In and Low Cost Avoidance				Scenario 5: Pure Ecological Network with High Cost Avoidance				Scenario 6: Pure Ecological Network with SACs Locked In and High Cost Avoidance				Scenario 7: Pure Ecological Network with SACs Locked In, High Cost Avoidance and Aggregate and Wind Farm Areas Locked Out				Scenario 8: 1st Iteration Networks			
		Extent of Features (ha)	No. in Region	Area (ha)	Area %	Number	Min Dia (km)	Extent Captured Area (ha)	Extent Captured %	Number	No Meeting Min Dia	Extent Captured Area (ha)	Extent Captured %	Number	No Meeting Min Dia	Extent Captured Area (ha)	Extent Captured %	Number	No Meeting Min Dia	Extent Captured Area (ha)	Extent Captured %	Number	No Meeting Min Dia	Extent Captured Area (ha)	Extent Captured %	Number	No Meeting Min Dia	Extent Captured Area (ha)	Extent Captured %	Number	No Meeting Min Dia	Extent Captured Area (ha)	Extent Captured %	Number	No Meeting Min Dia	Extent Captured Area (ha)	Extent Captured %	Number	No Meeting Min Dia
High Energy Intertidal Rock	A1.1	Not assessed																																					
Moderate Energy Intertidal Rock	A1.2	Not assessed																																					
Low Energy Intertidal Rock	A1.3	Not assessed																																					
Intertidal Coarse Sediment	A2.1	Not assessed																																					
Intertidal Sand and Muddy Sand	A2.2	Not assessed																																					
Intertidal Mud	A2.3	Not assessed																																					
Intertidal Mixed Sediments	A2.4	Not assessed																																					
Coastal Saltmarshes and Saline Reedbeds	A2.5	Not assessed																																					
Interitidal Sediments Dominated by Aquatic angiosperms	A2.6	Not assessed																																					
Intertidal Biogenic Reefs	A2.7	Not assessed																																					
High Energy Infralittoral Rock	A3.1	81035	>2	12155	15 - 31	2	5	51780	64	>2	>2	39431	49	>2	>2	42876	53	>2	>2	22784	28	>2	>2	12201	15	>2	>2	18306	23	>2	>2	17954	22	>2	>2	8729	11	>2	>2
Moderate Energy Infralittoral Rock	A3.2	55971	>2	9515	17 - 32	2	5	16193	29	>2	>2	9713	17	>2	>2	9550	17	>2	2	9537	17	>2	>2	9531	17	>2	>2	9523	17	>2	>2	9630	17	>2	>2	11986	21	>2	>2
Low Energy Infralittoral Rock	A3.3	5	1	1	16 - 32	2	5	3	62	1	0	5	100	1	0	3	62	1	0	5	100	1	0	3	62	1	0	5	100	1	0	5	100	1	0	5	100	1	0
High Energy Circalittoral Rock	A4.1	179853	>2	19784	11 - 25	2	5	19944	11	>2	>2	25787	14	>2	>2	28216	16	>2	>2	20124	11	>2	>2	19986	11	>2	2	19844	11	>2	>2	20001	11	>2	1	77332	43	>2	>2
Moderate Energy Circalittoral Rock	A4.2	99446	>2	12928	13 - 28	2	5	17888	18	>2	>2	12941	13	>2	>2	13080	13	>2	>2	13065	13	>2	>2	13154	13	>2	2	13752	14	>2	>2	14667	15	>2	1	17168	17	>2	>2
Low Energy Circalittoral Rock	A4.3	Not present																																					
Subtidal Coarse Sediment	A5.1	598106	>2	101678	17 - 32	2	5	101820	17	>2	>2	101752	17	>2	>2	101733	17	>2	>2	101715	17	>2	>2	101957	17	>2	>2	101695	17	>2	>2	101709	17	>2	>2	125826	21	>2	>2
Subtidal Sand	A5.2	572188	>2	85828	15 - 30	2	5	85904	15	>2	>2	148802	26	>2	>2	85959	15	>2	>2	154162	27	>2	>2	86100	15	>2	2	151073	26	>2	>2	138842	24	>2	>2	102869	18	>2	>2
Subtidal Mud	A5.3	29821	>2	4473	15 - 30	2	5	4606	15	>2	1	4767	16	>2	2	4736	16	>2	1	4581	15	>2	1	4484	15	>2	1	7970	27	>2	2	4539	15	>2	2	7549	25	>2	2
Subtidal Mixed Sediments	A5.4	149851	>2	23976	16 - 32	2	5	24016	16	>2	2	39294	26	>2	>2	23988	16	>2	>2	37237	25	>2	>2	24018	16	>2	>2	37689	25	>2	>2	35820	24	>2	>2	47423	32	>2	>2
Subtidal Macrophyte-dominated Sediment	A5.5	Not present																																					
Subtidal Biogenic Reefs	A5.6	Not present																																					
Deep-Sea Bed	A6	Not present																																					

Table 9. Scenario Performance for Connectivity of EUNIS Level 2 Habitats- Balanced Seas

EUNIS Level 2	Target	Scenario 1: Pure Ecological Network	Scenario 2: Pure Ecological Network with SACs Locked In	Scenario 3: Pure Ecological Network with Low Cost Avoidance	Scenario 4: Pure Ecological Network with SACs Locked In and Low Cost Avoidance	Scenario 5: Pure Ecological Network with High Cost Avoidance	Scenario 6: Pure Ecological Network with SACs Locked In and High Cost Avoidance	Scenario 7: Pure Ecological Network with SACs Locked In, High Cost Avoidance and Aggregate and Wind Farm Areas Locked Out	Scenario 8: 1st Iteration Networks
	(km)	(km)	(km)	(km)	(km)	(km)	(km)	(km)	(km)
A3	<80	10-82	55-85	25-124	10-65	12-95	25-70	25-105	5-51
A4	<80	7-82	150	25-124	40-65	4-95	25-70	25-105	5-51
A5	<80	8-60	5-52	3-70	10-65	4-43	25-70	25-80	5-36
A6	<80	Not present	Not present	Not present	Not present	Not present	Not present	Not present	Not present

Table 10. Scenario Performance for Habitat FOCI - Balanced Seas

Habitat FOCI	Balanced Seas Region			Targets		Scenario 1: Pure Ecological Network			Scenario 2: Pure Ecological Network with SACs Locked In			Scenario 3: Pure Ecological Network with Low Cost Avoidance			Scenario 4: Pure Ecological Network with SACs Locked In and Low Cost Avoidance			Scenario 5: Pure Ecological Network with High Cost Avoidance			Scenario 6: Pure Ecological Network with SACs Locked In and High Cost Avoidance			Scenario 7: Pure Ecological Network with SACs Locked In, High Cost Avoidance and Aggregate and Wind Farm Areas Locked Out			Scenario 8: 1st Iteration Networks		
	Area (ha)	Number of Sites	Number Patches Meeting Min Diameter	Number	Min Dia (km)	Extent Captured Area (ha)	Number	No Meeting Min Dia	Extent Captured Area (ha)	Number	No Meeting Min Dia	Extent Captured Area (ha)	Number	No Meeting Min Dia	Extent Captured Area (ha)	Number	No Meeting Min Dia	Extent Captured Area (ha)	Number	No Meeting Min Dia	Extent Captured Area (ha)	Number	No Meeting Min Dia	Extent Captured Area (ha)	Number	No Meeting Min Dia	Extent Captured Area (ha)	Number	No Meeting Min Dia
Blue Mussel Beds	232	11	0	3	5	47	2	0	232	3	0	17	3	0	232	>3	0	47	2	0	232	>3	0	232	>3	0	138	>3	0
Cold-water Coral Reefs		Not present																											
Coral Gardens		Not present																											
Deep-Sea Sponge Aggregations		Not present																											
Estuarine Rocky Habitats	31	22	0	3	5	18	>3	0	27	>3	0	14	>3	0	27	>3	0	18	>3	0	27	>3	0	27	>3	0	10	3	0
File Shell Beds		Not present																											
Fragile Sponge and anthozoan communities on subtidal rocky habitats		Not present																											
Intertidal Underboulder communities		Not assessed																											
Littoral Chalk Communities	967	58	0	3	5	86	>3	0	547	>3	0	71	>3	0	547	>3	0	214	>3	0	547	>3	0	547	>3	0	690	>3	0
Maerl Beds		Not present																											
Horse Mussel (Modiolus modiolus) beds		Not present																											
Mud Habitat in Deep Water		Not present																											
Sea-pen and burrowing megafauna communities		Not present																											
Native Oyster (Ostrea edulis) beds		Not assessed																											
Peat and Clay Exposures	131	3	0	3	5	28	3	0	57	2	0	57	2	0	57	2	0	28	2	0	57	2	0	57	2	0	131	3	0
Honeycomb Worm (Sabellaroa alveolata) Reefs		Not present																											
Ross Worm (Sabellaria spinulosa) Reefs		Not assessed																											
Seagrass Beds	252	25	0	3	5	62	3	0	158	>3	0	116	>3	0	158	>3	0	73	>3	0	158	>3	0	158	>3	0	115	>3	0
Sheltered Muddy Gravels		Not assessed																											
Subtidal Chalk	1425	22	0	3	5	123	3	0	1425	>3	0	148	>3	0	1425	>3	0	173	>3	0	1425	>3	0	1425	>3	0	291	>3	0
Subtidal Sands and Gravels	744588	2434	>3	3	5	218729	>3	3	141823	>3	>3	180403	>3	>3	146684	>3	>3	175091	>3	3	132529	>3	>3	127552	>3	>3	151355	>3	>3
Tide-Swept Channels	1356	62	0	3	5	34	3	0	42	>3	0	65	>3	0	45	>3	0	498	>3	0	45	>3	0	45	>3	0	899	>3	0

Table 11. Scenario Performance for Species FOCI - Balanced Seas

Species FOCI		Balanced Seas Region		Targets	Scenario 1: Pure Ecological Network		Scenario 2: Pure Ecological Network with SACs Locked In		Scenario 3: Pure Ecological Network with Low Cost Avoidance		Scenario 4: Pure Ecological Network with SACs Locked In and Low Cost Avoidance		Scenario 5: Pure Ecological Network with High Cost Avoidance		Scenario 6: Pure Ecological Network with SACs Locked In and High Cost Avoidance		Scenario 7: Pure Ecological Network with SACs Locked In, High Cost Avoidance and Aggregate and Wind Farm Areas Locked Out		Scenario 8: 1st Iteration Networks	
Latin Name	Common Name	Number of Points	Number of Patches	Number of Patches	No of Points Captured	Number of Patches Captured	No of Points Captured	Number of Patches Captured	No of Points Captured	Number of Patches Captured	No of Points Captured	Number of Patches Captured	No of Points Captured	Number of Patches Captured	No of Points Captured	Number of Patches Captured	No of Points Captured	Number of Patches Captured	No of Points Captured	Number of Patches Captured
Padina pavonica	Peacocks Tail	6	6	3	3	3	6	6	3	3	5	>3	3	3	5	>3	5	>3	1	1
Cruoria cruiriaeformis	Burgundy maerl paint weed	Not present																		
Grateloupia montagnei	Grateloups little-lobed weed	Not present																		
Lithothamnion corallioides	Coral maerl	Not present																		
Phymatolithon calcareum	Common Maerl	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1
Alkmaria romijni	Tentacled lagoon worm	Not present																		
Armandia cirrhosa	Lagoon Sandworm	Not present																		
Gobius cobitis	Giant Goby	Not present																		
Gobius couchi	Couch's Goby	Not present																		
Hippocampus guttulatus	Long snouted Seahorse	6	6	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1
Hippocampus hippocampus	Short snouted Seahorse	9	9	3	3	3	4	4	4	4	4	3	3	3	4	4	4	4	2	2
Victorella pavida	Trembling Sea Matt	Not present																		
Amphianthus dohrnii	Sea-fan Anemone	Not present																		
Eunicella verrucosa	Pink Sea fan	Not present																		
Haliclystus auricula	Stalked Jellyfish	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
Leptopsammia pruvoti	Sunset Cup Coral	Not present																		
Lucernariopsis campanulata	Stalked Jellyfish	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
Lucernariopsis cruxmelitensis	Stalked Jellyfish	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Nematostella vectensis	Starlet Sea Anemone	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Gammarus insensibilis	Lagoon Sand Shrimp	5	5	3	3	3	4	4	3	3	4	4	3	3	4	4	4	4	0	0
Gitanopsis bispinosa	Amphipod Shrimp	Not present																		
Pollicipes pollicepes	Gooseneck barnacle	Not present																		
Palinurus elephas	Spiny Lobster	Not present																		
Arctica islandia	Ocean Quahog	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
Atrinia pectinata	Fan Mussel	Not present																		
Caecum armoricum	Defolin's Lagoon Snail	Not present																		
Ostrea edulis	Native Oyster	352	>3	3	31	>3	81	>3	38	>3	72	>3	14	>3	74	>3	74	>3	31	>3
Paludinella littorina	Sea Snail	Not present																		
Tenellia adspersa	Lagoon Sea Slug	4	3	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	3	2
Osmerus eperlanus	Smelt	Not assessed																		
Anguilla anguilla	European Eel	Not assessed																		
Raja undulata	Undulate Ray	Not assessed																		

Table 12. Overlap Between MCZ Networks and Socio-economic Interests - Balanced Seas

Sector	Activity/Element	GIS Layer	Units	Total Extent in Balanced Seas Region	Scenario 1: Pure Ecological Network		Scenario 2: Pure Ecological Network with SAC Locked In		Scenario 3: Pure Ecological Network with Low Cost Avoidance	Scenario 4: Pure Ecological Network with SACs Locked in with Low Cost Avoidance		Scenario 5: Pure Ecological Network with High Cost Avoidance		Scenario 6: Pure Ecological Network with SACs Locked In with High Cost Avoidance		Scenario 7: SACs Locked In, Wind Ffarms and Marine Aggregate Activities Locked Out		Scenario 8: Balanced Seas 1st Iteration Network	
					Total Overlap	Overlap Minus SAC	Total Overlap	Overlap Minus SAC	Total Overlap	Total Overlap	Overlap Minus SAC	Total Overlap	Overlap Minus SAC	Total Overlap	Overlap Minus SAC	Total Overlap	Overlap Minus SAC	Total Overlap	Overlap Minus SAC
Aggregates	Existing licence areas	Dredging Licence Areas	KM²	372	140	127	152	119	178	105	72	0	0	63	31	49	16	3	3
	Application areas	Dredging Application areas	KM²	430	5	5	47	28	0	35	15	0	0	38	19	29	9	237	237
		Aggregates Prospecting Layer	KM²	1970	144	144	239	234	118	167	163	3	3	140	136	100	95	300	300
	Potential future interest use areas	Potential Future Aggregate Resource Medium	KM²	4158	1490	1490	67	62	851	297	292	1766	1766	527	522	549	544	560	560
		Potential Future Aggregate Resource High	KM²	10018	1643	1550	2508	2015	1410	2151	1658	562	558	1888	1395	1717	1224	1707	1635
Oil & Gas	Existing structures – surface + subsurface platforms, pipelines, cables	Surface installations		3	0	0	1	1	0	2	2	0	0	2	2	2	2	0	0
		Active Exploration Wells				0		0		No active			0				0		0
		Active Pipelines	KM			0		0		None			0				0		0
Offshore Wind	Existing and consented (not yet built) wind farms (apply to R1/R2 sites)	Wind Farms Round 1 & 2	KM²	287	0	0	189	84	10	192	87	0	0	159	54	130	25	0	0
	Cables for R1/R2 sites	Wind Farm Export Cables	KM	71	11	11	20	18	24	9	8	0	0	7	5	1	0	0	0
	Application areas (R2.5 and R3 sites)	Wind Farms Round 3	KM²	418	228	228	16	16	0	0		87	87	0	0	0	0	2	2
	Cable routes for R3 sites	Digitised R3 cable routes	KM	73	13	13	40	24	16	29	13	0	0	25	9	18	2	0	0
	Potential future interest use areas	Floating interest future use Medium	KM²	0	0	0	0	0	0	0		0	0	0	0		0		0
		Floating interest future use High	KM²	8	0	0	0	0	0	0		0	0	0	0		0	0	0
		Fixed foundation future use Medium	KM²	1301	398	398	258	221	337	151	114	304	304	113	76	154	117	283	283
		Fixed foundation future use High	KM²	511	118	118	85	76	136	24	16	26	26	26	17	24	16	142	142
	Possible future cable routes	Future Cable Routes	KM	345	0	0	297	139	53	304	146	0	0	238	80	209	51	7	7
		Wind Demonstration Sites	Count																
Wet Renewables	Existing leased areas and application areas (lease option areas?)	Pentland Firth Round 1 Lease Option Areas (Tidal). Ramsey sound, Wave hub etc				0		0					0				0		0
	Potential future interest use areas	Tide Future Interest (High)	KM²	5	0	0	5	5	5	5	5	0	0	5	5	5	5	5	5
		Tide Future Interest (Medium)	KM²	32	4	4	32	29	13	32	29	0	0	32	29	32	29	21	21
		Wave Future Interest (High)	KM²	30	0	0	30	30	0	5	5	0	0	9	9	29	29	27	27
		Wave Future Interest (Medium)	KM²	1583	297	297	84	84	234	2	2	404	404	1	1	66	66	636	636
Cables	Existing cables (live telecom cables, power interconnectors)	Telecom_cables	KM	958	72	72	87	79	41	100	93	132	132	136	128	112	104	119	116
	Future cables (proposed telecom cables and proposed power interconnectors/power grid)	brit-ned, anglo scot hvdc link,	KM	137	0	0	50	28	35	50	28	0	0	39	17	37	15	10	10
CCS/Gas Storage	Existing lease areas/option areas	Hydrocarbon Fields	KM²			0		0		None			0				0		0
		Gas Storage Leases				0		0		None			0				0		0
	Potential future use areas	Gas Potential Sites	KM²			0		0					0				0		0
		CCS Potential Sites	KM²			0		0					0				0		0
	Future pipeline	Proposed_pipelines				0		0					0				0		0
Dredging and disposal	Existing maintained areas	Maintained Dredge Areas	KM²	42	3	3	14	14	2	13	13	0	0	14	13	14	13	2	2
	Existing disposal areas	Disposal Sites	KM²	122	12	12	47	25	14	41	19	0	0	34	12	31	9	5	5
	New capital dredge areas	No information available				0		0					0		0		0		0
Commercial Fisheries	Fisheries values	VMS Data	Cost £	5096449	1548983	1542747	201017	177291	413833	290908	267183	1007717	1007672	388020	364294	353904	330179	1027222	1009287
		Number of VMS cells overlapping greater than £5000	count	157	67	67	2	2	4	1		17	17	5	5	1	1	30	30
	Shellfish Values	Shellfish Data (MB106)	KM²	24443	7089	6766	5558	4345	4850	4759	4759	4661	4559	4630	3417	4574	3361	3915	3733
Aquaculture	Finfish aquaculture	No Finfish Aquaculture within the area																	
	Shellfish aquaculture installations	Shellfish aquaculture sites	KM²	732	51	11	512	132	258	468	88	55	5	497	117	497	117	175	58
Total overlap (km²)			KM²	46462	11622	11153	9843	7520	8416	8446	7337	7868	7712	8176	5853	7999	5676	8019	7648
Total overlap (km)			KM	626	24	24	407	209	128	391	194	0	0	309	112	265	68	17	17

Based on Table 12, the following summaries are provided for individual TCE business activities.

3.3.3.1 Marine aggregates

There are approximately 372km^2 of existing licensed areas and 430km^2 of application areas within the Balanced Seas Region. Spatial overlap ranged from 0 to 178km^2 for existing licences and 0 to 237km^2 for application areas across the various scenarios. The extent of spatial overlap with aggregate prospecting areas and high and medium aggregate potential areas also varied considerably across scenarios, generally affecting up to 25% of these potential resource areas. The networks for scenario 5 (high cost avoidance) did not overlap with any existing or application areas. The locking out of marine aggregate areas outside of SACs resulted in some remaining overlap (49km^2). This area is mostly within SACs but extends outside of SACs where licence areas cross SAC boundaries.

3.3.3.2 Oil & Gas

There are only 3 oil & gas installations in the Balanced Seas Region. The different scenarios overlapped with between 0 to 2 of these installations.

3.3.3.3 Offshore wind

There are 287 km^2 of R1/R2 sites and 418 km^2 of R3 sites within the Balanced Seas Region. Spatial overlap ranged from 0 to 192km^2 for R1/R2 areas and 0 to 228km^2 for R3 zones across the various scenarios. The extent of spatial overlap with potential future interest areas also varied considerably across scenarios, generally affecting up to 30% of these potential resource areas. Several of the scenarios avoided any overlap with existing or proposed wind farm areas and involved minimum overlap with existing and potential cable routes.

3.3.3.4 Wet renewables

There are no existing wave and tidal lease areas in Balanced Seas Region. There are areas of potential future interest for wave and tidal deployments. Between 0 and 100% of these interest areas are captured within the different network scenarios. All of the tidal interest is captured in the majority of the scenarios explored.

3.3.3.5 Telecom cables

There are 958km of existing live telecom cable and 137km of planned telecom cable within the Balanced Seas Region. Spatial overlap ranged from 40 to 136km for existing cables and 0 to 50km for planned cable across the different scenarios.

3.3.3.6 Gas storage

There are no existing or potential facilities identified in Balanced Seas Region.

3.3.3.7 Carbon capture and storage

There are no existing or potential facilities identified in Balanced Seas Region.

3.3.3.8 Coastal business

The socio-economic assessment has included limited information on activities relevant to TCE's coastal business. There are 42 km^2 of maintained navigation channel and 122 km^2 of licensed dredged material disposal site within the Balanced Seas Region. Spatial overlap ranged from 2 to 14km^2 for maintained navigation channels and 0 to 47km^2 for dredged material disposal sites across the different scenarios.

3.3.3.9 Aquaculture

There is approximately 732 km^2 of waterbody containing shellfish aquaculture sites[4] in Balanced Seas Region and no finfish aquaculture occurs. Spatial overlap ranged from 11 to 497km^2 across the different scenarios. Approximately 380km^2 of this area is within existing/recently designated SACs.

3.4 Finding Sanctuary Area

3.4.1 Introduction

Figures 18 to 26 illustrate the MCZ networks generated for each scenario. Summary information for each scenario is presented in Table 13. The performance of each scenario against MCZ ecological criteria is summarised in Tables 14 - 17. The extent of overlap with socio-economic interests is presented in Table 18. The total extent for the Finding Sanctuary area is 94,872 km^2.

The First Iteration network under scenario 8 is twice the size of the networks developed by Marxan under scenarios 1-7 (39,804 km^2 compared to a range of 15,129 - 17,636 km^2) and this will need to be taken into consideration when interpreting results. The modelled scenario networks occupied between 16-19% of the Finding Sanctuary area. The size of the network within the different scenarios was not necessarily correlated with the number of sites which varied between 31-73.

3.4.2 Conformance with Ecological Criteria

The Marxan tool seeks to identify network options that meet the ecological criteria at 'minimum cost'. Thus for each scenario, the network solutions largely meet the criteria that have been coded within Marxan.

No assessment of performance has been made in relation to the following criteria: overall diversity, important areas for key life cycle stages of species, high natural pelagic productivity or reference areas.

[4] The location of individual shellfish aquaculture installations in England is commercially sensitive. The available data layer simply identifies waterbodies which contain shellfish aquaculture installations. For example, Portsmouth, Langstone & Chichester Harbours are identified as a waterbody containing shellfish aquaculture installations.

3.4.2.1 Broad-scale habitats

All of the scenarios met the minimum percentage area and the minimum number of areas required for broad-scale habitats (Table 14). The minimum diameter requirements for broad-scale habitats could not be coded within Marxan. However, the great majority of habitats met the minimum diameter requirements where possible (cells shaded green or orange). For A3.2 Moderate Energy Infralittoral Rock the minimum diameter requirements were met for five of the eight scenarios.

The criterion relating to the connectivity of EUNIS level 2 habitats could not be coded within Marxan but performance against the criterion has still been assessed. Connectivity was met for A4 (Circalittoral Rock) and A5 habitats (Sublittoral Sediment) except under a couple of scenarios where the maximum distance reached 85-95 km above the target of 80 km. However, the connectivity target was not met for A3 habitats (Infralittoral Rock) except for scenario 8.

3.4.2.2 Habitat FOCI

All the scenarios meet the minimum requirement for the number of habitat FOCI areas based on the extent and distribution of habitat actually present within the Finding Sanctuary area (Table 16, cells shaded green or orange). For example, blue mussel beds within the Finding Sanctuary area form a single patch of approx 0.772 ha (or 0.008 km^2). Therefore, the target for 3 habitat patches with a minimum diameter of 5 km will never be met.

It is not possible to code the minimum diameter for habitat areas within Marxan but performance against this criterion was still assessed. This criterion was not met for three of the habitat FOCI (mud habitat in deep water, seagrass beds and *Sabellaria spinulosa* reefs in most of the scenarios (red cells in Table 16). This is despite the fact that there are sufficient patches meeting the minimum diameter within the Finding Sanctuary area. Performance could therefore be improved by locking in some of the required areas into future scenarios.

3.4.2.3 Species FOCI

For the species FOCI, the greatest proportion of data is represented within the respective point layers rather than the polygon layers. The point layer was therefore used in preference to the polygon layer, although the polygon layer includes some areas not represented in the point layer. In using the point layer data it has therefore not been possible to assess whether the minimum patch diameters have been met. The evaluation has been limited to an assessment of whether the required number of patches has been captured within the network.

Most of the scenarios meet the minimum requirement for most of the species FOCI for the number of patches, based on the number of patches actually present within the Finding Sanctuary area (Table 16, cells shaded green or orange). Exceptions include *Alkmaria romijni* the tentacled lagoon worm (which inhabits saline lagoons) and the fan mussel *Atrina pectinata*. It is also worth noting that Scenario 8, the 1St iteration network from the regional project group did not perform well at meeting targets for six species despite being a larger network in terms of size, based on a comparison against the point data layers.

Table 13. Summary of Scenario Performance - Finding Sanctuary Area

Scenario	Network Area (Km²)	No of Sites	Extent to Which Ecological Criteria are Met	Overlap With Socio-Economic Interests - Area (km²)[1]	Overlap With Socio-Economic Interests - Length (km)[2]	Overlap With Socio-Economic Interests Outside SAC - Area (km²)[1]	Overlap With Socio-Economic Interests Outside SAC - Length (km)[2]
1. Pure ecological network (BLM = 0.1)	15738	68	All criteria were met where the minimum criteria were present within the region with the exception of: Broad-scale habitat A3.2 (minimum diameter); Broad-scale habitat A3 (connectivity >80Km); Habitat FOCI 'mud habitat in deep water', 'ross worm reefs', 'Seagrass beds' (minimum diameter).	36939	1132	35962	1064
2. Pure ecological network with SACs locked in (BLM = 0.1)	15209	31	All criteria were met where the minimum criteria were present within the region with the exception of: Broad-scale habitat 'Moderate energy infralittoral rock' (minimum diameter); Broad-scale habitats A3 (connectivity >80Km). Habitat FOCI 'mud habitat in deep water', 'ross worm reefs', 'seagrass beds' (minimum diameter). Species FOCI *A. romijni* (number).	35567	1376	30412	1194
3. As 1 but with low cost avoidance (BLM = 10)	17636	59	All criteria were met where the minimum criteria were present within the region with the exception of: Broad-scale habitat 'moderate energy infralittoral rock' (minimum diameter); Broad-scale habitat A3 & A5 (connectivity >80Km). Habitat FOCI 'seagrass beds' & '*S. spinulosa* reefs' (minimum diameter).	45503	1695	Not assessed	Not assessed
4. As 2 but with low cost avoidance (BLM = 0.1)	15248	34	All criteria were met where the minimum criteria were present within the region with the exception of: Broad-scale habitats A3 (connectivity >80Km); Habitat FOCI 'mud habitat in deep water' & 'seagrass beds' (minimum diameter). Species FOCI *A. romijni* (number) & *A. Pectinata* (number).	32989	1365	27879	1183
5. As 1 but with high cost avoidance (BLM = 10)	16258	73	All criteria were met where the minimum criteria were present within the region with the exception of: Broad-scale habitats A3 & A4 (connectivity >80Km); Habitat FOCI 'mud habitat in deep water', 'ross worm reefs' & 'seagrass beds' (minimum diameter).	34064	1394	Not assessed	Not assessed
6. As 2 but with high cost avoidance (BLM = 0.1)	15681	44	All criteria were met where the minimum criteria were present within the region with the exception of: Broad-scale habitat A3 & A4 (connectivity >80Km). Habitat FOCI 'mud habitat in deep water' & 'seagrass beds (minimum diameter). Species FOCI *A. romijni* (number) and *A. Pectinata* (number).	33846	1277	28736	1095
7. As 6 but with aggregate and wind farm areas locked out (BLM = 0.1)	15129	36	All criteria were met where the minimum criteria were present within the region with the exception of: Broad-scale habitat A3 (connectivity >80Km). Habitat FOCI 'mud habitat in deep water', 'ross worm reefs' & 'seagrass beds' (minimum diameter). Species FOCI *A. romijni* (number) & *A. Pectinata* (number).	33430	1186	28298	1004
8. 1st iteration network (BLM = 0.1)	39804	31	All criteria were met where the minimum criteria were present within the region with the exception of: Habitat FOCI 'seagrass beds' (minimum diameter) and species FOCI *A. cirrhosa, G. couchi, N. vectensis, G. bispinosa, P. pollicepes & T. adspersa* (number).	67203	3058	64245	2982

[1] For activities represented by polygon data - e.g. aggregates sites, aggregate application areas, offshore wind farms, dredge material disposal sites, gas storage sites, hydrocarbon fields, shellfishing areas etc. The total area of overlap exceeds the total area of the network, because activities can overlap, for example, the potential future use areas for marine aggregates and offshore wind overlap with existing uses and with each other.

[2] For activities represented by linear features - e.g. cables and pipelines

Table 14. Scenario Performance for Broadscale Habitats (EUNIS Level 3) - Finding Sanctuary

Broadscale Habitat	EUNIS Level3 Code	Finding Sanctuary Region		Targets				Scenario 1: Pure Ecological Network				Scenario 2: Pure Ecological Network with SACs Locked In				Scenario 3: Pure Ecological Network with Low Cost Avoidance				Scenario 4: Pure Ecological Network with SACs Locked In and Low Cost Avoidance				Scenario 5: Pure Ecological Network with High Cost Avoidance				Scenario 6: Pure Ecological Network with SACs Locked In and High Cost Avoidance				Scenario 7: Pure Ecological Network with SACs Locked In, High Cost Avoidance and Aggregate and Wind Farm Areas Locked Out				Scenario 8: 1st Iteration Networks			
		Extent of Features	Number in Region	Area		Number	Min Dia	Extent Captured		Number	No Meeting Min Dia	Extent Captured		Number	No Meeting Min Dia	Extent Captured		Number	No Meeting Min Dia	Extent Captured		Number	No Meeting Min Dia	Extent Captured		Number	No Meeting Min Dia	Extent Captured		Number	No Meeting Min Dia	Extent Captured		Number	No Meeting Min Dia	Extent Captured		Number	No Meeting Min Dia
		(ha)		(ha)	%		(km)	Area (ha)	%			Area (ha)	%			Area (ha)	%			Area (ha)	%			Area (ha)	%			Area (ha)	%			Area (ha)	%			Area (ha)	%		
High Energy Intertidal Rock	A1.1	Not assessed																																					
Moderate Energy Intertidal Rock	A1.2	Not assessed																																					
Low Energy Intertidal Rock	A1.3	Not assessed																																					
Intertidal Coarse Sediment	A2.1	Not assessed																																					
Intertidal Sand and Muddy Sand	A2.2	Not assessed																																					
Intertidal Mud	A2.3	Not assessed																																					
Intertidal Mixed Sediments	A2.4	Not assessed																																					
Coastal Saltmarshes and Saline Reedbeds	A2.5	Not assessed																																					
Intertidal Sediments Dominated by Aquatic angiosperms	A2.6	Not assessed																																					
Intertidal Biogenic Reefs	A2.7	Not assessed																																					
High Energy Infralittoral Rock	A3.1	67879	>2	10182	15 - 31	2	5	10186	15	>2	>2	42546	63	>2	>2	10186	15	>2	>2	43040	63	>2	>2	10274	15	>2	>2	42837	63	>2	>2	41526	61	>2	>2	25481	38	>2	>2
Moderate Energy Infralittoral Rock	A3.2	29656	>2	5042	17 - 32	2	5	5066	17	>2	1	16748	56	>2	1	5044	17	>2	1	16018	54	>2	>2	5069	17	>2	>2	15980	54	>2	>2	23567	79	>2	>2	12743	43	>2	>2
Low Energy Infralittoral Rock	A3.3	526	>2	84	16 - 32	2	5	110	21	>2	0	506	96	>2	0	109	21	>2	0	483	92	>2	0	218	41	>2	0	483	92	>2	0	506	96	>2	0	333	63	>2	0
High Energy Circalittoral Rock	A4.1	122109	>2	13432	11 - 25	2	5	45574	37	>2	>2	13465	11	>2	>2	13438	11	>2	>2	13506	11	>2	>2	18778	15	>2	>2	13582	11	>2	>2	13464	11	>2	>2	41182	34	>2	>2
Moderate Energy Circalittoral Rock	A4.2	1895844	>2	246460	13 - 28	2	5	329782	17	>2	>2	246470	13	>2	>2	470363	25	>2	>2	286770	15	>2	>2	418728	22	>2	>2	288477	15	>2	>2	262480	14	>2	>2	473777	25	>2	>2
Low Energy Circalittoral Rock	A4.3	321	>2	51	16 - 32	2	5	321	100	>2	0	321	100	>2	0	321	100	>2	0	321	100	>2	0	321	100	>2	0	321	100	>2	0	321	100	>2	0	80	25	>2	0
Subtidal Coarse Sediment	A5.1	2954543	>2	502272	17 - 32	2	5	503079	17	>2	>2	503097	17	>2	>2	503070	17	>2	>2	503077	17	>2	>2	518283	18	>2	>2	512161	17	>2	>2	503064	17	>2	>2	1421751	48	>2	>2
Subtidal Sand	A5.2	3363577	>2	504537	15 - 30	2	5	515146	15	>2	>2	520461	15	>2	>2	607903	18	>2	>2	504612	15	>2	>2	505686	15	>2	>2	504551	15	>2	>2	504696	15	>2	>2	1820391	54	>2	>2
Subtidal Mud	A5.3	633377	>2	95007	15 - 30	2	5	95014	15	>2	>2	101326	16	>2	>2	103312	16	>2	>2	95055	15	>2	>2	110491	17	>2	>2	95365	15	>2	>2	100433	16	>2	>2	298854	47	>2	>2
Subtidal Mixed Sediments	A5.4	291642	>2	46663	16 - 32	2	5	81107	28	>2	>2	59154	20	>2	>2	46674	16	>2	>2	46676	16	>2	>2	48680	17	>2	>2	89543	31	>2	>2	58151	20	>2	>2	155401	53	>2	>2
Subtidal Macrophyte-dominated Sediment	A5.5	Not present																																					
Subtidal Biogenic Reefs	A5.6	Not assessed																																					
Deep-Sea Bed	A6	Not present																																					

Table 15. Scenario Performance for Connectivity of EUNIS Level 2 Habitats - Finding Sanctuary

EUNIS Level 2	Target	Scenario 1: Pure Ecological Network	Scenario 2: Pure Ecological Network with SACs Locked In	Scenario 3: Pure Ecological Network with Low Cost Avoidance	Scenario 4: Pure Ecological Network with SACs Locked In and Low Cost Avoidance	Scenario 5: Pure Ecological Network with High Cost Avoidance	Scenario 6: Pure Ecological Network with SACs Locked In and High Cost Avoidance	Scenario 7: Pure Ecological Network with SACs Locked In, High Cost Avoidance and Aggregate and Wind Farm Areas Locked Out	Scenario 8: 1st Iteration Networks
	(km)	(km)	(km)	(km)	(km)	(km)	(km)	(km)	(km)
A3	<80Km	35-200km	20-100km	15-175km	7-85km	22-175km	15-96km	15-100km	5-60km
A4	<80Km	5-50Km	20-55km	15-45km	15-55km	12-85km	11-95km	15-58km	2-40km
A5	<80Km	4-50Km	4-75km	8-88km	15-75km	10-62km	5-72km	4-70km	2-40km
A6	<80Km	Not present	Not present	Not present	Not present	Not present	Not present	Not present	Not present

Table 16. Scenario Performance for Habitat FOCI - Finding Sanctuary

Habitat FOCI	Finding Sanctuary Region			Targets		Scenario 1: Pure Ecological Network			Scenario 2: Pure Ecological Network with SACs Locked In			Scenario 3: Pure Ecological Network with Low Cost Avoidance			Scenario 4: Pure Ecological Network with SACs Locked In and Low Cost Avoidance			Scenario 5: Pure Ecological Network with High Cost Avoidance			Scenario 6: Pure Ecological Network with SACs Locked In and High Cost Avoidance			Scenario 7: Pure Ecological Network with SACs Locked In, High Cost Avoidance and Aggregate and Wind Farm Areas Locked Out			Scenario 8: 1st Iteration Networks		
	Area (ha)	Number of Sites	Number Patches Meeting Min Dia	Number	Min dia (km)	Extent Captured Area (ha)	Number	No Meeting Min Dia	Extent Captured Area (ha)	Number	No Meeting Min Dia	Extent Captured Area (ha)	Number	No Meeting Min Dia	Extent Captured Area (ha)	Number	No Meeting Min Dia	Extent Captured Area (ha)	Number	No Meeting Min Dia	Extent Captured Area (ha)	Number	No Meeting Min Dia	Extent Captured Area (ha)	Number	No Meeting Min Dia	Extent Captured Area (ha)	Number	No Meeting Min Dia
Blue Mussel Beds	1	1	0	3	5	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0
Cold-water Coral Reefs		Not present																											
Coral Gardens		Not present																											
Deep-Sea Sponge Aggregations		Not present																											
Estuarine Rocky Habitats	5	15	0	3	5	2	3	0	5	>3	0	1	>3	0	5	>3	0	2	>3	0	5	>3	0	5	>3	0	5	>3	0
File Shell Beds		Not present																											
Fragile Sponge and anthozoan communities on subtidal rocky habitats		Not assessed																											
Intertidal Underboulder communities	0	1	0	3	5	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0
Littoral Chalk Communities		Not present																											
Maerl Beds	1542	>3	0	3	5	291	>3	0	1458	>3	0	234	>3	0	1180	>3	0	272	>3	0	1405	>3	0	1405	>3	0	1509	>3	0
Horse Mussel (Modiolus modiolus) beds		Not present																											
Mud Habitat in Deep Water	7465	1	1	3	5	30	1	0	143	1	0	2800	1	1	22	1	0	30	1	0	4	1	0	326	1	0	7465	1	1
Sea-pen and burrowing megafauna communities		Not assessed																											
Native Oyster (Ostrea edulis) beds	3	2	0	3	5	3	2	0	3	2	0	3	2	0	3	2	0	3	2	0	3	2	0	3	2	0	3	2	0
Peat and Clay Exposures		Not assessed																											
Honeycomb Worm (Sabellaroa alveolata) Reefs	2	4	0	3	5	1	>3	0	1	>3	0	1	>3	0	1	>3	0	1	3	0	1	>3	0	1	>3	0	2	>3	0
Ross Worm (Sabellaria spinulosa) Reefs	42694	1	1	3	5	44	1	0	20	1	0	44	1	0	1228	1	1	400	1	0	225	1	1	20	1	0	32253	1	1
Seagrass Beds	2291	>3	1	3	5	477	>3	0	1032	>3	0	523	>3	0	997	>3	0	402	>3	0	996	>3	0	1459	>3	0	1816	>3	0
Sheltered Muddy Gravels	51	>3	0	3	5	44	>3	0	44	>3	0	44	>3	0	44	>3	0	44	>3	0	44	>3	0	44	3	0	5	>3	0
Subtidal Chalk		Not assessed																											
Subtidal Sands and Gravels	761561	>3	>3	3	5	166132	>3	>3	146691	>3	>3	129208	>3	>3	66480	>3	>3	119611	>3	>3	54807	>3	>3	87178	>3	>3	202296	>3	>3
Tide-Swept Channels	117	>3	0	3	5	18	3	0	101	>3	>3	2	3	0	101	>3	0	10	3	0	101	>3	0	101	>3	0	76	>3	0

Table 17. Scenario Performance for Species FOCI - Finding Sanctuary

Species FOCI		Finding Sanctuary Region		Targets	Scenario 1: Pure Ecological Network		Scenario 2: Pure Ecological Network with SACs Locked In		Scenario 3: Pure Ecological Network with Low Cost Avoidance		Scenario 4: Pure Ecological Network with SACs Locked In and Low Cost Avoidance		Scenario 5: Pure Ecological Network with High Cost Avoidance		Scenario 6: Pure Ecological Network with SACs Locked In and High Cost Avoidance		Scenario 7: Pure Ecological Network with SACs Locked In, High Cost Avoidance and Aggregate and Wind Farm Areas Locked Out.		Scenario 8: 1st Iteration Networks	
Latin Name	Common Name	Number of Points	Number of Patches	Number of Patches	No of Points Captured	Number of Patches Captured	No of Points Captured	Number of Patches Captured	No of Points Captured	Number of Patches Captured	No of Points Captured	Number of Patches Captured	No of Points Captured	Number of Patches Captured	No of Points Captured	Number of Patches Captured	No of Points Captured	Number of Patches Captured	No of Points Captured	Number of Patches Captured
Padina pavonica	Peacocks Tail	20	20	3	3	3	15	>3	6	>3	14	>3	3	3	15	>3	13	>3	10	>3
Cruoria cruiriaeformis	Burgundy maerl paint weed	5	4	3	4	3	5	>3	4	3	5	>3	3	3	5	>3	5	>3	5	>3
Grateloupia montagnei	Grateloups little-lobed weed	Not present																		
Lithothamnion corallioides	Coral maerl	24	11	3	6	>3	24	>3	9	>3	24	>3	6	>3	24	>3	24	>3	21	>3
Phymatolithon calcareum	Common Maerl	44	25	3	3	3	25	>3	11	>3	30	>3	5	3	29	>3	23	>3	35	>3
Alkmaria romijni	Tentacled lagoon worm	16	9	3	4	3	2	2	3	3	2	2	5	>3	2	2	2	2	3	3
Armandia cirrhosa	Lagoon Sandworm	2	2	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	0
Gobius cobitis	Giant Goby	47	26	3	4	3	36	>3	8	3	37	>3	11	>3	37	>3	36	>3	45	>3
Gobius couchi	Couch's Goby	4	4	3	3	3	4	>3	3	3	4	>3	3	3	4	>3	4	>3	2	2
Hippocampus guttulatus	Long snouted Seahorse	6	6	3	3	3	6	>3	3	3	5	>3	3	3	5	>3	6	>3	5	>3
Hippocampus hippocampus	Short snouted Seahorse	9	9	3	3	3	7	>3	3	3	5	>3	3	3	5	3	6	>3	8	>3
Victorella pavida	Trembling Sea Matt	Not assessed																		
Amphianthus dohrnii	Sea-fan Anemone	31	18	3	12	>3	28	>3	14	>3	28	>3	10	3	28	>3	28	>3	11	>3
Eunicella verrucosa	Pink Sea fan	601	188	3	78	>3	516	>3	133	>3	499	>3	71	>3	499	>3	508	>3	311	>3
Haliclystus auricula	Stalked Jellyfish	20	19	3	3	3	16	>3	3	3	16	>3	3	3	16	>3	16	>3	16	>3
Leptopsammia pruvoti	Sunset Cup Coral	25	8	3	15	3	25	>3	15	3	25	>3	14	3	25	>3	25	>3	19	>3
Lucernariopsis campanulata	Stalked Jellyfish	14	14	3	3	3	8	>3	3	3	8	>3	3	3	8	>3	8	>3	14	>3
Lucernariopsis cruxmelitensis	Stalked Jellyfish	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Nematostella vectensis	Starlet Sea Anemone	2	2	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	0
Gammarus insensibilis	Lagoon Sand Shrimp	not assessed																		
Gitanopsis bispinosa	Amphipod Shrimp	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
Pollicipes pollicepes	Gooseneck barnacle	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
Palinurus elephas	Spiny Lobster	37	34	3	4	>3	29	>3	11	>3	29	>3	6	>3	28	>3	29	>3	16	>3
Arctica islandia	Ocean Quahog	27	26	3	6	>3	13	>3	3	3	15	>3	5	5	12	>3	14	>3	13	>3
Atrinia pectinata	Fan Mussel	11	5	3	9	3	6	>3	3	3	5	2	6	3	5	2	5	2	10	>3
Caecum armoricum	Defolin's Lagoon Snail	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Ostrea edulis	Native Oyster	193	61	3	40	>3	152	>3	39	>3	153	>3	40	>3	152	>3	152	>3	147	>3
Paludinella littorina	Sea Snail	16	12	3	3	3	13	>3	3	3	13	>3	3	3	13	>3	13	>3	10	>3
Tenellia adspersa	Lagoon Sea Slug	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
Osmerus eperlanus	Smelt	Not assessed																		
Anguilla anguilla	European Eel	Not assessed																		
Raja undulata	Undulate Ray	Not assessed																		

Table 18. Overlap Between MCZ Networks and Socio-economic Interests - Finding Sanctuary

Sector	Activity/Element	GIS Layer	Units	Total Extent in Finding Sanctuary Region	Scenario 1: Pure Ecological Network		Scenario 2: Pure Ecological Network with SAC Locked In		Scenario 3: Pure Ecological Network with Low Cost Avoidance	Scenario 4: Pure Ecological Network with SACs Locked in with Low Cost Avoidance		Scenario 5: Pure Ecological Network with High Cost Avoidance	Scenario 6: Pure Ecological Network with SACs Locked In with High Cost Avoidance		Scenario 7: SACs Locked In, Wind Farms and Marine Aggregate Activities Locked Out		Scenario 8: Finding Sanctuary 1st Iteration Network	
					Total Overlap	Overlap Minus SAC	Total Overlap	Overlap Minus SAC	Total Overlap	Total Overlap	Overlap Minus SAC	Total Overlap	Total Overlap	Overlap Minus SAC	Total Overlap	Overlap Minus SAC	Total Overlap	Overlap Minus SAC
Aggregates	Existing licence areas	Dredging Licence Areas	km²	15	None		1	0	None	1	0	0	1	0	0	0	11	11
	Application areas	Dredging Application areas	km²	8	None		None		None	None		None	None		None		8	8
		Aggregates Prospecting Layer	km²	45	None		6	6	None	6	6	1	6	6	6	6	5	5
	Potential future interest use areas	Potential Future Aggregate Resource Medium	km²	2028	None		211	121	179	180	90	143	200	111	115	25	654	570
		Potential Future Aggregate Resource High	km²	1241	23	23	143	36	23	188	80	34	155	47	143	35	784	697
Oil & Gas	Existing structures – surface + subsurface platforms, pipelines, cables	Surface installations	Count	2 but see notes 1 & 2 below	None		2 but see notes 1 & 2 below	1	None	1 but see note 1 below	0	None	1 but see note 1 below	0	1 but see note 1 below	0	2 but see notes 1 & 2 below	1
		Active Exploration Wells	Count	2 but see note 3	None		None		None	1	1	None	2	2	None		2	2
		Active Pipelines	km	None														
Offshore Wind	Existing and consented (not yet built) wind farms (apply to R1/R2 sites)	Wind Farms Round 1 & 2	km²	None														
	Cables for R1/R2 sites	Wind Farm Export Cables	km	89	21	15	50	16	25	51	17	7	50	16	57	23	62	35
	Application areas (R2.5 and R3 sites)	Wind Farms Round 3	km²	1204	166	166	0	0	13	43	43	7	129	129	None		953	953
	Cable routes for R3 sites	Digitised R3 cable routes	km	149	21	21	29	28	None	33	31	43	42	40	30	28	70	70
	Potential future interest use areas	Floating interest future use Medium	km²	43695	6263	6230	4975	4955	6117	5880	5880	6603	8240	8240	8232	8222	18079	17757
		Floating interest future use High	km²	1739	336	336	53	53	265	157	157	197	35	35	6	6	274	274
		Fixed foundation future use Medium	km²	1876	520	520	701	697	198	261	256	421	165	161	200	196	109	109
		Fixed foundation future use High	km²	67	25	25	52	48	32	32	28	2	25	21	49	45	16	16
	Possible future cable routes	Future Cable Routes	km	None														
		Wind Demonstration Sites	Count															
Wet Renewables	Existing leased areas and application areas	Pentland Firth Round 1 Lease Option Areas (Tidal). Ramsey sound, Wave hub etc ("Wave Lease Live")	Count	8	None		7	7	None	1	1	None	None		None		6	6
	Potential future interest use areas	Tide Future Interest (High)	km²	4	None		4	0	None	4	0	None	4	0	4	0	1	0
		Tide Future Interest (Medium)	km²	48	10	10	17	10	3	10	3	18	7	0	17	10	20	14
		Wave Future Interest (High)	km²	10116	1288	1272	2110	1976	1659	1746	1612	1237	1869	1735	1195	1061	3053	3040
		Wave Future Interest (Medium)	km²	55021	11015	10965	7524	7419	11527	7213	7132	11759	8756	8675	9262	9168	20023	19498
Cables	Existing cables (live telecom cables, power interconnectors)	Telecom cables	km	7587	1090	1029	1297	1150	1669	1282	1135	1343	1185	1039	1099	953	2927	2878
	Future cables (proposed telecom cables and proposed power interconnectors/power grid)	brit-ned, anglo scot hvdc link,	km	None														
CCS/Gas Storage	Existing lease areas/option areas	Hydrocarbon Fields	km²	None														
		Gas Storage Leases	Count	1	1	1	None		1	None		None	None		None		None	
	Potential future use areas	Gas Potential Sites	km²	None														
		CCS Potential Sites	km²	None														
	Future pipeline	Proposed pipelines	km	None														
Dredging and Disposal	Existing maintained areas	Maintained Dredged Areas	km²	5	1	1	4	1	0	4	1	1	4	1	4	1	3	1
	Existing disposal areas	Disposal Sites Open	km²	7	1	1	1	1	1	1	1	None	0	0	1	1	6	6
	New capital dredge areas	No information available												0				
Commercial Fisheries	Fisheries values	VMS Data	Cost £	32,445,929	12419309	12141573	8622225	7518854	11938822	7468339	6377444	10972464	7212504	6121609	6499347	5401305	12421741	11923831
		Number of VMS cells overlapping greater than £5000	Count	1705	513	495	440	378	31	420	359	526	507	446	391	330	662	626
	Shellfish Values	Shellfish Data (MB106)	km²	68134	17252	16397	19547	14995	25454	17066	12515	13607	14045	9494	13991	9440	22986	21179
Aquaculture	Finfish aquaculture	Finfish Aquaculture		None														
	Shellfish aquaculture installations	Shellfish aquaculture	km²	301	39	15	217	94	31	199	76	34	204	81	204	81	217	107
Total overlap (km²)				185556	36939	35962	35567	30412	45503	32989	27879	34064	33846	28736	33430	28298	67203	64245
Total overlap (km)				7825	1132	1065	1376	1194	1695	1365	1183	1394	1277	1095	1186	1004	3058	2982

NOTE 1: UK DEAL DATA - HINCKLEY POINT CEFAS WAVERIDER BUOY overlaps with this scenario!
In order to provide robust data for the EIA for Hinckley Point Nuclear Power Station, an extensive suite of hydrodynamic survey work was undertaken, including the installation of a long term Waverider buoy (which continues to operate) in 10m of water directly off-shore from Hinkley Point, to measure wave climate and seawater temperature.
NOTE 2: UK DEAL DATA - SWRDA WAVE MEASUREMENT BUOY overlaps with this scenario!
NOTE 3: 2 ACTIVE OIL WELLS are included in layer for this area
Well names: 98/16-1 and 98/16-2; Current owner: Total; Original owner: ELF Exploration UK plc; Licence: P535; Exploration wells completed on 23/10/1988 (98/16-1) and 22/03/1991 (98/16-2) ; Both noted as "Dry Hole" under "Hydrocarbon" field

3.4.3 Overlap with Socio-economic Interests

Table 18 summarises the extent of overlap between the various socio-economic interest layers and the individual network scenarios. Information is also provided on the extent of overlap between the networks and socio-economic interests in areas that are not already designated as SACs.

The total extent of socio-economic interests in Finding Sanctuary area (excluding commercial fin fishing) is around 186,000km^2 and 7,825km (for pipelines and cables) (Table 18). Between 18 to 35% of this total socio-economic interest is captured within the individual scenarios.

There is only a small amount of variation in total spatial overlap with socio-economic interests between the first seven scenarios; 32,989 km^2 under Scenario 4 (Pure ecological network with SACs locked in and with low cost avoidance) up to 45,503 km^2 under Scenario 3 (SACs not locked in and low cost avoidance). The highest level of overlap arose under Scenario 8, Finding Sanctuary's first iteration, of 67,203 km^2 (note that this network was twice as large as other networks produced under other scenarios).

The inclusion of cost layers to steer site selection away from areas of socio-economic interest had little consistent influence on total spatial overlap (Table 18 compare scenarios 1, 3 and 5) although scenario 5 reduced spatial overlap by around 10% compared to scenario 1. However, locking in SACs to the network reduced the area of overlap with socio-economic interests in all cases (Table 18 compare scenarios 1 and 2, 3 and 4, 5 and 6). If the area of overlap outside of existing/recently designated SACs is considered (which is likely to represent the primary additional cost to industry) the overlap by locking in SACs is reduced by 15% to 23%.

It is important to note that this overlap is not spread evenly among sectoral interests with some impacted more than others and that the performance of scenarios was not consistent for sectors or even individual sector layers; e.g. they were worse for some sectors but better for others. These patterns are summarised below for each individual TCE business activity that is present within the region.

The first iteration network resulted in a much higher level of spatial overlap with socio-economic interests compared to the modelled scenarios (Table 13). Furthermore, the scenario overlaps disproportionately with some activities for example, existing aggregate licence area, potential future interest areas for OWF, potential future interest areas for wave energy, telecoms cables and high value fishing areas.

3.4.3.1 Marine aggregates

Under scenarios 2 to 7, there is no additional impact from MCZs on existing licences for marine aggregates, 13% overlap with prospecting areas and there is a maximum of 6% of additional overlap with medium and high category future aggregate resources. In comparison, the 1st iteration network, scenario 8, revealed the highest overlap with current and future areas of interest for marine aggregates; 73% of existing licence areas, 100% of application areas, 11% of prospecting areas and 32% and 63% respectively of medium and high category future aggregate resources. Interestingly, for marine aggregates, locking in SACs (Scenario 2) did

not reduce the additional overlap compared to Scenario 1. Locking out current licence areas did not increase the impact on areas of potential future resource (Scenario 7).

3.4.3.2 Offshore wind and wet renewables

Scenario 7 locked out Round 3 sites for potential wind farm development but at the cost of increasing the overlap with potential future interest areas. No one scenario performed better than any others overall, although Scenario 8 generally resulted in much higher levels of overlap.

There is very little tidal resource within the region and the potential future high priority areas are already captured within existing and recently designated SACs. There is more wave interest within the region but little variation in the range of potential future medium and high priority sites captured among scenarios 1-7 outside of existing and recently designated SACs (10-20% and 13-20% respectively).

3.4.3.3 Telecom cables

There are 7587 km of existing live telecom cable within the Finding Sanctuary Region. Spatial overlap ranged from 1090 to 1669 km for existing cables across scenarios 1 to 7 and up to 2927 km for scenario 8. Very little existing cable is within existing and recently designated SACs.

3.4.3.4 Gas storage

There is only one proposed gas storage site within Finding Sanctuary off the Isle of Portland. This has been captured in scenarios 1 and 3.

3.4.3.5 Coastal business

The socio-economic assessment has included limited information on activities relevant to TCE's coastal business. There are only 4.9 km^2 of maintained navigation channels and 7.2 km^2 of licensed dredged material disposal sites within Finding Sanctuary. Across the scenarios, 0.5 - 0.8 km^2 of maintained navigation channels was captured outside of existing SACs and 0.6 - 5.8 km^2 of dredged material disposal sites.

3.4.3.6 Aquaculture

There is approximately 301 km^2 of waterbody containing shellfish aquaculture sites[5] in Finding Sanctuary and no finfish aquaculture. Spatial overlap ranged from 31 to 217 km^2 across the different scenarios although 51-62% of this is already within an existing or recently designated SAC.

[5] The location of individual shellfish aquaculture installations in England is commercially sensitive. The available data layer simply identifies waterbodies which contain shellfish aquaculture installations. For example, the Fal is identified as a waterbody containing shellfish aquaculture installations.

3.5 Irish Sea Area

3.5.1 Introduction

Figures 27 to 35 illustrate the MCZ networks generated for each scenario. Summary information for each scenario is presented in Table 19. The performance of each scenario against MCZ ecological criteria is summarised in Tables 20 - 23. The extent of overlap with socio-economic interests is presented in Table 24. The total extent for the Irish Sea Region area is 17,408 km^2.

The number of sites within the different scenarios has varied from 5 and 26 covering areas ranging between 2687 - 5958 km^2 (Table 19). This equates to 15-34% of the Irish Sea area.

3.5.2 Conformance with Ecological Criteria

The Marxan tool seeks to identify network options that meet the ecological criteria at 'minimum cost'. Thus for each scenario, the network solutions largely meet the criteria that have been coded within Marxan.

No assessment of performance has been made in relation to the following criteria: overall diversity, important areas for key life cycle stages of species, high natural pelagic productivity or reference areas.

3.5.2.1 Broad-scale habitats

All but one of the scenarios meet the minimum percentage area requirements for broad-scale habitats, the exception being scenario 8, the first iteration network, which failed on four of the 10 broad-scale habitats present within this area. The minimum number was also met for all broad-scale habitats with the exception of habitat A3.3, Low Energy Infralittoral Rock (Table 20) in three scenarios including the pure network and for A4.3, Low Energy Circalittoral Rock in scenario 6. Again scenario 8 did not meet the minimum number of areas for A3.1, High Energy Infralittoral Rock, A3.2, Moderate Energy Infralittoral Rock, A3.3 and A4.3. The minimum diameter requirements for broad-scale habitats could not be coded within Marxan. However, the great majority of habitats met the minimum diameter requirements where possible (cells shaded green or orange). For A4.1 High Energy Circalittoral Rock, the minimum diameter requirements were met for only four of the eight scenarios, while these requirements were only met in five of the eight for A4.2, Moderate Energy Circalittoral Rock.

The criterion relating to the connectivity of EUNIS level 2 habitats could not be coded within Marxan but performance against the criterion has still been assessed. Only one patch of A6 habitat (Deep Sea Bed) was present within the region therefore connectivity could not be assessed. Connectivity was met for A5 habitats (Sublittoral Sediment), however a proportion of A3 (Infralittoral Rock and other hard substrata) and A4 (Circalittoral Rock and other hard substrata) habitats did not met the connectivity target in some scenarios due to the spread of habitat patches selected within the region (Table 21).

3.5.2.2 Habitat FOCI

All of the modelled scenarios met the minimum requirement for the number of habitat FOCI areas where this was possible (Table 22) except for *Modiolus modiolus* beds, where this was not met at all in nay of the scenarios. For the 1st iteration network (scenario 8) only Subtidal Sands and Gravels met the requirement for the minimum number of sites.

It is not possible to code the minimum diameter for habitat areas within Marxan but performance against this criterion was still assessed. The criterion was met in all scenarios to the extent possible for all but two of the habitat FOCI - Mud Habitat in Deep Water, which was only met in 2 of the eight scenarios and Subtidal Sands and Gravels (which did not meet the criterion in scenario 1)(see red cells in Table 22). It is of note that for most of the habitat FOCI it is not possible to meet the ENG requirements in Irish Sea area because too few of the areas meet the minimum requirements (cells shaded orange in Table 22).

3.5.2.3 Species FOCI

There are relatively few of the species FOCI reported as occurring within the Irish Sea Region and assessments were undertaken for only four species. For the species assessed, the greatest proportion of data is represented within the respective point layers rather than the polygon layers. The point layer was therefore used in preference to the polygon layer, although the polygon layer includes some areas not represented in the point layer. In using the point layer data it has therefore not been possible to assess whether the minimum patch diameters have been met. The evaluation has been limited to an assessment of whether the required number of patches has been captured within the network.

Table 23 indicates that for two of the species, namely Common Maerl and Fan Mussel, there were too few patches to meet the minimum requirement (3 patches), however, the networks selected generally included the available patches (cells coloured orange). For *Arctica islandica* there were a large number of species points and compliance with the minimum patch requirements was therefore easily met. The minimum requirement for number of patches was met in all but two scenarios for *Ostrea edulis*, the native oyster.

The first iteration network (scenario 8) failed to meet the minimum requirements for number of patches for any of the species FOCI assessed, based on a comparison against the point data layers.

3.5.3 Overlap with Socio-economic Interests

Table 24 summarises the extent of overlap between the various socio-economic interest layers and the individual network scenarios. Information is also provided on the extent of overlap between the networks and socio-economic interests in areas that are not already designated as SACs.

The total extent of socio-economic interests in Irish Sea area (excluding commercial fin fishing) is around 33450km^2 and 580km (for pipelines and cables) (Table 24). Between 13 to 40% of this total socio-economic interest is captured within the individual scenarios.

There is significant variation in spatial overlap with socio-economic interests between scenarios with, for example, a 42% difference in the total area of overlap between scenario 1 (pure ecological network) and scenario 8 (Irish Sea first iteration). However, since scenario 8 failed on many of the ecological criteria, any comparisons should be treated with caution (Table 24). Similarly, there is a very significant variation in the extent of spatial overlap outside of existing/recently designated SACs, for example, the overlap for scenario 6 is around a third of the overlap for scenario 1 (Table 19).

The inclusion of cost layers to steer site selection away from areas of socio-economic interest reduces total spatial overlap with socio-economic interests by around 45% (Table 19 compare scenarios 1, 3 and 5). Locking-in SACs into the network appears to make little difference to the area of overlap with socio-economic interests outside of existing/recently designated SACs, for example, the area of overlap outside of SACs is slightly increased when SACs are locked in (Table 19 compare scenarios 1 and 2). This is considered to reflect the distribution of SACs in the Irish Sea Region (largely coastal). It is likely that locking in SACs would result in larger differences between scenarios if intertidal habitats were also being considered.

Table 19. Summary of Scenario Performance - Irish Sea Area

Scenario	Network Area (Km²)	No of Sites	Extent to Which Ecological Criteria are Met	Overlap With Socio-Economic Interests - Area (km²)[1]	Overlap With Socio-Economic Interests - Length (km)[2]	Overlap With Socio-Economic Interests Outside SAC - Area (km²)[1]	Overlap With Socio-Economic Interests Outside SAC - Length (km)[2]
1. Pure ecological network (BLM = 0.1)	3589	16	All criteria were met where the minimum criteria were present within the region with the exception of: Broad-scale habitat A3.2, A4.1, A4.2 & A5.3 (minimum diameter) and Broad-scale habitat A3.3 (number); Habitat FOCI 'horse mussel beds' (number), 'mud in deep water', 'subtidal sands and gravels' (minimum diameter).	10273	343	10203	343
2. Pure ecological network with SACs locked in (BLM = 0.1)	5958	11	All criteria were met where the minimum criteria were present within the region with the exception of: Habitat FOCI 'horse mussel beds' (number) & 'mud habitat in deep water' (minimum diameter). Species FOCI *O. edulis* (number).	13581	368	11515	294
3. As 1 but with low cost avoidance (BLM = 0.1)	2825	16	All criteria were met where the minimum criteria were present within the region with the exception of: Broad-scale habitat A3.3 (number); Broad-scale habitat A4.1 (minimum diameter); Habitat FOCI 'horse mussel beds' (number) 'mud habitat in deep water' (minimum diameter).	7304	186	Not assessed	Not assessed
4. As 2 but with low cost avoidance (BLM = 0.1)	4142	16	All criteria were met where the minimum criteria were present within the region with the exception of: Habitat FOCI 'horse mussel beds' (number).	5655	245	3589	171
5. As 1 but with high cost avoidance (BLM = 0.1)	2687	26	All criteria were met where the minimum criteria were present within the region with the exception of: Broad-scale habitat A3.2, A4.1, A4.2 (minimum diameter); Broadscale habitat A3.3 (number); Broad-scale habitat A4 (connectivity >80Km); Habitat FOCI 'horse mussel beds' (number), 'mud habitat in deep water' (minimum diameter).	4574	47	Not assessed	Not assessed
6. As 2 but with high cost avoidance (BLM = 0.1)	3301	16	All criteria were met where the minimum criteria were present within the region with the exception of: Broad-scale habitat A4.3 (number); Habitat FOCI 'horse mussel beds' (number), 'mud habitat in deep water' (minimum diameter).	5408	145	3342	71
7. As 6 but with aggregate and wind farm areas locked out (BLM = 0.1)	3307	18	All criteria were met where the minimum criteria were present within the region with the exception of: Broad-scale habitat A3 and A4 (connectivity >80Km); Habitat FOCI 'horse mussel beds' (number); Species FOCI *O. edulis* (number).	5452	164	3385	90
8. 1st iteration network	2773	5	All criteria were met where the minimum criteria were present within the region with the exception of: Broadscale habitats A3.1, A3.2, A3.3, A4.3 (extent captured); Broadscale habitats A4.1, A5.4 (minimum diameter); Broad-scale habitat A3 (only one patch); Habitat FOCI 'blue mussel beds', 'horse mussel beds', 'mud habitat in deep water', 'peat and clay exposures', 'honeycomb worm reefs', 'seagrass beds', 'sheltered muddy gravels' (number); All of the species FOCI were not met in relation to points or patches captured.	4334	36	4334	36

[1] For activities represented by polygon data - e.g. aggregates sites, aggregate application areas, offshore wind farms, dredge material disposal sites, gas storage sites, hydrocarbon fields, shellfishing areas etc. The total area of overlap exceeds the total area of the network, because activities can overlap, for example, the potential future use areas for marine aggregates and offshore wind overlap with existing uses and with each other.

[2] For activities represented by linear features - e.g. cables and pipelines

Table 20. Scenario Performance for Broadscale Habitats (EUNIS Level 3) - Irish Seas

Broadscale Habitat	EUNIS level3 code	Irish Sea Region		Targets				Scenario 1: Pure Ecological Network				Scenario 2: Pure Ecological Network with SACs Locked In				Scenario 3: Pure Ecological Network with Low Cost Avoidance				Scenario 4: Pure Ecological Network with SACs Locked In and Low Cost Avoidance				Scenario 5: Pure Ecological Network with High Cost Avoidance				Scenario 6: Pure Ecological Network with SACs Locked In and High Cost Avoidance				Scenario 7: Pure Ecological Network with SACs Locked In, High Cost Avoidance and Aggregate and Wind Farm Areas Locked Out				Scenario 8: 1st Iteration Networks			
		Extent of Features	Number in Region	Area		Number	Min Dia	Extent Captured		Number	No Meeting Min Dia	Extent Captured		Number	No Meeting Min Dia	Extent Captured		Number	No Meeting Min Dia	Extent Captured		Number	No Meeting Min Dia	Extent Captured		Number	No Meeting Min Dia	Extent Captured		Number	No Meeting Min Dia	Extent Captured		Number	No Meeting Min Dia	Extent Captured		Number	No Meeting Min Dia
		(ha)		(ha)	%		(km)	Area (ha)	%			Area (ha)	%			Area (ha)	%							Area (ha)	%			Area (ha)	%			Area (ha)	%			Area (ha)	%		
High Energy Intertidal Rock	A1.1	Not assessed																																					
Moderate Energy Intertidal Rock	A1.2	Not assessed																																					
Low Energy Intertidal Rock	A1.3	Not assessed																																					
Intertidal Coarse Sediment	A2.1	Not assessed																																					
Intertidal Sand and Muddy Sand	A2.2	Not assessed																																					
Intertidal Mud	A2.3	Not assessed																																					
Intertidal Mixed Sediments	A2.4	Not assessed																																					
Coastal Saltmarshes and Saline Reedbeds	A2.5	Not assessed																																					
Intertidal Sediments Dominated by Aquatic angiosperms	A2.6	Not assessed																																					
Intertidal Biogenic Reefs	A2.7	Not assessed																																					
High Energy Infralittoral Rock	A3.1	527	>2	79	15 - 31	2	5	154	29	>2	0	359	68	>2	0	79	15	>2	0	355	67	>2	0	167	32	>2	0	189	36	>2	0	240	46	>2	0	14	3	1	0
Moderate Energy Infralittoral Rock	A3.2	1169	>2	199	17 - 32	2	5	240	21	>2	0	868	74	>2	1	831	71	>2	1	804	69	>2	1	316	27	>2	0	782	67	>2	1	906	78	>2	1	0	0	0	0
Low Energy Infralittoral Rock	A3.3	178	>2	28	16 - 32	2	5	29	16	1	0	36	21	2	0	99	56	1	0	36	21	>2	0	29	16	1	0	36	21	2.00	0	36	21	>2	0	0	0	0	0
High Energy Circalittoral Rock	A4.1	6451	>2	710	11 - 25	2	5	872	14	>2	0	5388	84	>2	>2	1249	19	>2	1	5388	84	>2	>2	762	12	>2	0	5388	84	>2	2	5388	84	>2	2	1011	16	>2	0
Moderate Energy Circalittoral Rock	A4.2	26329	>2	3423	13 - 28	2	5	3895	15	>2	0	3578	14	>2	>2	3673	14	>2	>2	3425	13	>2	>2	5097	19	>2	1	3490	13	>2	>2	3446	13	>2	2	5489	21	>2	2
Low Energy Circalittoral Rock	A4.3	2221	>2	355	16 - 32	2	5	364	16	2	0	369	17	>2	0	365	16	>2	0	358	16	>2	0	377	17	>2	0	472	21	1	0	362	16	>2	0	0	0	0	0
Subtidal Coarse Sediment	A5.1	717982	>2	122057	17 - 32	2	5	150627	21	>2	>2	122268	17	>2	>2	122215	17	>2	2	122124	17	>2	>2	122074	17	>2	>2	122133	17	>2	>2	122210	17	>2	>2	161107	22	>2	>2
Subtidal Sand	A5.2	422401	>2	63360	15 - 30	2	5	84712	20	>2	>2	224870	53	>2	>2	63433	15	>2	>2	145285	34	>2	>2	63386	15	>2	>2	63527	15	>2	>2	63585	15	>2	>2	83889	20	>2	>2
Subtidal Mud	A5.3	368187	>2	55228	15 - 30	2	5	55458	15	>2	1	141895	39	>2	2	55308	15	>2	>2	55509	15	>2	>2	55258	15	>2	>2	55334	15	>2	>2	55314	15	>2	>2	49071	13	>2	2
Subtidal Mixed Sediments	A5.4	123442	>2	19751	16 - 32	2	5	60689	49	>2	>2	34876	28	>2	>2	32629	26	>2	>2	21547	17	>2	>2	19761	16	>2	>2	20098	16	>2	>2	19840	16	>2	>2	23753	19	>2	1
Subtidal Macrophyte-dominated Sediment	A5.5	Not present																																					
Subtidal Biogenic Reefs	A5.6	Not present																																					
Deep-Sea Bed	A6	Not present																																					

Table 21. Scenario Performance for Connectivity of EUNIS Level 2 Habitats - Irish Seas

EUNIS Level 2	Target	Scenario 1: Pure Ecological Network	Scenario 2: Pure Ecological Network with SACs Locked In	Scenario 3: Pure Ecological Network with Low Cost Avoidance	Scenario 4: Pure Ecological Network with SACs Locked In and Low Cost Avoidance	Scenario 5: Pure Ecological Network with High Cost Avoidance	Scenario 6: Pure Ecological Network with SACs Locked In and High Cost Avoidance	Scenario 7: Pure Ecological Network with SACs Locked In, High Cost Avoidance and Aggregate and Wind Farm Areas Locked Out	Scenario 8: 1st Iteration Networks
	(km)	(km)	(km)	(km)	(km)	(km)	(km)	(km)	(km)
A3	<80	25-55	4-45	15-40	4-44	47-50	5-42m	10-165	0 (one patch)
A4	<80	4-55	22-78	8-70	21-80	4-120	60-72	7-110	30-72
A5	<80	4-74	22-60	8-70	21-80	4-50	10-62	6-70	30-72
A6	<80	Not present	Not present	Not present	Not present	Not present	Not present	Not present	Not present

Table 22. Scenario Performance for Habitat FOCI - Irish Seas

Habitat FOCI	Irish Sea Region			Targets		Scenario 1: Pure Ecological Network			Scenario 2: Pure Ecological Network with SACs Locked In			Scenario 3: Pure Ecological Network with Low Cost Avoidance			Scenario 4: Pure Ecological Network with SACs Locked In and Low Cost Avoidance			Scenario 5: Pure Ecological Network with High Cost Avoidance			Scenario 6: Pure Ecological Network with SACs Locked In and High Cost Avoidance			Scenario 7: Pure Ecological Network with SACs Locked In, High Cost Avoidance and Aggregate and Wind Farm Areas Locked Out			Scenario 8: 1st Iteration Networks		
	Area (ha)	Number of Sites	Number Patches Meeting Min Diameter	Number	Min Dia (km)	Extent Captured Area (ha)	Number	No Meeting Min Dia	Extent Captured Area (ha)	Number	No Meeting Min Dia	Extent Captured Area (ha)	Number	No Meeting Min Dia	Extent Captured Area (ha)	Number	No Meeting Min Dia	Extent Captured Area (ha)	Number	No Meeting Min Dia	Extent Captured Area (ha)	Number	No Meeting Min Dia	Extent Captured Area (ha)	Number	No Meeting Min Dia	Extent Captured Area (ha)	Number	No Meeting Min Dia
Blue Mussel Beds	11	>3	0	3	5	10	>3	0	11	>3	0	10	>3	0	11	>3	0	8	>3	0	11	>3	0	11	>3	0	0	0	0
Cold-water Coral Reefs	Not present																												
Coral Gardens	Not present																												
Deep-Sea Sponge Aggregations	Not present																												
Estuarine Rocky Habitats	Not assessed																												
File Shell Beds	Not present																												
Fragile Sponge and anthozoan communities on subtidal rocky habitats	Not present																												
Intertidal Underboulder communities	Not assessed																												
Littoral Chalk Communities	Not present																												
Maerl Beds	Not present																												
Horse Mussel (Modiolus modiolus) beds	730	3	0	3	5	172	1	0	172	1	0	181	1	0	130	1	0	377	1	0	40	2	0	0	0	0	0	0	0
Mud Habitat in Deep Water	179287	2	2	3	5	4753	2	1	37685	2	1	1856	2	1	22674	2	2	5164	2	1	19476	2	1	21938	2	2	208	1	0
Sea-pen and burrowing megafauna communities	65056	1	1	3	5	3253	1	1	36885	1	1	1856	1	1	21251	1	1	3749	1	1	19076	1	1	10897	1	1	208	1	0
Native Oyster (Ostrea edulis) beds	Not present																												
Peat and Clay Exposures	10	>3	0	3	5	10	3	0	10	>3	0	10	>3	0	10	3	0	10	3	0	10	3	0	10	3	0	0	0	0
Honeycomb Worm (Sabellaroa alveolata) Reefs	351	>3	0	3	5	42	>3	0	181	>3	0	18	>3	0	136	>3	0	78	>3	0	117	>3	0	223	>3	0	0	0	0
Ross Worm (Sabellaria spinulosa) Reefs	Not assessed																												
Seagrass Beds	143	>3	0	3	5	25	>3	0	143	>3	0	22	>3	0	143	>3	0	22	>3	0	143	>3	0	143	>3	0	0	0	0
Sheltered Muddy Gravels	562	>3	0	3	5	50	>3	0	562	>3	0	54	>3	0	562	>3	0	50	3	0	562	>3	0	562	>3	0	0	0	0
Subtidal Chalk	Not present																												
Subtidal Sands and Gravels	776363	>3	>3	3	5	7593	>3	2	140429.46	>3	3	31603	>3	3	253350	>3	3	128349	>3	>3	181080	>3	>3	182637	>3	>3	223845	>3	>3
Tide-Swept Channels	Not assessed																												

Table 23. Scenario Performance for Species FOCI - Irish Seas

Species FOCI		Irish Sea Region		Targets	Scenario 1: Pure Ecological Network		Scenario 2: Pure Ecological Network with SACs Locked In		Scenario 3: Pure Ecological Network with Low Cost Avoidance		Scenario 4: Pure Ecological Network with SACs Locked In and Low Cost Avoidance		Scenario 5: Pure Ecological Network with High Cost Avoidance		Scenario 6: Pure Ecological Network with SACs Locked In and High Cost Avoidance		Scenario 7: Pure Ecological Network with SACs Locked In, High Cost Avoidance and Aggregate and Wind Farm Areas Locked Out		Scenario 8: 1st Iteration Networks	
Latin Name	Common Name	Number of Points	Number of Patches	Number of Patches	No of Points Captured	Number of Patches Captured	No of Points Captured	Number of Patches Captured	No of Points Captured	Number of Patches Captured	No of Points Captured	Number of Patches Captured	No of Points Captured	Number of Patches Captured	No of Points Captured	Number of Patches Captured	No of Points Captured	Number of Patches Captured	No of Points Captured	Number of Patches Captured
Padina pavonica	Peacocks Tail	Not present																		
Cruoria cruiriaeformis	Burgundy maerl paint weed	Not present																		
Grateloupia montagnei	Grateloups little-lobed weed	Not present																		
Lithothamnion corallioides	Coral maerl	Not present																		
Phymatolithon calcareum	Common Maerl	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
Alkmaria romijni	Tentacled lagoon worm	Not present																		
Armandia cirrhosa	Lagoon Sandworm	Not present																		
Gobius cobitis	Giant Goby	Not present																		
Gobius couchi	Couch's Goby	Not present																		
Hippocampus guttulatus	Long snouted Seahorse	Not present																		
Hippocampus hippocampus	Short snouted Seahorse	Not present																		
Victorella pavida	Trembling Sea Matt	Not present																		
Amphianthus dohrnii	Sea-fan Anemone	Not present																		
Eunicella verrucosa	Pink Sea fan	Not present																		
Haliclystus auricula	Stalked Jellyfish	Not present																		
Leptopsammia pruvoti	Sunset Cup Coral	Not present																		
Lucernariopsis campanulata	Stalked Jellyfish	Not present																		
Lucernariopsis cruxmelitensis	Stalked Jellyfish	Not present																		
Nematostella vectensis	Starlet Sea Anemone	Not present																		
Gammarus insensibilis	Lagoon Sand Shrimp	Not present																		
Gitanopsis bispinosa	Amphipod Shrimp	Not present																		
Pollicipes pollicepes	Gooseneck barnacle	Not present																		
Palinurus elephas	Spiny Lobster	Not present																		
Arctica islandia	Ocean Quahog	11	9	3	4	3	4	3	4	3	3	3	4	3	3	3	4	3	2	2
Atrinia pectinata	Fan Mussel	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
Caecum armoricum	Defolin's Lagoon Snail	Not present																		
Ostrea edulis	Native Oyster	4	4	3	3	3	2	2	3	3	3	3	3	3	3	3	2	2	0	0
Paludinella littorina	Sea Snail	Not present																		
Tenellia adspersa	Lagoon Sea Slug	Not present																		
Osmerus eperlanus	Smelt	Not assessed																		
Anguilla anguilla	European Eel	Not assessed																		
Raja undulata	Undulate Ray	Not assessed																		

Table 24. Overlap Between MCZ Networks and Socio-economic Interests - Irish Seas

Sector	Activity/Element	GIS Layer	Units	Total Extent in Irish Sea Region	Scenario 1: Pure Ecological Network		Scenario 2: Pure Ecological Network with SAC Locked In		Scenario 3: Pure Ecological Network with Low Cost Avoidance	Scenario 4: Pure Ecological Network with SACs Locked in with Low Cost Avoidance		Scenario 5: Pure Ecological Network with High Cost Avoidance		Scenario 6: Pure Ecological Network with SACs Locked In with High Cost Avoidance		Scenario 7: SACs Locked In, Windfarms and Marine Aggregate Activies Locked Out		Scenario 8: Irish Sea 1st Iteration Network	
					Total Overlap	Overlap Minus SAC	Total Overlap	Overlap Minus SAC	Total Overlap	Total Overlap	Overlap Minus SAC	Total Overlap	Overlap Minus SAC	Total Overlap	Overlap Minus SAC	Total Overlap	Overlap Minus SAC	Total Overlap	Overlap Minus SAC
Aggregates	Existing licence areas	Dredging Licence Areas	KM²	33	0	0	26	26	4	1	1	2	2	1	1	1	1	0	0
	Application areas	Dredging Application areas	KM²	65	7	7	3	3	0	2	2	0	0	0	0	0	0	0	0
		Aggregates Prospecting Layer	KM²	107	14	14	3	3	0	4	4	0	0	0	0	0	0	0	0
	Potential future interest use areas	Potential Future Aggregate Resource Medium	KM²	3098	255	243	2129	1323	387	2118	1313	476	460	1425	619	1448	642	70	70
		Potential Future Aggregate Resource High	KM²	4592	2459	2427	3262	3171	1625	609	518	217	204	496	405	375	284	745	745
Oil & Gas	Existing structures – surface + subsurface platforms, pipelines, cables	Surface installations	Count	7	1	0	3	2	1	2	1	1	0	1	0	1	0	0	0
		Active Exploration Wells	Count	108	71	71	93	93	57	19	19	0	0	0	0	0	0	68	68
		Active Pipelines	KM	780	393	393	561	538	232	199	176	25	25	48	25	72	49	270	270
Offshore Wind	Existing and consented (not yet built) wind farms (apply to R1/R2 sites)	Wind Farms Round 1 & 2	KM²	170	146	146	170	170	0	49	49	2	2	79	79	0	0	46	46
	Cables for R1/R2 sites	Wind Farm Export Cables	KM	89	19	19	89	58	5	89	58	10	10	48	18	48	17	0	0
	Application areas (R2.5 and R3 sites)	Wind Farms Round 3	KM²	2079	1251	1251	961	961	827	15	15	406	406	180	180	0	0	124	124
	Cable routes for R3 sites	Digitised R3 cable routes	KM	243	203	203	114	104	96	32	22	7	7	23	13	37	27	36	36
	Potential future interest use areas	Floating interest future use Medium	KM²	368	0	0	0	0	3	0	0	0	0	235	235	50	50	73	73
		Floating interest future use High	KM²	3066	22	22	12	12	172	86	86	127	127	505	505	587	587	840	840
		Fixed foundation future use Medium	KM²	947	427	427	433	433	322	98	98	108	108	66	66	76	76	69	69
		Fixed foundation future use High	KM²	1024	503	503	552	552	383	27	27	32	32	58	58	55	55	102	102
	Possible future cable routes	Future Cable Routes	KM	114	52	52	114	82	28	112	80	27	27	71	39	70	37	0	0
		Wind Demonstration Sites	Count																
Wet Renewables	Existing leased areas and application areas (lease option areas?)	Pentland Firth Round 1 Lease Option Areas (Tidal). Ramsey sound, Wave hub etc																	
	Potential future interest use areas	Tide Future Interest (High)	KM²	0															
		Tide Future Interest (Medium)	KM²	0															
		Wave Future Interest (High)	KM²	0															
		Wave Future Interest (Medium)	KM²	4605	8	8		0	2	1149	1149	1349	1349	525	525	911	911	1263	1263
Cables	Existing cables (live telecom cables, power interconnectors)	Telecom_cables	KM	847	342	342	576	571	317	204	200	141	141	99	94	88	83	134	134
	Future cables (proposed telecom cables and proposed power interconnectors/power grid)	brit-ned, anglo scot hvdc link,	KM	132	69	69	51	50	57	12	11	3	3	3	2	10	9	0	0
CCS/Gas Storage	Existing lease areas/option areas	Hydrocarbon Fields	KM²	161	146	146	161	161	105		0	0	0	0	0		0	157	157
		Gas Storage Leases	Counts	2	2	2	0	0	1	0	0	0	0	0	0		0		0
	Potential future use areas	Gas Potential Sites	KM²	0	0	0	2	2	0	0	0	0..0	0	0	0		0		0
		CCS Potential Sites	KM²	26	12	12	26	26	26	0	0	0	0	5	5	0	0	0	0
	Future pipeline	Proposed pipelines																	
Dredging and Disposal	Existing maintained areas	Maintained Dredged Areas	KM²	2	1	0	2	1	0	2	1	1	0	2	1	2	1	0	0
	Existing disposal areas	Disposal Sites Open	KM²	132	34	33	48	45	27	27	25	8	8	16	13	11	9	1	1
	New capital dredge areas	No information available																	
Commercial Fisheries	Fisheries values	VMS Data	Cost £	8735574	2307399	2305864	2333672	2306848	1620551	1152085	1125261	1324335	1313658	1020646	993822	1873834	1810619	386917	386917
		Number of VMS cells overlapping greater than £5000	count	387	124	124	139	135	89	45	41	54	54	46	42	71	67	26	26
	Shellfish Values	Commercial Shellfish Areas (MB106)	KM²	12634	5139	5120	5464	4815	3543	951	302	1835	1828	1303	654	1418	769	1000	1000
Aquaculture	Finfish aquaculture	No Finfish Aquaculture within the area	None																
	Shellfish aquaculture installations	Shellfish aquaculture sites	KM²	519	7	0	518	1	9	518	1	8	0	518	1	518	1	0	0
		Total overlap (km²)	KM²	33442	10274	10202	13581	11515	7304	5655	3589	4574	4529	5408	3342	5452	3385	4334	4334
		Total overlap (km)	KM	578	343	343	368	294	185	244	171	47	47	145	71	164	90	36	36

Based on Table 24, the following summaries are provided for individual TCE business activities. Due to the limitation of the networks and in particular the Irish Sea Region first iteration the text has concentrated on the differences in overlap of the total extent of the activity coverage and the 7 scenarios considered.

3.5.3.1 Marine aggregates

There are approximately 33km^2 of existing licensed areas and 65km^2 of application areas within the Irish Sea Region. Spatial overlap ranged from 0 to 26km^2 for existing licences and 0 to 7.5km^2 for application areas across the various scenarios. The extent of spatial overlap with aggregate prospecting areas and high and medium aggregate potential areas also varied considerably across scenarios, generally affecting up to 70% of these potential resource areas. All networks, except for scenario 8 (first iteration), overlapped to a slight degree with the existing areas and all showed high overlap with the potential future resource, both medium and high. The locking out of marine aggregate areas outside of SACs resulted in considerable overlap of up to 642km^2. This occurs because all the SACs within this region are coastal or estuarine.

3.5.3.2 Oil & Gas

There are over 115 oil & gas installations in the Irish Sea Region. The different scenarios overlapped with between 0 to 3 of the surface structures and up to 93 active wells.

3.5.3.3 Offshore wind

There are 170 km^2 of R1/R2 sites and 2080 km^2 of R3 sites within this Region. Spatial overlap ranged from 0 to 170km^2 for R1/R2 areas and 0 to 1251km^2 for R3 zones across the various scenarios. The extent of spatial overlap with potential future interest areas also varied considerably across scenarios, generally affecting between 0 and 100% of these potential resource areas. Scenario 7 avoided overlap with existing and proposed OWF. Overlap with existing and potential cable routes show a similar range of areas and lengths in all scenarios.

3.5.3.4 Wet renewables

There are no existing wave and tidal lease areas in Irish Sea Region. There are however up to 4605 km^2 of medium interest for potential future wave deployments. Between 0 and 29% of these potential interest areas are captured within the different network scenarios.

3.5.3.5 Telecom cables

There are 845km of existing live telecom cable and 132km of planned telecom cable within the Region. Spatial overlap ranged from 88 to 575km for existing cables and 3 to 70km for planned cable across the different scenarios.

3.5.3.6 Gas storage

There are 160km^2 of hydrocarbon fields within the Irish Sea Region and 2 gas storage sites. There are no potential gas sites or proposed pipelines identified in the Region.

3.5.3.7 Carbon capture and storage

There are no existing sites within the area however there are 26km^2 potential CCS facilities identified in the Irish Sea Region. Between 0-26km^2 of the interest was captured across the scenarios.

3.5.3.8 Coastal business

The socio-economic assessment has included limited information on activities relevant to TCE's coastal business in this Region. There are only 2 km^2 of maintained navigation channels with 132km^2 of licensed dredged material disposal site within the Irish Sea Region. Spatial overlap was therefore small for the maintained navigation channels and between 9 and 45km^2 for dredged material disposal sites across the different scenarios.

3.5.3.9 Aquaculture

There is approximately 520 km^2 of waterbody containing shellfish aquaculture sites[6] located within the Irish Sea Region and no finfish aquaculture occurs. Spatial overlap ranged from 7 to 520km^2 across the different scenarios. Approximately 500km^2 of this area is within existing/recently designated SACs.

3.6 Overall Assessment for English Territorial and Offshore Waters

Table 25 summarises the cumulative spatial overlap for key socio-economic activities relevant to TCE's business interests across the four English Regional Projects. The table reports the range of total spatial overlap encountered within the scenarios for each Region. Spatial overlap varies considerably within and between sectors and within and between Regions depending on the scenario. At an overall level, the minimum level of spatial overlap for all sectors was generally less than 10%, with maximum overlaps ranging from 12-90%. For those activities that are planned at national level, the overall national extent of overlap may be important in determining the deliverability of development plans. For activities that are planned at a regional level, the regional data are likely to be more useful in determining the possible scale of impacts on those sectors.

[6] The location of individual shellfish aquaculture installations in England is commercially sensitive. The available data layer simply identifies waterbodies which contain shellfish aquaculture installations. For example, Morecambe Bay is identified as a waterbody containing shellfish aquaculture installations.

Table 25. Summary of Cumulative Total Spatial Overlap for Key TCE Business Areas in English Waters

Spatial Overlap for Key Business Areas and Selected Indicator	Total Resource Area/Length	Net Gain	Balanced Seas	Finding Sanctuary	Irish Sea	Total
		Extent of Overlap (Area/Length and (%))				
Marine aggregates Existing licensed areas (km^2)	1165	73 - 343 10 - 46	0 - 178 0 - 48	0 - 11 0 - 73	0 - 26 0 - 72	73 - 397 6 - 34
Oil & Gas Length of active pipeline (km)	6740	1205 - 3143 18 - 47	0 0	0 0	26 - 561 3 - 72	1231 - 3704 18 - 55
Offshore wind Area of R1/R2/R2.5 and R3 sites (km^2)	24206	488 - 5554 2 - 28	2 -228 0.2 - 32	0 - 953 0 - 79	0 - 1398 0 - 62	490 - 8133 2 - 33
Wet renewables Existing lease areas (km^2)	9	0 - 1 0 - 100	0 0	0 - 7 0 - 87	0 0	0 - 8 0 - 89
Cables Length of active telecom cables (km)	12427	377 - 674 12 - 22	41 - 136 4 - 14	1090 - 2927 14 - 39	88 - 576 10 - 68	1596 - 4193 13 - 34
Gas storage Hydrocarbon Fields (km^2)	1270	7 - 562 1 - 51	0 0	0 0	0 - 161 0 - 100	7 - 723 0.1 - 57
Carbon Capture and Storage Potential lease areas (km^2)	154	1 - 126 1 - 99	0 0	0 0	0 - 26 0 - 100	1 - 18 1 - 12
Aquaculture Shellfish aquaculture sites (km^2)	1739	8 - 170 4 - 91	51 - 512 7 - 70	31 - 217 10 - 72	0 - 519 0 - 100	90 - 1418 5 - 82
Coastal Dredge and disposal areas (km^2)	573	4 - 63 2 - 24	0 - 61 0 - 37	1 - 9 8 - 75	1 - 50 1 - 37	6 - 183 1 - 32

4. Limitations

There are some inherent weaknesses in many of the datalayers on which the study has drawn. In particular, many of the data layers for habitat and species FOCI are based on limited survey data and are known to be incomplete. There are differences between the point and polygon layers for both habitat and species FOCI. For this study a decision was made to use the polygon layers for habitat FOCI and the point layers for species FOCI but it is recognised that this misses some of the known locations for interest features. The distribution of some species features is also known to be skewed by the data sets from which they have been compiled. For example, extensive reliance on the UKOAA database for species records in the North Sea has meant that some species distributions are spuriously positively correlated with the location of oil & gas installations, for example, *Arctica islandica* and *Gitanopsis bispinosa.*

In addition, the broad-scale habitat data is derived from a predictive model, UKSeaMap. The version of UKSeaMap available at the time of this study is known to have deficiencies in its predicted distribution of subtidal rock habitats - this is being addressed in later versions of the product. The current version of UKSeaMap also lacks intertidal data and therefore it was not possible to develop network scenarios incorporating intertidal areas.

There are also limitations in some of the socio-economic data layers. The locations of fixed infrastructure or areas of licensed activity are generally well known. However, activities such as commercial fishing are notoriously variable in time and space, making it difficult to adequately represent such activities with spatial data. The identification of potential future use locations for socio-economic activities is also problematic for reasons of lack of data and commercial confidentiality. Some progress has been made in this area, for example, TCE's indicative maps for marine aggregate potential, but the future locations for a number of activities remain unclear.

While the Marxan tool is capable of incorporating many of the MCZ ecological network criteria, it was not possible to code all of the requirements. In particular, it is not possible to specify minimum diameters or distances between features. These criteria had to be assessed manually based on the network outputs generated by Marxan. No assessment of performance has been made in relation to criteria such as overall diversity, important areas for key life cycle stages of species, high natural pelagic productivity or for reference areas. However, the limitations of Marxan were not found to be a major constraint in using the tool to support MCZ network design.

The factors and weightings included in the cost layers have been based on the judgments of the study team. The use of different factors and weights would lead to different outcomes for network design. The cost layers have sought to take account of the major economic interests and particularly those sectors for which measures are more likely to be required (e.g. bed disturbing activities). For example, no consideration has been given to shipping on the basis that minimal measures are envisaged. In assigning weights, the study team had regard to the potential costs of measures, based on information contained in Natural England and JNCC's inshore SAC Impact Assessments. While the results indicate that spatial overlap for all sectors could be reduced through the application of the cost layers, the weightings are subjective and some may feel disadvantaged by particular scenario outcomes.

The evaluation of potential conflict between MCZ networks and socio-economic interests is largely based on the extent of spatial overlap between the respective interests. While this is likely to be an important factor influencing the cost of potential management measures, it should be acknowledged that there are many additional factors that will influence both the requirement for management measures and their potential costs, in particular, the extent of socio-economic interest within reference areas, where more costly management measures may be required. However, it has not been possible within the scope of this study to seek to incorporate these factors.

5. Discussion

5.1 English MCZ Regions

The evaluation of the network scenarios for the four MCZ regions indicates that network design tools such as Marxan can be used to meet ecological criteria in the minimum amount of space. On the broad assumption that the costs of management measures are likely to be proportional to the size of the network, minimising the area of the network is an important mechanism for minimising potential socio-economic costs (Hull *et al*, 2010).

Overall, the modelled scenarios performed well against the ecological criteria for which they were assessed. The Balanced Seas and Finding Sanctuary first iteration networks also performed well against the broad-scale habitat and habitat FOCI criteria but performed less well in relation to the species FOCI criteria (based on a comparison against point layer data). The Irish Sea first iteration network performed poorly against all of the criteria.

The modelled scenarios should be considered as illustrative, as a large amount of further development would be required to develop specific proposals for sites. For example, sites may need to be adjusted to maximise performance against ecological criteria and to take account of additional supporting ecological factors. It may also be necessary to regularise the shape of individual sites for management purposes, although we note that this is not an ecological requirement and the regularization process runs the risk of both reducing ecological conformance and significantly increasing socio-economic costs.

The scenarios demonstrate significant variation in the extent of overlap with socio-economic interests, including activities within TCE's business areas. None of the scenarios tested in any of the Regions were able to completely avoid socio-economic interests, suggesting that some level of overlap is inevitable if the ecological criteria are to be met. Scenarios which locked out licensed marine aggregate areas and application areas, and offshore wind farm areas outside of existing/recently designated SACs were able to largely avoid overlap with these interests outside of SAC areas while still meeting the ecological criteria. Importantly there was no diminution in ecological performance with increasing application of socio-economic criteria (for the ecological criteria assessed).

The locking in of existing and recently designated SACs significantly reduces (by between 15 to 40%) the extent of overlap between MCZ networks and socio-economic interests outside of SAC areas for all but the Irish Sea Region. If it is assumed that management measures required under the Habitats Directive to support achievement of SAC objectives will generally largely address any requirements for measures in relation to MCZs (for which conservation objectives are broadly similar), then the locking-in of SAC areas into the Regional networks has the potential to significantly reduce the socio-economic costs attributed to MCZs. In the case of MCZ reference areas, more stringent conservation objectives are likely to be established. It is currently unclear whether the illustrative networks might meet the requirements for reference areas while also minimizing potential socio-economic costs nor whether locking in SACs into the network helps or hinders in minimizing these potential costs.

The scenarios also clearly demonstrate the scope for steering site selection away from areas of high socio-economic interest within each Region, including TCE interests. The use of cost layers reduced total overlap with socio-economic interests by between 10 to 50% depending on region and scenario.

The locking out of existing marine aggregate licence areas and application areas and offshore windfarm areas was successful in reducing the extent of spatial overlap for these activities outside of SACs. However, in several of the scenarios this resulted in an overall increase in spatial overlap suggesting that such reductions are achieved at the cost of other sectors and result in an overall less efficient solution from a socio-economic perspective.

Based on this study, the use of cost layers, which seek to steer site selection away from all key socio-economic interests, appears to be more effective at minimising spatial overlap compared to the bottom-up approach adopted for the first iteration networks. Furthermore, the cost layers also give a more equitable outcome compared to the first iteration networks which disproportionately impact some key activities.

The overall extent of spatial overlap across all four English Regional projects is also of interest for TCE's key business activities. For key activities, the maximum spatial overlap varied between 12 to 90% depending on the activity concerned. The information will be of value in considering the potential implications for those activities planned at national level.

Previous work has demonstrated that the potential costs to industry are largely a function of network size and the extent of overlap with socio-economic interests (ABPmer *et al*, 2007). On this basis the minimisation of areas of overlap outside of SACs could be a useful mechanism for minimising overall socio-economic costs.

In considering possible trade-offs that may need to be made between socio-economic interests and the achievement of ecological criteria, it is clear that there is considerable scope for reducing potential costs to industry while still meeting the ecological goals. Based on the analysis in this study it may be possible to further reduce spatial overlap (both for activities within and outside of TCE business areas although it is unlikely to be possible to avoid overlap completely. Furthermore, consideration will also need to be given to the implications of further reductions in spatial overlap for specific sectors in relation to the effects of displacement of MCZs onto areas supporting other socio-economic interests. It is currently unclear how the

Regional Projects might approach such trade-offs, if at all, or whether this will be addressed by the Marine Management Organisation on behalf of the Secretary of State. Based on comparable appraisal processes it is likely that issues of equity (the distribution of costs between sectors) and affordability (the ability of sectors to afford measures) would also need to be taken into account. It is unlikely that any sector would be able to avoid all costs unless it had overwhelming support in policy.

6. Conclusions

The Marxan tool can be used to identify alternative MCZ network options which take account of broad socio-economic criteria. The tool is able to minimize the area required for ecologically compliant networks. This will contribute to minimising socio-economic costs in its own right, as such costs are likely to be proportional to network size (Hull *et al*, 2010).

All of the modelled scenarios in this study largely met the ecological criteria for which they were assessed and to the extent possible, although further refinement of the networks would be required to develop firm proposals for sites. The performance of the first iteration networks from the Regional projects was variable. The Balanced Seas and Finding Sanctuary first iteration networks performed well against the broad-scale habitat and habitat FOCI criteria but performed less well in relation to the species FOCI criteria (based on a comparison with the point layer data). The Irish Sea first iteration network performed poorly against all of the criteria.

The locking-in of existing and recently designated SAC areas within the MCZ network has the potential to reduce the overlap with socio-economic interests outside of SAC areas by up to 50% depending on MCZ Region. The locking-in of SACs into the Regional networks therefore provides a potentially important way of reducing socio-economic costs. It is currently unclear what the implications of locking in SACs may be in terms of minimizing the potential costs of management measures within reference areas.

The scenarios demonstrate that it is possible to steer site selection away from areas of socio-economic interest without any obvious reduction in performance against the ecological network criteria assessed, with around a 10 to 50% reduction in total spatial overlap between the network and socio-economic interests across English MCZ Regions. None of the scenarios were able to completely avoid overlap with socio-economic interests suggesting that some level of overlap is inevitable if the ecological criteria are to be met. The locking out of key marine aggregate and offshore wind farm interests reduced spatial overlap for these activities but at the expense of other socio-economic sectors. The resulting network solutions also tended to be less efficient in terms of total spatial overlap compared to some of the other scenarios. Giving preference to one or a few sectors over others is likely to leave some feeling disadvantaged by particular scenario outcomes.

The total maximum spatial overlap for key TCE business areas for English waters as a whole ranged between 10 - to 90% depending on scenario and Region. It would be helpful to evaluate the significance of such overlap for those activities planned at national level.

In this study, the combination of locking in SACs and using cost layers to steer site selection away from socio-economic interests was able to reduce the overlap between the MCZ network and socio-economic interests by up to between 23 and 67% in areas outside of SACs compared to a pure ecological network scenario and depending on Region.

The first iteration networks for Balanced Seas, Finding Sanctuary and Irish Sea indicate variable performance in avoiding socio-economic interests, and perform less well than the modelled approach using cost layers. Furthermore, the approaches adopted by the Regional Projects do not appear to be delivering balanced outcomes for different socio-economic interests. The use of cost layers appears to be able to identify more optimal and equitable solutions.

The study has highlighted the importance of trade-offs between different socio-economic interests and not just between those interests and nature conservation. The *a priori* locking out of some socio-economic interests in preference to others is likely to be difficult to justify in policy terms, although it is clear that some interests have stronger policy support and contribute more to the economy that others. In these circumstances the use of differential weightings to reflect policy priorities or economic contribution may be appropriate. Such approaches may also be helpful in defining the trade-offs that need to be made and thus facilitate the negotiation of acceptable solutions.

7. References

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Figures

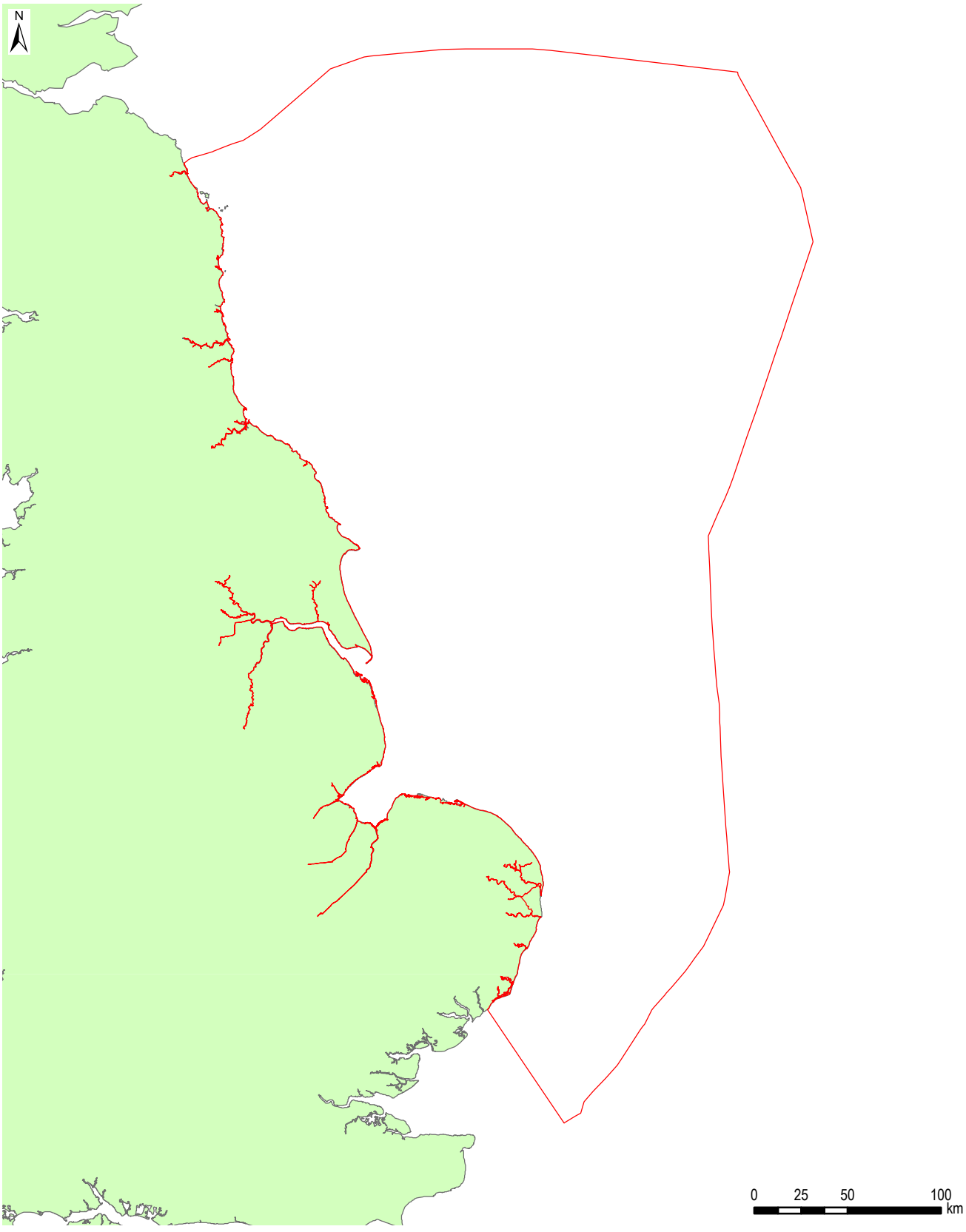

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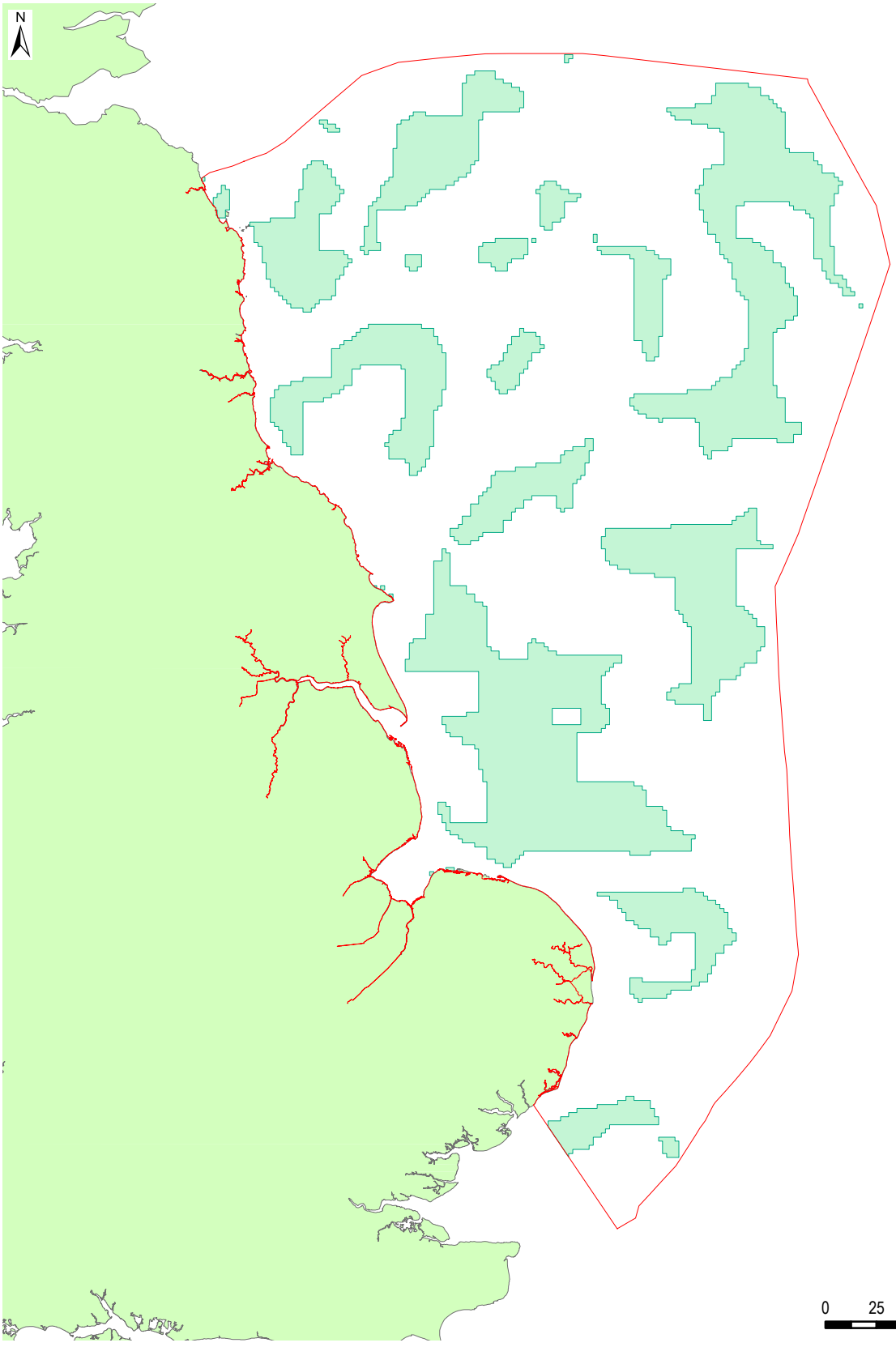
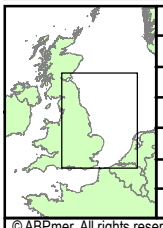
Figure 1





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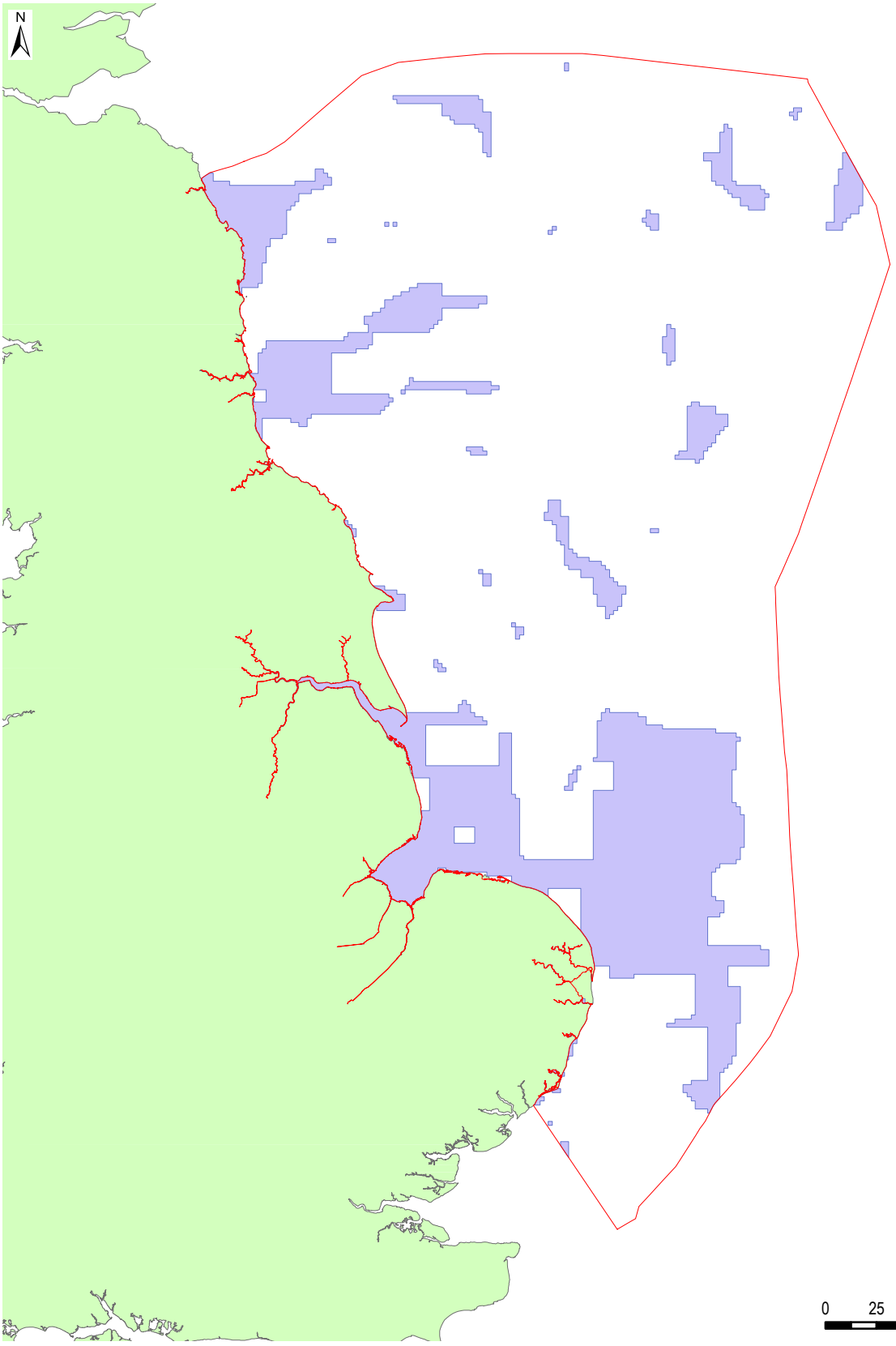
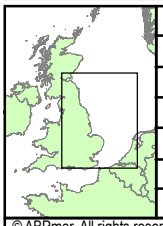
Net Gain Scenario 1 - Pure Ecological Network

Figure 2





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Pure Ecological Network with SACs Locked In

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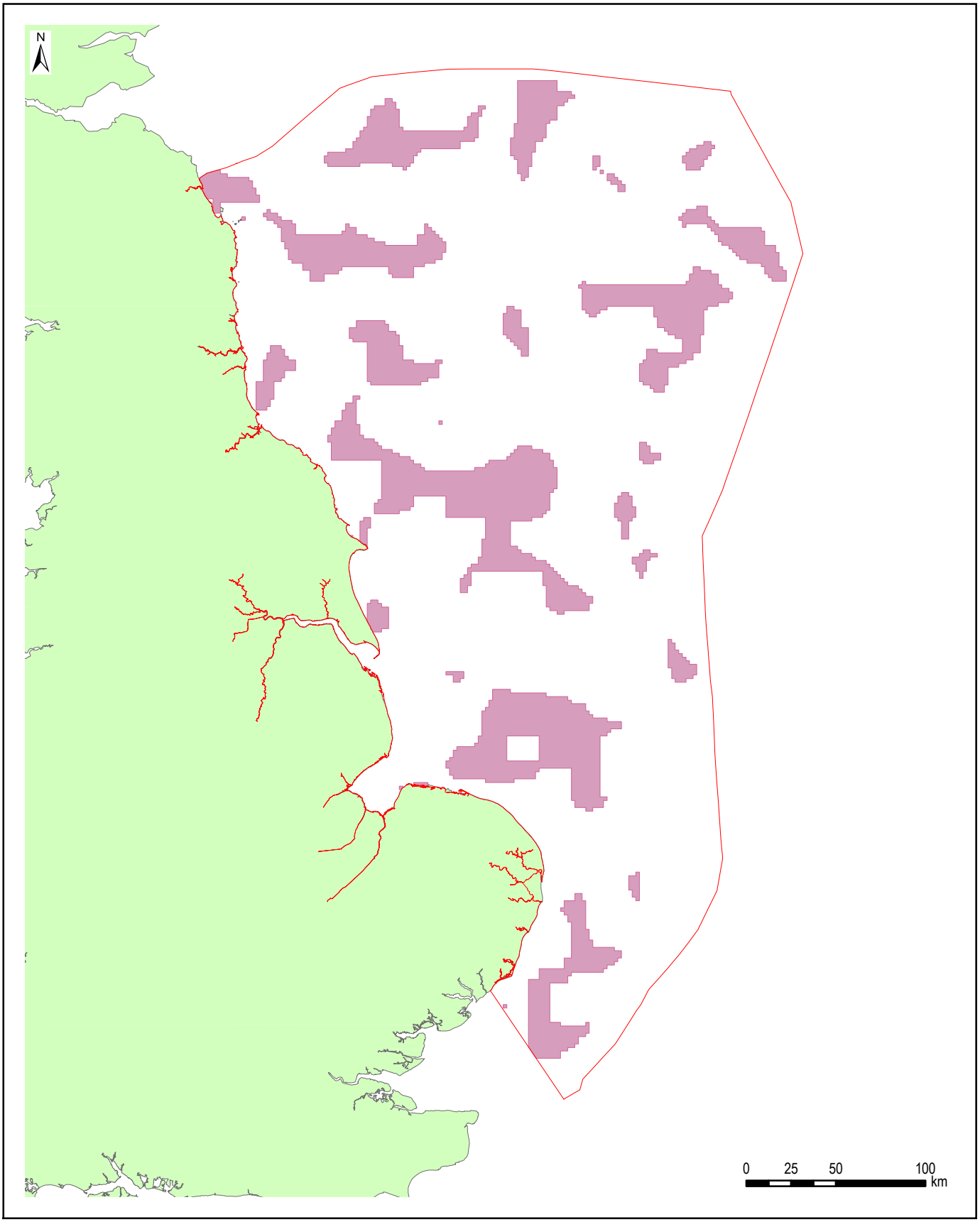
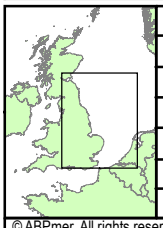
Net Gain Scenario 2 - Pure Ecological Network with SACs Locked In

Figure 3





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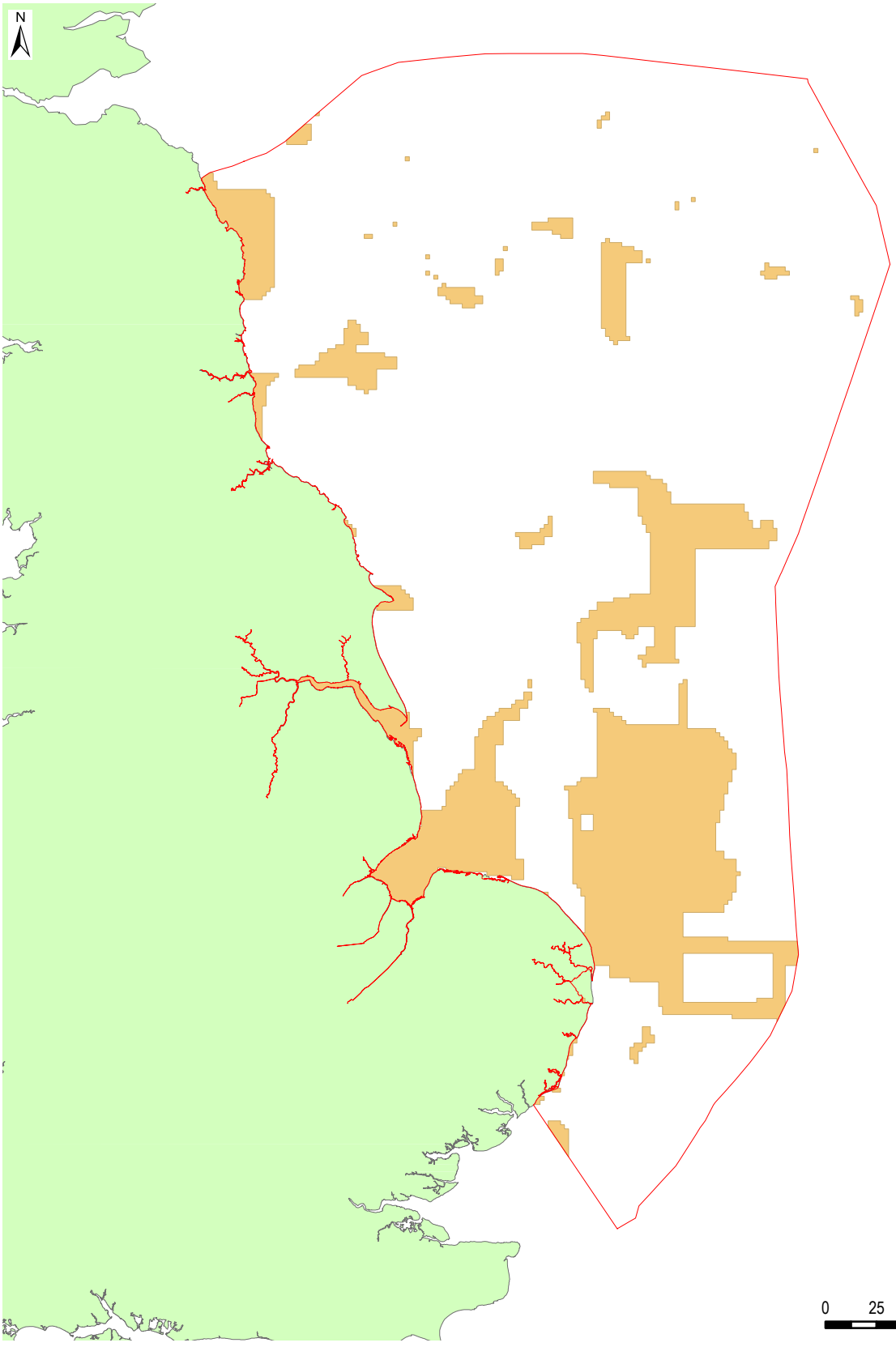
Net Gain Scenario 3 - Pure Ecological Network with Low Cost Avoidance

Figure 4



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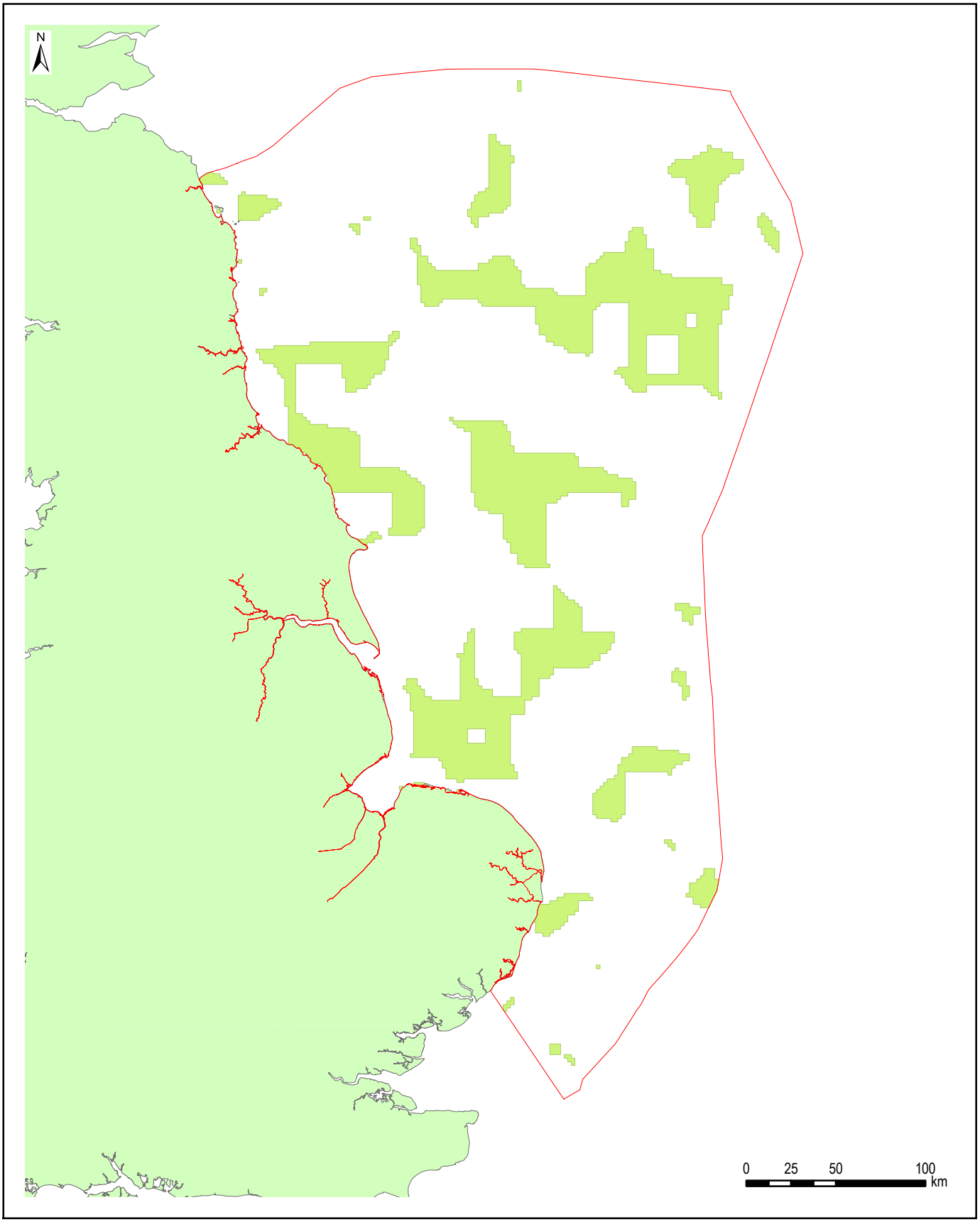
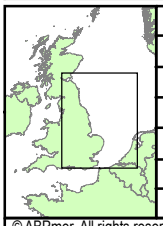
Net Gain Scenario 4 - Pure Ecological Network with SACs Locked In and Low Cost Avoidance

Figure 5





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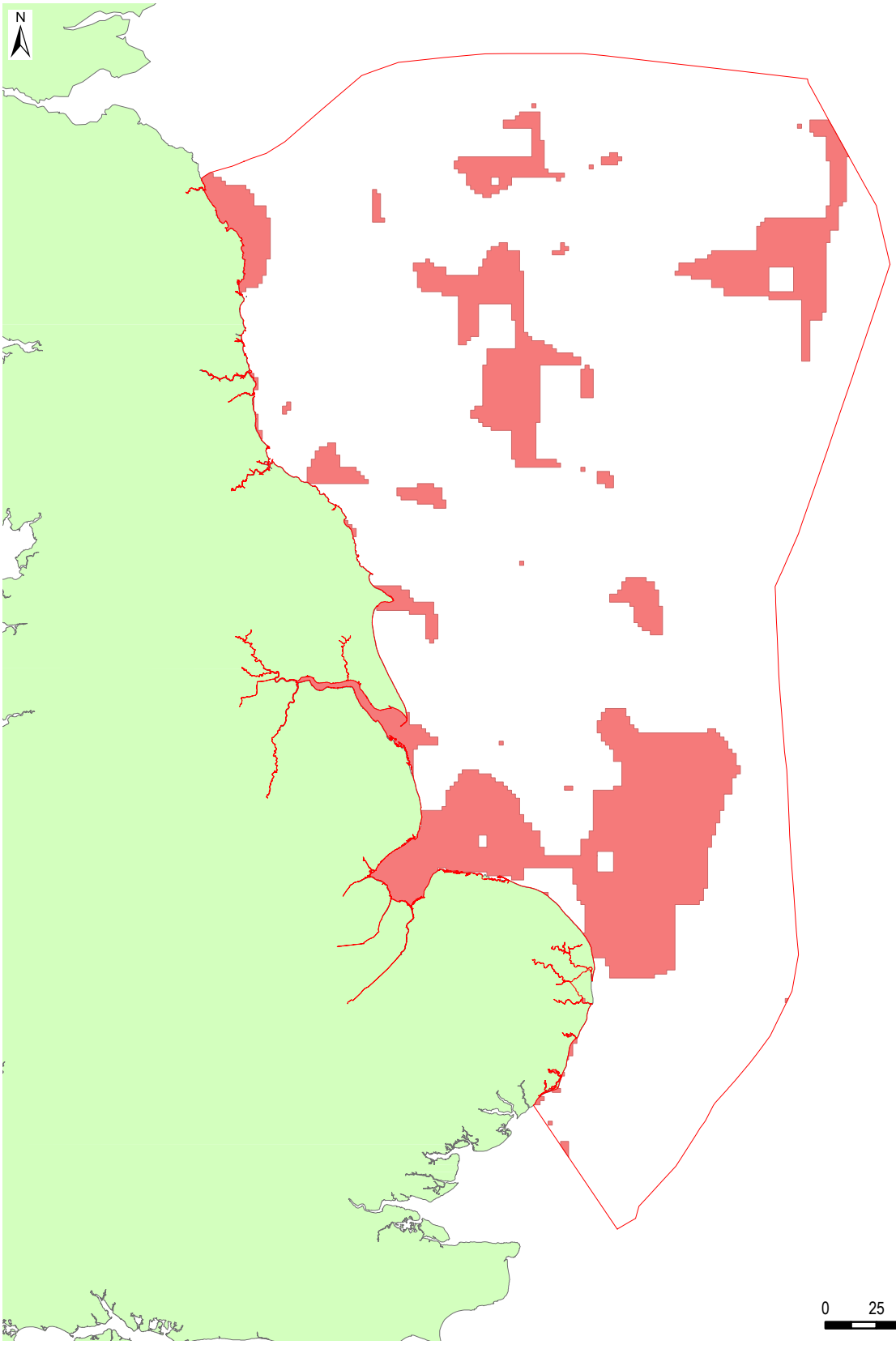
Net Gain Scenario 5 - Pure Ecological Network with High Cost Avoidance

Figure 6



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Pure Ecological Network with SACs Locked In and High Cost Avoidance

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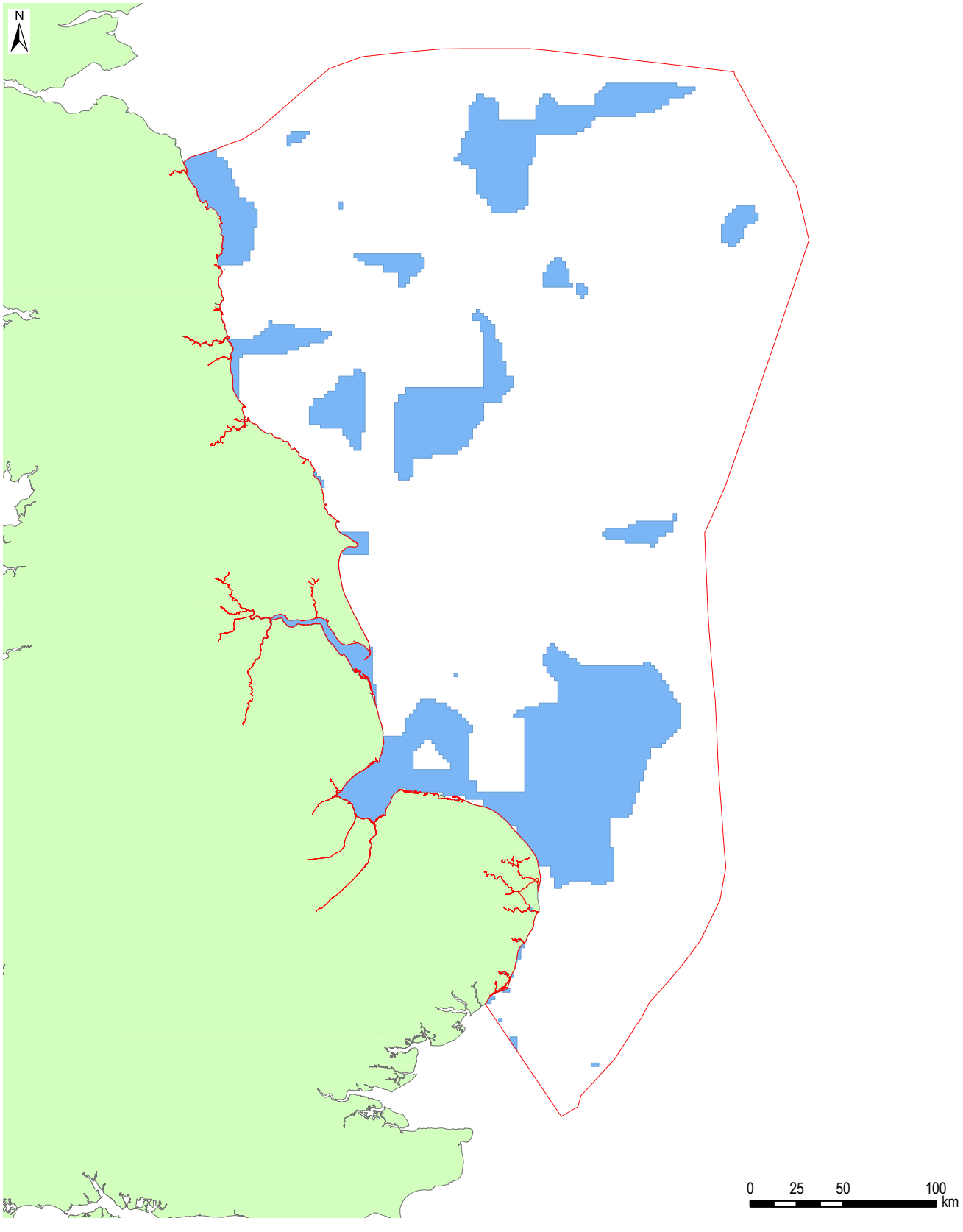
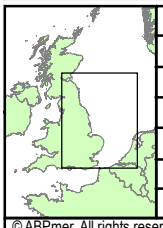
Net Gain Scenario 6 - Pure Ecological Network with SACs Locked In and High Cost Avoidance.

Figure 7





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Pure Ecological Network with SACs Locked In, High Cost Avoidance and Aggregate & Wind Farm Areas Locked Out.

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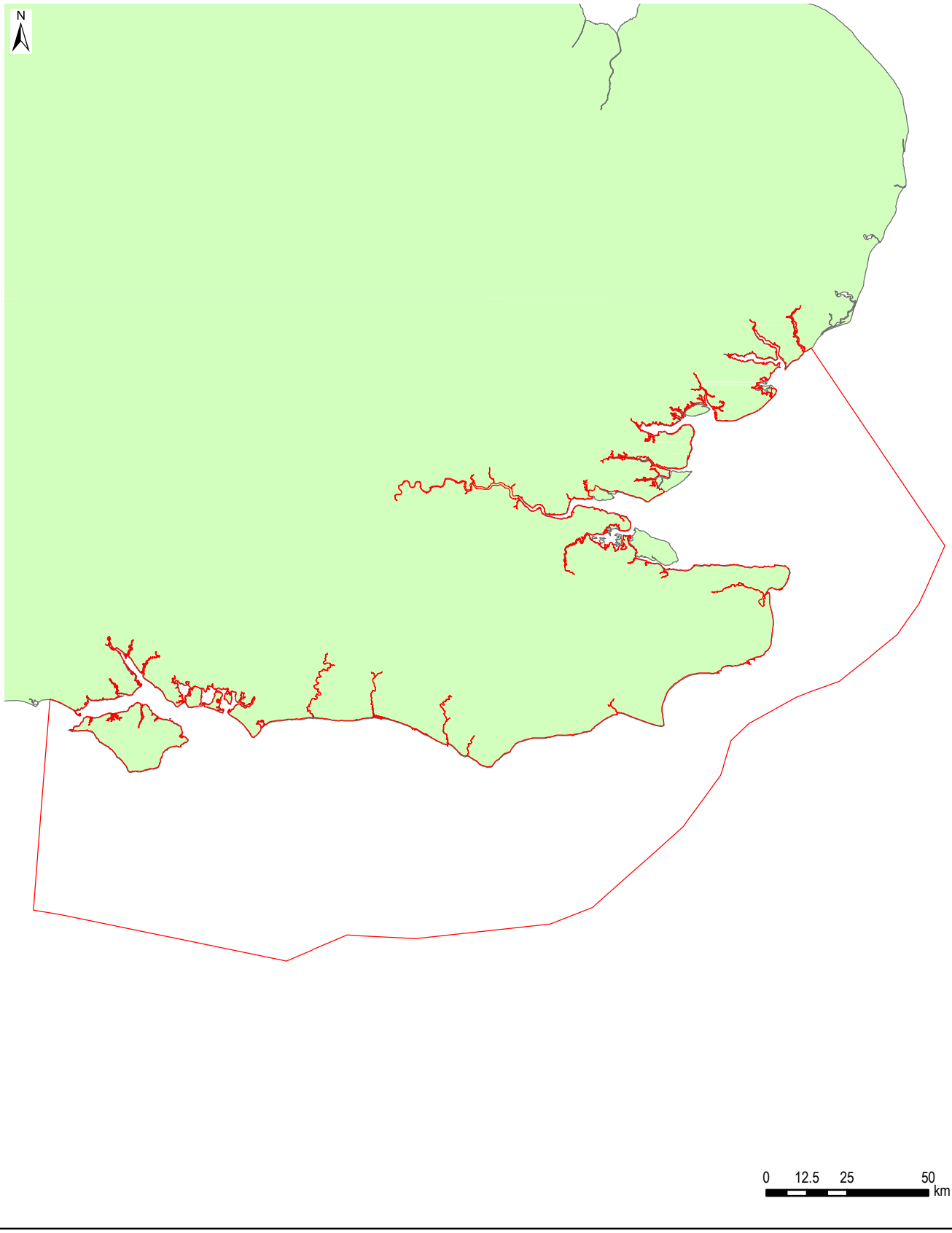
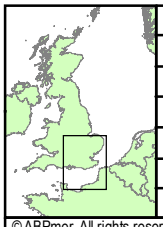
Net Gain Scenario 7 - Pure Ecological Network with SACs Locked In, High Cost Avoidance and Aggregate & Wind Farm areas Locked Out.

Figure 8





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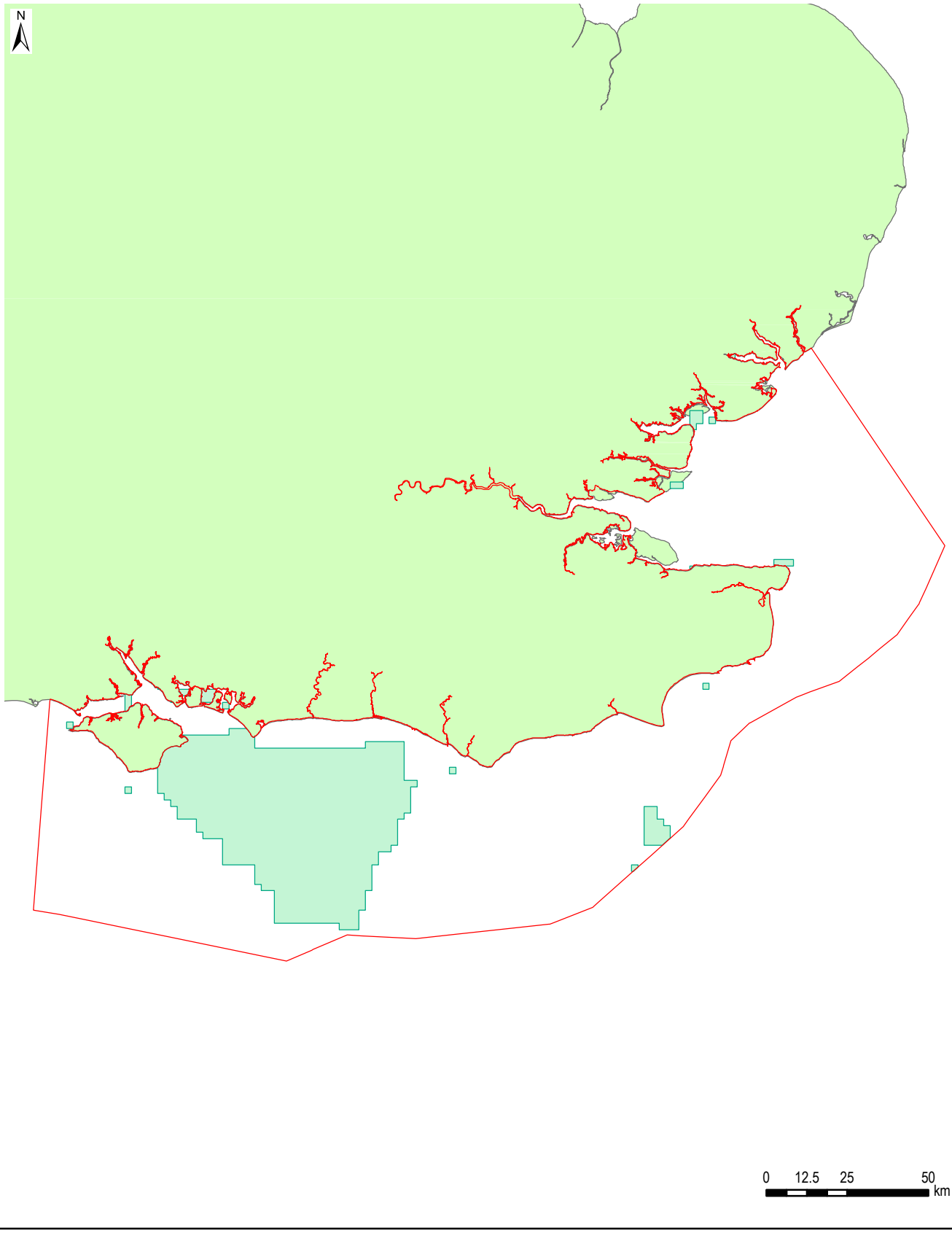
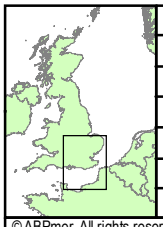
Balanced Seas Study Area

Figure 9





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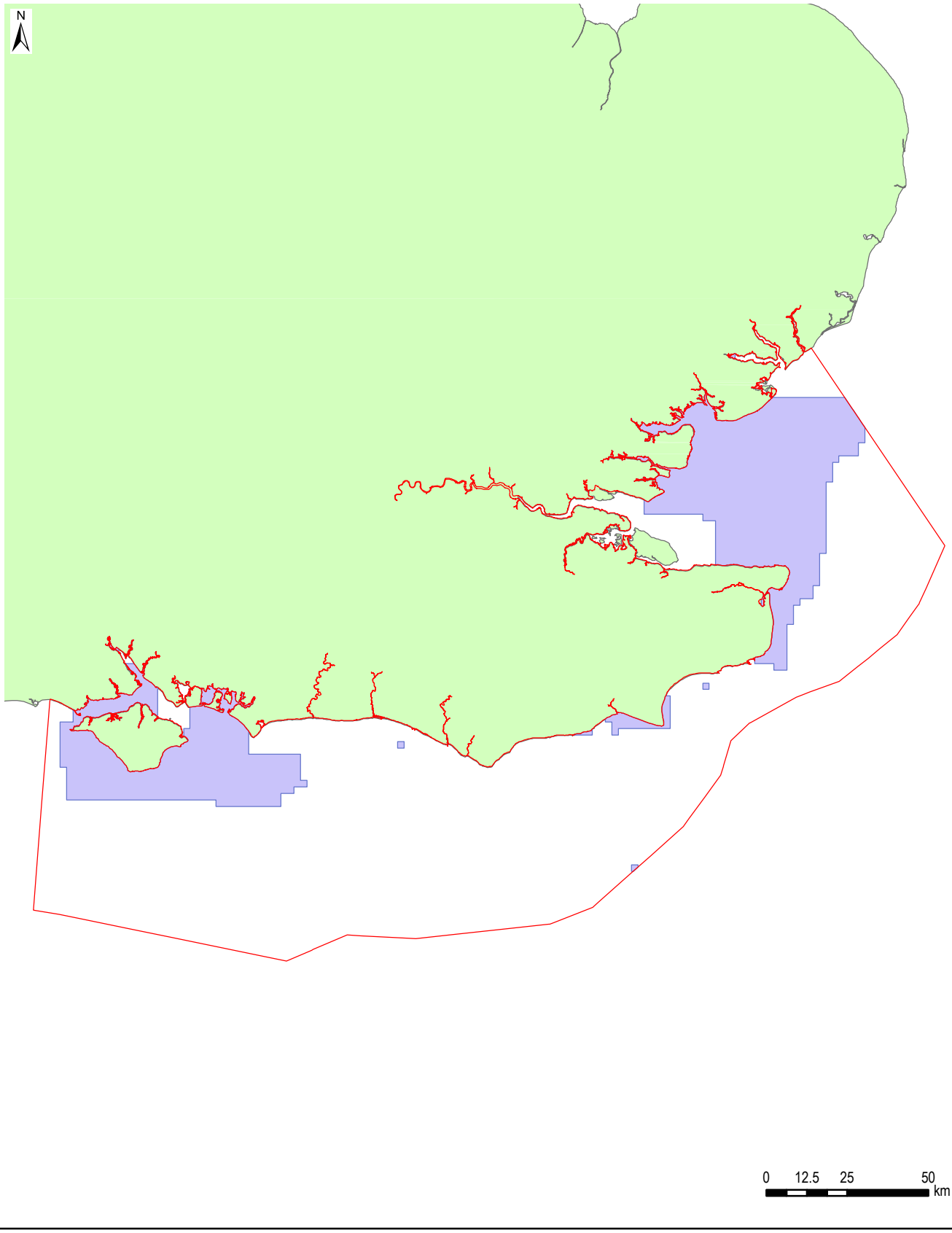
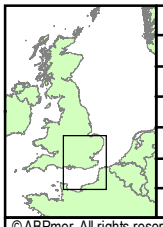
Balanced Seas Scenario 1 - Pure Ecological Network

Figure 10





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Balanced Seas Study Area

Pure Ecological Network with SACs Locked In

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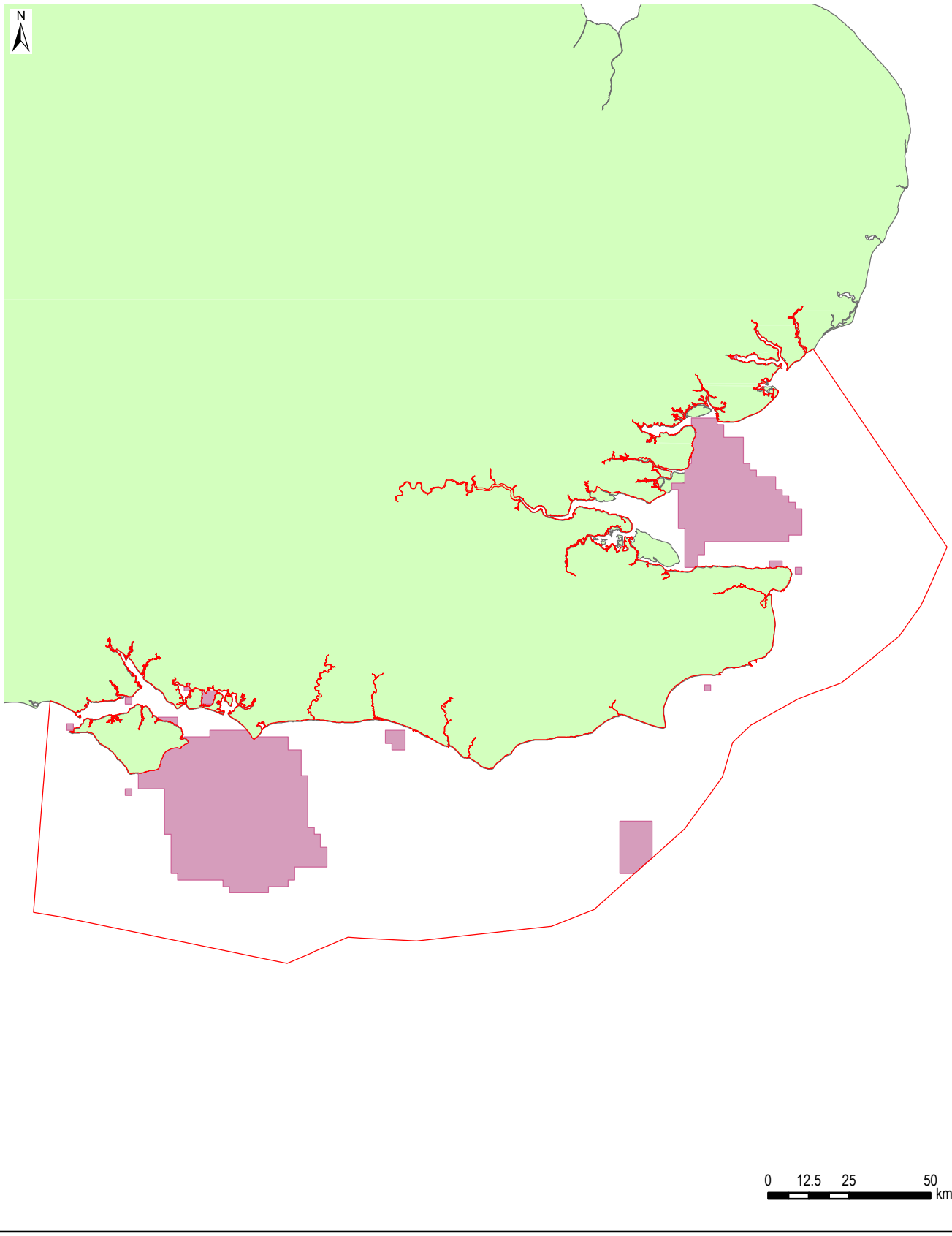
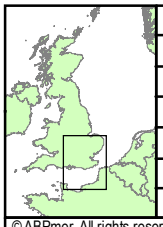
Balanced Seas Scenario 2 - Pure Ecological Network with SACs Locked In

Figure 11





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Pure Ecological Network with Low Cost Avoidance

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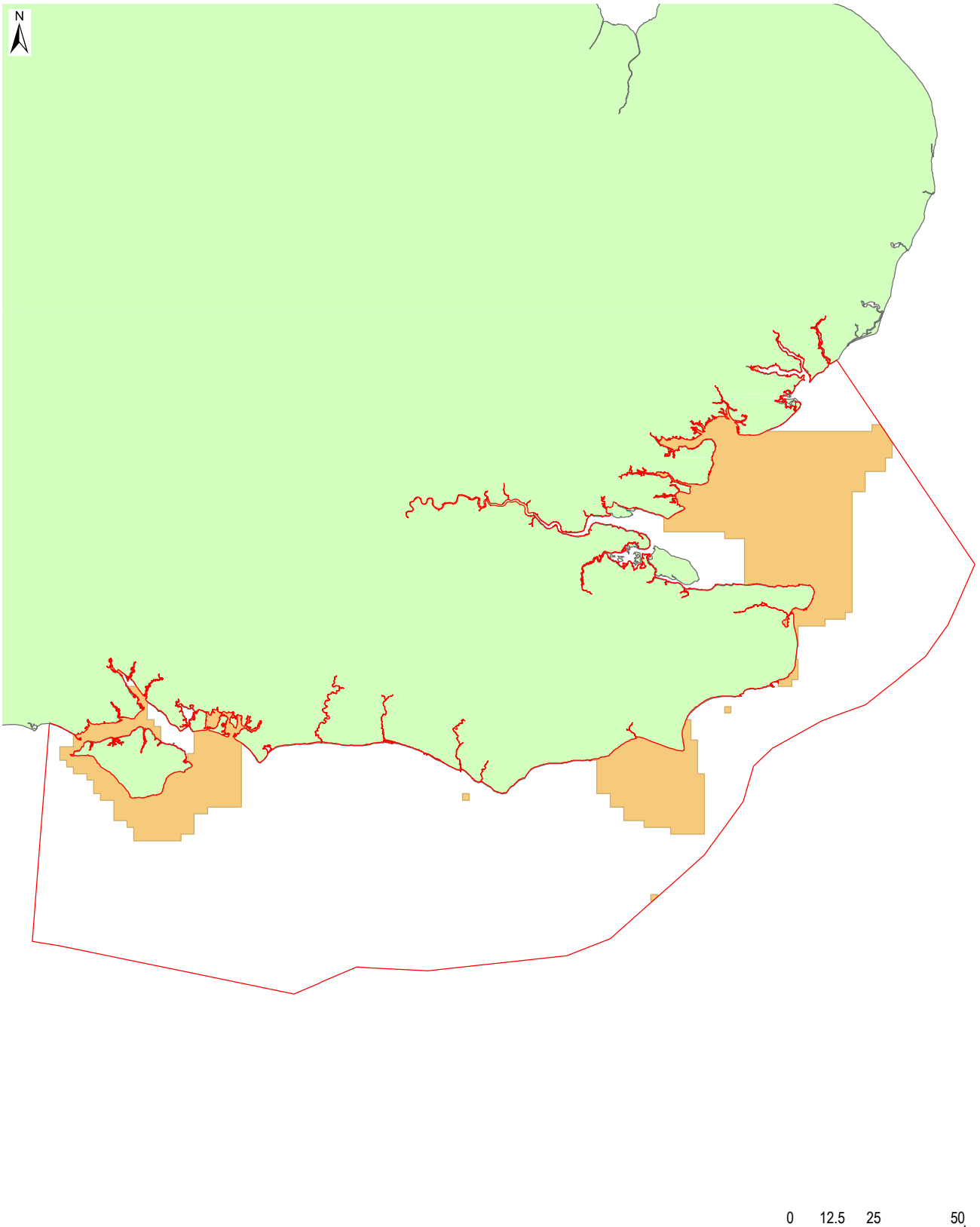
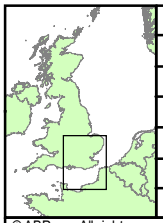
Balanced Seas Scenario 3 - Pure Ecological Network with Low Cost Avoidance

Figure 12





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Balanced Seas Study Area

Pure Ecological Network with SACs Locked In and Low Cost Avoidance

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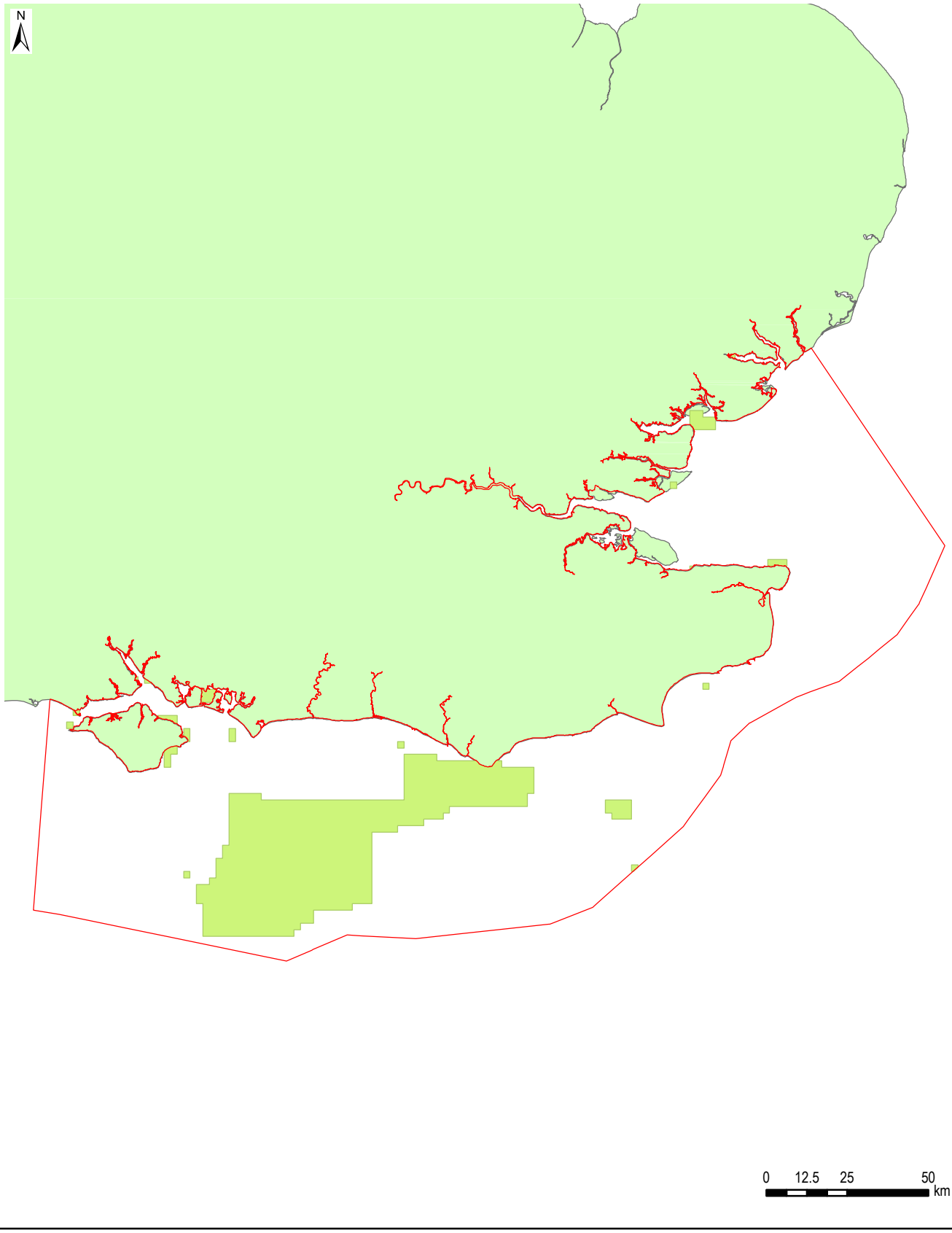
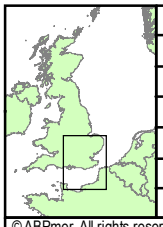
Balanced Seas Scenario 4 - Pure Ecological Network with SACs Locked In and Low Cost Avoidance

Figure 13





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Balanced Seas Study Area

Pure Ecological Network with High Cost Avoidance

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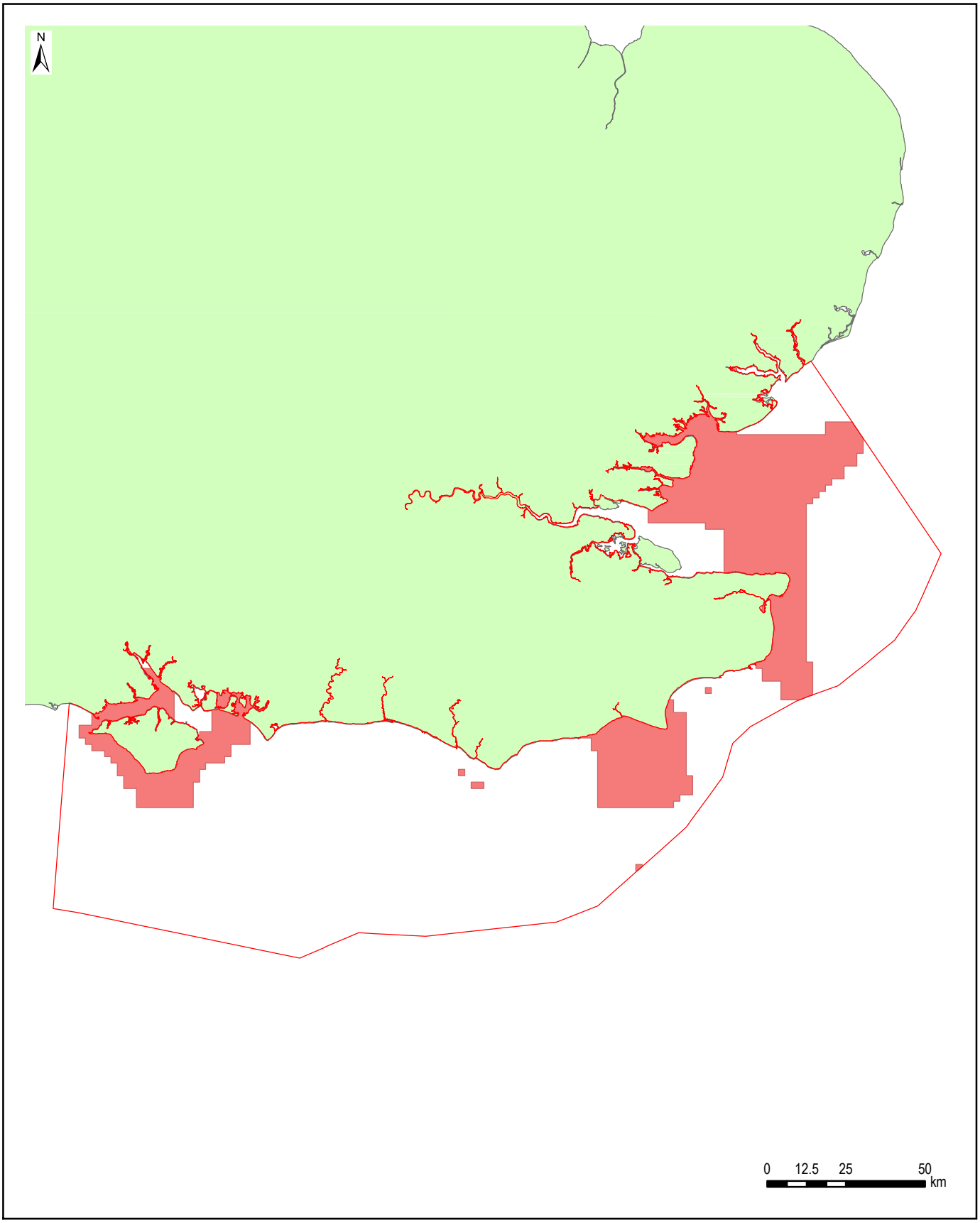
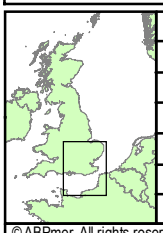
Balanced Seas Scenario 5 - Pure Ecological Network with High Cost Avoidance

Figure 14





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Balanced Seas Study Area

Pure Ecological Network with SACs Locked In and High Cost Avoidance

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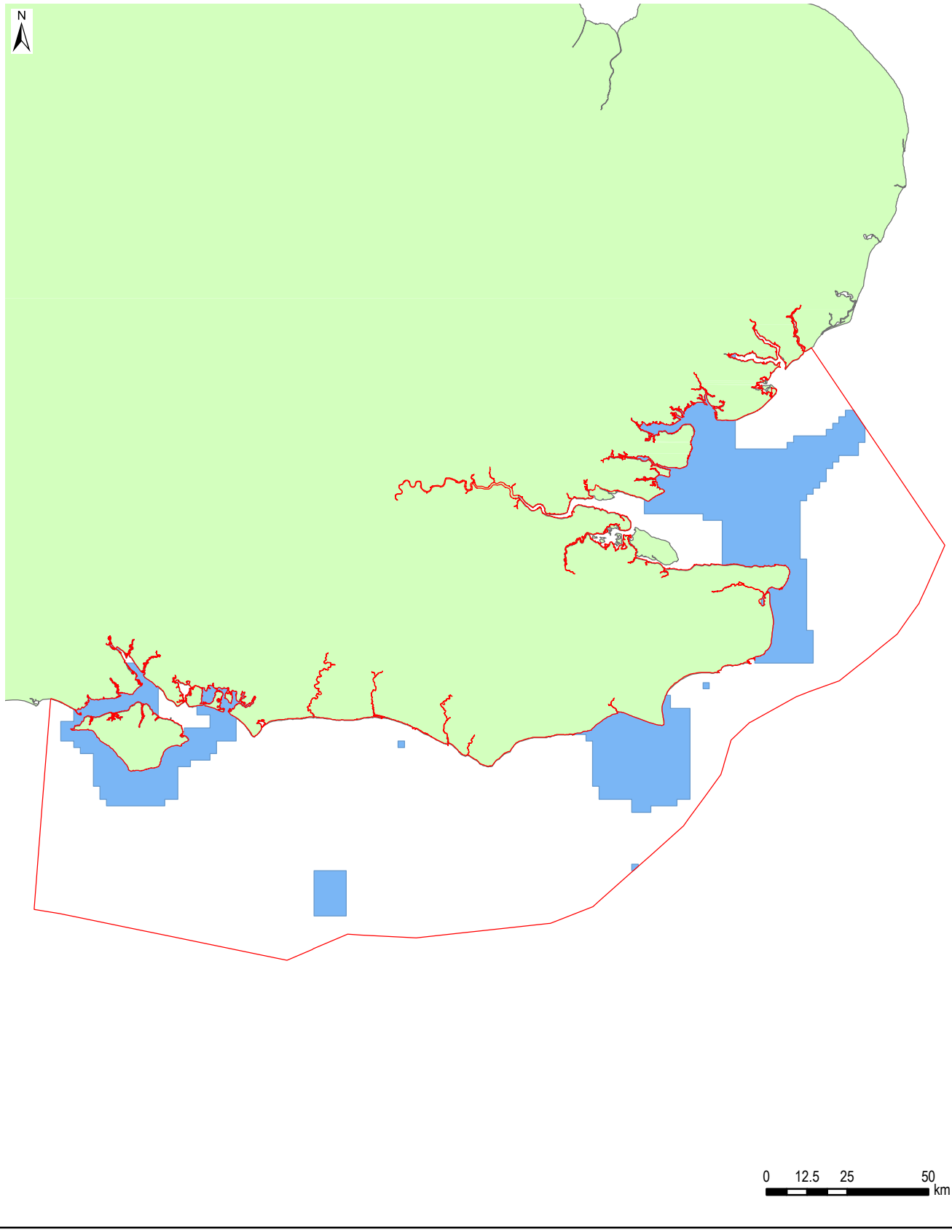
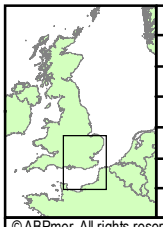
Balanced Seas Scenario 6 - Pure Ecological Network with SACs Locked In and High Cost Avoidance

Figure 15





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Balanced Seas Study Area

Pure Ecological Network with SACs Locked In, High Cost Avoidance and Aggregate & Wind Farm Areas Locked Out.

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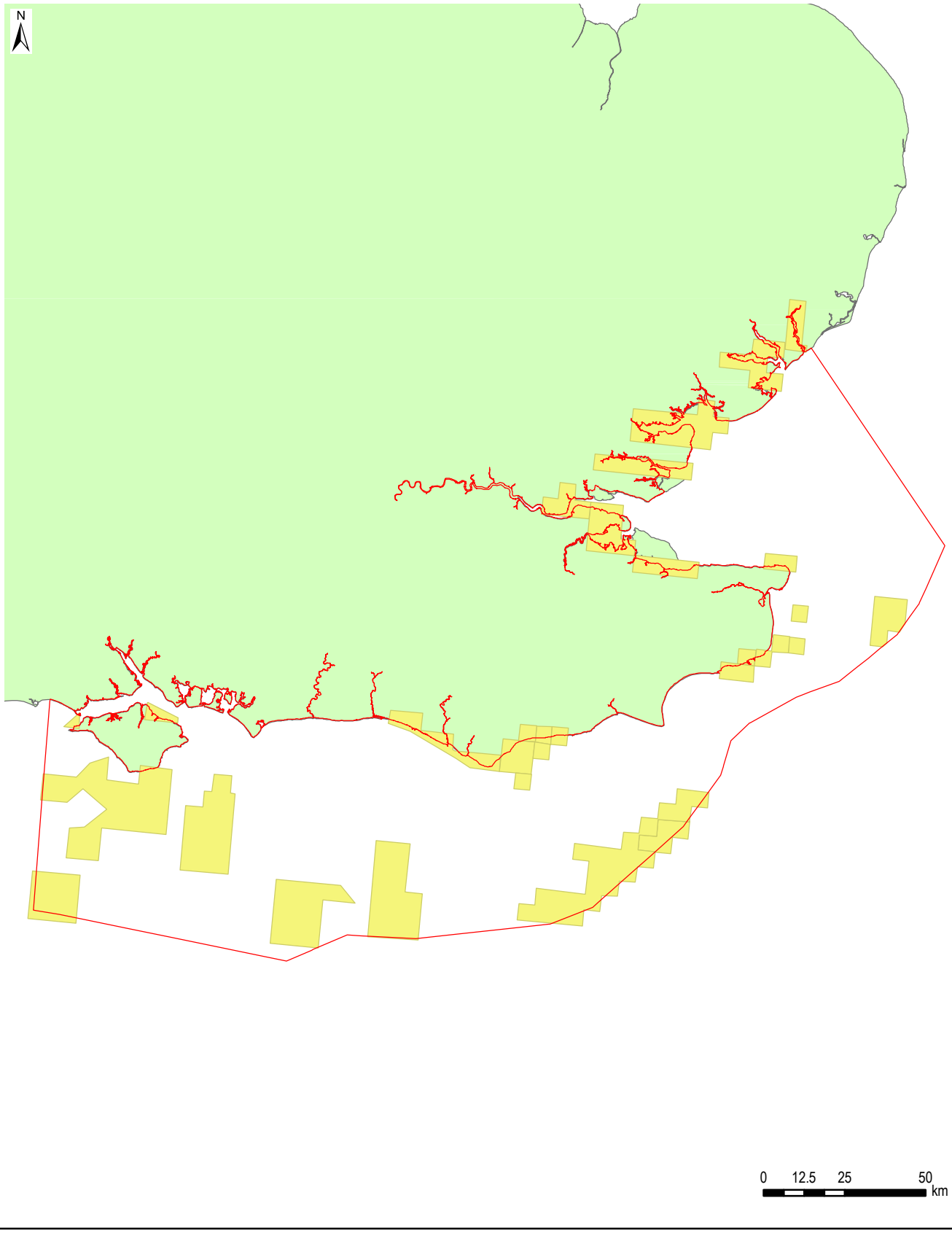
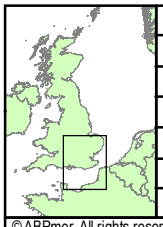
Balanced Seas Scenario 7 - Pure Ecological Network with SACs Locked In, High Cost Avoidance and Aggregate & Wind Farm Areas Locked Out.

Figure 16





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Balanced Seas Study Area

Balanced Seas 1st Iteration Network

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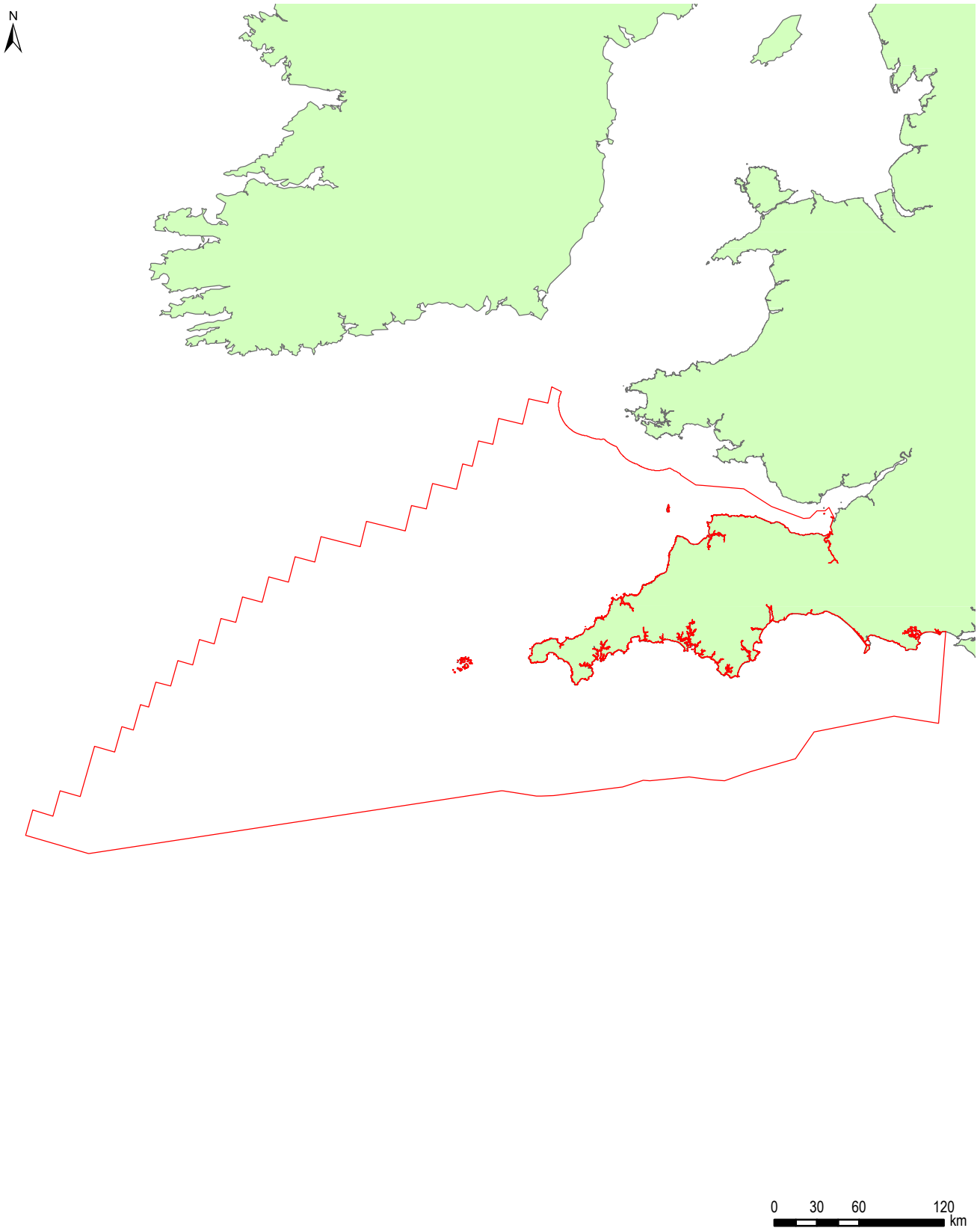
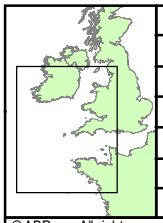
Balanced Seas Scenario 8 - First Iteration Network

Figure 17





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QA		FMM	
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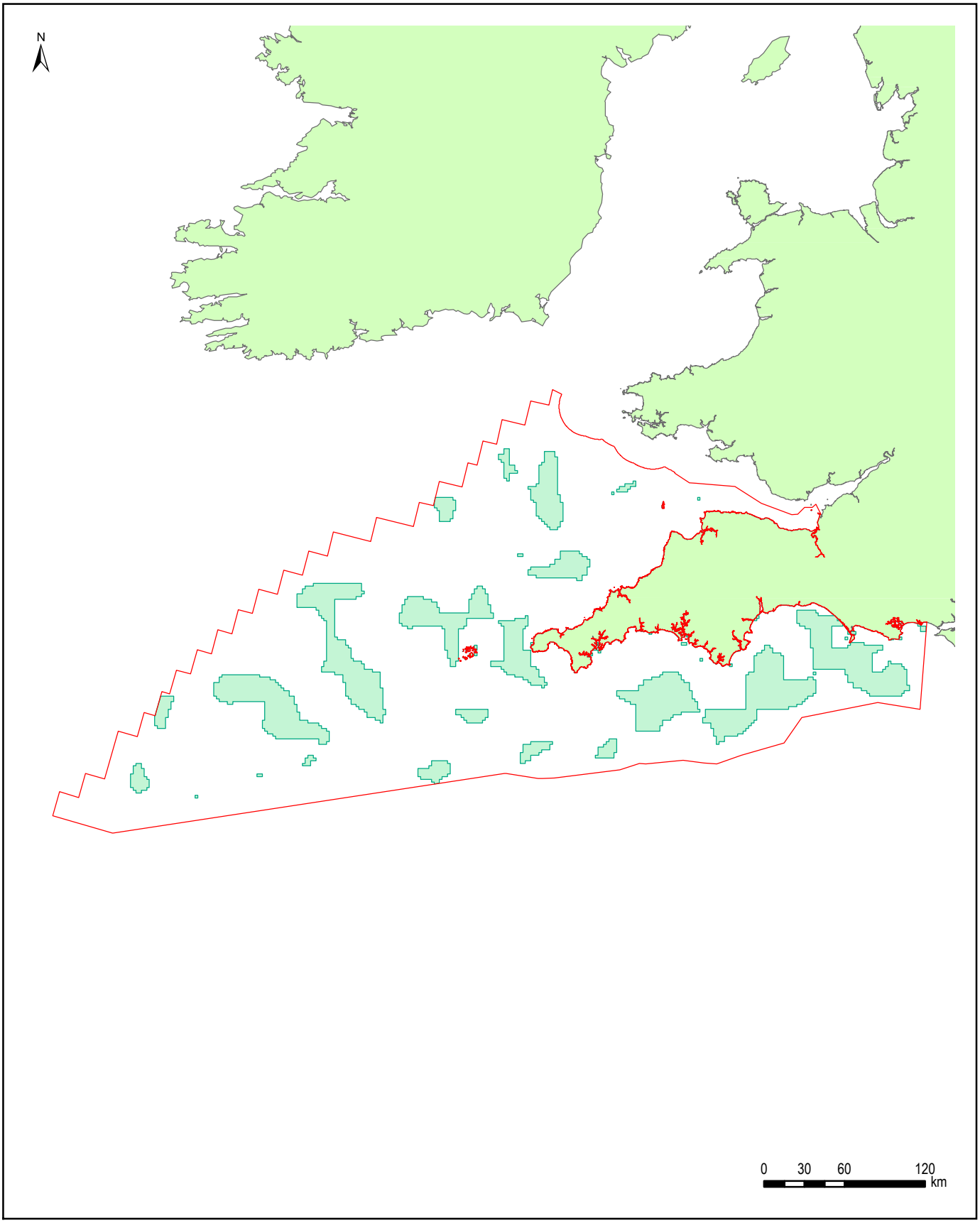
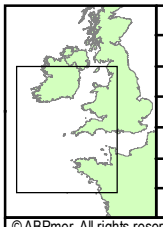
Finding Sanctuary Study Area | **Figure 18**





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Pure Ecological Network

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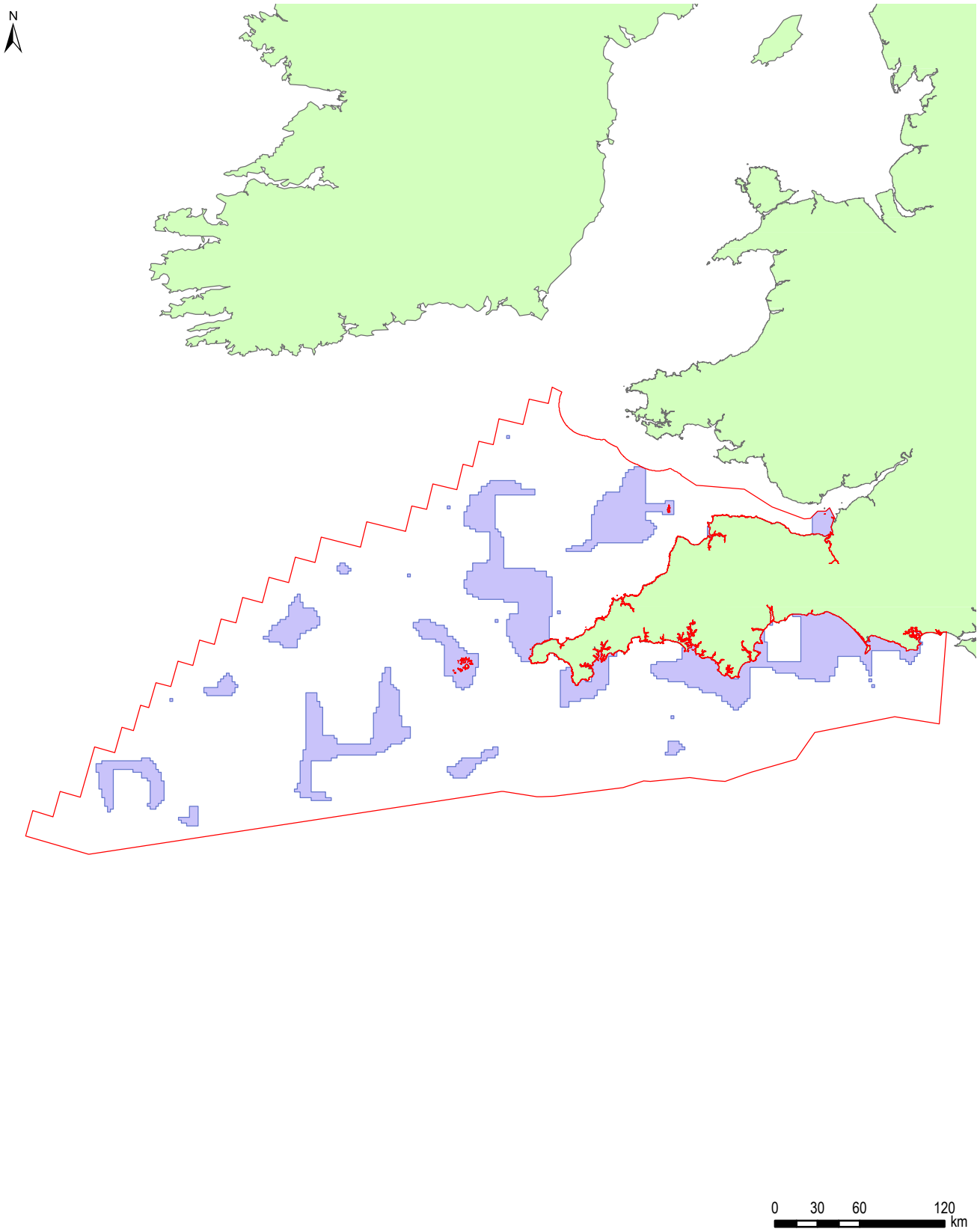
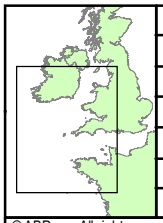
Finding Sanctuary Scenario 1 - Pure Ecological Network

Figure 19





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Pure Ecological Network with SACs Locked In

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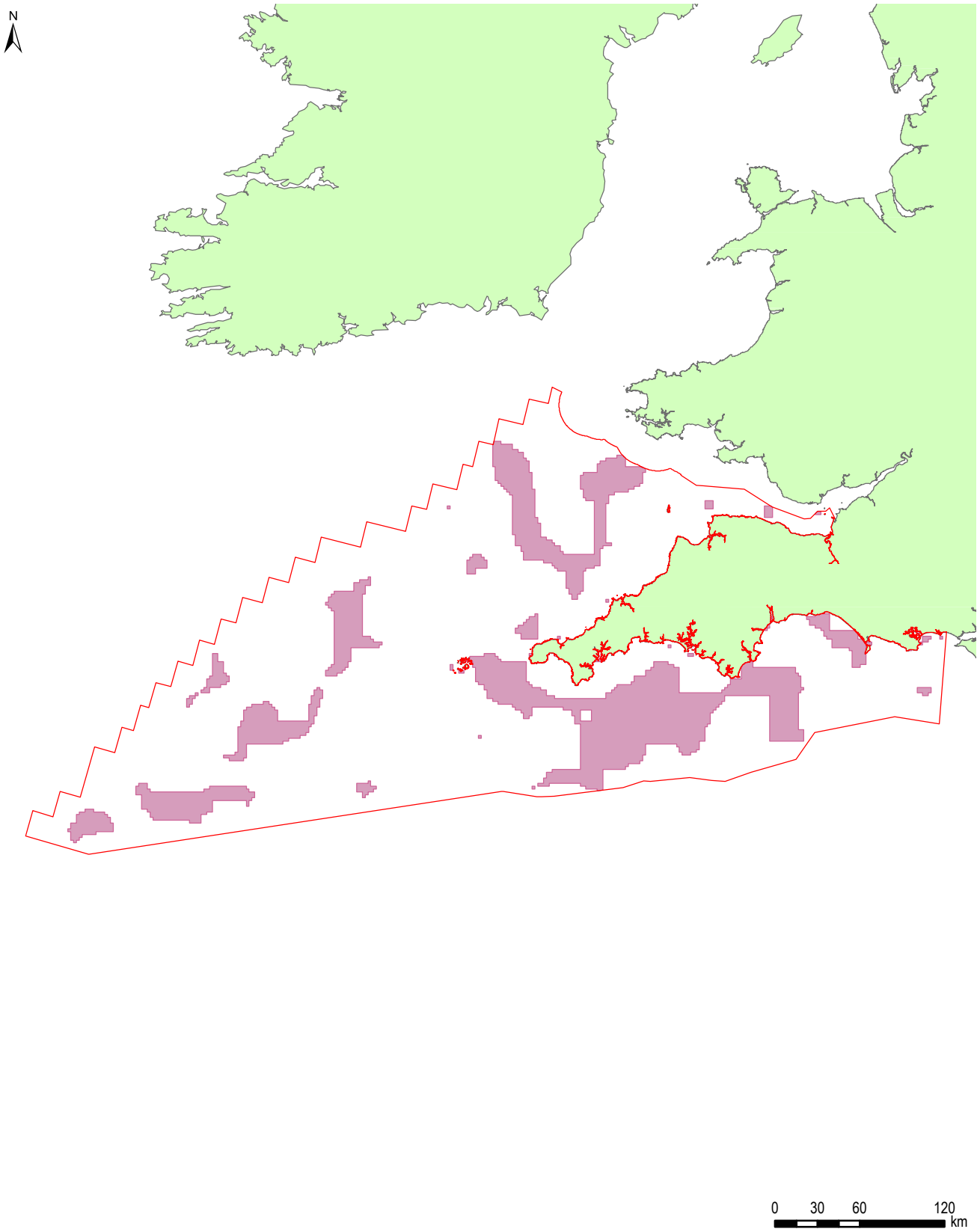
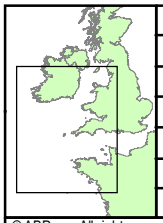
Finding Sanctuary Scenario 2 - Pure Ecological Network with SACs Locked In

Figure 20





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Pure Ecological Network with Low Cost Avoidance

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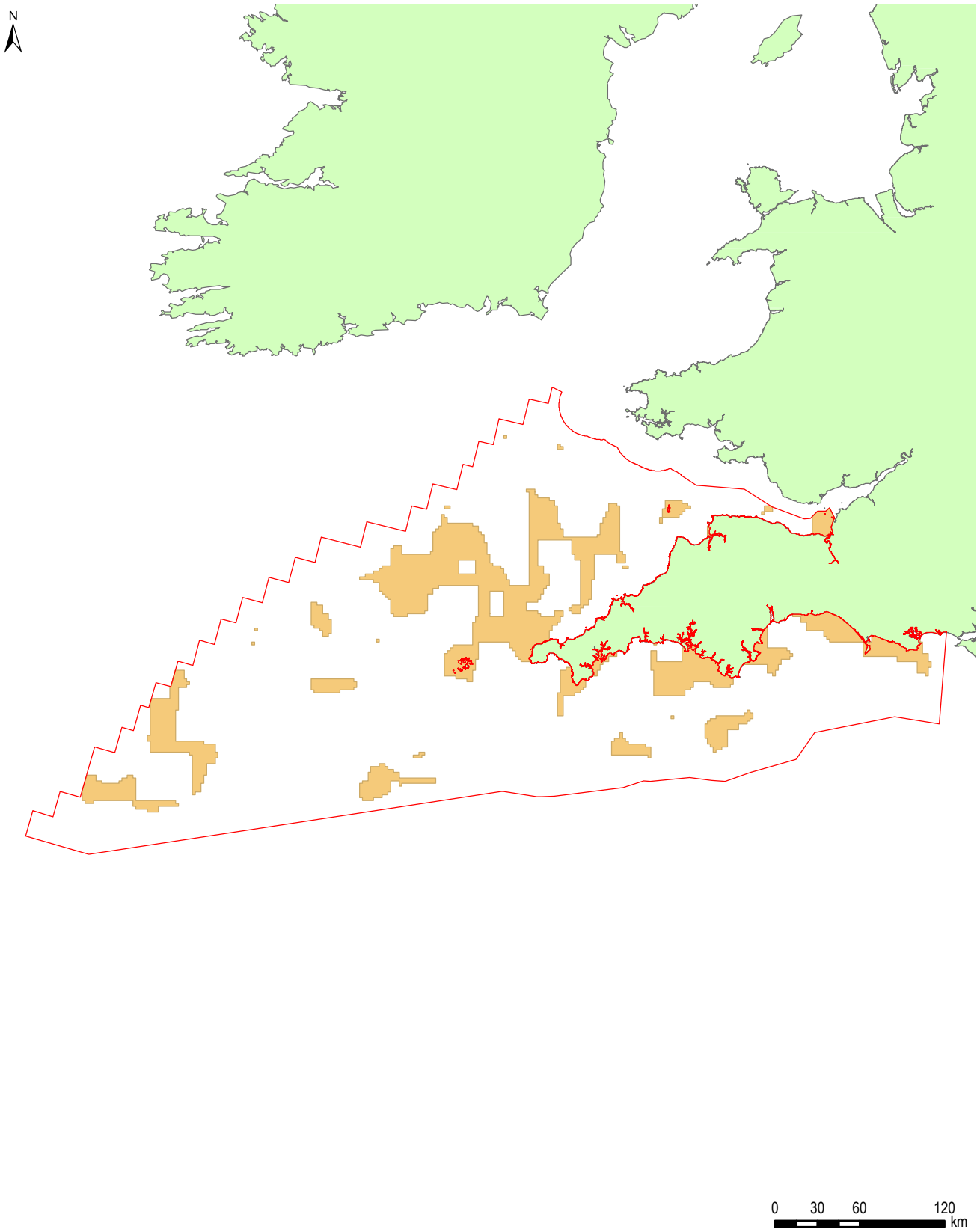
Finding Sanctuary Scenario 3 - Pure Ecological Network with Low Cost Avoidance

Figure 21



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Pure Ecological Network with SACs Locked In and Low Cost Avoidance

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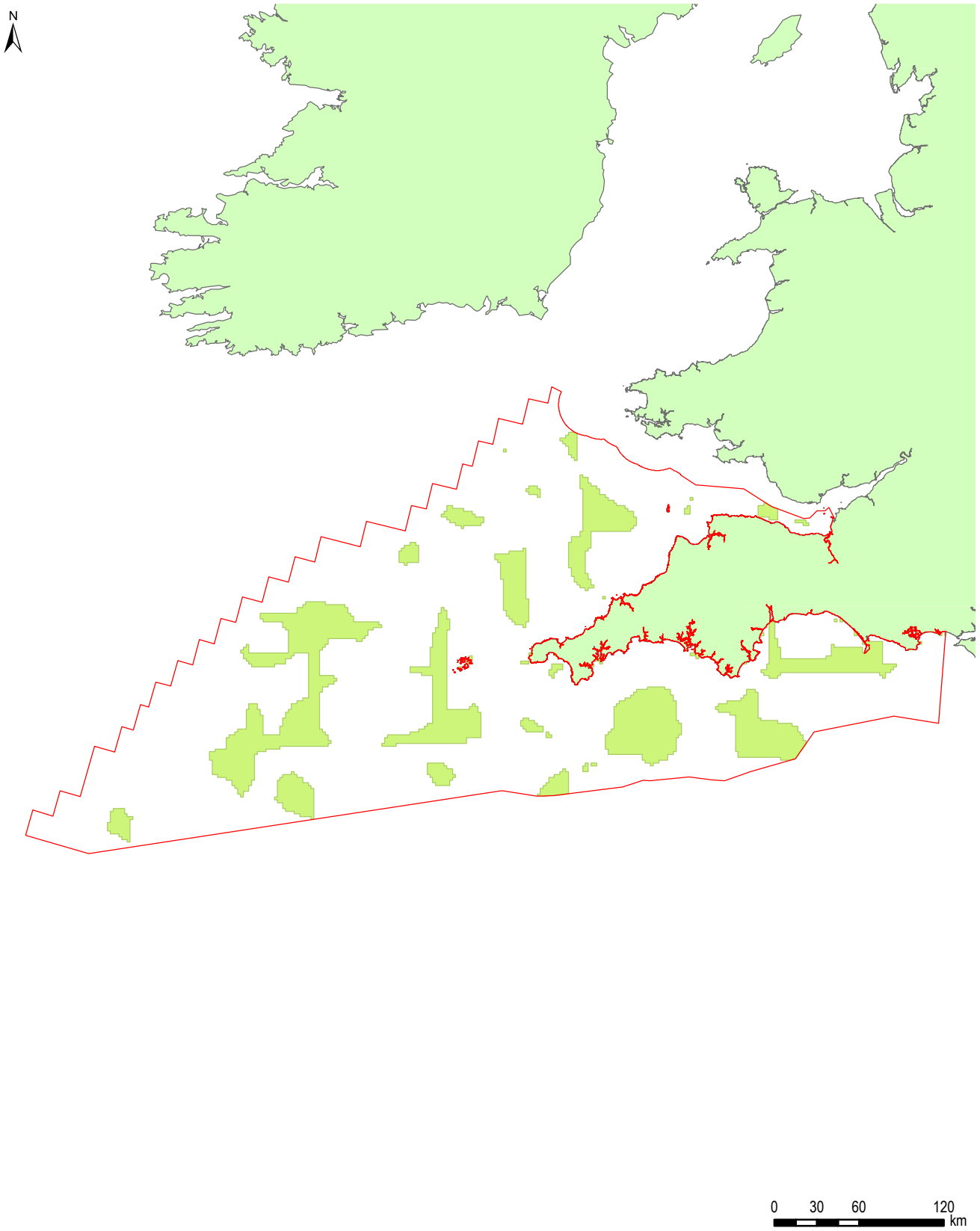
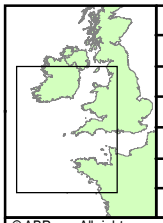
Finding Sanctuary Scenario 4 - Pure Ecological Network with SACs Locked In and Low Cost Avoidance

Figure 22





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Pure Ecological Network with High Cost Avoidance

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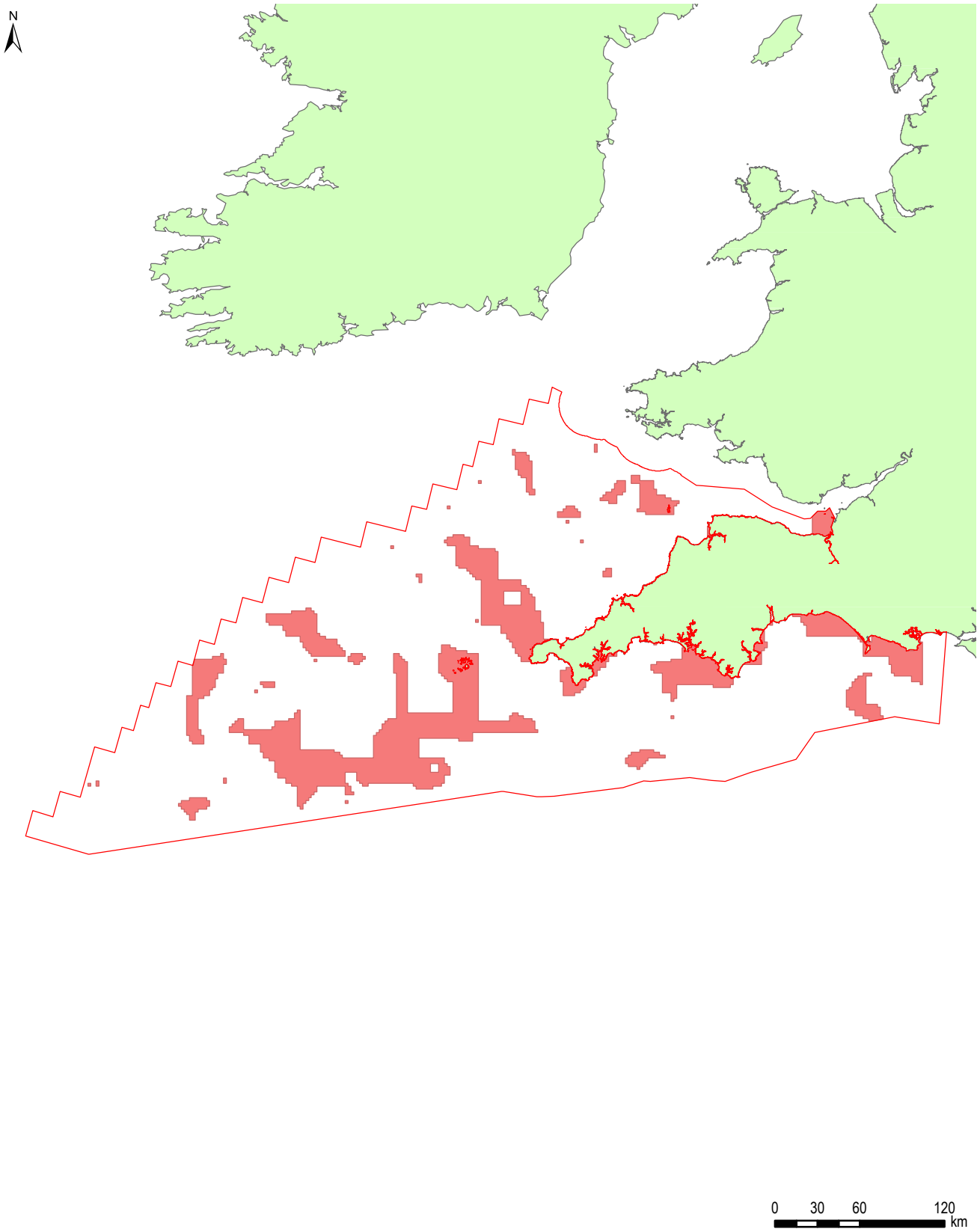
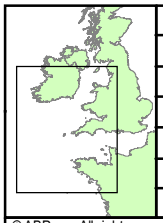
Finding Sanctuary Scenario 5 - Pure Ecological Network with HighCost Avoidance

Figure 23





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QA		FMM	
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Pure Ecological Network with SACs Locked In and High Cost Avoidance

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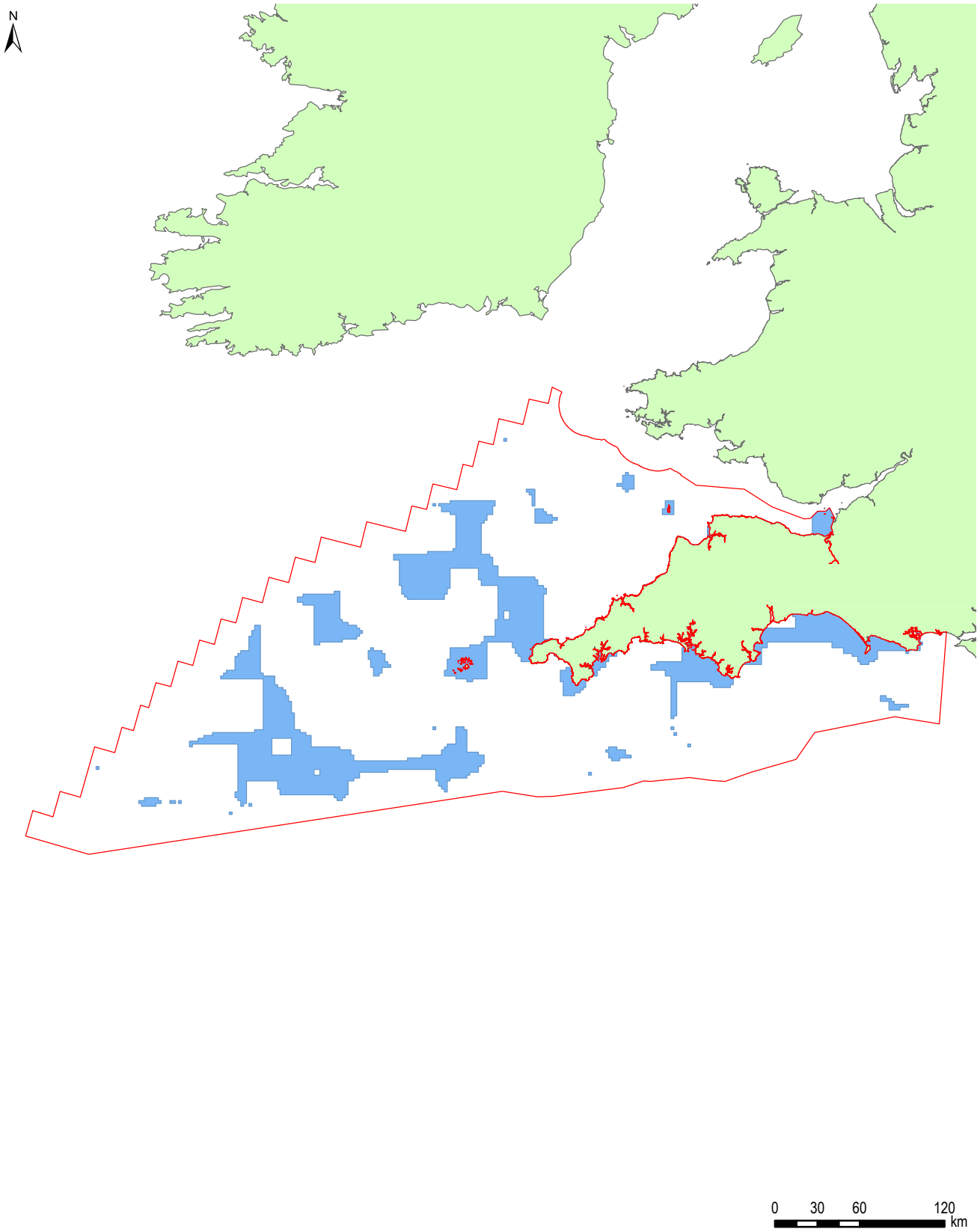
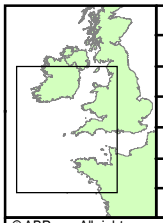
Finding Sanctuary Scenario 6 - Pure Ecological Network with SACs Locked In and High Cost Avoidance

Figure 24





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Pure Ecological Network with SACs Locked In, High Cost Avoidance and Aggregate & Wind Farm Areas Locked Out

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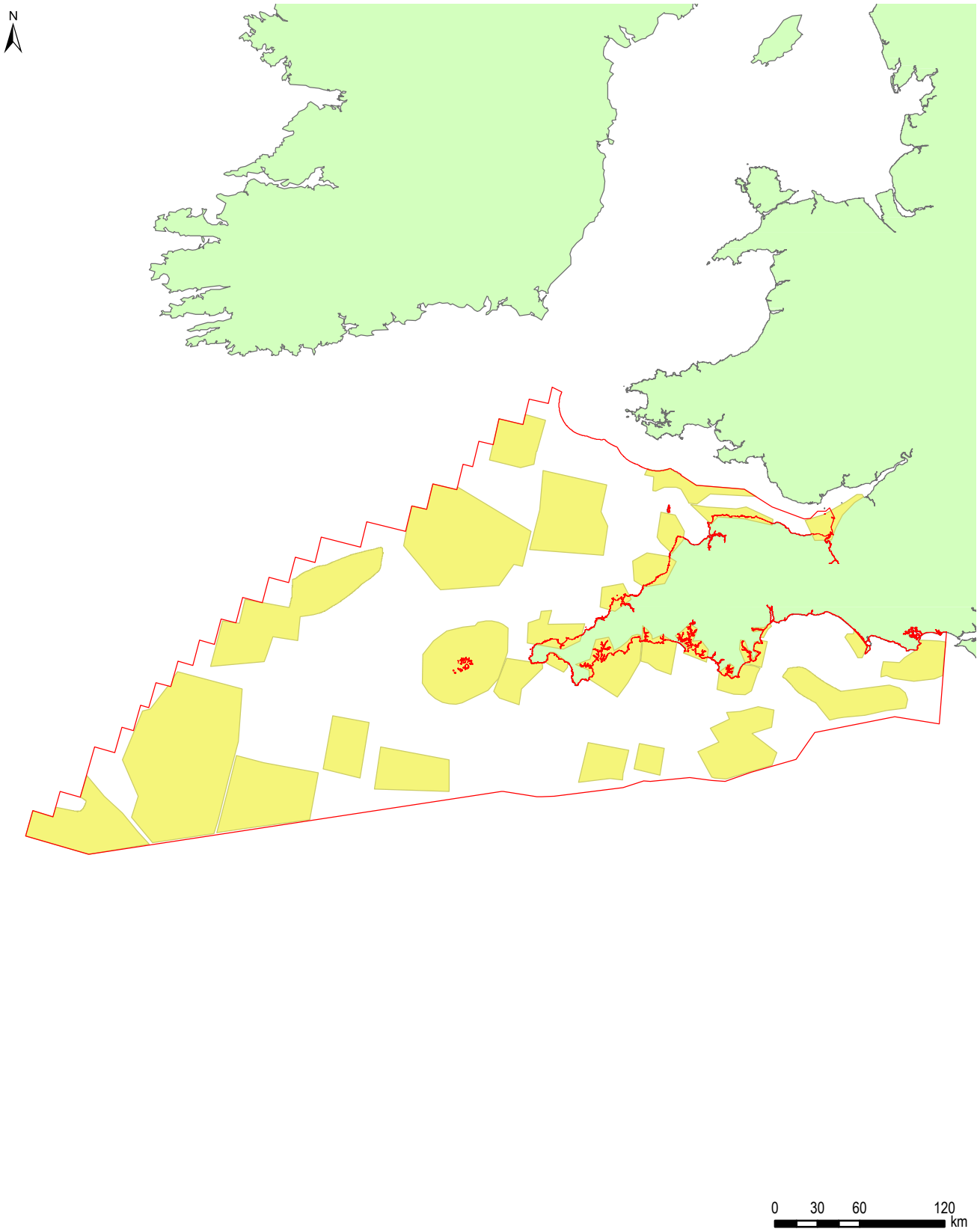
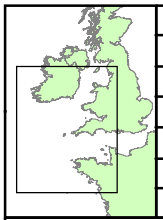
Finding Sanctuary Scenario 7 - Pure Ecological Network with SACs Locked In, High Cost Avoidance and Aggregate & Wind Farm Areas Locked Out

Figure 25





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3957 - Fig26_FS_Scenario8.mxd			
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Finding Sanctuary Study Area

Finding Sanctuary 1st Iteration

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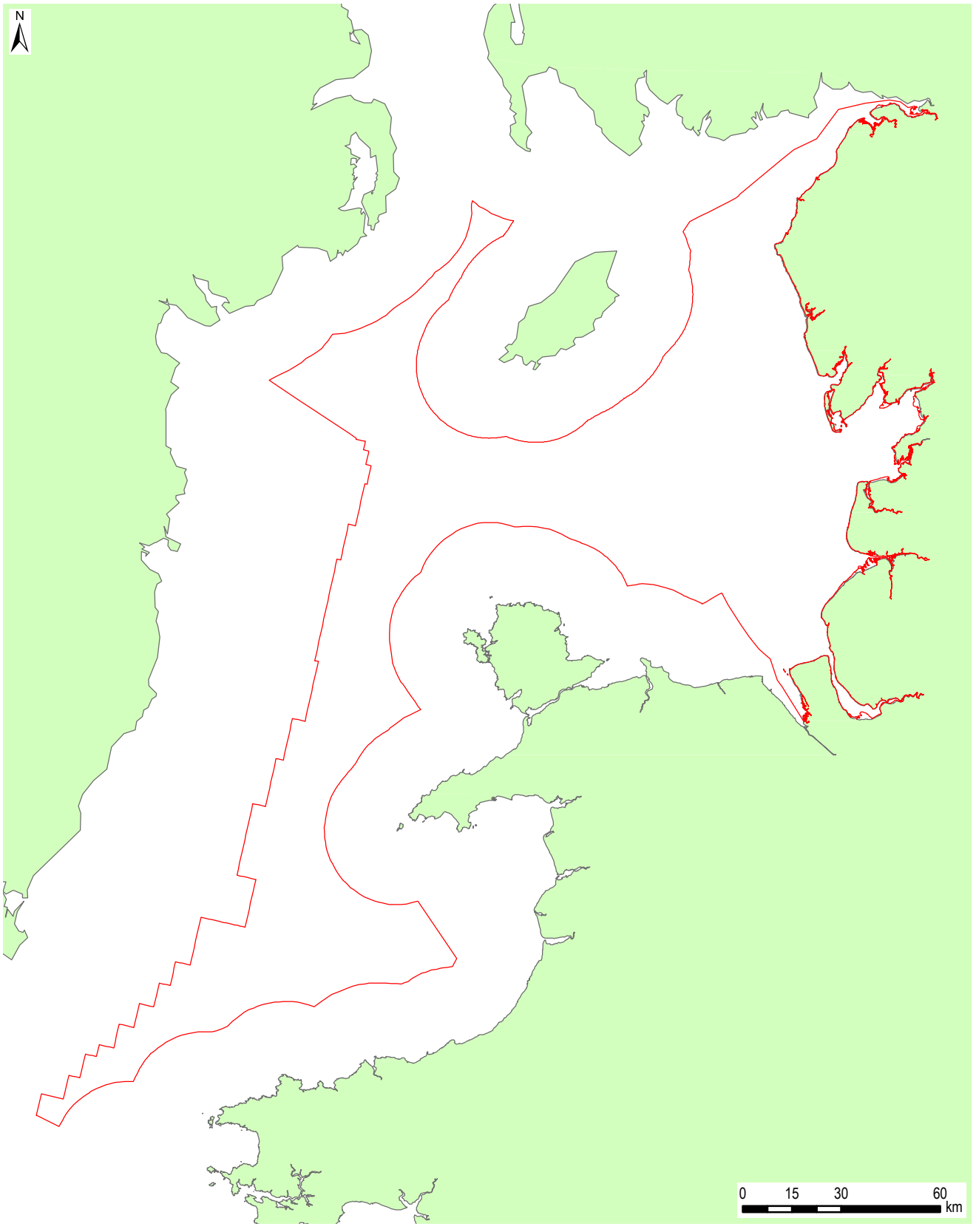
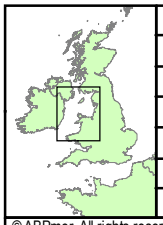
Finding Sanctuary Scenario 8 - First Iteration Network

Figure 26





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3957 - Fig27_IS_Study_Area.mxd			
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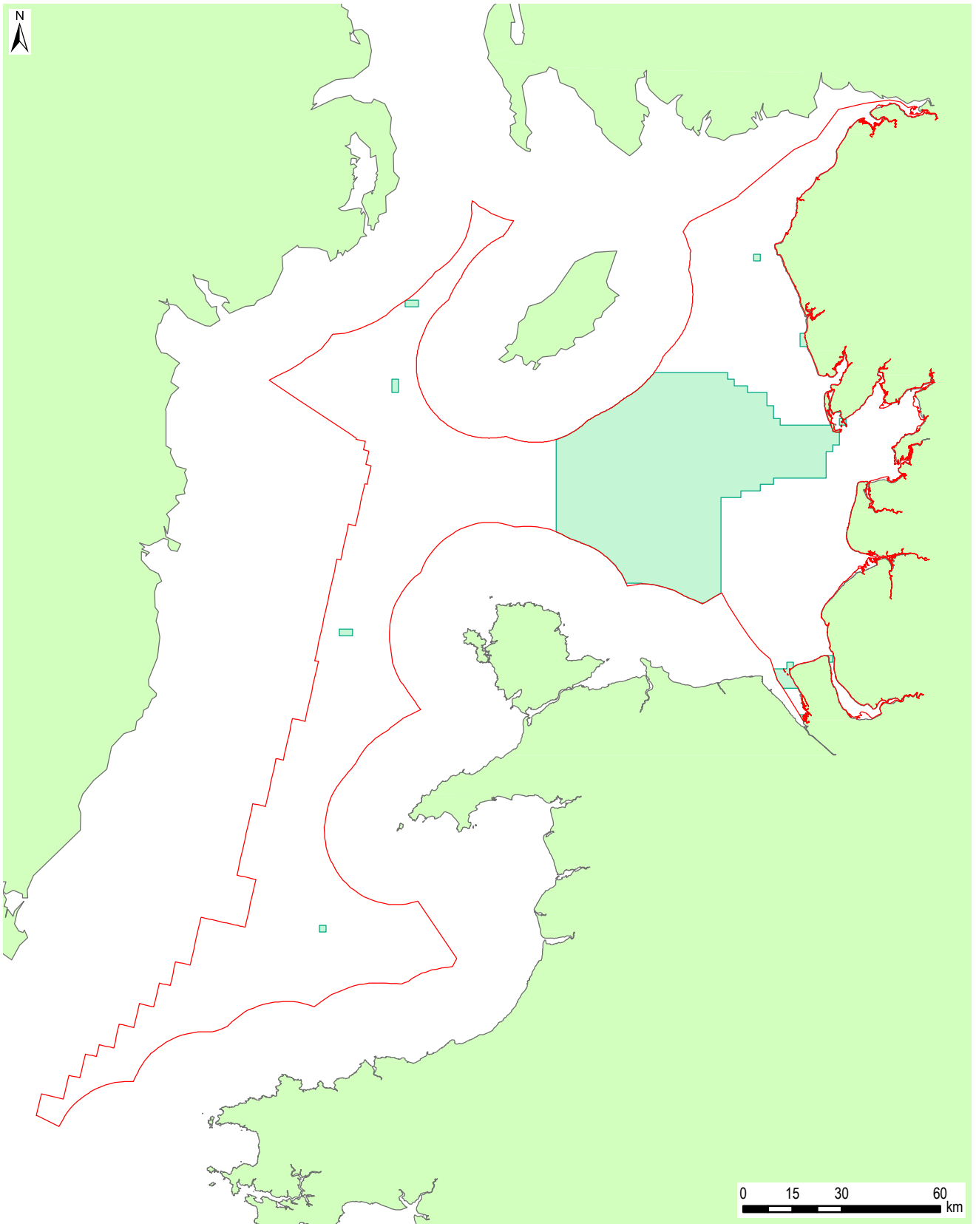
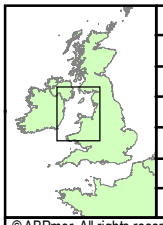
Irish Sea Study Area

Figure 27





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Pure Ecological Network

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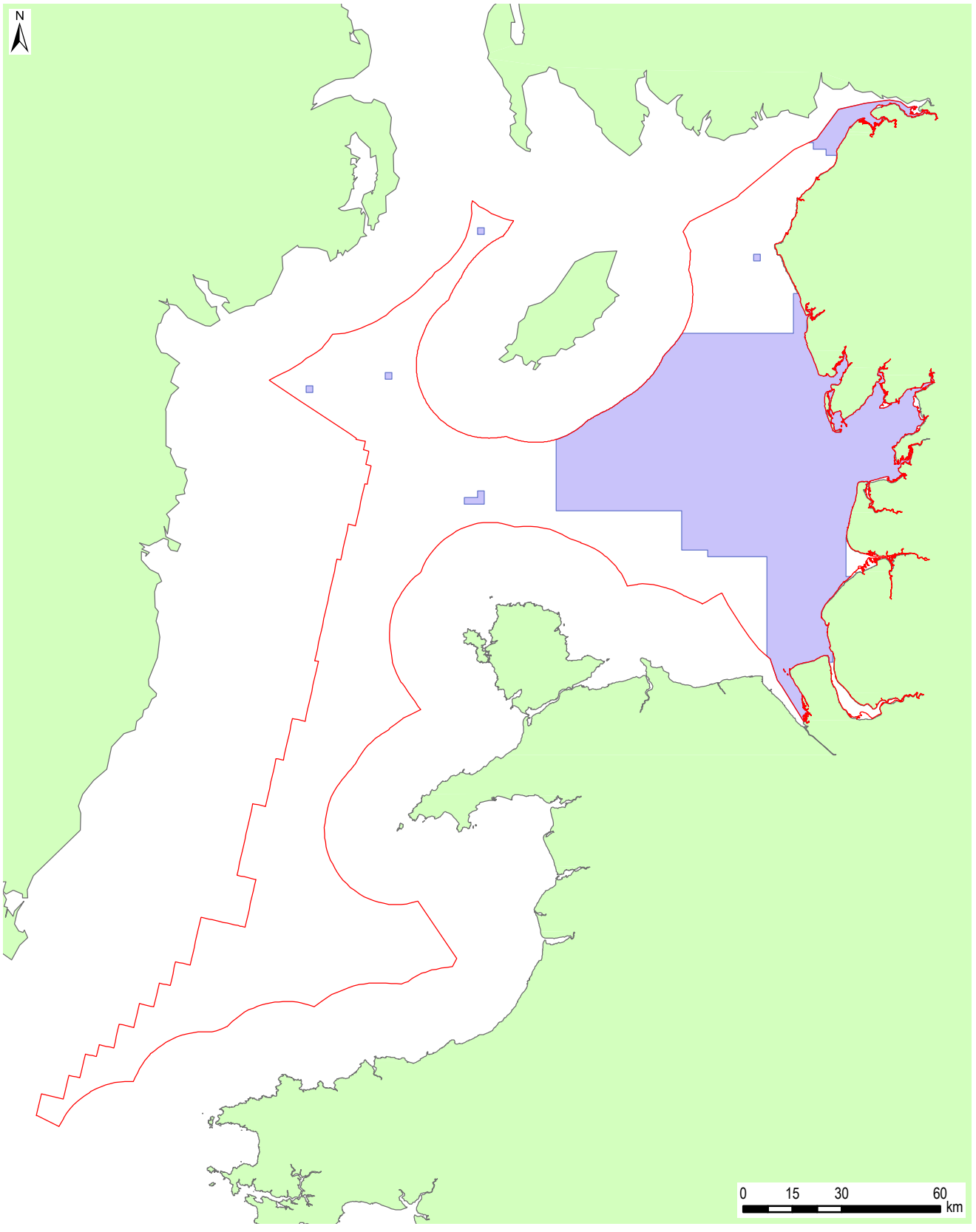
Irish Sea Scenario 1 - Pure Ecological Network

Figure 28



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Pure Ecological Network with SACs Locked In

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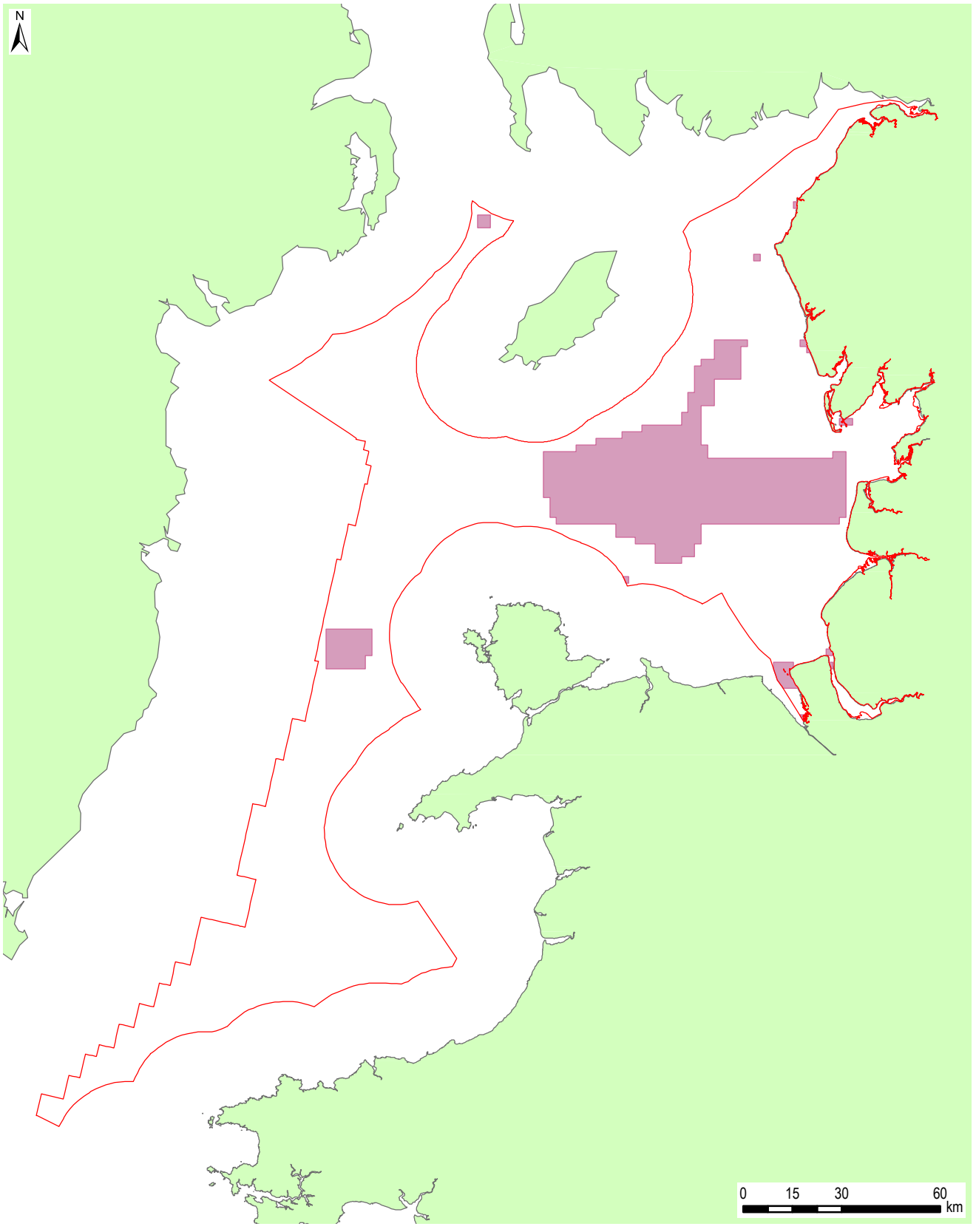
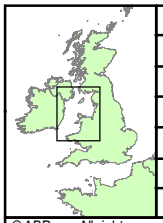
Irish Sea Scenario 2 - Pure Ecological Network with SACs Locked In

Figure 29





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Pure Ecological Network with Low Cost Avoidance

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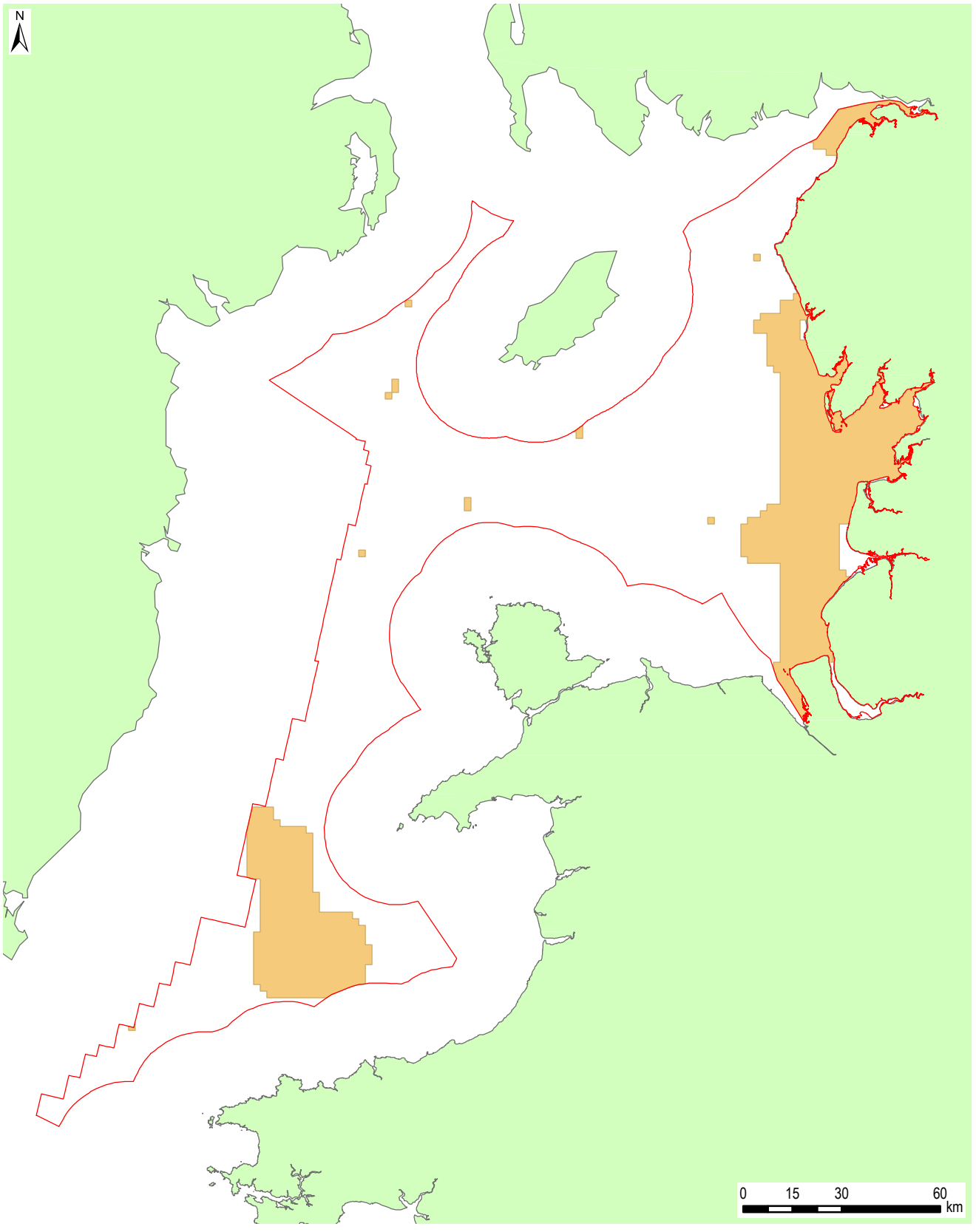
Irish Sea Scenario 3 - Pure Ecological Network with Low Cost Avoidance

Figure 30



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Pure Ecological Network with SACs Locked In and Low Cost Avoidance

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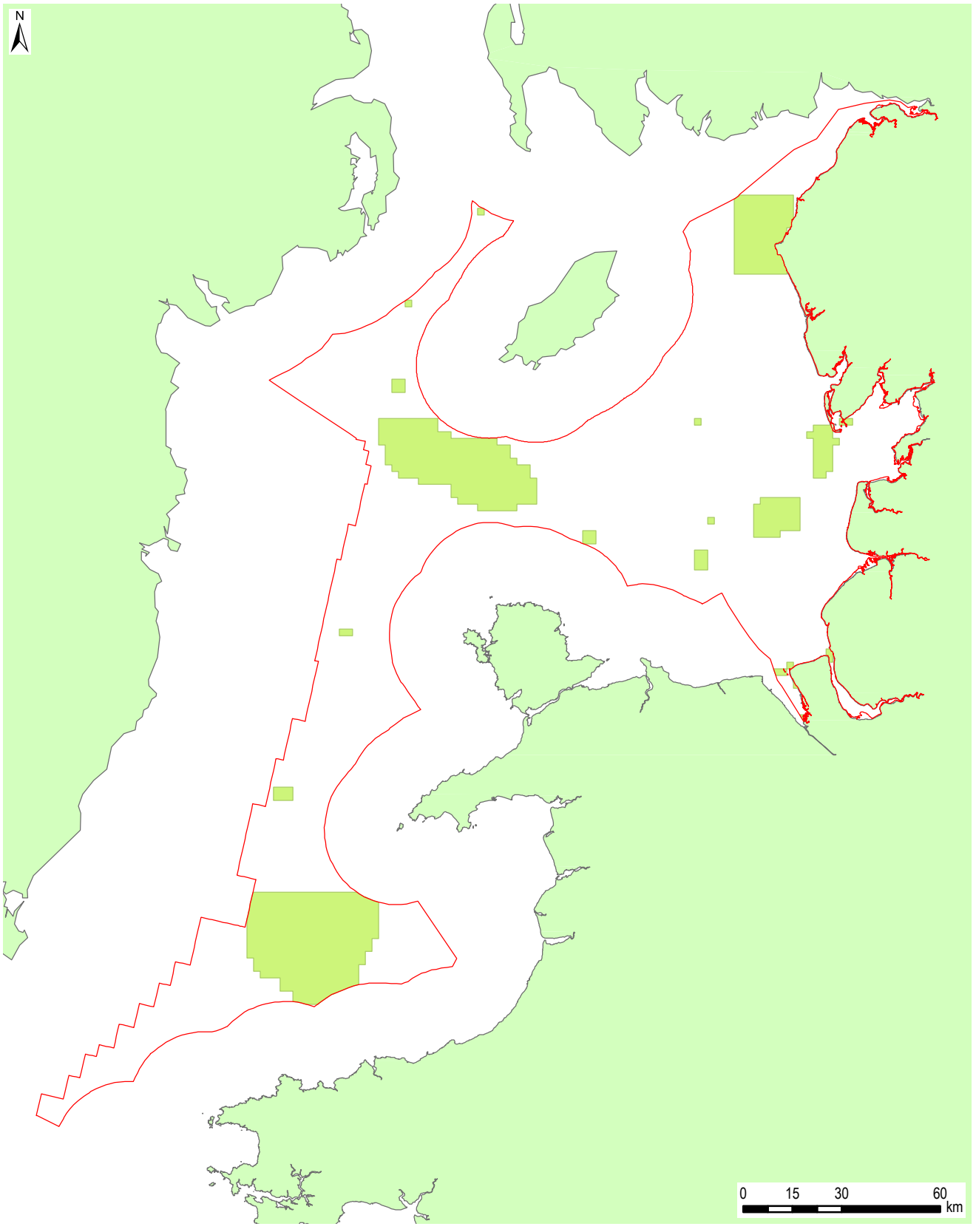
Irish Sea Scenario 4 - Pure Ecological Network with SACs Locked In and Low Cost Avoidance

Figure 31



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Projection		Albers	
Scale		1:1,700,000	
QA		FMM	
3957 - Fig32_IS_Scenario5.mxd			
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Irish Sea Study Area

Pure Ecological Network with High Cost Avoidance

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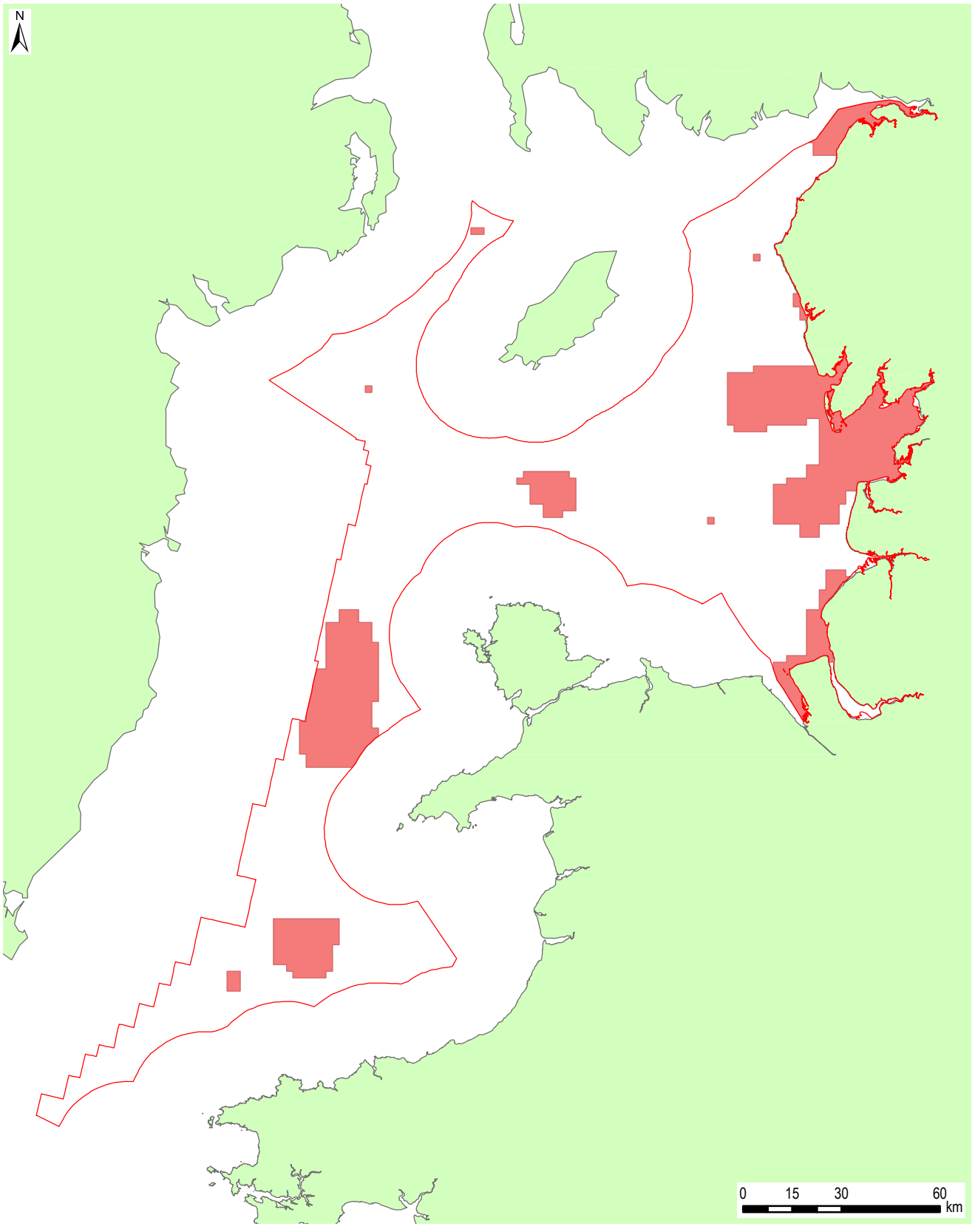
Irish Sea Scenario 5 - Pure Ecological Network with High Cost Avoidance

Figure 32



Date	By	Size	Version
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QA		FMM	
3957 - Fig33_IS_Scenario6.mxd			
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Irish Sea Study Area

Pure Ecological Network with SACs Locked In and High Cost Avoidance

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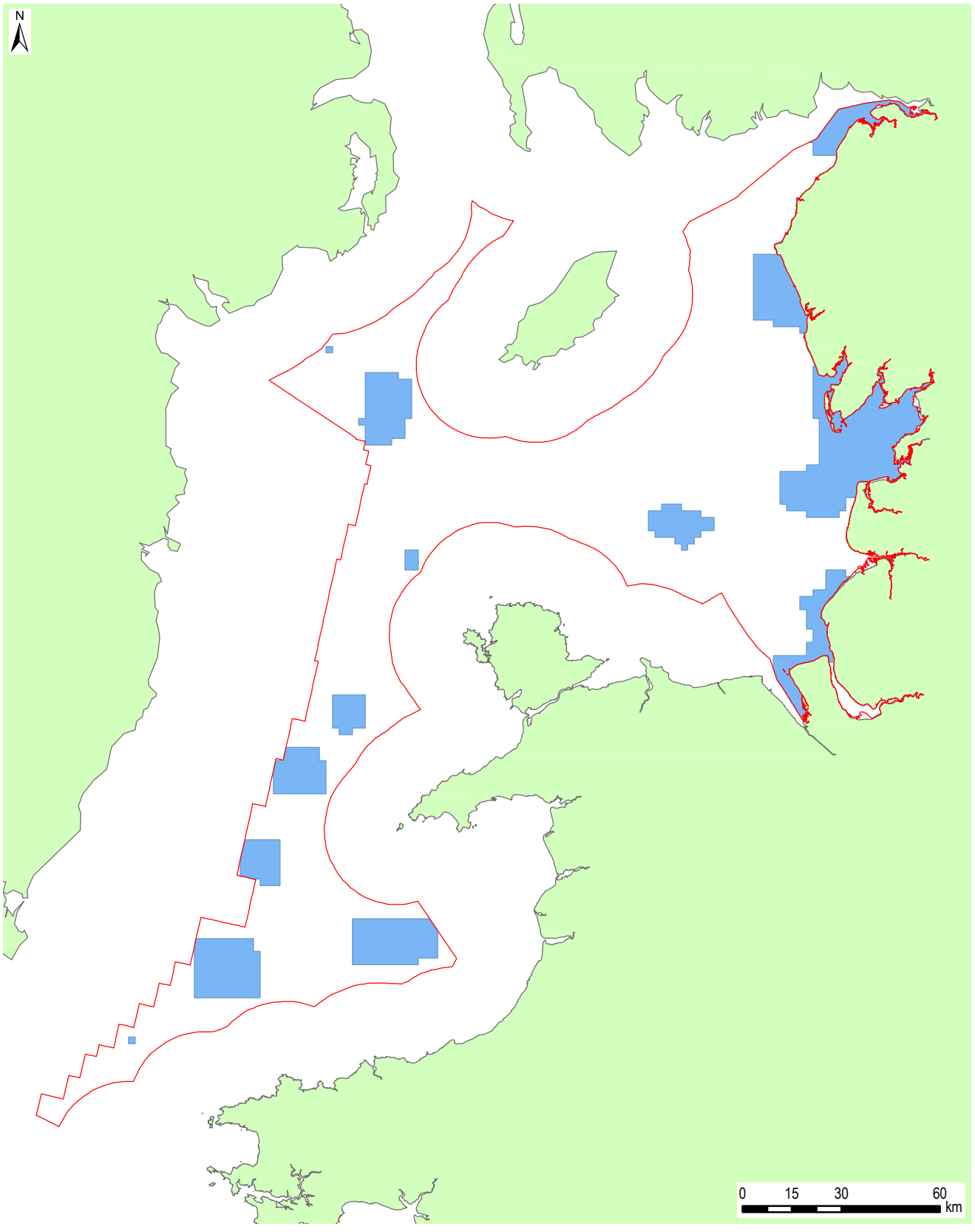
Irish Sea Scenario 6 - Pure Ecological Network with SACs Locked In and High Cost Avoidance

Figure 33



Date	By	Size	Version
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QA		FMM	
3957 - Fig34_IS_Scenario7.mxd			
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Irish Sea Study Area

Pure Ecological Network with SACs Locked In, High Cost Avoidance and Aggregate & Wind Farm Areas Locked Out

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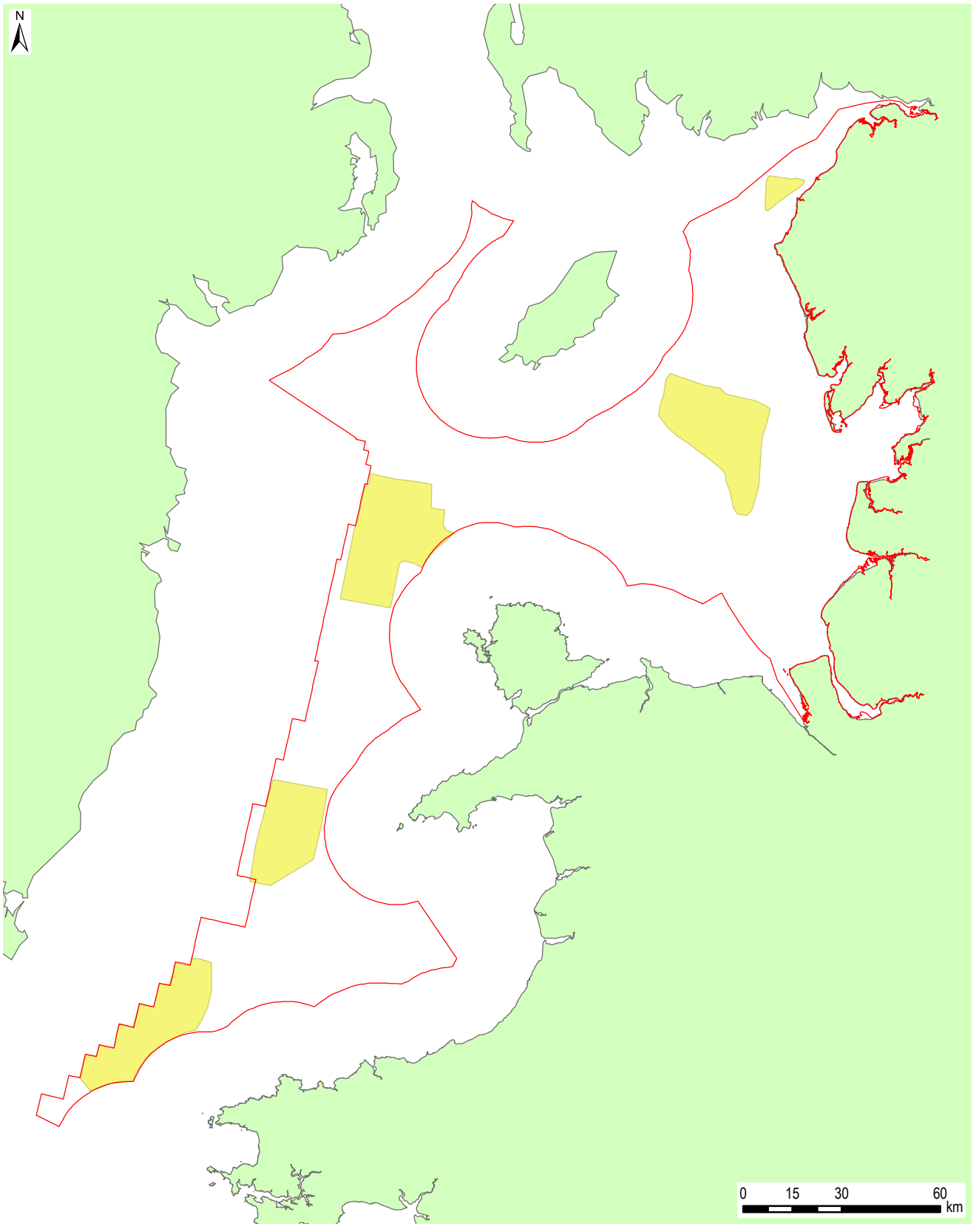
Irish Sea Scenario 7 - Pure Ecological Network with SACs Locked In, High Cost Avoidance and Aggregate & Wind Farm Areas Locked Out

Figure 34



Date	By	Size	Version
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QA		FMM	
3957 - Fig35_IS_Scenario8.mxd			
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Irish Sea Study Area

Irish Sea 1st Iteration

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Irish Sea Scenario 8 - First Iteration Network

Figure 35

Appendices

Appendix A

Description of Marxan

Appendix A. Description of Marxan

Marxan is a decision support tool designed to aid systematic reserve design on conservation planning (Ball *et al*, 2009). The tool is freely available and is the most widely adopted site selection tool globally. Marxan is a stand-alone software program that provides decision support identifying efficient areas that satisfy a number of ecological, social and economic objectives. The model was designed to minimize the cost of selected sites while meeting all representative targets and calculates the cost for each potential solution and tries to minimize this cost while generating an optimal solution. Different scenarios can be run and compared.

Marxan Optimised Version 2.1.1 was used and it works by performing an algorithm called "simulated annealing". This technique finds optimal combinations of sites that best satisfy the planning objective, subject to various constraints. The tool requires several pre-processing steps to prepare the files to be used as inputs.

The planning region has to be divided into a set of planning units that can be potentially selected as a part of the reserve system. These units should be no finer in resolution than the data on conservation features and no coarser than is realistic for management decisions. Smaller units are not always the best solution because they can generate solutions with a high number of separated small sites and therefore a not provide a realistic possible network.

Each planning unit is assigned a cost value based on its area, financial value and the opportunity cost of it being protected or any other relevant factor. The costs of each planning unit are stored in one of the input files required by Marxan.

The other input files list the features to protect and the targets to be met, the number or extension of each feature in the planning units and the cost of the boundaries between the planning units.

Another important variable to be set is the Boundary Length Modifier (BLM), which is used to determine how much emphasis should be placed on minimising the overall reserve system boundary length. Minimising this length will produce a more compact reserve system but usually with a higher total cost.

There are two most widely used solutions provided by Marxan; the first is called “sum solution” that reports out on all of the runs or solutions from a given scenario. This keeps track of how often each unit was involved in any solution. So if the user chooses the program to run one hundred times in a particular scenario, then the output reports on how many times any specific assessment unit is selected out of a hundred.

The second output is called the “best solution” which is the most optimal run in the scenario that best meets the defined parameters. The objective function states that the best or most efficient solution will be the selected sites at the lowest total cost. The solution from the ‘best’ run is only superior with regard to the objective function value. The ‘best solution’ output has been used in this study.

Reference

Ball, I.R., H.P. Possingham, and M. Watts. 2009. Marxan and relatives: Software for spatial conservation prioritisation. Chapter 14: Pages 185-195 in Spatial conservation prioritisation: Quantitative methods and computational tools. Eds Moilanen, A., K.A. Wilson, and H.P. Possingham. Oxford University Press, Oxford, UK.

Appendix B

Cost Layer Data Sources

Appendix B. Cost Layer Data Sources

Sector	Activity/Element	GIS Shapefile	Data Source
Aggregates	Existing licence areas	Dredging Licence Areas	Crown Estate, 2010
	Application areas	Private Commercial Licence Boundary AND Aggregates Prospecting Layer	Crown Estate, 2010
	High priority future use areas	Potential Future Aggregate Resource	Crown Estate, 2010
Oil & Gas	Existing structures - surface + subsurface platforms, pipelines, cables	Oil Wells and Oil Surface Installations	UK Deal, 2010
Offshore Wind	Existing and consented (not yet built) wind farms (apply to R1/R2 sites)	Wind Farms Round 1 and 2	Crown Estate, 2010
	Cables for R1/R2 sites	Wind Farm Export Cables	www.4offshore.com
	Application areas (R2.5 and R3 sites)	Wind Farms Round 3	Crown Estate, 2010
	Cable routes for R3 sites	Digitised R3 cable routes	www.4offshore.com
	Potential future interest areas	Floating Interest Future Use, Fixed Foundation Future Use AND Wind Demonstration	Crown Estate, 2010
	Possible future cable routes	Future Cable Routes	www.4offshore.com
Wet Renewables As only one area not thought to be an issue	Existing leased areas and application areas (lease option areas?)	Pentland Firth Round 1 Lease Option Areas (Tidal). Ramsey Sound And Wave Hub	Crown Estate, 2010
	Cables for existing leased areas and option areas	No information available	-
	Potential future interest areas	Wave Future Interest, Tide Future Interest (None in area) AND Tidal Demonstration	Crown Estate, 2010
Telecom Cables	Existing cables (live telecom cables, power interconnectors)	Telecom Cables	Kingfisher Cables (KIS-CA)
	Future cables (proposed telecom cables and proposed power interconnectors/power grid)	brit-ned, anglo scot hvdc link,	ABPmer, 2010
CCS/Gas Storage	Existing lease areas/option areas	Hydrocarbon Fields And Gas Storage Leases	Decc, The Crown Estate
	Existing pipeline routes	Oil & Gas Pipelines	UK Deal, 2010 & Crown Estate, 2010
	Potential future interest areas	CCS and Gas Potential Sites	Crown Estate
	Future pipeline?	Proposed Pipelines	UK Deal, 2010 & Crown Estate, 2010
Dredging and Disposal	Existing maintained areas	Maintained Dredge Areas	ABPmer, 2010
	Existing disposal areas	Disposal Sites	CEFAS, 2010
	New capital dredge areas	No information available	-
Commercial Fisheries	Fisheries values	VMS Data	Cowrie, 2009
	Shellfish Values	Shellfisheries	MB106
Aquaculture	Finfish aquaculture	No Finfish Aquaculture within the area	-
	Shellfish aquaculture installations	Shellfish Aquaculture Sites	ABPmer, 2009

Appendix C

Ecological Layer Data Sources

Appendix C. Ecological Layer Data Sources

Datasets	Data Layers	Data Source
Broad-scale habitats (EUNIS Level 3)	Broad-scale habitats (EUNIS Level 3)	UK SeaMap, 2010
Habitats of Conservation Importance	Blue Mussel Beds	DASSH, 2010
	Cold-water Coral Reefs	DASSH, 2010
	Coral Gardens	DASSH, 2010
	Deep-Sea Sponge Aggregations	DASSH, 2010
	Estuarine Rocky Habitats	DASSH, 2010
	File Shell Beds	DASSH, 2010
	Fragile Sponge and anthozoan communities on subtidal rocky habitats	DASSH, 2010
	Intertidal Underboulder communities	DASSH, 2010
	Littoral Chalk Communities	DASSH, 2010
	Maerl Beds	DASSH, 2010
	Horse Mussel (Modiolus modiolus) beds	DASSH, 2010
	Mud Habitat in Deep Water	DASSH, 2010
	Sea-pen and burrowing megafauna communities	DASSH, 2010
	Native Oyster (Ostrea edulis) beds	DASSH, 2010
	Peat and Clay Exposures	DASSH, 2010
	Honeycomb Worm (Sabellaroa alveolata) Reefs	DASSH, 2010
	Ross Worm (Sabellaria spinulosa) Reefs	DASSH, 2010
	Seagrass Beds	DASSH, 2010
	Sheltered Muddy Gravels	DASSH, 2010
	Subtidal Chalk	DASSH, 2010
	Subtidal Sands and Gravels	DASSH, 2010
	Tide-Swept Channels	BODC, 2010
Species of Conservation Importance (limited and/ or low mobility)	Alkmaria romijni	DASSH, 2010
	Amphianthus dohrnii	DASSH, 2010
	Artica islandica	DASSH, 2010
	Armandia cirrhosa	DASSH, 2010
	Atrina pectinata	DASSH, 2010
	Caecum armoricum	DASSH, 2010
	Cruoria cruoriaeformis	DASSH, 2010
	Eunicella verrucosa	DASSH, 2010
	Gammarus insensibilis	DASSH, 2010
	Gitanopsis bispinosa	DASSH, 2010
	Gobius cobitis	DASSH, 2010
	Gobius couchi	DASSH, 2010
	Grateloupia montagnei	DASSH, 2010
	Haliclystus auricula	DASSH, 2010
	Hippocampus guttulatus	DASSH, 2010
	Hippocampus hippocampus	DASSH, 2010
	Leptopsammia pruvoti	DASSH, 2010
	Lithothamnion coralloides	DASSH, 2010
	Lucernariopsis campanulata	DASSH, 2010
	Lucernariopsis cruxmelitensis	DASSH, 2010
	Nemastostella vectensis	DASSH, 2010
	Ostrea edulis	DASSH, 2010
	Padina pavonica	DASSH, 2010
	Palinurus elephas	DASSH, 2010
	Paludinella littorina	DASSH, 2010
	Phymatolithon calcareum	DASSH, 2010
	Pollicipes pollicepes	DASSH, 2010
	Tenellia adspersa	DASSH, 2010
	Victorella pavida	DASSH, 2010
Species of Conservation Importance (high mobility)	Anguilla anguilla	DASSH, 2010
	Raja undulata	DASSH, 2010
	Osmerus eperlanus	DASSH, 2010

Appendix D

Development of Cost Layer

Appendix D. Development of Cost Layers

Sector	Activity/Element	GIS Shapefile	Low Restriction Scenario	Weight	High Restriction Scenario	Weight
Aggregates	Existing licence areas	Dredging Licence Areas	Additional monitoring costs for existing licence areas	4	Additional monitoring costs for existing licence areas; controls on screening at some sites; possible revocation of non-EIA compliant licenses or controls on intensity/spatial extent	10
	Application areas	Private Commercial Licence Boundary and Aggregates Prospecting Layer	Additional licensing and monitoring costs for application areas	4	Additional licensing and monitoring costs for application areas; controls on screening at some sites; spatial controls on intensity and extent of activities; possible refusal of some applications	10
	Potential future interest areas	Potential Future Aggregate Resource	Additional licensing and monitoring costs for high priority possible future use aggregates areas	2	Additional licensing and monitoring costs for high priority possible future use aggregates areas; controls on screening at some sites; spatial controls on intensity and location of activities; possible refusal of some applications	5
Oil & Gas	Existing structures - surface + subsurface platforms, pipelines, cables	Oil Wells and Oil Surface Installations	Some additional monitoring and maintenance costs	4	Significant additional monitoring and maintenance costs;	10
Offshore Wind	Existing and consented (not yet built) wind farms (apply to R1/R2 sites)	Wind Farms Round 1 and 2	Some additional monitoring and maintenance costs	4	Significant additional monitoring and maintenance costs;	10
	Cables for R1/R2 sites	Wind Farm Export Cables		1	Some additional monitoring and maintenance costs	2
	Application areas (R2.5 and R3 sites)	Wind Farms Round 3	Additional licensing, monitoring and maintenance costs	4	Additional licensing, monitoring and maintenance costs; project delays, restrictions on location of development, possible refusal of applications	10
	Cable routes for R3 sites	Digitised R3 cable routes	Additional licensing, monitoring and maintenance costs	4	Possible diversion of cable routes	10
	Potential future interest areas	Floating Interest Future Use, Fixed Foundation Future Use and Wind Demonstration	Additional licensing, monitoring and maintenance costs	2	Additional licensing, monitoring and maintenance costs; project delays, restrictions on location of development, possible refusal of applications	5
	Possible future cable routes	Future Cable Routes	No additional measures required	-	Significant additional monitoring and maintenance costs	10
Wet Renewables As only one area not thought to be an issue	Existing leased areas and application areas (lease option areas?)	Pentland Firth Round 1 Lease Option Areas (Tidal). Ramsey Sound and Wave Hub	Some additional monitoring and maintenance costs	4	Significant additional monitoring and maintenance costs	10
	Cables for existing leased areas and option areas	No information available	No additional measures required	-	Some additional monitoring and maintenance costs	2
	Potential future interest areas	Wave Future Interest, Tide Future Interest and Tidal Demonstration	Additional licensing, monitoring and maintenance costs	2	Additional licensing, monitoring and maintenance costs; project delays, restrictions on location of development, possible refusal of applications	5
Telecom Cables	Existing cables (live telecom cables, power interconnectors)	Telecom Cables	No additional measures required	-	Some additional monitoring and maintenance costs	2
	Future cables (proposed telecom cables and proposed power interconnectors/power grid)	brit-ned, anglo scot hvdc link,	No additional measures required	-	Some additional licensing, monitoring and maintenance cables; possible diversion of cable routes to avoid sensitive features	10
CCS/Gas Storage	Existing lease areas/option areas	Hydrocarbon Fields and Gas Storage Leases	Some additional monitoring and maintenance costs	4	Significant additional monitoring and maintenance costs	10
	Existing pipeline routes	Oil & Gas Pipelines	Some additional monitoring and maintenance costs	4	Significant additional monitoring and maintenance costs	10
	Potential future interest areas	CCS and Gas Potential Sites	Some additional monitoring costs	2	Additional licensing, monitoring and maintenance costs; project delays, restrictions on location of development, possible refusal of applications	5
	Future pipeline?	Proposed Pipelines	Some additional monitoring costs	2	Additional licensing, monitoring and maintenance costs; project delays, restrictions on location of development, possible refusal of applications	5
Dredging and Disposal	Existing maintained areas	Maintained Dredge Areas	No additional measures required	-	Some additional monitoring of maintenance dredging	2
	Existing disposal areas	Disposal Sites	No additional measures required	-	Some additional monitoring and possible controls on disposal	10
	New capital dredge areas	No information available	NA	-	NA	-
Commercial Fisheries	Fisheries values	VMS Data - update threshold	Fisheries values >£2500 cell	4	Fisheries values>£5000 cell	10
	Shellfish Values	Shellfisheries	Fisheries values >£2500 cell	4	Fisheries values>£5000 cell	10
Aquaculture	Finfish aquaculture	No Finfish Aquaculture within the area	NA	-	NA	-
	Shellfish aquaculture installations	Shellfish Aquaculture Sites	Avoid imposing additional costs	4	Avoid imposing additional costs	10

ABP Marine Environmental Research Ltd
Suite B, Waterside House
Town Quay
Southampton
Hampshire SO14 2AQ

Tel: +44 (0)23 8071 1840
Fax: +44 (0)23 8071 1841
Email: enquiries@abpmer.co.uk

www.abpmer.co.uk