Natural England Commissioned Report NECR018

Representativity and replication for a coherent network of Marine Protected Areas in England's territorial waters

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Foreword

Natural England commission a range of reports from external contractors to provide evidence and advice to assist us in delivering our duties. The views in this report are those of the authors and do not necessarily represent those of Natural England.

Background

Currently, we only protect 2.2% of UK waters for marine conservation (Defra 2008) but the UK is committed to delivering an ecologically coherent network of well managed Marine Protected Areas (MPA) by 2012. This will require:

- A network of sites that will adequately protect rare, threatened and valued habitats throughout our seas.
- Enough sites to conserve a range of habitats and species that are vital for the health of marine ecosystems.

In seeking to deliver an ecologically coherent network Defra have adopted a series of network design principles. Representativity and replication are two of the principles adopted. Defining and identifying important marine features and protecting examples of them is an essential first step in developing this coherent network. This report results from research commissioned to investigate the existing coverage and gaps in protection and provide guidance on **representativity** and **replication** for a coherent network of Marine Protected Areas in England's territorial waters.

- **Representativity** - all biogeographic regions and the major habitats within them should be represented within a network.
- **Replication** - all habitats within each region should be replicated, and these should be spatially separate, to safeguard against unexpected failures or collapse of populations.

The study identifies gaps in the current coverage of broad scale landscape and habitat types that require protection in order to achieve a fully representative and replicated network of MPAs across each region.

Our knowledge and understanding of network principles has developed significantly since this work was commissioned in early 2008. In particular a workshop held by the Joint Nature Conservation Committee (JNCC) in September 2008 looked in more detail at representativity. However, Natural England have used the findings and recommendations to help:

- Produce technical guidance, with JNCC, on the selection of MCZs in order to achieve a coherent network of well managed MPAs.
- Provide background information to the Regional MCZ Projects tasked with identifying a network of Marine Conservation Zones by 2011.

Natural England Project Manager - Kate Bull, Marine Protected Areas Specialist, Policy Team, Natural England, Phoenix House, 32-33 North Street, Lewes, BN7 2PH

Contractor - Marine Life Information Network (MarLIN), Marine Biological Association (MBA), The Laboratory, Citadel Hill, Plymouth, PL1 2PB, UK. **www.marlin.ac.uk**.

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Further information
This report can be downloaded from the Natural England website: **www.naturalengland.org.uk**. For information on Natural England publications contact the Natural England Enquiry Service on 0845 600 3078 or e-mail **enquiries@naturalengland.org.uk**.

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Project details

This report results from research commissioned by Natural England in order to investigate the existing coverage and subsequent gaps in protection and provide guidance on representativity and replication for a coherent network of Marine Protected Areas in England's territorial waters. The work was undertaken by the Marine Life Information Network (MarLIN) of the Marine Biological Association (MBA) under contract no. SAE03-02-104.

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Summary

Background

The UK is committed to delivering an ecologically coherent network of well managed Marine Protected Areas (MPA) to fulfil obligations under OSPAR and WSSD by 2012. This means having a network of sites large enough to protect rare, threatened and valued habitats throughout our seas; with sites close enough together for species to move between them; and enough sites to conserve a range of habitats that are vital for the health of marine ecosystems. Defining and identifying important marine features and protecting examples of them is an essential first step.

Currently, we only protect 2.2% of UK waters for marine conservation (Defra, 2008). The type of Marine Protected Area (MPA) depends on the legislative measure in place to provide protection to the marine species and habitats that occur in them. Sites may be protected as part of European or national legislation. MPAs designated as part of the European Natura 2000 network and referred to as European marine sites are Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) which have marine components. However, these sites only allow us to protect habitats and species of European importance, not national importance and in order to do this we must identify which features are nationally important, their distribution and their occurrence within the current network of MPAs. If the representation and replication of features within the current network is insufficient we must set minimum targets for their protection that should be met when designing an extended network.

The following report addresses two of the design criteria necessary to achieve ecological coherence, as recognized by international best practice (WCPA\IUCN 2007 and CBD Technical series no. 13, BDC 07/03/14-E). They are:

- Representativity –all biogeographic regions and the major habitats within them should be represented within a network; and
- Replication –all habitats within each region should be replicated, and these should be spatially separate, to safeguard against unexpected failures or collapse of populations.

The study reviews the current scientific literature and provides guidance and recommendations on ways of achieving full representativity and replication at the national and regional scale. In addition the report presents a ‘stock-take’ of the present coverage of protected habitats and species, including the percentage and, where possible, the area found within the boundaries of current MPAs in each of four project study regions within English Territorial Waters (ETWs, 0-12nm). The study also identifies gaps in the current coverage of broad scale landscape and habitat types that require protection in order to achieve a fully representative and replicated network of MPAs across each region.

Representativity

In reviewing the literature on the criterion ‘Representativity’, the study identified two critical factors in assessing representativity. The first is the level of habitat classification used and the second is the limits of the area of search (AoS) (i.e. identifying representativity at a national, regional, biogeographical or global context).

The major issue in identifying a habitat classification scheme that is suitable to ensure representativity is that the single European classification (EUNIS) requires knowledge of biology to classify biotopes present, whilst the landscape classification used in the UK (i.e. UKSeaMap) does not. However, in the absence of full coverage information on the biotopes, there is a requirement to utilise broad-scale modelled features in conjunction with actual biotope and species records in order to examine representativity with the best available information (as per OSPAR guidelines).

In the current study two of the UKSeaMap layers where examined; Coastal Physiographic features and Modelled Seabed features. These two data sets overlap when presented together, however for the purposes of assessing representativity they were analysed separately. Although the modelled data of UKSeaMap provide full coverage information and are meaningful from the point-of-view of establishing units for comparing like-with-like in broad-scale biodiversity, the surrogates for biological features and the seabed landscape categories developed for UKSeaMap were not designed to be used for assessing representativity for biodiversity and conservation.

OSPAR guidelines recommend classification of the marine environment to EUNIS Level 3 where possible (which will be achievable with the predicted maps from MESH) "to reasonably reflect the variation in biological character of the habitats in the OSPAR area". However, it is only at Level 4 of the EUNIS classification that biological characteristics are apparent. The Marine Habitat Classification for Britain and Ireland, which links to EUNIS, can be useful in assessing representativity at a national level (OSPAR assessment guideline 2.3). However, working within the EUNIS classification across all scales will have the advantage of being able to identify gaps at different levels of the hierarchy.

The second key factor in assessing representativity is the area of search. OSPAR recommend the use of the biogeographic classification of the OSPAR Area by Dinter (2001). However, at a national level finer-scale subdivisions of biogeographic regions, incorporating geomorphology, provide a more ecologically meaningful scale for biodiversity conservation planning and practical application of representation. Draft regional MPA Project Boundaries have been developed from the JNCC regional seas boundaries to identify regions of England within which studies could be set up to establish MPA networks. Although broadly biogeographical, the boundaries are primarily based on political borders and Natural England administrative regions. These regions have been employed for the current exercise in order that the outputs can be used by each of the project studies.

Replication

The criterion of 'Replication' is a more clearly defined term than 'Representativity'. 'Replication' – "all habitats within each region should be replicated and these should be spatially separate to safeguard against unexpected failures and collapse of populations" WCPA/IUCN 2007 and CBD Technical series no.13, BDC 07/03/14-E (Secretariat of the Convention on Biological Diversity, 2004).

Discrepancies occur in the literature in terms of what scale the replication is applied at. Most organizations agree that replication should be at every possible level from global to local and that networks should be incorporated into an integrated coastal or large marine ecosystem (LME) management plan. OSPAR guidelines (Principle 11) state "replication of habitats, species and ecological processes in separate OSPAR MPAs in each biogeographic area is desirable where it is possible". In order to be able to scale up to national and higher (e.g. European or global), this study addresses replication within the draft Natural England MPA project study regions.

The guidelines for the selection of biological SSSI state that "a minimum aim in terms of replication, should be to represent all the different habitats and species that are present by at least one – and preferably the best – example or population within an AoS" (Joint Nature Conservation Committee, 1998). In a marine context the AoS used were the JNCC Coastal cells. Using biogeographical and physiographic boundaries as the AoS may allow the original minimum of one example to be sufficient. With this in mind, replicating at least one good example of the different species or habitat within each physiographic type it occurs and within each coastal natural area (Jones *et al.*, 2004) is arguably a more relevant method of ensuring minimum levels of replication.

Assessing representativity and replication of current MPAs

In the present exercise, representation is based on occurrences of habitats and species. The targets for occurrences within MPAs (replicates) were based on OSPAR guidelines and experiences of the Irish Sea Pilot Priority. Species and habitats were given a target of 20% of the occurrence/extent within Project study region and 5 replicates. All other habitats (based on EUNIS level 4 classification) were given a target of 10% and 3 replicates. For the landscapes, due to the dataset being full coverage, it was possible to assess representation based on area rather than point occurrences.

Broader scale classifications require greater representation and replications because when applied at "a very coarse scale, replication will only include gross variation in habitat types" (Paragraph 24 of OSPAR Guidance, OSPAR, 2003a). The OSPAR guidelines also state that "*where data are coarse with a larger margin of error, areas identified are likely to be larger than had better data been available*" (OSPAR, 2003a). Landscape targets were set at 40% and 6 replicates for the current exercise.

In order to carry out the stock take of current representation of all marine habitats and species (that occur within the study area), a geodatabase was constructed to allow each one of the seabed types and listed species to be 'called-up' on the GIS to view their distribution within existing MPAs. Three main data sources were used together during analysis of representativity: GIS layers of the UKSeaMap (coastal physiographic features and modelled seabed features) were acquired; MESH survey data; and a snapshot (February 2008) of the full National Biodiversity Network (NBN) Marine Recorder database.

For the purposes of this study, MPA boundaries were based on the current SAC and SSSI sites within English Territorial waters. The list of SACs 'with marine components' identified by the nature conservation agencies and JNCC was used to identify SACs.

The representation of 124 listed species in English territorial waters (including 21 BAP species, seven OSPAR threatened species and 142 candidate NIMF species) within the current network of MPAs was examined. Using the target that each of these species should be replicated in at least five MPAs in each study region, the database was queried to look at which species occurred within the boundaries of a current MPA and how many times within each region. The exercise was repeated for landscapes and habitats.

What this report does and does not cover

- The study reviews the current literature regarding the MPA design criteria of representativity and replication and applies the information within a stock-take of the representation of marine biodiversity within current network of MPAs.
- This study focuses on benthic features. Full representativity of England's marine biodiversity should incorporate information on pelagic habitats and species.
- The study uses national datasets. Regional studies may have access to other datasets and local information. All available information should be used when examining representativity and replication.
- The study suggests targets for representation and replication of features.
- As part of the stock-take this study examines representativity using minimum targets. For many features these targets will not be adequate for ecological coherence. Consultation with specific experts, for example via the workshops set up by Finding Sanctuary, should help to refine these baseline targets for representativity at a regional scale.
- The current exercise proposes a broad brush method for examining inclusion of representative habitats within the current network of MPAs. However the ecosystem functioning of many habitats which occur within different landscapes can be very different depending on the specific environmental conditions. In addition to addressing representation through the use of classifications and lists, there is also need to use expert knowledge to identify specific areas where the physical and biological environment result in specific functioning of these habitats.
- The study does not intend to imply that species and habitats currently within the boundaries of an MPA currently gain protection as this is often not the case. This will need to be addressed during the design of the network, i.e. if the current MPAs are "locked-in" to the design the level of protection they afford will still need to be reviewed based on the features present.
- This report does not account for the connectivity of replicates. Replication and the spatial distribution of replicates, links directly to issues of connectivity within MPA networks. Connectivity of MPAs and consideration of factors such as larval dispersal are being

considered in a parallel study to this one and will not be considered here (Roberts et al., *in prep*).

- This report does not examine representativity in terms of typicalness and proportional representation between sites (for example using the "protection ratio" outlined in Annex II of OSPAR guidelines, OSPAR, 2007).

National summary

For those UKSeaMap landscapes that are found within 12nm, all are represented by the current network of MPAs at a national scale except for 'Shelf mixed sediment plain - strong tide stress' and 'Shelf coarse sediment plain - strong tide stress'. Thirteen physiographic landscapes are found in less than six MPAs at a national level. Of these, all the coastal physiographic features have greater than 40% of their total area coverage within the current network of MPAs at national level. However, some inshore features are under represented by UKSeaMap due to the methods used, for example 'Barrier beaches' and 'Sounds', so whilst the target for percentage of total extent may appear to be met, this value should be reconsidered with improved information on the actual extent of these features.

Of all the species examined, none met the target of being replicated in more than five MPAs in each study region. Thirty five species were identified as a priority for protection because they are currently not recorded for any MPAs but do occur in English territorial waters. One hundred and eleven additional species were recorded for in less than five MPAs at a national level. Fifty seven of these species were replicated in less than five MPAs nationally, despite known records allowing greater replication, 11 of these species were BAP species.

Of all the habitats examined none met the target of being replicated in more than five MPAs in each study region. Two cNIMF habitats were identified as a priority for protection because they are currently not recorded for any MPAs but do occur in English territorial waters. They were the biotopes:

- Sparse *Modiolus modiolus*, dense *Cerianthus lloydii* and burrowing holothurians on sheltered circalittoral stones and mixed sediment; and
- *Spisula subtruncata* and *Nephtys hombergii* in shallow muddy sand.

Twelve habitats were recorded in less than five MPAs at a national level despite known records allowing greater replication, of these three habitats were BAP and two were OSPAR listed habitats.

Using the EUNIS classification (to level 4), of all the habitats examined none met the target of replication in MPAs for all study regions. The EUNIS habitat 'Brachiopod and ascidian communities on circalittoral rock' (code A4.31) was identified as a priority for protection because it is currently not recorded for any English MPAs but has been recorded in English territorial waters (one record for the South West region).

Seventeen habitats were recorded for less than five MPAs at a national level (see Table 21), although for two (A5.31- 'Sublittoral mud in low or reduced salinity lagoons' and A5.41- 'Sublittoral mixed sediment in low or reduced salinity lagoons') their actual recorded occurrence was a valid limiting factor. For the latter (A5.41), the percentage of occurrences that were in MPAs was >10% (20% for those associated with OSPAR, Habitats Directive, BAPS and cNIMFs) of their known occurrences.

Regional summaries

South West
The South West represents an area which is both species rich (due to the higher numbers of southerly species at the limits of their northern distributions) but also data rich in terms of marine species and habitat information stored at a national level (as utilized in the current study).

In terms of seabed landscapes in the South West project study region, the following are not currently represented in the network of MPAs but do occur within 12nm of the coast within the South West region, making them a priority for inclusion in a future network:

- Shallow mixed sediment plain –weak tide stress landscapes
- Shelf mud plain
- Shelf mixed sediment plain –weak, moderate and strong tide stress landscapes

Of the 104 species examined for the South West project region, only five species are already replicated in five or more different MPAs. Fifty three species are found in less than five protected locations, despite known records allowing greater replication. But most importantly, the study identified that there are 28 species that are recorded for the South West but that are not recorded within the boundaries of any of the MPAs (including the BAP species *Anotrichium barbatum* and *Hippocampus hippocampus*, see Table 10).

An assessment of habitats in MPAs in the South West showed that over 15 recorded listed habitats are replicated in less than five MPAs, despite known records allowing greater replication. One cNIMF habitat, '*Spisula subtruncata* and *Nephtys hombergii* in shallow muddy sand' was not protected at all in the South West but was only recorded in this region. Another, '*Ceramium* sp. and piddocks on eulittoral fossilised peat' was not found in protected areas in the South West region and was found in less than five MPAs nationally (despite records allowing greater replication). The cNIMF habitat '*Capitella capitata* and *Tubificoides* spp. in reduced salinity infralittoral muddy sediment' was recorded but not found in protected areas in the region. This habitat occurs in less than five MPA locations nationally but this is due to a limited number of recorded occurrences. Of those habitats where known records limited their replication within the South West (17 habitats) eight did not meet the target of having 20% of their total occurrence represented (including the BAP habitat *Modiolus modiolus* beds). All eight should be high priorities for future protection.

An assessment of all EUNIS level 4 habitats found in the South West (and those currently within MPAs) showed that of the 66 recorded listed habitats one half (33) were found in less than five (three for those habitats that were not cNIMF, BAP, OSPAR or Habitats Directive) different MPAs. 'Sublittoral mussel beds on sediment' (A5.62) are not found in protected areas in the region. This habitat is found in other regions but is protected in less than five locations nationally due to limits in its occurrence. 'Sublittoral polychaete worm reefs on sediment' (A5.61) are again not found in protected areas in region, although this habitat is found in other regions and in at least five locations nationally. Twenty three of the habitats examined do not meet the target of representation of 20% of the regional occurrence of the habitat.

South East

In the South East, five of the 20 landscape features (including Sounds) that occur within 12nm of the coast are not currently represented in the network of MPAs in this region but do occur within 12nm of the coast within this region, making them a priority for inclusion in a future network.

Fewer species are recorded for the South East (40 species from the BAP, OSPAR and cNIMF lists). Of these species only one species (OSPAR threatened species *Nucella lapillus*) is already replicated in five different MPAs. There are 20 species that are recorded for the South East but are not found in any of the MPAs and there are an additional eight species that are found within the South West but not in any other regions of England (OSPAR Species *Alosa alosa* and cNIMF species *Dasya punicea*, *Epistomia bursaria*, *Leptochiton scabridus*, *Microcosmus claudicans*, *Smittina affinis*, *Spongionella pulchella* and BAP species *Lucernariopsis cruxmelitensis*). Another important gap in current protection are those species which are found in less than five protected locations, despite known records allowing this (BAP species *Ostrea edulis* and *Raja undulate*; cNIMF species *Anguilla anguilla*, *Barnea candida*, *Epistomia bursaria*, *Leptocheirus hirsutimanus*, *Leptocheirus pectinatus, Sabellaria alveolata* and *Tritaeta gibbosa*; and the OSPAR species *Raja montagui*).

The BAP Habitat 'Mud habitats in deep water', occurs but is not protected in the South East region. This habitat is found in less than five MPAs at a national level and is therefore a priority for protection in the South East. A further 16 habitats are found in the region but not within MPAs. Twenty habitats

in the South East do not meet the target of five replicates in different MPAs despite known records allowing greater replication. Although four of these do meet the target of 20% of occurrences being represented in MPAs, 16 do not (including Annex I Habitats 'Estuaries' and 'Submerged or partially submerged sea caves'; and OSPAR habitats '*Modiolus modiolus* beds', '*Ostrea edulis* beds' and 'Sea-pen and burrowing megafauna communities').

An assessment of all EUNIS level 4 habitats found in the South East region identified six habitats that are not recorded in any protected areas in the region, and are either only found in the region or are found in other regions but protected in less than five locations nationally. They are:

- A3.36 Faunal communities on variable or reduced salinity infralittoral rock;
- A4.24 Mussel beds on circalittoral rock;
- A4.25 Circalittoral faunal communities in variable salinity;
- A4.71 Communities of circalittoral caves and overhangs;
- A5.25 Circalittoral fine sand; and
- A5.36 Circalittoral fine mud.

North East
For the North East project study region, the analysis identified that five of the landscape feature types found within 12nm of the coast are currently not represented in any MPA. They are:

- Photic rock;
- Shallow mixed sediment plain - strong tide stress;
- Shelf coarse sediment plain - weak tide stress;
- Shelf coarse sediment plain - strong tide stress; and
- Shelf mixed sediment plain - strong tide stress.

Out of those that are represented, only the coastal physiographic type 'Bays' has at least 40% of its total extent (area by region) represented in the current MPA network.

None of the 32 priority species recorded for the North East met the target of being present in five different MPAs despite13 species having enough occurrences to allow five replicates (including cNIMF species *Alkmaria romijni*, *Barnea candida,* and *Tritaeta gibbosa;* BAP species *Ostrea edulis* and as in the North West region, OSPAR species *Arctica islandica, Nucella lapillus* and *Raja montagui*). Five cNIMF species do not meet the targets for protection and are only recorded for the North East region. They are *Baldia johnstoni, Corophium affine, Diphasia nigra, Nematostella vectensis* and *Ocnus planci*.

In the North East project study region, only five habitats were not found in any MPA and one, the cNIMF habitat 'sparse *Modiolus modiolus*, dense *Cerianthus lloydii* and burrowing holothurians on sheltered circalittoral stones and mixed sediment' is only recorded for this region, making it a priority for representation in future MPAs. Importantly, there were 31 habitats replicated in less than five MPAs in the North East region, despite known records allowing greater replication.

Of the 58 EUNIS level 4 habitats recorded in the North East, 32 are replicated in less than five MPAs in the this region, despite known records allowing greater replication. Eight of these habitats do not meet the target of representation of 20% of the regional occurrence of the habitat.

Five habitats are not found in any protected areas in the region, and are either only found in the region or are found in other regions but protected in less than five locations nationally, making them a priority for protection in this region. They are:

- A2.71 Littoral [Sabellaria] reefs;
- A3.72 Infralittoral fouling seaweed communities;
- A4.72 Circalittoral fouling faunal communities;
- A5.31 Sublittoral mud in low or reduced salinity (lagoons); and
- A5.36 Circalittoral fine mud.

North West
In the North West there are not enough current MPAs for any of the landscape features to be replicated at least six times. However, of the 15 landscape features that are found in the region (see Table 7), four are currently not represented in any MPA ('Aphotic rock', 'Photic rock', 'Shallow coarse sediment plain - strong tide stress' and 'Shallow mixed sediment plain - weak tide stress' landscapes).

Eighteen species from the BAP, OSPAR and cNIMF lists were recorded for the North West but none met the target of being present in five different MPAs. Out of these the cNIMF species *Gobius gasteveni, Laomedea angulata, Parvipalpus capillaceus* and *Tritaeta gibbosa* did not meet the target of 20% of occurrences within MPAs. Importantly, there are five species that are recorded for the North West but are not found in any of the MPAs (including cNIMF *Tritaeta gibbossa* and *Laomedea angulata*, and OSPAR species *Raja montagui*).

Six habitats had recorded locations in the North West region but did not occur within any of the MPAs, including cNIMF habitat '*Mytilus edulis* and piddocks in eulittoral firm clay'. This habitat is protected in less than five locations nationally despite being known from six locations around the UK. Due to the low numbers of MPAs in this region, no habitat met the target of having five replicated MPA locations.

Forty five EUNIS level 4 habitats were recorded in the North West, but none of these habitats were found in at least five (three for those species that were not cNIMF, BAP, OSPAR or Habitats Directive) different MPAs. Two habitats ('Mussel beds on circalittoral rock, A4.24' and 'Circalittoral fine mud, A5.36') are not found in any protected areas in the region, and are either only found in the region or are found in other regions but protected in less than five locations nationally, making them a priority for protection.

Key Recommendations

The report provides specific recommendations for achieving representation and replication within each of the study areas; this can be found in section 5 of this document, but key recommendations are summarised below.

What to protect and classification to use:

- The entire suite of habitats and species found in the study region (in this case English territorial waters out to 12nm) should be protected under the new network and not just those protected under specific legislation (Ballantine, 1999) or in some way highlighted as flagship or distinctive habitats or species (Roff & Evans, 2002).
- We recommend that individual species and habitats are assessed to determine whether their threatened or declining status can benefit to a lesser or greater extent from spatially based conservation measures.
- Habitats information should be translated to a standard level 4 of the EUNIS classification for assessing representativity when using decision tools such as Marxan (Ball & Possingham, 2002) to identify a number of potential locations for MPAs.
- Data on habitats classified to Levels 5 and 6 where available can then be used to identify good examples for specific site selection.
- Recommend that in addition to addressing representation, through the use of classifications and lists, there is also a need to use expert knowledge to identify specific areas where the physical and biological environment results in specific functioning of these habitats.

Targets for representativity:

- Applicable targets for representativity within English territorial waters are 20% of area or known occurrences of priority species and habitats (BAP, OSPAR threatened or declining and cNIMF) and a minimum of 10% representation of all other habitats (EUNIS level 4) within each draft MPA project boundary. These targets should be used as baselines

against which each feature is examined and either increased or decreased based on set criteria within each of the within each draft MPA project regions.

- For landscape representation (for EUNIS level 3 habitats) an applicable target is a minimum of 10% of the known area within each draft MPA project boundary. However this comes with the caveat that individual areas are large and replication is greater within each region for these features.

Targets for replication:

- A full audit of each of the priority species should be carried out to identify whether recorded occurrence based distributions are accurate or biased by data availability prior to identifying true replicates.
- A minimum level of replication (which could be increased based on the information above or decrease for very rare features) should be at least one good example of the different species or habitats for each physiographic type it occurs in, within each coastal natural area and marine area. When applied at a very coarse scale, replication will only include gross variation in habitat types and therefore it is recommended that a greater number of replicates is employed.
- Once information on connectivity has been reviewed (Roberts *et al.,* in prep), minimum and maximum distances between replicates should be taken in to account.

Data requirements

- Identify gaps in our knowledge of biological characteristics of areas currently with little or inadequate data and survey, initially by acoustic survey and always then by an adequate density of direct *in situ* methods (Phase 1 intertidal surveys, high quality video or diver surveys underwater), to enable accurate mapping.
- We recommend that there is a review of the candidate Nationally Important Marine Features list.
- We recommend some assessment of survey effort versus the number of species and habitats recorded occurrences to examine whether lower species number records are an artefact of data availability for some regions.

Adequate protection for representatives

- The occurrence of species and habitats within boundaries of MPAs does not necessarily mean that they are protected. In designing a network of MPAs, the level of protection afforded to species and habitats already represented within the current network of MPA should be reviewed.
- Features should not only be protected from the current pressures they are exposed to but from the whole suite of pressures that they would be vulnerable to and that may result from activities that do not yet exist or that are extremely novel. One suggested way forwards would be to utilise the sensitivity information for species and habitats to a range of physical, chemical and biological factors, which can then be traced back to current human activities.

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1 Introduction

1.1 England's marine environment is under pressure from an ever increasing array of human activities, some dating back thousands of years such as fishing, and others, for example marine renewable energy, which are so novel their impacts on the biodiversity and ecosystem functioning of our seas are as yet difficult to predict. In addition to these tangible pressures, there is little doubt that human-induced climate change is emerging and whilst there is still debate regarding the magnitude of future temperature changes, sea level rises, acidification and wind pattern shifts, it is clear that these will have significant consequences for biological production, diversity, distributions and functioning. Natural systems have a large capacity for autonomous adaptation to such changes but these resilience and resistance functions are affected by human activities (Hughes *et al.*, 2005). With livelihoods and human welfare depending on the goods and services provided by the marine environment, its protection is of high importance and value (Moran *et al.*, 2007). However, it is important that tools used to protect our marine life are appropriate to the job.

1.2 Defining and identifying important marine features and protecting examples of them is an essential first step but is insufficient from a ecological viewpoint. What is needed is an ecologically coherent network of well managed Marine Protected Areas, as proposed by OSPAR (Oslo Paris convention on the protection of the north east Atlantic) and the WSSD (World Summit on Sustainable development). This means having a network of sites large enough to protect rare, threatened and valued habitats throughout our seas; with sites close enough together for species to move between them; and enough sites to conserve a range of habitats that are vital for the health of marine ecosystems.

1.3 The UK is committed to delivering an MPA network to fulfil obligations under OSPAR and WSSD by 2012. The draft Marine Bill was published, for consultation, on 3 April 2008, at the heart of which is the creation of the Marine Management Organisation (MMO). The MMO will work closely with Natural England to designate new Marine Conservation Zones, which rather than being isolated cases will form a chain of protected areas around the whole coast.

1.4 Currently, we only protect 2.2% of UK waters for marine conservation (Defra, 2008). The type of Marine Protected Area (MPA) depends on the legislative measure in place to provide protection to the marine species and habitats that occur in them. Sites may be protected as part of European or national legislation. MPAs designated as part of the European Natura 2000 network and referred to as European marine sites are Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) which have marine components. SACs, in addition to National Marine Nature Reserves (MNRs) and Special Protection Areas (SPAs) are protected by statutory obligations. The UK also has voluntary MPAs such as Voluntary Marine Conservation Areas (VMCAs) and Voluntary Marine Nature Reserves (VMNRs). In addition, there are areas closed to fishing using bottom trawling and static gear to protect deep-water corals, such as the North East Atlantic Fisheries Commission (NEAFC) closed areas at Hatton and Rockall Banks. However, these sites only allow us to protect habitats and species of European importance, not national importance and in order to do this we must identify which features are nationally important, their distribution, their occurrence within the current network of MPAs and identify set minimum targets for their protection that should be met when designing an extended network.

1.5 International best practice recognizes that there are several MPA network design criteria necessary to achieve ecological coherence (WCPA\IUCN 2007 and CBD Technical series no. 13, BDC 07/03/14-E). These include the following.

- Representativity – all biogeographic regions and the major habitats within them should be represented within a network.

- Replication – all habitats within each region should be replicated, and these should be spatially separate, to safeguard against unexpected failures or collapse of populations.

- Adequacy/viability – Marine Protected Areas should be ecologically viable. They should be large enough so that most ecological processes will be able to operate within the area. Sites should be self sustaining as far as possible.

- Connectivity – The design of the MPA network should maximise connectivity through enhancing the linkages amongst MPAs within the network. This can be achieved through larval and propagule dispersal and movement of adults.

1.6 The following report addresses the first of these two criteria 'Representativity' and 'Replication' by first reviewing the current scientific literature and then providing guidance and recommendations on ways of achieving full representativity and replication at the national and regional scale.

1.7 Knowing what is and what is not protected within the current network of MPAs and to what extent they are protected (extent and replication) is an important step as these areas will be locked in to any future design. In this study a first cut 'stock take' of the present coverage of protected habitats and species was undertaken, including the percentage and, where possible, the area under *Natura 2000*, OSPAR and other types of MPA in each of four project study regions within English Territorial Waters (ETWs, 0-12nm). The study also identifies gaps in the current coverage of broad scale landscape and habitat types that require protection in order to achieve a fully representative and replicated network of MPAs across each region. In addition to the information presented in this report, a searchable database and excel spreadsheets are available that summarize the stock take and allow the information to be queried by region and for different target levels. These can be obtained from Natural England if required.

2 Review of MPA selection Criteria:

Representativity

2.1 'Representativity' has been an important criterion for identification of areas of wildlife and geological importance since the early days of criteria-based site selection (see Ratcliffe, 1977 where the term 'Typicalness' is used). However, the term 'representativeness' (or 'representativity', 'representation', 'representative') is applied in the recent literature in two distinct senses (Stevens, 2002), which can often be confusing. It is used to describe some concept of a type of *system* of MPAs (Kelleher *et al.*, 1995) and as a specific *criterion*, among others, for the selection of core protected areas (Joint Nature Conservation Committee, 1998). For example under the OSPAR criteria for identifying marine protected areas 'Representativity' is defined (OSPAR, 2003b) as: "the area contains a number of habitat/biotope types, habitat/biotope complexes, species, ecological processes or other natural characteristics that are representative for the OSPAR maritime area as a whole or for its different biogeographical regions and sub-regions".

2.2 Under the criteria listed in Annex III of the Habitats Directive 'representativity' is defined as the degree to which a given habitat corresponds to a described type (Council Directive 92/43/EEC, consolidated version 1.1.2007). Under the EU guidance for the assessment of representativity a ranking of A to C (Excellent, Good and Significant, respectively) are awarded to a site. However, this application of the term representativity is applied at the survey or site selection level, not at the scale of looking at networks of MPAs.

2.3 In the Review of Marine Nature Conservation volume on identification of Nationally Important Marine Areas (Connor *et al.*, 2002), representativity is called 'Typicalness' and is defined as: "the area contains examples of marine landscapes, habitats and ecological processes or other natural characteristics that are typical of their type in their natural state."

2.4 Similarly, 'representativeness' is equated with 'typicalness' within the guidelines for the identification of biological SSSI (Joint Nature Conservation Committee, 1998, a revision of the 1989 Nature Conservancy Council Guidelines), which are supplemented by specific guidelines for intertidal marine habitats and saline lagoons (Joint Nature Conservation Committee, 1996). In these guidelines, representativeness is not adopted as a criterion but is described as "selecting a site which best represents a particular field of interest, in the possession of as many as possible of both the characteristic and the special features of habitat and species."

2.5 The authors of the NCC guidelines (Joint Nature Conservation Committee, 1998) go on to say that on closer inspection "representativeness is a selection criterion which encompasses a mixture of attributes that need to be separated". In their interpretation, representativeness subsumes the criteria of diversity and typicalness in particular but also to a lesser degree, size and rarity. Their guidelines therefore advised that the concept of representation should be regarded as an underlying principle, which selection criteria aim to satisfy. However, the guidelines do allude to the fact that the representativeness concept applies not just to the individual site but to the totality of all sites.

2.6 In his review of the uses of the term, Stevens (2002) describes 'representativity' in the strict sense, stating that it "is used as a noun to describe the concept that a sample of every type of habitat occurring in the area under consideration should be included in a MPA". In the

broader sense, Stevens describes how representative is used to mean “that MPAs within a network should contain core areas that meet at least one (preferably more) of the following criteria: high biodiversity, uniqueness, critical habitat for ecosystem function or for a species of particular interest, high productivity, representativeness in the strict sense etc. The concept of representation in the strict sense includes the idea that each habitat type has an intrinsic functional position in marine ecosystems and thus an inherent conservation value, which is not based on being the biggest, richest or rarest anything.” At its simplest then, representation of all habitat types is achieved when at least one spatial unit of each defined habitat type, at the minimum of the scale mapped is included in the MPA system.

2.7 The exercise being undertaken here used an approach based on the most recent and relevant (from the point-of-view of Natural England’s duties) interpretation of the criterion of representativity for biodiversity conservation in the marine environment (WCPA/IUCN 2007 and CBD Technical series no.13, BDC 07/03/14-E), that is ‘Representativity’ is defined as “all biogeographic regions and the major habitats within them should be represented within a network”

2.8 In the strict sense, an assessment of representativity should look at the entire suite of habitats found in the study region (in this case English territorial waters out to 12nm), and not just those protected under specific legislation (Ballantine, 1999) or in some way highlighted as flagship or distinctive habitats or species (Roff & Evans, 2002). There are two critical factors in assessing representativity under this definition. The first is the level of habitat classification used and the second is the limits of the area of search (i.e. identifying representativity at a national, regional, biogeographical or global context).

Biogeographic representation

2.9 Biogeographic representation involves ensuring representative coverage of all biogeographic regions in protected areas, including transition zones. Dinter (2001) identified a number of biogeographically-determined regions within the OSPAR Maritime area using primarily the factors of temperature, depth and currents and has validated these with biological data. OSPAR guidance promotes the use of these regions. The coast of England lies across an area of biogeographical change (Boreal-Lusitanean and Boreal; Dinter, 2001) and, although much of that change is a gradual transition, it is possible to identify areas of coast and adjacent seabed that at least share distinctive biogeographical, as well as physiographical, characteristics. Within the UK there have been various attempts to developed finer scale subdivisions of biogeographic regions, incorporating geomorphology, to provide a more ecologically meaningful scale for biodiversity conservation planning, which could be used at a national level to aid in the practical application of biogeographic representation. This concept has seen six major iterations in the way that descriptions and survey information is separated.

2.10 **MNCR coastal sectors** are based on those used by the Intertidal Survey Unit, a project funded by the Nature Conservancy Council from 1975 to 1980 (Bishop & Holme, 1980). In turn, those units were fitted, wherever appropriate, to the statistical rectangles of the International Council for the Exploration of the Sea (ICES) and the recording areas of the Conchological Society (Seaward, 1990). Further oceanographic and other studies have reinforced the validity of many of these boundaries. MNCR coastal sectors are not analogous with the 'Natural Areas' concept introduced by English Nature (English Nature, 1994) although, in many cases, MNCR coastal sectors can be broken down into such areas based on landscape and geomorphology. The 15 MNCR sector boundaries correspond with one or more of the following:

- locations where the geomorphology of the coast changes significantly;
- locations where the edge of range of several species coincide;
- locations where frontal systems separate different water bodies; and
- locations where there is a marked change in coastal aspect (i.e. wave exposure).

2.11 Often, these locations correspond to headlands where currents sweep offshore. Sector boundaries rarely correspond to administrative boundaries, which often extend down the middle of estuaries or terminate along part of a geomorphologically very similar coastline, making administrative boundaries unsuitable for the separation of units within which ecological comparisons are to be made.

2.12 Using the MNCR coastal sectors as 'Areas of Search' (AoS) has the advantage that data collected by the MNCR is identified to each sector.

2.13 **'Coastal cells'** (areas within which localised coastal sediment processes are considered largely restricted) in England and Wales (Motyka & Brampton, 1993), were used in the SSSI Intertidal and Saline Lagoons Selection Guidelines to define Areas of Search. Most of the critical boundaries correspond to MNCR sector boundaries but the use of cells based on coastal sediment processes (rather than on biodiversity features) means that the use of the cells from a biogeographical perspective is limited.

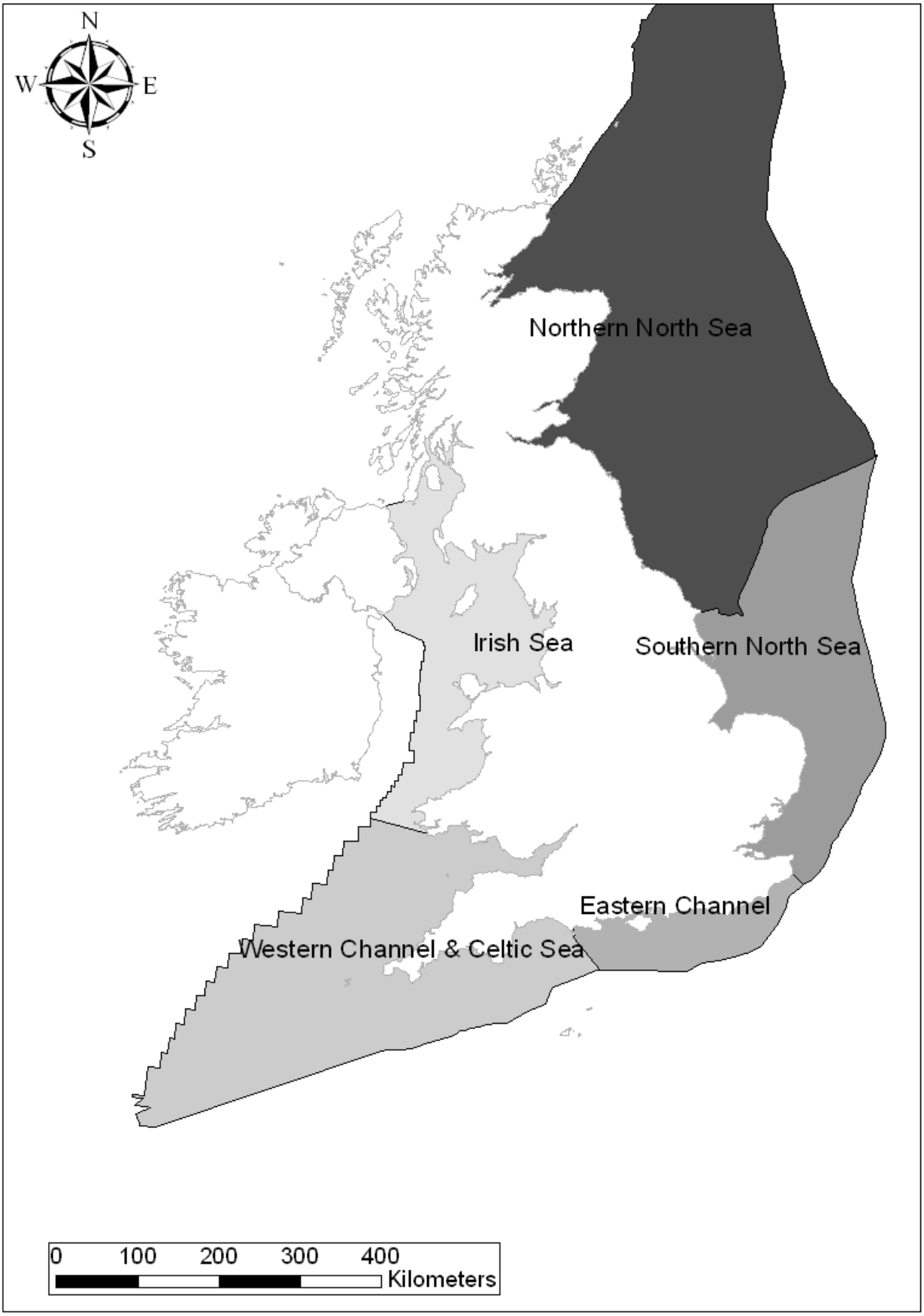
2.14 **Coastal Directory regions** - the Coastal Directories were an initiative of the nature conservation agencies, resulting in the publication of a series of volumes for 17 regions. Those regions were defined, where possible, by local or national coastal boundaries that most closely approximated to the limits of major coastal process cells. It is notable that, of the boundaries between countries, only the east coast boundary between England and Scotland constituted a Coastal Directory regional boundary. Whilst useful for coastal zone planning, the Coastal Directories are too descriptive and the regions unrepresentative from a biogeographical point-of-view.

2.15 **Marine Natural Areas** (see Figure 1) which also shows the Coastal Natural Areas) were identified by Natural England (then English Nature) together with the Joint Nature Conservation Committee (Jones *et al.*, 2004) take account of oceanographic processes, bathymetry and broad biogeographic characteristics. The objective of defining these six areas was to provide a framework within which to develop and implement an ecosystem approach to managing human activities. Though the boundaries of the Marine Natural Areas reflect a number of natural factors, the boundaries only encompass the seas around England, not other parts of the UK. It was recognized from the initial consultation that the basis of 'regional seas' was likely to evolve as interest in a regional approach to the marine environment gathered momentum.

2.16 **JNCC Draft Regional Seas** (see Figure 2) are the latest iteration of these subdivisions of the whole UK coast and seas (Vincent *et al.*, 2004). These areas were designed to equate to EU biogeographic regions. Whilst some Regional Seas boundaries are not biogeographically based (for instance, the Pembrokeshire islands and most of Pembrokeshire belong in a south-west biogeographic region), fortunately, the boundaries in England 'make sense' from a biogeographic point-of-view.

2.17 **Draft regional MPA Project Boundaries** (see Figure 3) have been developed by JNCC and Natural England to identify regions of England within which studies could be set up to establish MPA networks. Although broadly biogeographical, the boundaries are primarily based on political borders and Natural England administrative regions. These regions have been employed for the current exercise in order that the outputs can be used by each of the studies. However, since other more biogeographic regions exist (e.g. the MNCR coastal sectors and Marine Natural Areas) it is strongly recommended that each study region examines representativity within their subset of biogeographical or geomorphological regions.

Figure 1 Natural England's Coastal Natural Areas and Marine Natural areas (Jones *et al.*, 2004)



[Map copyright JNCC 2004] (Vincent *et al.*, 2004)

Figure 2 Draft Regional seas around the UK identified by JNCC

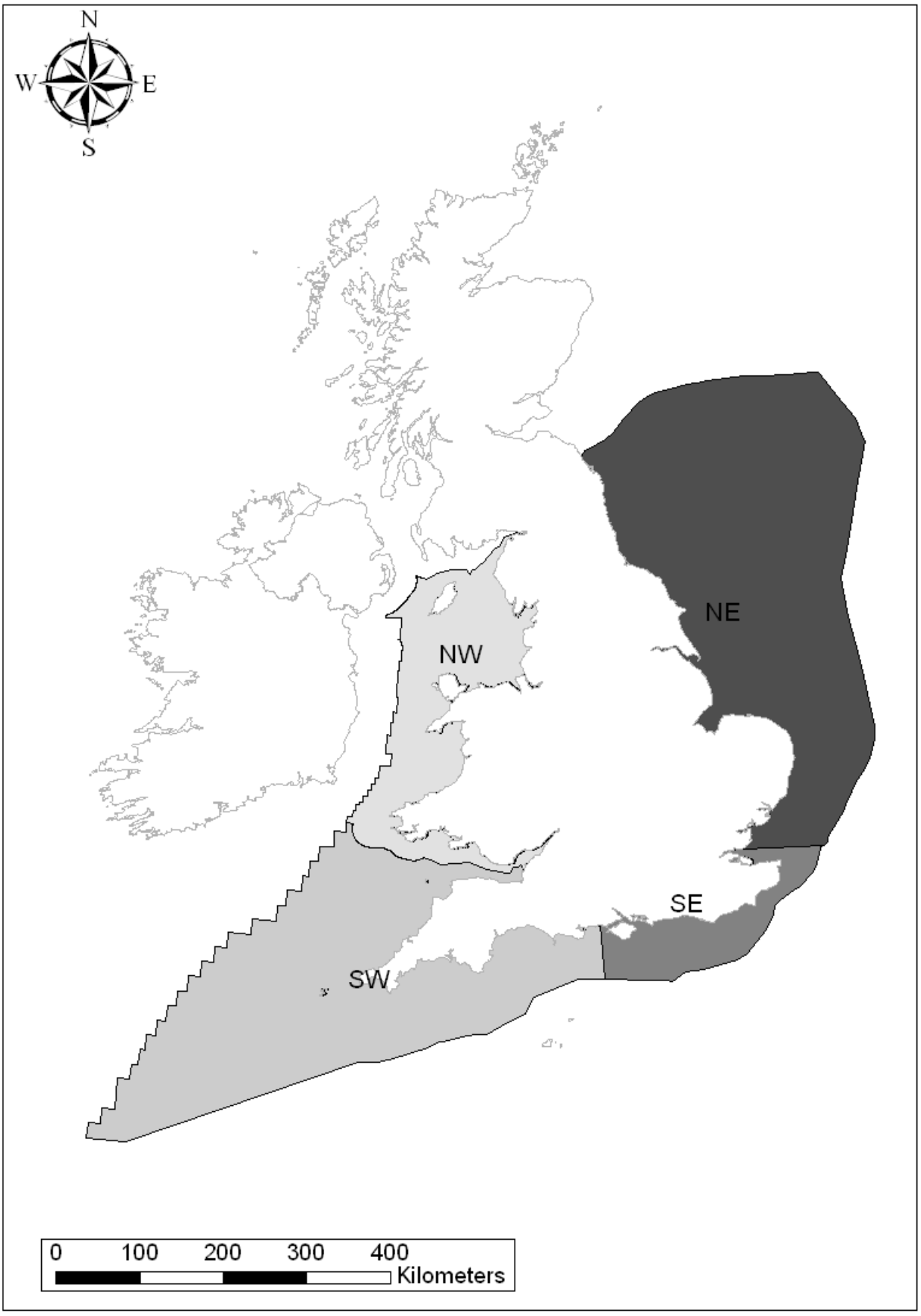


Figure 3 Draft Natural England Project Study Regions

Identification of representativity on available information: identifying and classifying seabed types

2.18 Ideally an assessment of representativity would be based on a full knowledge of the distributions of all known habitats (down to biotope level) and species. However such information does not exist and is unlikely to be available in the near future. In the absence of full coverage information on biotopes, there is a requirement to utilise broad-scale modelled features in conjunction with actual biotope and species records in order to examine representativity with the best available information (OSPAR, 2003b). Choices are available regarding which classification scheme to use and can influence the assessment of representativity.

2.19 Whilst there is good work in Europe to rationalise and standardise habitat and biotope classifications, there are still a variety of schemes to choose from when identifying and mapping habitats. The variety of schemes and something of the history behind their development is explained on the MESH (Mapping European Seabed Habitats) website (see **http://www.searchmesh.org**). The major issue in identifying a scheme that is suitable to ensure representativity is that the single European classification requires knowledge of biology to classify biotopes present, whilst the landscape classification used in the UKSeaMap does not.

European Nature Information System (EUNIS)

2.20 The EUNIS Habitat type classification is a pan-European system to facilitate the harmonised description and collection of data. Habitat type is defined for the purposes of the EUNIS habitat type classification as follows: 'Plant and animal communities as the characterizing elements of the biotic environment, together with abiotic factors operating together at a particular scale.' As a hierarchical classification it can be used at various levels of detail (to level 6 for marine habitats). The EUNIS database includes EUNIS Habitats and Annex I Habitats of the EU Habitats Directive[1]. JNCC have produced translation tables that match habitat types in the EUNIS habitat classification to the following schemes:

- the marine habitat classification for Britain and Ireland (v04.05);
- EC Habitats Directive Annex I types;
- OSPAR priority habitat types; and
- UK Biodiversity Action Plan priority habitat types (Source: Joint Nature Conservation Committee, 2007)

2.21 In 2004, the OSPAR Biodiversity Committee[2] agreed to use the EUNIS habitat classification scheme (Davies *et al.*, 2004) as a working system for characterizing the OSPAR maritime area (BDC 04/14/1-E). OSPAR guidelines recommend classification of the marine environment to EUNIS Level 3 where possible (see Table 1 for a brief description of EUNIS classification levels). Level 3 is recommended "to reasonably reflect the variation in biological character of the habitats in the OSPAR area". However, it is only at Level 4 of the classification that biological characteristics (other than biogenic habitats, which appear in Level 3) are apparent. Therefore for the present study we have attempted to use available information to the EUNIS Level 4 of the classification.

---

[1] Annex I habitats are natural habitat types which are (i) are in danger of disappearance in their natural range, or (ii) have a small natural range following their regression or by reason of their intrinsically restricted area, or (iii) present outstanding examples of typical characteristics of one or more of the five following biogeographical regions: Alpine, Atlantic, Continental, Macaronesian and Mediterranean (EEC, 1992).

[2] BDC was established by OSPAR 2000 to facilitate the implementation of the OSPAR Strategy on the Protection and Conservation of the Ecosystems and Biological Diversity of the Maritime Area. OSPAR 2003 created two new groups under BCD: the Working Group on Marine Protected Areas, Species and Habitats (MASH) and the Working Group on the Environmental Impact of Human Activities (EIHA). MASH and EIHA carry out the work formerly done by SEABED.

Table 1 Description of EUNIS classification levels

Level	Description
1	*Environment (marine)* A single category is defined within EUNIS to distinguish the marine environment from terrestrial and freshwater habitats.
2	*Broad physical habitats* based on depth and broad substrata (e.g. rock or sediment) or water column
3	*Main habitats:* Mainly physical based on energy regime but with some general description of biogenic habitat e.g. Littoral sediments dominated by aquatic Angiosperms, and Sublittoral macrophyte dominated sediment
4	*Dominant community type:* Community type described without specific reference to conspicuous species
5	*Community:* distinguished by their different dominant species or suites of conspicuous species

Coastal Physiographic types

2.22 Coastal physiographic types (landscapes) provide a first, coarse, sift of features that will include a different biology to each other (see Figure 4). A representative series of marine protected areas should therefore include examples of all of the major physiographic features present within each of the Regional Seas.

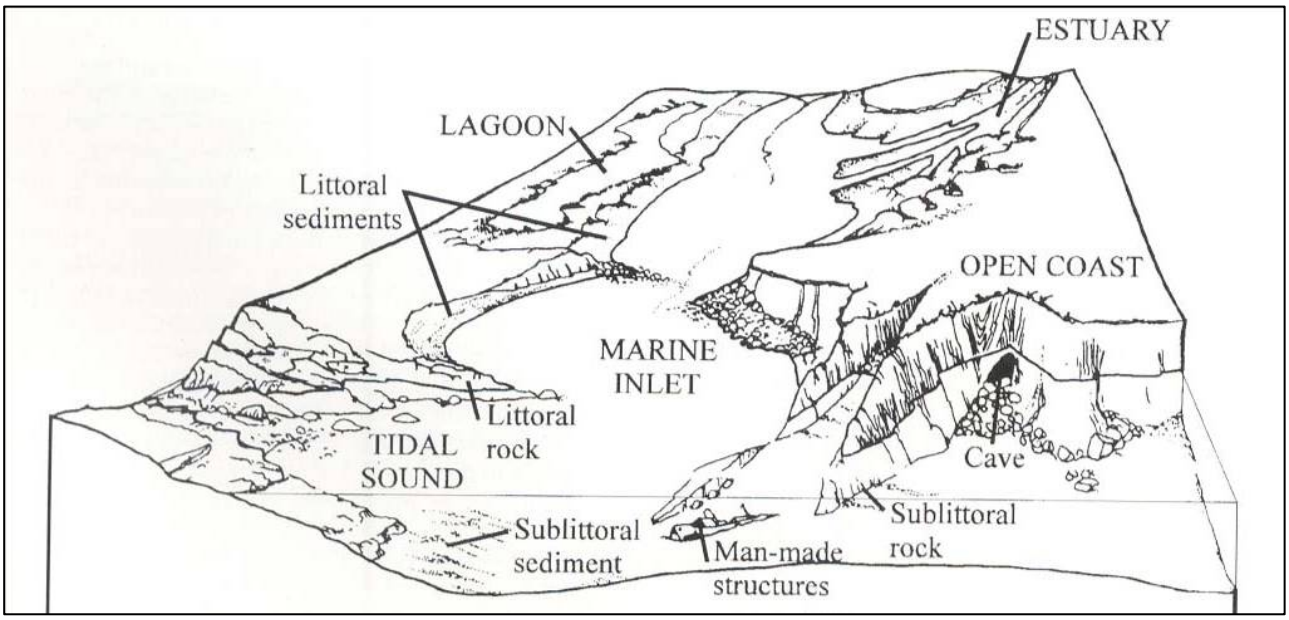


Figure 4 Representation of major coastal physiographic features of the coast that are relevant to identifying different associated biological communities (from the MNCR Rationale and Methods; Hiscock, 1996)

2.23 MNCR survey results can be separated into the following physiographic types (from Hiscock, 1996). Those categories that are repeated in the UKSeaMap classification (see section 2.27 below) are emboldened:

- Open coast - Any part of the coast, including offshore rocks and islands, which is not within a marine inlet or lagoon.
  - Linear coast - Areas of open coast including large islands which do not comply with categories below.
  - Islands / rocks - Features separated from the coast of the mainland or large islands.
  - Offshore seabed - Seabed beyond 3 miles (~ 5 km) from the shore.

- Semi-enclosed coast [equivalent to 'Bay' in UKSeaMap] - An area of coast bounded by headlands which provide some shelter from along-shore winds but which is predominantly open to onshore winds (compare 'embayments').
- Strait / Sound - Channels between the mainland and an island, or between two islands which are open at both ends to the open coast (it does not refer to similar features or narrows within marine inlets).
- Barrier beach - Coastal features caused by long-shore drift which create sheltered areas (of sediment) behind them.

- Enclosed coast - Marine inlets and lagoons which are fully enclosed from the open sea except at the entrance. They include sea lochs, voes, estuaries, rias and harbours.
  - Embayment - An enclosed area of coast in which the entrance provides shelter from onshore winds for the major part of the coast inside, but which is not a sea loch, ria, voe, estuary or lagoon.
  - Sealoch - Glacially formed inlets (fjords, fjards) of western Scotland and Ireland; typically elongate and deepened by glacial action with little freshwater influence. Often with narrows and sills dividing the loch into a series of basins.
  - Ria / voe - Drowned river valleys of south-west Britain (ria) and Shetland (voes). Often with a greater presence of rock and more marine in character than estuaries.
  - Estuary - Downstream part of a river where it widens to enter the sea; often with significant freshwater influence and predominantly comprising sediment habitats.
  - Isolated saline water (lagoon) - Enclosed bodies of water, separated from the sea by shingle, sand or sometimes rock and with a restricted exchange of water with the sea, yielding varying salinity regimes.

2.24 **The physiographic features in UKSeaMap should all be represented in a marine protected area site series together with 'linear coasts' and 'offshore seabed'**.

2.25 We have reviewed the thematic reviews that have been undertaken for estuaries and lagoons (see Davidson *et al*. 1991 for estuaries; Barnes, 1988 and 1989, and Smith & Laffoley, 1992 for lagoons). Whilst both estuaries and lagoons are further subdivided into types which may in turn have contrasting biological features, we have not attempted to incorporate those different types in a systematic analysis of data. However, the different lagoon types are included in the SSSI selection guidelines and have, therefore, been included in the database of interest features maintained by Natural England and used in this project. Representativity in relation to the different lagoon types can therefore be taken into account.

UKSeaMap

2.26 UKSeaMap, based on marine landscapes concepts (Golding *et al.*, 2004), provides a way of classifying all of the seabed around the UK in a way that has ecological relevance (Connor *et al.*, 2002). The UKSeaMap project follows on from the Irish Sea Pilot study (Vincent *et al.*, 2004), where seabed and coastal marine landscapes were derived by integrating a number of geophysical attributes including bathymetry, seabed sediments, bed-forms, maximum near-bed stress. The ecological relevance of the derived marine landscape units was tested by assessing the correlation with different biological communities, determining the degree to which a particular landscape could be used as a surrogate for biological communities. In UKSeaMap this approach was extended to produce maps of seabed landscapes and seasonal water column features for the rest of UK waters. The UKSeaMap classification scheme is shown in Figure 5.

2.27 The seabed landscapes classification of UKSeaMap has three elements:

1) **Topographic/ bed-form features** – (e.g. subtidal sediment bank, shelf mound or pinnacle, shelf trough, pockmark field, continental slope, iceberg plough-mark zone, canyon, deep ocean rise, carbonate mounds, deep-water mounds).
2) **Coastal physiographic features** (e.g. estuary, sound, lagoon, ria, sea loch, embayment, barrier beach and bay).

3) **Modelled sea bed feature** (e.g. photic rock and aphotic rock, shallow mixed sediment plain – weak tidal stress).

2.28 The topographic/ bed-form and coastal physiographic features have been identified based primarily on their shape, whilst the seabed modelled features are mapped based on temperature, substratum, depth and energy. As a consequence, the two sets of data overlap. The final map has therefore been presented with topographic/bed-form features and coastal physiographic features overlying and obscuring the seabed modelled features, such that the latter are only visible where they occur as plains (i.e. <2% slope).

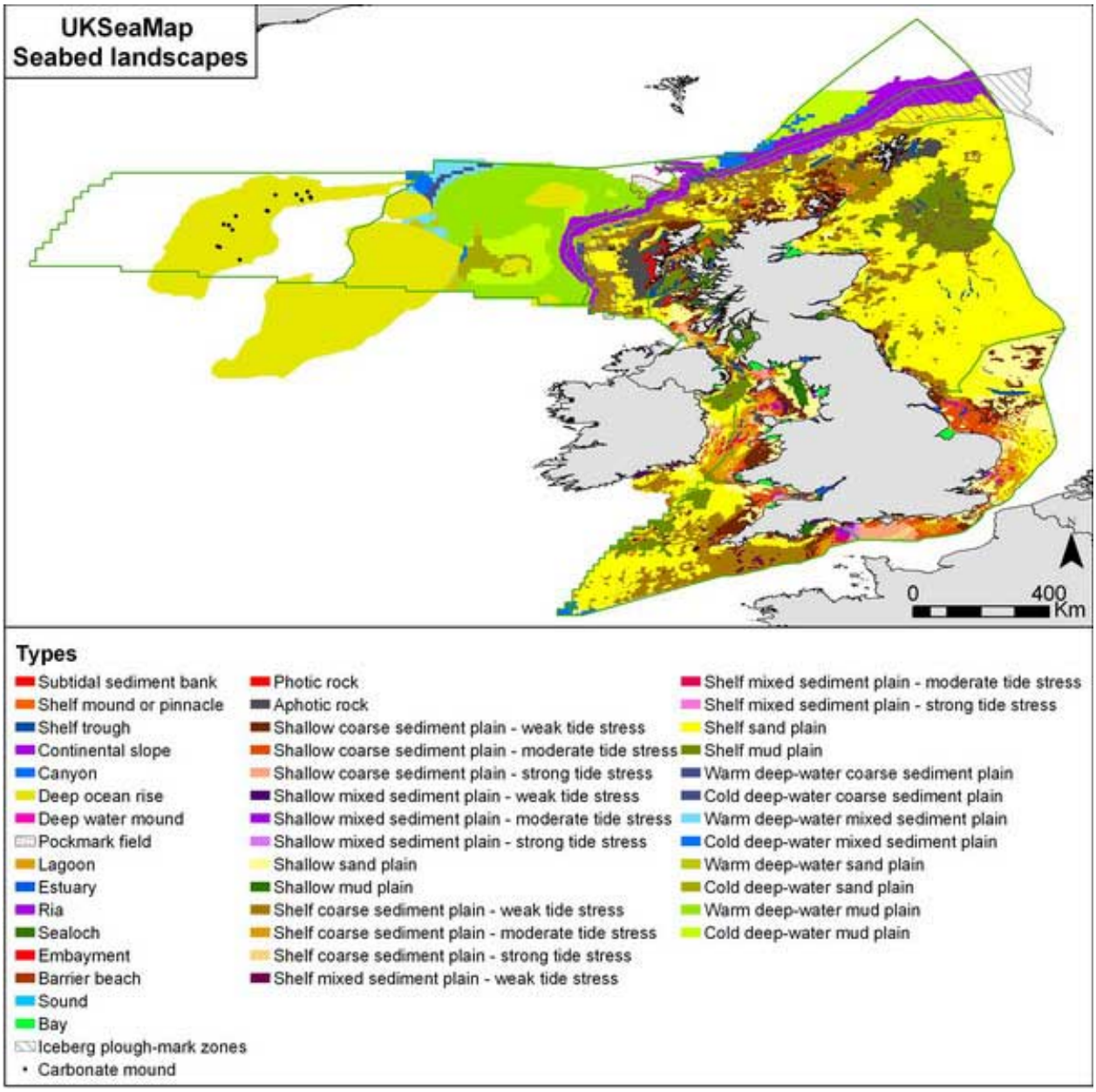


Figure 5 UKSeaMap seabed landscapes (from **http://www.jncc.gov.uk/page-2118**)

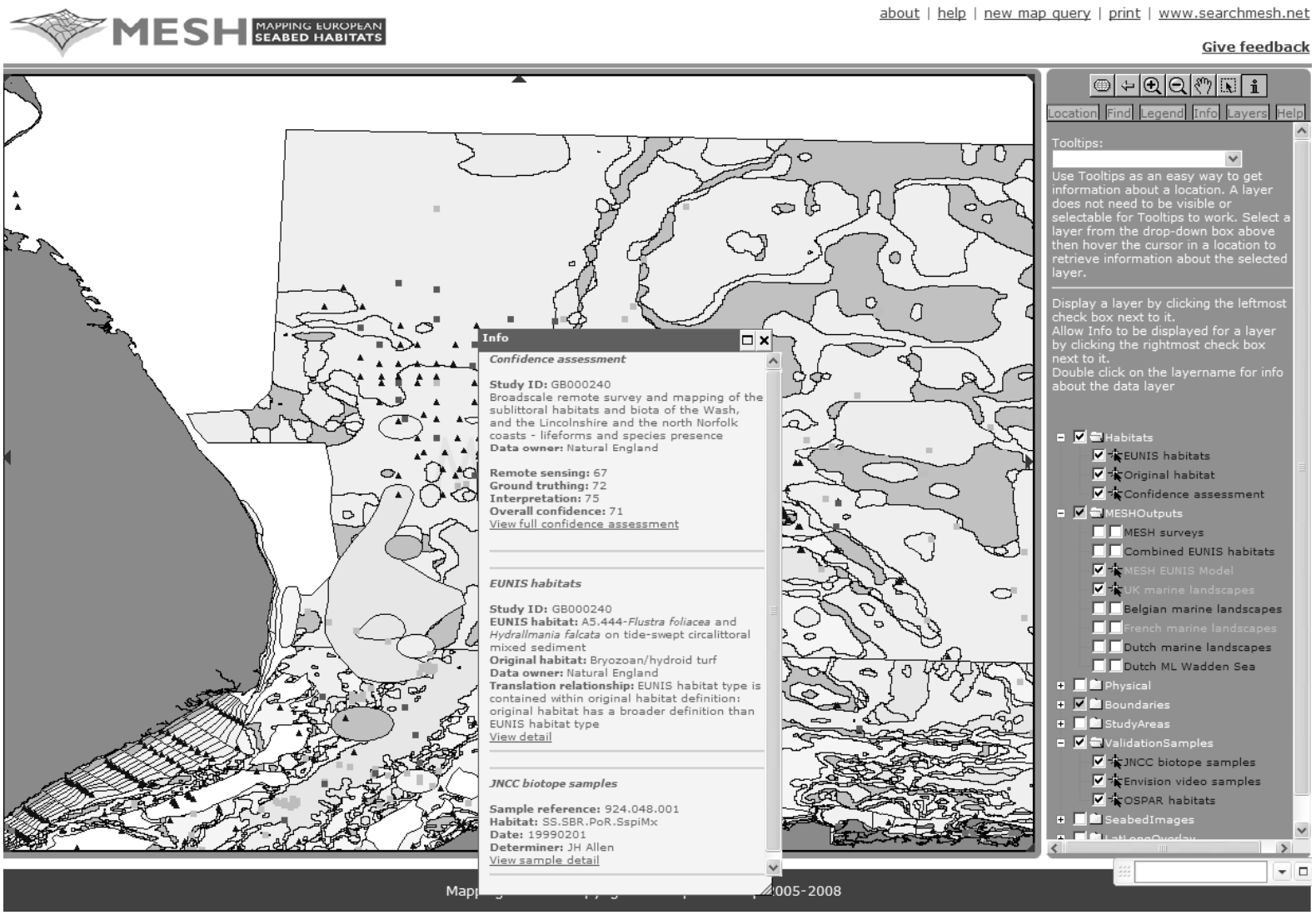
2.29 There are some significant issues with using the seabed landscapes for assessing representativity. The same seabed habitat types are likely to occur in several different physiographic features. Look up tables (LUT) devised during UKSeaMap reporting use a rough set approach to relate marine seabed landscape types with the Habitats Directive Annex I habitats and the EUNIS habitat classification (see Annex 7 of Connor *et al.*, 2006). In terms of a surrogate for assessing representation of habitats, because landscape types do link with Annex I features (although UKSeaMap was not designed to do this) the landscape maps provide an initial overview of Annex I habitat distribution in the UK. However, the

authors of UKSeaMap warn “as the Annex I habitats are specifically defined in EC guidance (European Commission 1999), and are subject to modification, the landscape maps should not be taken to encompass all areas that might qualify as Annex I habitat. For instance, the areas of ‘Reef’ habitat are significantly under represented in the maps (due to the lack of coastal rock in the substratum data set). Conversely only a portion of the sea lochs, embayments and bays in the landscape map will meet the EC definition (which is interpreted in the UK to have a particular depth limit)” (Connor *et al.*, 2006). Also, whilst sediment types are separated by degree of tidal stress, rock habitats are not, and neither are they separated by strength of wave action. The strength of tidal currents and degree of exposure to wave action are the primary factors determining the type of community that occurs on any stable hard substratum. The two surrogates for biological features could not be used to adequately classify relevant biodiversity on reef habitats and ‘photic rock’ may be dominated by animals where conditions are most favourable to grazers and suspension feeders. Unfortunately, most of the habitats on the OSPAR List are at a finer level of detail than marine landscape types and are better equated to habitats within the EUNIS classification, and there is rarely a simple 1:1 relationship to EUNIS.

2.30 Although the modelled data of UKSeaMap provide full coverage information and are meaningful from the point-of-view of establishing units for comparing like-with-like in broad-scale biodiversity, the surrogates for biological features and the seabed landscape categories developed for UKSeaMap were not designed to be used for assessing representativity for biodiversity and conservation.

Mapping European Seabed Habitats MESH

2.31 The MESH Project set out to generate the first compiled marine habitat map for north-west Europe. It did this by collating, standardizing and quality testing available seabed habitat mapping information and developing habitat modeling techniques to predict the distribution of habitats for areas with no existing information. Over 250 maps were translated from their original habitat classes to their corresponding EUNIS habitats using expert judgment by the MESH Partners but large gaps are still apparent (see Figure 6). Although not completed prior to the current report (and therefore not available for use in the current analysis), the potential distribution of EUNIS habitats are currently being predicted by MESH partners using models based on environmental variables known to be important in defining these habitat types for all UK waters except North West approaches (see current progress in Figure 8). The modeled EUNIS dataset represent a potentially useful datasets for use by the MPA Project regional studies.



The triangle at top left of the pop-up box has been interrogated and the habitat type in terms of the JNCC biotope sample has been revealed in the box along with the EUNIS habitat classification and the confidence assessment

Figure 6 Survey data available from MESH

Sample Details

View survey details

Sample metadata	
Name	N13 (Inner Dowsing)
Sample reference	924.048.001
Habitat	Muddy gravel at 16m bsl.
Description	Muddy gravel at 16m bsl.
Date	01/02/1999
Determiner(s)	James Allen
Method	Grab - Hamon
Position	53.41668658,0.534996107
Physical data	
Depth zone	SubLittoral
Depth	Sublittoral, -16 (SL)
Habitats	
SS.SBR.PoR.SspiMx	Sabellaria spinulosa on stable circalittoral mixed sediment

Species name	Abundance	Characterising?
Nemertea	Count: 4	
Golfingia	Count: 1	
Pholoe synophthalmica	Count: 1	
Nereis longissima	Count: 2	
Lumbrineris latreilli	Count: 1	
Protodorvillea kefersteini	Count: 11	
Minuspio cf. multibranchiata	Count: 6	
Minuspio cirrifera	Count: 3	

Where a species is characterizing, the 'Characterizing' field of the lower right table will contain the text 'Yes'.

Figure 7 The 'View sample detail' in the pop-up box in Figure 6 has been interrogated to reveal the survey data

2.32 The MESH Web GIS also provides a platform for disseminating the results of surveys which, where the 'pop-up' box offers 'View survey detail' gives raw data from surveys (Figure 6 and Figure 7). UKSeaMap landscapes are used in MESH outputs. In terms of EUNIS habitat information the GIS displays individual EUNIS habitat maps (overlapping studies) and Combined EUNIS habitats (non-overlapping studies, where the overlaps are erased based on confidence levels as assessed by MESH confidence assessment.

2.33 What the MESH programme has done and which provides us with relevant units for assessment, is to identify the EUNIS seabed types for a significant number of point samples and polygons from 170 seabed surveys which have produced interpreted seabed habitat maps. In the majority of cases, the sample data in MESH has been interpreted to level 4 of EUNIS e.g. 'A3.21 - Kelp and red seaweeds (moderate energy infralittoral rock)'. However, the habitat at some sample points, particularly sediments identified from acoustic survey, could not be identified beyond level 2. At the time of this study some sample points and polygons also remain classified in the format of the Britain and Ireland classification, for example the Isles of Scilly.

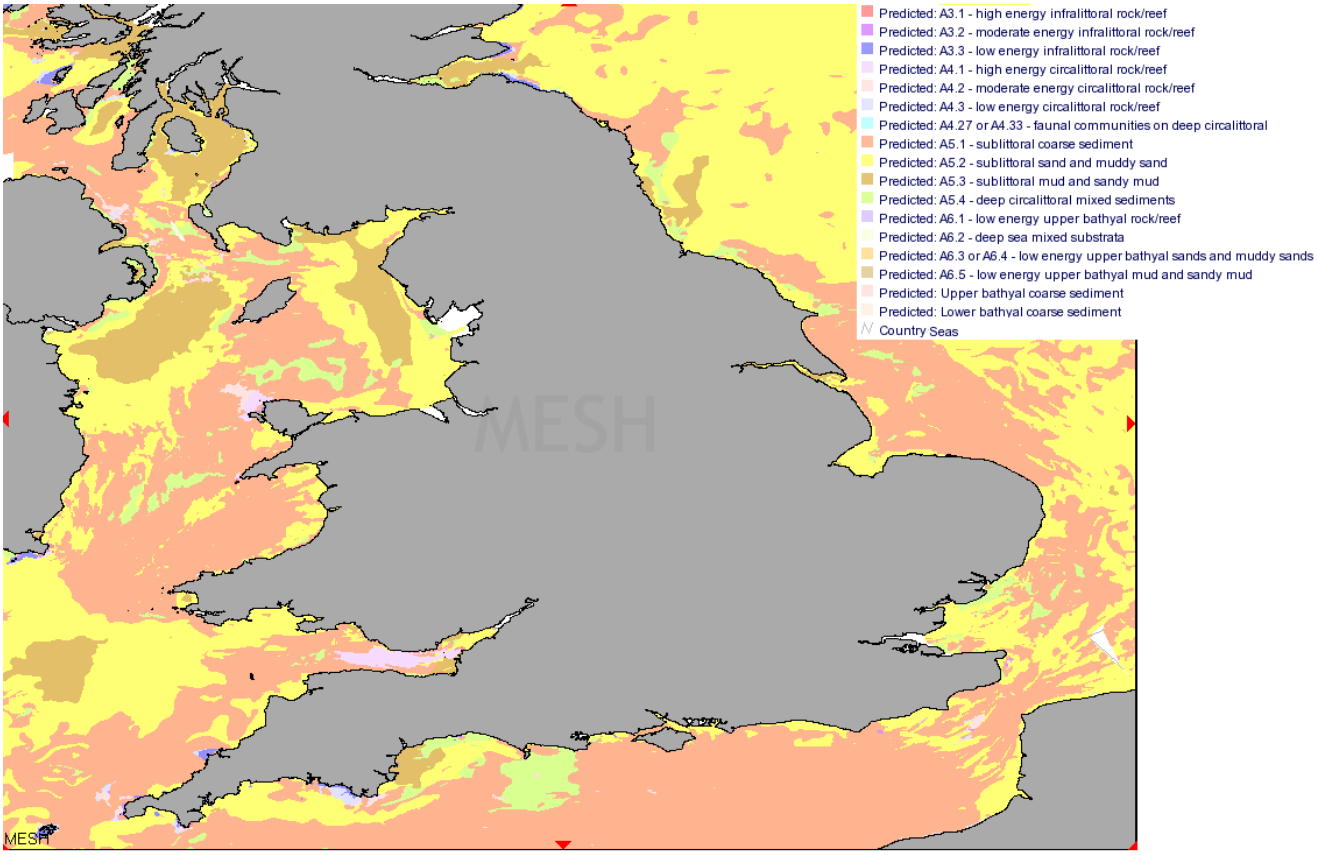


Figure 8 MESH predicted EUNIS types

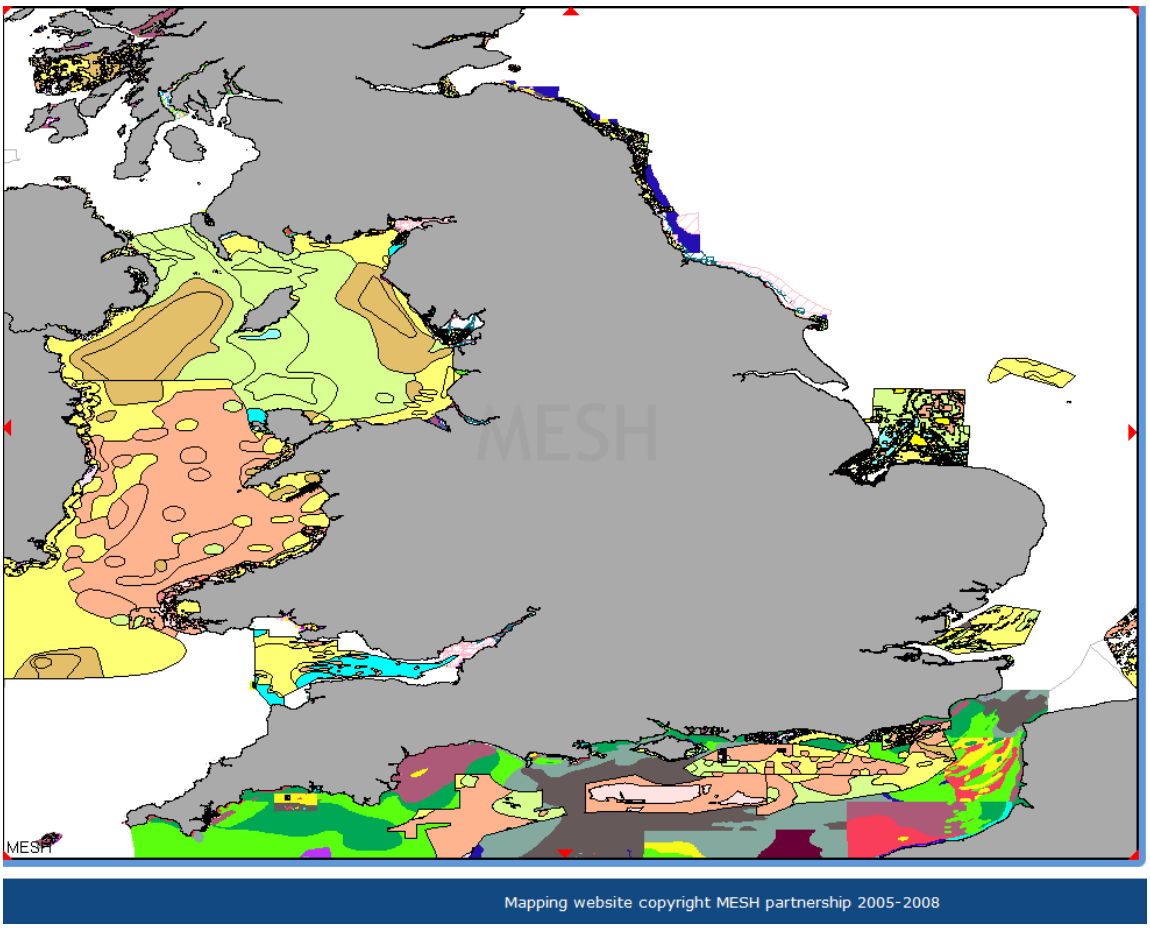


Figure 9 Coverage of habitat maps collated by MESH

Application of Biodiversity Action Plan (BAP) priority species and habitats

2.34 UK BAP is the UK Government's response to the Convention on Biological Diversity (CBD) signed in 1992. The list of BAP species and habitats has recently been revised. That exercise included all species and habitats and not just marine. The list has increased in numbers since the original Biodiversity Action Plan list was compiled ten years ago because the review involved a more rigorous analysis of a wider range of species and habitats. The review also took better account of less well known species. Some species are newly included because they are in decline or under threat. The criteria used were reliant on quantitative information being available. For 'Rarity', that quantitative information was generally available for marine species and of key importance to them being listed. For 'Decline', the quantitative measures required were difficult or impossible to find and many 'worthy' species did not qualify (see Hiscock *et al.,* 2006).

Application of 'Nationally Important Marine Areas' criteria

2.35 The Review of Marine Nature Conservation considered the identification of Nationally Important Marine Areas (Connor *et al.,* 2002) and identified a set of selection criteria that included 'Typicalness', which under some definitions is equated to 'Representativity' (see Section 1). The criteria for identifying Nationally Important Marine Areas included 'Area important for a priority marine feature'. Those 'priority marine features' would be identified as 'Nationally Important Marine Features' (NIMF) for which criteria are established in Connor *et al.* (2002). NIMF include species and habitats. Candidate NIMF were identified in the exercise undertaken by Hiscock *et al*. (2006). The criteria for identifying candidate NIMF species and habitats do not require the same quantitative rigour that proved so difficult to apply in identifying marine BAP species and habitats. However, all of the BAP species and habitats are also NIMF and so the candidate NIMF list provides the most suitable measure to address the criterion 'Area important for a priority marine feature'. The NIMF (including BAP) species that are relevant to the current exercise are listed in Appendix 1. "Relevant" is interpreted as listed species that are known or believed to occur in English waters and that may at least establish themselves temporarily in a particular location.

2.36 The presence of NIMF in an area enhances its value as a representative location for biodiversity conservation and should be taken into account in the current exercise. However, it should be noted that the list of NIMF species and habitats is currently a candidate list only. The list of NIMF species is not very 'even' in coverage across the major taxonomic groups. Some of the specialists approached to review groups indicated that they did not believe in the relevant concepts. Nevertheless, the candidate list provides a best current indication of species to be protected.

Taking account of OSPAR guidelines and lists of threatened habitats and species

2.37 OSPAR has identified criteria for the identification of a network of OSPAR sites for the protection of marine biodiversity (see OSPAR, 2003). The target year for the identification of that network is 2010 and site lists are submitted via a *pro forma* prepared by OSPAR. The criteria include representativity. The UK has prepared a preliminary list of 'OSPAR sites'. These are the SACs with marine components double-badged as OSPAR sites. Further work is underway to ensure that OSPAR criteria and lists of threatened and declining species will be included within the UK MPA network. The species that are listed by OSPAR as threatened and that are relevant[3] to the establishment of MPAs in English waters are given in Appendix 1. The habitats that are listed by OSPAR as threatened and that are relevant[2] to the establishment of MPAs in English waters are given in Appendix 2, although OSPAR recognises that a representative network of MPAs should include all habitats not just those that are currently threatened and declining (see below).

[3] "relevant" is interpreted as listed species that are registered by OSPAR as occurring in OSPAR regions that include English waters and that may at least establish themselves temporarily in a particular location.

How much is representative?

2.38 Once the level of habitat classification to be used and the limits of the area of search have been decided, the amount of representation in a system of existing MPAs can be simply expressed in terms of an aerial extent, or as a proportion of each derived unit contained in the current system. However, determining how much should be contained within a system is more complex (Stevens, 2002), and requires good information regarding the known distribution of habitats within our territorial waters, both inshore and offshore.

2.39 The 5th IUCN World Parks Congress recommends that in order to establish representative networks of marine and coastal protected areas, at least 20-30% of each habitat should be included (IUCN, 2003). OSPAR guidelines (Principle 4) recommend between 20 and 60% of known occurrences of threatened and declining species and habitats i.e. those meeting aims (a) and (b) of the OSPAR network (see Table 2), are represented in the OSPAR network of MPAs.

Table 2 Correlation between the OSPAR ecological criteria/considerations and the aims of the OSPAR Network

Aims of the OSPAR Network	(a) Protect, conserve and restore species, habitats and ecological processes which are adversely affected as a result of human activities	(b) Prevent degradation of and damage to species, habitats and ecological processes following the precautionary principle	(c) Protect and conserve areas which best represent the range of species, habitats and ecological processes in the maritime area
Ecological criteria	(1) High priority habitats and species which meet the Texel-Faial criteria of 'Decline'	(1) High priority habitats and species which meet the Texel-Faial criteria of 'high probability of a significant decline' (2) Important habitats and species which meet the other Texel-Faial criteria (global importance, local (species)/regional (habitats) importance, rarity, sensitivity, keystone species, ecological significance) (6) Sensitivity	(3) Ecological significance (4) High natural biological diversity (of species within a habitat and of habitats in an area) (5) Representativity, including the biogeographic regions (7) Naturalness

Numbers refer to those assigned to criteria in agreement 2003-17, 1 of OSPAR Guidelines (Source: Appendix 3 OSPAR Guidelines; (OSPAR, 2003b)

2.40 To protect and conserve areas that best represent the distribution of biodiversity in the region and meet aim (c) of the OSPAR network(Table 2), the guidelines also recommend including 20% of the total extent of each EUNIS level 3 habitat or species population (where considered appropriate) but that at least 10% should be included within the network. These proportions are based on:

- the appropriateness of site based protection for the species or habitat;
- its degree of decline in extent and quality (habitat) or population size and distribution (species);
- the degree of naturalness of species and habitat types as a result of a lack of human induced disturbance or degradation;
- the degree to which it is under threat from ongoing and future activities;
- its natural sensitivity (i.e. its ability to recover from damage); and
- its rarity within the OSPAR maritime area (Source: OSPAR, 2007).

2.41 To examine proportional representation by area requires good data on the coverage of habitats within the area of search. Despite concerted efforts to map habitats there are still too many gaps in the information currently available for English waters. Under OSPAR guidelines: "when detailed biological survey data are not available, existing biological data should be used in conjunction with the other approaches, to ensure that biological representativity is likely to be achieved". In the present exercise, representation will be based on occurrences of habitats and species, with the areas of specific habitats within SACs given where the data was available in MESH. The targets for occurrences within MPAs (replicates) were based on OSPAR guidelines and experiences of the Irish Sea Pilot (Table 3). For the broad-scale, full coverage, landscape classification the current study set targets of 40% representation within the current network of MPAs (which are all coastal). This target was set because where data are coarse with a larger margin of error, areas identified within MPAs would need be large to actually be representative.

Table 3 'Representation' and 'Replication' targets for features within each of the Draft Natural England Project Study Regions

Feature	Relevant OSPAR MPA network Aim (see Table 2)	Proposed Targets	
		Percentage of known occurrence/extent[4] within NE Project study region	Number of replicates per NE Project study region [5]
OSPAR threatened or declining	(a), (b)	20	5
cNIMF[6]	(a), (b)	20	5
BAP		20	5
All other habitats (EUNIS Level 4) found in region	(c)	10	3
Landscape level features found in region	(c)	40	6

Replication

Why replicate?

2.42 The criterion of 'Replication' is a more clearly defined term than 'Representativity'. 'Replication' - All habitats within each region should be replicated and these should be spatially separate to safeguard against unexpected failures and collapse of populations" WCPA/IUCN 2007 and CBD Technical series no.13, BDC 07/03/14-E (Secretariat of the Convention on Biological Diversity, 2004)]

2.43 Although 'Replication' (within each of the Regional Seas) is not a criterion for the selection of a network of MPAs as such it is clearly desirable to have more than one example of each major type of habitat within a series of marine protected areas.

[4] As proposed under the OSPAR Guidelines.

[5] As proposed during the Irish Sea Pilot. Roberts C.M., Gell F.R. & Hawkins J.P. (2003). Protecting nationally important marine areas in the Irish Sea Pilot Project Region. Environment Department, University of York, York, 133 pp.

[6] cNIMF, refers to candidate Nationally Important Marine Features, for details see page17.

2.44 Replication of main types of habitat provides for:

- regional variation in biology based on biogeographical or local environmental characteristics (such as geology or water quality) differences within the same regional sea;
- locations that could act as a source for re-colonization if a similar area is damaged;
- an 'insurance policy' should one example be degraded (either by damaging events or via long-term change affecting individual MPAs); and
- a greater number of connections between sites thereby enhance connectivity in the network.

Which scale to replicate at?

2.45 Once again, discrepancies occur in the literature because of the scale used, i.e. at what level of scale is the replication applied at. Most organizations agree that replication should be at every possible level from global to local and that networks should be incorporated into an integrated coastal or large marine ecosystem (LME) management plan. OSPAR guidelines (Principle 11) state "replication of habitats, species and ecological processes in separate OSPAR MPAs in each biogeographic area is desirable where it is possible". In order to be able to scale up to national and higher (e.g. European or global) levels, this study addressed replication within English project study regions (Figure 2). Where species and habitats are at the limits of their biogeographical range such replication will be difficult to achieve. In order to protect such species and habitats effectively requires trans-boundary cooperation of nations, which must be guided by inter-governmental bodies, such as OSPAR.

2.46 The scale of habitat classification is another important consideration when assessing what level of replication is required. The coarser the scale of habitat classification used the greater the number of required replicates within a biogeographic region in order to ensure appropriate level of natural variation. Greater knowledge of the features present at a finer scale therefore allows greater efficiency in the setting up of MPA networks.

How many replicates?

2.47 With the general agreement that replication of habitats, species and ecological processes in separate MPAs in each biogeographic area is desirable where it is possible (Principle 11 of OSPAR guidelines), the question remains, how many replicates are needed? Many studies suggest values but invariably these values are not backed up with any reasoning. Within the Irish Sea Pilot (Roberts *et al.*, 2003) it was agreed that habitats should be replicated in at least three, and preferably five or more, protected areas spread throughout the Irish Sea region, wherever the extent and distribution of a habitat allows. Whilst no definitive reason was given for these values it was suggested that levels of replication of a habitat in different protected areas could be directed by:

- desired target levels of coverage for that habitat;
- the availability of suitable examples; and
- the distribution of features around the management region being considered (Source: Roberts *et al.*, 2003).

2.48 The guidelines for the selection of biological SSSI state that "a minimum aim in terms of replication, should be to represent all the different habitats and species that are present by at least one – and preferably the best – example or population within an AoS" (Joint Nature Conservation Committee, 1998). In a marine context, the AoS used were the JNCC Coastal cells. Whilst these AoS do not adequately represent marine biogeographical boundaries their abundance and spatial division are such that the statement below probably holds true:

"*Provided that selection is adequate within each AoS, representation of national gradients in features determined by climate and other environmental factors will automatically be accommodated in the countrywide network of SSSIs*".

2.49 The guidelines go on to say that in practice the local differences in climate and other environmental factors often require that several features are selected to adequately represent the variation within each AoS. Based on previous experience, the guidelines advise that for widespread features selection of the five best replicates within an AoS gives adequate representation (Joint Nature Conservation Committee, 1998). Using biogeographical and physiographic boundaries as AoS of search may allow the original minimum of one example to be sufficient. With this in mind, replicating at least one good example of the different species or habitat within each physiographic type it occurs in and within each coastal natural area (Jones *et al.*, 2004) is arguably more relevant method of ensuring minimum levels of replication.

2.50 The SSSI guidelines importantly note that extra weight should be given to those features at the limits of their geographical distribution in a particular AoS (Joint Nature Conservation Committee, 1998).

2.51 The present study intended to identify where replicates exist within a region and whether they are appropriate for a particular feature based on the factors above. With the overall aim that each feature is replicated at least three times, preferably five and that these replicates are spread throughout the project study regions to allow risk to be spread, and also that the habitats in each MPA are sufficiently large to maintain their ecological integrity (Roberts *et al.*, 2003). The targets summarized from this information and proposed for use in this exercise are shown in Table 3. Replication and the spatial distribution of replicates, links directly to issues of connectivity within MPA networks. Connectivity of MPAs and consideration of factors such as larval dispersal are being considered in a parallel study to this one and will not be considered here (Roberts et al., *in prep*).

Types of Marine Protected Areas in England

2.52 Areas that have statutory protection for their marine biodiversity features are hereby described as 'existing marine protected areas' (Figure 10). Chronologically, Sites of Special Scientific Interest, Marine Nature Reserves (there is one in England, Lundy) and Special Areas of Conservation were established. Special Protection Areas (SPAs) are sites of European Community importance designated under the Wild Birds Directive (Commission of the European Communities Council Directive 79/409/EEC of 2 April 1979 on the Conservation of Wild Birds). SPAs are classified for rare and vulnerable birds, listed in Annex I to the Birds Directive, and for regularly occurring migratory species of birds. As the current study focused on benthic marine species, SPAs are not considered within this report. Whilst there were approximately six candidate Marine Nature Reserves following the inclusion of provisions for their establishment in the 1981 Wildlife and Countryside Act, there was no systematic application of criteria that could be relevant to the present exercise and candidate MNR's will not feature in considerations.

Sites of Special Scientific Interest (SSSIs)

Historical perspective

2.53 SSSIs are essentially a means of notifying planning authorities and owners and occupiers of land of their scientific importance. The seaward extent to which SSSIs could be notified in England is Mean Low Water. The significance of SSSI notification increased after the passing of the Wildlife and Countryside Act 1981 where provisions for safeguard were increased. In 1994, an exercise was undertaken by the Marine Nature Conservation Review of Great Britain to establish how many SSSI included intertidal areas in Great Britain. Only 83 included marine biological interest in the citation and, hence, it is only these 83 SSSIs that provide any protection for marine biodiversity features.

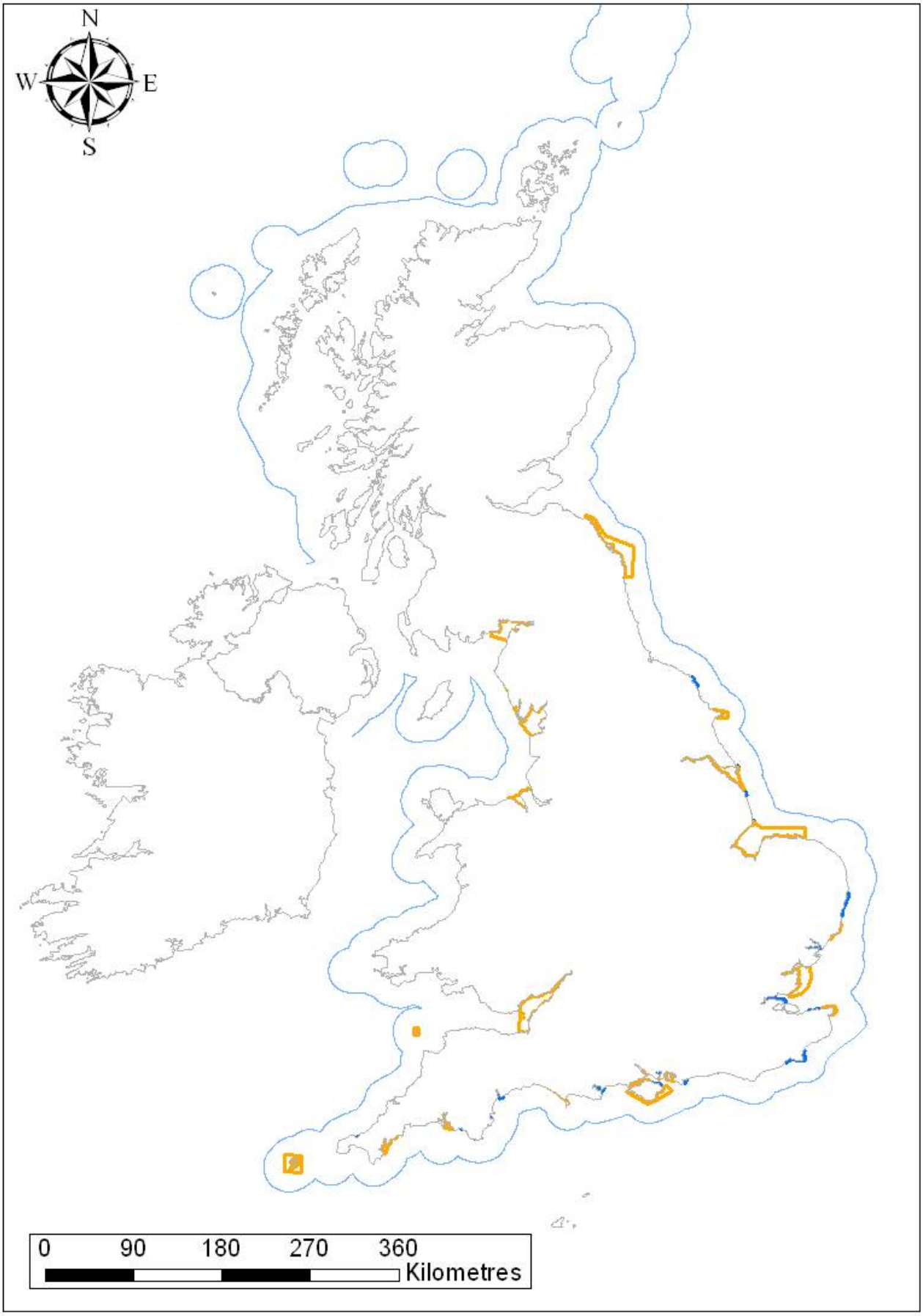


Figure 10 Locations of MPAs (SSSIs and SACs) in English Territorial waters

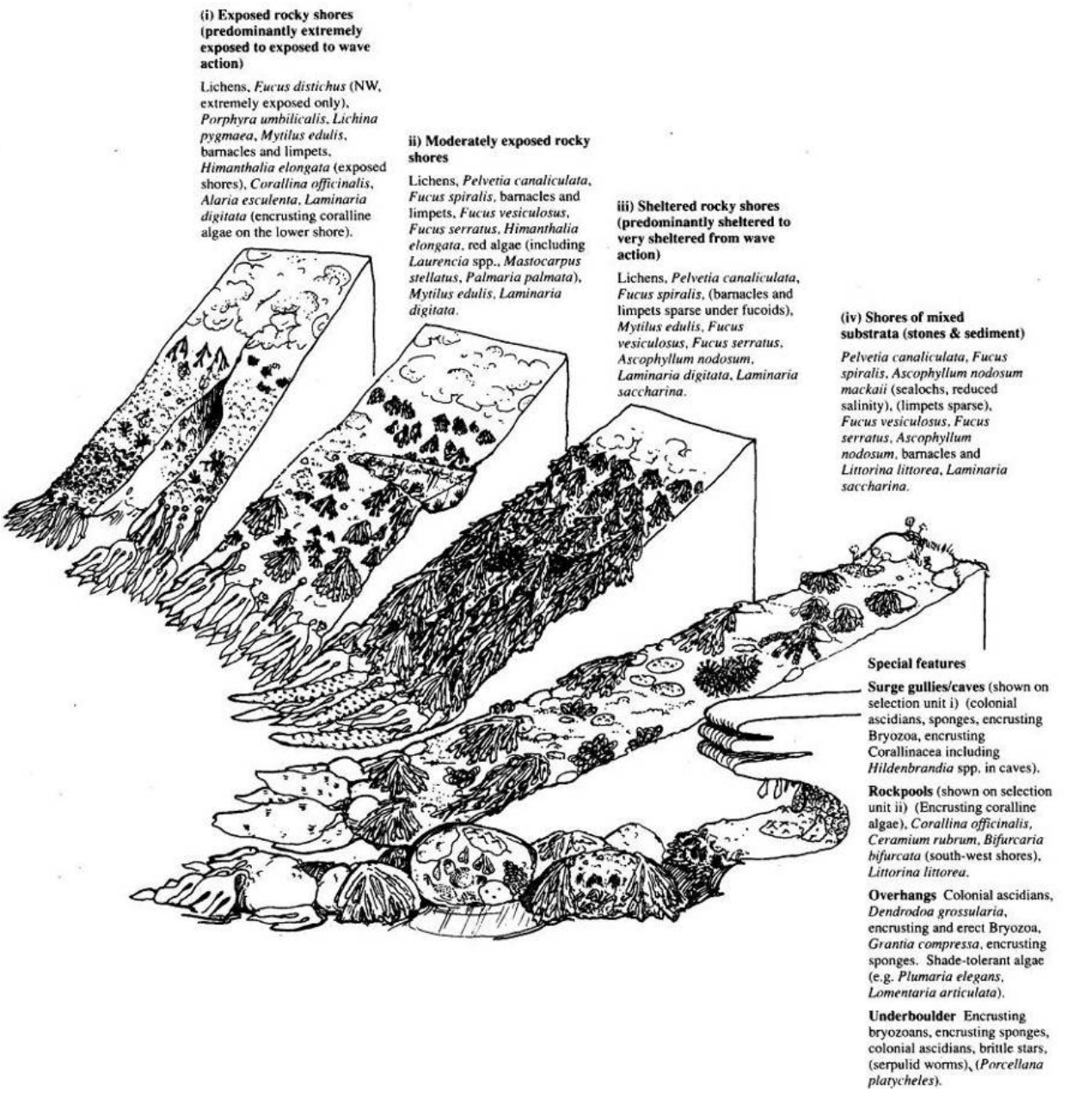
Procedures for SSSI selection: representativity and replication

2.54 The guidelines use the following approach to representativity (typicalness in the criteria used for SSSI).

- Within each AoS, a minimum aim of SSSI selection is to include examples (and preferably the best) of the full range of habitats and associated communities which satisfy the guidelines for selection.
- Particular care is taken to ensure those habitats and their associated communities and species which have a restricted national or international distribution are included in SSSIs. In general, the more important the habitat (according to degree of rarity or if listed in international conventions), the greater the percentage of that habitat that should be selected.

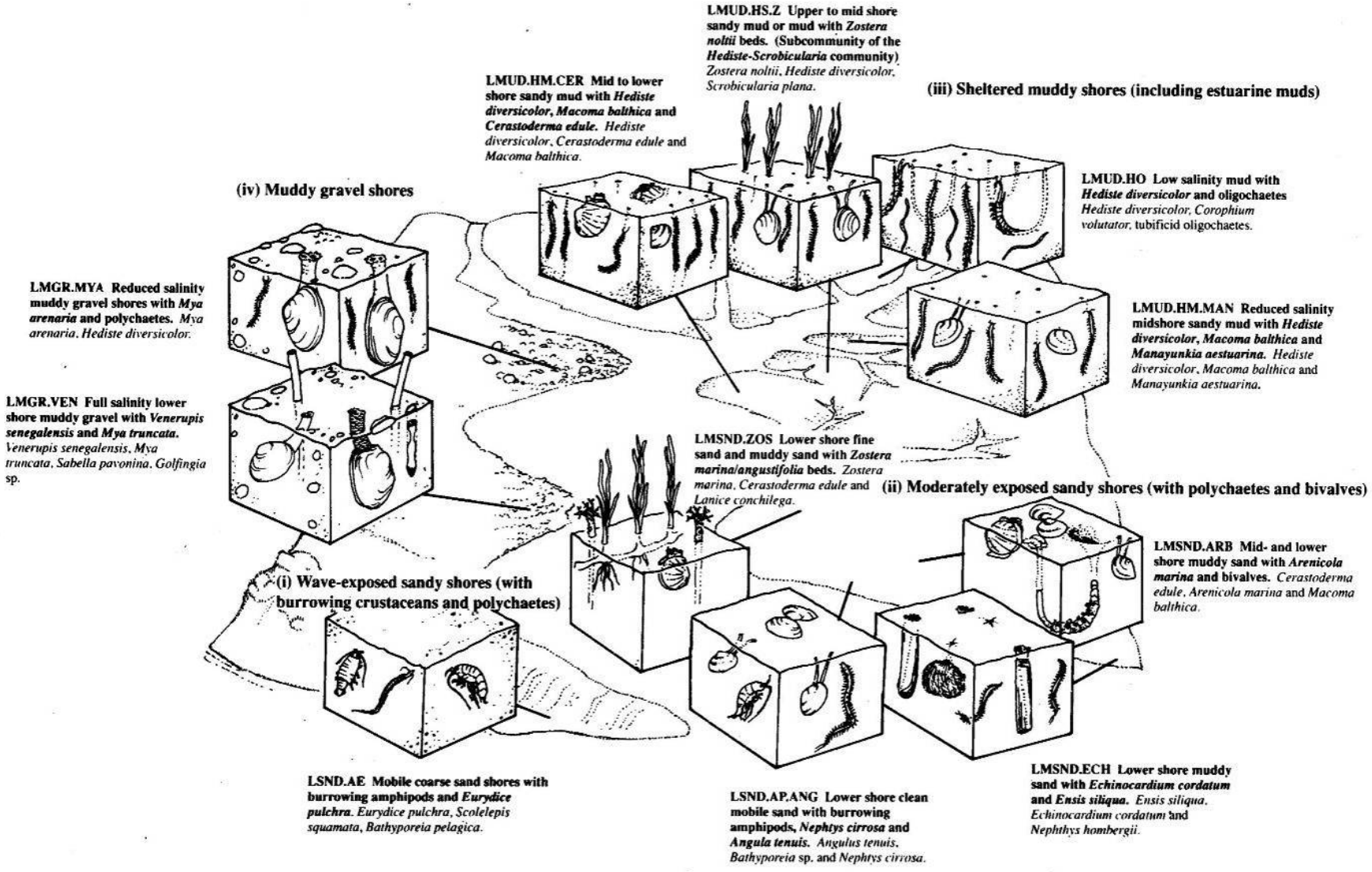
2.55 The AoS for intertidal habitats were based on the major coastal cell boundaries and there were eight in England. The AoS for saline lagoons were counties. The "examples of habitats and communities" were based on the 'Selection Units', which were habitat types (eight rocky intertidal types, four sediment shore types and five saline lagoon types) described in the Guidelines (see examples in Figure 11 and Figure 12).

2.56 'Rarity' was identified through lists of nationally rare and scarce species and species listed in the Wildlife & Countryside Act 1981 and included in British Red Data Books were also included in the Guidelines.



[Source: JNCC, (1996)]

Figure 11 Selection units for intertidal (rocky shores) SSSI



(Source: JNCC, (1996)

Figure 12 Selection units for intertidal (sediment shores) SSSI

Relevance to the current study

2.57 Whilst the *Guidelines for selection of intertidal marine habitats and saline lagoons* (Joint Nature Conservation Committee, 1996) provided a well thought-through approach consistent with terrestrial SSSI selection guidelines, there is no evidence that an intertidal SSSI series was identified using them. Also, the guidelines were produced at a time when the biotopes classification was at an early stage of development so that the selection units do not read-across easily to the current classification, and coastal cell boundaries turned-out to be temporarily fashionable for matters related to biodiversity and biogeography. In the 'Notified SSSI features' catalogue provided by NE, all or most of the Selection Units are included. 'Saline lagoon inlets' may be the category 'Saline coastal lagoon' in that list and 'Special features' is essentially a modifying feature rather than a specific selection unit. The Selection Units can be identified to the EUNIS classification at level 3 and, for some, level 4 (Table 4).

2.58 Of the species listed in the Guidelines as rare, scarce or listed in the Wildlife & Countryside Act 1981 or British Red Data Books (RDBs), all of those that are intertidal and were, at the time, listed in the 1981 Act or in the RDBs are included in the 'Notified SSSI features' catalogue provide by Natural England, except that the mollusc *Truncatella subcylindrica*.

Conclusion

2.59 There are currently a number of intertidal SSSI with marine biology in the citation, some of which are worthy of inclusion in a MPA series.

Table 4 SSSI selection units from JNCC (1996) and possible equivalents

Selection Units from JNCC (1996)	Equivalent in EUNIS classification (All are classified to level 3 and, unless specific examples at Level 4 are given, include all biotopes at a finer level of classification)	Notes
Exposed rocky shores (predominantly extremely exposed to exposed to wave action)*	A1.1 High energy littoral rock	
Moderately exposed rocky shores*	A1.2 Moderate energy littoral rock	
Sheltered rocky shores (predominantly sheltered to very sheltered from wave action)*	A1.3 Low energy littoral rock	
Shores of mixed substrata (stone & sediment)*	A2.1 Littoral coarse sediment	
'Special features' (Surge gullies/caves; Rockpools; Overhangs; Underboulders)	A1.4 Features of littoral rock, specifically A1.41 Communities of littoral rockpools; A1.42 Communities of rockpools in the supralittoral zone; A1.44 Communities of littoral caves and overhangs	May occur within the main rocky shore types in SSSI selection guidelines. Unfortunately, the EUNIS classification does not include underboulder communities which are distinctive and threatened.
Wave exposed sandy shores*	A2.2 Littoral sand and muddy sand, specifically A2.22 Barren or amphipod-dominated mobile sand shores	

Table continued...

Selection Units from JNCC (1996)	Equivalent in EUNIS classification (All are classified to level 3 and, unless specific examples at Level 4 are given, include all biotopes at a finer level of classification)	Notes
Moderately exposed sandy shores*	A2.2 Littoral sand and muddy sand, specifically A2.23 Polychaete / amphipod-dominated fine sand shores; A2.24 Polychaete/bivalve-dominated muddy sand shores	
Sheltered muddy shores*	A2.3 Littoral mud	
Muddy gravel shores*	A2.4 Littoral mixed sediments	
Isolated saline lagoon*	A5.41 Sublittoral mixed sediment in low or reduced salinity (lagoons)	Pools that are completely isolated from the sea by a barrier of rock or sediment.
Percolation saline lagoons*	A5.41 Sublittoral mixed sediment in low or reduced salinity (lagoons)	Separated by a permeable barrier such as shingle or pebbles.
Sluiced saline lagoons*	A5.41 Sublittoral mixed sediment in low or reduced salinity (lagoons)	Tidal water flow is restricted by a sluice or pipe. Most are small. Many of the lagoons in SE England are of this type.
Silled saline lagoons*	A5.41 Sublittoral mixed sediment in low or reduced salinity (lagoons)	Similar to some sluiced lagoons. Usually rocky basins. Mainly in Scotland.
Saline lagoon inlets	A5.41 Sublittoral mixed sediment in low or reduced salinity (lagoons)	A permanent but restricted connection with the open sea, for instance, The Fleet. Perhaps included as 'Saline coastal lagoon' in the 'Notified SSSI features'.

(* = Listed in 'Notified SSSI features')

2.60 It is debatable whether SSSI designation is a suitable means of protection for marine biological features especially when the interest of a location is often on the lowest shore, below Mean Low Water. If measures being proposed to specifically protect marine biodiversity at specified locations (the 'Marine Conservation Zones' proposed in the recent Marine Bill White Paper'), then SSSI designation for marine biodiversity conservation may not be needed.

Special Areas of Conservation

2.61 The Habitats Directive (Council Directive 92/43/EEC of 21 May 1992) requires EU Member States to create a network of protected wildlife areas, known as Natura 2000, across the European Union. This network consists of Special Areas of Conservation (SACs) and Special Protection Areas (SPAs), established to protect wild birds under the Birds Directive (Council Directive 79/409/EEC of 2 April 1979).

2.62 The marine habitats specified in Annex I of the Directive are very broad and are mainly physiographic types. The 'Open sea and tidal areas' habitats are:

- Sandbanks which are slightly covered by sea water all the time
- Estuaries
- Mudflats and sandflats not covered by seawater at low tide
- Lagoons
- Large shallow inlets and bays
- Reefs

2.63 The following is included in the category ‘Other rocky habitats’:

- Submerged or partly submerged sea caves

2.64 The list also includes deep water habitats and salt marshes, which are not considered in this study.

2.65 The SACs that constitute ‘SACs with marine components’ have recently been identified by the nature conservation agencies and JNCC. Furthermore, lagoons without a direct connection to the sea were not included as a marine habitat in the JNCC co-ordinated exercise, although they are populated by marine species. However, all of those lagoons exist within SACs with other marine features and so are identified as ‘marine SACs’ within this exercise.

3 Methodology

Data collation and analysis

3.1 Based on the reviews in the previous section, the final approach to the current exercise was to catalogue the seabed types, habitats and species recorded for the English Territorial waters (i.e. out to 12nm) within each of the MPA project areas.

3.2 In order to carry out a stock take of current representation of all marine habitats and species (that occur within the study area), a geodatabase was constructed to allow each one of the seabed types and listed species to be 'called-up' on the GIS to view their distribution within existing MPAs. Three main data sources were used together during analysis of representativity: GIS Layers of the UKSeaMap ('coastal physiographic features' and 'modelled seabed features'); MESH survey data; and a snapshot (February 2008) of the full NBN Marine Recorder database.

3.3 UKSeaMap ('coastal physiographic features' and 'modelled seabed features') was used to identify representation at a coarse level but with full coverage of the area being examined. Due to overlaps in the data the analysis examined each layer as a separate entity. The modelled seabed layer provided had some issues. These were primarily caused because the modelled information finishes in many places short of the coastline and meant that some areas of seabed near the coast were lacking physiographic information. In some cases blocks also overlapped the land. It was not possible to clip the land against the seabed features as this would have excluded information for some coastal features such as estuaries. There was modelled information for some areas with coastal physiographic features such as in bays and estuaries but not in others and therefore sediment types in some areas may have been underestimated.

3.4 Survey data held by MESH and searchable online is now available to download but it was not at the time of this study. Although, the metadata catalogue provides the mechanism for individual data owners to be contacted with over 400 data owners relevant to the current studies, this was not feasible within the time constraints of the current study. In order to utilise survey data from MESH, queries were carried out by JNCC staff to identify the areas of EUNIS habitats (down to level 4) found within English MPAs.

3.5 The full NBN Marine Recorder database was used to query species and biotope records. The species dictionary used in Marine Recorder is not up-to-date and a few species (e.g. *Ascophyllum nodosum mackii*) that were not recognised when queried against our list in the database were checked manually.

3.6 The coverage of candidate NIMF and OSPAR threatened species were checked using the NBN Marine Recorder snapshot and any species with no results recorded in England or within 12nm were discounted. All migratory species, whales, dolphins, sharks, turtles, and large mobile fish species were excluded, and all seals except for Grey and Common which have distinct pupping and haul out sites around England. All the species that were included in the analysis are listed in Appendix 1, along with a list of priority species not examined in the current study (i.e. migratory or those not recorded within ETWs).

3.7 All habitats from the NBN snapshot were translated into EUNIS codes using the EUNIS translation spreadsheet provided by JNCC. BAP and OSPAR habitats that do not contain specific biotope codes listed with them were cross-referenced using the list for BAP/OSPAR in the spreadsheet and were checked with Keith Hiscock and JNCC that they had been

translated accurately (particularly new BAP habitats as the spreadsheet only had the old BAP list). NIMF habitats contained biotope codes so were translated directly.

3.8 For the purposes of this study MPA boundaries were based on the current SAC and SSSI sites within English Territorial waters. The list of SACs 'with marine components' identified by the nature conservation agencies and JNCC was used to identify SACs. Furthermore, lagoons without a direct connection to the sea were not included as a marine habitat in the JNCC co-ordinated exercise, although they are populated by marine species. However, all of those lagoons exist within SACs with other marine features and so are identified as 'marine SACs' within this exercise.

3.9 In the current study the 'Notified SSSI features' list was used to identify some of the SSSI with marine biology but gaps existed, therefore, all coastal SSSI citations were inspected (Natural England pers. comm.) to identify those SSSIs that were established:

- primarily for their marine biological interest, or
- where marine biology was included in the citation.

3.10 Any SSSI that was completely within an SAC was removed from the current analysis. However, due to the degree of overlap, Thanet Coast has an entry both as an SAC and SSSI separately in the database to avoid confusion over the features found within them. Table 5 shows the numbers of SAC and SSSI examined during the stock take (a full list is given in Appendix 3).

Table 5 Numbers of SACs and SSSIs which include marine biology features in the citation used in the current study

Project Study region	Number of marine SACs	Number of marine SSSI	Total
North East	8	4	12
North West	5	0	5
South East	3	6	9
South West	7	8	15

3.11 For the purposes of analysis a MySQL database was constructed. This database was converted to a Microsoft Access database and provided with this report to allow specific queries of the MPA sites against a number of criteria. The database tables (see structure in Figure 13) contain the lists of priority species and habitats, MPA sites, regional boundaries (including JNCC draft regional seas and the draft MPA Project Areas), UKSeaMap features and the orders of priority for protection. A number of queries have been set up so that searches can be performed under the following criteria:

- by site name to identify the region/s they are within, the UKSeaMap features, species and/or habitats which occur within them;
- by species and habitat names to identify the site/s they occur within, their protected status and the order of priority protection; and
- by UKSeaMap landscape feature to query against the regions they are found in.

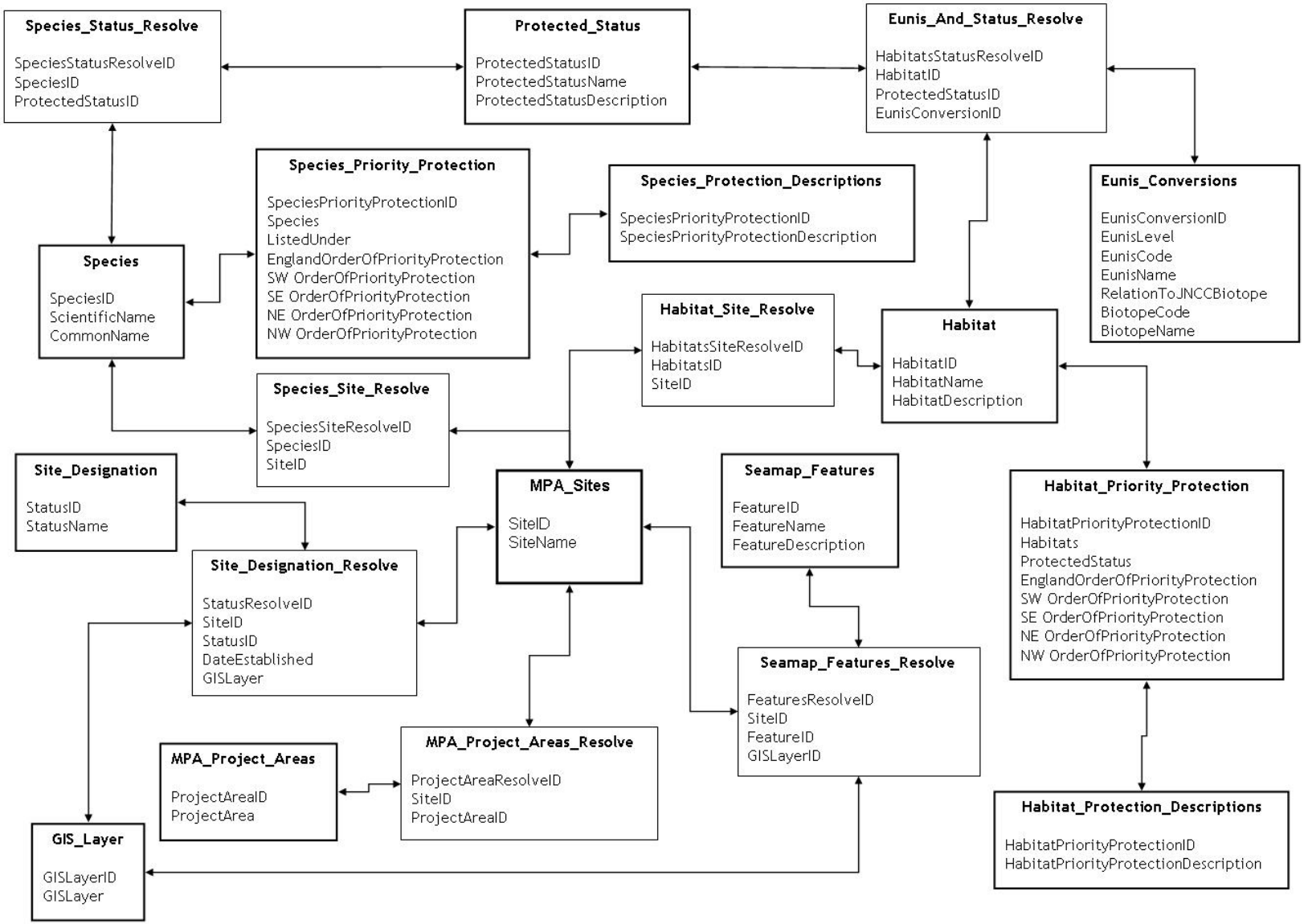


Figure 13 Database structure

3.12 Physiographic seabed landscape features could be examined on an occurrence and area basis (area proportional representation) using the modelled UKSeaMap layers. Although the categories are particularly broad and in many cases relate to many different habitats, they allow a coarse filter for identifying areas of search for identifying species and habitats which may not yet be represented in the MPA network. According to OSPAR guidelines, the coarser the level of habitat classification the greater the number of replicates and area within an MPA required (Assessment guideline 3.4, (OSPAR, 2007). Therefore, for the physiographic landscapes, targets were set at having each type replicated in at least six MPAs within a region and with at least 40% of the area of occurrence represented. The summary of representation and replication presented should be interpreted within the confines of the issues discussed in an earlier section.

3.13 The 'representation' of 124 listed species in English territorial waters (including 21 BAP species, seven OSPAR threatened species and 142 candidate NIMF species) within the current network of MPAs was examined. Using the target that each of these species should be replicated in at least five MPAs in each study region, the database was queried to look at which species fell in to which of the following categories and prioritised (1-5, with 1 being high) for protection.

- Species that occur within a study region but not within an MPA (Priority 1).
- Species that occur within at least one MPA within a study region but do not meet the replication target of five within the region but do meet the target of five at a national level (this level of replication is likely to meet OSPAR guidelines if OSPAR broad biogeographical boundaries), (Priority 2).
- Species that are not found in at least five MPAs but there is a valid reason (i.e. species distribution limited[7]), (Priority 3).
- Species that are found in at least five MPAs within a region (Priority 4 – not a priority for protection unless current protection not sufficient due to connectivity of replicates).
- Species does not occur within the region (Priority 5 - not a priority for additional protection unless species distribution disputable).

3.14 The 'representation' of 70 habitats listed as of importance for biodiversity in English territorial waters within the current network of MPAs was examined. Although some habitats subsumed others (e.g. Annex I habitat 'Reefs' included many of the more precisely defined habitats), the list included the seven Annex I habitats, seven OSPAR threatened and declining habitats, 19 BAP habitats and 40 candidate NIMF habitats (see Appendix 2 for full list). Using the target that each of these habitats should be replicated in at least five MPAs in each study region, the database was queried to look at which species fell in to which of the following categories and prioritised (1-7, with 1 being high) for protection:

- Habitat currently not recorded in protected areas in a region and only found in a region or found in other regions but protected in less than five locations nationally with no valid reason (Priority 1).
- Habitat currently not recorded in protected areas in a region but found in other regions but protected in less than five locations nationally but with valid reason (i.e. the recorded occurrences of the habitat limit greater replication) (Priority 2).
- Habitat currently not recorded in protected areas in a region but found in other regions and in at least five locations nationally (this level of replication is likely to meet OSPAR guidelines if OSPAR broad biogeographical boundaries are used) (Priority 3).
- Habitat protected in a region but in less than five locations and no valid reason (i.e. the recorded occurrences of the habitat do not limit greater replication) (Priority 4).
- Habitat protected in less than five locations regionally, but valid reason (Priority 5).

[7] Note that for the purposes of this exercise, this distribution was based on total occurrences from the NBN Marine Recorder database, see Recommendation Point 4.

- Habitat protected in at least five locations in region (Priority 6).
- Habitat not recorded in a region (Priority 7).

3.15 To assess representativity of the full suite of habitats found within ETWs, all habitat/biotopes (irrespective of whether they occurred on the lists mentioned in the previous paragraph) were translated to EUNIS level 4 using JNCC translation tables and the assessment above repeated. Using the target that each of the habitats classified at EUNIS level 4 should be replicated in at least three MPAs in each study region (unless cNIMF, BAP, OSPAR or Habitats Directive, in which case the level of replication remains at 5), the database was queried to look at which habitats fell in to which of the following categories and prioritised (1-7, with 1 being high, as above) for protection.

4 Results

Physiographic Landscapes

English Territorial Waters

4.1 Twelve of the 44 seabed features described in UKSeaMap are not found within 12nm of the coast and their representation within the current network of MPAs is therefore not addressed (e.g. deepwater features, continental slope etc.). For those landscapes that are found within 12nm, all are represented by the current network of MPAs at a national scale except for 'Shelf mixed sediment plain - strong tide stress' and 'Shelf coarse sediment plain - strong tide stress'. Thirteen physiographic landscapes are found in less than six MPAs at a national level (see Table 6) including rias, sounds and photic rock. Of these, all the coastal physiographic features have greater than 40% of their total area coverage within the current network of MPAs in ETWs (see Table 6). However, some inshore features are under represented by UKSeaMap due to the methods used, for example 'Barrier beaches' and 'Sounds', so whilst the target for percentage of total extent may appear to be met, these values should be reconsidered with improved information on the actual extents of these features.

Table 6 Replicates in MPAs and percentage of total extent, within English Territorial Waters, of each physiographic landscape features.

Physiographic landscape features	Occurrence in MPAs (replication) across England	Percentage of total extent in English Territorial waters found in MPAs.
Barrier beach	1	99.93
Bay	12	71.43
Embayment	10	71.38
Estuary	31	99.95
Lagoon	21	69.43
Ria	2	63.31
Sounds	1	50.60
Photic rock	1	28.70
Aphotic rock	8	12.34
Shallow coarse sediment plain - moderate tide stress	12	12.50
Shallow coarse sediment plain - strong tide stress	6	10.18
Shallow coarse sediment plain - weak tide stress	18	12.18
Shallow mixed sediment plain - moderate tide stress	5	3.82
Shallow mixed sediment plain - strong tide stress	5	3.02

Table continued...

Physiographic landscape features	Occurrence in MPAs (replication) across England	Percentage of total extent in English Territorial waters found in MPAs.
Shallow mixed sediment plain - weak tide stress	10	7.14
Shallow mud plain	13	8.80
Shallow sand plain	31	15.43
Shelf coarse sediment plain - moderate tide stress	2	4.25
Shelf coarse sediment plain - weak tide stress	1	11.93
Shelf mixed sediment plain - moderate tide stress	2	7.51
Shelf mixed sediment plain - weak tide stress	1	0.55
Shelf mud plain	6	3.03
Shelf sand plain	5	1.34
Shelf coarse sediment plain - strong tide stress	0	0
Shelf mixed sediment plain - strong tide stress	0	0

Regional: South West England

4.2 At a regional scale the patterns of representation differ. In the South West project study region all but three of the 25 landscape features examined are found within 12nm of the coast, the exceptions being 'Shelf coarse sediment plain - strong tide stress landscapes', 'Barrier beach and 'Sounds'. 'Shallow mixed sediment plain –weak tide stress landscapes', 'Shelf mud plain' and 'Shelf mixed sediment plain –weak, moderate and strong tide stress' landscapes are not currently represented in the network of MPAs but do occur within 12nm of the coast within the region, making them a priority for inclusion in a future network[8]. Nineteen of the 22 landscape features are represented in less than six MPAs and of these 16 do not have at least 40% of their total extent (area by region) represented in the current MPA network (see Table 7).

Regional: South East England

4.3 In the South East project study region only 20 of the 25 landscape features examined occur within 12nm of the coast (see Table 7). The following landscape features are not currently represented in the network of MPAs in the South East region but do occur within 12nm of the coast within this region, making them a priority for inclusion in a future network:

- Shelf coarse sediment plain - moderate tide stress landscapes;
- Shelf coarse sediment plain - weak tide stress landscapes;
- Sounds;
- Shelf mixed sediment plain - weak tide stress landscapes; and
- Shelf coarse sediment plain - strong tide stress landscapes.

[8] see recommendation 1

Table 7 Replicates in MPAs and percentage of total extent, by region, of each modelled physiographic landscape features.

	Occurrence in MPAs (replication) by project study region				Percentage of total extent (area by region) found in MPAs.			
Physiographic landscape features	**SW**	**SE**	**NE**	**NW**	**SW**	**SE**	**NE**	**NW**
Barrier beach	0	0	1	0	N/A	N/A	99.93	N/A
Bay	7	1	3	1	2.57	96.06	97.03	99.87
Embayment	3	6	1	0	57.47	89.41	63.31	N/A
Estuary	7	9	11	4	69.08	15.61	81.24	68.28
Lagoon	4	9	7	1	92.76	57.55	49.44	55.83
Ria	2	0	0	0	63.30	N/A	N/A	N/A
Aphotic rock	5	1	0	0	4.27	3.64	N/A	0
Photic rock	2	1	1	0	v	14.20	22.77	0
Shallow coarse sediment plain - moderate tide stress	2	2	7	1	0.85	4.47	50.50	0.20
Shallow coarse sediment plain - strong tide stress	1	3	1	0	0.43	43.00	0.48	0
Shallow coarse sediment plain - weak tide stress	4	4	8	2	4.99	1.35	32.94	5.05
Shallow mixed sediment plain - moderate tide stress	1	2	1	1	0	25.06	9.83	2.89
Shallow mixed sediment plain - strong tide stress	1	2	0	2	0	20.27	0	34.86
Shallow mixed sediment plain - weak tide stress	1	3	5	0	0	1.86	18.63	0
Shallow mud plain	4	3	4	0	0.15	0.77	33.40	0
Shallow sand plain	6	7	13	5	1.73	2.13	28.61	24.03
Shelf coarse sediment plain - moderate tide stress	1	0	1	0	3.13	0	8.77	N/A
Shelf coarse sediment plain - weak tide stress	1	0	0	0	15.79	0	10.16	N/A
Shelf mixed sediment plain - moderate tide stress	0	0	2	0	0	N/A	9.49	N/A
Shelf mixed sediment plain - weak tide stress	0	0	1	0	0	0	0.92	N/A
Shelf mud plain	2	0	2	0	0	N/A	3.52	N/A
Shelf sand plain	1	1	0	1	1.98	0.34	0.63	15.26
Sound	0	0	0	1	N/A	0	N/A	99.54
Shelf coarse sediment plain - strong tide stress	0	0	0	0	N/A	0	0	N/A
Shelf mixed sediment plain - strong tide stress	0	0	0	0	0	N/A	0	N/A

4.4 Eleven of the 15 landscape features that are represented in at least one MPA are found in less than six MPAs and of these eight do not have at least 40% of their total extent (area by region) represented in the current MPA network, they are:

- Aphotic rock;
- Shallow coarse sediment plain - moderate tide stress;
- Shallow coarse sediment plain - weak tide stress;
- Shallow mixed sediment plain - moderate tide stress;
- Shallow mixed sediment plain - strong tide stress;
- Shallow mixed sediment plain - weak tide stress;
- Shallow mud plain; and
- Shelf sand plain landscapes.

Regional: North East England

4.5 For the North East project study region the analysis identified 22 of the landscape feature types within 12nm of the coast (see Table 7). Three of these are currently not represented in any MPA. They are:

- Shallow mixed sediment plain - strong tide stress;
- Shelf coarse sediment plain - weak tide stress;
- Shelf coarse sediment plain - strong tide stress; and
- Shelf mixed sediment plain - strong tide stress.

4.6 Of those that are 'represented' in at least one MPA in the North East 13 are found in less than six MPAs (see Table 7) and three of these (Bays, Embayments and 'Shallow coarse sediment plain - strong tide stress') have at least 40% of its individual total extent (area by region) represented in the current MPA network.

Regional: North West England

4.7 In the North West there are not enough current MPAs for any of the features to be replicated at least six times. However, of the 15 landscape features that are found in the region (see Table 7), five are currently not represented in any MPA. They are:

- Aphotic rock;
- Photic rock;
- Shallow mud plain;
- Shallow coarse sediment plain - strong tide stress landscapes; and
- Shallow mixed sediment plain - weak tide stress landscapes.

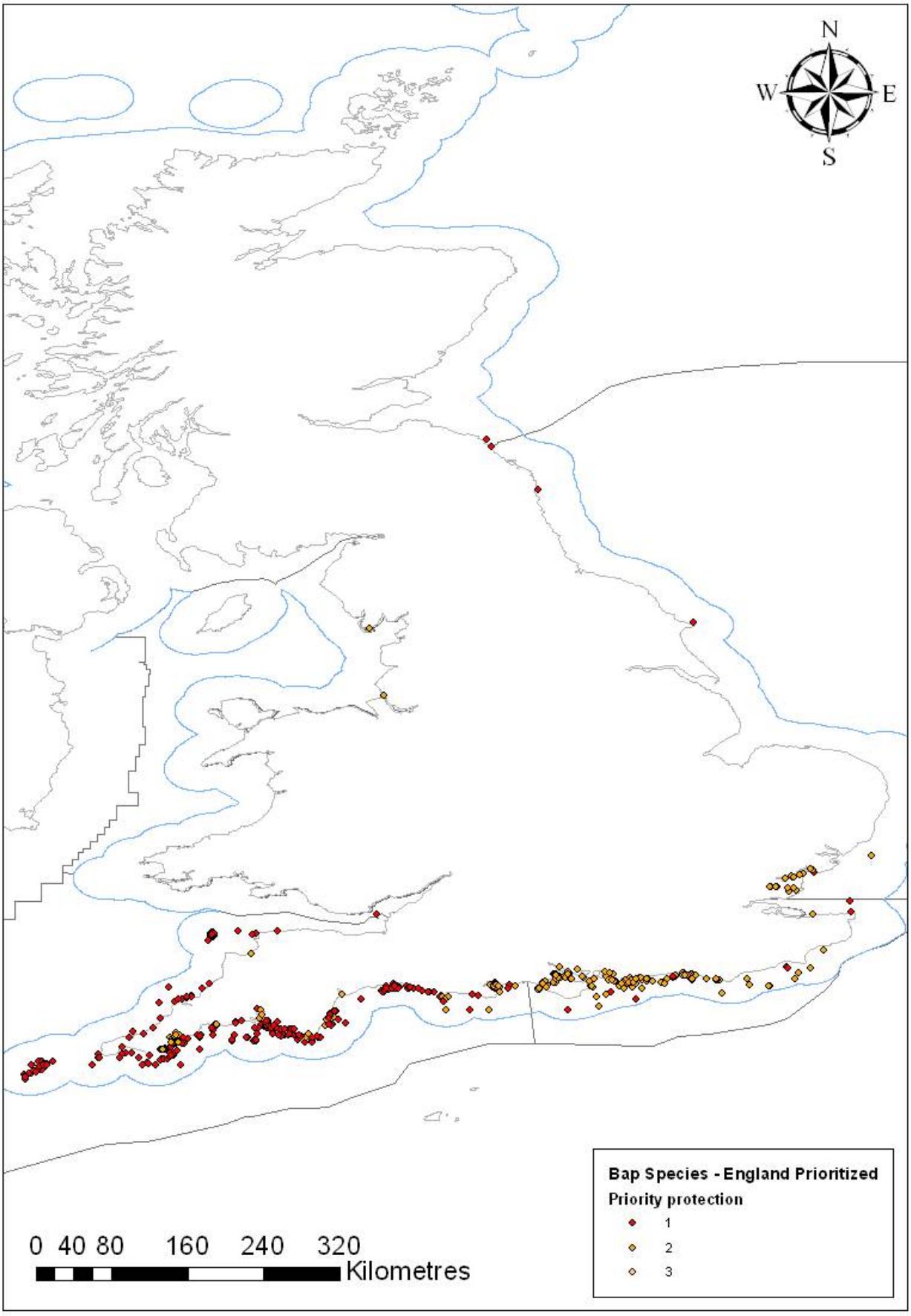
4.8 Of the 11 landscape features that are represented in at least one MPA in the North West, six have less than 40% of their total extent (area by region) represented in the current MPA network. They are:

- Shallow coarse sediment plain - moderate tide stress landscapes;
- Shallow coarse sediment plain - weak tide stress landscapes;
- Shallow mixed sediment plain - moderate tide stress landscapes;
- Shallow mixed sediment plain - strong tide stress landscapes;
- Shallow mud plains; and
- Shelf sand plains.

Species

English Territorial Waters

4.9 The map in Figure 14 illustrates the locations of BAP species (known distributions according to national datasets) within English territorial waters as a whole and their proposed priority for protection based on their representation in the current network of MPAs (English and regional maps for cNIMF and OSPAR species can be found in Appendix 2).



(12 nautical mile limit and draft Natural England Project Study Regions are marked)

Figure 14 BAP species occurrences and their priority for protection based on their representation in the current network of MPAs at a national level

4.10 Of all the species examined none met the target of being replicated in more than five MPAs in each study region. However one species, the dog whelk *Nucella lapillus*, was replicated in at least three MPAs in each region. *Nucella lapillus* is a common species in English territorial waters but classed as threatened due to the measured occurrence of imposex in those individuals exposed to TBT (Birchenough *et al.*, 2002). Thirty five species were identified as a priority for protection because they are currently not recorded for any MPAs but do occur in English territorial waters (Table 8).

4.11 One hundred and eleven additional priority species were recorded in less than five MPAs at a national level, although for 54 of these species their actual occurrence was a valid limiting factor (including the BAP species *Hippocampus hippocampus, Squalus acanthias, Anotrichium barbatum*, *Atrina fragilis*, *Lucernariopsis cruxmelitensis*, *Phoca vitulina* and *Tenellia adspersa*). For these species the percentage of total occurrences that were in MPAs was calculated to examine which species met the target of >20% of their known occurrences being represented in MPAs. Thirty of the 54 species met this target. Of the 57 species which were replicated in less than five MPAs nationally, despite known records allowing greater replication, 11 species were BAP species (see Table 9). Rare species and species at the limits of their distribution require specific targeted protection.

Table 8 Species occurring in English territorial waters but not recorded in the current network of MPAs.

Species	Notes
BAP	
Anotrichium barbatum	
Atrina fragilis	Known to occur in Plymouth Sounds & Estuaries SAC
Hippocampus hippocampus	
Phoca vitulina	Not recorded in surveys contributing to Marine Recorder. Known to occur in English SACs.
Raja undulata	
Squalus acanthias	
Candidate NIMF	
Adreus fascicularis	Known to occur in Lundy SAC
Alosa alosa	Not recorded in surveys contributing to Marine Recorder
Alosa fallax	Not recorded in surveys contributing to Marine Recorder
Anotrichium barbatum	
Antedon petasus	Not expected in English territorial waters
Asperococcus scaber	
Atrina fragilis	Known to occur in Plymouth Sounds & Estuaries SAC
Corophium affine	
Cucumaria frondosa	Not expected in English territorial waters
Dasya punicea	
Desmacidon fruticosum	Known to occur in Isles of Scilly SAC
Endectyon delaubenfelsi	
Glossus humanus	

Table continued...

Species	Notes
Gobius gasteveni	
Hippocampus hippocampus	
Leptochiton scabridus	
Leptoclinides faeroensis	
Leuconia gossei	
Ocnus planci	Not expected in English territorial waters
Onchidella celtica	
Paraphellia expansa	
Parazoanthus anguicomus	
Parvipalpus capillaceus	
Phoca vitulina	Not recorded in surveys contributing to Marine Recorder. Known to occur in English SACs.
Pollicipes pollicipes	
Smittina affinis	
Spongionella pulchella	
Sternaspis scutata	
Thyasira gouldi	
OSPAR	
Alosa alosa	Not recorded in surveys contributing to Marine Recorder
Hippocampus hippocampus	

Table 9 BAP species which are recorded in less than five MPAs nationally and not limited by total occurrences within English territorial waters

Species	MPAs records occur in	Actual recorded occurrences in England	Notes
Amphianthus dohrnii	2	18	Sea fan anemone, distribution associated with *Eunicella*
Cruoria cruoriaeformis	3	5	Red seaweed associated with maerl. Meets target of 20% of occurrences represented nationally.
Dermocorynus montagnei	2	18	Rare non-coralline crustose alga. Meets target of 20% of occurrences represented nationally.
Eunicella verrucosa	4	697[9]	Despite over large numbers of occurrences the SW vulnerable pink sea fan is recorded in only 4 MPAs.

Table continued...

[9] See recommendation point 4

Species	MPAs records occur in	Actual recorded occurrences in England	Notes
Haliclystus auricula	4	26	This stalked jellyfish is found only within four MPAs (three in the South West), the protection of this species is linked to the distribution of its basal species e.g. *Zostera*[10].
Leptopsammia pruvoti	2	32	The sunset cup coral is restricted to five known locations andis only found in two MPAs nationally, but occurrences would allow greater replication in the South West.
Lithothamnion corallioides	1	32	This southerly occurring maerl is only recorded in two MPAs nationally, but occurrences would allow greater replication in the South West. May be protected as habitat.
Palinurus elephas	4	39	The European spiny lobsters are only found four MPAs nationally but occurrences would allow greater replication in the South West.
Padina pavonica	3	6	This southerly species is only found three MPAs nationally, but occurrences would allow greater replication in the South West. Meets target of 20% of occurrences represented nationally
Phymatolithon calcareum	1	61	This species is only found one MPA nationally, but occurrences would allow greater replication in the SW. May be protected as habitat.
Raja undulata	0	16	This southerly species is only found three MPAs nationally, but occurrences would allow greater replication in the South West SW

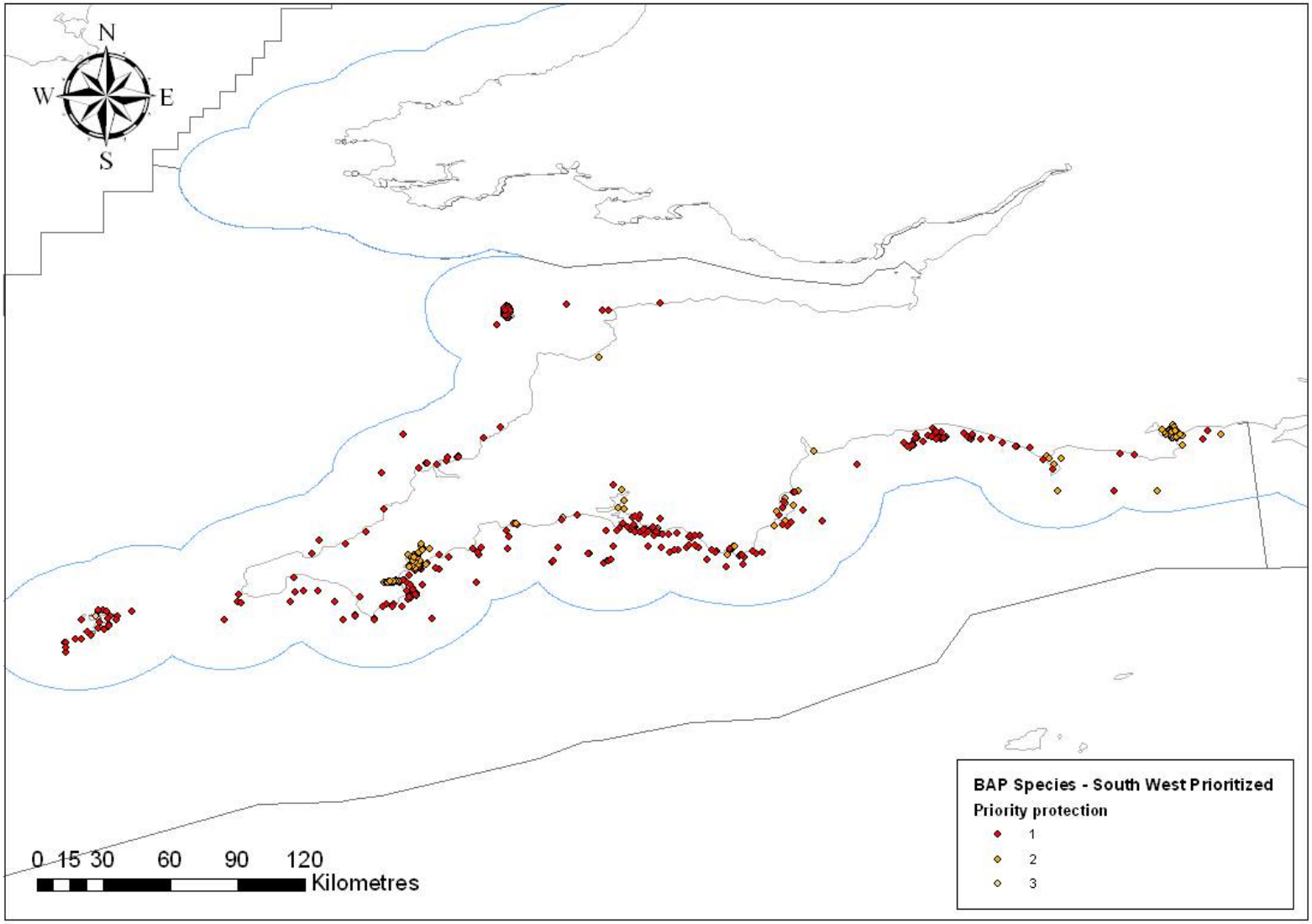
Regional: South West England

4.12 The South West represents an area that is both species rich (due to the higher numbers of southerly species at the limits of their northern distributions) but also data rich in terms of marine species and habitat information stored at a national level (Figure 15). Of the 104 species examined for the South West project region, five species are already replicated in five or more different MPAs. Those species are OSPAR threatened species *Nucella lapillus*, BAP species *Ostrea edulis*, the cNIMF species *Anguilla anguilla*, *Sabellaria alveolata* and *Caryophyllia smithii*. Forty six species do not meet the specified targets of five replicates within the region but this is due to limited records of these species. Of these, 27 species do have 20% of known occurrences within MPAs. More importantly there are 28 species that are recorded for the South West but are not found in any of the MPAs (see Table 10) and there are an additional 78 species that are found within the South West but not in any other regions of England. Fifty one of these are cNIMF and many are species that are at the limit of their distributions. Also, an important gap in current protection is those species which are found in less than five protected locations, despite known records allowing this (53 species in total).

[10] See recommendation point 8

Table 10 Species occurring in the South West project study region but not recorded in the current network of MPAs for this region

Species
BAP
Hippocampus hippocampus
Raja undulate
Squalus acanthias
Phoca vitulina
Anotrichium barbatum
Atrina fragilis
Candidate NIMF
Adreus fascicularis
Alosa fallax
Amathia pruvoti
Phoca vitulina
Atrina fragilis
Anotrichium barbatum
Antedon petasus
Hippocampus hippocampus
Desmacidon fruticosum
Asperococcus scaber
Cucumaria frondosa
Dysidea pallescens
Endectyon delaubenfelsi
Gammarus chevreuxi
Gammarus insensibilis
Glossus humanus
Leptoclinides faeroensis
Leuconia gossei
Onchidella celtica
Paracentrotus lividus
Paraphellia expansa
Parazoanthus anguicomus
Pyura microcosmus
Sternaspis scutata
Thyasira gouldi
OSPAR
Hippocampus hippocampus



(OSPAR and cNIMF species maps can be seen in Appendix 2).

Figure 15 BAP species occurrences and their priority for protection based on their representation in the current network of MPAs within the South West project region

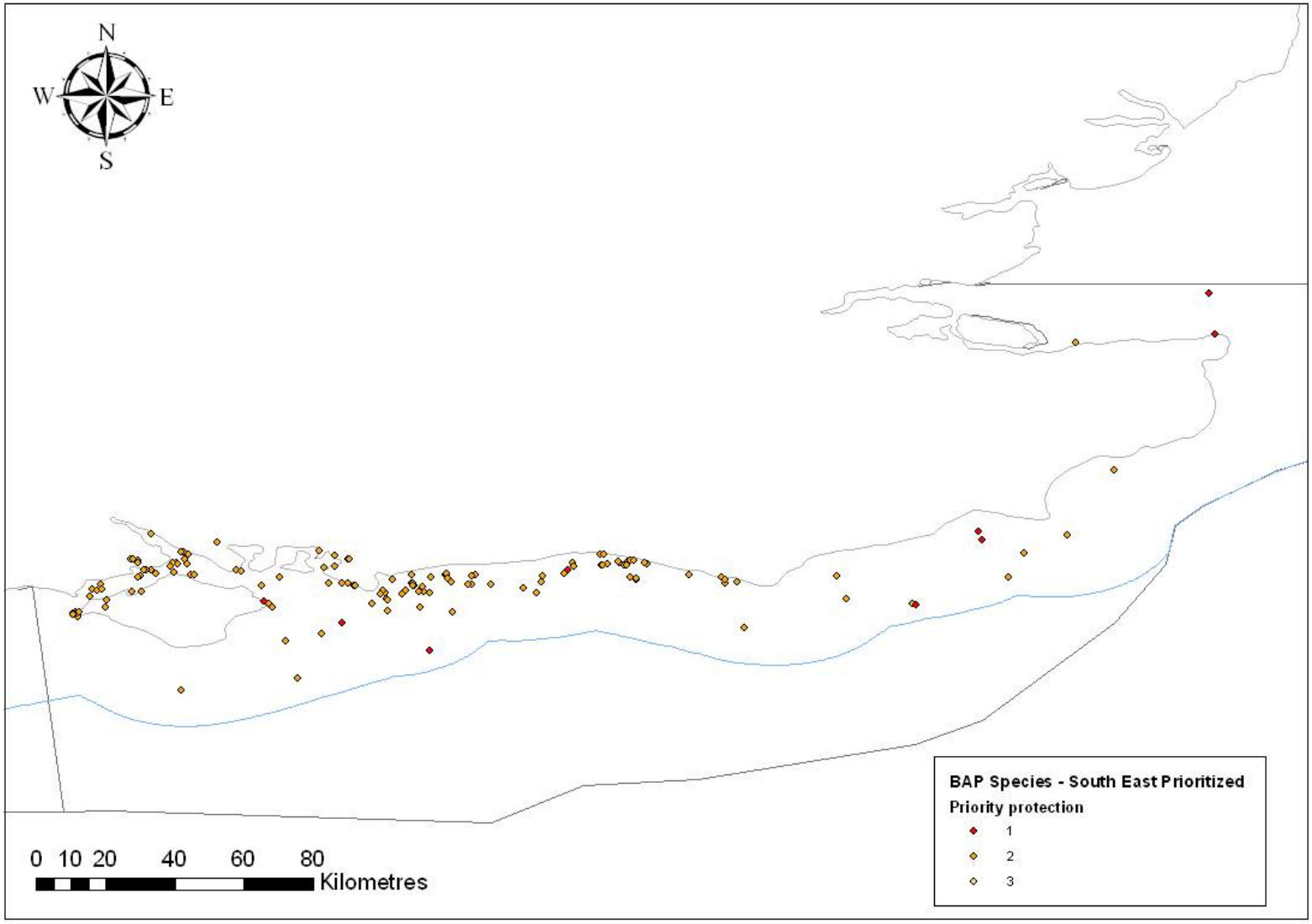
Regional: South East England

4.13 In the South East, fewer priority species are recorded (40 species from the BAP, OSPAR and cNIMF lists, see BAP Species in Figure 16). Of these species only one species (OSPAR threatened species *Nucella lapillus*) is already replicated in five different MPAs. Twenty nine species do not meet the specified targets of five replicates within the region but this is due to limited records of the species. Of these, 14 species do have 20% of known occurrences within MPAs (including the BAP species *Lucernariopsis campanulata*, *Lucernariopsis cruxmelitensis*, *Microcosmus claudicans* and *Padina pavonica*). More importantly there are 20 species that are recorded for the South East but are not found in any of the MPAs (see Table 11) and there are an additional eight species that are found within the South East but not in any other regions of England (OSPAR species *Alosa alosa* and candidate NIMF Species *Dasya punicea*, *Epistomia bursaria*, *Leptochiton scabridus* , *Microcosmus claudicans*, *Smittina affinis*, *Spongionella pulchella* and BAP species *Lucernariopsis cruxmelitensis*).

4.14 Also an important gap in current protection are those species which are found in less than five protected locations, despite known records allowing this (BAP species *Ostrea edulis* and *Raja undulate*; cNIMF species *Anguilla anguilla*, *Barnea candida*, *Epistomia bursaria*, *Leptocheirus hirsutimanus*, *Leptocheirus pectinatus, Sabellaria alveolata* and *Tritaeta gibbosa*; and the OSPAR species *Raja montagui*).

Regional: North West England

4.15 In the North West, 18 species from the BAP, OSPAR and cNIMF lists were examined (based on the recorded occurrences on the NBN Marine Recorder database). None of these species met the target of being present in five different MPAs. Six species are known in enough occurrences to allow five replicates (cNIMF species *Actinauge richardi, Sabellaria alveolata* and *Strongylocentrotus droebachiensis* and OSPAR species *Arctica islandica, Nucella lapillus* and *Raja montagui*). The remaining 12 species did not meet the specified target due to limited records of the species. Out of these, eight species do have 20% of known occurrences found within MPAs. The cNIMF species *Gobius gasteveni, Laomedea angulata, Parvipalpus capillaceus* and *Tritaeta gibbosa*) did not meet this 20% target. Importantly there are five species that are recorded for the North West but are not found in any of the MPAs (see Table 12). One of which, *Gobius gasteveni* is recorded for the North West but no other regions of England. The lower priorities for protection in this region (see Figure 17) may be an artefact of the lower number of species records for this region, which may not be a true representation of the species present.



(OSPAR and cNIMF species maps can be seen in Appendix 4).

Figure 16 BAP species occurrences and their priority for protection based on their representation in the current network of MPAs within the South East project region

Table 11 Species occurring in the South East project study region but not recorded in the current network of MPAs for this region

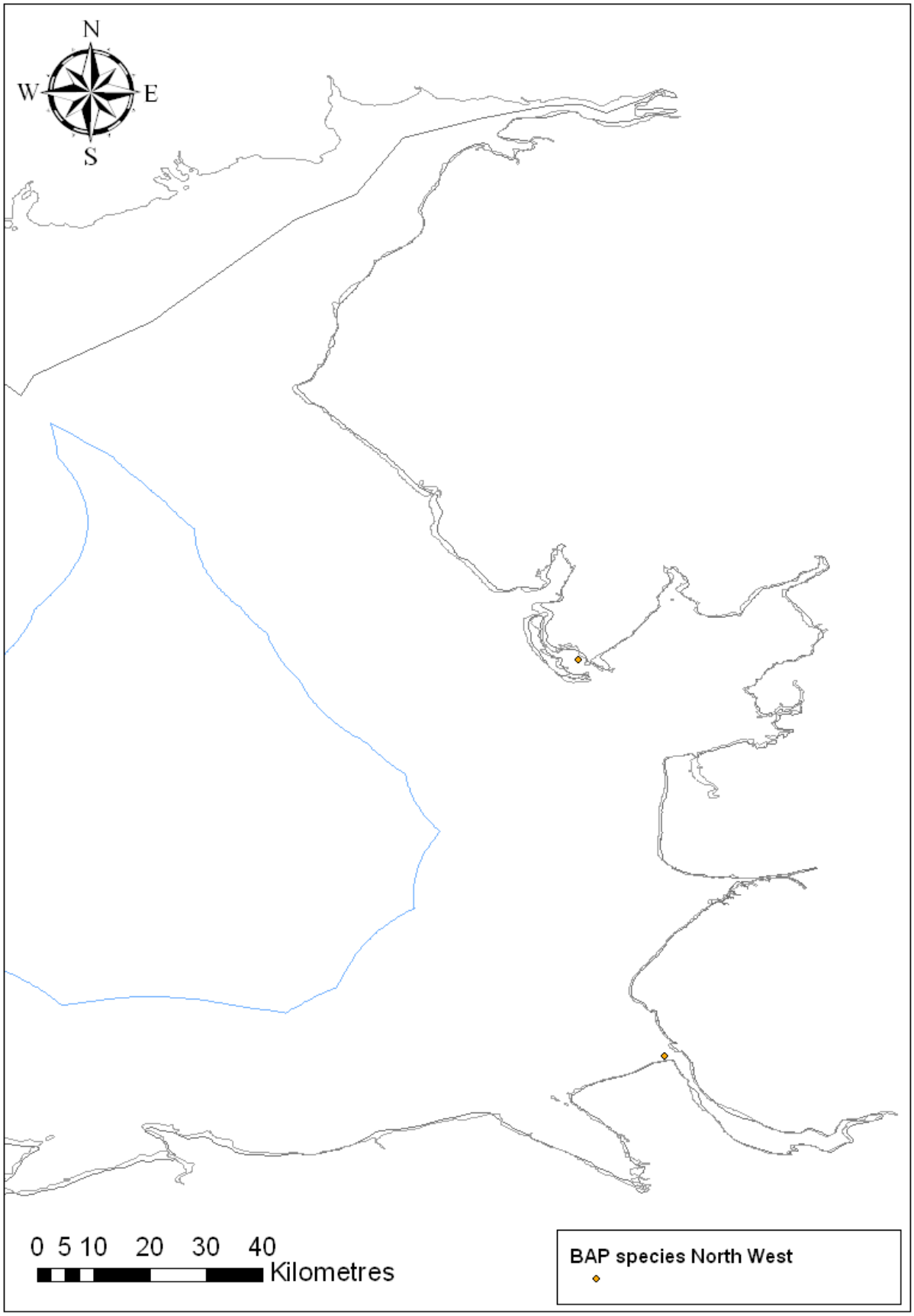
Species
BAP
Raja undulate
Haliclystus auricular
candidate NIMF
Alosa fallax
Apletodon dentatus
Anguilla anguilla
*Dasya punicea**
Diazona violacea
Haliclystus auricula
Leptocheirus hirsutimanus
Leptocheirus pectinatus
*Leptochiton scabridus **
Leptoclinides faeroensis
Leucothoe procera
Parametaphoxus fultoni
Parvipalpus capillaceus
Schizobrachiella sanguinea
*Smittina affinis**
*Spongionella pulchella**
OSPAR
Raja montagui
*Alosa alosa**
Arctica islandica

(* indicates species not recorded in other study regions)

Table 12 Species occurring in the North West project study region but not recorded in the current network of MPAs for this region

Species
candidate NIMF
*Gobius gasteveni**
Laomedea angulata
Parvipalpus capillaceus
Tritaeta gibbosa
OSPAR
Raja montagui

(* indicates species not recorded in other study regions)



(OSPAR and cNIMF species maps can be seen in Appendix 4).

Figure 17 BAP species occurrences and their priority for protection based on their representation in the current network of MPAs within the North West project region

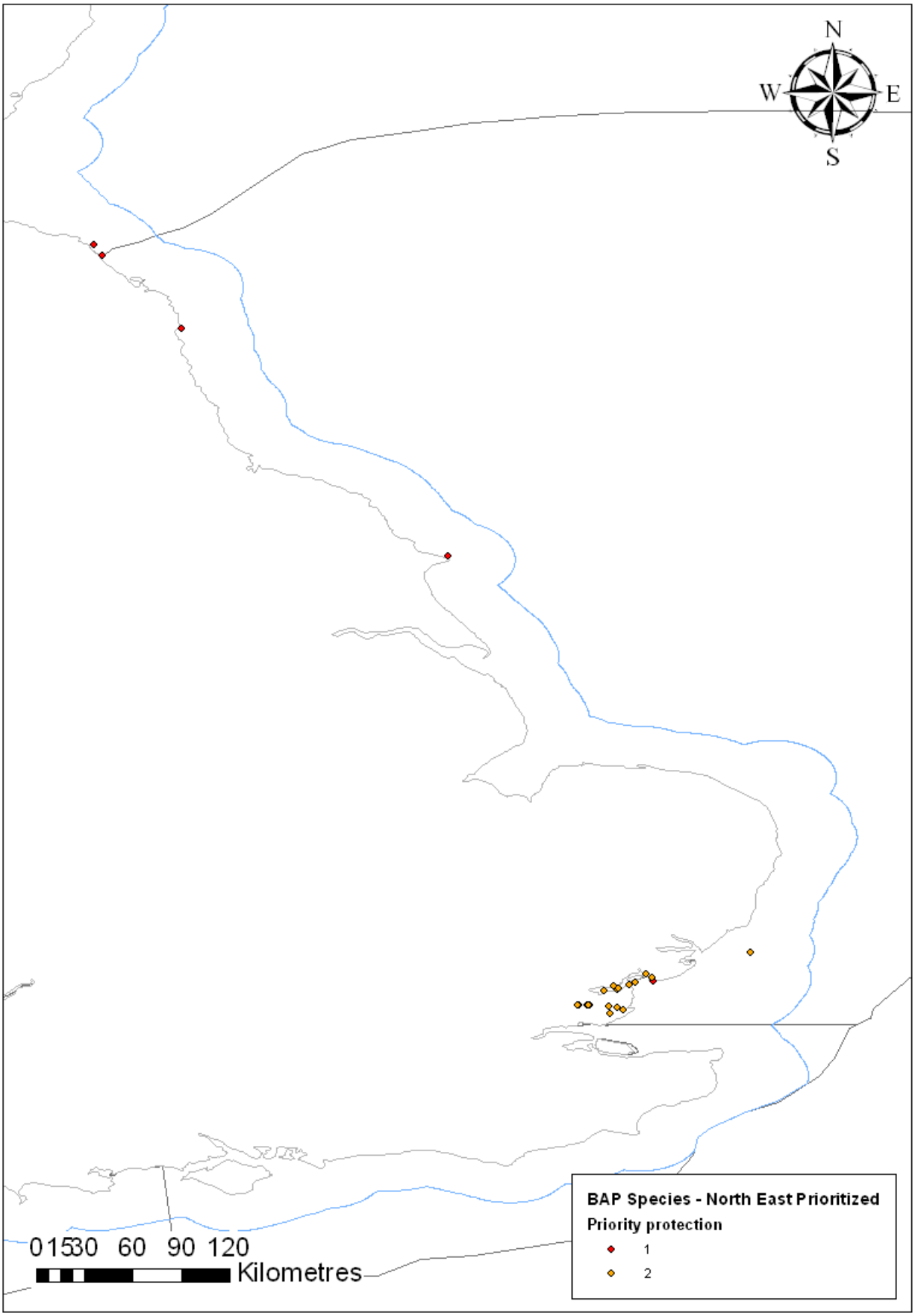
Regional: North East England

4.16 Finally, in the North East, 32 species from the BAP, OSPAR and cNIMF lists were examined (based on the recorded occurrences on the NBN Marine Recorder database). None of these species met the target of being present in five different MPAs. Thirteen species are known in enough occurrences to allow five replicates (cNIMF species *Alkmaria romijni*, *Anguilla anguilla, Baldia johnstoni, Barnea candida, Caryophyllia smithii, Diphasia nigra, Halichoerus grypus, Leptocheirus hirsutimanus* and *Tritaeta gibbosa;* BAP species *Ostrea edulis* and as in the North West region, OSPAR species *Arctica islandica, Nucella lapillus* and *Raja montagui*). Of those species that did not meet the specified target due to limited records, 12 species do have 20% of known occurrences found within MPAs. The cNIMF species *Corophium affine*, *Laomedea angulata*, *Leptocheirus pectinatus*, *Parvipalpus capillaceus*, *Phallusia mammillata* and *Psolus phantapus;* did not meet this 20% target. Importantly there are eight species that are recorded for the North East but are not found in any of the MPAs (see Table 13). Five cNIMF species do not meet the targets for protection and are only recorded for the North East region. They are *Baldia johnstoni, Corophium affine, Diphasia nigra, Nematostella vectensis* and *Ocnus planci*. The priorities for protection in this region for known occurrences of BAP species are shown in Figure 18 (those for cNIMF and OSPAR can be found in Appendix 4).

Table 13 Species occurring in the North East project study region but not recorded in the current network of MPAs for this region

Species
candidate NIMF
*Baldia johnstoni**
*Corophium affine**
Laomedea angulata
Leptocheirus pectinatus
Parvipalpus capillaceus
Phallusia mammillata
Psolus phantapus
OSPAR
Raja montagui

(* indicates species not recorded in other study regions)



(OSPAR and cNIMF species maps can be seen in Appendix 4)

Figure 18 BAP species occurrences and their priority for protection based on their representation in the current network of MPAs within the North East project region

Habitats

Priority Habitats English Territorial Waters

4.17 The map in Figure 19 illustrates the locations of cNIMF habitats (known distributions according to national datasets) within English territorial waters as a whole and their proposed priority for protection based on their representation in the current network of MPAs (English and regional maps for OSPAR, BAP and Annex I Habitats can be found in Appendix 4). Of all the habitats examined none met the target of being replicated in more than five MPAs in each study region.

4.18 Two cNIMF habitats were identified as a priority for protection because they are currently not recorded for any MPAs but do occur in English territorial waters. They were the biotopes:

- Sparse *Modiolus modiolus*, dense *Cerianthus lloydii* and burrowing holothurians on sheltered circalittoral stones and mixed sediment; and
- *Spisula subtruncata* and *Nephtys hombergii* in shallow muddy sand.

4.19 Nineteen habitats were recorded from less than five MPAs at a national level (see Table 14), although for seven their actual occurrence was a valid limiting factor (including cNIMF habitats 'Burrowing megafauna and Maxmuelleria lankesteri in circalittoral mud', 'Ceramium sp. and piddocks on eulittoral fossilised peat' and 'Ostrea edulis beds on shallow sublittoral muddy mixed sediment'; BAP Habitats 'Saline lagoons' and 'Horse mussel (Modiolus modiolus) beds'; OSPAR habitat 'Ostrea edulis beds' and the Annex I habitat 'Coastal lagoons'. For all these habitats the percentage of occurrences that were in MPAs was >20% of their known occurrences. Of greater importance in terms of gaps in current protection, are the 12 habitats which were replicated in less than five MPAs nationally, despite known records allowing greater replication (see those habitats without '*' in Table 14). Three of these habitats were BAP and two were OSPAR listed habitats.

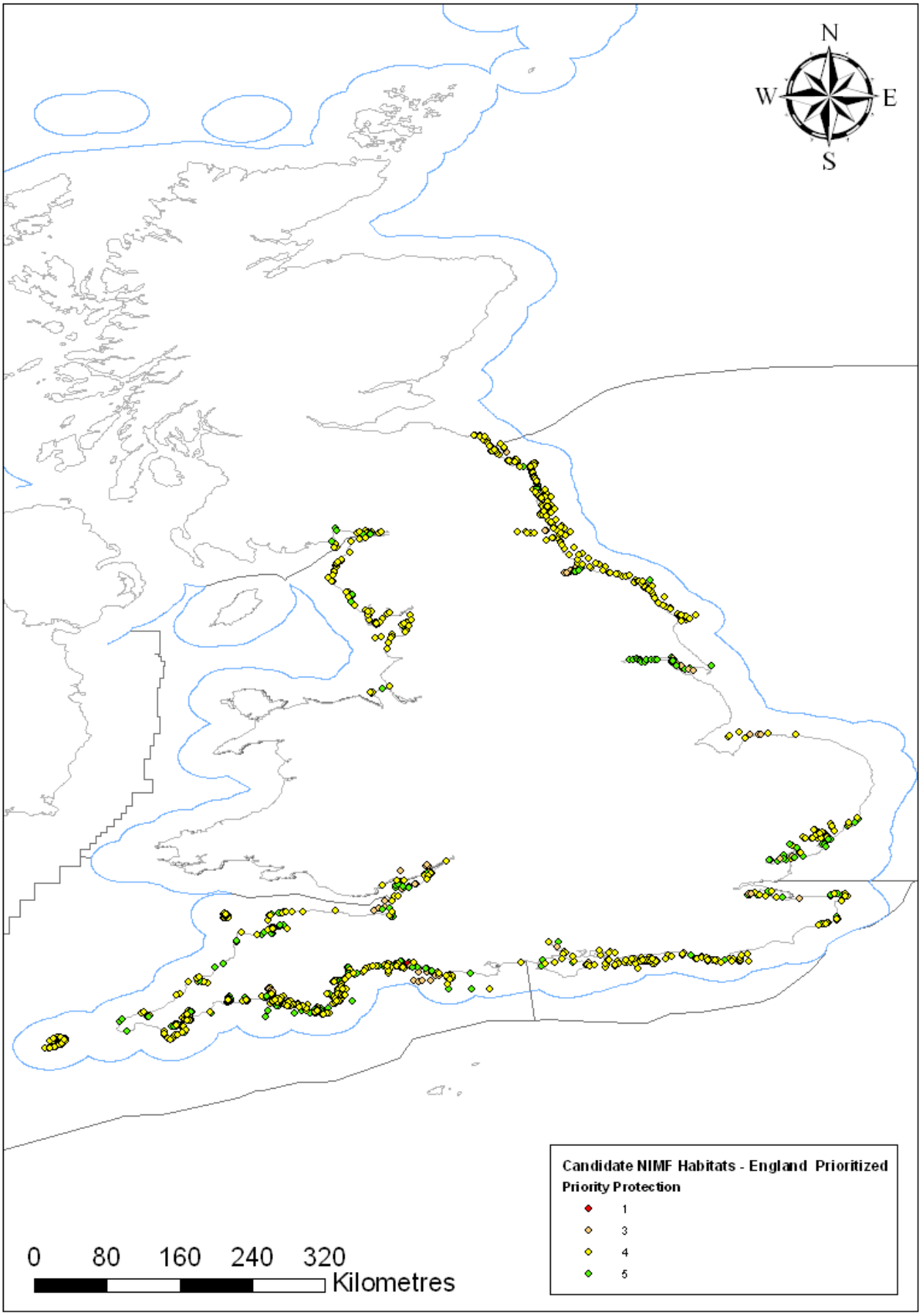


Figure 19 Locations of candidate NIMF habitats (known distributions according to national datasets) within English territorial waters as a whole and their proposed priority for protection based on their representation in the current network of MPAs

Table 14 Habitats recorded in less than five MPAs at a national level

Habitat
candidate NIMF
Burrowing megafauna and *Maxmuelleria lankesteri* in circalittoral mud*
Capitella capitata and *Tubificoides* spp. in reduced salinity infralittoral muddy sediment
Ceramium sp. and piddocks on eulittoral fossilised peat*
Eunicella verrucosa and *Pentapora foliacea* on wave-exposed circalittoral bedrock
Faunal communities on variable or reduced salinity infralittoral rock
Mediomastus fragilis, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or grave
Mytilus edulis and piddocks in eulittoral firm clay
Neopentadactyla mixta in circalittoral shell gravel or coarse sand
Oligochaetes in variable or reduced salinity infralittoral muddy sediment
Sea-pens and burrowing megafauna in circalittoral fine mud
Ostrea edulis beds on shallow sublittoral muddy mixed sediment *
BAP
Fragile sponge & anthozoan communities on subtidal rocky habitats
Horse mussel (*Modiolus modiolus*) beds *
Maerl beds
Saline lagoons*
Mud habitats in deep water
OSPAR
Horse mussel (*Modiolus modiolus*) beds *
Maerl beds
Ostrea edulis beds*
Sea-pen and burrowing megafauna communities
Annex I
Coastal lagoons *

(*replicates limited by recorded occurrence but > 20% of total occurrences are in MPAs)

Priority Habitats South West Region

4.20 An assessment of habitats in MPAs in the South West showed that of the 66 recorded listed habitats approximately one third (23) were found in at least five different MPAs. The habitats listed in Table 15 are habitats that are replicated in less than five MPAs in the SW, despite known records allowing greater replication. One cNIMF habitat, '*Spisula subtruncata* and *Nephtys hombergii* in shallow muddy sand' was not protected at all in the SW and was only recorded in this region. Another, '*Ceramium* sp. and piddocks on eulittoral fossilised peat' was not found in protected areas in the region and protected in less than five locations nationally with no valid reason. The cNIMF habitat '*Capitella capitata* and *Tubificoides* spp. in reduced salinity infralittoral muddy sediment' was recorded but not found in protected areas in the region, this habitat occurs in less than five MPA locations nationally but with valid reason (i.e. limited distribution). All are high priorities for future protection.

4.21 Of those habitats where known records limited their replication within the South West (17 habitats) eight did not meet the target of having 20% of their total occurrence represented (including the BAP habitat 'Horse mussel (*Modiolus modiolus*) beds').

Table 15 Habitats replicated in less than five MPAs in the SW, despite known records allowing greater replication

Habitat
BAP
Coastal saltmarsh
Fragile sponge & anthozoan communities on subtidal rocky habitats
Intertidal chalk
Mud habitats in deep water
Peat and clay exposures
Sabellaria alveolata reefs
Sabellaria spinulosa reefs
Maerl beds
Subtidal chalk
candidate NIMF
Alaria esculenta on exposed sublittoral fringe bedrock
Ascophyllum nodosum & *Fucus vesiculosus* on variable salinity mid eulittoral rock
Bryozoan turf and erect sponges on tide-swept circalittoral rock
Cerianthus lloydii and other burrowing anemones in circalittoral muddy mixed sediment
Cirratulids and *Cerastoderma edule* in littoral mixed sediment
Eunicella verrucosa and *Pentapora foliacea* on wave-exposed circalittoral bedrock
Faunal communities on variable or reduced salinity infralittoral rock
Fucus serratus and under-boulder fauna on exposed to moderately exposed lower eulittoral boulders
Fucus vesiculosus on variable salinity mid eulittoral boulders & stable mixed substrata
Laminaria digitata and under-boulder fauna on sublittoral fringe boulders
Littoral caves & overhangs
Mediomastus fragilis, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel
Melinna palmata with *Magelona* spp. and *Thyasira* spp. in infralittoral sandy mud
Moerella spp. with venerid bivalves in infralittoral gravelly sand
Neopentadactyla mixta in circalittoral shell gravel or coarse sand
Oligochaetes in variable or reduced salinity infralittoral muddy sediment
Seapens and burrowing megafauna in circalittoral fine mud
Sponges, cup corals and anthozoans on shaded or overhanging circalittoral rock
Underboulder communities
OSPAR
Littoral chalk communities
Maerl beds
Sea-pen and burrowing megafauna communities

Priority Habitats South East Region

4.22 Of the 70 habitats examined, 45 are recorded for the South East region. The BAP habitat 'Mud habitats in deep water' occurs but is not protected in this region. This habitat is found in less than five MPAs at a national level and is therefore a priority for protection in the South East. 16 habitats are found in the region but not within MPAs (see Table 16). A further 20 habitats in the South East do not meet the target of five replicates in different MPAs despite known records allowing greater replication, although four of these do meet the target of 20% of occurrences being represented in MPAs, 16 do not (including Annex I Habitats 'Estuaries' and 'Submerged or partially submerged sea caves'; and OSPAR habitats '*Modiolus modiolus* beds', '*Ostrea edulis* beds' and 'Sea-pen and burrowing megafauna communities').

Table 16 Habitats which occur in the South East but not within MPAs

Habitat
BAP
Blue mussel beds
Estuarine rocky habitats
Mud habitats in deep water
candidate NIMF
Ascophyllum nodosum & *Fucus vesiculosus* on variable salinity mid eulittoral rock
Burrowing megafauna and *Maxmuelleria lankesteri* in circalittoral mud
Cerianthus lloydii and other burrowing anemones in circalittoral muddy mixed sediment
Faunal communities on variable or reduced salinity infralittoral rock
Fucus ceranoides on reduced salinity eulittoral rock
Fucus vesiculosus on variable salinity mid eulittoral boulders & stable mixed substrata
Mussel and/or barnacle communities
Mytilus edulis and piddocks in eulittoral firm clay
Oligochaetes in variable or reduced salinity infralittoral muddy sediment
Polydora ciliata and *Corophium volutator* in variable salinity infralittoral firm mud or clay
Seaweeds in sediment-floored eulittoral rockpools
OSPAR
Sea-pen and burrowing megafauna communities
Intertidal *Mytilus edulis* beds on mixed and sandy sediments

Priority Habitats North East Region

4.23 In the North East project study region, 18 of the 70 habitats examined did not occur in the region. For those that did, only five were not found in any MPAs (see Table 17) and one, the cNIMF habitat 'sparse *Modiolus modiolus*, dense *Cerianthus lloydii* and burrowing holothurians on sheltered circalittoral stones and mixed sediment' is only recorded for this region, making it a priority for representation in future MPAs.

4.24 Importantly there were 31 habitats replicated in less than five MPAs in the North East region, despite known records allowing greater replication (see Table 18). Of those with limited distribution in the region preventing the target replication numbers being met, all met the target of 20% of total occurrences.

Table 17 Habitats which occur in the North East but not within any MPAs

Habitat
BAP
Mud habitats in deep water
candidate NIMF
Mediomastus fragilis, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel
Melinna palmata with *Magelona* spp. and *Thyasira* spp. in infralittoral sandy mud
Oligochaetes in variable or reduced salinity infralittoral muddy sediment
Sparse *Modiolus modiolus*, dense *Cerianthus lloydii* and burrowing holothurians on sheltered circalittoral stones and mixed sediment

Table 18 Habitats replicated in less than five MPAs in the North East, despite known records allowing greater replication

Habitat
Annex I Habitat
Sandbanks which are slightly covered by sea water all the time
Submerged or partially submerged sea caves
BAP
Coastal saltmarsh
Intertidal boulder communities
Intertidal chalk
Peat and clay exposures
Sabellaria spinulosa reefs
Seagrass (*Zostera*) beds
Sheltered muddy gravels
Subtidal chalk
candidate NIMF
Alaria esculenta on exposed sublittoral fringe bedrock
Ascophyllum nodosum on very sheltered mid eulittoral rock
Capitella capitata and *Tubificoides* spp. in reduced salinity infralittoral muddy sediment
Capitella capitata in enriched sublittoral muddy sediments
Circalittoral mixed sediment
Cirratulids and *Cerastoderma edule* in littoral mixed sediment
Coralline crust-dominated shallow eulittoral rockpools
Fucoids and kelp in deep eulittoral rockpools
Fucus ceranoides on reduced salinity eulittoral rock
Fucus serratus and under-boulder fauna on exposed to moderately exposed lower eulittoral boulders
Fucus serratus with sponges, ascidians and red seaweeds on tideswept lower eulittoral mixed substrata
Fucus vesiculosus on variable salinity mid eulittoral boulders & stable mixed substrata

Table continued...

Habitat
Laminaria digitata and under-boulder fauna on sublittoral fringe boulders
Littoral caves & overhangs
Mussel and/or barnacle communities
Mytilus edulis and *Fucus vesiculosus* on moderately exposed mid eulittoral rock
Neomysis integer and *Gammarus* spp. in variable salinity infralittoral mobile sand
Polydora ciliata and *Corophium volutator* in variable salinity infralittoral firm mud or clay
Seaweeds in sediment-floored eulittoral rockpools
Underboulder communities
OSPAR
Littoral chalk communities

Priority Habitats North West Region

4.25 Finally, in the North West region, six habitats had recorded locations in the region but did not occur within any of the MPAs (Table 19). Due to the low numbers of MPAs in this region, no habitat met the target of having five replicated MPA locations, although of these, seven habitats were of limited occurrences but had at least 20% of their occurrences within MPAs. However, 24 habitats are replicated in less than five MPAs in the North West, despite known records allowing greater replication (Table 20).

Table 19 Habitats which occur in the North West but not within any MPAs

Habitat
BAP
Peat and clay exposures
Sabellaria spinulosa reefs
candidate NIMF
Cerianthus lloydii and other burrowing anemones in circalittoral muddy mixed sediment
Fucoids and kelp in deep eulittoral rockpools
Mytilus edulis and piddocks in eulittoral firm clay
Seaweeds in sediment-floored eulittoral rockpools

4.26 The cNIMF habitat '*Mytilus edulis* and piddocks in eulittoral firm clay' is recorded but not protected in the North West. This habitat is protected in less than five locations nationally despite being known from six locations around the UK.

Table 20 Habitats replicated in less than five MPAs in the North West, despite known records allowing greater replication

Habitat
Annex I
Estuaries
Large shallow inlets and bays
Mudflats and sandflats not covered by seawater at low tide
Reefs
Sandbanks which are slightly covered by sea water all the time
BAP
Blue mussel beds
Coastal saltmarsh
Estuarine rocky habitats
Intertidal boulder communities
Sabellaria alveolata reefs
Sheltered muddy gravels
Subtidal sands and gravels
Tide-swept channels
Intertidal mudflats
Ascophyllum nodosum on very sheltered mid eulittoral rock
Circalittoral mixed sediment
Fucus ceranoides on reduced salinity eulittoral rock
Fucus vesiculosus on variable salinity mid eulittoral boulders & stable mixed substrata
Laminaria digitata and under-boulder fauna on sublittoral fringe boulders
Littoral mixed sediments
Mussel and/or barnacle communities
Mytilus edulis and *Fucus vesiculosus* on moderately exposed mid eulittoral rock
Underboulder communities
OSPAR
Intertidal mudflats
Intertidal *Mytilus edulis* beds on mixed and sandy sediments

EUNIS Habitats (Level 4): English Territorial Waters

4.27 The map in Figure 20 illustrates the locations of EUNIS habitats (known distributions according to national datasets) within English territorial waters as a whole and their proposed priority for protection based on their representation in the current network of MPAs. Of all the habitats examined none met the target of replication in MPAs for all study regions.

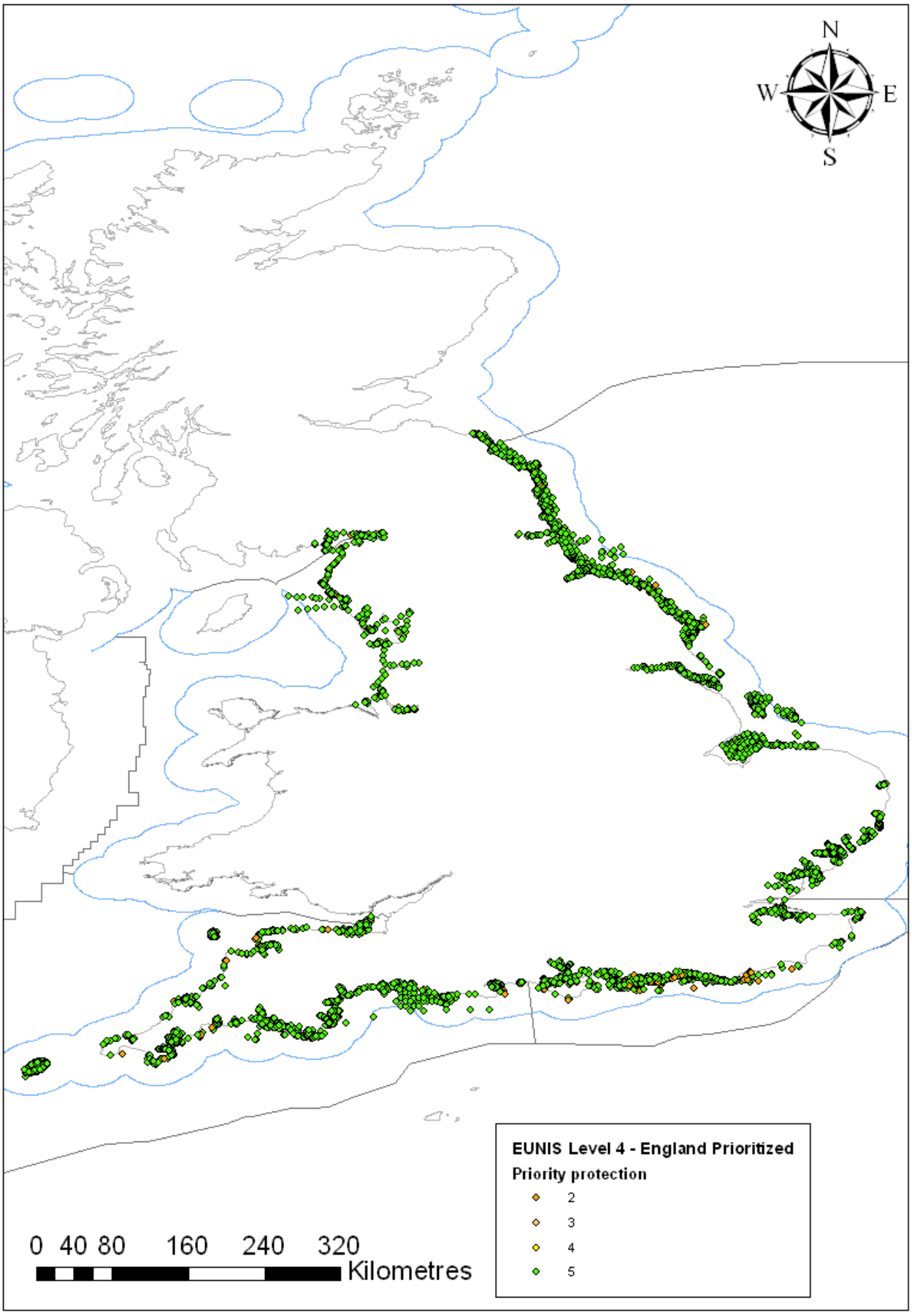


Figure 20 The locations of EUNIS habitats (known distributions according to national datasets) within English territorial waters as a whole and their proposed priority for protection based on their representation in the current network of MPAs

4.28 The EUNIS habitat 'Brachiopod and ascidian communities on circalittoral rock' (code A4.31) was identified as a priority for protection because it is currently not recorded for any English MPAs but has been recorded in English territorial waters (one record for the South West region).

4.29 Seventeen habitats were recorded for less than five MPAs at a national level (see Table 21), although for two (A5.31- 'Sublittoral mud in low or reduced salinity lagoons' and A5.41- 'Sublittoral mixed sediment in low or reduced salinity lagoons') their actual recorded occurrence was a valid limiting factor. For the latter (A5.41) the percentage of occurrences that were in MPAs was >10% (20% for those associated with OSPAR, Habitats Directive, BAPS and cNIMFs) of their known occurrences).

Table 21 Habitats replicated in less than five MPAs at a national level

EUNIS level 4 habitat code	EUNIS name
A2.71	Littoral [*Sabellaria*] reefs
A3.22	Kelp and seaweed communities in tide-swept sheltered conditions
A3.32	Kelp in variable salinity on low energy infralittoral rock
A3.36	Faunal communities on variable or reduced salinity infralittoral rock
A3.72	Infralittoral fouling seaweed communities
A4.11	Very tide-swept faunal communities on circalittoral rock
A4.22	[*Sabellaria*] reefs on circalittoral rock
A4.24	Mussel beds on circalittoral rock
A4.25	Circalittoral faunal communities in variable salinity
A4.71	Communities of circalittoral caves and overhangs
A4.72	Circalittoral fouling faunal communities
A5.25	Circalittoral fine sand
A5.31	Sublittoral mud in low or reduced salinity (lagoons)
A5.36	Circalittoral fine mud
A5.41	Sublittoral mixed sediment in low or reduced salinity (lagoons)
A5.51	Maerl beds
A5.62	Sublittoral mussel beds on sediment

EUNIS Habitats (Level 4): South West region

4.30 An assessment of all EUNIS level 4 habitats found in the South West (and those currently within MPAs) showed that of the 66 recorded listed habitats approximately one half (33) were found in at least five (three for those habitats that were not cNIMF, BAP, OSPAR or Habitats Directive) different MPAs.

4.31 The habitats listed in Table 22 are habitats that are replicated in less than five MPAs in the South West, despite known records allowing greater replication. 'Sublittoral mussel beds on sediment' (A5.62) are not found in protected areas in the region. This habitat is found in other regions but is protected in less than five locations nationally due to limits in its occurrence. 'Sublittoral polychaete worm reefs on sediment' (A5.61) are again not found in protected areas in region, although this habitat is found in other regions and in at least five locations nationally. Twenty three of the habitats shown in Table 22 do not meet the target of representation of 20% of the regional occurrence of the habitat.

Table 22 Habitats that are replicated in less than five MPAs in the South West, despite recorded occurrences allowing greater replication

EUNIS level 4 habitat code	EUNIS name
A1.15	Fucoids in tide-swept conditions
A1.22	[*Mytilus edulis*] and fucoids on moderately exposed shores
A1.45	Ephemeral green or red seaweeds (freshwater or sand-influenced) on non-mobile substrata
A2.11	Shingle (pebble) and gravel shores*
A2.21	Strandline*
A2.22	Barren or amphipod-dominated mobile sand shores
A2.43	Species-poor mixed sediment shores
A2.61	Seagrass beds on littoral sediments*
A2.71	Littoral [*Sabellaria*] reefs
A2.82	Ephemeral green or red seaweeds (freshwater or sand-influenced) on mobile substrata*
A3.22	Kelp and seaweed communities in tide-swept sheltered conditions
A3.32	Kelp in variable salinity on low energy infralittoral rock*
A3.36	Faunal communities on variable or reduced salinity infralittoral rock
A3.71	Robust faunal cushions and crusts in surge gullies and caves
A3.72	Infralittoral fouling seaweed communities*
A4.21	Echinoderms and crustose communities on circalittoral rock
A4.23	Communities on soft circalittoral rock
A4.24	Mussel beds on circalittoral rock
A4.25	Circalittoral faunal communities in variable salinity
A4.71	Communities of circalittoral caves and overhangs*
A4.72	Circalittoral fouling faunal communities
A5.22	Sublittoral sand in variable salinity (estuaries)*
A5.25	Circalittoral fine sand
A5.26	Circalittoral muddy sand
A5.31	Sublittoral mud in low or reduced salinity (lagoons)
A5.33	Infralittoral sandy mud
A5.34	Infralittoral fine mud
A5.35	Circalittoral sandy mud*
A5.36	Circalittoral fine mud
A5.41	Sublittoral mixed sediment in low or reduced salinity (lagoons)*
A5.51	Maerl beds
A5.61	Sublittoral polychaete worm reefs on sediment
A5.62	Sublittoral mussel beds on sediment

* Habitats with greater than 20% of recorded occurrences in MPAs at Regional level

EUNIS Habitats (Level 4): South East region

4.32 An assessment of all EUNIS level 4 habitats found in the South East region (and those currently within MPAs) showed that of the 55 recorded listed habitats only one habitat, 'Kelp and red seaweeds (moderate energy infralittoral rock)' (A3.21), was found in at least five different MPAs. The habitats listed in Table 23 are habitats that are replicated in less than five MPAs in the South East, despite known records allowing greater replication. All but one of these habitats does not meet the target of representation of 20% of the regional occurrence of the habitat.

Table 23 Habitats that are replicated in less than five MPAs in the South East, despite recorded occurrences allowing greater replication

EUNIS level 4 habitat code	EUNIS name
A1.15	Fucoids in tide-swept conditions
A1.22	[*Mytilus edulis*] and fucoids on moderately exposed shores
A1.45	Ephemeral green or red seaweeds (freshwater or sand-influenced) on non-mobile substrata
A2.11	Shingle (pebble) and gravel shores*
A1.12	Robust fucoid and/or red seaweed communities
A1.21	Barnacles and fucoids on moderately exposed shores
A1.22	[*Mytilus edulis*] and fucoids on moderately exposed shores
A1.31	Fucoids on sheltered marine shores
A1.41	Communities of littoral rockpools
A1.44	Communities of littoral caves and overhangs
A1.45	Ephemeral green or red seaweeds (freshwater or sand-influenced) on non-mobile substrata
A2.11	Shingle (pebble) and gravel shores
A2.23*	Polychaete/amphipod-dominated fine sand shores*
A2.24	Polychaete/bivalve-dominated muddy sand shores
A2.31	Polychaete/bivalve-dominated mid estuarine mud shores
A2.32	Polychaete/oligochaete-dominated upper estuarine mud shores
A2.41	[*Hediste diversicolor*] dominated gravelly sandy mud shores
A3.12	Sediment-affected or disturbed kelp and seaweed communities
A3.72	Infralittoral fouling seaweed communities
A4.13	Mixed faunal turf communities on circalittoral rock
A4.23	Communities on soft circalittoral rock
A4.72	Circalittoral fouling faunal communities
A5.12	Infralittoral coarse sediment
A5.23	Infralittoral fine sand
A5.24	Infralittoral muddy sand
A5.32	Sublittoral mud in variable salinity (estuaries)

Table continued…

EUNIS level 4 habitat code	EUNIS name
A5.34	Infralittoral fine mud
A5.42	Sublittoral mixed sediment in variable salinity (estuaries)
A5.43	Infralittoral mixed sediments
A5.44	Circalittoral mixed sediments
A5.52	Kelp and seaweed communities on sublittoral sediment
A5.61	Sublittoral polychaete worm reefs on sediment
A5.62	Sublittoral mussel beds on sediment
B3.11	Lichens or small green algae on supralittoral and littoral fringe rock

* Habitats with greater than 20% of recorded occurrences in MPAs at Regional level

4.33 Six habitats are not found in any protected areas in the region, and are either only found in the region or are found in other regions but protected in less than five locations nationally, they are:

- A3.36 Faunal communities on variable or reduced salinity infralittoral rock;
- A4.24 Mussel beds on circalittoral rock;
- A4.25 Circalittoral faunal communities in variable salinity;
- A4.71 Communities of circalittoral caves and overhangs;
- A5.25 Circalittoral fine sand; and
- A5.36 Circalittoral fine mud.

EUNIS Habitats (Level 4): North East region

4.34 Of the 58 EUNIS level 4 habitats recorded in the North East (and those currently within MPAs), 15 were found in at least five (three for those species that were not cNIMF, BAP, OSPAR or Habitats Directive) different MPAs.

4.35 The habitats listed in Table 24 are habitats that are replicated in less than five MPAs in the North East, despite known records allowing greater replication. Eight of the habitats shown in Table 24 do not meet the target of representation of 20% of the regional occurrence of the habitat.

4.36 Five habitats are not found in any protected areas in the region, and are either only found in the region or are found in other regions but protected in less than five locations nationally, making them a priority for protection in this region, they are:

- A2.71 Littoral [Sabellaria] reefs;
- A3.72 Infralittoral fouling seaweed communities;
- A4.72 Circalittoral fouling faunal communities;
- A5.31 Sublittoral mud in low or reduced salinity (lagoons); and
- A5.36 Circalittoral fine mud.

Table 24 Habitats that are replicated in less than five MPAs in the North East, despite recorded occurrences allowing greater replication

EUNIS level 4 habitat code	EUNIS name
A1.11	[Mytilus edulis] and/or barnacle communities
A1.12	Robust fucoid and/or red seaweed communities
A1.15*	Fucoids in tide-swept conditions*
A1.21	Barnacles and fucoids on moderately exposed shores
A1.42	Communities of rockpools in the supralittoral zone
A1.44	Communities of littoral caves and overhangs
A2.41	[Hediste diversicolor] dominated gravelly sandy mud shores
A2.42*	Species-rich mixed sediment shores*
A2.43*	Species-poor mixed sediment shores*
A2.61*	Seagrass beds on littoral sediments*
A2.72	Littoral [Mytilus edulis] beds on sediment
A3.11	Kelp with cushion fauna and/or foliose red seaweeds
A3.12	Sediment-affected or disturbed kelp and seaweed communities
A3.21	Kelp and red seaweeds (moderate energy infralittoral rock)
A3.71*	Robust faunal cushions and crusts in surge gullies and caves*
A4.13	Mixed faunal turf communities on circalittoral rock
A4.21	Echinoderms and crustose communities on circalittoral rock
A4.22*	[Sabellaria] reefs on circalittoral rock*
A4.23	Communities on soft circalittoral rock
A5.12	Infralittoral coarse sediment
A5.13	Circalittoral coarse sediment
A5.22	Sublittoral sand in variable salinity (estuaries)
A5.23	Infralittoral fine sand
A5.24	Infralittoral muddy sand
A5.26	Circalittoral muddy sand
A5.35	Circalittoral sandy mud
A5.42	Sublittoral mixed sediment in variable salinity (estuaries)
A5.43*	Infralittoral mixed sediments*
A5.44	Circalittoral mixed sediments
A5.52*	Kelp and seaweed communities on sublittoral sediment*
A5.61	Sublittoral polychaete worm reefs on sediment
B3.11	Lichens or small green algae on supralittoral and littoral fringe rock

* Habitats with greater than 20% of recorded occurrences in MPAs at Regional level

EUNIS Habitats (Level 4): North West region

4.37 Forty five EUNIS level 4 habitats were recorded in the North West (and those currently within MPAs) but none of these habitats were found in at least five (three for those species that were

not cNIMF, BAP, OSPAR or Habitats Directive) different MPAs. The habitats listed in Table 25 are habitats that are replicated in less than five MPAs in the North West, despite known records allowing greater replication. None of the habitats shown in Table 25 meet the target of representation of 20% of the regional occurrence of the habitat.

4.38 Two habitats ('Mussel beds on circalittoral rock', A4.24 and 'Circalittoral fine mud', A5.36) are not found in any protected areas in the region, and are either only found in the region or are found in other regions but protected in less than five locations nationally, making them a priority for protection.

Table 25 Habitats that are replicated in less than five MPAs in the North West, despite recorded occurrences allowing greater replication

EUNIS level 4 habitat code	EUNIS name
A1.11	[*Mytilus edulis*] and/or barnacle communities
A3.21	Kelp and red seaweeds (moderate energy infralittoral rock)
A4.13	Mixed faunal turf communities on circalittoral rock
A5.22	Sublittoral sand in variable salinity (estuaries)
A5.23	Infralittoral fine sand
A5.24	Infralittoral muddy sand
A5.43	Infralittoral mixed sediments
A5.44	Circalittoral mixed sediments
B3.11	Lichens or small green algae on supralittoral and littoral fringe rock

5 Conclusions and Recommendations

5.1 It is of fundamental importance to the identification of representative locations for biodiversity conservation, that information on the locations of species and habitats are available and organized in a way that is meaningful for biological diversity. Britain and Ireland probably have the greatest density of available biological survey information on which to apply marine natural heritage selection criteria. Nevertheless, there are major gaps in usable information because of:

- Poor/incomplete interpretation and mapping of available information of seabed physical characteristics;
- Application of different classification schemes to seabed mapping; and
- Non-availability of survey data for interpretation and mapping habitats.

5.2 With this in mind we would like to make the following points that, if pursued, could improve prospects for achieving representativity and replication within a network of MPAs.

Point 1. Recommendations on which classification to use

5.3 Biological data is sparse and therefore we initially need to focus on broad scale datasets to help to achieve full representativity where no biological data exist. Using broad scale datasets also captures the variability of habitats at larger scales.

5.4 It was extremely helpful that the MESH team had worked effectively to translate the habitat codes or descriptions given in different sources to the EUNIS classification. However, some descriptors were obviously too coarse or poorly defined so that they could not be translated. UKSeaMap modelled seabed types are too coarse to be useful in assessing inshore areas. The two categories of rock ('photic rock' and 'aphotic rock') are inadequate to describe the variety of reef habitats where wave exposure and tidal current velocity are the major environmental factors to consider after depth and algal cover. Fundamentally, there is a mismatch between the 'predicted seabed' types of UKSeaMap classification and the EUNIS classification, although there are plans to replace the former with the predicted EUNIS types derived by MESH when available.

5.5 Using the EUNIS classification for a coarse level assessment of representativity has significant advantages over the UKSeaMap classification. In terms of achieving representativity the hierarchical classification of EUNIS makes it the preferred choice. Even for the broader scale habitats (seabed landscapes) this classification should be used as it will allow under-represented features (due to possible under recording) at finer scales to be potentially represented by applying a higher level of protection to parent (broader) levels of the classification.

5.6 EUNIS level 4 is the first level of the classification to include some biological information in terms of the habitats and biotopes, and is therefore the minimum level of the classification that should be used to examine biological habitat representativity. For some areas habitat information is available to Level 6 of the EUNIS classification. However, the use of lower levels is a trade off between data availability and biological meaningfulness. It is recommended that habitat information be translated to a standard level 4 of the EUNIS classification for use in decision tools such as Marxan to identify a number of potential locations for MPAs. Data on habitats classified to Levels 5 and 6 where available can then be used to identify good examples for specific site selection.

Point 2. What are applicable targets for representativity?

5.7 In the current exercise we carried out an analysis of gaps in the representation of species and habitats using targets recommended by OSPAR and adapted during the Irish Sea Pilot (see Table 3). However, we recommend that these targets be used as baselines against which each feature is examined and either increased or decreased based on set criteria within each of the study regions. For example habitats which are structural and vulnerable to physical damage should have the target for inclusion within a network of MPAs increased (or at least the proportion within Highly Protected Marine Nature Reserves increased). This recommendation follows OSPAR guidance (OSPAR, 2003b):

"Contracting Parties that are members of the European Union will be familiar with guidance from the European Commission that suggests between 20 and 60% of the national extent or population of an EU Habitats Directive Annex I habitat or Annex II species should be included within a Member State's contribution to Natura 2000, with a proportional response within this range to be taken by Member States according to the rarity of each habitat or species (Habitats Committee, 1997) and bearing in mind the provisions of Article 4 of the Directive for aquatic species."

5.8 For the broad scale, full coverage, landscape classification the current study set targets of 40% representation within the current network of MPAs (which are all coastal). This target was set because where data are coarse with a larger margin of error, areas identified within MPAs would need be large to actually be representative. However in terms of targets for representativity within a new network, where the AoS extends beyond 12nm, 40% representation for these landscapes would not be practical or necessary as long as the individual MPAs included large areas of the landscape and replication was greater. Therefore for landscape representation (for EUNIS level 3 habitats) our recommendation is in line with the OSPAR guideline of 10-20%. However this recommendation comes with the caveat that individual areas are large and replication is greater within each region for these features.

Point 3. How many replicates are appropriate?

5.9 To appropriately assign accurate replication targets, individual assessments of a species' and habitats' actual distribution are required. Due to contractual limits the current exercise used nationally recorded occurrences as a substitute. Currently, online databases do exist against which actual species distributions can be examined individually (MarLIN, Fishbase, Algaebase). We recommend that a full audit of each of the species is carried out to identify whether recorded occurrence based distributions are accurate or biased by data availability. This will also allow identification of species and biotopes that are at the limits of their biogeographical range. Species that are on the limits of their distribution or unique within the study region may also require different targets for replication within the network of MPAs increased.

5.10 The current study used previously recommended targets for replication for large AoS as a basis for identifying gaps in representation and replication (five replicates as standard per project study region). This method was useful in identifying species and habitats with potentially insufficient replication within the current network. However, for selecting sites for a new network of MPAs, we recommend a minimum level of replication to be at least one good example of the different species or habitats for each physiographic type it occurs in, within each coastal natural area and marine area. This level of replication could be increased based on the information above or decrease for very rare features)

5.11 For the broad scale, full coverage, landscape classification the current study set targets of six replicates. When applied at a very coarse scale, replication will only include gross variation in habitat types and therefore it is recommended that a greater number of replicates is employed.

5.12 For species and habitats the current study used occurrences as replicates. However where the data is available, minimum size replicate areas/ populations will need to be set. In addition

to the size of habitat patch, the number of replicates should reflect the separation distance (see proposed levels of replication in figure below).

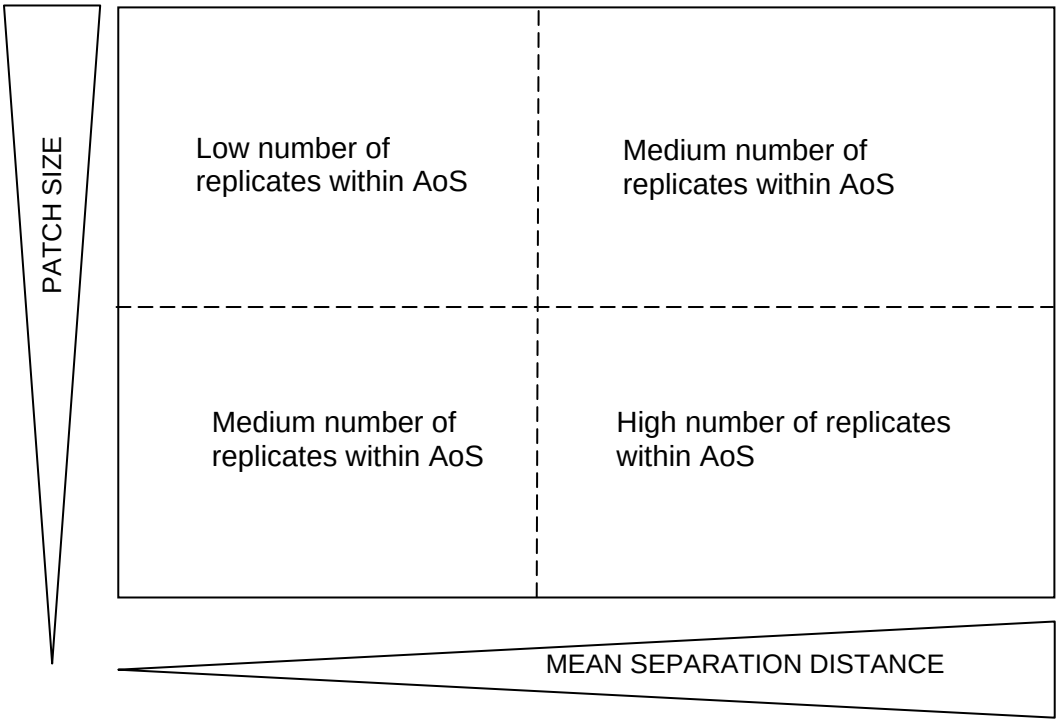


Figure 21 Proposed changing levels of replication with separation distance and patch size

Point 4. What should be protected?

5.13 An assessment of representativity should look at the entire suite of habitats and species found in the study region (in this case English territorial waters out to 12nm), and not just those protected under specific legislation (Ballantine, 1999) or in some way highlighted as flagship or distinctive habitats or species (Roff & Evans, 2002).

5.14 Although an attempt was made here to limit the study to those species that may benefit from spatial based conservation measures more than other species (e.g. pelagic or migratory species were not included), expert knowledge of particular habitats and species would allow similar studies to be more focused. We recommend that individual species and habitats are assessed to determine whether their threatened or declining status can benefit to a lesser or greater extent from spatially based conservation measures.

5.15 Focus should be given to protecting habitats; however, each protected species (in particular rare species) should be linked to a habitat to help prioritise the representation of those within a network. Species should also be flagged as epibiotic and measures undertaken to ensure proper protection of the basal species. It would also be valuable to tag species by functional group, or by trophic level, so that priority is given to important functional or structural species or species at base of food webs.

5.16 Ephemeral biotopes (and species) require special consideration in terms of representativity and replication. It is recommended that for those species and biotopes identified as ephemeral, temporal data is used to highlight areas where these features show some degree of persistence. If this does not meet the targets for representativity it is recommended that protection is based on all current known occurrences of these ephemeral features in order to protect areas where the species or habitat was able to exist.

Point 5. Representativity of Ecological processes

5.17 Ecological processes link the physical and biological environment and, in some cases, result in a strong biological response in a confined geographical area, which could influence the functioning of specific habitats found there. The current exercise proposed a method for examining inclusion of representative habitats within the current network of MPAs based on different classifications of habitats (in terms of the priority habitats). However, the ecosystem functioning of many habitats which occur within different landscapes can be very different depending on the specific environmental conditions. Whilst some habitat classifications incorporate these differences (e.g. EUNIS habitat A3.31 'Silted kelp on low energy infralittoral rock with full salinity'), others do not. We recommend that in addition to addressing representation, through the use of habitat classifications and priority species lists, there is also the need to use expert knowledge to identify specific areas where the physical and biological environment result in specific functioning of these habitats within the wider ecosystem.

Point 6. Data requirements, is the "best" available?

5.18 Data that is 'easy' to obtain and progress to the NBN has mainly been processed. However, it is widely known that there are both physical and biological datasets in existence, that are not accessible at present. These datasets include data collected with Government funding, by University researchers and by commercial enterprises.. For example, access to detailed Hydrographic Office physical seabed data would be particularly useful when combined with geological data from the British Geological Survey. There are biological survey datasets that are not being progressed to NBN, including data from the fisheries laboratories and universities. The mechanisms to make available data from surveys being undertaken by the offshore wind energy companies and the aggregate industries have proven slow to implement.

5.19 Nevertheless, current improvements in data flow and data access being championed by Defra and the Marine Environmental Data Information Network (MEDIN) and the national network of marine Data Archive Centres, e.g. DASSH[11], BODC[12], and UKHO are beginning to change the culture of data exchange within the UK marine sector. Sectoral initiatives such as COWRIE (Collaborative Offshore Wind Research Into The Environment) and within the Aggregate Levy Sustainability Fund research programme aim to ensure that their sectoral survey data is collated, quality assured and made widely available. We recommend that the work of MEDIN and its partners is supported.

5.20 'Non-availability of data for interpretation and mapping' (see paragraph 5.1) also refers to the fact that there are very large gaps in even superficial survey coverage of large areas within the 12 mile limit of territorial seas.

5.21 In order to generate more relevant information for the purpose of assessing a series of representative locations for the conservation of seabed marine biodiversity, we need to:

1) More effectively gather physical and biological data already collected from seabed;
2) Identify gaps in our knowledge of biological characteristics of areas currently with little or inadequate data and survey, initially by acoustic survey and always then by an adequate density of direct *in situ* methods (Phase 1 intertidal surveys, high quality video or diver surveys underwater), to enable accurate mapping; and
3) Interpret data as EUNIS codes to a minimum of level 4.

5.22 The UKSeaMap and MESH projects have enabled a very thorough mapping of available information. However, broad scale mapping results that are a very low level of discrimination have been used in some areas where better data exists due to licence restrictions (e.g. on BGS and UKHO data). Bathymetry obtained from SeaZone was used in both the UKSeaMap seabed landscape predictions and the prediction of EUNIS habitat in MESH. Furthermore,

[11] Data Archive for Seabed Species and Habitats (DASSH), based at the MBA , Plymouth
[12] British Oceanographic Data Centre (BODC), Proudman Laboratory, Liverpool

the often extensive areas of reef habitat that often occur within three nautical miles of the coast are poorly mapped in the data available to MESH.

Point 7.Taking the results of this stock take forward

5.23 For those species and habitats that do not appear from the current study to be found in MPAs (or with sufficient replicates), a first step approach may be to check with site project officers to see if any recent records for these species or habitats may exist which have not yet been entered on to national databases. For some of the cNIMF, identification issues may exist and specific training for those surveying sites may be needed. It might also be that some cNIMF species have been included in the lists by specialist taxonomists searching obscure habitats and may never be expected to occur in survey data (particularly the case for some molluscs and amphipod crustaceans).

Point 8. Survey effort and other sampling artefacts

5.24 We recommend some assessment of survey effort versus the number of species and habitats occurrences to examine whether lower species number records are an artefact of data availability for some regions.

5.25 The current exercise used occurrences to identify available and actual replicates of species and habitats within the current MPA network. However, it did not account for the proximity of like occurrences. This raises two issues. Firstly, it was noted that for some species records in the Marine Recorder Snapshot the location information had not been validated (primarily Seasearch records) and coordinates did not match up with location names. Secondly, once information on connectivity has been reviewed (Roberts *et al.*, in prep), minimum and maximum distances between replicates should be taken in to account.

Point 9. Replication and Representativity targets for different levels of protection

5.26 The new type of marine protected area proposed in the draft Marine Bill, Marine Conservation Zones (MCZs), will allow varying levels of protection to be given to individual sites, from 'restricting certain activities' to 'Highly Protected Marine Reserves', where no extractive, constructive or other damaging activities will be allowed.

5.27 Although an assessment of replication and representativity targets for different levels of protection was out of the scope of this work, applying appropriate levels of protection and adjusting targets for representativity accordingly is an important consideration in determining a network of MPAs. Firstly, in some cases spatially based protection may not be appropriate for a species/habitat because the pressures cannot be prevented by managing an area of sea, for example diffuse pollution or nutrient enrichment. Features should not only be protected from the current pressures they are exposed to but from the whole suite of pressures that they would be vulnerable to and that may result from activities that do not yet exist or that are extremely novel. One suggested way forwards would be to utilise the sensitivity information for species and habitats stored on databases such as MarLIN (**www.marlin.ac.uk**) which identifies sensitivity (based on intolerance and recoverability) to a range of physical, chemical and biological factors, which can then be traced back to current human activities (see **http://www.marlin.ac.uk/pdf/activities3.pdf**) but could be matched to future as yet unknown activities.

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Appendix 1 - Species listed for protection and examined for representation in MPAs in the current study

Table A Complete list of all the species examined during the study and the lists they occur on

Species	Designation
Padina pavonica	BAP Species
Phymatolithon calcareum	BAP Species
Raja undulata	BAP Species
Squalus acanthias	BAP Species
Amphianthus dohrnii	BAP Species and candidate NIMF Species
Anotrichium barbatum	BAP Species and candidate NIMF Species
Atrina fragilis	BAP Species and candidate NIMF Species
Cruoria cruoriaeformis	BAP Species and candidate NIMF Species
Dermocorynus montagnei	BAP Species and candidate NIMF Species
Eunicella verrucosa	BAP Species and candidate NIMF Species
Haliclystus auricula	BAP Species and candidate NIMF Species
Leptopsammia pruvoti	BAP Species and candidate NIMF Species
Lithothamnion corallioides	BAP Species and candidate NIMF Species
Lucernariopsis campanulata	BAP Species and candidate NIMF Species
Lucernariopsis cruxmelitensis	BAP Species and candidate NIMF Species
Palinurus elephas	BAP Species and candidate NIMF Species
Phoca vitulina	BAP Species and candidate NIMF Species
Tenellia adspersa	BAP Species and candidate NIMF Species
Phocoena phocoena	BAP Species and OSPAR Species
Hippocampus hippocampus	BAP Species, OSPAR Species and candidate NIMF Species
Ostrea edulis	BAP Species,OSPAR Species and candidate NIMF Species
Actinauge richardi	candidate NIMF Species
Adreus fascicularis	candidate NIMF Species
Aiptasia mutabilis	candidate NIMF Species
Alcyonium glomeratum	candidate NIMF Species
Alkmaria romijni	candidate NIMF Species
Allomelita pellucida	candidate NIMF Species
Alosa fallax	candidate NIMF Species
Amathia pruvoti	candidate NIMF Species
Anguilla anguilla	candidate NIMF Species
Antedon petasus	candidate NIMF Species
Anthopleura thallia	candidate NIMF Species
Apletodon dentatus	candidate NIMF Species
Armandia cirrhosa	candidate NIMF Species
Asperococcus scaber	candidate NIMF Species
Asterina phylactica	candidate NIMF Species
Axinella damicornis	candidate NIMF Species

Table continued...

Species	Designation
Baldia johnstoni	candidate NIMF Species
Barnea candida	candidate NIMF Species
Bornetia secundiflora	candidate NIMF Species
Brachystomia carrozzai	candidate NIMF Species
Caryophyllia inornata	candidate NIMF Species
Caryophyllia smithii	candidate NIMF Species
Cataphellia brodricii	candidate NIMF Species
Chondria coerulescens	candidate NIMF Species
Choristocarpus tenellus	candidate NIMF Species
Colomastix pusilla	candidate NIMF Species
Corophium affine	candidate NIMF Species
Cryptonemia seminervis	candidate NIMF Species
Cucumaria frondosa	candidate NIMF Species
Dasya corymbifera	candidate NIMF Species
Dasya punicea	candidate NIMF Species
Desmacidon fruticosum	candidate NIMF Species
Desmarestia dresnayi	candidate NIMF Species
Diazona violacea	candidate NIMF Species
Dikoleps cutleriana	candidate NIMF Species
Diphasia alata	candidate NIMF Species
Diphasia nigra	candidate NIMF Species
Dysidea pallescens	candidate NIMF Species
Endectyon delaubenfelsi	candidate NIMF Species
Epistomia bursaria	candidate NIMF Species
Euonyx chelatus	candidate NIMF Species
Farrella repens	candidate NIMF Species
Gammarus chevreuxi	candidate NIMF Species
Gammarus insensibilis	candidate NIMF Species
Glossus humanus	candidate NIMF Species
Gobius cobitis	candidate NIMF Species
Gobius couchi	candidate NIMF Species
Gobius gasteveni	candidate NIMF Species
Gracilaria bursa-pastoris	candidate NIMF Species
Guernea coalita	candidate NIMF Species
Halichoerus grypus	candidate NIMF Species
Haliclona angulata	candidate NIMF Species
Laomedea angulata	candidate NIMF Species
Lepadogaster candollei	candidate NIMF Species
Leptocheirus hirsutimanus	candidate NIMF Species
Leptocheirus pectinatus	candidate NIMF Species
Leptochiton scabridus	candidate NIMF Species
Leptoclinides faeroensis	candidate NIMF Species
Leuconia gossei	candidate NIMF Species
Leucothoe procera	candidate NIMF Species
Leucothoe spinicarpa	candidate NIMF Species
Microcosmus claudicans	candidate NIMF Species
Mycale contarenii	candidate NIMF Species
Nematostella vectensis	candidate NIMF Species
Nephasoma rimicola	candidate NIMF Species
Ocnus planci	candidate NIMF Species
Onchidella celtica	candidate NIMF Species
Ophiopsila annulosa	candidate NIMF Species
Ophiopsila aranea	candidate NIMF Species

Table continued...

Species	Designation
Otina ovata	candidate NIMF Species
Paracentrotus lividus	candidate NIMF Species
Parametaphoxus fultoni	candidate NIMF Species
Paraphellia expansa	candidate NIMF Species
Parazoanthus anguicomus	candidate NIMF Species
Parerythropodium coralloides	candidate NIMF Species
Parvipalpus capillaceus	candidate NIMF Species
Phakellia ventilabrum	candidate NIMF Species
Phallusia mammillata	candidate NIMF Species
Pollicipes pollicipes	candidate NIMF Species
Polyplumaria flabellata	candidate NIMF Species
Psolus phantapus	candidate NIMF Species
Pterosiphonia pennata	candidate NIMF Species
Pyura microcosmus	candidate NIMF Species
Sabella flabellata	candidate NIMF Species
Sabellaria alveolata	candidate NIMF Species
Schizobrachiella sanguinea	candidate NIMF Species
Schmitzia hiscockiana	candidate NIMF Species
Scolanthus callimorphus	candidate NIMF Species
Smittina affinis	candidate NIMF Species
Spinularia spinularia	candidate NIMF Species
Spongionella pulchella	candidate NIMF Species
Sternaspis scutata	candidate NIMF Species
Stiliger bellulus	candidate NIMF Species
Strongylocentrotus droebachiensis	candidate NIMF Species
Stylostichon dives	candidate NIMF Species
Suberites massa	candidate NIMF Species
Thyasira gouldi	candidate NIMF Species
Tritaeta gibbosa	candidate NIMF Species
Zanardinia prototypus	candidate NIMF Species
Nucella lapillus	OSPAR Species
Raja montagui	OSPAR Species
Alosa alosa	OSPAR Species and candidate NIMF Species
Arctica islandica	OSPAR Species and candidate NIMF Species

All migratory species, whales, dolphins, sharks, turtles, and large mobile fish species were excluded, and all seals except for Grey and Common which have distinct pupping and haul out sites around England.

Table B Species not covered by the current study either because they do not meet the criteria or were not recorded within ETWs

Species	Designation
Acipenser sturio	BAP Species and candidate NIMF Species
Ammodytes marinus	BAP Species and candidate NIMF Species
Aphanopus carbo	BAP Species
Arachnanthus sarsi	BAP Species
Arrhis phyllonyx	BAP Species
Ascophyllum nodosum ecad mackii	BAP Species
Asteronyx loveni	candidate NIMF Species
Austrosyrrhoe fimbriatus	candidate NIMF Species
Boccardia	candidate NIMF Species
Caretta caretta	BAP Species and OSPAR Species
Celleporina decipiens	candidate NIMF Species
Centroscymnus coelolepsis	BAP Species
Clavopsella navis	BAP Species
Clupea harengus	BAP Species and candidate NIMF Species
Coregonus lavaretus	BAP Species
Coregonus lavaretus oxyrinchus	OSPAR Species
Coryphaenoides rupestris	BAP Species
Danilia tinei	candidate NIMF Species
Dermochelys coriacea	BAP Species and OSPAR Species
Dipturus batis	BAP Species and OSPAR Species
Edwardsia timida	BAP Species
Gadus morhua	BAP Species, OSPAR Species and candidate NIMF Species
Gitanopsis bispinosa	BAP Species
Hippocampus guttulatus	BAP Species and OSPAR Species
Hoplostethus atlanticus	BAP Species and OSPAR Species
Lampetra fluviatilis	candidate NIMF Species
Leucoraja circularis	BAP Species
Liostomia clavula	candidate NIMF Species
Lophius piscatorius	BAP Species and candidate NIMF Species
Macrourus berglax	candidate NIMF Species
Malacocephalus laevis	candidate NIMF Species
Megabalanus azoricus	OSPAR Species
Merlangius merlangus	BAP Species and candidate NIMF Species
Merluccius merluccius	BAP Species and candidate NIMF Species
Micromesistius poutassou	BAP Species and candidate NIMF Species
Molva dypterygia	BAP Species
Molva molva	BAP Species and candidate NIMF Species
Orcinus orca	BAP Species
Pachycerianthus multiplicatus	BAP Species
Patella ulyssiponensis aspera	OSPAR Species
Petromyzon marinus	OSPAR Species and candidate NIMF Species
Phellia gausapata	candidate NIMF Species
Pleuronectes platessa	BAP Species and candidate NIMF Species
Pollachius virens	candidate NIMF Species
Reinhardtius hippoglossoides	BAP Species

Table continued…

Species	Designation
Rostroraja alba	BAP Species
Salmo salar	OSPAR Species and candidate NIMF Species
Scomber scombrus	BAP Species
Solea vulgaris	BAP Species
Styela gelatinosa	BAP Species
Swiftia pallida	BAP Species
Thunnus thynnus	BAP Species and OSPAR Species
Trachurus trachurus	BAP Species and candidate NIMF Species
Truncatella subcylindrica	candidate NIMF Species
Cantrainea peloritana	candidate NIMF Species
Eriopisa elongata	candidate NIMF Species
Eurypon clavatum	candidate NIMF Species
Fucus distichus	BAP Species
Funiculina quadrangularis	BAP Species and candidate NIMF Species
Halcampoides elongatus	candidate NIMF Species
Hippoglossus hippoglossus	BAP Species
Isurus oxyrinchus	BAP Species
Leptometra celtica	candidate NIMF Species
Liljeborgia kinahani	candidate NIMF Species
Listriella picta	candidate NIMF Species
Mitella pollicipes	BAP Species
Monoculodes packardi	candidate NIMF Species
Parastichopus tremulus	candidate NIMF Species
Polysiphonia foetidissima	candidate NIMF Species
Polysyncraton lacazei	candidate NIMF Species
Sphacelaria mirabilis	candidate NIMF Species
Synoicum incrustatum	candidate NIMF Species
Phocoena phocoena	BAP Species and OSPAR Species
Ocnus planci	candidate NIMF Species

Appendix 2 - Habitats listed for protection and examined for representation in MPAs in the current study

Table C Habitats listed for protection and examined for representation in MPAs in the current study

Habitat	Status
Coastal lagoons	Annex I Habitat
Estuaries	Annex I Habitat
Large shallow inlets and bays	Annex I Habitat
Mudflats and sandflats not covered by seawater at low tide	Annex I Habitat
Reefs	Annex I Habitat
Sandbanks which are slightly covered by sea water all the time	Annex I Habitat
Submerged or partially submerged sea caves	Annex I Habitat
Blue mussel beds	BAP
Coastal saltmarsh	BAP
Estuarine rocky	BAP
Fragile sponge & anthozoan communities on subtidal rocky	BAP
Intertidal boulder communities	BAP
Intertidal chalk	BAP
Mud in deep water	BAP
Peat and clay exposures	BAP
Sabellaria alveolata reefs	BAP
Sabellaria spinulosa reefs	BAP
Saline lagoons	BAP
Seagrass (*Zostera*) beds	BAP
Sheltered muddy gravels	BAP
Subtidal chalk	BAP
Subtidal sands and gravels	BAP
Tide-swept channels	BAP
Horse mussel (*Modiolus modiolus*) beds	BAP /OSPAR
Intertidal mudflats	BAP /OSPAR
Maerl beds	BAP /OSPAR
Alaria esculenta on exposed sublittoral fringe bedrock	candidate NIMF
Ascophyllum nodosum & *Fucus vesiculosus* on variable salinity mid eulittoral rock	candidate NIMF
Ascophyllum nodosum on very sheltered mid eulittoral rock	candidate NIMF
Bryozoan turf and erect sponges on tide-swept circalittoral rock	candidate NIMF
Burrowing megafauna and *Maxmuelleria lankesteri* in circalittoral mud	candidate NIMF
Capitella capitata and *Tubificoides* spp. in reduced salinity infralittoral muddy sediment	candidate NIMF
Capitella capitata in enriched sublittoral muddy sediments	candidate NIMF
Ceramium sp. and piddocks on eulittoral fossilised peat	candidate NIMF
Cerianthus lloydii and other burrowing anemones in circalittoral muddy mixed sediment	candidate NIMF
Circalittoral mixed sediment	candidate NIMF
Cirratulids and *Cerastoderma edule* in littoral mixed sediment	candidate NIMF

Table continued...

Habitat	Status
Coralline crust-dominated shallow eulittoral rockpools	candidate NIMF
Eunicella verrucosa and *Pentapora foliacea* on wave-exposed circalittoral bedrock	candidate NIMF
Faunal communities on variable or reduced salinity infralittoral rock	candidate NIMF
Fucoids and kelp in deep eulittoral rockpools	candidate NIMF
Fucus ceranoides on reduced salinity eulittoral rock	candidate NIMF
Fucus serratus and under-boulder fauna on exposed to moderately exposed lower eulittoral boulders	candidate NIMF
Fucus serratus with sponges, ascidians and red seaweeds on tideswept lower eulittoral mixed substrata	candidate NIMF
Fucus vesiculosus on variable salinity mid eulittoral boulders & stable mixed substrata	candidate NIMF
Laminaria digitata and under-boulder fauna on sublittoral fringe boulders	candidate NIMF
Littoral caves & overhangs	candidate NIMF
Littoral mixed sediments	candidate NIMF
Mediomastus fragilis, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel	candidate NIMF
Melinna palmata with *Magelona* spp. and *Thyasira* spp. in infralittoral sandy mud	candidate NIMF
Moerella spp. with venerid bivalves in infralittoral gravelly sand	candidate NIMF
Mussel and/or barnacle communities	candidate NIMF
Mytilus edulis and *Fucus vesiculosus* on moderately exposed mid eulittoral rock	candidate NIMF
Mytilus edulis and piddocks in eulittoral firm clay	candidate NIMF
Neomysis integer and *Gammarus* spp. in variable salinity infralittoral mobile sand	candidate NIMF
Neopentadactyla mixta in circalittoral shell gravel or coarse sand	candidate NIMF
Oligochaetes in variable or reduced salinity infralittoral muddy sediment	candidate NIMF
Ostrea edulis beds on shallow sublittoral muddy mixed sediment	candidate NIMF
Philine aperta and *Virgularia mirabilis* in soft stable infralittoral mud	candidate NIMF
Polydora ciliata and *Corophium volutator* in variable salinity infralittoral firm mud or clay	candidate NIMF
Seapens and burrowing megafauna in circalittoral fine mud	candidate NIMF
Seaweeds in sediment-floored eulittoral rockpools	candidate NIMF
Sparse *Modiolus modiolus*, dense *Cerianthus lloydii* and burrowing holothurians on sheltered circalittoral stones and mixed sediment	candidate NIMF
Spisula subtruncata and *Nephtys hombergii* in shallow muddy sand	candidate NIMF
Sponges, cup corals and anthozoans on shaded or overhanging circalittoral rock	candidate NIMF
Underboulder communities	candidate NIMF
Intertidal *Mytilus edulis* beds on mixed and sandy sediments	OSPAR
Littoral chalk communities	OSPAR
Ostrea edulis beds	OSPAR
Sea-pen and burrowing megafauna communities	OSPAR

Appendix 3 - SACs with a marine component and the SSSIs contained wholly or partly within them

Any SSSI that was completely within an SAC was removed from the analysis to avoid duplication. However, due to the degree of overlap, Thanet Coast has an entry both as an SAC and SSSI separately in the database to avoid confusion over the features found within them.

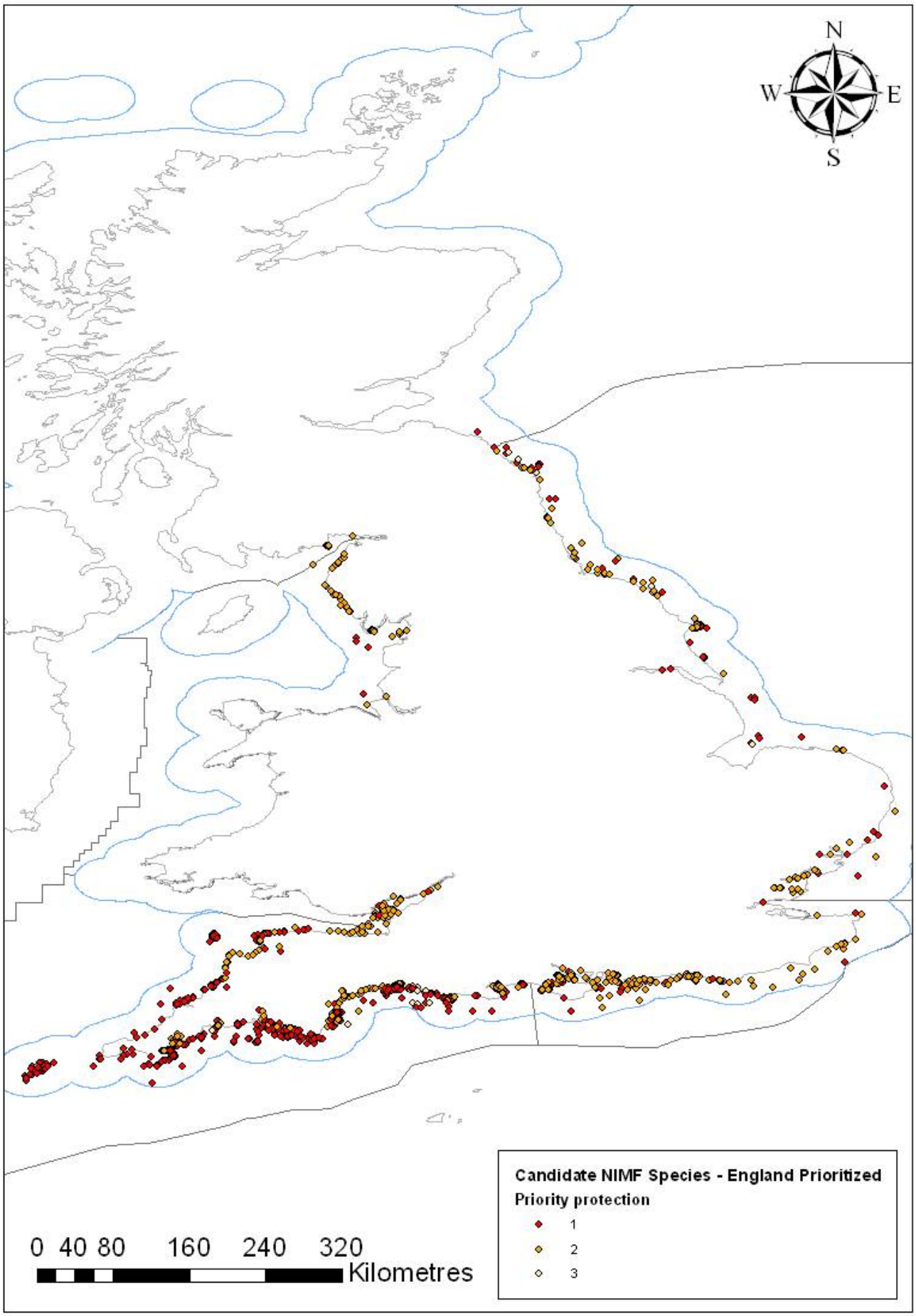
Table D SACs with a marine component and the SSSIs contained wholly or partly within them

SACs	SSSIs within
Alde, Ore and Butley Estuaries	Alde-Ore Estuary
Berwickshire and North Northumberland coast	
Braunton Burrows	
Chesil and the Fleet	Chesil & The Fleet
Drigg Coast	
Essex Estuaries	
Fal and Helford	Lower Fal & Helford Intertidal Rosemullion
Flamborough Head	
Humber Estuary	Humber Estuary
Isles of Scilly Complex	Pool of Bryher & Popplestone Bank (Bryher) St. Martin's Sedimentary Shore
Lundy	
Morecambe Bay	Duddon Estuary South Walney and Piel Channel Flats
North Norfolk Coast	
Orfordness - Shingle Street	
Plymouth Sound and Estuaries	Plymouth Sound shore and cliffs Tamar - Tavy Estuary Yealm Estuary
Severn Estuary	Severn Estuary
Solent and Isle of Wight Lagoons	Hurst Castle and Lymington River Estuary (partially) Langstone Harbour (partially)
Solent Maritime	Chichester Harbour Eling and Bury Marshes Hurst Castle and Lymington River Estuary (partially) Hythe to Calshot Marshes King's Quay Shore (partially) Langstone Harbour (partially) Lincegrove and Hackett's Marshes Medina Estuary Newtown Harbuor Thorness Bay Yar Estuary

Table continued...

SACs	SSSIs within
Solway Firth	
South Wight Maritime	Compton Chine to Steephill Cove Whitecliff Bay and Bembridge Ledges
Thanet Coast	Thanet Coast (partially)
The Dee Estuary	
The Wash and North Norfolk Coast	The Wash Gibraltar Point (partially)
Tweed Estuary	Tweed Catchment Rivers - England: Lower Tweed and Whiteadder

Appendix 4 - England wide and regional maps for cNIMF and OSPAR species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E
S
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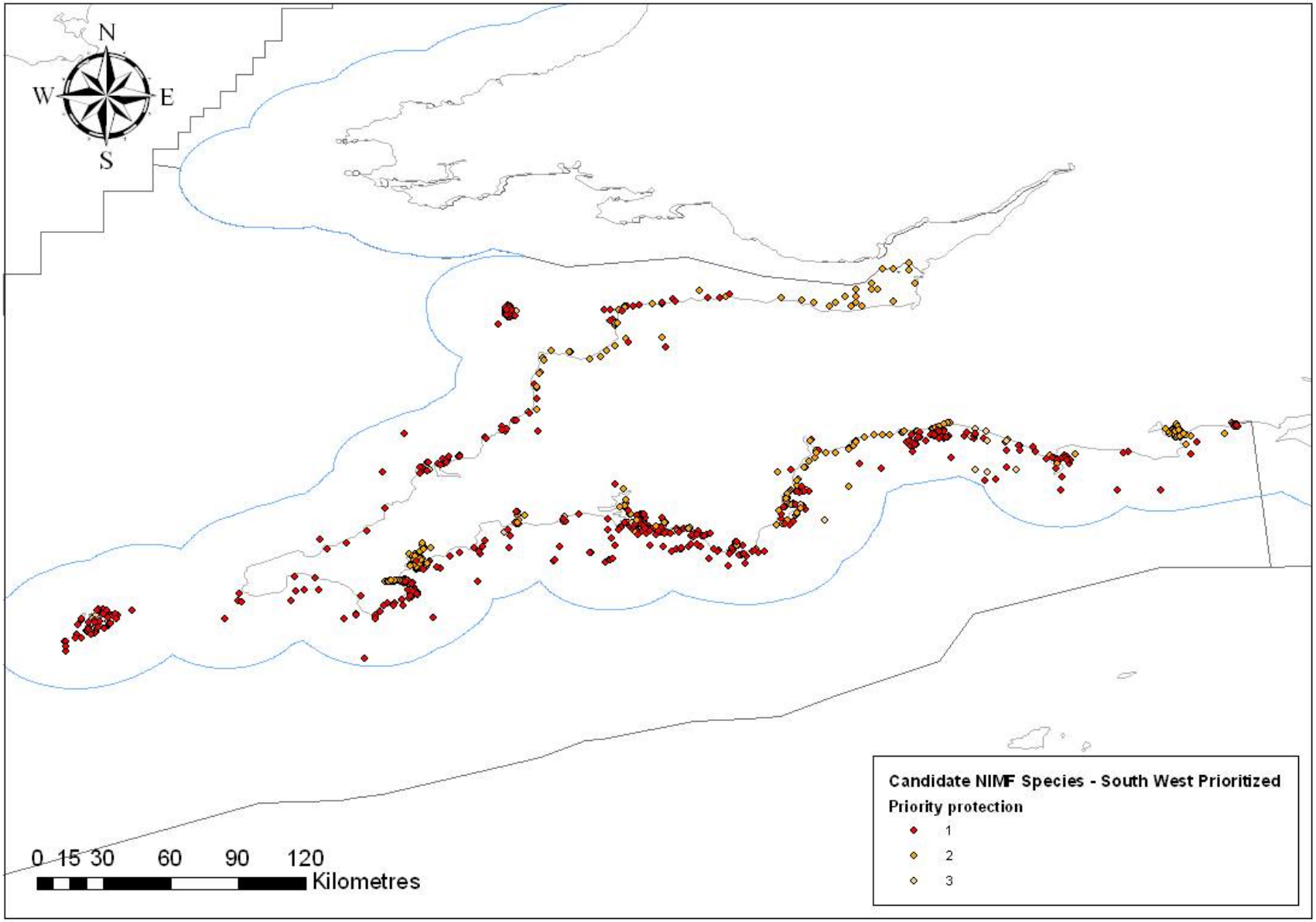
Kilometres
Candidate NIMF Species - England Prioritized
Priority protection
1
2
3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W
E
S
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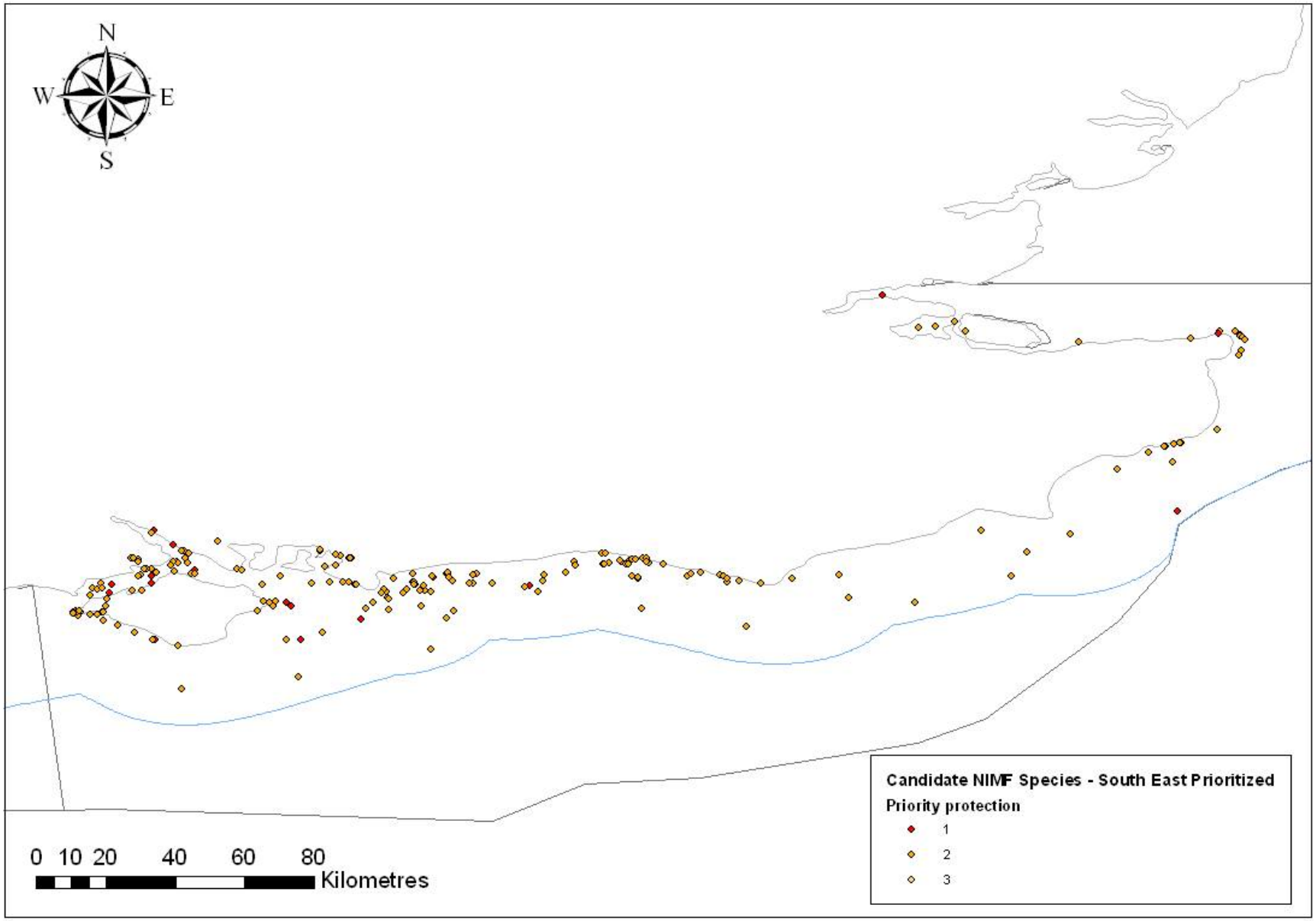
Kilometres
Candidate NIMF Species - South West Prioritized
Priority protection
1
2
3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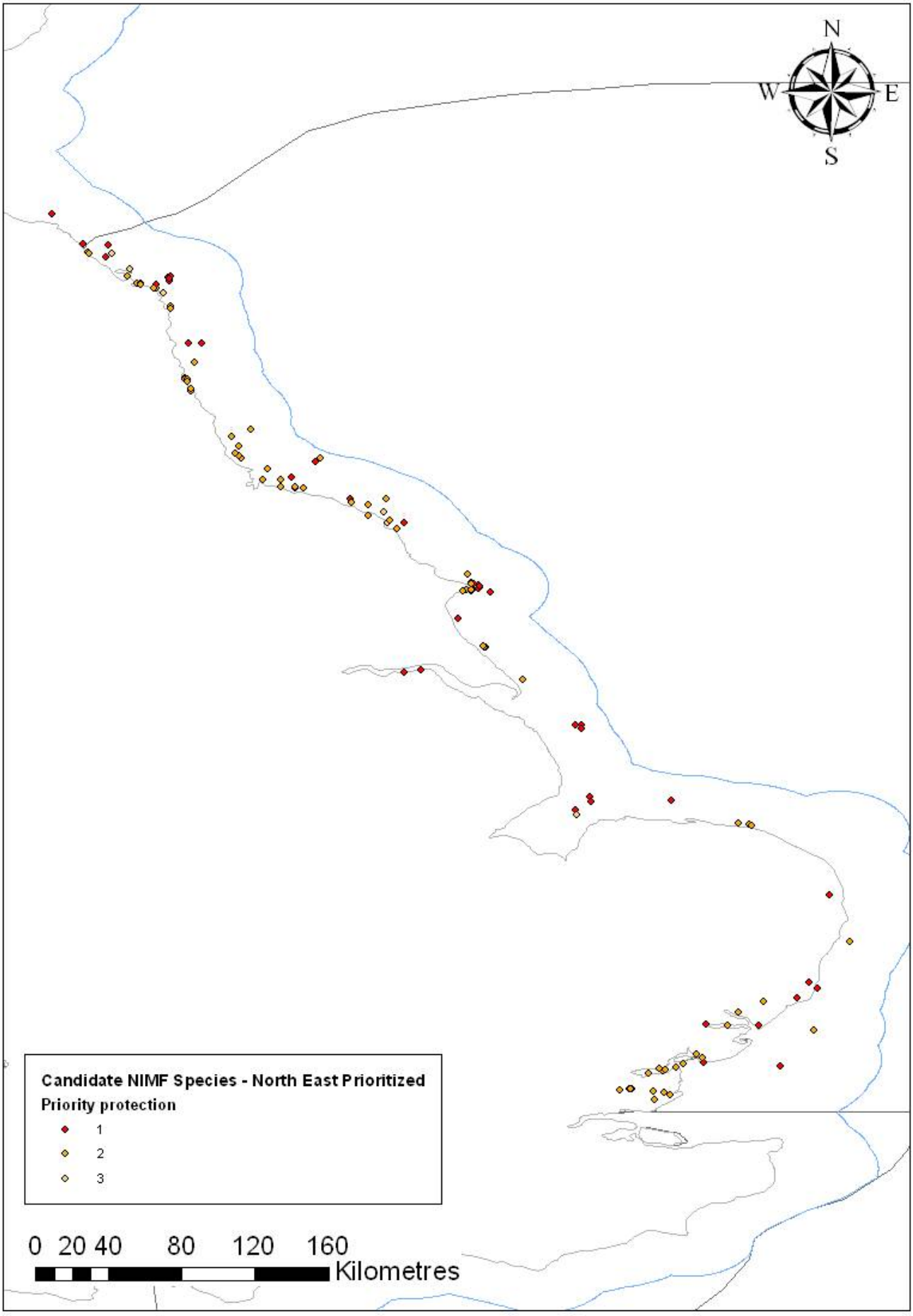
Kilometres
Candidate NIMF Species - South East Prioritized
Priority protection
1
2
3


N
W
E
S
Candidate NIMF Species - North East Prioritized
Priority protection
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2
3
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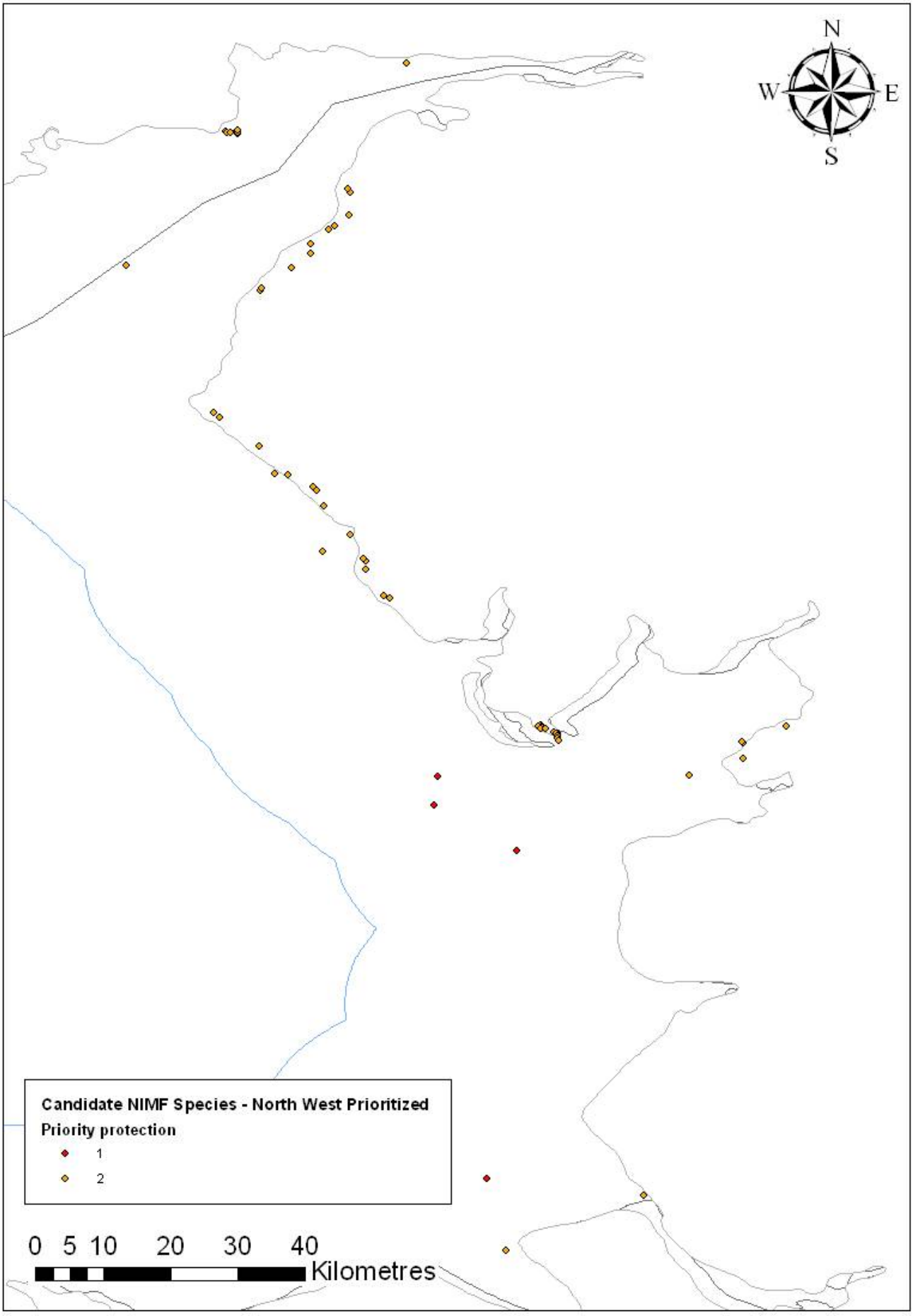
Kilometres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W
E
S
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Priority protection
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2
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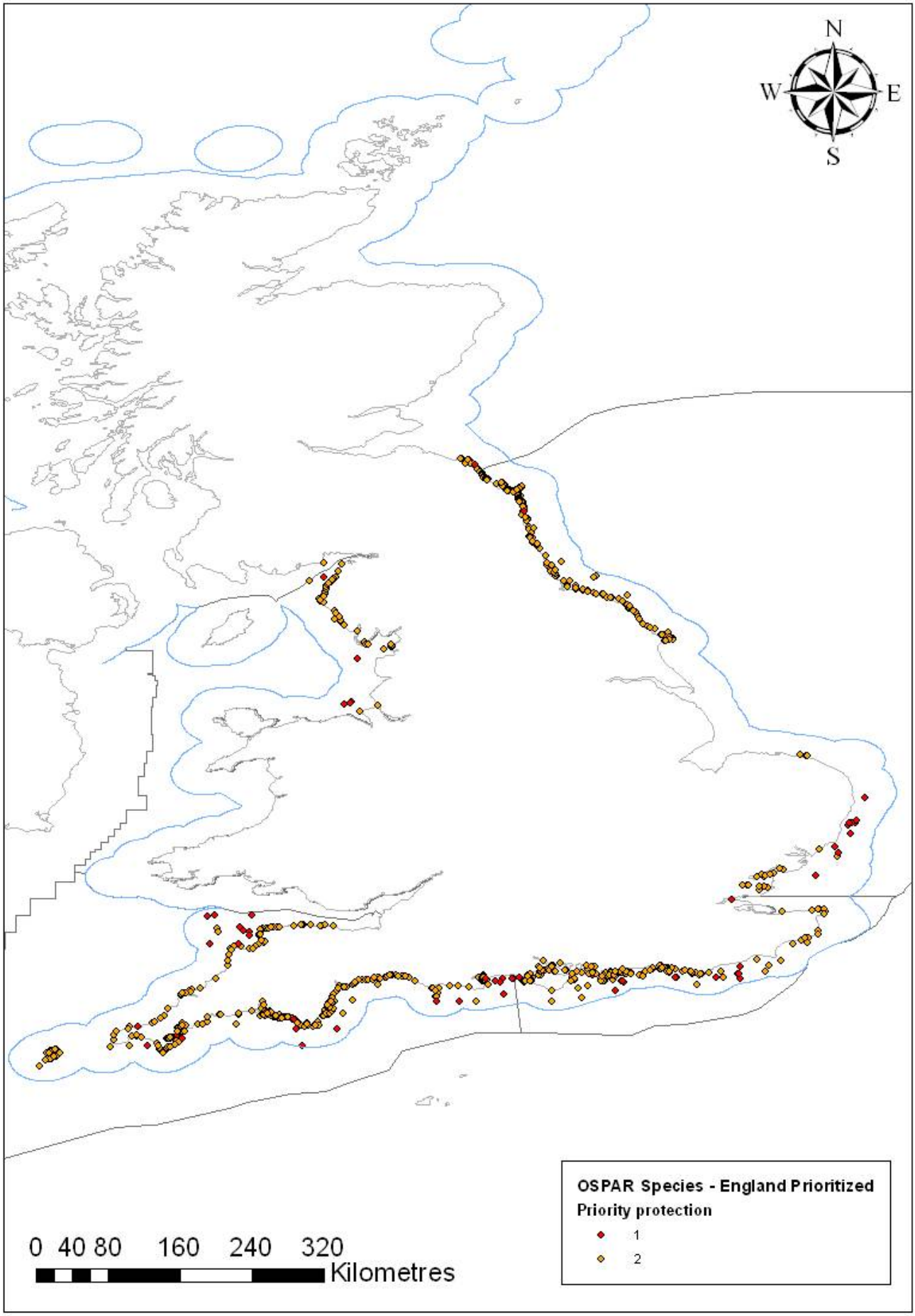
Kilometres


N
W
E
S
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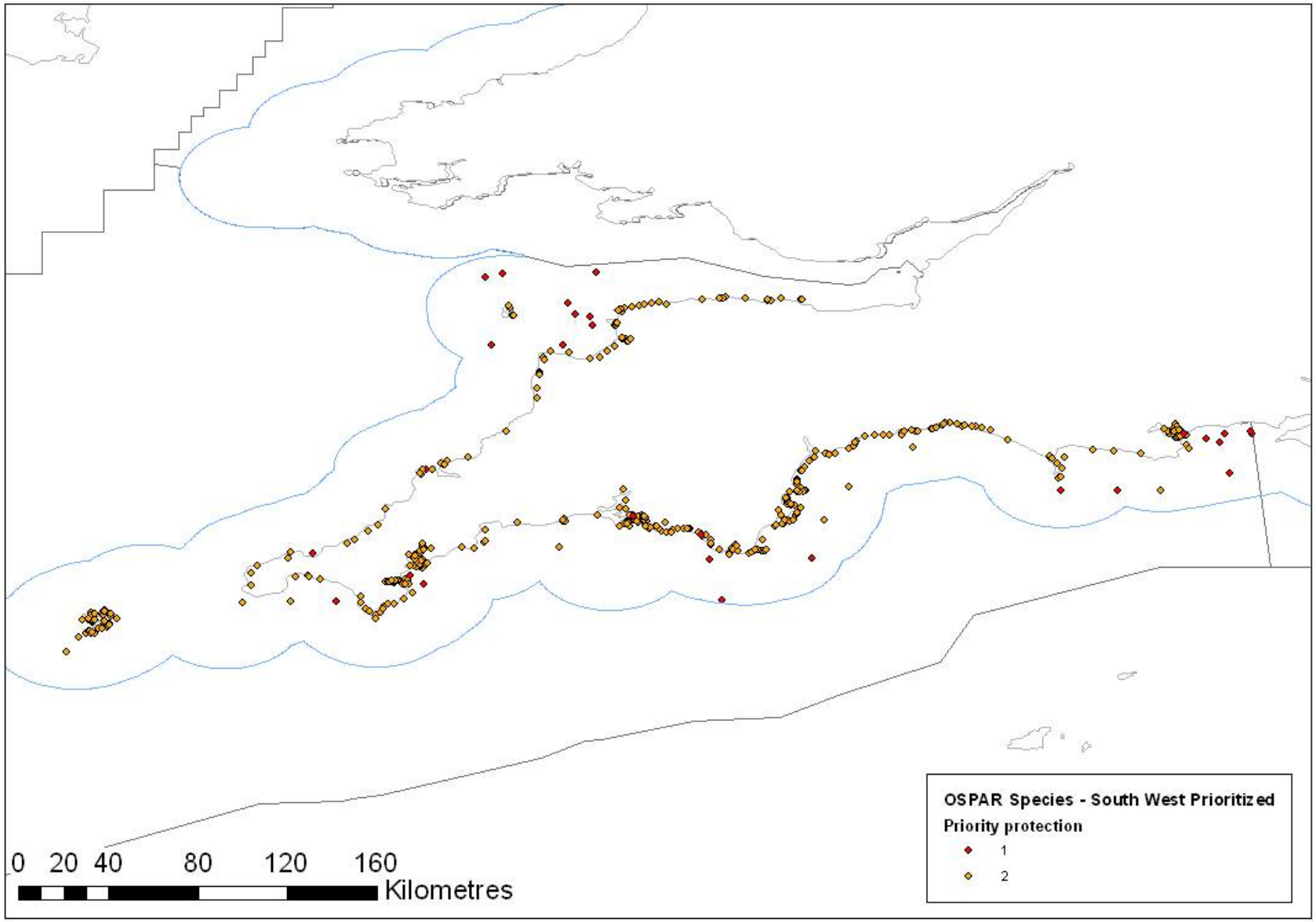
Kilometres
OSPAR Species - England Prioritized
Priority protection
1
2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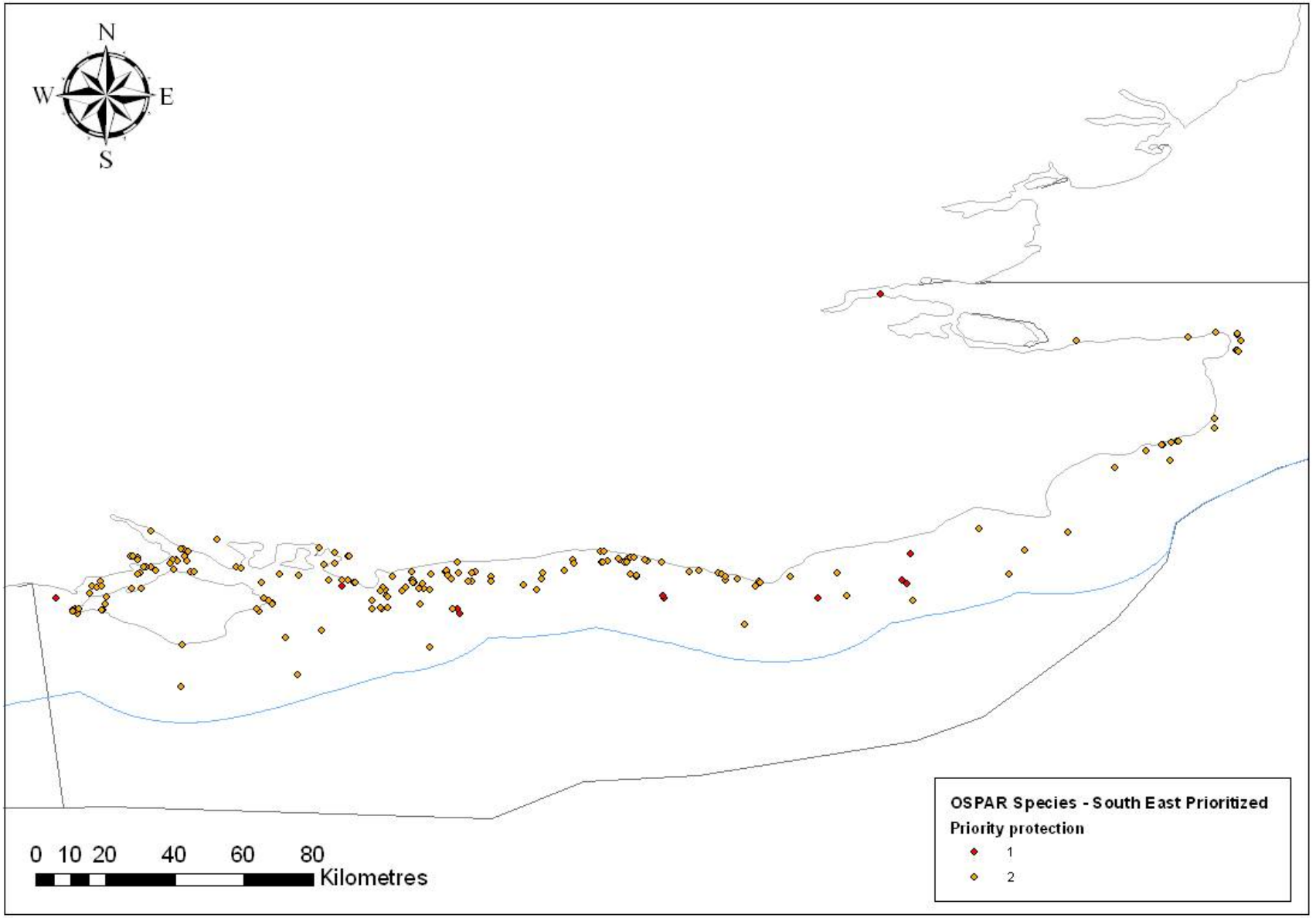
Kilometres
OSPAR Species - South West Prioritized
Priority protection
1
2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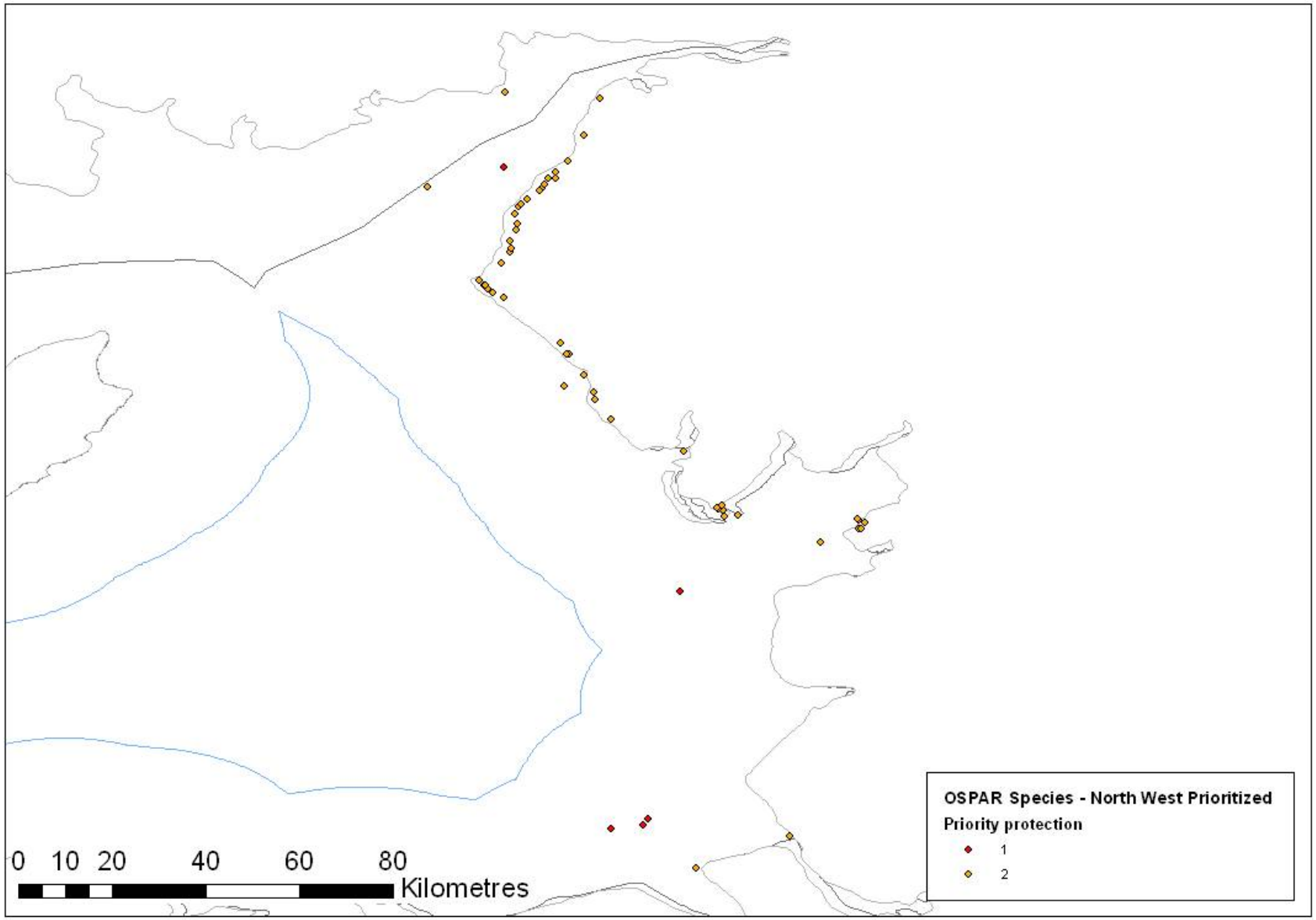
W
E
S
0 10 20 40 60 80
Kilometres
OSPAR Species - South East Prioritized
Priority protection
1
2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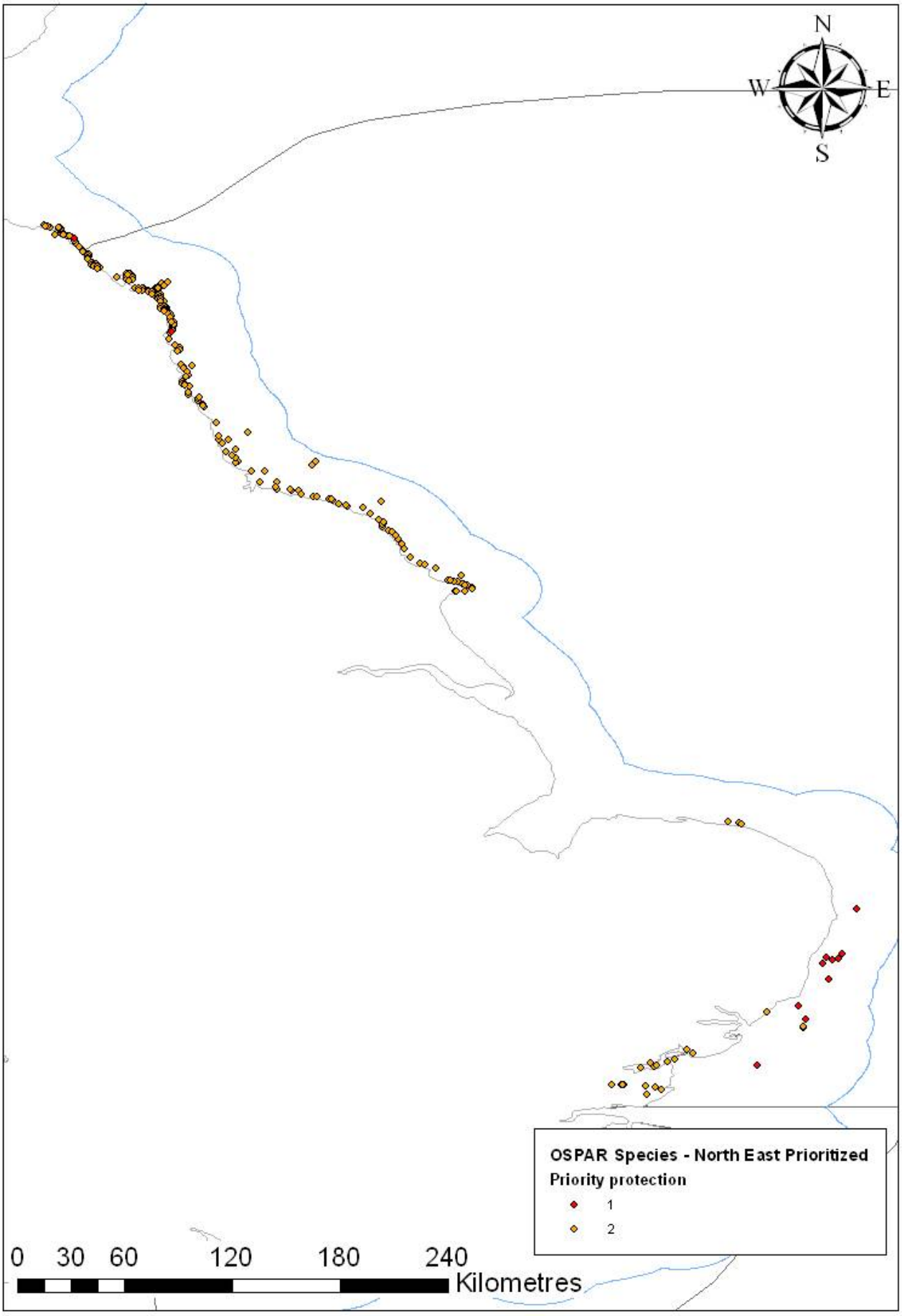
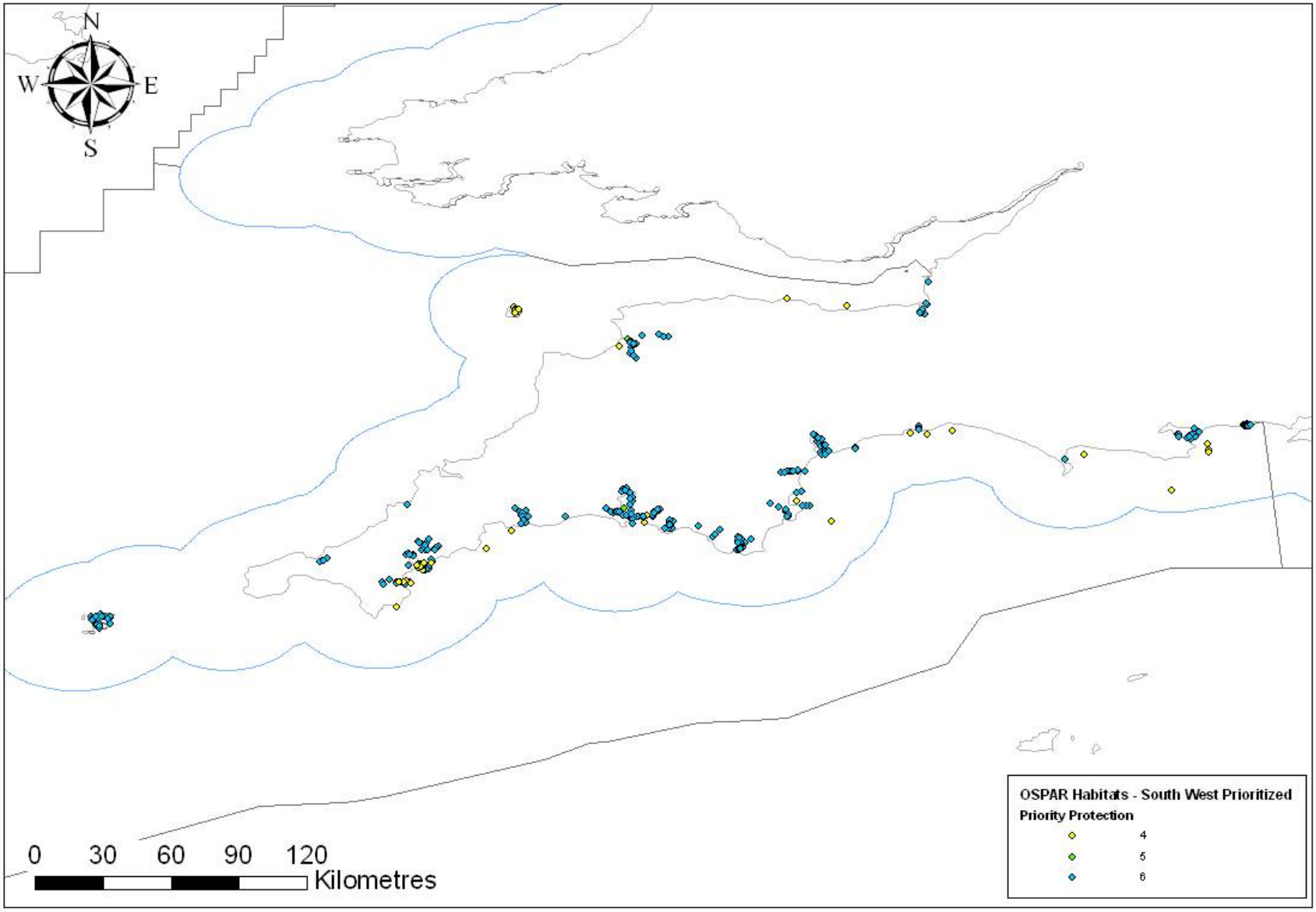
Kilometres
OSPAR Species - North West Prioritized
Priority protection
1
2


N
W
E
S
OSPAR Species - North East Prioritized
Priority protection
1
2
0 30 60 120 180 240
Kilometres

Appendix 5 - England wide and regional maps for OSPAR, BAP and Annex 1 Habitats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E
S
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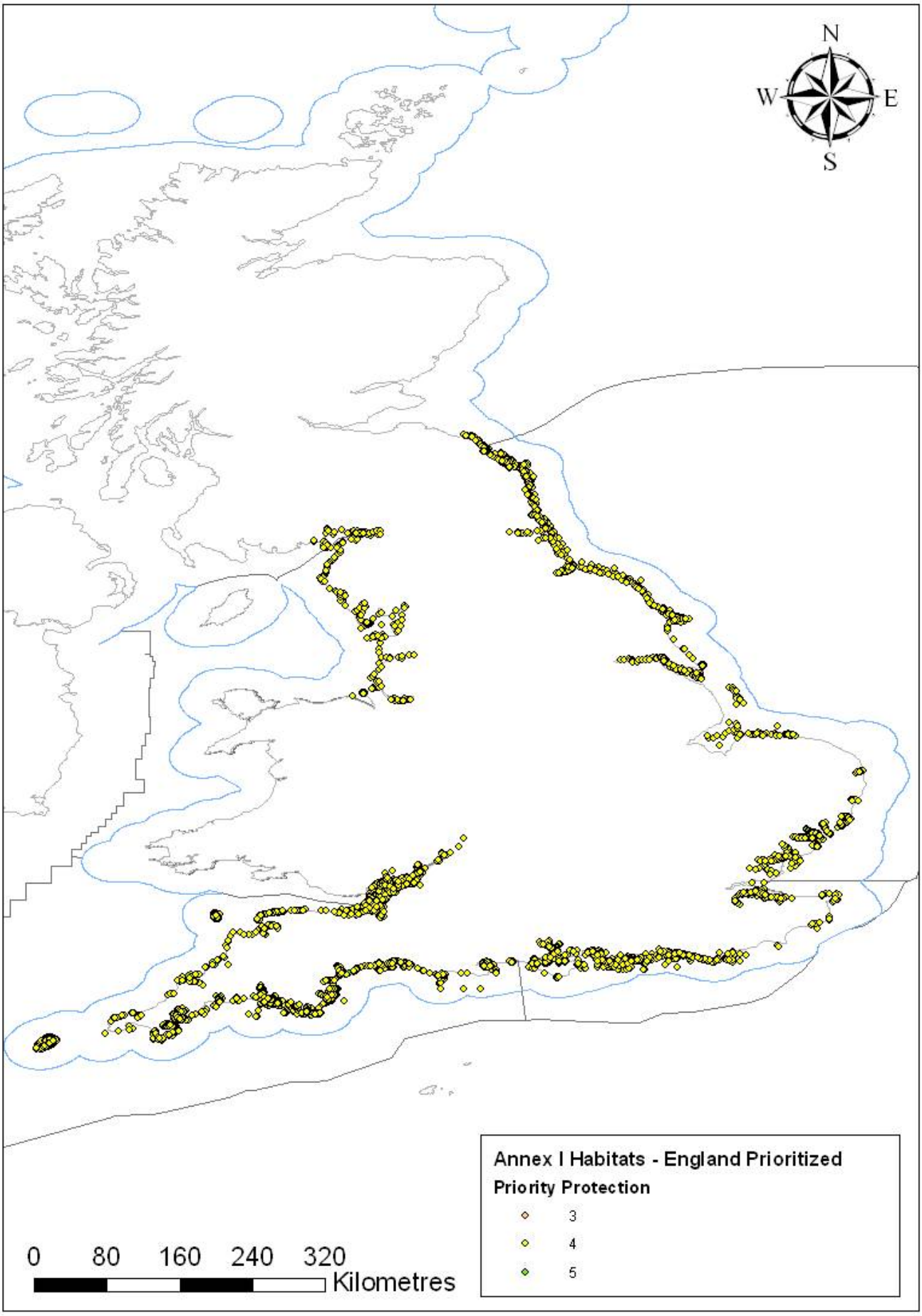
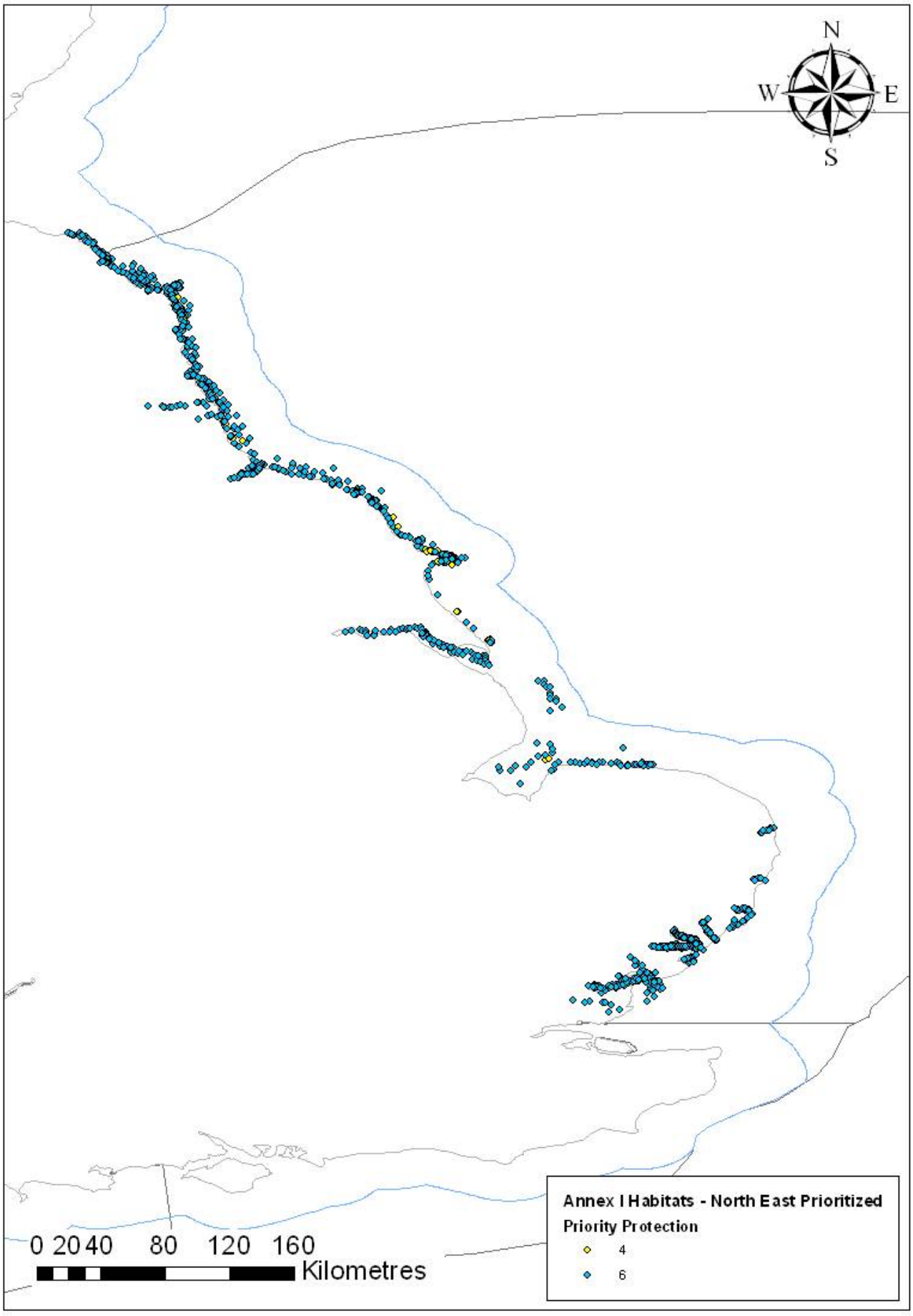
Kilometres
OSPAR Habitats - South West Prioritized
Priority Protection
4
5
6


N
W
E
S
Annex I Habitats - England Prioritized
Priority Protection
3
4
5
0
80
160
240
320
Kilometres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E
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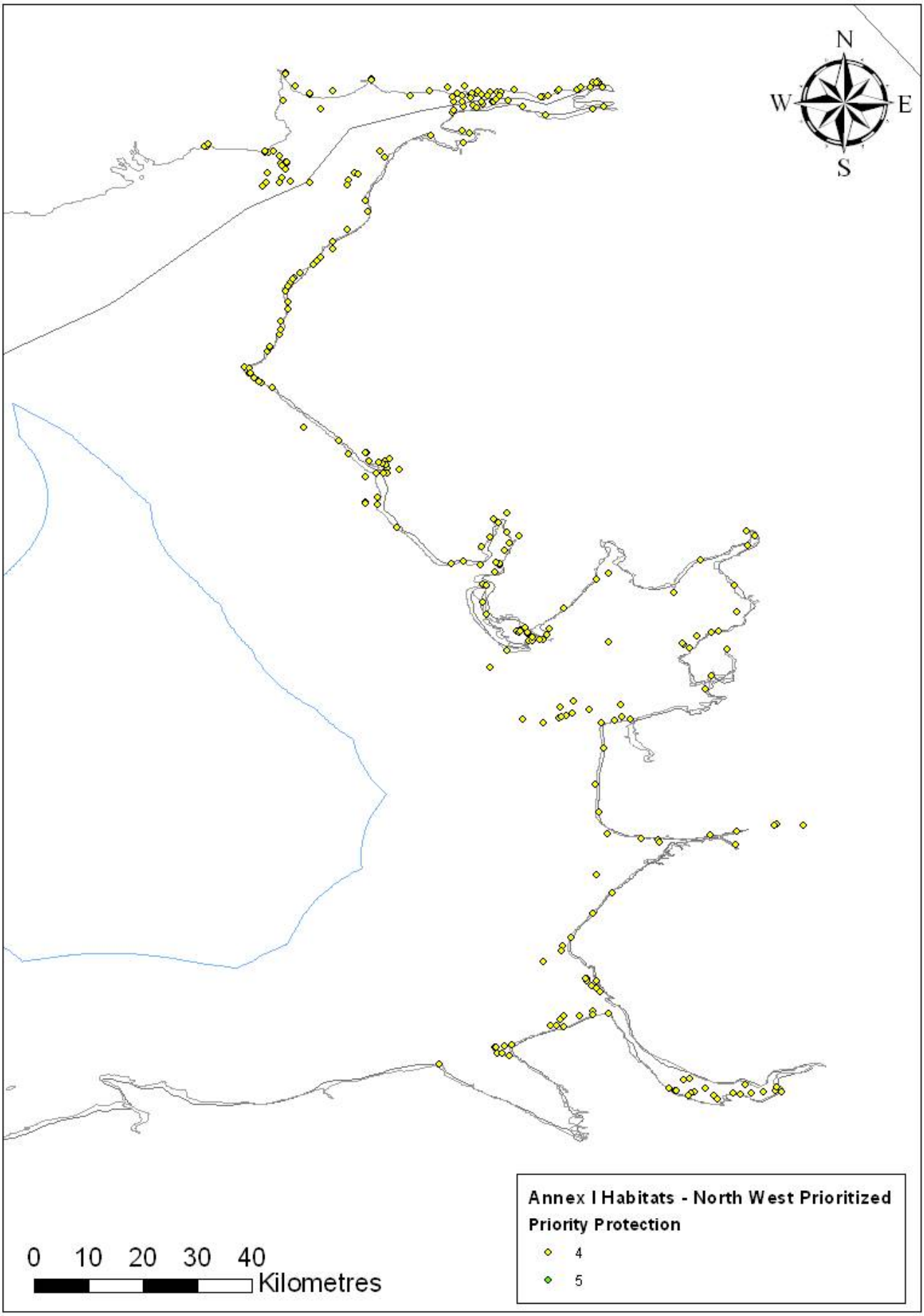
Kilometres
Annex I Habitats - North East Prioritized
Priority Protection
4
6


N
W
E
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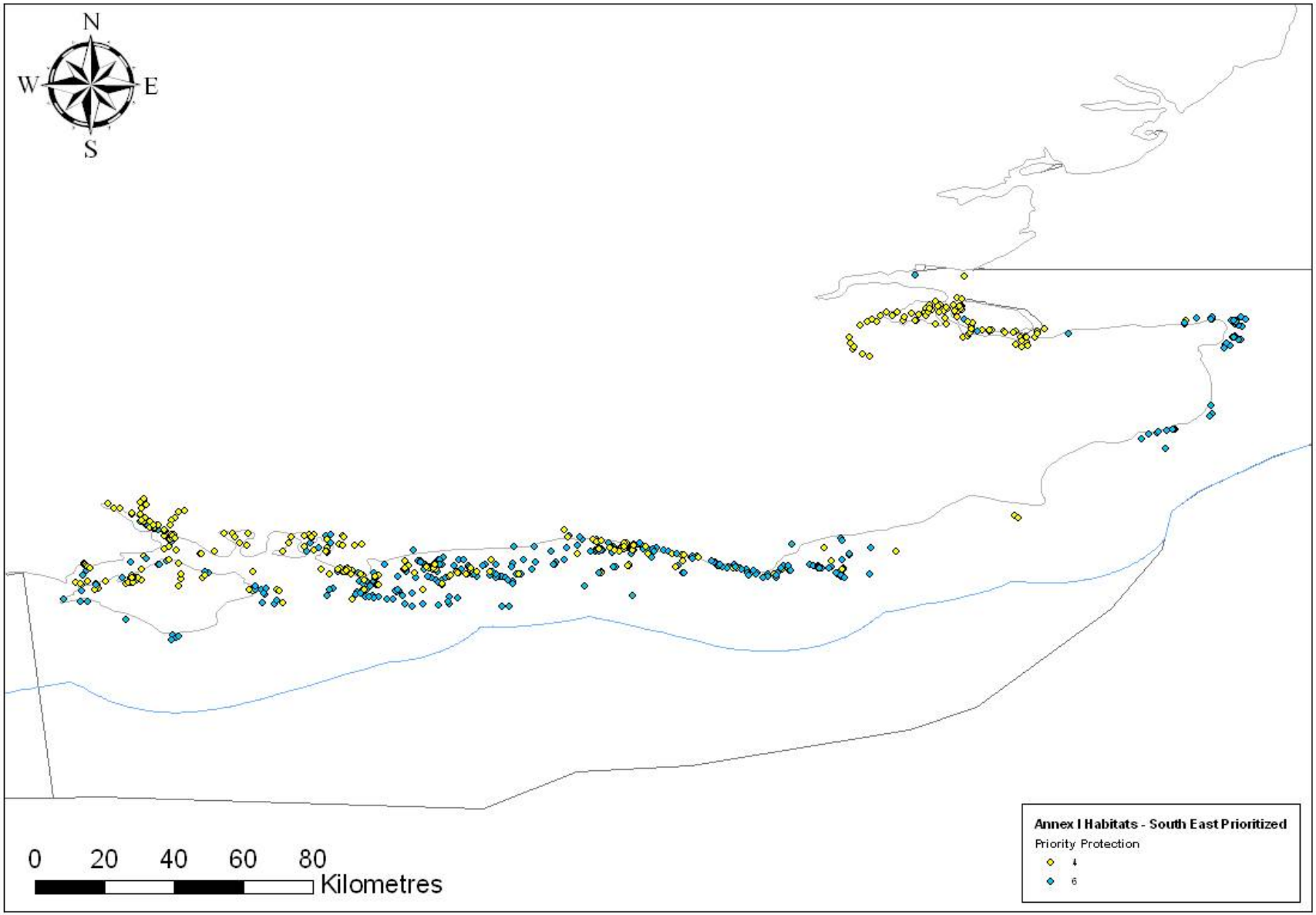
Kilometres
Annex I Habitats - North West Prioritized
Priority Protection
4
5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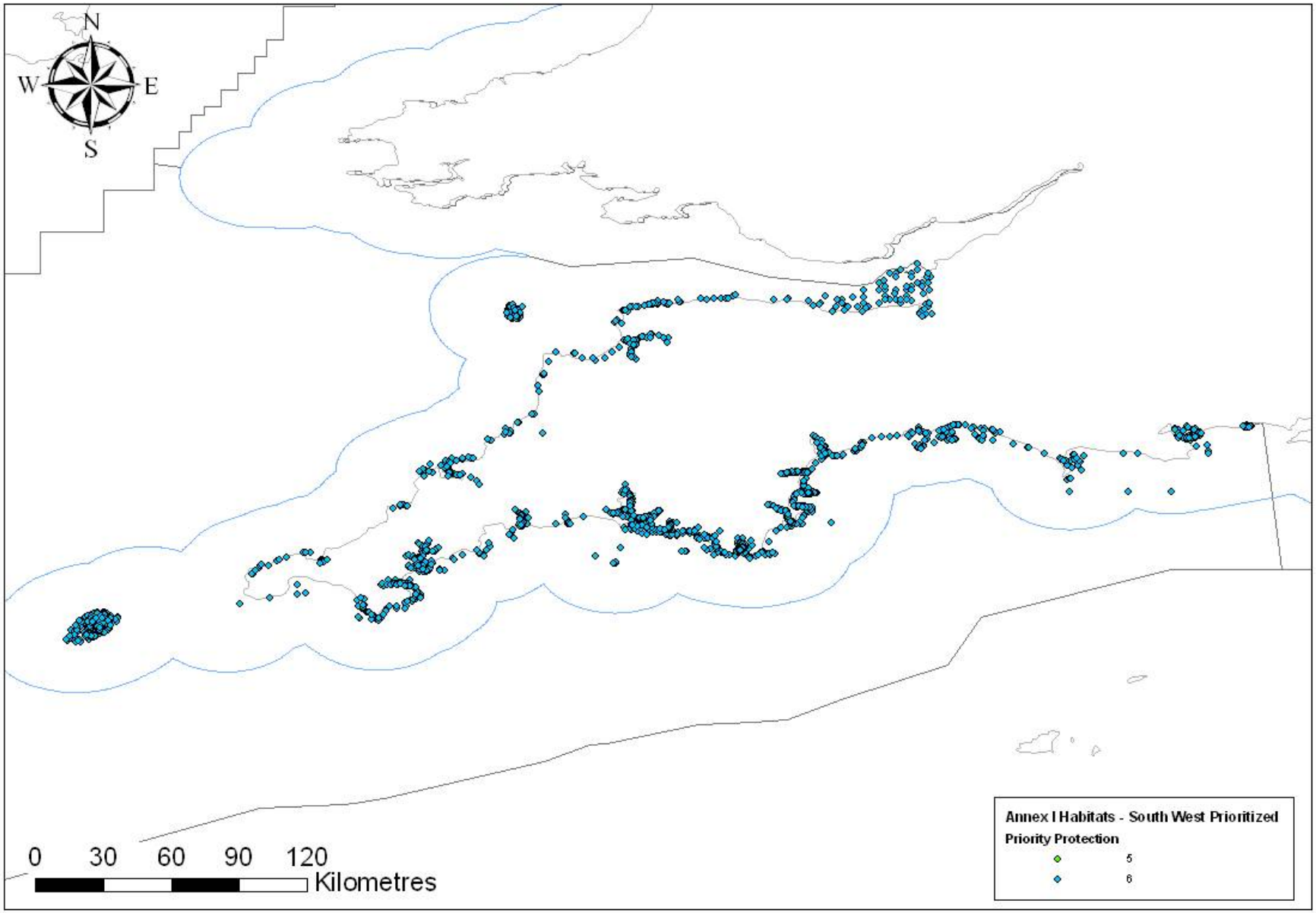
Kilometres
Annex I Habitats - South East Prioritized
Priority Protection
1
6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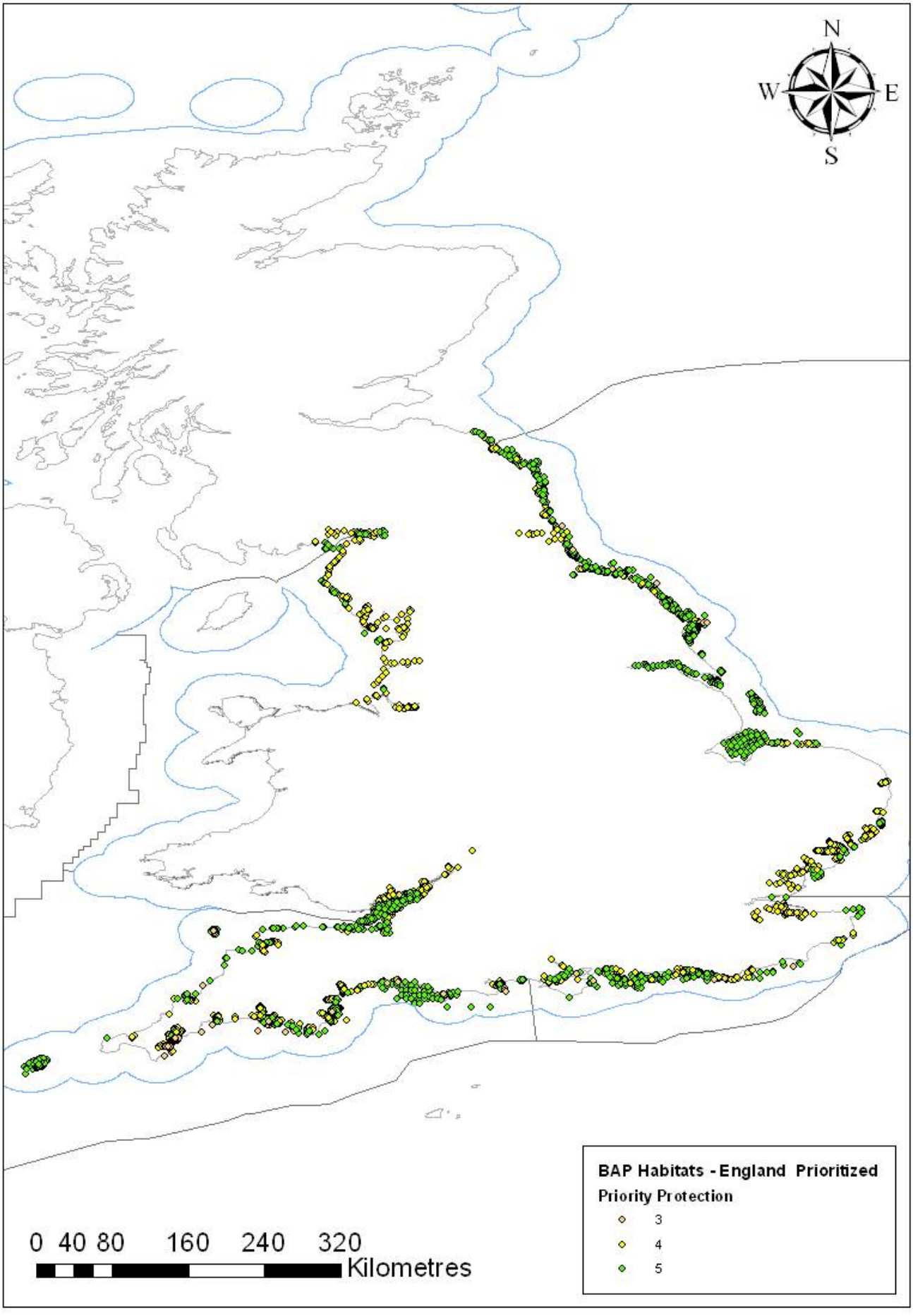
E
S
0 30 60 90 120
Kilometres
Annex I Habitats - South West Prioritized
Priority Protection
5
6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W
E
S
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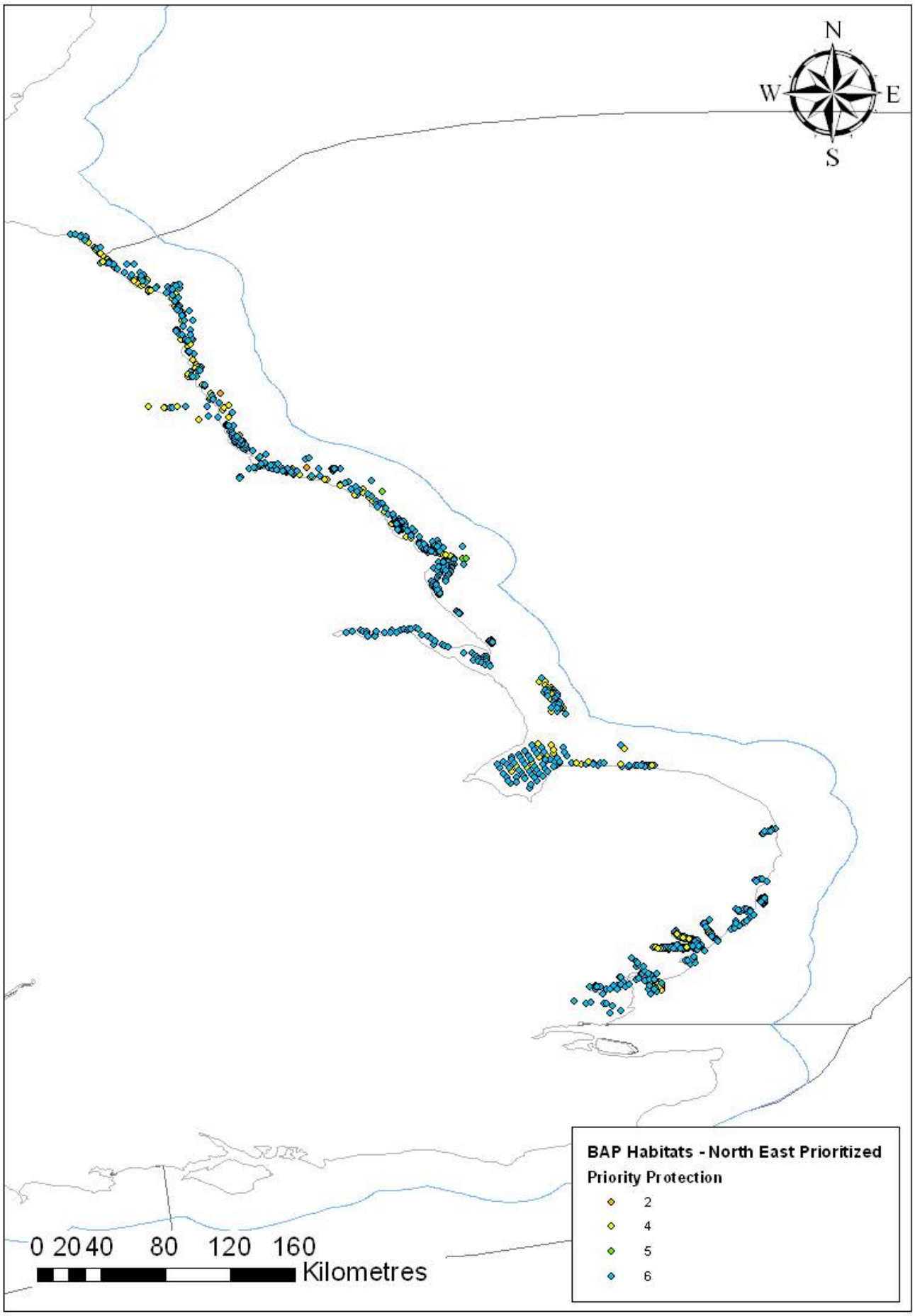
Kilometres
BAP Habitats - England Prioritized
Priority Protection
3
4
5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S
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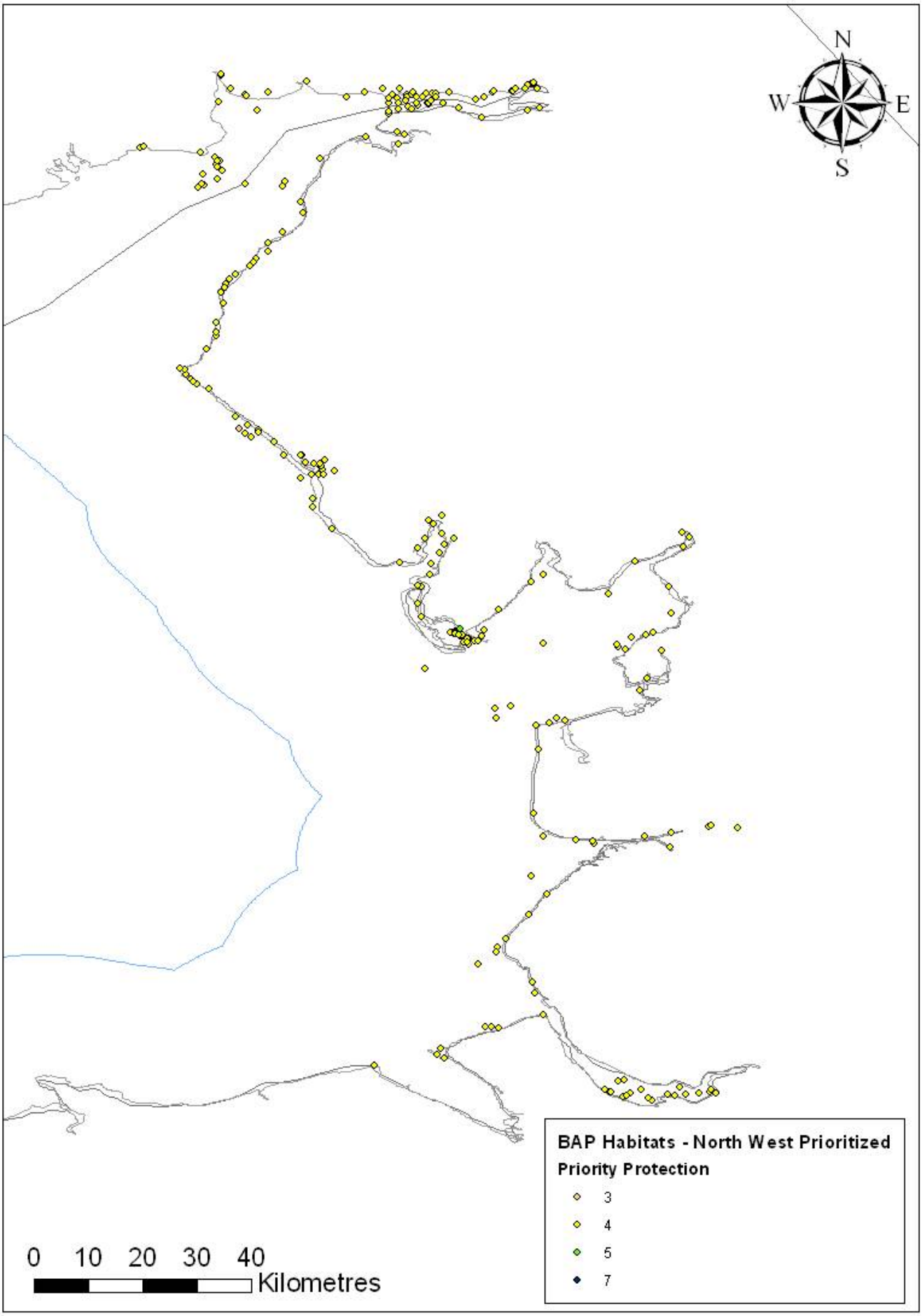
Kilometres
BAP Habitats - North East Prioritized
Priority Protection
2
4
5
6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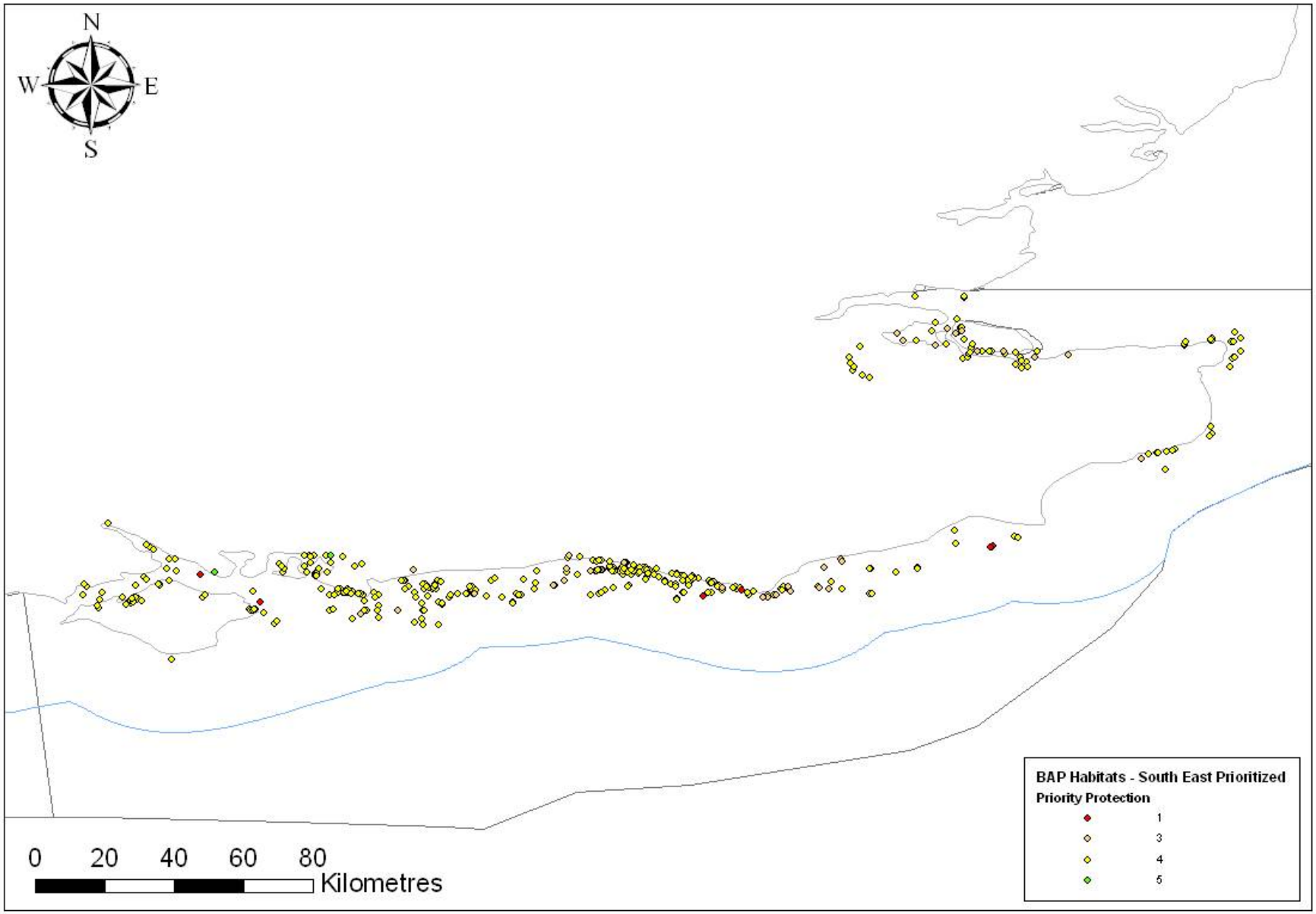
W
E
S
BAP Habitats - North West Prioritized
Priority Protection
3
4
5
7
0 10 20 30 40
Kilometres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W
E
S
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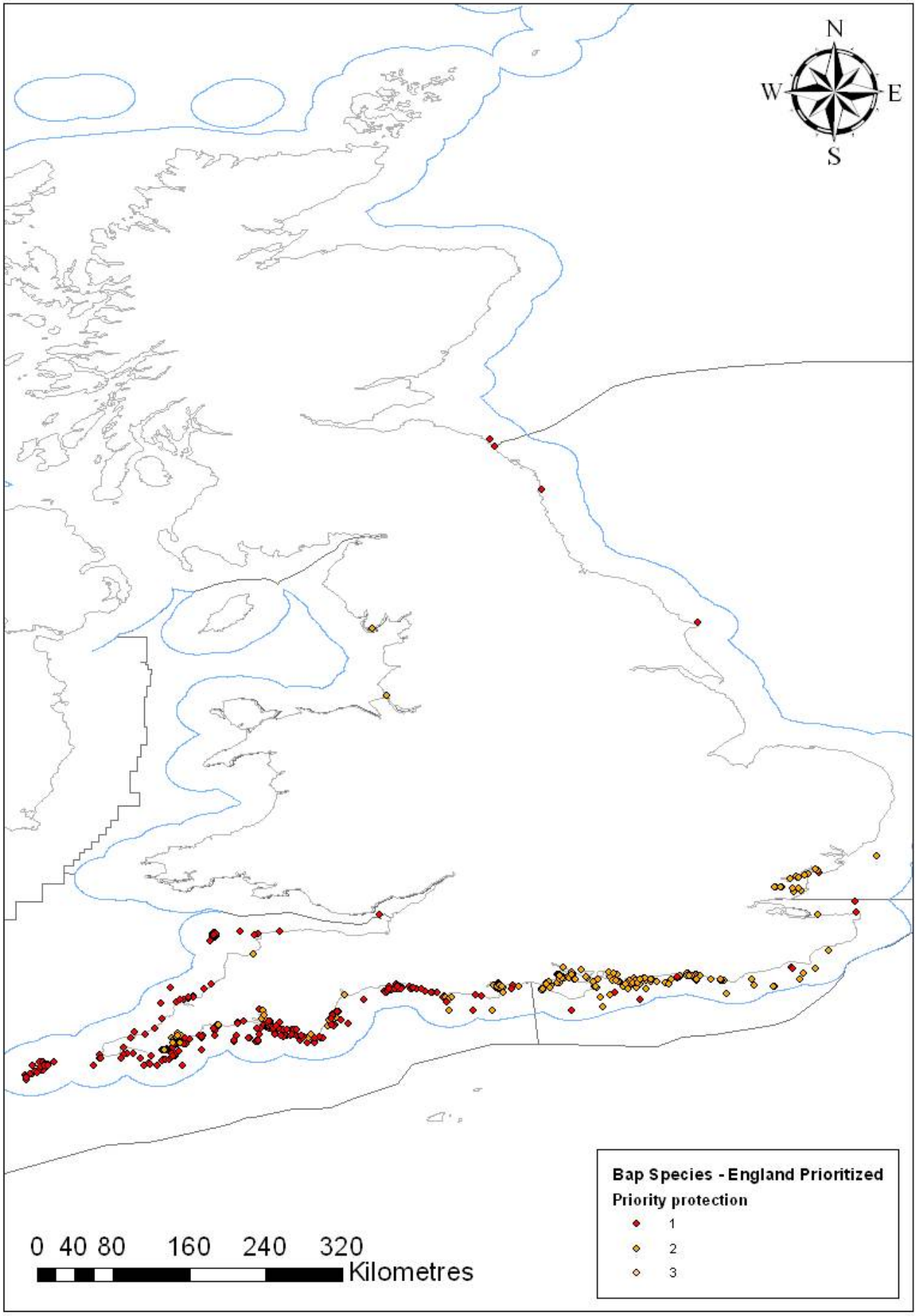
20
40
60
80
Kilometres
BAP Habitats - South East Prioritized
Priority Protection
1
3
4
5


N
W
E
S
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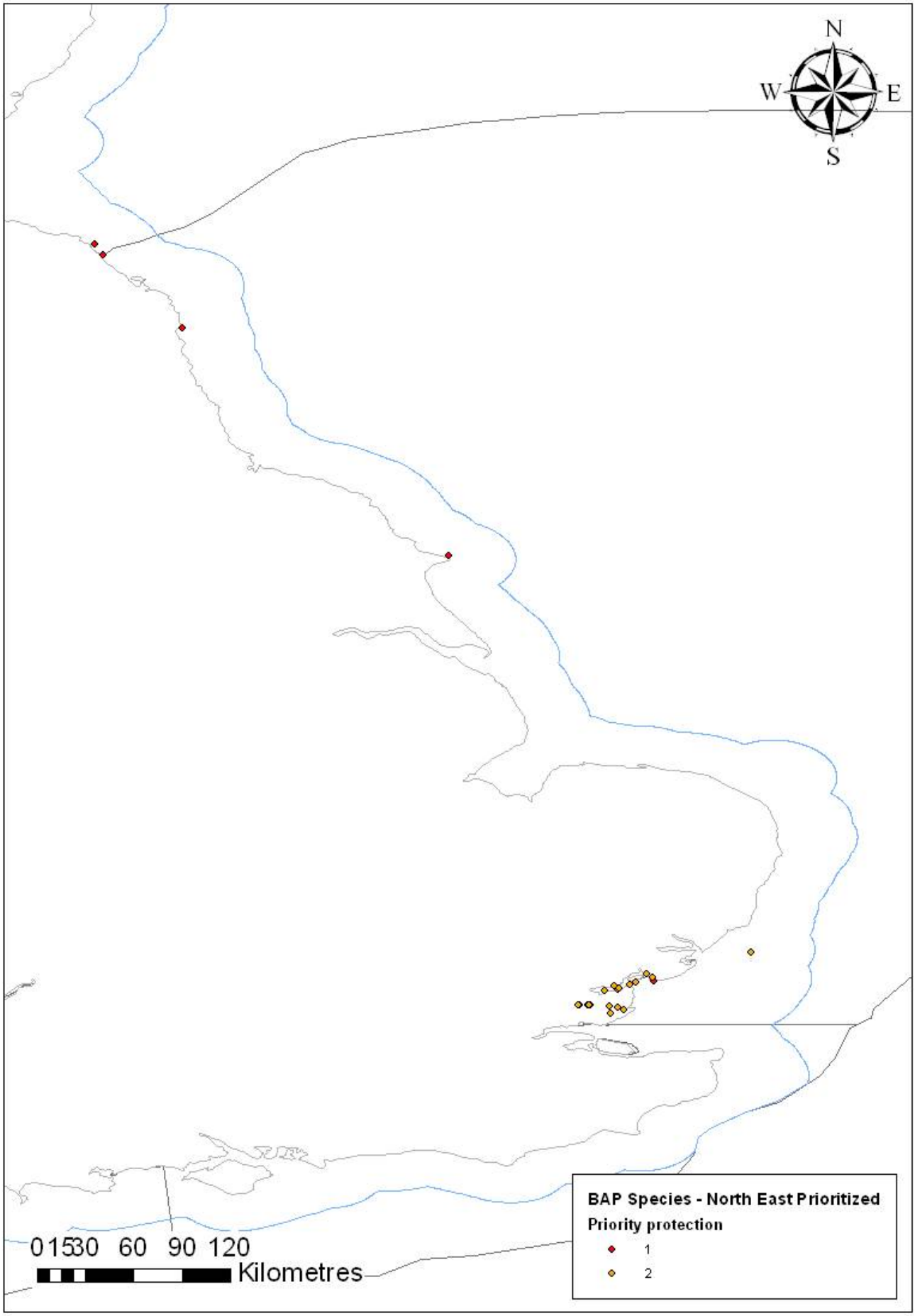
Kilometres
Bap Species - England Prioritized
Priority protection
1
2
3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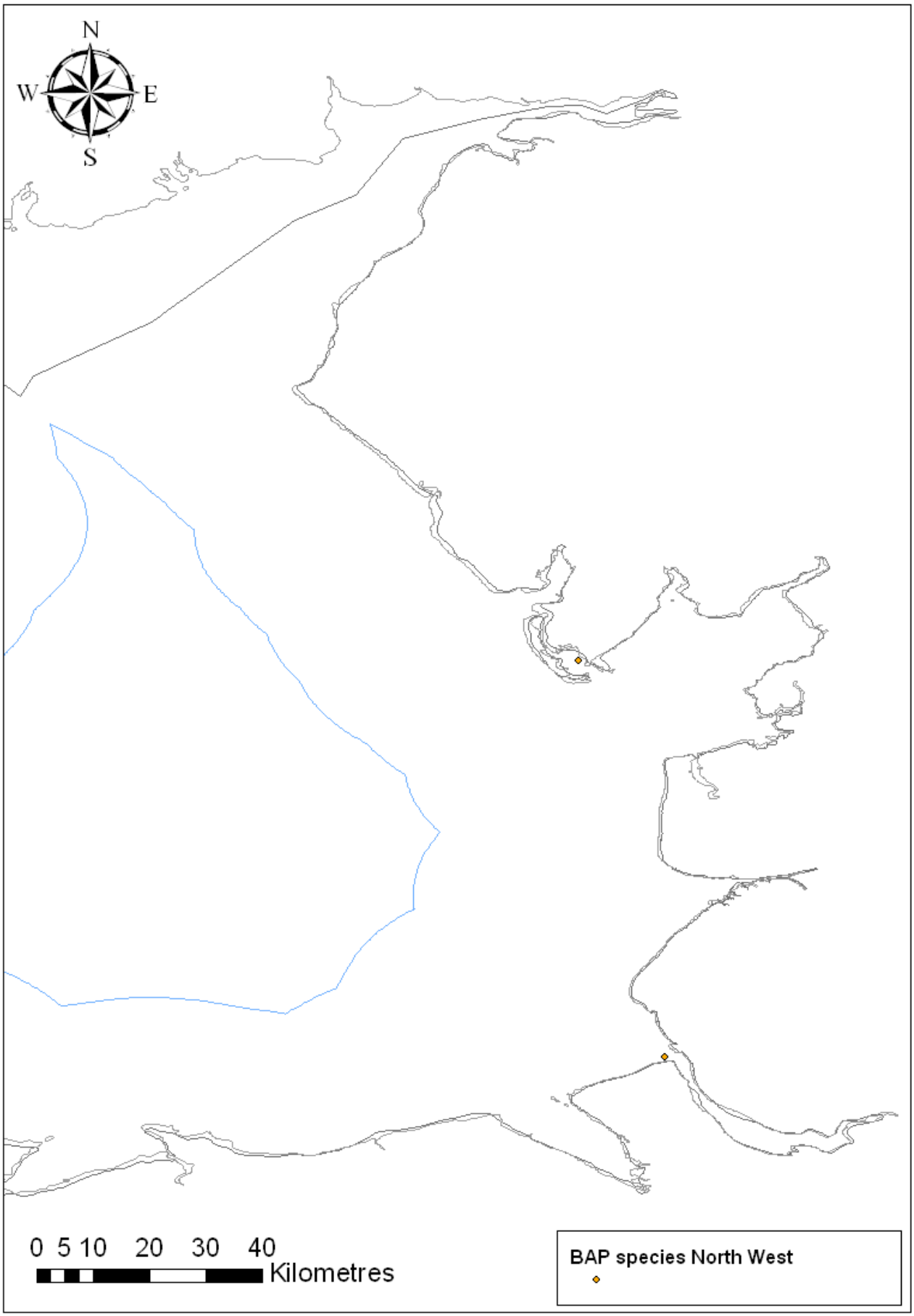
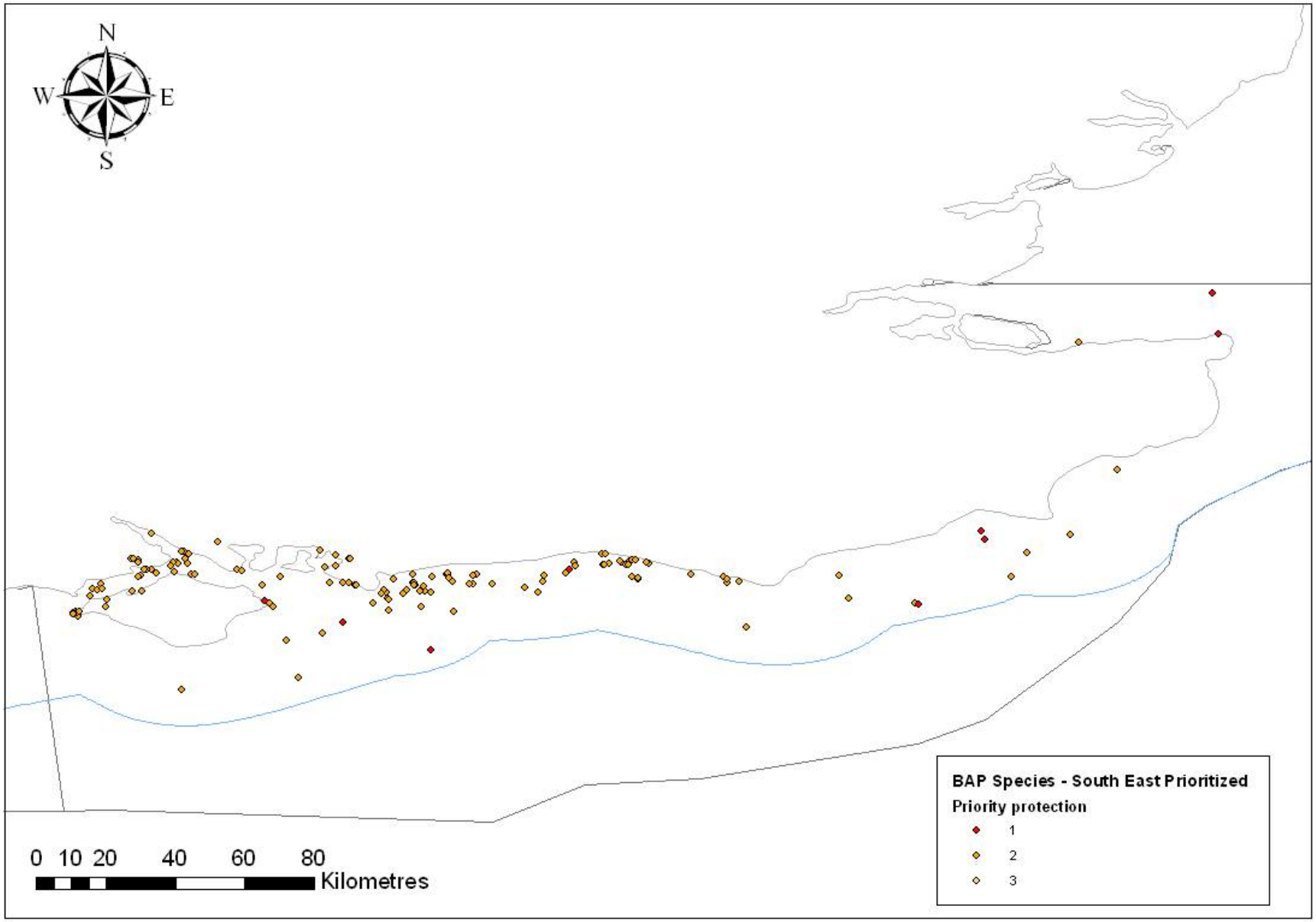
W
E
S
0 15 30 60 90 120
Kilometres
BAP Species - North East Prioritized
Priority protection
1
2


N
W
E
S
0 5 10 20 30 40
Kilometres
BAP species North West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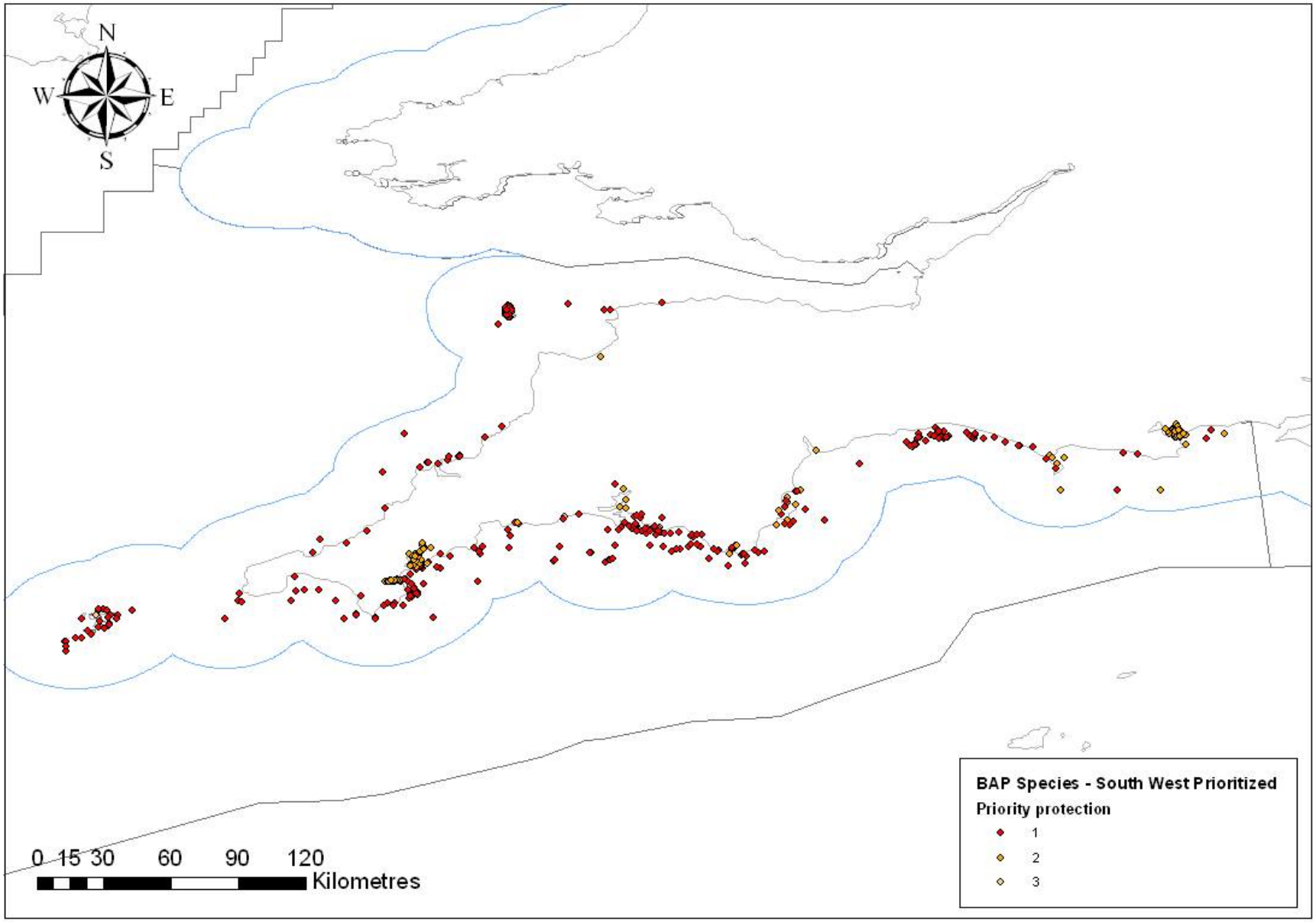
W
E
S
0 10 20 40 60 80
Kilometres
BAP Species - South East Prioritized
Priority protection
1
2
3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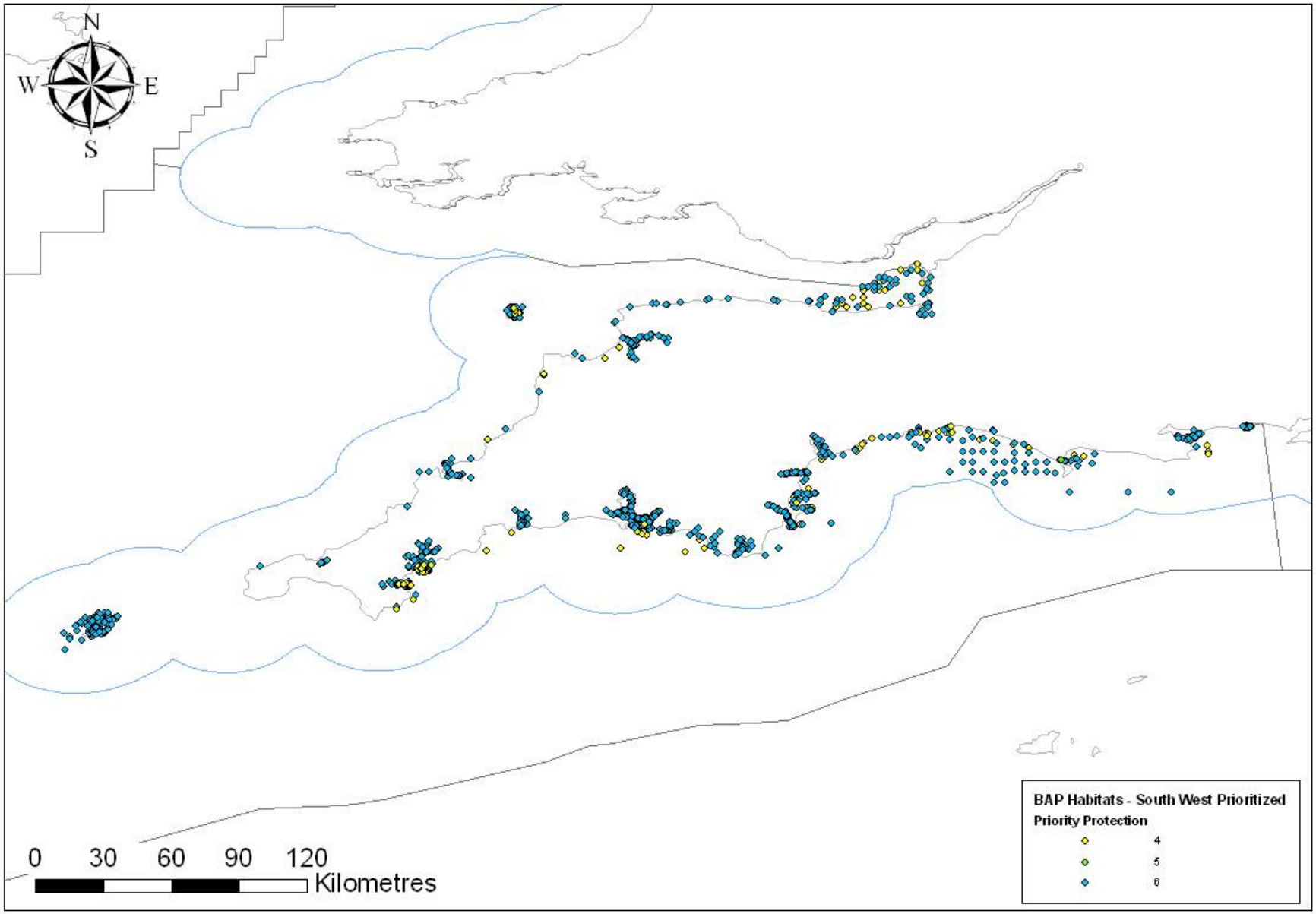
W
E
S
0 15 30 60 90 120
Kilometres
BAP Species - South West Prioritized
Priority protection
1
2
3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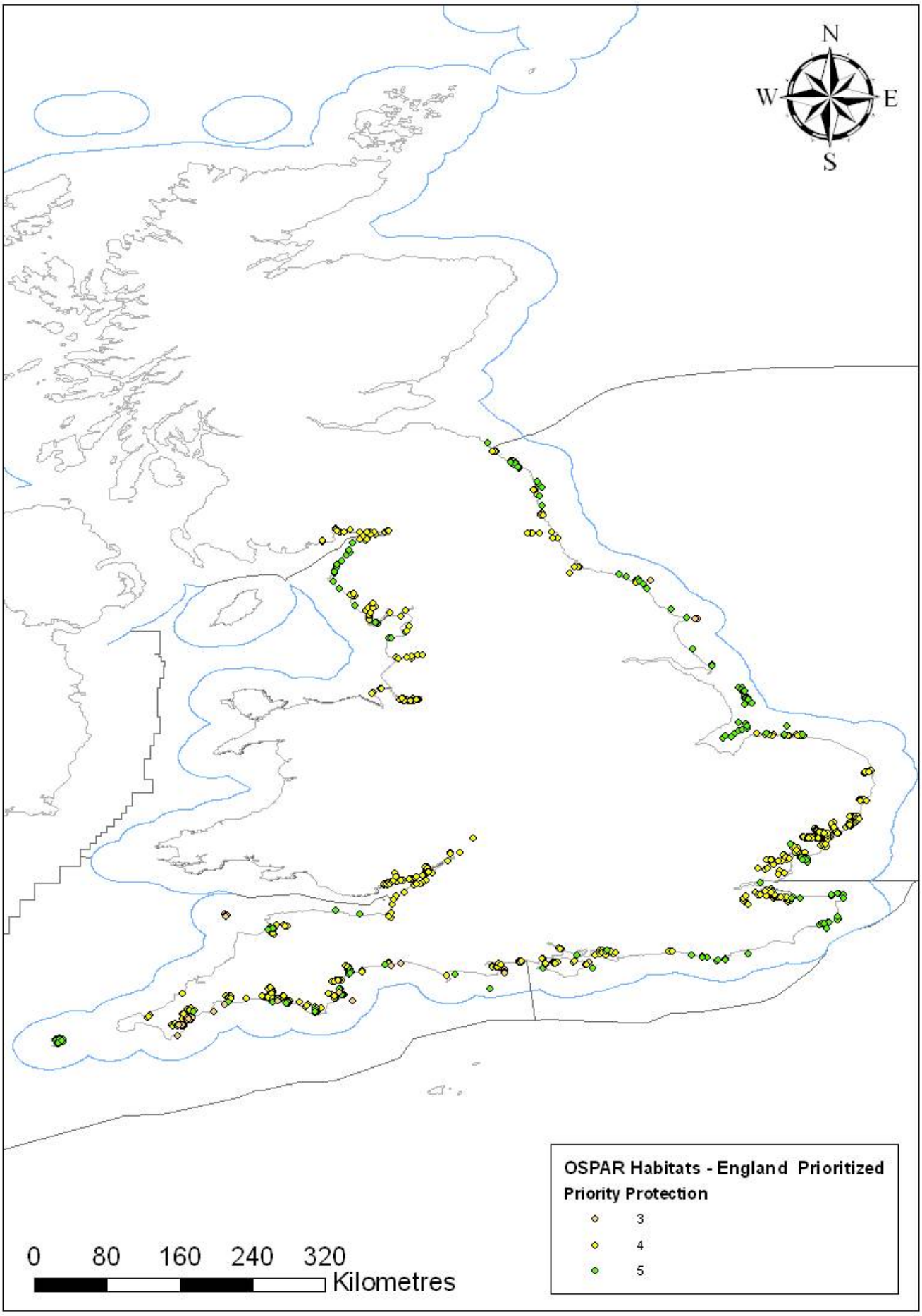
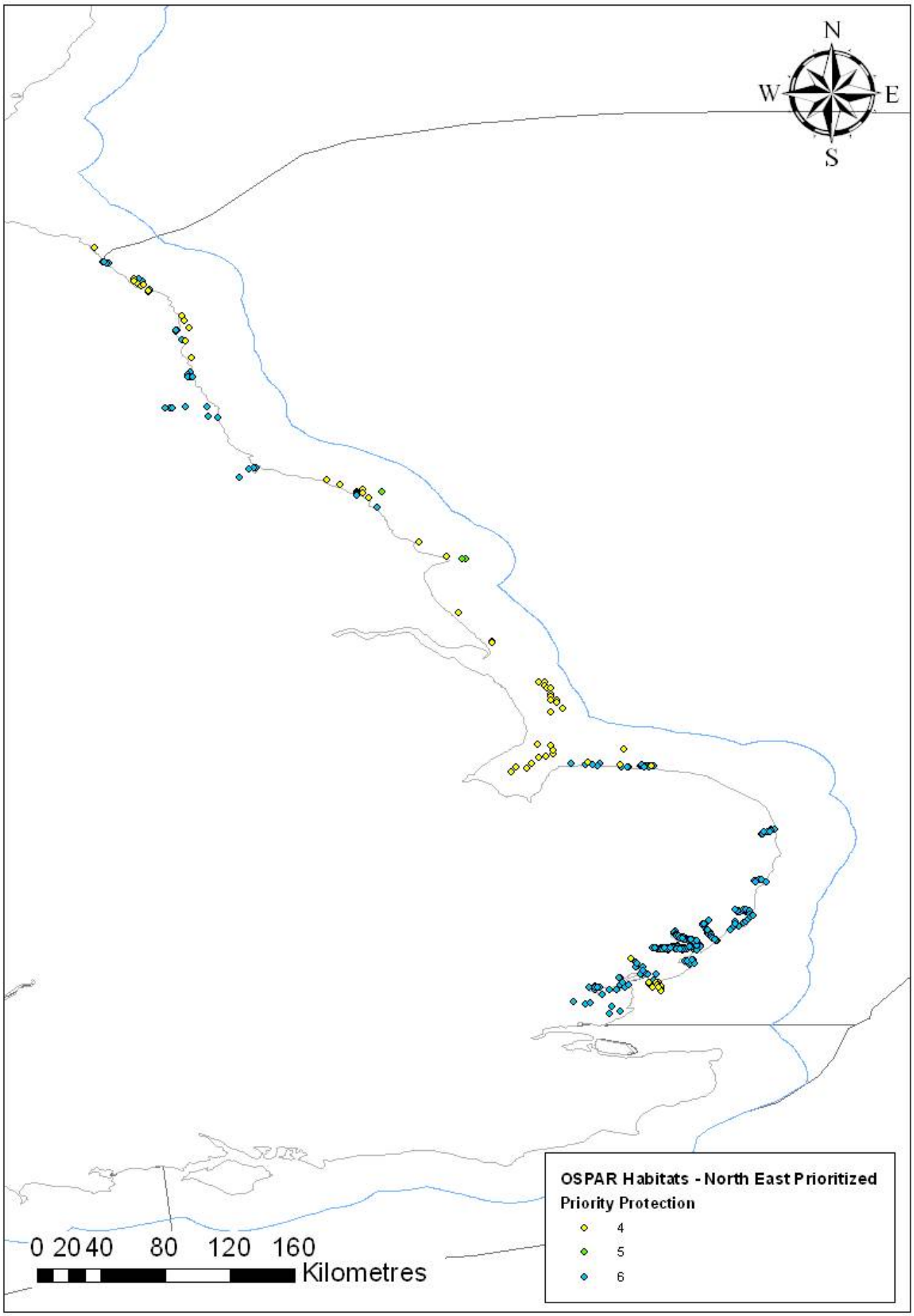
W
E
S
0 30 60 90 120
Kilometres
BAP Habitats - South West Prioritized
Priority Protection
4
5
6


N
W
E
S
0
80
160
240
320
Kilometres
OSPAR Habitats - England Prioritized
Priority Protection
3
4
5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E
S
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Kilometres
OSPAR Habitats - North East Prioritized
Priority Protection
4
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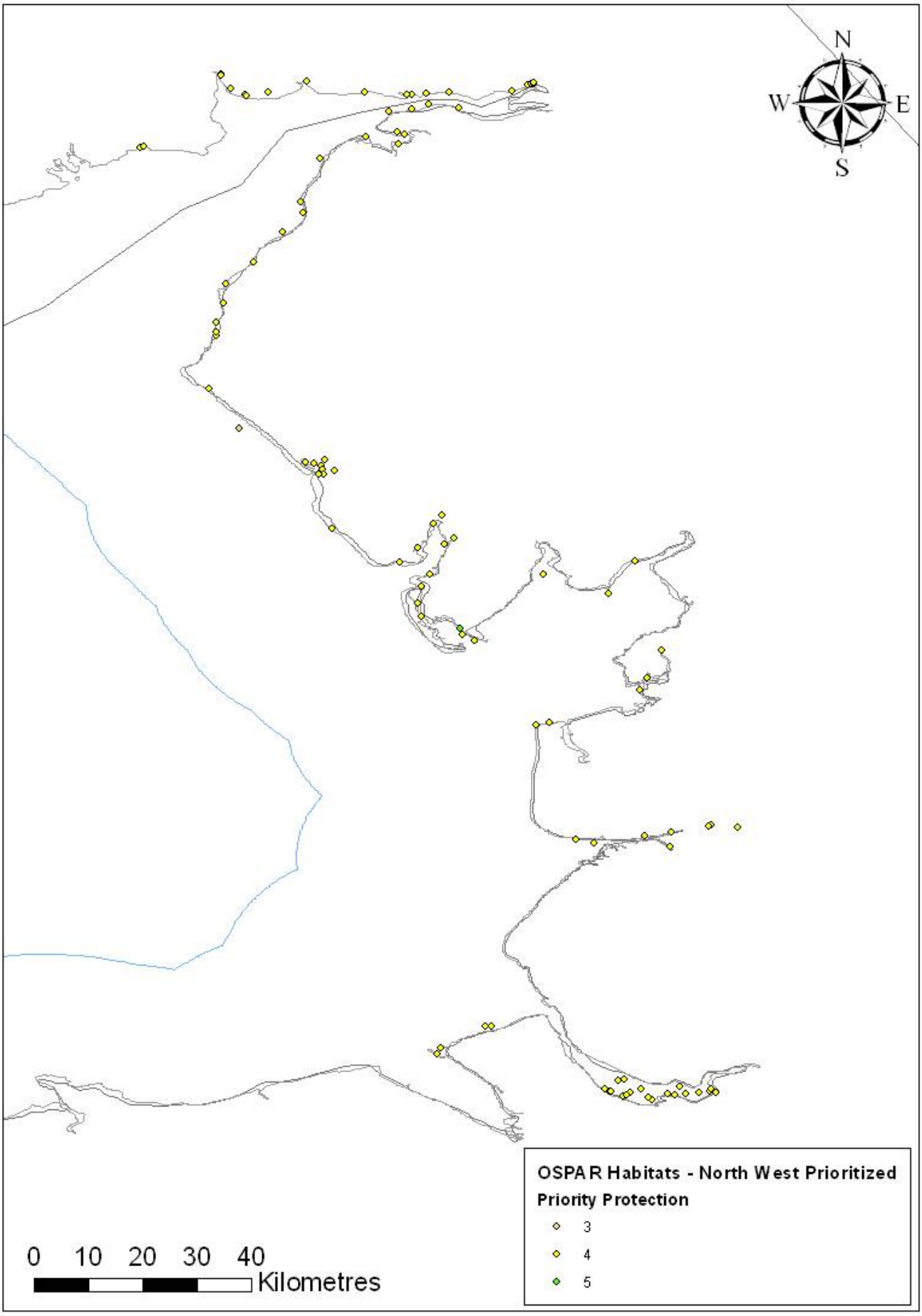
6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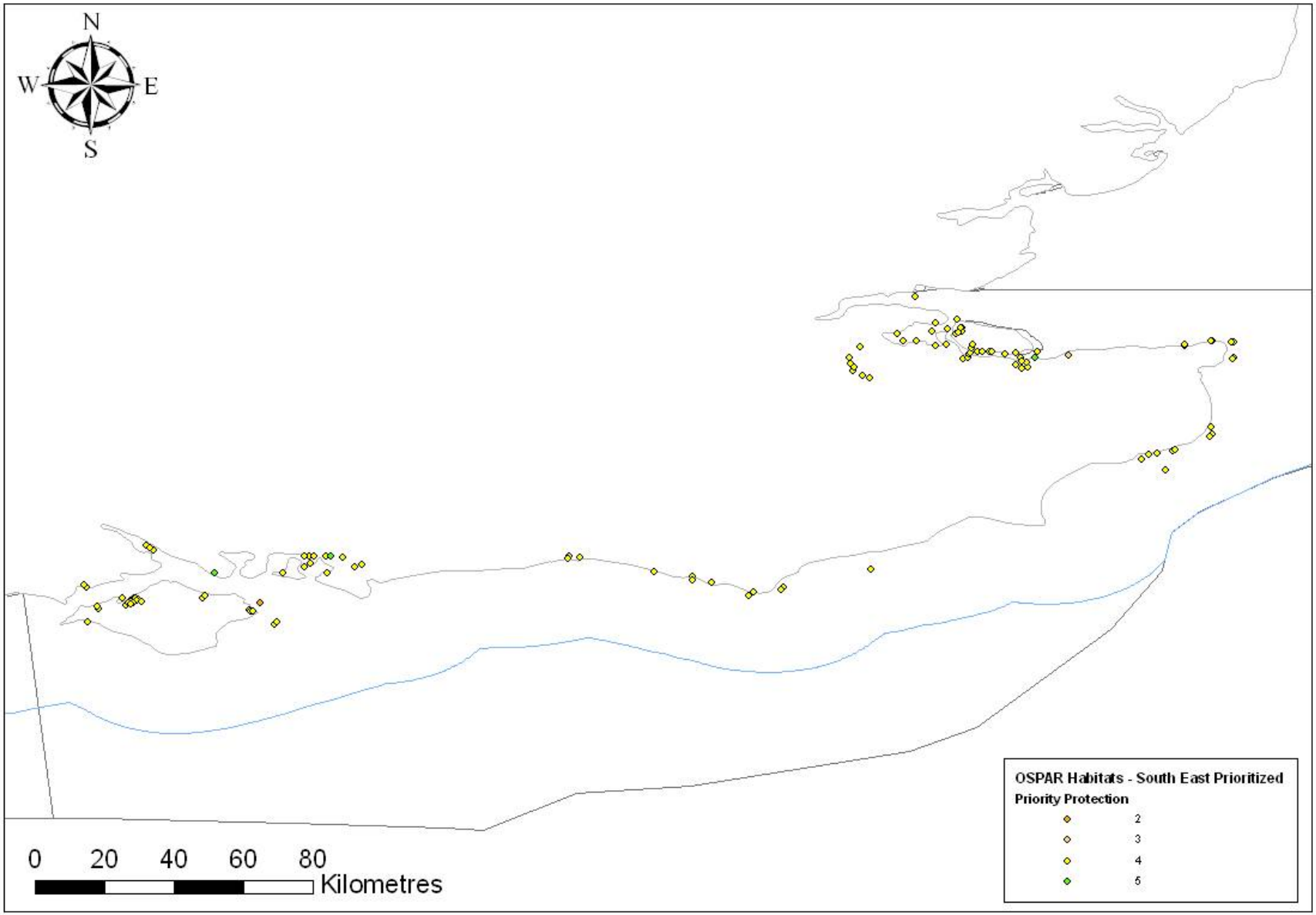
Kilometres
OSPAR Habitats - North West Prioritized
Priority Protection
3
4
5


N
W
E
S
0 20 40 60 80
Kilometres
OSPAR Habitats - South East Prioritized
Priority Protection
2
3
4
5

Appendix 6 - EUNIS level 4 habitat codes correlations

Table E EUNIS level 4 habitat codes, names and their correlations with Annex 1, BAP, OSPAR and candidate NIMF

EUNIS Level 4 code	EUNIS name	Annex 1	BAP	OSPAR	cNIMF
A1.11	[*Mytilus edulis*] and/or barnacle communities	X	X		X
A1.12	Robust fucoid and/or red seaweed communities	X	X	X	X
A1.15	Fucoids in tide-swept conditions	X	X		X
A1.21	Barnacles and fucoids on moderately exposed shores	X	X	X	X
A1.22	[*Mytilus edulis*] and fucoids on moderately exposed shores	X	X		X
A1.31	Fucoids on sheltered marine shores	X			X
A1.32	Fucoids in variable salinity	X	X		X
A1.41	Communities of littoral rockpools	X			X
A1.42	Communities of rockpools in the supralittoral zone	X			
A1.44	Communities of littoral caves and overhangs	X	X	X	X
A1.45	Ephemeral green or red seaweeds (freshwater or sand-influenced) on non-mobile substrata	X			
A2.11	Shingle (pebble) and gravel shores				
A2.21	Strandline				
A2.22	Barren or amphipod-dominated mobile sand shores	X			
A2.23	Polychaete/amphipod-dominated fine sand shores	X			
A2.24	Polychaete/bivalve-dominated muddy sand shores	X	X		
A2.31	Polychaete/bivalve-dominated mid estuarine mud shores	X	X	X	
A2.32	Polychaete/oligochaete-dominated upper estuarine mud shores	X	X	X	
A2.41	[*Hediste diversicolor*] dominated gravelly sandy mud shores				X
A2.42	Species-rich mixed sediment shores				X
A2.43	Species-poor mixed sediment shores				X
A2.61	Seagrass beds on littoral sediments	X	X	X	

Table continued...

EUNIS Level 4 code	EUNIS name	Annex 1	BAP	OSPAR	cNIMF
A2.71	Littoral [*Sabellaria*] reefs	X	X		
A2.72	Littoral [*Mytilus edulis*] beds on sediment	X	X	X	
A2.82	Ephemeral green or red seaweeds (freshwater or sand-influenced) on mobile substrata				
A3.11	Kelp with cushion fauna and/or foliose red seaweeds	X			X
A3.12	Sediment-affected or disturbed kelp and seaweed communities	X			
A3.21	Kelp and red seaweeds (moderate energy infralittoral rock)	X	X		X
A3.22	Kelp and seaweed communities in tide-swept sheltered conditions	X	X		
A3.31	Silted kelp on low energy infralittoral rock with full salinity	X			
A3.32	Kelp in variable salinity on low energy infralittoral rock	X			X
A3.36	Faunal communities on variable or reduced salinity infralittoral rock	X	X		X
A3.71	Robust faunal cushions and crusts in surge gullies and caves	X			
A3.72	Infralittoral fouling seaweed communities	X			
A4.11	Very tide-swept faunal communities on circalittoral rock	X			
A4.13	Mixed faunal turf communities on circalittoral rock	X			
A4.21	Echinoderms and crustose communities on circalittoral rock	X			
A4.22	[*Sabellaria*] reefs on circalittoral rock	X			
A4.23	Communities on soft circalittoral rock	X			
A4.24	Mussel beds on circalittoral rock	X			
A4.25	Circalittoral faunal communities in variable salinity	X			
A4.31	Brachiopod and ascidian communities on circalittoral rock	X			
A4.71	Communities of circalittoral caves and overhangs	X			X
A4.72	Circalittoral fouling faunal communities	X			
A5.12	Infralittoral coarse sediment	X	X		X
A5.13	Circalittoral coarse sediment		X		X
A5.22	Sublittoral sand in variable salinity (estuaries)	X	X		X
A5.23	Infralittoral fine sand	X	X		
A5.24	Infralittoral muddy sand	X	X		

Table continued...

EUNIS Level 4 code	EUNIS name	Annex 1	BAP	OSPAR	cNIMF
A5.25	Circalittoral fine sand		X		
A5.26	Circalittoral muddy sand		X		
A5.31	Sublittoral mud in low or reduced salinity (lagoons)	X	X		
A5.32	Sublittoral mud in variable salinity (estuaries)	X			X
A5.33	Infralittoral sandy mud				X
A5.34	Infralittoral fine mud	X			X
A5.35	Circalittoral sandy mud				
A5.36	Circalittoral fine mud		X	X	X
A5.41	Sublittoral mixed sediment in low or reduced salinity (lagoons)	X	X		
A5.42	Sublittoral mixed sediment in variable salinity (estuaries)	X			
A5.43	Infralittoral mixed sediments			X	X
A5.44	Circalittoral mixed sediments				X
A5.51	Maerl beds	X	X	X	
A5.52	Kelp and seaweed communities on sublittoral sediment	X	X		
A5.53	Sublittoral seagrass beds	X	X	X	X
A5.61	Sublittoral polychaete worm reefs on sediment	X	X	X	X
A5.62	Sublittoral mussel beds on sediment	X	X	X	
B3.11	Lichens or small green algae on supralittoral and littoral fringe rock	X		X	

Greyed out boxes indicate a correlation (for more details on specific correlations , i.e. whether direct or not, see Joint Nature Conservation Committee, 2007).

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