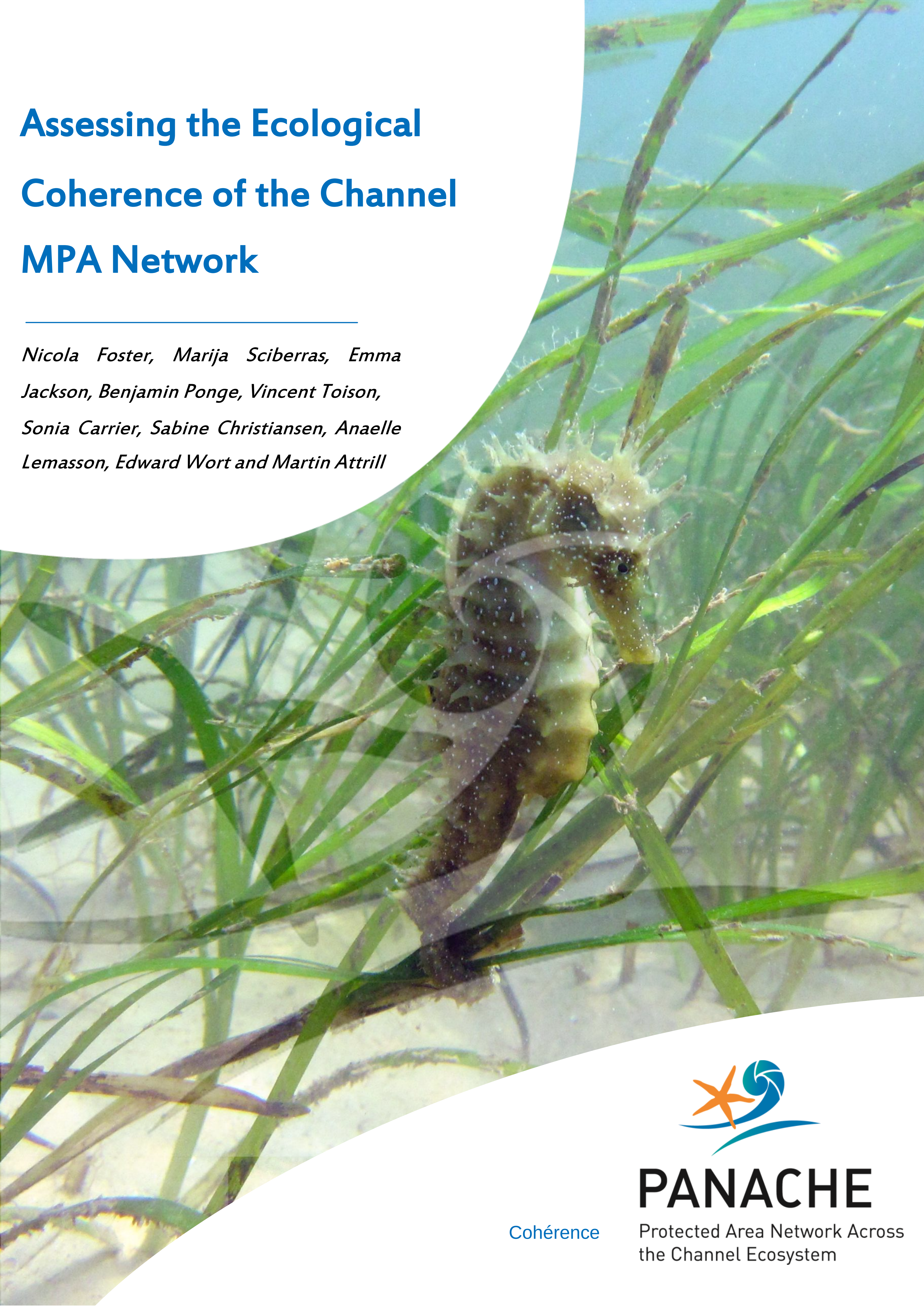
Assessing the Ecological Coherence of the Channel MPA Network

Nicola Foster, Marija Sciberras, Emma Jackson, Benjamin Ponge, Vincent Toison, Sonia Carrier, Sabine Christiansen, Anaelle Lemasson, Edward Wort and Martin Attrill



Cohérence

PANACHE

Protected Area Network Across the Channel Ecosystem

Assessing the Ecological Coherence of the Channel MPA Network

Coherence

Prepared on behalf of / Etabli par

by / par

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Assessing the Ecological Coherence of the Channel MPA Network

Evaluation de la cohérence écologique du réseau d'aires marines protégées en Manche

ABSTRACT

Both France and the UK have committed to a number of European and International agreements to contribute to ecologically coherent networks of MPAs. Using 6 published criteria and 3 methodologies, we assessed the ecological coherence of the MPA network spanning the English Channel. This is the first attempt to conduct a cross-border analysis of the ecological coherence of MPAs often designated individually to form a network of conservation areas using multiple methods. Despite the challenges experienced through a lack of data and universal reporting systems, and the general limitations of such a desk-based study, we were able to draw some conclusions about the conservation potential of the current Channel MPA network. We found that the 222 MPAs designated in the region effectively cover 89 sites, which provide good representation and replication of the habitats and species within the nearshore region. Within the PANACHE study region, MPA designations cover 31% of French waters, 10% of English waters and 3% of Channel Island waters, providing relatively good coverage of coastal and inshore waters, with a few exceptions. However, there is a noticeable lack of MPAs in offshore areas and in deeper waters, which were frequently highlighted as important areas for a number of habitats and species, in particular those with pelagic or migratory behaviour. The size of MPAs was also of concern, with only 33% in the optimal size range of 10-100 km^2 and just 4 MPAs greater than 1000 km^2, implying that the network is unlikely to support wide-ranging species or those with long distance dispersal. The potential connectivity of a number of habitats within MPAs along the coastline was found to be adequate, particularly along the French coast, but connectivity among MPAs across the Channel was unlikely to exist. Ninety-eight percent of 149 MPAs assessed for management status were found to have medium to high levels of management. However, the level of management status was found to vary for individual MPAs depending on which authority responded to the questionnaire. Based on the results of the overall assessment, the Channel MPA network cannot be considered to be ecologically coherent. Thus, we recommend the designation of larger MPAs in offshore areas and in deeper water to improve protection to offshore habitats and species and to better take into account cross-Channel connectivity.

KEYWORDS: English Channel, marine protected area network, ecological coherence, matrix approach, spatial analysis

RÉSUMÉ

La France et le Royaume-Uni ont adopté un certain nombre d'accords européens et internationaux afin de contribuer à des réseaux écologiquement cohérents d'AMP. En utilisant 6 critères et 3 méthodologies publiés dans la littérature, nous avons évalué la cohérence écologique du réseau des AMP dans la Manche. Basée sur plusieurs méthodes, ceci représente une première tentative, en tant qu'analyse transfrontalière de la cohérence écologique des AMP, désignées parfois individuellement mais ayant vocation à former un réseau de zones pour la préservation de l'environnement marin. Malgré les difficultés rencontrées, dues au manque de données, à l'absence d'un système commun de stockage et de diffusion des données, ainsi que les limites générales inhérentes aux études documentaires, nous avons pu tirer quelques conclusions quant au potentiel de conservation du réseau actuel des AMP dans la Manche. Nous avons constaté que les 222 AMP désignées dans cette zone couvrent en fait 89 sites, et fournissent une forte représentation et duplication des habitats et espèces en zone côtière. Dans la zone d'étude couverte par PANACHE, les AMP couvrent 31% des eaux françaises, 10% des eaux anglaises et 3% des eaux des îles Anglo-Normandes, fournissant une couverture relativement bonne des eaux côtières et littorales, avec quelques exceptions. Néanmoins, il y a des lacunes notoire en termes d'AMP dans les zones du large et les eaux profondes, qui sont fréquemment présentées comme des zones importantes pour plusieurs habitats et espèces, en particulier ceux ayant un mode de vie migratoire ou pélagique. La taille des AMP pose également question, puisque seulement 33% des AMP sont dans l'intervalle optimal de taille entre 10 et 100 km² et que seules 4 AMP mesurent plus de 1000 km², impliquant qu'il est peu probable que le réseau puisse soutenir des espèces à forte mobilité ou ayant des distances de dispersion importantes. L'étude a montré que la connectivité potentielle d'un certain nombre d'habitats parmi les AMP proches de la côte était adéquate, particulièrement le long des côtes françaises, mais la connectivité entre les AMP de part de d'autre de la Manche semble peu probable. 98% des 149 AMP évaluées quant à l'état de la gestion présentent des niveaux de gestion moyens à hauts. Cependant, le niveau de gestion rapporté individuellement pour les AMP change en fonction de l'organisation ayant répondu au sondage. Sur la base des résultats de l'évaluation dans son ensemble, le réseau d' AMP de la Manche ne peut pas être considéré comme écologiquement cohérent. De fait, nous recommandons la désignation d'AMP plus grandes et au large afin d'améliorer la protection des habitats et espèces qui se trouvent dans les eaux profondes et de mieux prendre en compte la connectivité de part et d'autre de la Manche.

MOTS-CLÉS : La Manche, réseau d'aires marines protégées, cohérence écologique, approche matricielle, analyse spatiale

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Contents

Acknowledgements 4

List of Figures 9

List of Tables 13

List of frequently used acronyms 16

I. Introduction 17

II. General Methodology 21

2.1 The English Channel 21

2.2 The study area 21

2.3 The MPA network 22

2.4 Data sources 24

2.4.1 Matrix approach 25

2.4.2 Spatial analysis 25

2.5 Data handling prior to analysis 27

2.5.1 Marine Conservation Zones 27

2.5.2 Overlapping MPAs 27

2.5.3 Spatial analysis 28

2.5.4 EUSeaMap data layer 28

III. Spatial Analysis 30

3.1 Representativity 30

3.1.1 Methodology 30

a) Geographical representativity 30

b) Biogeographic representativity 30

c) Bathymetric representativity 30

d) Marine mammals and seabirds 31

e) Spawning grounds for cuttlefish (*Sepia officinalis*) 33

f) Breeding areas for bird species listed in the EU Birds Directive 33

3.1.2 Results 34

a) MPA distribution in national waters ... 34
b) Distribution of MPAs within inshore and offshore areas ... 36
c) Distribution of MPAs in the eastern and western Channel ... 37
d) Distribution of MPAs within biogeographic provinces ... 37
e) MPA Distribution in different depth zones ... 39
f) Importance of MPA network for marine mammals (Aerial surveys) ... 39
g) Importance of the MPA network for seabirds at sea (Aerial surveys) ... 41
h) Spawning grounds for cuttlefish (*Sepia officinalis*) ... 47
i) Breeding Areas for Bird Species Listed in the EU Birds Directive ... 48
3.1.3 Discussion ... 53
3.2 Replication ... 55
3.2.1 Methodology ... 56
a) EUNIS Level 3 Habitats ... 56
b) Habitats of Conservation Importance ... 56
c) Species of Conservation Importance ... 56
3.2.2 Results ... 57
a) Replication of EUNIS Level 3 Habitats ... 57
b) Replication of Habitats of Conservation Importance ... 59
c) Replication of Species of Conservation Importance ... 59
3.2.3 Discussion ... 61
3.3 Viability ... 62
3.3.1 Methodology ... 62
a) Size, compactness and edge-to-area ratio of MPAs ... 62
b) Size Distribution of EUNIS Level 3 Habitat Patches within the MPA Network ... 63
3.3.2 Results ... 63
a) Size Distribution, Compactness and Edge-to-Area Ratio of MPAs ... 63
b) Size Distribution of EUNIS Level 3 Habitat Patches ... 65
3.3.3 Discussion ... 67
3.4 Adequacy ... 69
3.4.1 Methodology ... 69
a) Area of EUNIS Level 3 Habitats within the MPA Network ... 69

b) Area of Habitats of Conservation Importance within the MPA Network 69

3.4.2 Results 70

a) Area of EUNIS Level 3 Habitats and Habitats of Conservation Importance 70

3.4.3 Discussion 71

3.5 Connectivity 72

3.5.1 Methodology 74

a) Habitat Patch (polygon) Aggregation 74

b) Minimum Habitat Patch Size 74

c) Maximum Dispersal Distance 75

d) Analyses 75

3.5.2 Results 76

a) Connectivity among MPAs within the Network 76

b) Habitat connections within and outside the MPA network 77

c) Within-MPA versus among-MPA Connectivity 79

d) Habitat Buffers 81

e) Summary of Connectivity 82

3.5.3 Discussion 82

IV. Matrix Approach 85

4.1 Methodology 85

4.2 Representativity 86

4.2.1 Results 86

a) Qualifying Species 86

b) EUNIS Level 3 Habitats 87

c) OSPAR Habitats 87

d) Annex 1 Habitats (Habitats Directive) 87

4.3 Replication 88

4.3.1 Results 88

a) Qualifying Species 88

b) EUNIS Level 3 Habitats 89

c) OSPAR Habitats 89

d) Annex 1 Habitats (Habitats Directive) 90

4.4 Discussion 91
V. Expert-based Knowledge Questionnaire 93
5.1 Methodology 94
5.1.1 Expert-based Knowledge Questionnaire 94
5.1.2 Questionnaire Scoring System 95
5.2 Results 95
5.2.1 Questionnaire 95
5.2.2 Assessment of the MPAs' Management Capacity 97
5.2.3 Responses from other authorities 99
5.3 Discussion 101
VI. Challenges and Limitations 102
6.1 Data Availability and Quality 102
6.2 Matrix Approach 103
6.3 Assessment of Connectivity 103
6.4 A cautionary note: Conservation objectives 105
VII. Conclusions 107
VIII. Recommendations 113
IX. References 116
Appendices 123
Appendix 1 – Marine Protected Areas 123
Appendix 2 – EUNIS Level 3 Habitats 129
Appendix 3 – Qualifying Species 131
Appendix 4 - Guidance notes for questionnaire participants 134
Appendix 5 – Questionnaire 137
Appendix 6 - Scoring System for Questionnaire 141
Appendix 7 – Management Status Scores 142
Appendix 8 - Additional marine mammal and seabird results 145

List of Figures

Figure 1: The PANACHE study area highlighting the range of MPA designation types within the network. 22
Figure 2: Examples of full (a) and partial (b) MPA overlaps, and feature distribution in overlapping MPAs (c, d) in the Channel MPA network. 28
Figure 3: Aerial transects conducted within the Channel during Winter 2011-2012 and Summer 2012. 32
Figure 4: The number (represented by labels on pie chart) and area (km^2; represented by the size of the pie-chart segments) of MPAs of each designation category with the Channel network. 36
Figure 5: The location of MPAs in the Channel in relation to the continental shelf biogeographic provinces as defined by Dinter (2001). 38
Figure 6: The location of MPAs in the Channel in relation to the pelagic biogeographic provinces as defined by Dinter (2001). 38
Figure 7: Bathymetric range of (a) Channel waters and (b) representation of depth zones in designated MPAs. 39
Figure 8: Encounter rates of Harbour Porpoise in winter 2011-2012 (left panel) and summer 2012 (right panel) in the English Channel. 40
Figure 9: Encounter rates of the Common Bottlenose Dolphin in winter 2011-2012 (left panel) and summer 2012 (right panel) in the English Channel. 41
Figure 10: Encounter rates of Common Murres and Razorbills (Auks) in winter 2011-2012 (top panel) and summer 2012 (bottom panel) in the English Channel. 42
Figure 11: Encounter rates of Northern Fulmar in winter 2011-2012 (top panel) and summer 2012 (bottom panel) in the English Channel. 43
Figure 12: Encounter rates of Great or Lesser Black-backed Gulls in winter 2011-2012 (top panel) and summer 2012 (bottom panel) in the English Channel. 44
Figure 13: Encounter rates of Black-legged Kittiwake in winter 2011-2012 (top panel) and summer 2012 (bottom panel) in the English Channel. 45
Figure 14: Encounter rates of the terns in 2011-2012 (top panel) and summer 2012 (bottom panel) in the English Channel. 46
Figure 15: Encounter rates of Gannets in winter 2011-2012 (top panel) and summer 2012 (bottom panel) in the English Channel. 47
Figure 16: Predicted suitable spawning habitat for the cuttlefish Sepia officinalis (shown in red) overlaid with the Channel MPA network. 48
Figure 17: Distribution of the Channel MPA network and Alca torda (Razorbill) breeding populations in England and the Channel Islands. 49
Figure 18: Distribution of the Channel MPA network and Fratercula arctica (Atlantic Puffin) breeding populations in England and the Channel Islands. 50
Figure 19: Distribution of the Channel MPA network and Fulmarus glacialis (Northern Fulmar) breeding populations in England and the Channel Islands. 51

Figure 20: *Distribution of the Channel MPA network and Rissa tridactyla (Black-legged Kittiwake) breeding populations in England and the Channel Islands.* 52
Figure 21*: Distribution of the Channel MPA network and Sterna dougallii (Roseate Tern) breeding colonies in England and the Channel Islands.* 52
Figure 22*: Distribution of the Channel MPA network and Sterna sandvicensis (Sandwich Tern) breeding populations in England and the Channel Island.* 53
Figure 23: *Distribution of the EUNIS Level 3 habitat sublittoral coarse sediment (A5.1) within the PANACHE study region and overlap with the Channel MPA network.* 58
Figure 24: *Distribution of the EUNIS Level 3 habitat sublittoral sand (A5.2) within the PANACHE study region and overlap with the Channel MPA network.* 58
Figure 25*: Distribution of Ostrea edulis populations within the PANACHE study region and occurrence within boundaries of MPAs within the Channel network. Note: Only data on populations along the English coastline are presented.* 60
Figure 26: *Distribution of Hippocampus guttulatus populations within the PANACHE study region and occurrence within the boundaries of MPAs within the Channel network. Note: Only data on populations along the English coastline are presented.* 60
Figure 27: *Size distribution of MPAs within the Channel MPA network. The inset plot shows the size distribution of MPAs smaller than 100 km^2; red lines denote optimum MPA size range recommended by Halpern and Warner (2003); blue lines denote optimum MPA size range recommended by Shanks et al. (2003).*.. 64
Figure 28*: Relationship between MPA area and mean depth of MPAs within the network. Inset shows MPAs with an area <100 km^2; red lines denote optimum MPA size range recommended by Halpern and Warner (2003); blue lines denote optimum MPA size range recommended by Shanks et al. (2003).* 64
Figure 29*: Compactness index of MPA sites within the Channel MPA network.* 65
Figure 30*: Edge-to-Area ratio of MPA sites within the Channel MPA network.* 65
Figure 31: *Size frequency distribution of habitat patch sizes within the PANACHE study area (black bars) and within the MPA network (grey bars) for EUNIS Level 3 habitats with >1000 km^2 within the*. 67
Figure 32*: Distribution of EUNIS Level 3 habitats and habitats of conservation importance inside and outside the Channel MPA network. EUNIS Level 3 habitat abbreviations provided in table 12.* 71
Figure 33: *The number of MPAs connected throughout the Channel MPA network for each of the EUNIS Level 3 habitats, Maerl beds, Sabellaria reefs and Zostera beds. The total number of MPAs in which each habitat occurs is provided next to habitat type. EUNIS Habitat abbreviations defined in Table 14.*.. 77
Figure 34*: Number of connections among habitat patches located inside and outside the MPA network (one connection represents two connected habitat patches). EUNIS Habitat abbreviations defined in Table 14.* 78
Figure 35*: Potential number of connections (degree centrality) among habitat patches of EUNIS Level 3 sublittoral coarse sediment (A5.1) using a maximum connection distance of 40 km, overlaid with the*

Channel MPA network. 20 km buffers around MPAs containing A5.1 habitat patches are also shown (green shading) 78
Figure 36: *Potential number of connections (degree centrality) among habitat patches of EUNIS Level 3 low energy infralittoral rock (A3.3) using a maximum connection distance of 40 km, overlaid with the Channel MPA network. 20 km buffers around MPAs containing A3.3 habitat patches are also shown (green shading).* 79
Figure 37: *Potential number of connections (degree centrality) among habitat patches of EUNIS Level 3 low energy circalittoral rock (A4.3) using a maximum connection distance of 40 km, overlaid with the Channel MPA network; 20 km buffers around MPAs containing A4.3 habitat patches are also shown (green shading).* 79
Figure 38: *The proportion of connected habitat patches occurring within one (within-site connectivity) or several (between-site connectivity) MPA sites in the Channel MPA network for EUNIS Level 3 habitats, Sabellaria reefs, Maerl beds and Zostera bed. EUNIS Habitats defined in Table 14.* 80
Figure 39: *Potential number of connections (degree centrality) among habitat patches of Zostera using a maximum connection distance of 40 km, overlaid with the Channel MPA network; 20 km buffers around MPAs containing Zostera habitat patches are also shown (green shading). No data available for France in the East Channel.* 81
Figure 40*: Potential number of connections (degree centrality) among habitat patches of sublittoral sand (A5.2) using a maximum connection distance of 40 km; 20 km buffer around A5.2 habitat type contained with MPA Network.* 82
Figure 41: *Proportions of the 11 taxonomic groups listed within MPAs within the Channel network.* . 87
Figure 42*: Frequency of occurrence of Taxonomic Groups within MPAs in the Channel network.* 88
Figure 43*: Frequency of occurrence of EUNIS Level 3 Habitats within MPAs in the Channel network. EUNIS Level 3 habitat abbreviations are defined in Appendix 2.* 89
Figure 44*: Frequency of occurrence of OSPAR Habitats within MPAs in the Channel network.* 90
Figure 45*: Frequency of occurrence of Annex 1 Habitats within MPAs in the Channel network. Habitat abbreviations are defined in Table 16.* 90
Figure 46*: Level of management status assigned to individual MPAs in France, England and the Channel Islands.* 96
Figure 47: *Level of management status assigned to MPAs within the Channel MPA network.* 97
Figure 48*: Detailed responses to the five questions posed in the management status questionnaire for MPAs within the Channel network.* 99
Figure 49: Distribution of Maerl beds within the Channel MPA network. 105
Figure 50*: Encounter rates of Seals (Halichoerus grypus and Phoca vitulina) in winter 2011-2012 (top panel) and summer 2012 (bottom panel) in the English Channel.* 146
Figure 51*: Encounter rates of Small Oceanic Dolphins (Delphinus delphis, Stenella coeruleoalba) in winter 2011-2012 (top panel) and in summer 2012 (bottom panel) in the English Channel).* 146
Figure 52*: Encounter rates of Pilot Whales in winter 2011-2012 (top panel) and in summer 2012 (bottom panel) in the English Channel.* 147

***Figure 53**: Encounter rates of Rorquals (the common Minke Whale in the Channel) in winter 2011-2012 (top panel) and in summer 2012 (bottom panel) in the English Channel.* 147
***Figure 54**: Encounter rates of the Great Skua in winter 2011-2012 (top panel) and in summer 2012 (bottom panel) in the English Channel.* 148
***Figure 55:** Encounter rates of Black-headed and Mediterranean Gulls in winter 2011-2012 (top panel) and in summer 2012 (bottom panel) in the English Channel.* 148
***Figure 56**: Encounter rates of European Herring or Yellow-legged in winter 2011-2012 (top panel) and in summer 2012 (bottom panel) in the English Channel.* 149
***Figure 57:** Encounter rates of the Little Gull in winter 2011-2012 (top panel) and in summer 2012 (bottom panel) in the English Channel.* 149
***Figure 58**: Encounter rates of Storm Petrels in winter 2011-2012 (top panel) and in summer 2012 (bottom panel) in the English Channel.* 150
***Figure 59**: Encounter rates of Small Shearwaters (mainly the Manx Shearwater) in winter 2011-2012 (top panel) and in summer 2012 (bottom panel) in the English Channel.* 150

List of Tables

Table 1: *Sampling effort of marine mammal and seabird aerial surveys in the PANACHE study area.* 31

Table 2: *Overall area of waters under the national jurisdiction of the UK (England), France and the Channel Islands within the boundaries of the PANACHE study region, and area of respective national waters within the Channel MPA network. MPA overlaps were taken into account. Values meeting threshold of 10% of an area (CBD, 2010) are shaded in green, those below threshold in red.* 35

Table 3*: The number of each MPA category in waters under the national jurisdiction of the UK (England), France and the Channel Islands, and the area and percentage of national waters occurring within each MPA category, within the boundaries of the PANACHE study region. MPA overlaps not taken into account.* 35

Table 4*: The proportions of inshore (12 nm from the shore) and offshore (12-200 nm from the shore) areas occurring within MPAs within the boundaries of the PANACHE study region. Overlaps among MPAs were taken into account.* 36

Table 5: *The area and percentage of geographic regions within national waters of each country covered by MPAs, and the proportion of the eastern and western Channel covered by MPAs in each geographic region of each country. Note: Marine Conservation Zones are included; Overlaps among MPAs were taken into account.* 37

Table 6*: The occurrence of biogeographic provinces in the Channel and within MPAs in the Channel network. Values meeting threshold of 10% of an area (Jackson et al., 2008) are shaded in green, those below threshold in red.* 37

Table 7: *Marine mammal observation indices within the Channel MPA network, winter 2011-2012 and summer 2012. * The observation indices of Rorquals in winter in the Channel were minimal.* 39

Table 8: *Seabird observation indices within the Channel MPA network, winter 2011-2012 and summer 2012.* 41

Table 9: *Replication of EUNIS Level 3 habitats within MPAs in the Channel network. Occurrence of habitats within overlapping MPAs was only counted once. Blank cells denote areas where habitats and MPAs did not overlap. Values meeting threshold of two replicates are shaded in green.* 57

Table 10*: Occurrence of habitats of conservation importance within MPAs in the Channel network. Occurrence of habitats within overlapping MPAs was only counted once. NA denotes data not available. Values meeting threshold of three replicates are shaded in green.* 59

Table 11: *Occurrence of species of conservation importance within MPAs in the English section of the Channel MPA network. Values meeting threshold of three replicates are shaded in green.* 59

Table 12*: Occurrence of EUNIS Level 3 habitats within the PANACHE study area and within MPAs in the Channel network. [1]Denotes thresholds recommended by Rondinini (2010) and turquoise shading indicates threshold was met. Habitats with an area in the network of <20% are shown in yellow, between 20 – 60% are shown in blue and > 60% in green (HELCOM, 2010).* 70

Table 13: *Occurrence of habitats of conservation importance within the PANACHE study area and*

within MPAs in the Channel network. Habitats with an area in the network of between 20 – 60% are shown in blue and > 60% in green (HELCOM, 2010). 71

***Table 14**: Habitat type, area within PANACHE study region, area within MPAs in the network, minimum patch size and maximum dispersal distance used for calculating degree centrality and buffers. Values in parentheses denote EUNIS habitat code (European Environment Agency, 2007). NB: the minimum patch size for EUNIS Level 3 habitats is the minimum cell size from the EUSeaMap.* 75

***Table 15:** Number of MPAs in which OSPAR threatened and declining habitats are named as conservation targets in the Channel network. Values represent minimum occurrences where 100% and partial MPA overlap are accounted for. Blank cells denote a habitat or species is not listed as a qualifying feature in the MPAs in that region of the Channel. Values meeting threshold of three replicates shaded in green, those below threshold in red.* 87

***Table 16**: Number of MPAs in which Annex 1 habitats (Habitats Directive) are named as conservation targets in the Channel network. Values represent minimum occurrence where 100% and partial MPA overlap are accounted for. Blank cells denote that a habitat or species is not listed as a qualifying feature in the MPAs in that region of the Channel. Values meeting threshold of three replicates shaded in green.* 87

***Table 17**: Satutory bodies contacted and number of questionnaires returned for the assessment of MPA management status of MPAs within the Channel network.* 99

***Table 18**: Total score and management status category for English MPAs with multiple questionnaire responses. For MMO scores, + denotes Q1 was excluded. NA denotes questionnaire not sent to authority, NR denotes no response received.* 100

***Table 19**: The proportion of Maerl beds within MPAs which have been specifically designated to conserve Maerl beds (+ Designated features) and those which have not been (- Designated features).* 106

***Table 20:** Summary of the main conclusions of the ecological coherence assessment of the Channel MPA network. Positive results highlighted in green, intermediate results highlighted in yellow and gaps in the network highlighted in red.* 108

***Table 21**: Name, designation, location and area of all Marine Protected Areas within the PANACHE study area as of December 2013. † denotes MCZ not yet designated; * denotes MCZs used only in marine mammal and cetacean analysis.* 123

***Table 22**: Occurrence of EUNIS Level 3 habitats within the Channel MPA network. Values represent minimum occurrence where 100% and partial MPA overlap are accounted for. Blank cells denote that a habitat or species is not listed as a qualifying feature in the MPAs that region of the Channel*....... 129

***Table 23**: Qualifying species and number of MPAs in which they are listed as conservation objectives within the MPA network.* 131

***Table 24:** Questionnaire scores and management status category for MPAs within the Channel Network. X denotes no response. NA denotes questionnaire not sent.* 142

***Table 25**: Number of sightings of marine mammals during aerial surveys of the Channel in winter*

2011-2012 and summer 2012. Please note: A sighting of 1 denotes a single sighting irrespective of the number of individuals present. 145

Table 26*: Number of sightings of seabirds during aerial surveys of the Channel in winter 2011-2012 and summer 2012. Please note: A sighting of 1 denotes a single sighting irrespective of the number of individuals present.* 145

List of frequently used acronyms

AAMP – Agence des aires marines protégées (French Marine Protected Areas Agency)

APPB - Arrêtés préfectoral de protection de biotope (Prefectural Orders for the Protection of Biotopes)

BALANCE - Baltic Sea Management – Nature Conservation and Sustainable Development of the Ecosystem through Spatial Planning

BAP – Biodiversity Action Plan

CBD - Convention on Biological Diversity

CHARM – Channel Integrated Approach for Marine Resource Management

CRESH - Cephalopod Recruitment from English-Channel Spawning Habitats (CRESH)

cSAC – candidate Special Area of Conservation

DASSH - Data Archive for Seabed Species & Habitats

Defra – Department for Environment, Food and Rural Affairs

DOCOB - Documents d'Objectifs (MPA objectives document)

DPM - Parties maritimes du domaine relevant du Conservatoire de l'espace littoral et des rivages lacustres (Public Coastal Domain Sites entrusted to Coastline Conservation)

DREAL - Direction régionale de l'environnement, de l'aménagement et du logement (Regional Directorates of Environment, Planning and Housing)

EEZ – Exclusive Economic Zone

EMS – European Marine Site

ERCCIS - Environmental Records centre for Cornwall & the Isles of Scilly

EUNIS - European Nature Information System (http://eunis.eea.europa.eu/)

HELCOM – Helsinki Commission/Baltic Marine Environment Protection Commission

IFCA – Inshore Fisheries and Conservation Authority

IUCN – International Union for Conservation of Nature

JNCC – Joint Nature Conservation Committee

MBA – Marine Biological Association

MCZ – Marine Conservation Zone

MESH – Mapping European Seabed Habitats (http://www.searchmesh.net/default.aspx?page=1953)

MI – Marine Institute

MMO – Marine Management Organisation

MSFD – Marine Strategy Framework Directive

OSPAR – Oslo-Paris Commission

PACOMM - Programme d'Acquisition de Connaissances sur les Oiseaux et les Mammifères Marins (Acquisition of knowledge program on birds and marine mammals)

PNM – Parc naturels marins (Natural Marine Park/Parc naturel marin)

RNR - Regional Nature Reserve (Réserve naturelle régionale)

RNN –National Nature Reserve (Réserve naturelle nationale)

SAC - Special Area of Conservation

SAMM - Survol aérien de la mégafaune marine (Aerial survey of marine megafauna)

SCI – Site of Community Importance

SPA – Special Protection Area

SSSI – Site of Special Scientific Interest

WSSD - World Summit on Sustainable Development

I. Introduction

In recent decades, marine and coastal ecosystems worldwide have come under increasing pressure from a diverse range of threats, with the synergistic effects of natural and anthropogenic disturbances transforming once complex ecosystems into monotonous level bottoms (Jackson, 2008; Lester et al., 2009; Metcalfe et al., 2013). Human activities affect the runoff of pollutants and nutrients into coastal waters, remove, alter or destroy natural habitats, extract resources and change species composition (Halpern et al., 2008). Natural disturbances include changes in sea surface temperature, fluctuations in sea level, changes in ocean biogeochemistry and extreme weather events (Jackson, 2008; Sutherland et al., 2009). The changes brought about by these natural and human disturbances are not only causing acute declines in marine biodiversity, they are depleting populations of economically and culturally important species, altering community structure and compromising ecosystem functioning and delivery of services (Lester et al., 2009). The capacity of the world's oceans to recover from these perturbations, and thus, maintain ecosystem functioning and services is being increasingly impaired (Worm et al., 2006). Consequently, the need to conserve biodiversity, protect key ecosystems and maintain the goods and services they provide is imperative.

One management tool increasingly used to respond to these threats is the establishment of Marine Protected Areas (MPAs). Using the IUCN definition, an MPA is 'a clearly defined geographical space recognised, dedicated and managed, through legal or other effective means, to achieve long-term conservation of nature with associated ecosystem services and cultural values' (Dudley, 2008). Fully-protected MPAs are typically areas set aside to maintain functioning natural ecosystems, to act as refuges for species and to maintain ecological processes that cannot survive in the majority of intensively used seascapes (Dudley, 2008). However, there are a variety of MPA categories with varying degrees of protection that aim to contribute to the long-term conservation of ecosystems and biodiversity. By reducing local-scale stressors, MPAs can provide a number of benefits including, conservation of biodiversity and biomass, protection of habitats, strengthening of trophic cascades and enhancement of ecosystem services (Lubchenco et al., 2003; Mumby and Harborne, 2010). In this report, we use the term 'Marine Protected Area' to refer to the variety of protected area designations within the English Channel.

Historically, MPAs have been established on an individual *ad hoc* basis, over varying timescales and with different conservation objectives, rather than through a systematic, planned process (UNEP-WCMC, 2008). The need for a global representative system was first recognised in 1988, at the 17th IUCN General Assembly in San José, Costa Rica; however, it was not until 2002 that the World Summit on Sustainable Development (WSSD) called for the "establishment of marine protected areas consistent with international law and based on scientific information, including representative networks by 2012" (UNEP-WCMC, 2008). In 2004, the Convention on Biological Diversity (CBD) called for Party states to establish, by 2012, comprehensive, effectively managed, and ecologically representative national and regional systems of MPAs, and that there should be effective conservation of at least

10% of each of the world's ecological regions by 2010 (UNEP-WCMC, 2008). Additionally, in 2003, the Helsinki Commission (HELCOM) and the Oslo-Paris Commission (OSPAR) committed to establish an ecologically coherent network of well-managed MPAs by 2010, consisting of Baltic Sea Protected Areas (BSPAs), OSPAR MPAs in the North East Atlantic and the Natura 2000 network (coastal and marine Special Areas of Conservation and Special Protection Areas) (HELCOM, 2010). Both France and the UK have committed to a number of European and International agreements to contribute to ecologically coherent networks of MPAs. Under the Habitats Directive (EU, 1992) and the Birds Directive (EU, 1979), both the UK and France are required to contribute to a coherent European ecological network of protected sites by designating Special Areas of Conservation for habitats and species and Special Protection Areas for birds.

The call to establish representative networks of MPAs has led to the development of methods to assess whether existing MPAs, often established on an *ad hoc* basis, could be considered to form 'representative' or 'ecologically coherent' networks (Ardron, 2008a, b; OSPAR, 2006). However, formal definitions of these terms are lacking. An MPA network is defined as a 'collection of individual MPAs operating cooperatively and synergistically, at various spatial scales, and with a range of protection levels, in order to fill ecological aims more effectively and comprehensively than individual sites could alone' (WCPA/IUCN, 2007). Ecological coherence is a legally-defined term that lacks any clear conceptual or empirical basis in ecological science, and its definition, assessment and implementation are directly linked to the statutory duties associated with the designation and management of Natura 2000 sites (Catchpole, 2012). Neither OSPAR nor HELCOM has a formal definition for ecological coherence, and though 'coherent' and 'coherence' are used throughout the EC Habitats (1992) and EC Birds (1979) Directives, these terms are not explicitly defined (Ardron, 2008a). To date, the most comprehensive working definition put forward is that by OSPAR (2007b) and Ardron (2008a) based on previous work by OSPAR (2006) and Laffoley et al (2006):

a) An ecologically coherent network of MPAs:
    i. Interacts and supports the wider environment (OSPAR, 2006, Sects. 5.3, 6);
    ii. Maintains the processes, functions, and structures of the intended protected features across their natural range (Laffoley et al., 2006); and
    iii. Functions synergistically as a whole, such that the individual protected sites benefit from each other to achieve the above two objectives (based on OSPAR, 2006, Sect. 5.2)
b) Additionally, an ecologically coherent network of MPAs may:
    i. Be designed to be resilient to changing conditions (OSPAR, 2006, Sect. 5)

Based on this working definition of ecological coherence, it is evident that a number of ecological processes need to be considered when designing, or retrospectively assessing, networks of MPAs for ecological coherence. Many marine species utilise pelagic larval stages that enable dispersal via ocean currents, and/or they have juvenile or adult stages that utilise different habitats throughout their life history (Palumbi, 2003; Shanks et al., 2003). Understanding the extent to which populations and sites are connected by larval dispersal, adult movement, and/or through functional linkages between communities, ecosystems and ecological processes is critical both for the design of MPA networks to protect biodiversity, and for the development of conservation strategies to protect species associated with degrading and fragmenting habitats (Jones et al., 2007; UNEP-WCMC, 2008). Species with wide dispersal capabilities may be less susceptible to global extinction because of their large ranges, multiple populations, and potential for local recovery through larval transport than species that disperse just a few metres (Jones et al., 2007).

With this in mind, a number of assessment criteria have been agreed upon to further improve the assessment and design of ecologically coherent MPA networks and ensure consistency across regions. Seven criteria of ecological coherence (features, representativity, connectivity, resilience, management, replication and adequacy/viability) have been developed by OSPAR, in collaboration with HELCOM and the BALANCE project, and are now widely recognised as important constituent components to consider during assessments of ecological coherence (OSPAR, 2008b). The critical elements of these criteria are reviewed elsewhere (Olsen et al., 2013; OSPAR, 2006, 2007b; Sciberras et al., 2013) and will not be covered here. In addition to the assessment criteria, three different initial approaches to assessing ecological coherence were considered by the OSPAR Biodiversity Committee, which agreed that these approaches should be developed further (Ardron, 2008b; OSPAR, 2007c). Adapted from Ardron (2008b), these are:

a) **Self-assessments**: Those involved in the network design report subjectively on how well they feel the criteria were met in the MPA selection.
b) **Species-habitat tabular assessments (matrix approach):** Cross-tabulation of species and habitats, reported to be contained within the network, against MPAs.
c) **Spatial assessments:** Examination of the overall network using tests that consider the spatial arrangement and spatial characteristics of the MPA network.

The overall aim of the PANACHE project is to develop a stronger and more coherent approach to the management, monitoring and involvement of stakeholders of MPAs in the English Channel/La Manche. There are significant efforts taking place in England and France to ensure MPAs meet European and International biodiversity protection obligations; this report provides an interim assessment to ensure that approaches being taken on either side of the Channel are more coherent and effective.

Both England and France have been working to meet their requirements under national legislation, European directives (e.g. Birds Directive, Habitats Directive and Marine Strategy Framework Directive) and global (e.g. CBD, RAMSAR) and regional conventions (e.g. OSPAR) to establish well-managed MPAs within their waters (inshore and offshore areas, and Exclusive Economic Zones). The objective of Work Package 1 (WP1) of PANACHE is to determine whether the network of MPAs designated to date across the Channel area is ecologically coherent at a transnational level, using criteria and methods put forward by OSPAR and others. The specific aims of WP1 are to:

1) Determine whether the current and planned MPAs within the Channel area meet internationally recognised ecological coherence criteria;
2) Identify gaps in the network that influence coherence; and
3) Test existing, and develop additional, ecological coherence criteria and methods for conducting an assessment of ecological coherence of an MPA network.

Following initial meetings of WP1 partners and a literature review of the methods and criteria used to assess ecological coherence (Sciberras and Rodriguez-Rodriguez, 2013; Sciberras et al., 2013), an expert workshop was convened by the Marine Institute, at Plymouth University, to agree on the criteria under which ecological coherence would be measured for the Channel MPA network. The six criteria agreed upon were: representativity, replication, viability, adequacy, connectivity and management status (previously referred to as level of protection) (Sciberras, 2013).

Using thresholds published in the literature for each of these criteria, we assess the ecological coherence of the network of MPAs spanning the English Channel (referred to hereafter as the Channel MPA network). This is the first attempt to conduct a cross-border analysis of the ecological coherence of an MPA network using multiple methods. From this study, we hope to generate recommendations for future work assessing the ecological coherence of MPA networks.

II. General Methodology

2.1 The English Channel

The English Channel (La Manche) is a shallow epicontinental sea geographically separating northern France and southern England, and connecting the North Sea to the Atlantic Ocean (Coggan and Diesing, 2011; Delavenne, 2012). The Channel extends over 750 km, and varies in width from 200 km at its widest point in the western margins to a minimum of 30 km in the eastern margins (Dover Strait) (Dauvin, 2012). The western Channel is notably deeper than the eastern Channel and the basin steeply slopes down from the shoreline to a narrow undersea trench over 170 m deep (Dauvin, 2012; McClellan et al., 2014). In the western Channel, hydrologic and oceanographic features are mainly dominated by the influence of Atlantic water and the presence of a summer thermocline offshore of Plymouth, while those in the eastern Channel are mainly affected by the Seine Estuary, which forms a 'desalinated coastal flow' parallel to the French coast (Dauvin, 2012).

The Channel constitutes a bio-geographical transition zone between the warm temperate Atlantic oceanic system and the boreal North Sea and Baltic Sea continental systems of northern Europe, encompassing a range of ecological conditions (Metcalfe et al., 2013). The meeting of warmer and colder water in the west of the Channel produces a diverse marine community, and the near-shore seabed is composed of an assortment of mixed sediments, including gravel, shells, sand and mud (Davies, 1998; Natural England, 2008). There are also occasional exposures of bedrock and boulder reefs, often extending steeply from the seabed to within a few metres of the surface (Natural England, 2008). Many of the species in the western Channel are normally associated with warmer Mediterranean waters and are considered to be at the edge of their range (Davies, 1998; Natural England, 2008). Much of the seabed in the eastern Channel is composed of mixed sand and gravel sediments, with important areas of chalk substrate (Covey, 1998; Natural England, 2008). Due to cooler temperatures and a change in substratum, the diversity of habitats and species in the eastern Channel is relatively restricted in comparison to the western Channel (Covey, 1998).

Human pressures are significant in the Channel, with activities including shipping, fisheries, mariculture, coastal and marine tourism, and submarine mining, which although they generate high revenue have the potential to adversely impact the Channel environment (McClellan et al., 2014). Furthermore, maritime traffic is intense and the Channel is ranked as one of the World's busiest seaways, with approximately 500 vessels making the crossing each day, and between 90 and 120 daily ferry crossings between the European continent, England and the Channel Islands (Dauvin, 2012; Martin et al., 2009; McClellan et al., 2014).

2.2 The study area

Following discussions among project partners, it was agreed that the westernmost and easternmost limits of the study area for WP1 would follow the OSPAR Region III boundary in the west and extend east of Margate on the UK coast to encompass fully the French Exclusive Economic Zone (EEZ) to the east (Figure 1). The upper limits of the study area were delimited by the mean high water mark along both coastlines. The PANACHE study area covers an area of 86,139 km^2, with French waters covering 44,559 km^2 of the study area, English waters covering 35,370 km^2 and Channel Island waters covering 6,210 km^2.

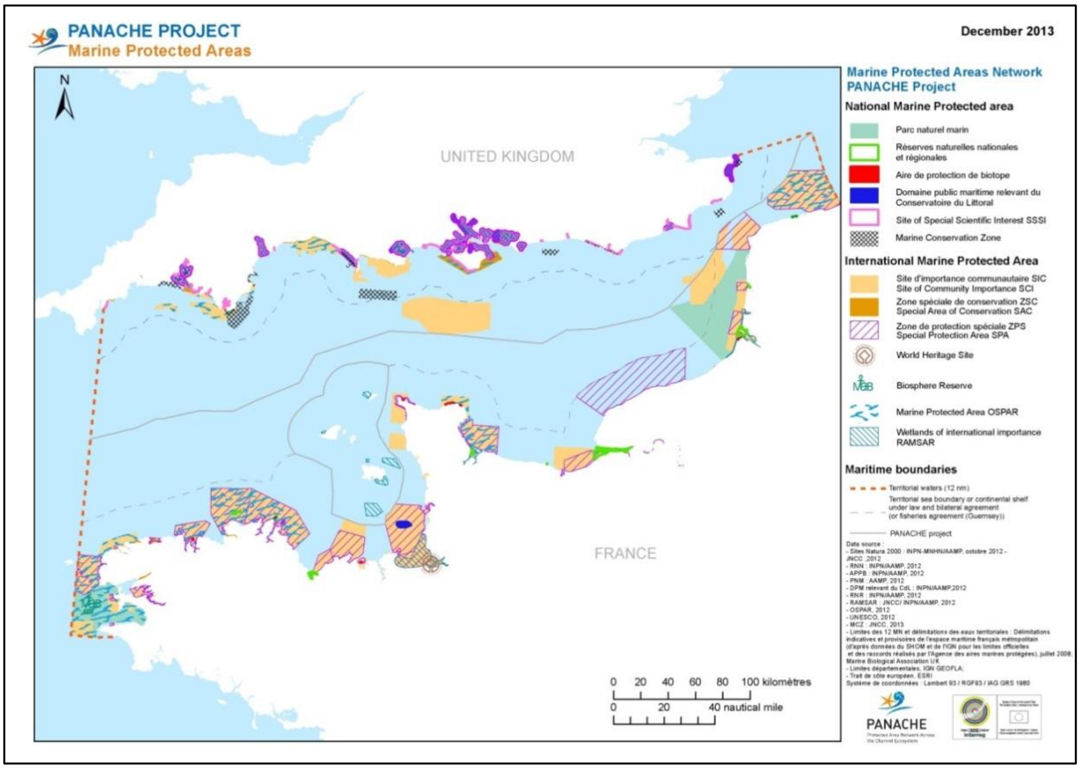


Figure 1*: The PANACHE study area highlighting the range of MPA designation types within the network.*

2.3 The MPA network

MPAs encompassed within the PANACHE study area were included in the analysis if:

1. They are either fully marine or include a marine component (e.g. SACs with marine components were included).
2. They fall within the PANACHE study area. Those MPAs that fall partially within the study area were also included and their area was clipped to the boundaries of the study region (i.e. only the area of the MPA within the study boundaries was included in analyses).

A number of SSSIs were included within the analysis, but only the area between mean low and high water was included to ensure only marine features were incorporated. These selection criteria resulted in a total of 222 sites designated as at least partly MPAs within the PANACHE study area, which fall within the following statutory designation categories for each country:

In the UK

- *Special Area of Conservation (SAC).* SACs fall within the broader category of “European Marine Sites” and were originally set up in article 3 of the Habitats Directive (EU, 1992). According to the Directive (EU, 1992), SACs “hosting the natural habitat types listed in Annex I and habitats of the species listed in Annex II, shall enable the natural habitat types and the species' habitats concerned to be maintained or, where appropriate, restored at a favourable conservation status in their natural range”.
- *Candidate Special Area of Conservation (cSAC).* cSACs are sites that have been submitted to the European Commission to be considered as SACs but have not yet been formally adopted (JNCC, 2014). At the time of analysis, two cSACs existed within the Channel network (Studland to Portland and Wight-Barfleur Reef) but these are now SCIs.
- *Site of Community Importance (SCI).* SCIs are sites that have been adopted by the European Commission to become SACs but have not yet been formally designated by the government of each country in whose territory the site lies (JNCC, 2014).
- *Special Protection Area (SPA).* SPAs are included within the broader category of “European Marine Sites”, and were originally established under the Birds Directive (EU, 1979) (EU, 1979). According to the Directive (EU, 1979), SPAs should consist of the most suitable territories in number and size for the conservation of the bird species mentioned in Annex I in the geographical sea and land area covered by the Directive in order to ensure their survival and reproduction in their area of distribution.
- *Site of Special Scientific Interest (SSSI).* SSSIs were originally established by an Act of Parliament in 1949, with a purpose to protect the best of England’s natural habitats, wildlife and geological heritage for the benefit of present and future generations (Natural England, 2011).
- *Ramsar sites with marine components.* These sites are designated under the Ramsar Convention (Ramsar Convention, 1971) to protect wetlands of international importance in terms of ecology, botany, zoology, limnology or hydrology. In the first instance, wetlands of international importance to waterfowl at any season should be included.
- *OSPAR Site.* In 2003, the OSPAR commission recommended contracting parties to consider whether any sites within their jurisdiction could contribute to the OSPAR network of MPAs (OSPAR, 2003). Thus, to date, all OSPAR MPAs in the UK are also “European Marine Sites” and form part of the Natura 2000 network of internationally important sites.
- *Marine Conservation Zone (MCZ).* MCZs are established under Part 5 (Nature conservation) of the Marine and Coastal Access Act (UK, 2009) for the purpose of conserving marine flora or fauna, marine habitats or types of marine habitat, or features of geological or geomorphological interest (UK, 2009).

In France

- *Zone spéciale de conservation (SAC).* As detailed above, SACs fall within the broader category of “European Marine Sites” and were originally set up in article 3 of the Habitats Directive (EU, 1992).

- *Site d'importance communautaire (SCI).* As detailed above, SCIs are sites that have been adopted by the European Commission but have not yet been formally designated by the government of each country in whose territory the site lies (JNCC, 2014).
- *Zone de protection spéciale (SPA).* As detailed above, SPAs are included within the broader category of "European Marine Sites", and were originally established under the Birds Directive (EU, 1979).
- *Zone humide d'importance internationale (Ramsar).* As detailed above, these sites are designated under the Ramsar Convention (Ramsar Convention, 1971) to protect wetlands of international importance.
- *Zone marine protégée de la convention (OSPAR).* To date, some of the Natura 2000 sites, Marine Natural Parks or Nature Reserves are registered as OSPAR sites, meeting the requirements asked by the commission.
- *Réserve naturelle nationale ou régionale (RNN or RNR; National or Regional Nature Reserve).* These sites are mainly terrestrial and are created to protect fauna, flora, soil, waters, mineral deposit and fossils or whichever environment of particular significance or that needs to be prevented from artificial activity susceptible to degrade them. They are created by the state (national) or on local impulse (regional), and are considered MPAs if they have a maritime component.
- *Parc naturels marins (PNM; Marine Natural Park).* A recent creation (2006), marine natural parks are designed for integrated management of large-scale areas. They contribute to the protection and sustainable development of the marine environment. They are created following a public inquiry and are always managed directly by a team attached to the AAMP.
- *Arrêtés préfectoral de protection de biotope (APPB; Prefectural Order for the Protection of Biotopes).* These areas are orders, issued by the prefect, to protect natural biotopes required for feeding, breeding, resting and/or survival by one or several protected animal or plant species. They are considered as MPAs if they have a maritime component and are led by a management board.
- *Parties maritimes du domaine relevant du Conservatoire de l'espace littoral et des rivages lacustres (DPM; Public Coastal Domain Site entrusted to Coastline Conservation).* Public land policy, carried out in partnership with local authorities, to conserve the coastal area, and maintain natural sites and the ecological balance by acquiring land in order to ensure long-term protection of fragile and threatened sites.

2.4 Data sources

Throughout this study, we used a range of datasets. Broad-scale datasets were used to assess the biogeography, bathymetry and habitats within the Channel MPA network. Where available, finer-scale datasets were also used to assess the occurrence of habitats and species. However, for some species and habitats, data are lacking or were unavailable during the course of the study. Thus, large surrogate datasets were used in these situations. More details on the specific sources of data are provided below.

2.4.1 Matrix approach

For MPAs within English waters, data were extracted from Regulation 33/35 advice packages, Natura2000 Standard Data Forms, Ramsar Information Sheets and the OSPAR MPA network database. Information was also collated from a number of websites: JNCC (JNCC, 2013), Natural England (Natural England, 2013) and from personnel at Natural England (NE).

For MPAs within French waters, data were extracted from DOCOBs (Documents d'Objectifs - document detailing management objectives for the MPA), the OSPAR MPA network database, the French MPA database, and data were also provided by personnel at AAMP (Agence des aires marines protégées) and DREAL (Direction régionale de l'environnement, de l'aménagement et du logement).

2.4.2 Spatial analysis

Species and habitats were selected for inclusion in the spatial analyses based on the availability of comprehensive spatial data and listings within specific directives (OSPAR threatened and declining habitats and species, Habitats Directive, Birds Directive). The data layers used in the spatial assessment of the MPA network were collated from a number of sources, including national and international databases and datasets held by PANACHE partners. Specific details are provided below.

EUNIS Level 3 Habitats

The EUNIS Habitat classification system is a comprehensive pan-European system to facilitate the harmonised description and collection of data across Europe through the use of criteria for habitat identification; it covers all types of habitats from natural to artificial, from terrestrial to freshwater and marine (EUNIS, 2014). The first level of the hierarchy divides marine habitats (signified by code letter 'A') from coastal and terrestrial habitats. In general, Level 2 uses the biological zone and the presence/absence of rock as classification criteria and Level 3 introduces energy into the classification for hard substrata, and splits the softer substrata by different sediment types (EUNIS, 2014).

- The data source for broad-scale modelled habitats was the EUSeaMap, which was downloaded from the MESH (Mapping European Seabed Habitats) website (http://www.searchmesh.net/default.aspx?page=1953)

Maerl Beds, *Zostera beds, Sabellaria* reefs

- Defra contract MB0102 – gathering/developing and assessing the data for the planning of a network of Marine Conservation Zones (http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=16368)
- MESH website (http://www.searchmesh.net/default.aspx?page=1953)
- Environmental Records centre for Cornwall & the Isles of Scilly (ERCCIS)
- AAMP

Arctica islandica, Hippocampus guttulatus

- Defra contract MB0102 – gathering/developing and assessing the data for the planning of a network of Marine Conservation Zones (http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=16368)

Eunicella verrucosa,

- Defra contract MB0102 – gathering/developing and assessing the data for the planning of a network of Marine Conservation Zones (http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=16368)
- ERCCIS
- Data Archive for Seabed Species & Habitats (DASSH)

Mytilus edulis

- Defra contract MB0102 – gathering/developing and assessing the data for the planning of a network of Marine Conservation Zones (http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=16368)
- ERCCIS
- MESH website (http://www.searchmesh.net/default.aspx?page=1953)

Ostrea edulis

- Defra contract MB0102 – gathering/developing and assessing the data for the planning of a network of Marine Conservation Zones (http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=16368)
- MESH website (http://www.searchmesh.net/default.aspx?page=1953)

Homarus gammarus

- DASSH

Bird data

- _Breeding pairs data (AAMP, Seabirds 2000)_
- _Abundance (PACOMM)_

Cetacean data

- _PACOMM project_

Cuttlefish spawning area

- _Isobel Bloor_

Bathymetry

- _CHARM II & III (Sandrine Vaz, IFREMER)_

2.5 Data handling prior to analysis

2.5.1 Marine Conservation Zones

The analyses detailed in this study were conducted with and without Marine Conservation Zones (MCZs) because during the planning and analysis phases of WP1 it was unclear which, if any, MCZs were going to be designated. The 12 MCZs included in the analysis are Beachy Head West, Chesil Beach and Stennis Ledges, Folkestone Pomerania, Hythe Bay, Kingmere, Pagham Harbour, Skerries Bank and surrounds, South Dorset, Tamar Estuary Sites, Torbay, Upper Fowey and Pont Pill, and Whitsand and Looe Bay (Appendix 1). Eleven of these MCZs were designated on 21st November 2013, with Hythe Bay being the only MCZ included within the analysis that is yet to be designated. Thus, the results presented in this report include the 12 MCZs.

2.5.2 Overlapping MPAs

Most MPA sites in the Channel were designated under more than one legal framework. Therefore, the actual area covered by MPAs is far less than the sum of all MPA areas. A number of MPA designation types within the Channel network overlap, either fully or partially (e.g. SACs with OSPAR). To ensure analyses were not duplicated in overlapping MPAs, and to avoid over-estimating the number of MPAs in which a particular feature occurs, those MPAs with full or partial overlaps were merged, using GIS software, to create a single polygon. Thus, of the 222 MPAs within the Channel network, 89 polygons remained following the merging of overlapping areas. For simplicity, we will refer to the 89 merged polygons as MPAs throughout the report. However, it is important to note that there are 222 MPA designations within the Channel MPA network that form a footprint of 89 MPAs.

Prior to the spatial analysis, overlaps among MPA polygons were identified in GIS software using the intersection tool, and fully or partially overlapping MPA polygons were merged into single MPA polygons and a new data layer was created.

Prior to the Matrix analysis, MPAs were re-coded to account for several MPA designations that overlap to limit over- or under-estimation of the number of MPAs in which a feature occurs. There were two types of overlap within the Channel MPA network, 100% overlap where MPAs were identical in size or shape, or where one MPA fitted completely within the other MPA (Figure 2 a). In this case, duplicate features common to both MPAs were removed from the analysis. There were also cases of partial overlap (Figure 2 b), where sections of two or more MPAs overlapped. These cases were slightly more challenging to account for. Thus, for the matrix analysis, we developed a working assumption that any feature (habitat/species) listed as qualifying in two or more partially overlapping MPAs actually occurs in the overlapping areas between the MPA (Figure 2 c), so the feature is counted as being present in just one MPA. This assumption is necessary as we do not take into account the distribution of species or habitats within the matrix approach, therefore, we cannot map out how features are spatially distributed in relation to the location of MPAs. The implication of this assumption is that, whereas in some cases (e.g. Figure 2 c) the value for the number of MPAs in which a feature occurs is accurate (one MPA in the case of Figure 2 c), in other instances (e.g. Figure 2 d) the value is underestimated as in this situation the feature is actually present in two MPAs. To account for this problem, we calculated two values: A minimum value, where duplicates from 100% and partial overlaps have been removed and a maximum value, where only duplicates from 100% overlaps have been removed. Here, we took the precautionary approach and present only the minimum values.

2.5.3 Spatial analysis

For the spatial analyses conducted in ArcGIS, all the data layers were re-projected to the 'ETRS 1989 UTM Zone 30N' coordinate system, if they were not already projected in this coordinate system. The PANACHE study area was clipped to the mean high water mark along the French and English coasts. The data for the mean high water mark were provided by Becky Seeley (DASSH) for the UK and by Sonia Carrier (AAMP) for France. Area calculations of MPAs and habitats occurring within the PANACHE study area were performed after the MPA network layer and species and habitat data layers were clipped to the study area.

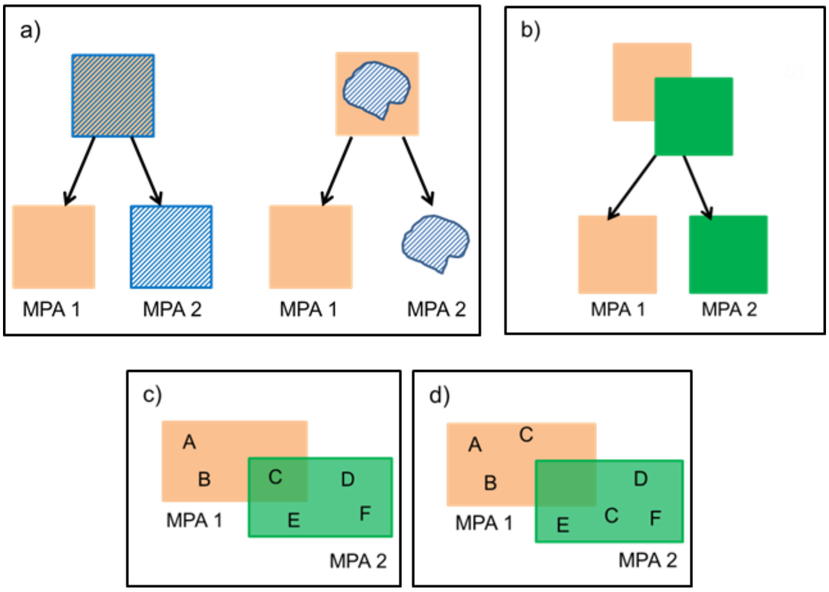


***Figure 2**: Examples of full (a) and partial (b) MPA overlaps, and feature distribution in overlapping MPAs (c, d) in the Channel MPA network.*

2.5.4 EUSeaMap data layer

The EUSeaMap is a broad-scale modelled habitat map of the Channel, the North Sea and Celtic Sea created using the EUNIS 2007-11 classification system (Cameron and Askew (2011); http://jncc.defra.gov.uk/euseamap), and it was used in a number of analyses within this study. The EUSeaMap model was created using raster input layers (substrate, biological zone, energy) with a cell size of 167 × 333 m or 55,611 m^2 (0.056 km^2) (Cameron and Askew, 2011) and only includes the sublittoral zone. Due to the high variability of the littoral zone, a lack of detailed substrate data and the resolution of the model, it was difficult to predict littoral habitats accurately, particularly in areas close to the coast. Given that the majority of the MPAs in the PANACHE study area are coastal, we took a conservative approach by removing (prior to any analysis) any habitat polygons smaller than 111,222 m^2 or 0.12 km^2 (which equates to two pixels on the EUSeaMap habitat map). This removed any small ‘slivers’ of habitat that might have been generated (by chance) due to the low predictive power of the model when input data, such as substrate data, was scarce or lacking. Thus, the 0.12 km^2 polygon size referred to in the methodology for the replication, connectivity and adequacy analyses is just a precautionary measure for the low predictive power of the EUSeaMap model, particularly in areas close to the coast, rather than a specific biological setting.

Additionally, a current limitation of the EUSeaMap is that it does not provide coverage of the intertidal area. As a result, it was not possible to evaluate the coverage of EUNIS Level 3 habitats within the categories of littoral rock and other hard substrata (A1) and littoral sediment (A2) during the spatial analysis (these habitat categories were assessed in the matrix approach).

III. Spatial Analysis

3.1 Representativity

Representativity refers to the inclusion of the full range of ecosystems, habitats, biotic diversity, ecological processes, and environmental gradients (e.g. depth, wave exposure) within the MPA network (HELCOM, 2010; OSPAR, 2006; Roberts et al., 2003b; Rondinini, 2010; UNEP-WCMC, 2008). The objective in applying this criterion to MPA networks is to ensure representative coverage of all biodiversity and biogeographic regions by the network (Jackson et al., 2008; Roberts et al., 2003b). Representativity of the MPA network within the PANACHE study area was investigated using a number of spatial analyses.

3.1.1 Methodology

a) Geographical representativity

An assessment of how the MPAs within the Channel network are distributed within each country's waters, between the eastern and western Channel and between inshore and offshore areas was conducted. The division of the Channel into the eastern (North Sea Ecoregion) and western Channel (Celtic Seas Ecoregion) was based on work by Dauvin (2012), Delavenne et al. (2012) and Spalding et al. (2007), who differentiated the Channel into these two regions based on differences in oceanographic characteristics and species' composition. Inshore areas were defined as those within 12 nm of the shore and offshore areas as those beyond 12 nm of the shore. The current global target of conservation of 10% of coastal and marine areas (CBD, 2010) was applied as a threshold.

b) Biogeographic representativity

Due to the predominant current patterns within the Channel, three distinctive benthic and two pelagic bio-geographic provinces are distinguished, according to the OSPAR biogeographic classification (Dinter, 2001). The Channel lies between the Lusitanian provinces to the south and the Boreal province to the north (Dinter, 2001), making it a biogeographical transition zone for many species and a zone of remarkable conservation interest (Dauvin, 2012). During the spatial analysis, Dinter's (2001) biogeographical classification was used to determine the proportions of both the continental shelf and the pelagic biogeographic provinces included within the MPA network. The target of 10% of the known area within the study region be enclosed within the boundaries of MPAs was applied as a threshold (Jackson et al., 2008).

c) Bathymetric representativity

An assessment of how the MPAs within the Channel network are distributed across different bathymetric areas was conducted. Bathymetry was used as a surrogate for habitat diversity. The CHARM Sextant depth layer was imported into GIS software and the zonal statistics tool was used to calculate the mean (±SD) water depth (m) within each MPA in the network. A histogram of mean depth was plotted and the distribution of depth zones within the PANACHE study area and MPA network was assessed using normality tests.

d) Marine mammals and seabirds

Aerial surveys of the Channel were conducted under the framework of the PACOMM project (http://cartographie.aires-marines.fr/?q=node/45) to assess the importance of MPAs within the Channel network for seabirds and marine mammals (Figure 3). Seasonal variations in abundance were taken into account by conducting surveys once in winter 2011-2012 and once in summer 2012. Each survey (winter and summer) consisted of two passages but unfortunately the second passage was not completed during the summer survey, thus, only 91% of the expected area was covered (Table 1). As the Channel is exclusively covered by water less than 200 m deep, coastal and neritic survey patterns were used for this analysis, providing homogenous coverage across the PANACHE study area (Figure 3).

Table 1: *Sampling effort of marine mammal and seabird aerial surveys in the PANACHE study area.*

	Surface to survey (km^2)	**Expected transect length (km)**	**Realised transect length (km)**	**Survey completed (%)**	**Spatial coverage (%)**
Winter	92875	7201	7173	100%	8%
Summer	92875	7201	6556	91%	7%

The transects undertaken during the aerial surveys followed a zigzag pattern (Figure 3) widely used in aerial sampling surveys (Pettex et al., 2014). The pattern is designed to have a homogenous spatial coverage and is directed to cross isobaths in order to comprehensively sample the range of depths. To prevent observer error due to tiredness, transects did not exceed 100 nautical miles, which corresponds roughly to one hour of observations. Technical considerations also influenced the transect shape, and the observation width was estimated to be 1000 m, which provides a total surveyed surface area that can be used as an indicator of sampling intensity. The raw data consists of points, located along transects, detailing the species observed and the number of individuals. In certain cases, the observers were not able to identify individuals to the species level, thus, groups of species were recorded. For example, the category “large shearwater” includes the three species: *Calonectris diomedea, Puffinus gravis* and *Puffinus griseus*.

As the survey area was not covered uniformly, a gridded dataset was created to standardize the number of observations recorded based on the observation effort. A square grid (cell) of 40 km × 40 km was selected (this is the optimum size as less than 40 km would lead to a high number of empty cells). In each cell, for a given species or group of species, the total number of observations was divided by the transect length (in thousands of kilometres) surveyed in this cell. The number of observed individuals was not taken into account in this analysis, so an observation of one or several individuals is translated into one encounter of a species. Therefore, we use the term ‘encounter rates’ for this dataset. It is important to note that gridding the datasets creates a bias in the results, e.g. coastal species are assigned to cells that can extend up to 40 km off the coast, so it is important to keep this limitation in mind.

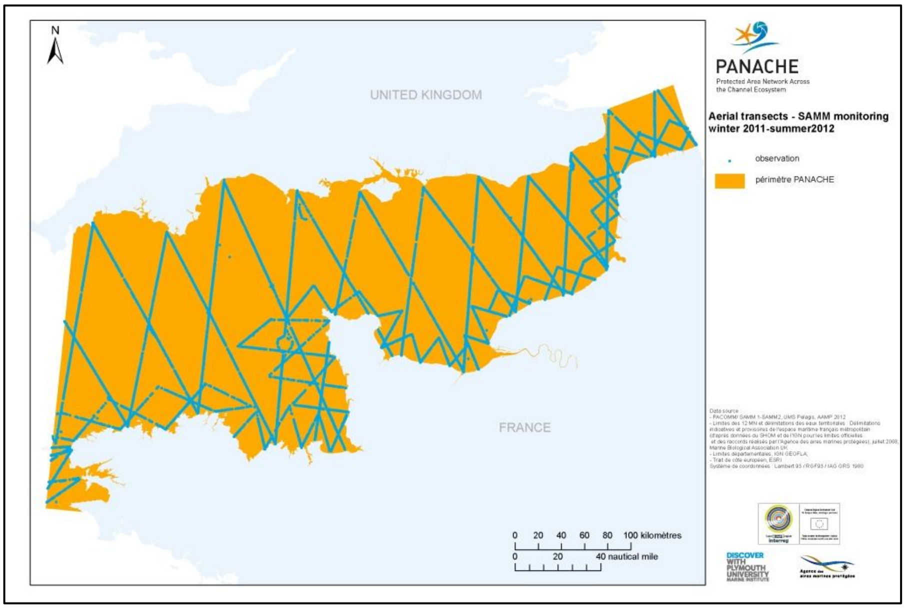


Figure 3: *Aerial transects conducted within the Channel during Winter 2011-2012 and Summer 2012.*

Using the data of encounter rates and details of the Channel MPA network, we assessed the importance of MPAs within the Channel network for seabirds and marine mammals. As the size of MPAs within the Channel network varies, an observation index was calculated:

observation index = encounter rates × the surface area (km^2) of the polygon in question

A selection of MPAs from the Channel network was used to assess the importance of the network for marine mammals and seabirds. Only those MPAs with objectives specific to marine mammals and seabirds were included (see below) along with two additional MCZs (Poole Rocks and Thanet coast) that were not used in the other analyses in this report. Thus, a total of 117 MPAs were used in this section. For overall representation, overlapping MPAs were taken into account and the distribution data was overlaid with only the relevant MPA network footprint.

The MPAs assessed for marine mammals are:

- the sites designated under the Natura 2000 Habitats Directive (Site of Community Importance or Special Area of Conservation), as most of the species we observed are listed in the annexes of the Directive;
- Marine Conservation Zones, although they do not directly target these species, we consider here that they may provide benefit;
- Ramsar sites in the Channel Islands waters as they are the only MPA category in these waters and they have wider objectives than Ramsar sites in the English or French waters. In this context, it was considered that Ramsar sites in the Channel Islands may provide benefits to marine mammals, even if at this stage those species are not part of the management objectives;
- Marine Natural Park (PNM). Two of these are located in the French waters of the PANACHE study area and both have objectives in terms of the conservation of marine mammals.

The MPAs assessed for seabirds are:

- the sites designated under the Natura 2000 Birds Directive (Special Protection Area), as several species observed are part of the annexes of the Directive and the Directive also calls for the conservation of migratory species;
- Marine Conservation Zones, although they do not directly target these species, we consider here that they may provide benefit;
- Ramsar sites in the Channel Islands waters, as they are the only MPA category in these waters and they have wider objectives than Ramsar sites in the English or French waters, and the management framework of the Ramsar sites in the Channel Islands already includes conservation of seabirds;
- Parcs naturels marins (PNM). Two of these are located in the French waters of the PANACHE study area and both have objectives in terms of the conservation of seabirds.

e) Spawning grounds for cuttlefish (*Sepia officinalis*)

Cuttlefish spawning grounds were assessed to demonstrate the important role of benthic habitats in overall ecosystem functioning. Cuttlefish attach their eggs to stones or other coarse substrates in waters less than 40 m depth. There are a number of important cuttlefish spawning grounds within the Channel and although juveniles and adults are mobile, they are not migratory. Thus, cuttlefish populations are likely to benefit from inclusion of their spawning grounds within MPAs. Further, cuttlefish are a relatively coastal species and are likely to benefit from the Channel MPA network in particular, as the majority of MPAs are coastal and within shallow waters, provided that conservation measures for the benthic habitats are undertaken. Reliable predictive habitat maps of cuttlefish spawning grounds enabled us to assess the distribution of spawning grounds in relation to the MPA network.

Habitat suitability maps for *S. officinalis* spawning grounds were created in MaxEnt using egg distribution data from the English Channel collected between 1995 and 2012 (Bloor, 2012; CRESH, 2012). In ArcGIS, the predicted habitat suitability map for *S. officinalis* spawning grounds within the English Channel was overlaid with the Channel MPA network map, highlighting where the spawning grounds happen to occur within the boundaries of MPAs.

f) Breeding areas for bird species listed in the EU Birds Directive

SPAs designated under the EU Birds Directive (EU, 1979) are dedicated to the protection and conservation of bird species detailed in the annexes of the directive. Here, we identify which breeding populations of a selection of seabirds occur within the boundaries of SPAs within the Channel network and which populations fall outside SPAs and outside the entire network entirely.

In ArcGIS, distribution maps of breeding populations of six seabird species were overlaid with the Channel MPA network map to determine which populations of the seabirds happen to occur within the boundaries of MPAs within the network. The distribution of breeding populations of the following important seabird species was assessed: *Fulmarus glacialis* (Northern Fulmar), *Alca torda* (Razorbill), *Fratercula arctica* (Atlantic Puffin), *Rissa tridactyla* (Black-legged Kittiwake), *Sterna dougallii* (Roseate Tern) and *Sterna sandvicensis* (Sandwich Tern).

3.1.2 Results

a) MPA distribution in national waters

The MPA network within the PANACHE study area (Channel MPA network) consists of 222 MPAs, covering a combined area of 34,318 km^2 (including overlapping MPAs), which corresponds to 89 sites (excluding overlaps) covering an effective area of 17,426 km^2 or 20% of the PANACHE study region (Figure 1). Considering the spatial overlap, the 99 MPAs established on the English side of the Channel cover approximately 10% of England's waters within the PANACHE study area and the 116 MPAs established on the French side of the Channel cover approximately 31% of France's waters within the study area. The remaining seven MPAs occur within Channel Island waters, and cover approximately 3% of their waters. MPAs within French waters cover almost four times the area of MPAs within English waters (13,688 km^2 and 3531 km^2, respectively; Table 2).

Overall in the PANACHE study area, the most common MPA designation category is the SCI (48 of 222; 22%) followed by the SPA (38 of 222; 17%) and then OSPAR (30 of 222; 14%) (Figure 1). There are just two Parc Naturel Marin MPAs within the PANACHE study area, yet these two MPAs combined cover 12% of the MPA network (Figure 1). There is no comparable designation category for Parc Naturel Marin in English waters.

Table 2: *Overall area of waters under the national jurisdiction of the UK (England), France and the Channel Islands within the boundaries of the PANACHE study region, and area of respective national waters within the Channel MPA network. MPA overlaps were taken into account. Values meeting threshold of 10% of an area (CBD, 2010) are shaded in green, those below threshold in red.*

Country	Area of national waters within boundaries of PANACHE study region (km^2)	Area (and %) of national waters within boundaries of PANACHE study region covered by MPAs (km^2)
England	35370	3531 (10%)
France	44559	13688 (31%)
Channel Islands	6210	210 (3%)

The most common MPA category in England is the SSSI, with 40% of MPAs occurring under this designation (Table 3). However, this designation category covers only intertidal habitats and the seaward limit is the mean low water mark. Thus, in the current study for SSSIs only the area between mean low and high water was included in the analyses to ensure only marine features were incorporated. The largest MPA within English waters of the PANACHE study area is an offshore candidate Special Area of Conservation (Wight-Barfleur Reef), which covers 1373 km^2.

Table 3: *The number of each MPA category in waters under the national jurisdiction of the UK (England), France and the Channel Islands, and the area and percentage of national waters occurring within each MPA category, within the boundaries of the PANACHE study region. MPA overlaps not taken into account.*

Country	MPA Category	Number of each MPA category occurring in national waters, within boundaries of PANACHE study region	Area (and %) of national waters occurring in each MPA category, within boundaries of PANACHE study region (km^2)
England	cSAC	2	1702 (4.8%)
	SAC	10	580 (1.6%)
	SCI	3	720 (2%)
	OSPAR	13	1111 (3.1%)
	SPA	10	163 (0.5%)
	RAMSAR	10	163 (0.5%)
	MCZ	12	718 (2%)
	SSSI	39	159 (0.5%)
Channel Islands	RAMSAR	7	210 (3.4%)
France	APPB	4	2 (0.004%)
	DPM	3	53 (0.1%)
	RNN	9	113 (0.3%)
	SAC	4	29 (0.1%)
	SCI	45	9001 (20%)
	OSPAR	18	6405 (14%)
	SPA	28	8673 (20%)
	RAMSAR	3	518 (1.2%)
	PNM	2	4033 (9.1%)

In France, the majority of MPAs (77 out of 116) in the study area are Natura 2000 sites (i.e. SAC/SCI, SPA). However, only 4 out of 49 MPAs have been designated as Special Areas of Conservation to date, the remaining 45 sites are Sites of Community Importance (SCI), and are still in the process of being rectified under national legislation (Table 3). The largest MPA within French waters of the PANACHE study area is the Parc Natural Marin des Estuaires Picards et Mer d'Opale, which covers 2344 km^2.

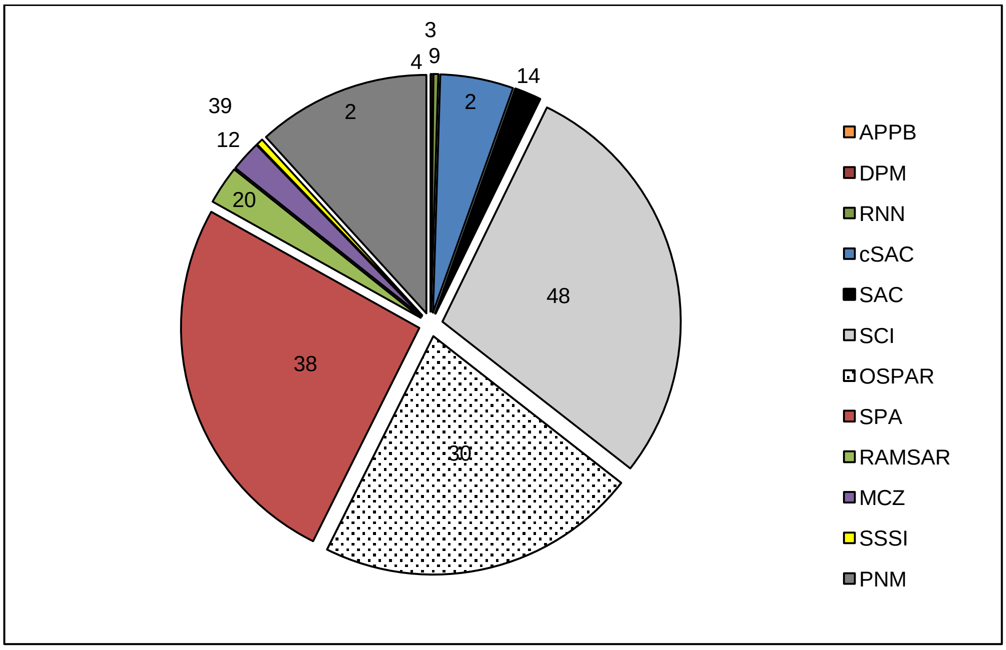


Figure 4*: The number (represented by labels on pie chart) and area (km^2; represented by the size of the pie-chart segments) of MPAs of each designation category with the Channel network.*

b) Distribution of MPAs within inshore and offshore areas

The majority of MPAs (218 out of 222 MPAs) within the Channel network lie within 12 nm of the coast. Fifty percent of France's inshore water within the PANACHE study area is enclosed within the boundaries of MPAs, compared to just 14% of England's inshore water. Within the Channel network, France and England have just 9% and 7% of their offshore water (beyond 12 nm of the shore) within MPAs, respectively (Table 4). England has only two offshore MPAs and France has two MPAs that span inshore and offshore waters (Table 4). Sixty-nine percent of MPAs within the Channel network occur within France's inshore waters, compared to just 12% in England's inshore waters.

Table 4*: The proportions of inshore (12 nm from the shore) and offshore (12-200 nm from the shore) areas occurring within MPAs within the boundaries of the PANACHE study region. Overlaps among MPAs were taken into account.*

Country	Legal Zone within the Channel	Area of national waters within boundaries of PANACHE study region (km^2)	Area (and %) of national waters within boundaries of PANACHE study region covered by MPAs (km^2)
England	Within 12 nm of shore	15486	2090 (14%)
	Beyond 12 nm of shore	19779	1441 (7%)
France	Within 12 nm of shore	24352	12141 (50%)
	Beyond 12 nm of shore	20208	1847 (9%)
Channel Islands	Within 12 nm of shore	6210	210 (0.04%)

c) Distribution of MPAs in the eastern and western Channel

The distribution of areas covered by MPA designations in the eastern and western Channel is not fully balanced. Both France and England have a greater proportion of the eastern Channel within MPAs compared to the western Channel (Table 5). In England, this is likely a result of tranche 1 of the MCZs being designated in late 2013. Therefore, approximately 26% of the eastern Channel waters are enclosed within MPAs designated by France, England and the Channel Islands. Conversely, only approximately 16% of the western Channel falls within MPAs (Table 5).

Table 5: *The area and percentage of geographic regions within national waters of each country covered by MPAs, and the proportion of the eastern and western Channel covered by MPAs in each geographic region of each country. Note: Marine Conservation Zones are included; Overlaps among MPAs were taken into account.*

Country	Geographic region of the Channel	Area (and %) of geographic region within national waters covered by MPAs (km^2)	Proportion (%) of western (46437 km^2) and eastern (38910 km^2) Channel waters covered by MPAs for each geographic region in each country
England	Western channel	1022 (6%)	2.2%
	Eastern channel	2510 (14%)	6.5%
France	Western channel	6169 (23%)	13.3%
	Eastern channel	7520 (35%)	19.3%
Channel Islands	Western channel	210 (0.8%)	0.5%

d) Distribution of MPAs within biogeographic provinces

Based on the classification by Dinter (2001), the benthic habitats in the eastern Channel all belong to the Boreal province, whereas in the western Channel the habitats in roughly English waters are characterised by Boreal-Lusitanian communities and in French waters by Lusitanian-Boreal communities. The majority (95%) of MPAs in the Channel network occur within the Lusitanian-Boreal and the Boreal provinces (Table 6, Figure 5). Conversely, just 6% of MPAs occur within the Boreal-Lusitanian province (Figure 5, Table 6).

Two biogeographic provinces are distinguished in the pelagic system of the Channel waters: a cool-temperate province in the eastern and north of the western Channel, and a warm-temperate province predominating in the south of the western Channel (Figure 6). Therefore, nearly two thirds of the Channel network occurs within the cool-temperate province (Table 6, Figure 6).

Table 6*: The occurrence of biogeographic provinces in the Channel and within MPAs in the Channel network. Values meeting threshold of 10% of an area (Jackson et al., 2008) are shaded in green, those below threshold in red.*

Biogeographic Province	Area of Province within the PANACHE study region (km^2)	Area (and %) of province within the PANACHE study region covered by MPAs (km^2)	% of Channel MPA network that occurs within each province
Biome: Shelf & continental slope			
Boreal-Lusitanian	20209	1040 (5%)	6
Lusitanian-Boreal	26228	6360 (24%)	37

Boreal	38910	10030 (26%)	58
Biome: (Holo) Pelagic			
Cool-temperate water	59097	11070 (19%)	64
Warm-temperate water	26249	6360 (24%)	37

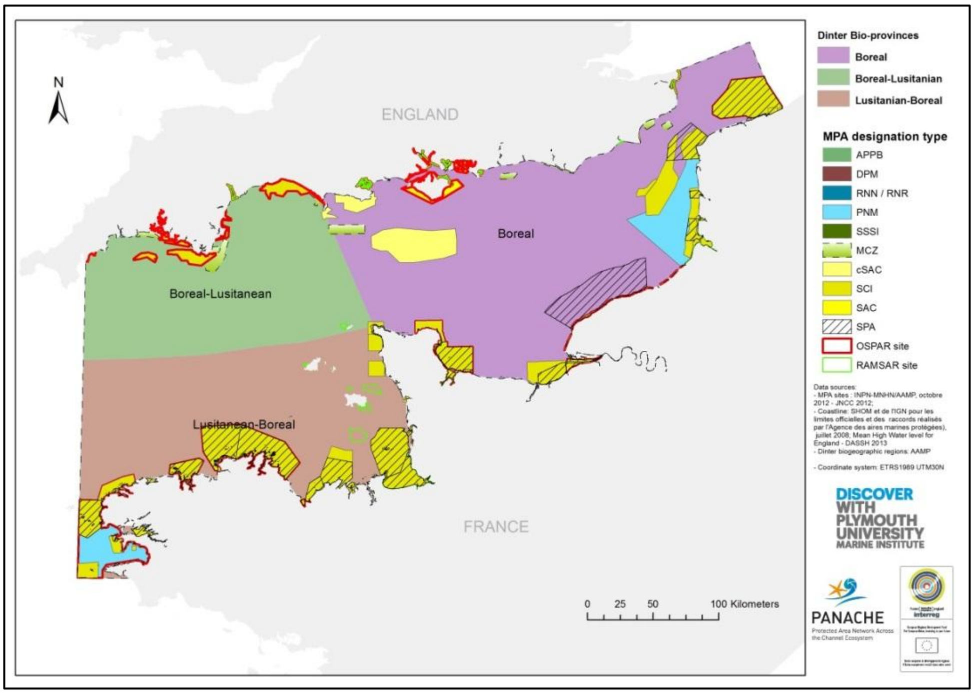


Figure 5: *The location of MPAs in the Channel in relation to the continental shelf biogeographic provinces as defined by Dinter (2001).*

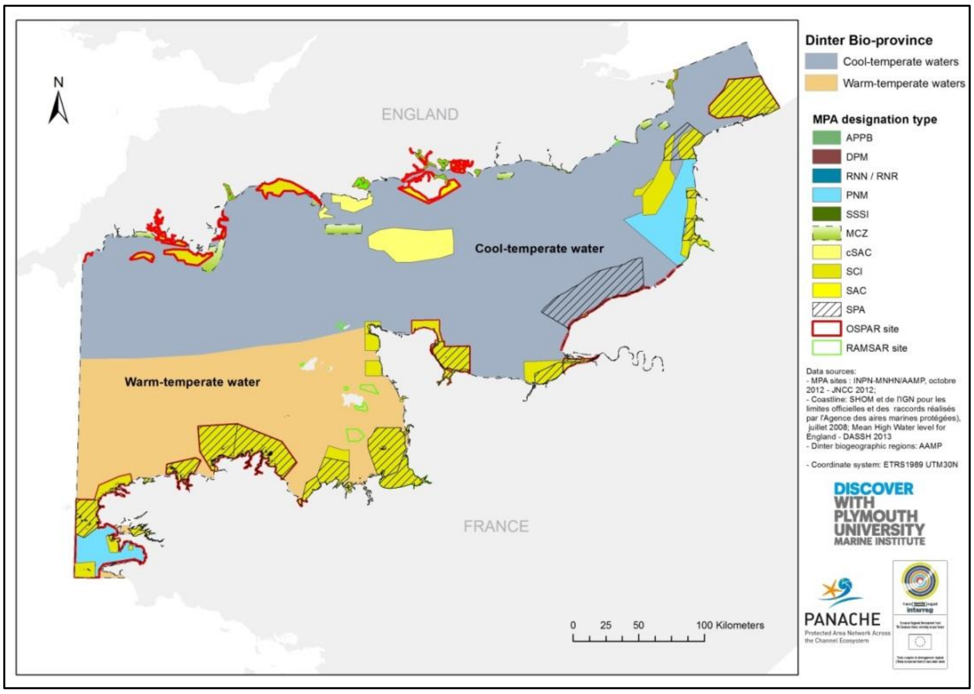


Figure 6: *The location of MPAs in the Channel in relation to the pelagic biogeographic provinces as defined by Dinter (2001).*

e) MPA Distribution in different depth zones

The water depth for the entire PANACHE study area ranges from less than 0.2 m to 146 m with a mean depth of 46 m (± 26.32 SD) (Figure 7). In comparison, the mean water depth within the Channel MPA network is 30 m (± 16.56 SD), ranging from 0.2 to 88 m; therefore, most MPAs are located in shallow water (20-30 m; Figure 7). Only 14% of the Channel network is located in water greater than 60 m, despite 42% of the PANACHE study area occurring in water deeper than 60 m.

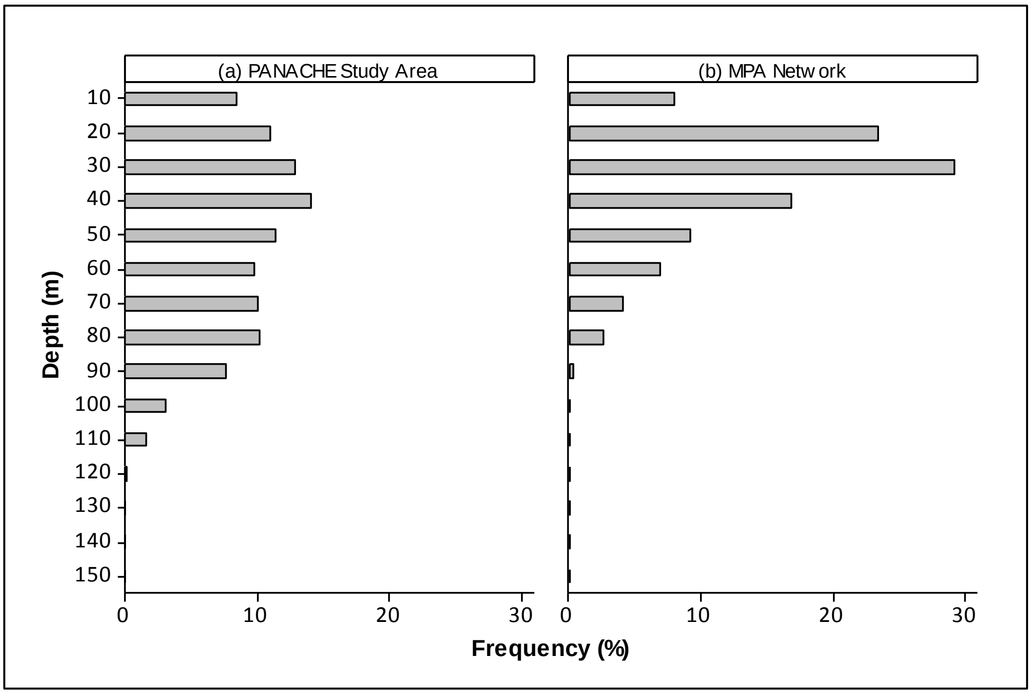


***Figure 7**: Bathymetric range of (a) Channel waters and (b) representation of depth zones in designated MPAs.*

f) Importance of MPA network for marine mammals (Aerial surveys)

Harbour porpoises were the most frequently encountered marine mammal species within the Channel, and Rorquals were the least frequently encountered (Table 7). The total number of encounters of marine mammals within the Channel was consistently higher in summer than in winter; however, despite lower encounter rates in winter, marine mammals appeared to occur more frequently within designated MPAs compared to summer (Table 7). The results from selected species are discussed in more detail below based on observation indices. Actual sightings data are also provided in Appendix 8. These results should be considered with caution, as the majority of species are not very abundant.

***Table 7:** Marine mammal observation indices within the Channel MPA network, winter 2011-2012 and summer 2012. * The observation indices of Rorquals in winter in the Channel were minimal.*

Species	% of observation indices within MPAs		Total observation indices within MPAs		Total observation indices in PANACHE study region	
	Winter	Summer	Winter	Summer	Winter	Summer
Rorqual*	**0%**	**21%**	0	2747	8740	13254
Pilot whales	**13%**	**15%**	3508	5114	27281	34218
Harbour porpoise	**32%**	**13%**	368308	184367	1156736	1447025

Seals	**34%**	**18%**	25443	19183	75785	106731
Small oceanic dolphins	**9%**	**18%**	29988	6531	339597	36012
Common bottlenose dolphin	**5%**	**20%**	2096	10739	42507	53789

Harbour Porpoise (*Phocoena phocoena*)

The harbour porpoise is the most frequently sighted species of the marine mammals (Table 7, Figure 8) and appears to occur frequently (more than 30% of all encounters) in the location of designated MPAs in winter (Table 7). In particular, several MPAs in the Strait of Dover coincide with the highest encounter rates (Figure 8). However, in summer, only 13% of encounters coincide with the location of MPAs, with the majority of these within MPAs occurring in the Strait of Dover (Figure 8; Table 7). During summer, harbour porpoises were generally encountered further west, up to the shelf edge and in areas where no MPAs are currently designated (Figure 8).

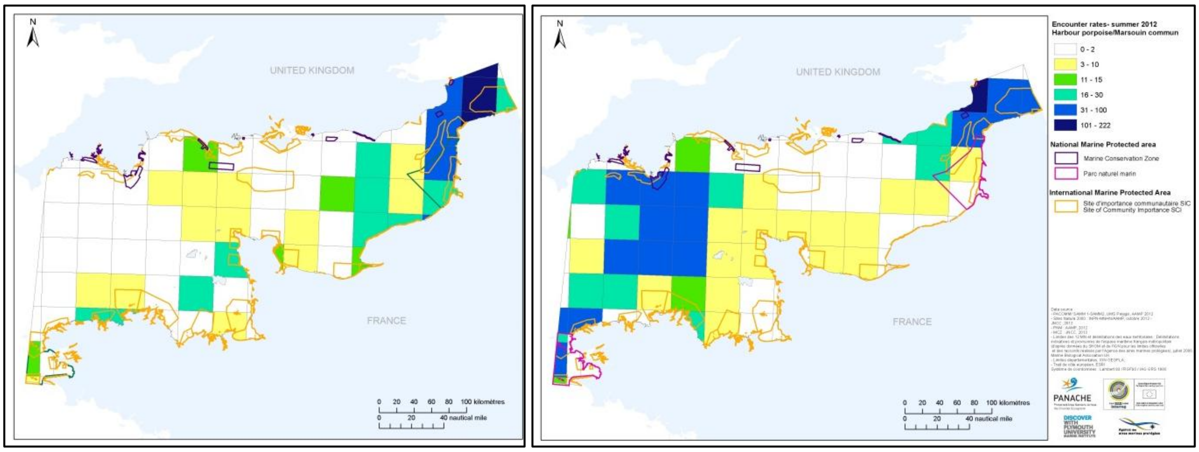


***Figure 8**: Encounter rates of Harbour Porpoise in winter 2011-2012 (left panel) and summer 2012 (right panel) in the English Channel.*

Common Bottlenose Dolphin (*Tursiops truncatus*)

Common bottlenose dolphins were sighted infrequently during the aerial surveys in the Channel. The sightings in winter did not coincide with any MPA locations, and in summer 20% of the encounters occurred within MPAs (Figure 9). However, the distribution patterns in summer seem to indicate areas of importance in the western Channel on the French coastline, which corresponds to a known resident population, and off south Cornwall on the English coastline (Figure 14). To date, no MPAs have been designated in these areas.

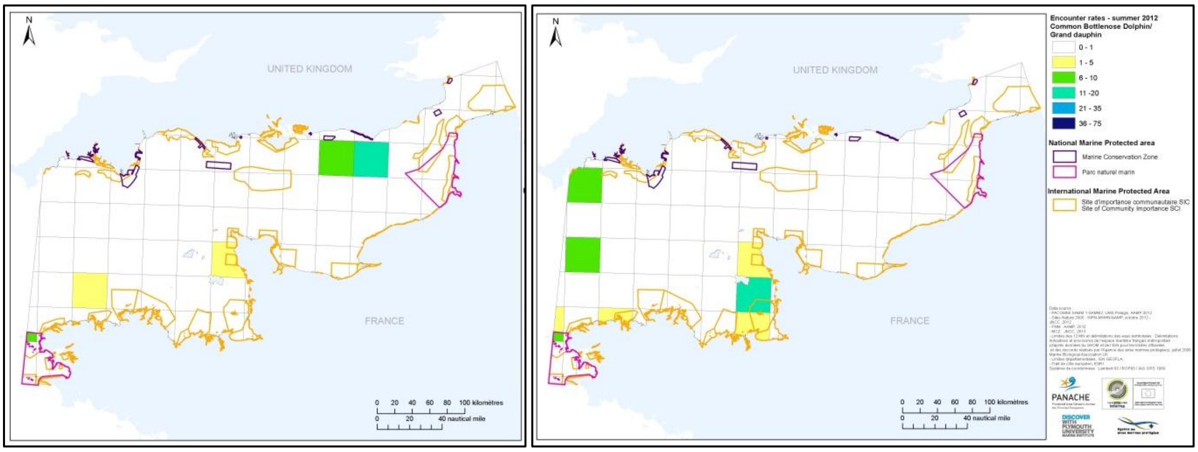


***Figure 9**: Encounter rates of the Common Bottlenose Dolphin in winter 2011-2012 (left panel) and summer 2012 (right panel) in the English Channel.*

g) Importance of the MPA network for seabirds at sea (Aerial surveys)

Auks and Gannets were the most frequently encountered species and the Great Skua was the least encountered species (Table 8). Encounter rates of seabirds within the Channel were generally higher in winter than in summer; however, there was no consistent pattern in the occurrence of seabirds within MPAs in winter or summer (Table 8). The results from selected species are discussed in more detail below based on observation indices. Actual sightings data are also provided in Appendix 8.

***Table 8:** Seabird observation indices within the Channel MPA network, winter 2011-2012 and summer 2012.*

Species	% of observation indices within MPAs		Total observation indices within MPAs		Total observation indices within PANACHE study region	
	Winter	Summer	Winter	Summer	Winter	Summer
Common Murre or Razorbill (Auks)	**20%**	**8%**	4867151	146483	24092998	1949361
Black-headed gull or Mediterranean Gull	**26%**	**32%**	1424472	471396	5448677	1456961
Great Skua	**18%**	**24%**	59544	30523	336540	126542
Northern Fulmar	**11%**	**30%**	204579	95682	1891327	321465
European Herring Gull or Yellow-legged Gull	**31%**	**31%**	733478	1573987	2379759	5026447
Great or Lesser Black-backed Gull	**32%**	**23%**	1031067	565222	3175239	2464538
Little Gull*	**37%**	**0%**	185151	0	499627	14205
Storm Petrels*	**3%**	**13%**	861	59341	29941	455409
Small Shearwaters*	**0%**	**11%**	1	67013	11650	594243
Black-legged Kittiwake	**13%**	**19%**	1126481	66384	8350269	349044
Terns	**35%**	**41%**	16921	936253	48805	2261094
Northern Gannet	**25%**	**15%**	2981103	1594801	11731470	10996319

* The observation rates of storm petrels and small shearwaters in winter (and respectively the Little gull in summer) in the Channel are not significant

<u>Auks</u>

Auks are represented here by the Common Murre (*Uria aalge*) and the Razorbill (*Alca torda*). During winter, 20% of encounters occurred within MPAs, which incorporated several aspects: fairly consistent occurrence in MPAs along the French coast, particularly in the eastern Channel, but inconsistent occurrence in MPAs along the English coast, despite high encounter rates in most areas (Figure 10).

Conversely, in summer only 8% of encounters occurred within MPAs. The areas of highest encounter rates (Lyme bay and offshore) appear to be inadequately covered by the relevant MPAs (Figure 10).

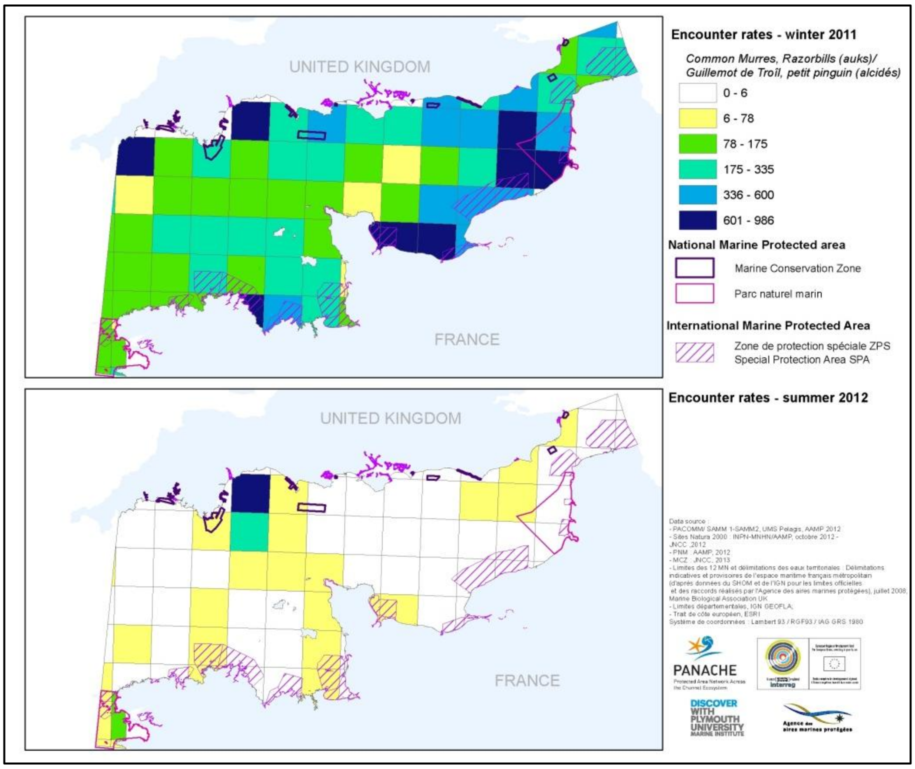


***Figure 10**: Encounter rates of Common Murres and Razorbills (Auks) in winter 2011-2012 (top panel) and summer 2012 (bottom panel) in the English Channel.*

<u>Northern Fulmar (*Fulmarus glacialis*)</u>

The Northern Fulmar was frequently encountered in the Channel in winter yet occurrence within MPAs was low and likely accidental (10%, Table 8). The best MPA coverage exists along the French coast inside 12 nm, but this does not adequately take into account the habitat needs due to the pelagic behaviour of this species. In summer, approximately a third of encounters (28%) occurred within designated MPAs within the network, but this is likely due to the species breeding and feeding closer to land than in winter (Figure 11).

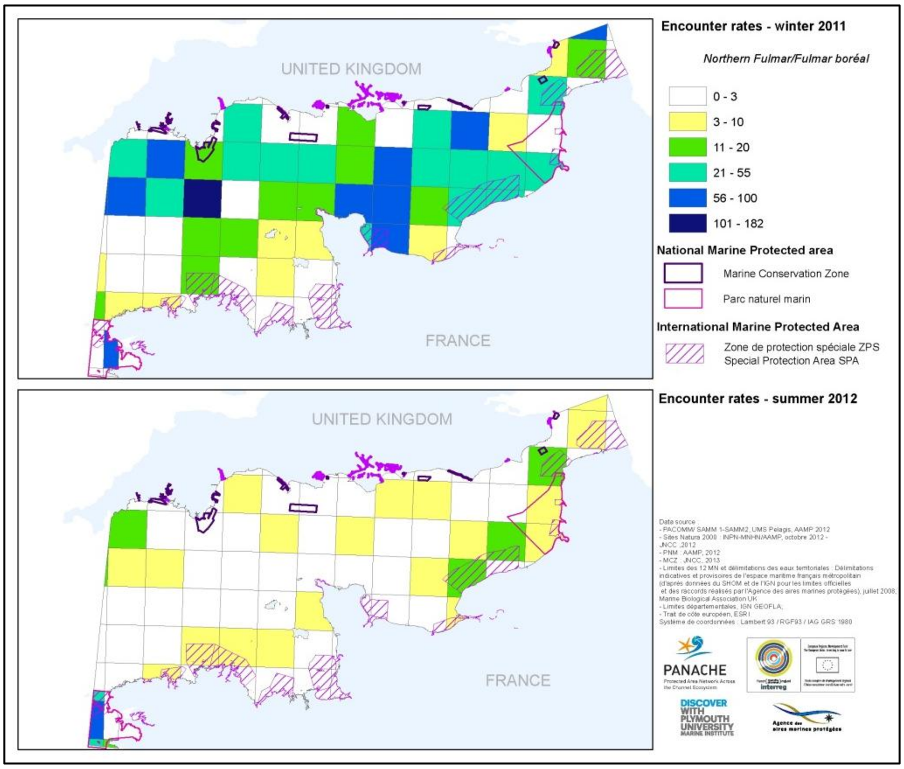


Figure 11*: Encounter rates of Northern Fulmar in winter 2011-2012 (top panel) and summer 2012 (bottom panel) in the English Channel.*

<u>Great or Lesser Black-backed Gull (*Larus marinus* and *Larus fuscus*)</u>

The Channel appears to be an important area for these species in both winter and summer. Encounter rates were more concentrated in the eastern Channel during winter with approximately a third of encounters occurring within MPAs (32%) (Table 8). However, in summer, the species were also encountered more frequently further offshore, lowering the observation frequency inside designated bird MPAs (Table 8). In particular, around the tip of the Cotentin Peninsula and in the western Channel, an important part of the population seems to be offshore, where there are very few MPAs (Figure 12).

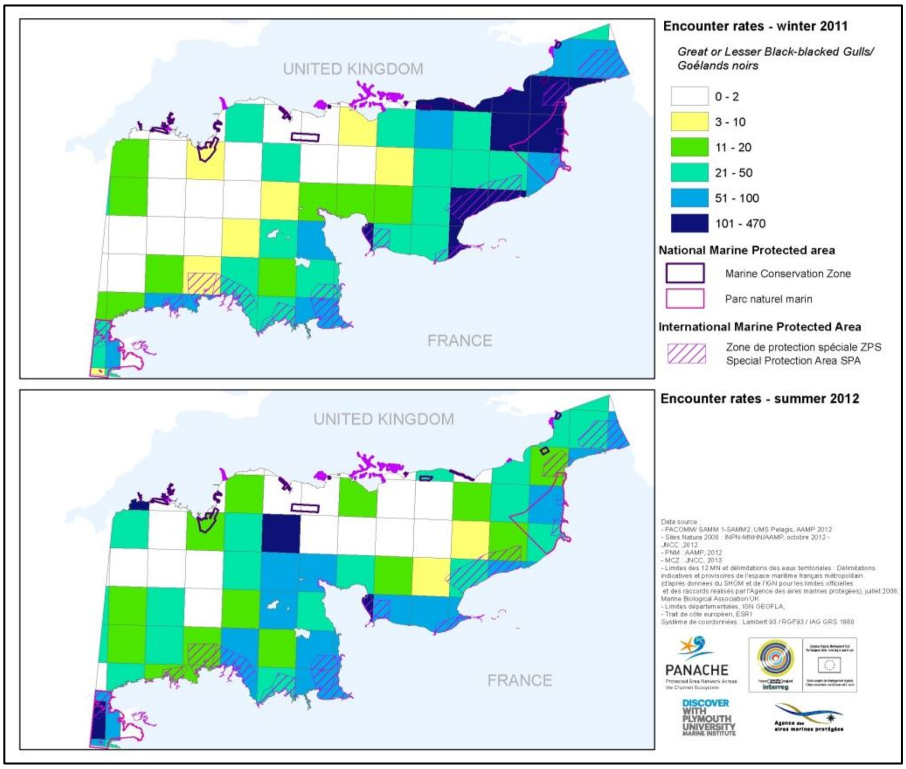


Figure 12: *Encounter rates of Great or Lesser Black-backed Gulls in winter 2011-2012 (top panel) and summer 2012 (bottom panel) in the English Channel.*

<u>Black-legged Kittiwakes (*Rissa tridactyla*)</u>

In winter, Black-legged Kittiwakes were frequently encountered in both the eastern and western Channel. The highest encounter rates were recorded along the English coast, where only a few bird MPAs exist (Figure 13). Therefore, only 13% of encounters occurred within the boundaries of designated MPAs (Table 8). Further, a significant number of encounters were recorded in offshore waters, where MPAs are very limited (Figure 13). In summer, a fifth (20%, Table 8) of the limited number of individuals encountered was sighted within the boundaries of MPAs (Figure 13).

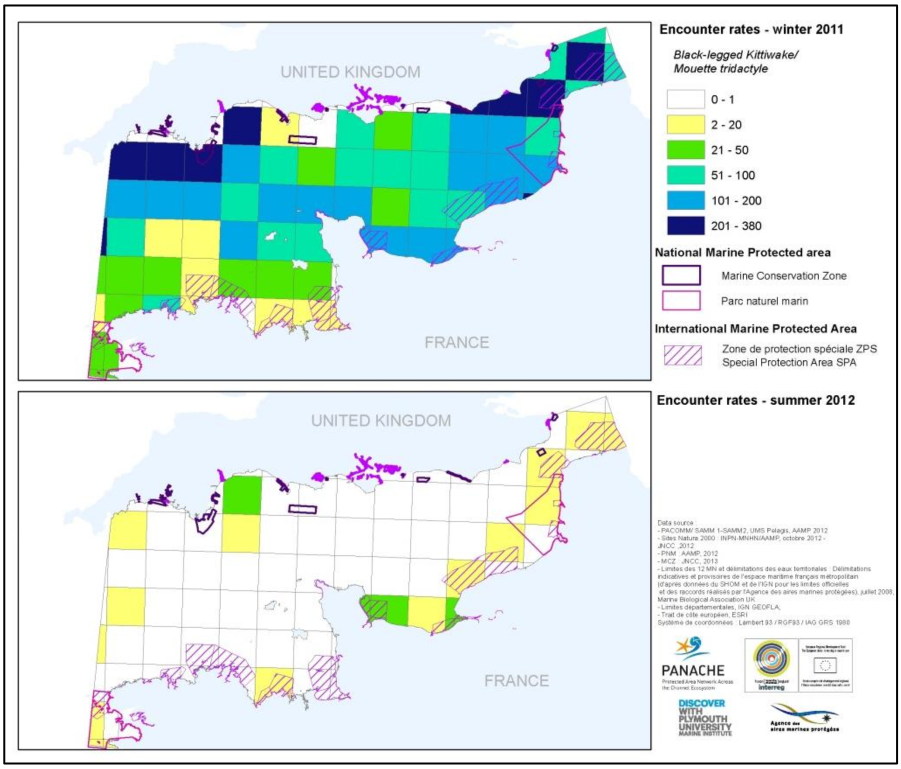


***Figure 13**: Encounter rates of Black-legged Kittiwake in winter 2011-2012 (top panel) and summer 2012 (bottom panel) in the English Channel.*

<u>Terns</u>

In winter, Terns were not frequently encountered; however occurrence within the boundaries of bird MPAs was good (35%, Table 8). In summer, terns were frequently encountered in the Channel with the highest observation frequencies occurring along the French coastline, where a number of bird MPAs exist (Figure 14). Thus, the occurrence of observations within the boundaries of bird MPAs was very good (41%, Table 8).

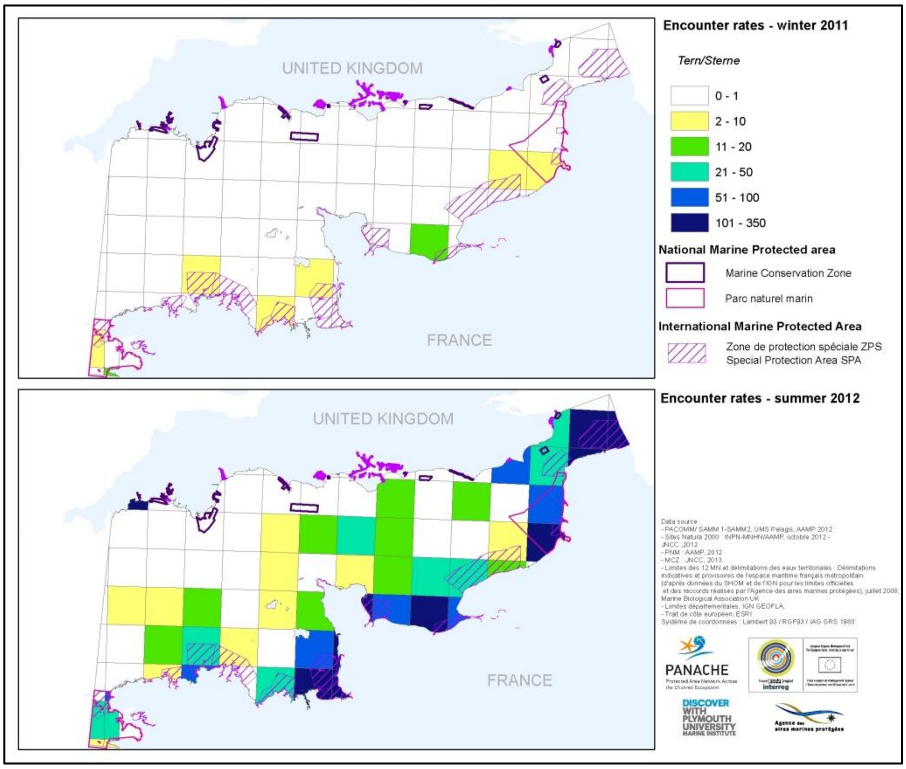


Figure 14*: Encounter rates of the terns in 2011-2012 (top panel) and summer 2012 (bottom panel) in the English Channel*.

Northern Gannet (*Morus bassanus*)

The observation indices of Northern Gannets within the boundaries of bird MPAs within the network varies from 25% in winter to 15% in summer (Table 8). Whereas in winter the population appears to concentrate in the eastern Channel, in summer the highest encounters occurred in the western Channel (Figure 15). In both seasons, a large portion of the population was encountered offshore. Due to the differential MPA coverage in English and French waters, inside and beyond 12 nm, the encounter rates of the species coinciding with MPA boundaries was low. In particular, offshore areas where birds were frequently recorded are not covered by relevant MPAs, predominantly around the northern Channel Islands and some hotspots off the English coast in the western Channel (Figure 15). It is likely that these areas of high abundance represent feeding grounds.

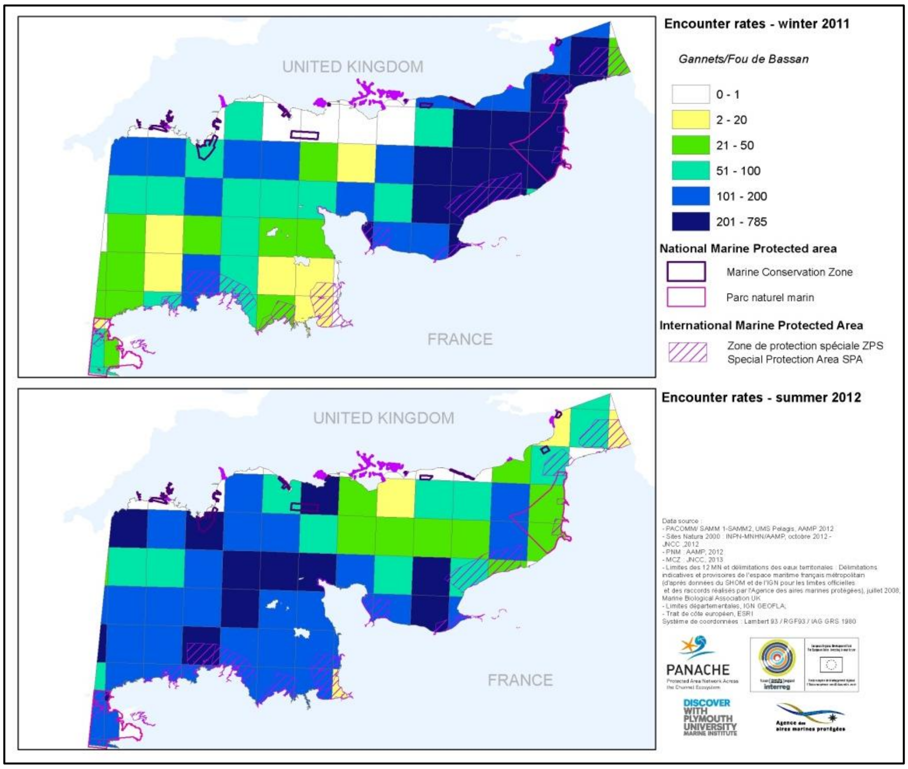


***Figure 15**: Encounter rates of Gannets in winter 2011-2012 (top panel) and summer 2012 (bottom panel) in the English Channel.*

h) Spawning grounds for cuttlefish (*Sepia officinalis*)

In the eastern Channel, MPAs along the French coastline coincide with a considerable amount of the predicted spawning grounds for *Sepia officinalis* (Figure 16). However, there are few MPAs along the English coastline in this area of the Channel; thus, to a large extent the predicted spawning area is not enclosed within MPAs (Figure 16). In the western Channel, MPAs along both French and English coastlines coincide with a portion of the predicted spawning grounds (Figure 16).

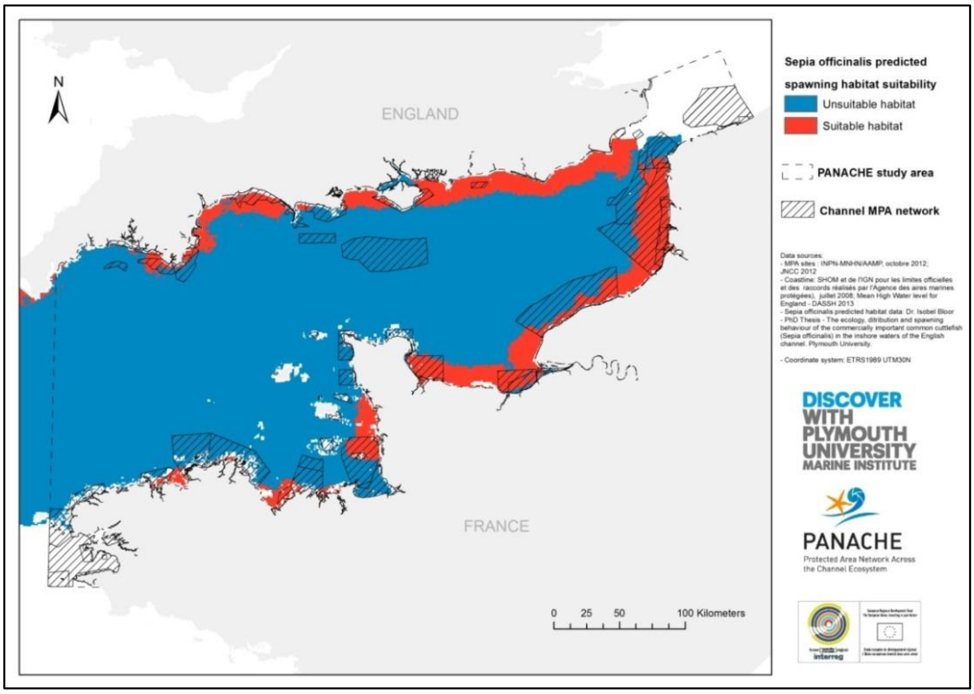


Figure 16*: Predicted suitable spawning habitat for the cuttlefish Sepia officinalis (shown in red) overlaid with the Channel MPA network.*

i) Breeding Areas for Bird Species Listed in the EU Birds Directive

<u>Razorbill (*Alca torda*)</u>

The majority of breeding pairs of Razorbills are located in the Channel Islands, with three populations along the English coastline and three populations along the French coastline (Figure 17). Of these populations, those located in the Channel Islands and France fall within or close to the boundaries of MPAs with specific objectives for birds, in this case SPAs and Ramsar sites (Figure 17). Two of the three breeding populations along the English coastline occur within SACs, which may potentially offer some level of protection and the Portland population is a notified feature of a SSSI.

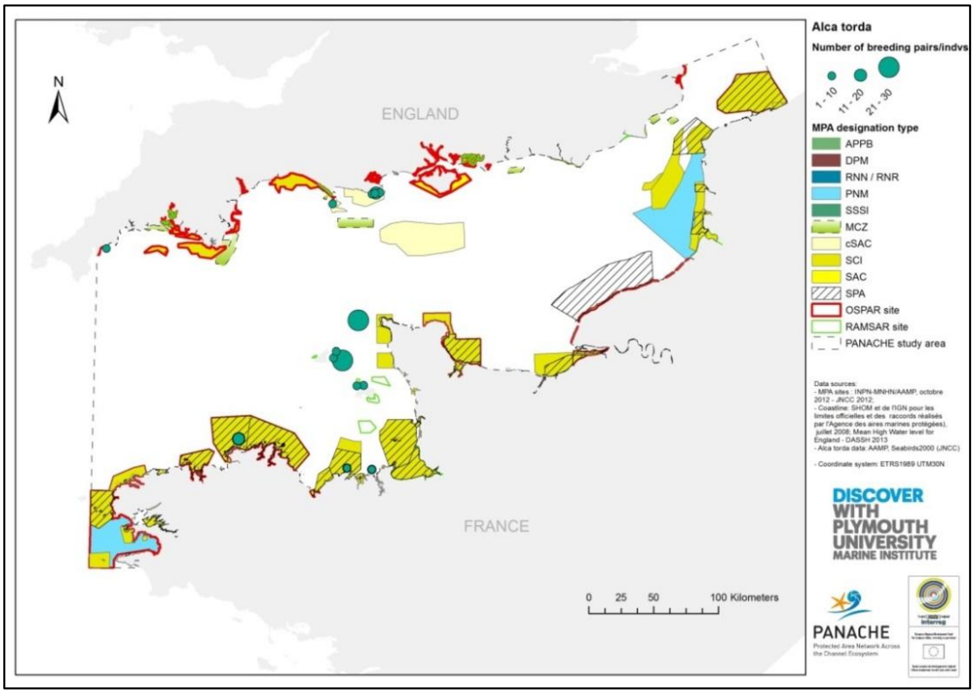


Figure 17: *Distribution of the Channel MPA network and Alca torda (Razorbill) breeding populations in England and the Channel Islands.*

<u>Atlantic Puffin (*Fratercula arctica*)</u>

The majority of the breeding pairs of Atlantic Puffins occur in the Channel Islands, with three populations along the French coastline and three small populations along the English coastline (Figure 18). The populations along the French coastline and in the Channel Islands occur within or close to SPAs and Ramsar sites, respectively, which both have bird specific objectives (Figure 18). However, the populations along the English coastline occur within SACs, which do not have bird specific objectives. Although, the Portland population is a notified feature of a SSSI.

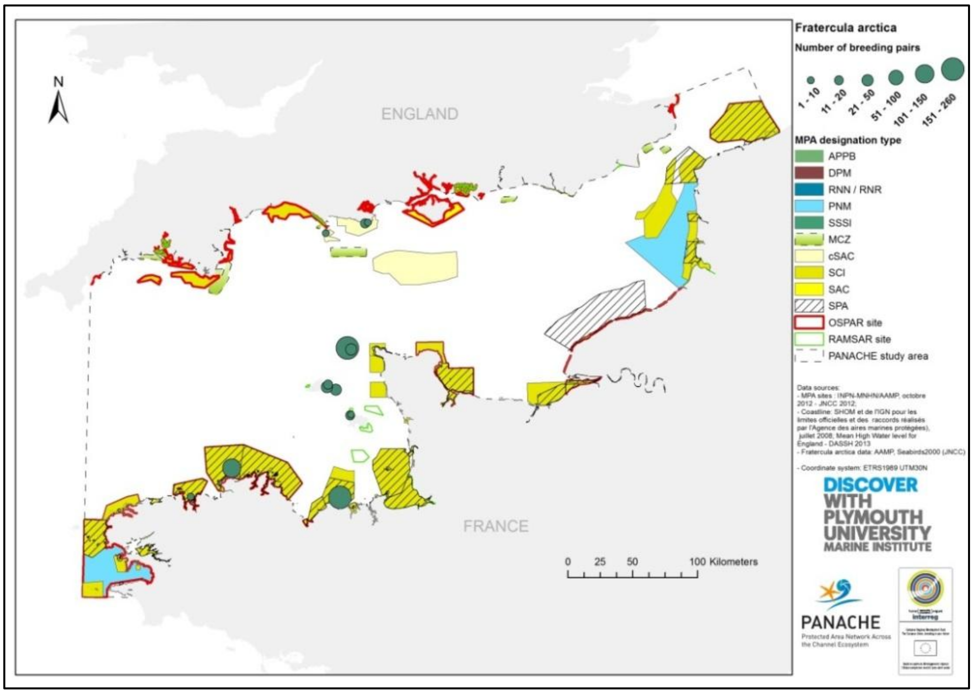


Figure 18: *Distribution of the Channel MPA network and Fratercula arctica (Atlantic Puffin) breeding populations in England and the Channel Islands.*

<u>Northern Fulmar (*Fulmarus glacialis*)</u>

Breeding populations of the Northern Fulmar are distributed throughout the Channel Islands and extensively along the French and English coastlines (Figure 19). Due to the diffuse nature of these breeding populations, a number of them occur within or close to the boundaries of MPAs with bird specific objectives. A number of populations in the Channel Islands are within Ramsar sites, 16 of the 18 populations along the French coastline occur within SPAs and some of the populations along the English coastline occur within or close to Ramsar sites and SPAs. A large number of the breeding populations along the English coastline occur within SACs.

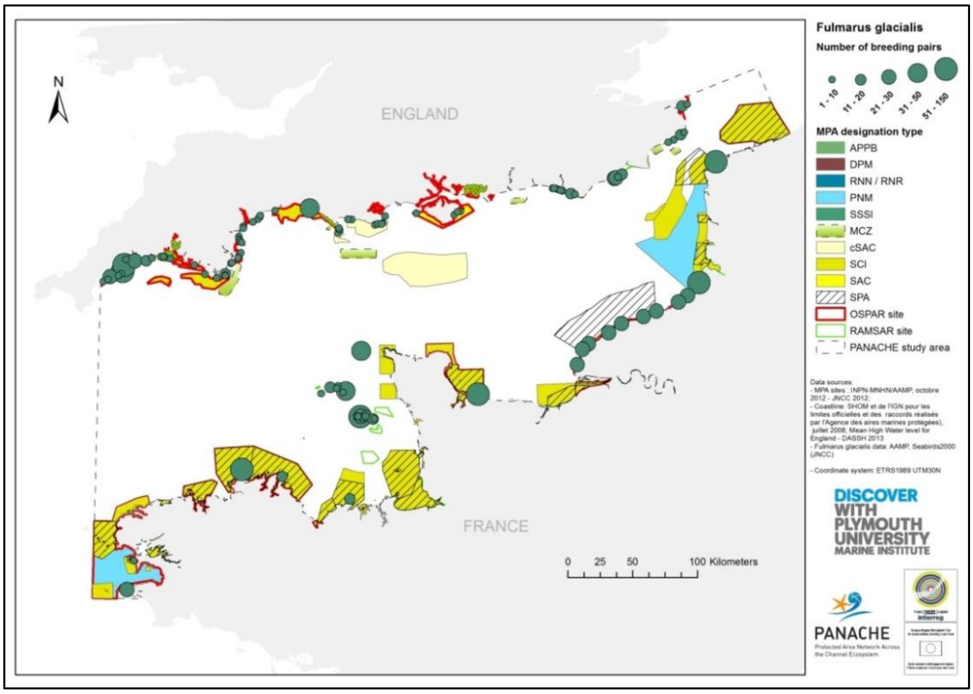


Figure 19*: Distribution of the Channel MPA network and Fulmarus glacialis (Northern Fulmar) breeding populations in England and the Channel Islands.*

Black-legged Kittiwake (*Rissa tridactyla*)

Breeding populations of the Black-legged Kittiwake occur along the French and English coastlines, with a smaller breeding population in the Channel Islands (Figure 20). While the breeding population in the Channel Islands is small (less than 20 breeding pairs), it does occur within the boundaries of a Ramsar site. Further, five of the seven populations along the French coastline occur within SPAs (Figure 20). In contrast, along the English coastline, many of the populations occur outside the boundaries of MPAs or within the boundaries of MPAs without specific bird objectives. Two of the large populations (between 200 and 800 breeding pairs) along the English coastline in the eastern Channel are very close to a Ramsar site (Figure 20).

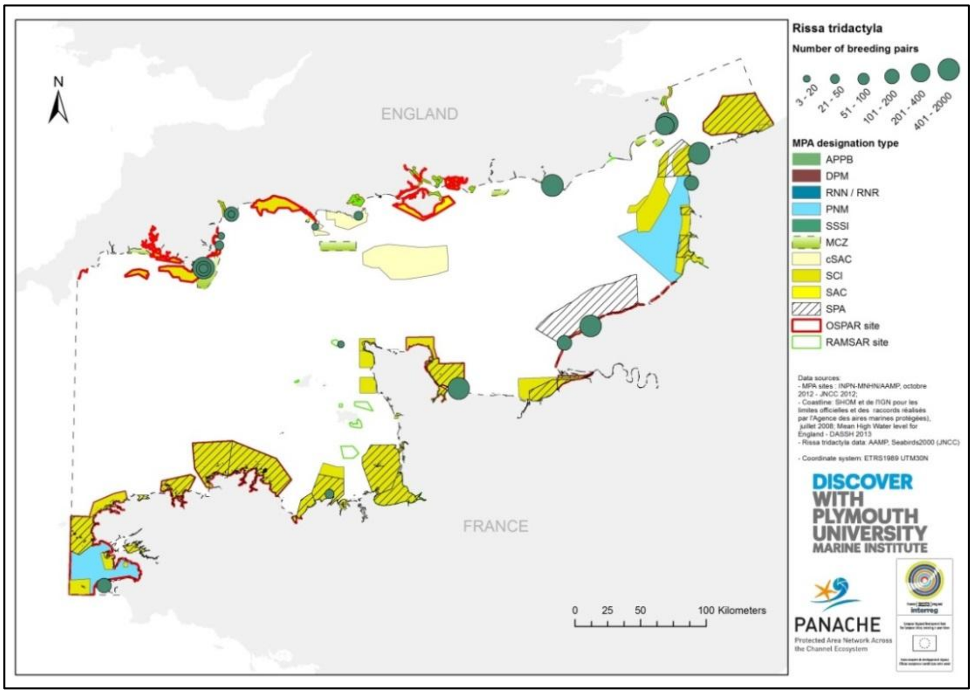


Figure 20: *Distribution of the Channel MPA network and Rissa tridactyla (Black-legged Kittiwake) breeding populations in England and the Channel Islands.*

Roseate Tern (*Sterna dougallii*)

There are very few known breeding populations of the Roseate Tern within the English Channel and the largest of these (up to 60 breeding pairs) occurs along the French coastline within an SPA (Figure 21). There is a very small population along the English coastline (1 to 10 breeding pairs), close to The Solent, which occurs within the boundaries of a Ramsar site (Figure 21).

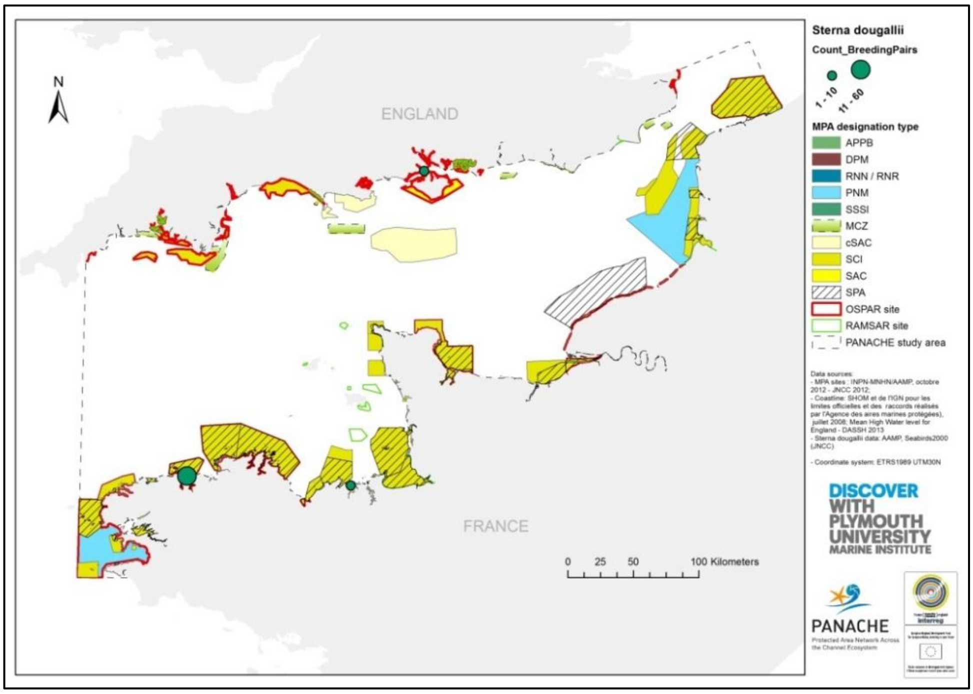


Figure 21*: Distribution of the Channel MPA network and Sterna dougallii (Roseate Tern) breeding colonies in England and the Channel Islands.*

Sandwich Tern (*Sterna sandvicensis*)

There are eight breeding populations of the Sandwich Tern within the PANACHE study area, three along the English coastline and five along the French coastline (Figure 22). Two of the populations located along the French coastline occur within the boundaries of SPAs and two of the three populations along the English coastline occur within SPAs. The two colonies in the Solent are features of the SPAs in which they occur, thus, they have associated conservation objectives and are specifically managed within these SPAs (Figure 22).

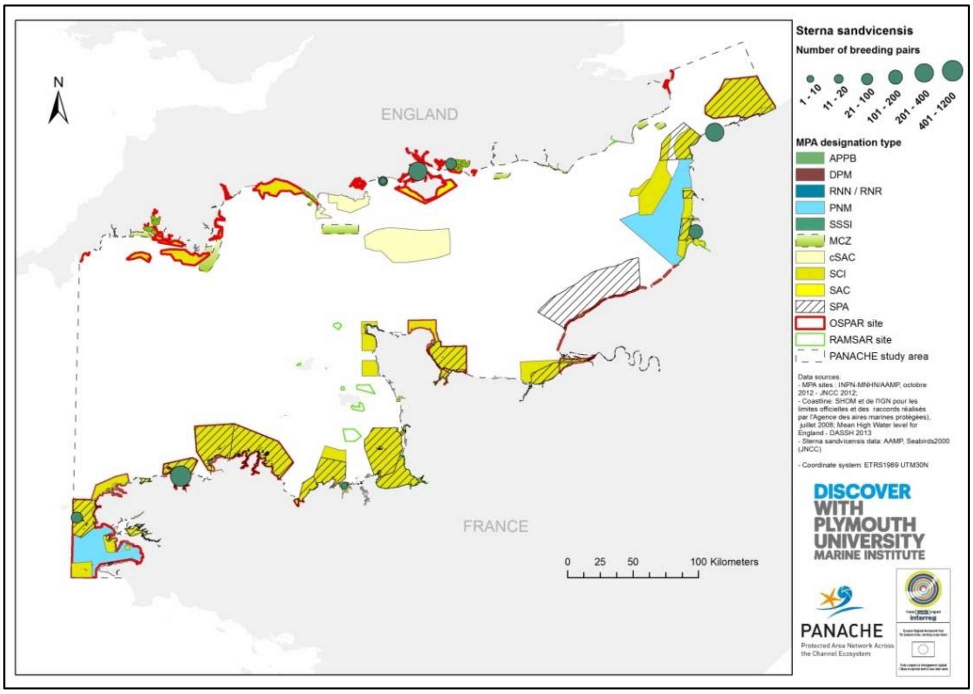


Figure 22: *Distribution of the Channel MPA network and Sterna sandvicensis (Sandwich Tern) breeding populations in England and the Channel Island.*

3.1.3 Discussion

The assessment of representativity of the Channel MPA network found that 20% of the PANACHE study area, 31% of French waters, 10% of English waters and 3% of Channel Island waters are included within the MPA network. Therefore, in the PANACHE study region, the current global marine protection target of 10% (CBD, 2010) is met in French and English waters, but not in Channel island waters. There is unequal coverage of western and eastern areas of the Channel within the MPA network, with 26% of the eastern Channel within MPAs compared to 16% of the western Channel. The most obvious gap in the network highlighted by the assessment of geographical representativity was the lack of MPAs within offshore areas. Two hundred and eighteen of the 222 MPAs within the Channel MPA network are located within 12 nm of the shore, with just four MPAs located solely or partially in offshore areas, beyond the 12 nm limit. Thus, offshore areas are inadequately represented within the Channel network, possibly excluding critical biogeographical regions, habitats and species. This situation is not restricted to the Channel, and other MPA networks throughout Europe have been found to be lacking MPAs in offshore areas and in the EEZ (HELCOM, 2010; Olsen et al., 2013). Another key aspect of the Channel under-represented within the MPA network is areas of deep water.

Just 14% of the MPA network occurs in water deeper than 60 m, despite 42% of the PANACHE study area occurring in water deeper than 60 m. While the Channel itself is an area of shallow water, there are regions that extend beyond 170 m (Dauvin, 2012; McClellan et al., 2014) and these areas should be represented within the MPA network.

Of the three continental shelf biogeographical provinces within the MPA network, two of these (Lusitanian-Boreal province and Boreal province) are adequately represented, with 24% and 26% of their area included within the network, respectively. However, the third province, Boreal-Lusitanian, has just 5% of its area within the MPA network, which is below the minimum 10% threshold recommended by Jackson et al. (2008). The pelagic cool-temperate and warm-temperate provinces within the Channel are both adequately represented within the network, exceeding the 10% threshold recommended by Jackson et al. (2008), with 18% of the known extent of the cool-temperature province and 24% of the known extent of the warm-temperate province occurring within the network. However, the pelagic waters within most MPAs in the Channel will not likely be subject to conservation objectives and measures.

The importance of the Channel MPA network for six marine mammals and twelve groups of seabirds was assessed using aerial surveys. Despite the inherent bias in the 40 km × 40 km gridded data and the calculation method used, this analysis allows us to draw some general conclusions in terms of the potential benefits of the MPA network for marine mammals and seabirds. Encounter rates of marine mammals and seabirds within the boundaries of MPAs in the Channel varied seasonally and by species. Not surprisingly, the coverage of the MPA network is highly dependent on the coastal or offshore nature of the species under observation. Since the network is restricted to mainly waters inside 12 nm in both France and England, gaps in the network were noticeable for offshore or partially offshore species, such as cetaceans (even if they are not predominant in the Channel), and seabirds species with pelagic behaviour (Northern Fulmars, Storm Petrels, Auks, Black Legged-kittiwakes and the Northern Gannets). In terms of areas to consider for inclusion within MPAs, the central western Channel was highlighted a number of times for both marine mammals (particularly the Harbour Porpoise) and seabirds, although it would be very difficult to delineate an area accurately. The proposed and well-named “western channel MCZ” in the Finding Sanctuary project, would likely have particular relevance in this context, but other areas are also necessary within French waters.

The representativity of the MPA network was also assessed for a number of areas of ecological importance. Spawning grounds for the cuttlefish, *S. officinalis*, are well covered by existing MPA designations, although significant improvements could be made along the English coastline in the eastern Channel. However, it is important to remember that no targeted cuttlefish management currently exists for this fishery in the English Channel (Bloor, 2012), and the occurrence of spawning grounds within MPAs is purely by chance and not design. Thus, despite being adequately represented within the network, cuttlefish spawning grounds are not directly managed and will only receive limited benefits indirectly through the conservation of other species listed within the MPAs. It has been proposed to develop and add conservation objectives for such habitats of particular ecological importance to MPAs.

The location of MPAs with bird-specific conservation objectives seem well-suited to deliver benefits to the breeding populations of key breeding bird species along the French coastline and in particular in the Channel Islands, where a number of breeding populations can be found. However, breeding populations along the English coastline occur predominantly outside MPAs or within the boundaries of SACs, which do not have bird specific objectives. One option to consider along the English coastline would be to designate new SSSIs where the breeding populations occur, e.g. at Studland, Dorset.

Overall, the biogeography of the Channel is not considered to be adequately represented within the MPA network, with gaps in the network in deeper water, in offshore areas and within the Boreal-Lusitanian province. The biodiversity of the Channel is generally adequately represented; however, improvements could be made to the network with the addition of MPAs in offshore areas and in the central western Channel.

Therefore, it is recommended to strengthen the definition of representativity as follows:

i. Each habitat (EUNIS level 4 preferable) and habitat complex, each major population of species and all major ecological processes occurring within the assessment area should be represented and conserved by MPAs
ii. It is recommended to aim for adequate representation of each habitat and each habitat complex/population/ecological process within MPAs (compare to the section on Adequacy; see also OSPAR (2007b)) with a specific conservation objective to maintain/restore this particular habitat/species/process or the designation of marine reserves
iii. The size of the baseline area/population should be ecologically relevant and be at least at the sub-regional biogeographic scale

3.2 Replication

To ensure natural variation and to minimise the effects of damaging events and long-term changes, adequate replication of all habitats and species is recommended within MPA networks (HELCOM, 2010; OSPAR, 2007b). Replication enhances the resilience of ecosystems to change and reduces the possibility that catastrophic events may wipe out entire populations of species or habitats within the network (HELCOM, 2010; OSPAR, 2007b; Roberts et al., 2003b).

Replication of ten EUNIS Level 3 habitats, habitats of conservation importance and species of conservation importance within the Channel MPA network was assessed using spatial analyses. It is important to note that spatial analysis does not consider the actual conservation objectives of the MPAs themselves. Even if the analysis implies adequate replication of the habitats and species within the network, these habitats and species may not be listed within the conservation objectives of the

MPAs in which they occur. Thus, the habitats and species would not necessarily benefit from the management measures in place within those MPAs.

3.2.1 Methodology

a) EUNIS Level 3 Habitats

The replication of EUNIS Level 3 habitat types, with significant coverage in the PANACHE study area, was assessed within the MPA network. In ArcGIS, the MPA network and EUSeaMap data layers were overlaid and the number and designation type of MPAs in which different EUNIS Level 3 habitats occur was determined.

b) Habitats of Conservation Importance

Several example habitats of conservation importance, *Zostera* Beds, Maerl Beds and *Sabellaria* Reefs, were selected based on the availability of comprehensive spatial data and listings in Annex I of the Habitats Directive and in the OSPAR threatened and declining habitats list. Data on the distribution of the three habitats within the PANACHE study area were collated from a number of sources (2.4 Data sources). French datasets for Maerl beds included polygons for both 'live Maerl only' and for 'live and dead Maerl beds'. Estimates of the replication of Maerl beds within MPAs were obtained using 'live Maerl only' polygons. In ArcGIS, the MPA network and habitat data layers were overlaid to determine the number and designation type of MPAs in which *Zostera* Beds, Maerl Beds and *Sabellaria* Reefs occur.

c) Species of Conservation Importance

Six species of conservation importance (*Arctica islandica, Eunicella verrucosa, Hippocampus guttulatus, Hippocampus hippocampus, Mytilus edulis, Ostrea edulis,*) were selected based on the availability of comprehensive spatial data and listings in Annex I of the Habitats Directive, in the OSPAR threatened and declining species list and in the UK Biodiversity Action Plan (BAP). Data on the distribution of the six species within the PANACHE study area were collated from a number of sources (2.4 Data sources). No data was provided on invertebrates for French waters for the species considered in the analysis, thus, the analysis was only completed for MPAs in English waters. In ArcGIS, the MPA network and species data layers were overlaid to determine the number and designation type of MPAs in which different species of conservation importance occur within the MPA network.

We apply three different thresholds from the literature to our results (at the scale of the PANACHE study area):

a) at least two MPAs for each EUNIS Level 3 habitat and at least three MPAs for OSPAR threatened and declining habitats and species (OSPAR, 2008a);
b) five replicates for priority species and habitats (BAP, OSPAR threatened or declining and cNIMF) (Jackson et al., 2008);

c) at least three, and preferably five or more replicates of each habitat (Roberts et al., 2003c).

3.2.2 Results

a) Replication of EUNIS Level 3 Habitats

The broad scale occurrence of EUNIS Level 3 habitats within the boundaries of MPAs in the Channel network ranges from four MPAs (A4.3 - low energy circalittoral rock) to 52 MPAs (A5.2 - sublittoral sand). Patches of sublittoral sediment (A5.1) and sublittoral sand (A5.2) overlap with the highest number of MPA sites within the network, 51 and 52 MPAs, respectively (Table 9, Figure 23, Figure 24). Patches of low energy circalittoral rock (A4.3) and low energy infralittoral rock (A3.3) overlap with just four and six MPAs, respectively (Table 9).

Table 9: *Replication of EUNIS Level 3 habitats within MPAs in the Channel network. Occurrence of habitats within overlapping MPAs was only counted once. Blank cells denote areas where habitats and MPAs did not overlap. Values meeting threshold of two replicates are shaded in green.*

EUNIS Level 3 Habitat		Area of habitat in PANACHE study region (km^2)	Number of occurrences in MPAs					Total occurrence in MPAs
			England		France		Channel Islands	
Code	Description		West	East	West	East		
A3.1	High energy infralittoral rock	1993	5	6	13	8	5	**37**
A3.2	Moderate energy infralittoral rock	1055	5	6	10	4	2	**27**
A3.3	Low energy infralittoral rock	10	2		3	1		**6**
A4.1	High energy circalittoral rock	1659	6	7	7	6	2	**28**
A4.2	Moderate energy circalittoral rock	9996	4	7	6	3		**20**
A4.3	Low energy circalittoral rock	601	3			1		**4**
A5.1	Sublittoral coarse sediment	44971	9	13	14	10	5	**51**
A5.2	Sublittoral sand	9652	8	11	17	15	1	**52**
A5.3	Sublittoral mud	1099	5	3	7	3	1	**19**
A5.4	Sublittoral mixed sediments	13079	2	4	14	9	1	**30**

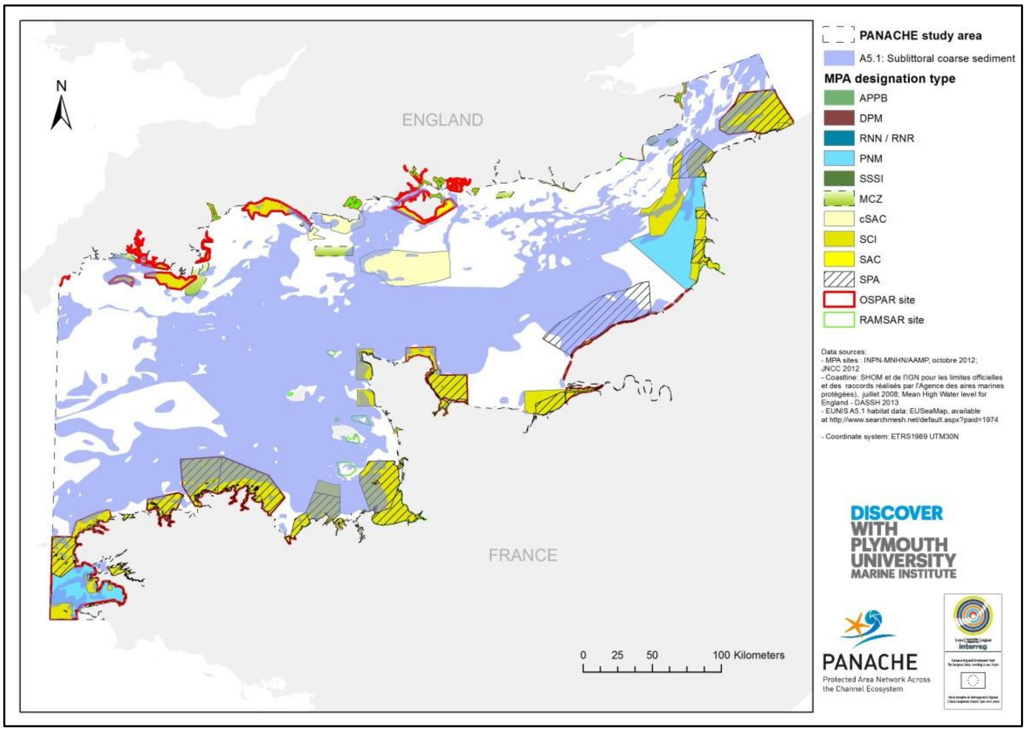


Figure 23: *Distribution of the EUNIS Level 3 habitat sublittoral coarse sediment (A5.1) within the PANACHE study region and overlap with the Channel MPA network.*

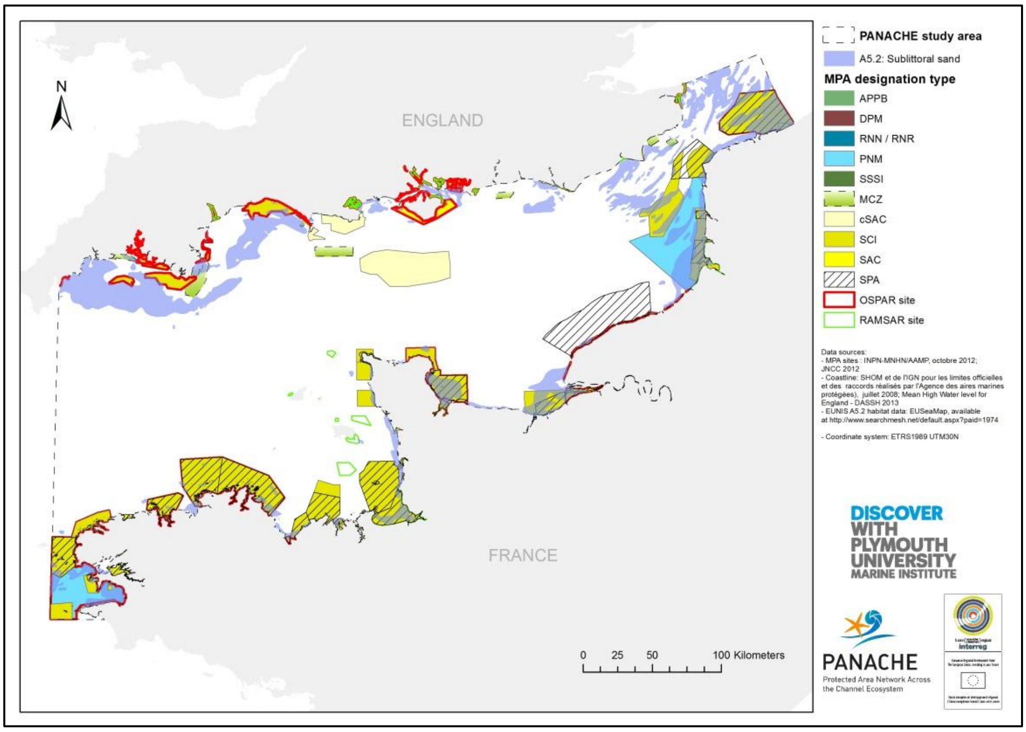


Figure 24: *Distribution of the EUNIS Level 3 habitat sublittoral sand (A5.2) within the PANACHE study region and overlap with the Channel MPA network.*

b) Replication of Habitats of Conservation Importance

Zostera beds, Maerl beds and *Sabellaria* reefs occur within the boundaries of 32, 17 and 7 MPAs in the Channel network, respectively (Table 10). French MPAs currently seem to cover these habitats to a greater extent compared to MPAs in English and Channel Islands waters, which is expected given that there is a higher number of MPAs on the French coast (Table 10).

***Table 10**: Occurrence of habitats of conservation importance within MPAs in the Channel network. Occurrence of habitats within overlapping MPAs was only counted once. NA denotes data not available. Values meeting threshold of three replicates are shaded in green.*

Habitat	Area of habitat in PANACHE study region (km^2)	Number of occurrences in MPAs					Total occurrence in MPAs
		England		France		Channel Islands	
		West	East	West	East		
***Zostera* Beds**	68*	8	6	16	1	1	32
Maerl Beds	1037	2	2	10	2	1	17
***Sabellaria* Reefs**	NA	1	2	4	0	NA	7

* Note that the area is an underestimate of the actual seagrass area in the Channel because of the lack of spatial data for France in the east Channel and because of lack of polygon data for some of the English sites (i.e. some data is point data)

c) Replication of Species of Conservation Importance

The occurrence of species of conservation importance within the boundaries of MPAs in the English section of the Channel network ranges from four MPAs (*A. islandica* and *H. guttulatus*) to 17 MPAs (*O. edulis*) (Table 11). Populations of the European flat oyster (*O. edulis*) are well distributed along the English coastline and occur within 17 MPAs (Figure 25). Populations of the Long-snouted seahorse (*H. guttulatus*) overlap with a total of four MPAs along the English coastline; however, there are a number of populations in the eastern Channel that occur outside the boundaries of MPAs (Figure 26).

***Table 11:** Occurrence of species of conservation importance within MPAs in the English section of the Channel MPA network. Values meeting threshold of three replicates are shaded in green.*

Species	Number of occurrences in MPAs in England		Total occurrence in MPAs
	West Channel	East Channel	
Arctica islandica	3	1	4
Eunicella verrucosa	6	1	7
Hippocampus guttulatus	2	2	4
Hippocampus hippocampus	3	3	6
Homarus gammarus	7	7	14
Mytilus edulis	2	3	5
Ostrea edulis	5	12	17

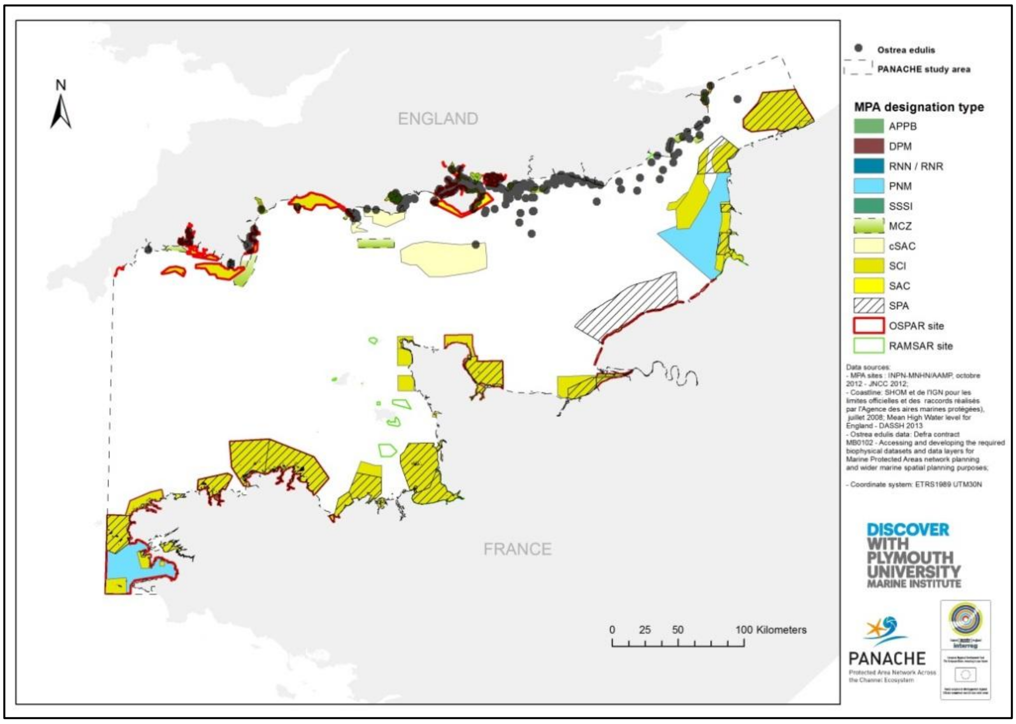


Figure 25: *Distribution of Ostrea edulis populations within the PANACHE study region and occurrence within boundaries of MPAs within the Channel network. Note: Only data on populations along the English coastline are presented.*

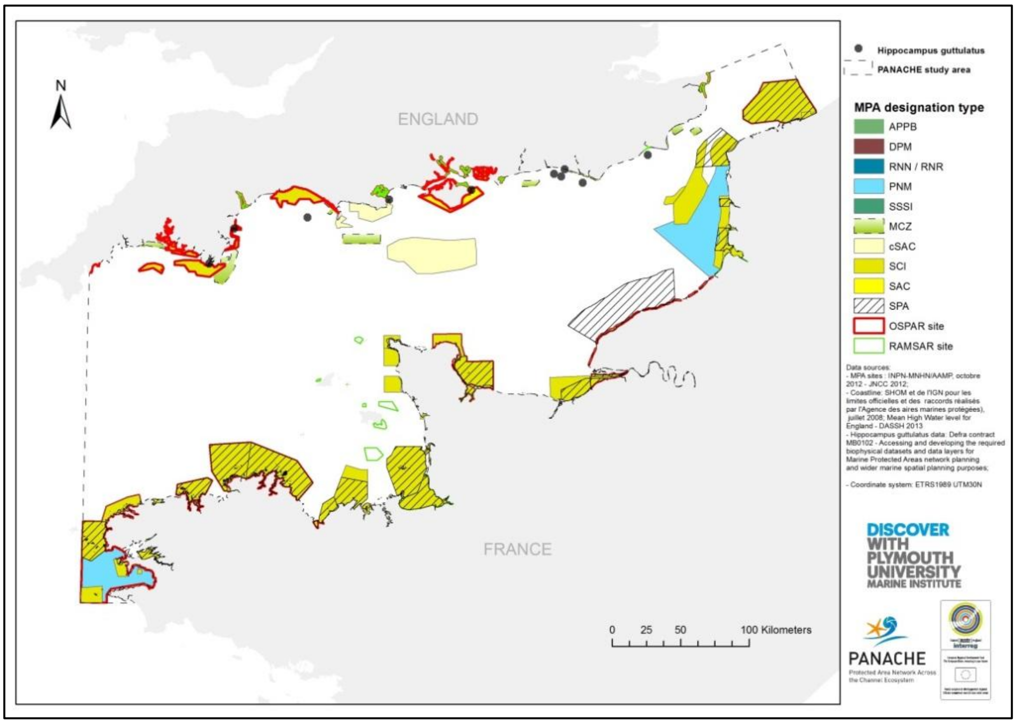


Figure 26: *Distribution of Hippocampus guttulatus populations within the PANACHE study region and occurrence within the boundaries of MPAs within the Channel network. Note: Only data on populations along the English coastline are presented.*

3.2.3 Discussion

The recommended thresholds for the replication of species and habitats within MPA networks has yet to be clearly defined, with suggested values ranging from one replicate of each to five or more (HELCOM, 2010; Jackson et al., 2008; OSPAR, 2008a; Roberts et al., 2003c). Here, we apply three different thresholds from the literature (at the scale of the PANACHE study area):

a) at least two MPAs for each EUNIS Level 3 habitat and at least three MPAs for OSPAR threatened and declining habitats and species (OSPAR, 2008a);
b) five replicates for priority species and habitats (BAP, OSPAR threatened or declining and cNIMF) (Jackson et al., 2008);
c) at least three, and preferably five or more replicates of each habitat (Roberts et al., 2003c).

Based on the spatial analysis, the results suggest that there is good replication of EUNIS Level 3 habitats, habitats of conservation importance and species of conservation importance within MPAs in the Channel network, with occurrence ranging from four to 52 MPAs. These results meet the minimum thresholds suggested by Roberts et al. (2003c) and OSPAR (2008a). However, replication of low energy circalittoral rock (A4.3) habitats, and populations of *A. islandica* and *H. guttulatus* fall below the minimum threshold of five replicates put forward by Jackson et al. (2008).

It is important to note that the spatial analysis of replication is based on simple spatial overlay of habitat and species distribution maps with the map of the Channel MPA network. Furthermore, species data were only available as point data, where each point indicates the presence of the species at that particular location, but it does not provide information on population size. For a habitat or species to be recorded as occurring within the boundaries of an MPA, only a fraction of that habitat or population needs to occur within the MPA. While the analysis implies adequate replication of the majority of habitats and species within the network, it may be that only a very small portion of the habitat or species occurs within the MPA boundaries, and this may not be of sufficient size to maintain that habitat or population should the area outside the boundaries of the MPA be completely degraded. Moreover, as mentioned in the methodology, this analysis does not consider the actual conservation objectives of the MPAs themselves. While the results imply adequate replication of the majority of habitats and species within the network, these habitats and species may not be listed within the conservation objectives of the MPAs in which they occur. Thus, the habitats and species may not directly benefit from the management measures in place within those MPAs. Furthermore, the assessment of EUNIS Level 3 habitats is a preliminary approach and future assessments should aim to evaluate replication at the habitat level, such as EUNIS Level 4 habitats.

Additionally, the thresholds from the literature are recommended to be applied to each biogeographic region within the study area, rather than the study area as a whole. Unfortunately, limited availability of data prevented analysis at the scale of biogeographic regions within the Channel. If the analyses were to be repeated and thresholds applied to each biogeographic regions rather than the study area as a whole, the results would likely suggest that there would be insufficient replication of some species and habitats within the biogeographic regions.

Therefore, it is suggested to strengthen the definition of ‘replication’ as follows:

i. the baseline for replication should be not the number of sites where a species or habitat occurs, but a fixed (adequate) percentage of the overall habitat or population in the biogeographic region (compare to ‘Adequacy’ section) occurring within MPAs with a specific conservation objective to maintain or restore this particular habitat or species.
ii. assessments should aim to evaluate replication at EUNIS Level 4 or lower.

3.3 Viability

Viability refers to the inclusion of self-sustaining, geographically dispersed component MPA sites of sufficient size to ensure species and habitats can persist through natural cycles of variation (Rondinini, 2010). Thus, the objective in applying this criterion to MPA networks is to determine if MPAs within the network are of sufficient size and shape, and are appropriately spaced to incorporate most naturally occurring ecological process and the home ranges of the species characteristic of the habitats of interest (Hill et al., 2010), to enable them to be resilient to, and recover from, natural variation and human impacts. Viability can also apply to the size of habitat patches that occur within the MPA network, with larger habitat patches preferred over smaller ones, as they will inevitably protect sessile and low mobility species as well as widely dispersing species. Viability of the MPA network within the PANACHE study area was investigated using the summary thresholds for home ranges and minimum area requirements put forward by Hill et al. in their (2010) review. The size distribution, compactness and edge-to-area ratio of MPAs in the network were assessed, along with the size distribution of broad-scale habitats within the MPA network.

3.3.1 Methodology

a) Size, compactness and edge-to-area ratio of MPAs

The area of each of the 222 MPAs in the network was calculated in ArcGIS using the MPA network polygon layer. A histogram of MPA size was plotted in R and comparisons were made to thresholds provided in the literature. The relationship between MPA area and mean MPA depth was also assessed.

‘Spill-over’ effects of MPAs are partially dependent on the edge-to-area ratio, which, along with other ‘edge effects’, can vary greatly depending on the compactness of the MPA’s shape (OSPAR, 2007b). Compact sites (i.e. circles) are said to have less ‘spill-over’ and greater internal viability than less compact sites of the same size for a given feature of interest (OSPAR, 2007b). The compactness (C) (OSPAR, 2007b) of each of the 222 MPAs within the network was calculated using the following equation:

$$C = \left(4\pi A / p^2\right)^{0.5}$$

Where, A is the area of the MPA and p is its perimeter. This equation is based on Selkirk's circularity ratio (Selkirk, 1982), whereby a circle receives a score of 1 (i.e. it is the most compact shape) and all other shapes will receive a score of less than 1 (OSPAR, 2007b).

The greater the edge-to-area ratio of an MPA, the faster the movement of organisms across its boundaries; thus, MPAs with a large edge-to-area ratio will offer less protection to species inside the MPA than MPAs with less perimeter (Roberts et al., 2003c; Roberts and Hawkins, 2000). Small MPAs have a greater edge-to-area ratio than large MPAs and long, thin MPAs have a greater edge-to-area ratio compared to circular MPAs (Roberts and Hawkins, 2000). The edge-to-area ratio of each of the 222 MPAs in the network was calculated by dividing the perimeter of each MPA by its area.

b) Size Distribution of EUNIS Level 3 Habitat Patches within the MPA Network

The EUSeaMap was used to determine the size distribution of habitat patches of EUNIS Level 3 habitats (with substantial coverage in the PANACHE study area: >300 km^2) occurring within the MPA network. In ArcGIS, the area of individual habitat patches occurring within the MPA network was calculated for each EUNIS Level 3 habitat (patches smaller than 0.12 km^2 were excluded from the analysis). A histogram of area was created in Minitab using the following patch size classes: 0-1 km^2, 1-10 km^2, 10-50 km^2, 50-100 km^2 and >100 km^2 (Roberts et al., 2010).

The viability of the network was assessed by looking at the spread of different size classes of each EUNIS Level 3 habitat within and outside MPAs. The size classes were generated to reflect MPAs that may potentially offer protection to sessile or very limited mobility species (0-1 km^2), species that have low mobility (1-10 km^2), species with medium mobility (10-50 km^2), species that are highly mobile (50-100 km^2) and species that are very highly mobile (>100 km^2), and were adapted from Roberts et al. (2010). An equal spread in the frequency of habitats among all the size classes may indicate benefit to a wider range of species with different motilities.

3.3.2 Results

a) Size Distribution, Compactness and Edge-to-Area Ratio of MPAs

The size of MPAs within the Channel network is uneven and ranges from less than 2 km^2 to more than 2000 km^2 (Figure 27). The median size of MPAs in the Channel network is 15.7 km^2 and 70% of MPAs (67 out of 222) are larger than 4 km^2 (Figure 27, inset). However, only eight MPAs exceed 1000 km^2 (Figure 27). Therefore, the size distribution of MPAs within the Channel network is highly skewed towards the smallest size classes (Figure 27; Kolmogorov-Smirnov = 0.323, $p < 0.01$). Although the relationship is not significant, larger MPAs also tended to have a greater mean depth (Figure 28).

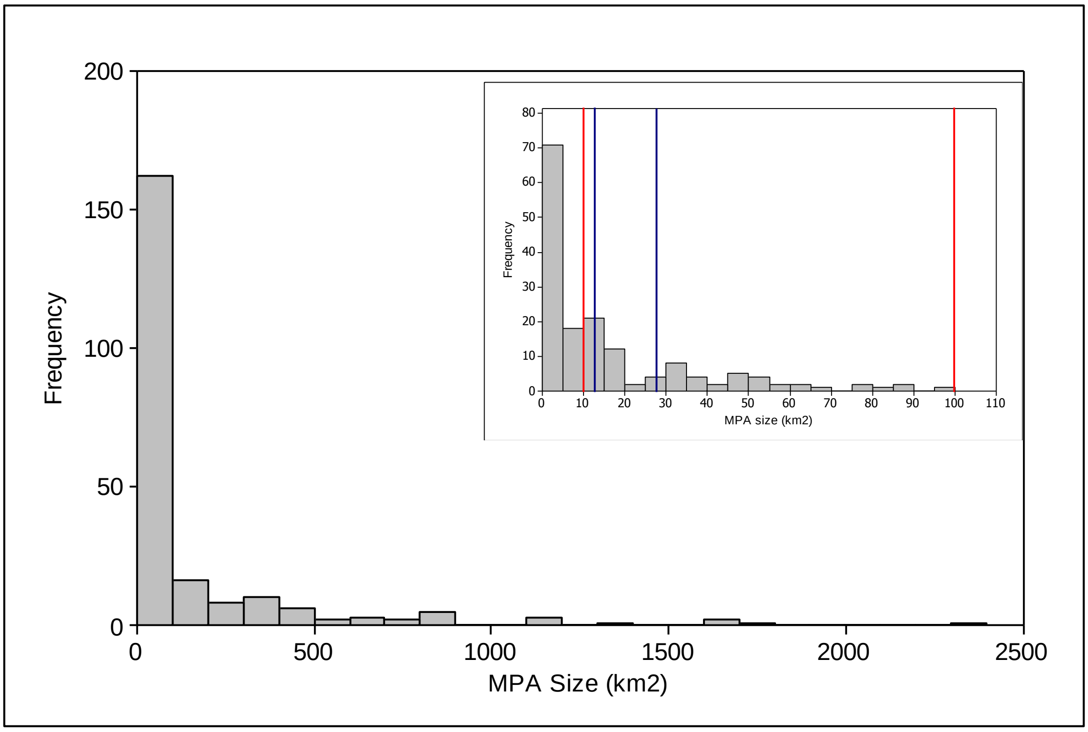


Figure 27: *Size distribution of MPAs within the Channel MPA network. The inset plot shows the size distribution of MPAs smaller than 100 km^2; red lines denote optimum MPA size range recommended by Halpern and Warner (2003); blue lines denote optimum MPA size range recommended by Shanks et al. (2003).*

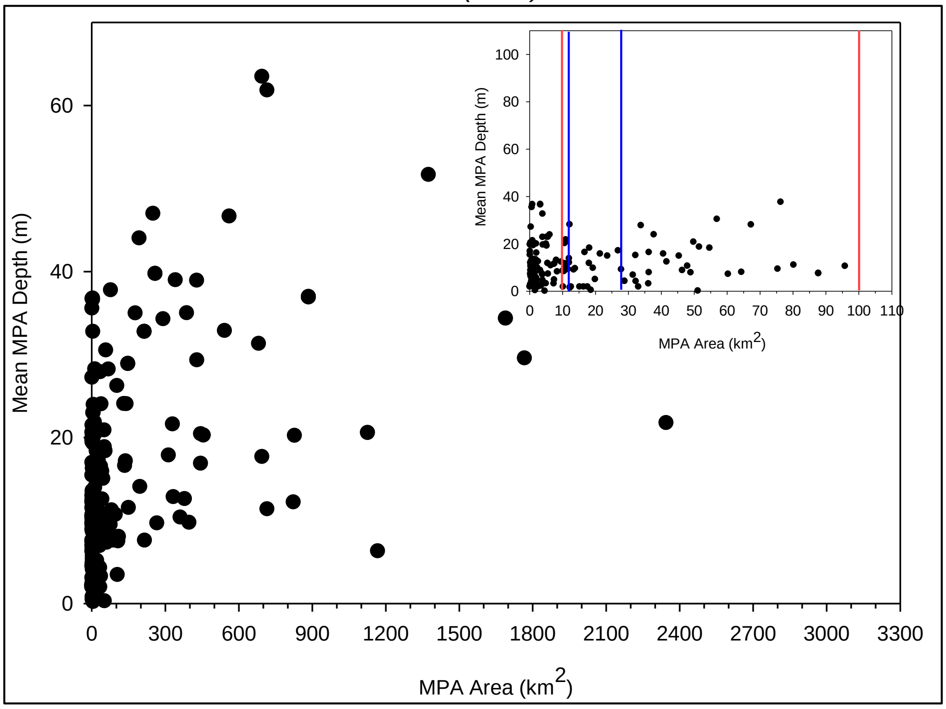


Figure 28*: Relationship between MPA area and mean depth of MPAs within the network. Inset shows MPAs with an area <100 km^2; red lines denote optimum MPA size range recommended by Halpern and Warner (2003); blue lines denote optimum MPA size range recommended by Shanks et al. (2003).*

Compactness is used to describe to what extent the shape of an area approaches a circle (compactness = 1). Within the Channel network, the mean (±SD) compactness index of MPAs is 0.36 ± 0.24. The distribution of the compactness indices of MPAs within the Channel network is skewed towards smaller values indicating that the majority of MPAs are not circular, and are less compact (Figure 29). Nevertheless, 8% of MPAs have a compactness indicator of greater than 0.8 indicating that these MPAs are close to circular in shape.

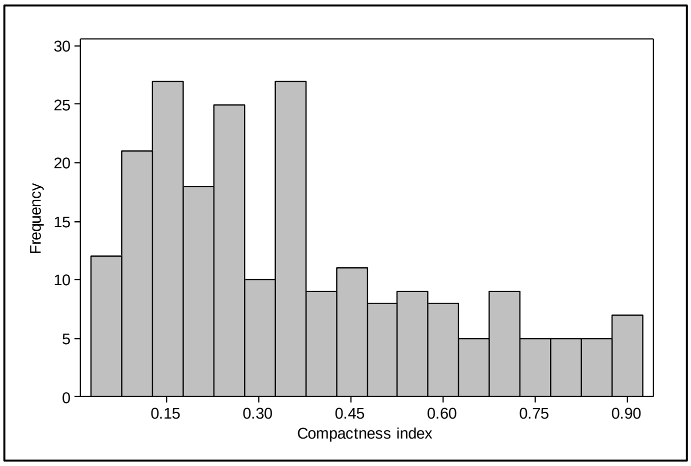


Figure 29*: Compactness index of MPA sites within the Channel MPA network.*

The edge-to-area ratio is another method of determining to what extent an area is open to the surrounding area. MPAs with a large edge-to-area ratio will offer less protection to species inside the MPA than MPAs with a small edge-to-area ratio because of their large perimeter (Roberts and Hawkins, 2000). In the Channel network, the median edge-to-area ratio of MPAs in the Channel network is 3.4, with the distribution skewed towards smaller edge-to-area ratios (Figure 30).

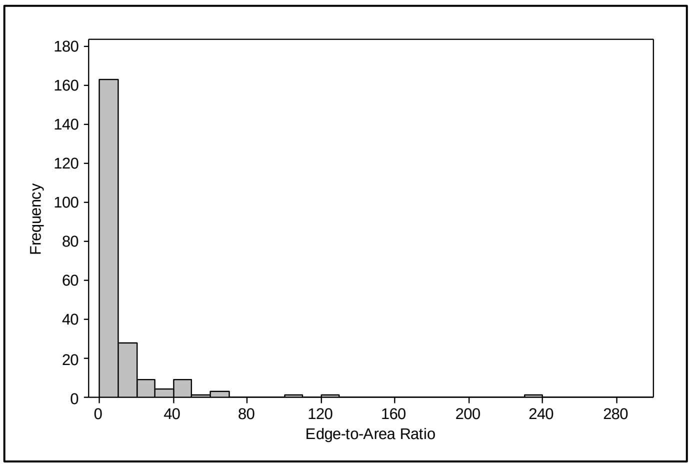
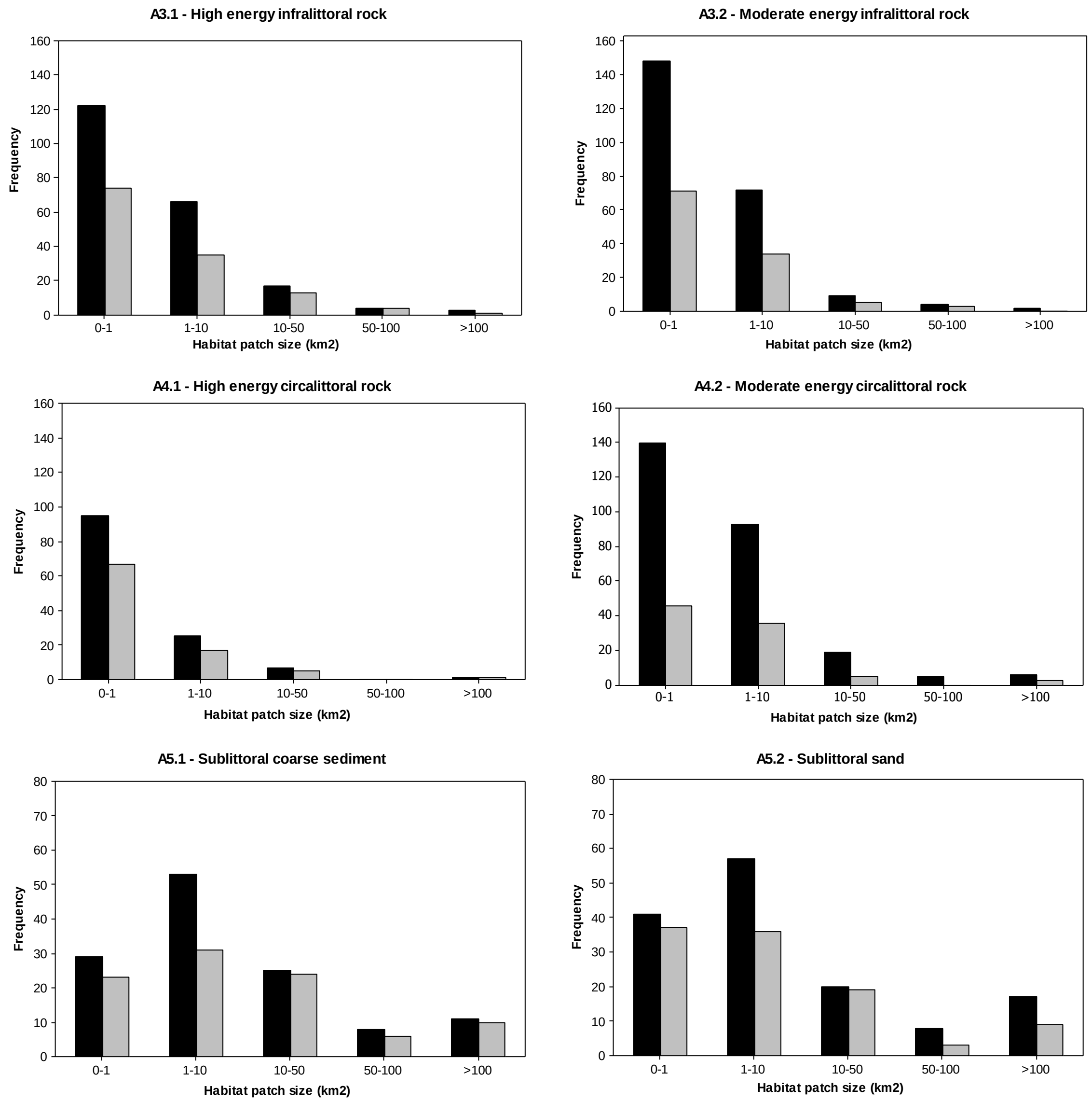


Figure 30*: Edge-to-Area ratio of MPA sites within the Channel MPA network.*

b) Size Distribution of EUNIS Level 3 Habitat Patches

The patch sizes of EUNIS Level 3 habitats with substantial coverage in the Channel network (total area within network >1000 km^2) were assessed in the PANACHE study area as a whole and within designated MPAs within the Channel network.

The size distribution of the majority of these habitats is skewed towards the smaller size classes (0-1 km^2 and 1-10 km^2) and in many cases only approximately half of these patches occur within the boundaries of MPAs in the network (A3.1 – high energy infralittoral rock, A3.2 – moderate energy infralittoral rock, A4.2 – moderate energy circalittoral rock, A5.1 – sublittoral coarse sediment, A5.4 – sublittoral mixed sediment; Figure 31). However, three of the habitats (A5.1 – sublittoral coarse sediment, A5.2 – sublittoral sand, A5.4 - sublittoral mixed sediment) have a substantial number of habitat patches in the >100 km^2 size class and over half of these patches occur within the boundaries of MPAs (Figure 31).



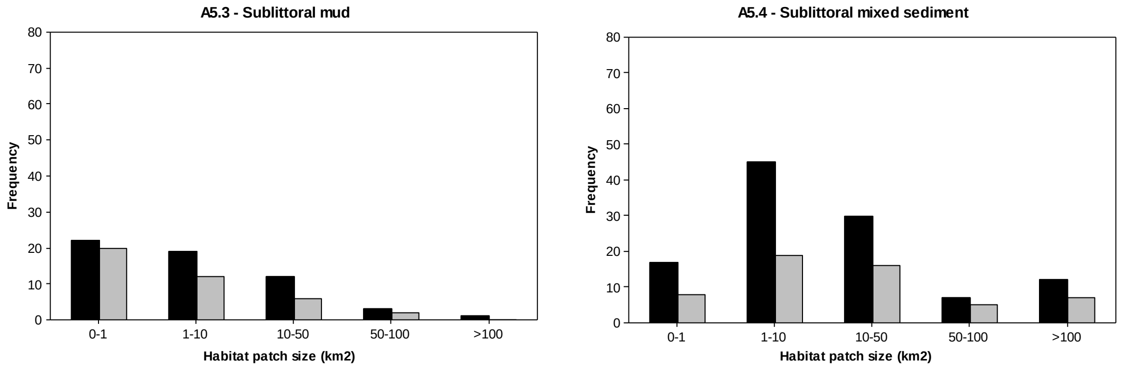


Figure 31: *Size frequency distribution of habitat patch sizes within the PANACHE study area (black bars) and within the MPA network (grey bars) for EUNIS Level 3 habitats with >1000 km^2 within the MPA network.*

Furthermore, both sublittoral coarse sediment (A5.1) and sublittoral mixed sediment (A5.4) have a patch of habitat greater than 1000 km^2 enclosed within the MPA network. This is likely a result of extensive areas of these habitat types occurring within the boundaries of large MPAs within French waters. While large extents of these habitats also occur within English waters, MPAs are typically smaller and do not encompass such large extents of habitat. Thus, a few large MPAs appear to be better suited to encompassing large areas of habitat than many smaller MPAs. Notably, the majority of patches in the 10-50 km^2 size class for high energy infralittoral rock (A3.1), moderate energy infralittoral rock (A3.2), high energy circalittoral rock (A4.1), sublittoral coarse sediment (A5.1) and sublittoral sand (A5.2) occur within the boundaries of MPAs.

3.3.3 Discussion

The viability of the Channel MPA network was evaluated in two ways: by assessing the size and shape of individual MPAs and by assessing the size distribution of EUNIS Level 3 habitat patches within the MPA network. The optimum size, shape and frequency of protected areas has long been debated in the scientific literature (Zhou and Wang, 2006). Halpern and Warner (2003) found a consensus recommending networks with variable MPA sizes in the range 10-100 km^2, with a minimum size of 10 km^2, to accommodate species with a variety of dispersal distances. While Shanks et al. (2003) recommend a minimum MPA size of 3.14 km^2 but a preferable size in the range 12.5 to 28.5 km^2, based on larval dispersal distances. Based on these values, 24% and 40% of MPAs within the network are smaller than the minimum recommendations of 3.14 and 10 km^2, respectively, with only 33% in the optimal size range of 10-100 km^2 recommended by Halpern and Warner (2003). These results imply that almost half of the MPAs within the Channel network may be too small to sustain populations of species with a variety of different dispersal patterns. However, it is important to keep in mind that some of the smaller MPAs were designated for specific purposes, such as protecting bird colonies, and do not necessarily need to be of a large size.

Halpern (2003) has demonstrated that the size of reserves has limited effects on the abundance, biomass, size and diversity of organisms, with both large and small reserves producing measurable benefits. Furthermore, evidence has suggested that local retention of larvae is more common than previously thought, suggesting that even small MPAs provide some recruitment benefits within their boundaries (Almany et al., 2009; Jones et al., 2005). One criteria that has been demonstrated to be important is the edge-to-area ratio of reserves, with the large ratios of small reserves resulting in more efficient export of larvae and adults to surrounding areas (Roberts et al., 2003a). Thus, while 40% of MPAs within the Channel network are smaller than 10 km^2, they may still be efficient at conserving biodiversity and their larger edge-to-area ratio may also support efficient export of individuals into the surrounding areas. Interestingly, the median size of MPAs within the Channel network is 15.7 km^2, which is considerably larger than the global average of 4.6 km^2 (Wood et al., 2008). Nevertheless, it is important to remember that many of the studies investigating the success of MPAs have focused on no-take reserves, and there is not a single MPA within the Channel network that is entirely a no-take area. The success of having a representative and replicated network of sites for conservation depends heavily on the ongoing activities within the MPA itself.

It is also important to note that there are geographic limitations to the definitions of compactness and edge-to-area ratio used here to assess the criteria of viability. The majority of MPAs within the Channel network are coastal or linear and as such are bounded by the coast. Thus, these MPAs will score poorly on compactness and this index may not truly reflect the shape of the MPAs. Furthermore, calculations of edge-to-area ratio also do not take into consideration the perimeters of MPAs bounded by coastline. Thus, the large edge-to-area ratios of smaller MPAs that suggest they may be efficient at exporting adults and larvae may be confounded by the fact that a portion of the MPA perimeter is bounded by the coastline, and export along this edge does not occur.

There are also other implications to consider regarding the size of MPAs. Small MPAs may not be self-sustaining or able to support self-seeding populations of species with a widely dispersing larval stage (Hill et al., 2010; Roberts et al., 2003b). For many sessile or sedentary species with a planktonic larval stage, dispersal occurs over large distances and MPAs greater than 1000 km^2 are thought to be necessary to allow for self-sustaining communities of these species (Hill et al., 2010). Only eight of the 222 MPAs within the Channel network cover an area greater than 1000 km^2, thus, the Channel network may not be ecologically viable in terms of supporting self-seeding populations of species with widely dispersing larvae.

The size distribution of EUNIS Level 3 habitats within the PANACHE study area and within MPAs was also assessed as a means of evaluating the viability of the MPA network. Although only 21% of EUNIS Level 3 habitat patches within the MPA network are greater than 10 km^2, these represent a significant portion of the larger habitat patches found within the PANACHE study area. For example, 67% of habitat patches in the size range 10-100 km^2 within the PANACHE study area occur within the boundaries of MPAs. Further, while only 4% of EUNIS Level 3 habitat patches within the MPA network are greater than 100 km^2, these represent 59% of habitat patches of this size within the PANACHE study area. Thus, while smaller habitat patches appear to predominate throughout the Channel MPA network, supporting limited and low mobility species, a significant proportion of larger habitat patches available within the study area are enclosed within the boundaries of MPAs, supporting species that are more mobile.

3.4 Adequacy

Adequacy refers to the concept of ensuring that the individual components of an MPA network are of sufficient size, shape and appropriate spatial distribution to ensure ecological viability and integrity of populations and species (HELCOM, 2010; UNEP-WCMC, 2008). In addition to the size and shape of the MPA network, adequacy also refers to the proportion of each feature protected within the network (OSPAR, 2013). The total area of EUNIS Level 3 habitats and habitats of conservation importance within the Channel MPA network were assessed. It was not possible to test this criterion for species of conservation importance due to the nature of the data. Only point data, indicating presence of a species at a particular location, were available.

3.4.1 Methodology

a) Area of EUNIS Level 3 Habitats within the MPA Network

The EUSeaMap was used to determine the proportion of EUNIS Level 3 habitats (with substantial coverage within the PANACHE study area) occurring within the MPA network (high energy infralittoral rock (A3.1), moderate energy infralittoral rock (A3.2), low energy infralittoral rock (A3.3), high energy circalittoral rock (A4.1), moderate energy circalittoral rock (A4.2), low energy circalittoral rock (A4.3), sublittoral coarse sediment (A5.1), sublittoral sand (A5.2), sublittoral mud (A5.3), sublittoral mixed sediments(A5.4)). In ArcGIS, the EUSeaMap data layer was clipped to the MPA network data layer and the area (km^2) of EUNIS Level 3 habitats that occurs within the boundaries of MPAs was calculated.

b) Area of Habitats of Conservation Importance within the MPA Network

Data on the distribution of *Zostera* Beds and Maerl Beds in the PANACHE study area were collated from a number of sources (2.4 Data sources). As for the EUNIS Level 3 habitats, spatial data layers for *Zostera* and Maerl beds were clipped to the MPA network data layer and the area of habitat that occurs within the boundaries of MPAs was calculated. Only point data were available for *Sabellaria* reefs, thus, adequacy could not be assessed for this habitat.

Cautionary Note: The proportion of *Zostera* beds within the MPA network should be interpreted with caution, as areas may have been under-estimated because data were not available for the eastern Channel in French waters, and data from Cornwall Wildlife Trust were point data, rather than polygon data. The proportion of Maerl beds within the MPA network should be interpreted with caution, as areas may have been under-estimated. French datasets consisted of two polygons, ‘live Maerl only’ and ‘live and dead Maerl beds’; however, area estimates for Maerl were obtained using the ‘live Maerl’ polygons only. The majority of datasets for *Sabellaria* reefs consisted of point data only. Therefore, it was not considered appropriate to conduct ‘Adequacy’ analysis, which is based on the proportion of area within the MPA network.

3.4.2 Results

a) Area of EUNIS Level 3 Habitats and Habitats of Conservation Importance

The coverage of ten EUNIS Level 3 habitats within the PANACHE study area was investigated to assess the adequacy of the MPA network. The percentage area of habitat that was enclosed within the MPA network ranged from 0.3% to 55% (Table 12). Less than 1% of low energy circalittoral rock (A4.3) was found to be enclosed within the MPA network, and less than 15% of moderate energy circalittoral rock (A4.2) and sublittoral coarse sediment (A5.1) was found to be enclosed within the MPA network (Table 12, Figure 32). The remaining seven habitats assessed have between 24% and 55% of their area enclosed within the MPA network (Table 12, Figure 32).

The adequacy of habitats of conservation importance were also assessed, with 65% of Zostera beds and 48% of Maerl beds within the PANACHE study area enclosed within the MPA network

Table 13, Figure 32).

***Table 12**: Occurrence of EUNIS Level 3 habitats within the PANACHE study area and within MPAs in the Channel network. [1]Denotes thresholds recommended by Rondinini (2010) and turquoise shading indicates threshold was met. Habitats with an area in the network of <20% are shown in yellow, between 20 – 60% are shown in blue and > 60% in green (HELCOM, 2010).*

Habitat Code	Habitat description	Area of habitat within PANACHE study region (km^2)	Area (and %) of habitat within MPAs (km^2)	% of habitat recommended to conserve 80% of species[1]	% of habitat recommended to conserve 90% of species[1]
A3.1	High energy infralittoral rock	1993	1000 (50%)	31	57
A3.2	Moderate energy infralittoral rock	1055	446 (42%)	32	59
A3.3	Low energy infralittoral rock	10	6 (55%)	32	59
A4.1	High energy circalittoral rock	1659	546 (33%)	25	52
A4.2	Moderate energy circalittoral rock	9996	1389 (14%)	28	55
A4.3	Low energy circalittoral rock	601	1.5 (0.3%)	32	58
A5.1	Sublittoral coarse sediment	44971	5866 (13%)	33	59
A5.2	Sublittoral sand	9652	3583 (37%)	30	57
A5.3	Sublittoral mud	1099	361 (33%)	30	57
A5.4	Sublittoral mixed sediments	13079	3152 (24%)	32	58

Table 13: *Occurrence of habitats of conservation importance within the PANACHE study area and within MPAs in the Channel network. Habitats with an area in the network of between 20 – 60% are shown in blue and > 60% in green (HELCOM, 2010).*

Habitat	Area within PANACHE study area (km^2)	Area (km^2) and % within Channel MPA network
Zostera beds	69*	44 (65%)
Maerl beds	1037	495 (48%)

*The area is an underestimate of the actual *Zostera* presence in the Channel because of the lack of spatial data for France in the east Channel and lack of polygon data for some of the UK sites.

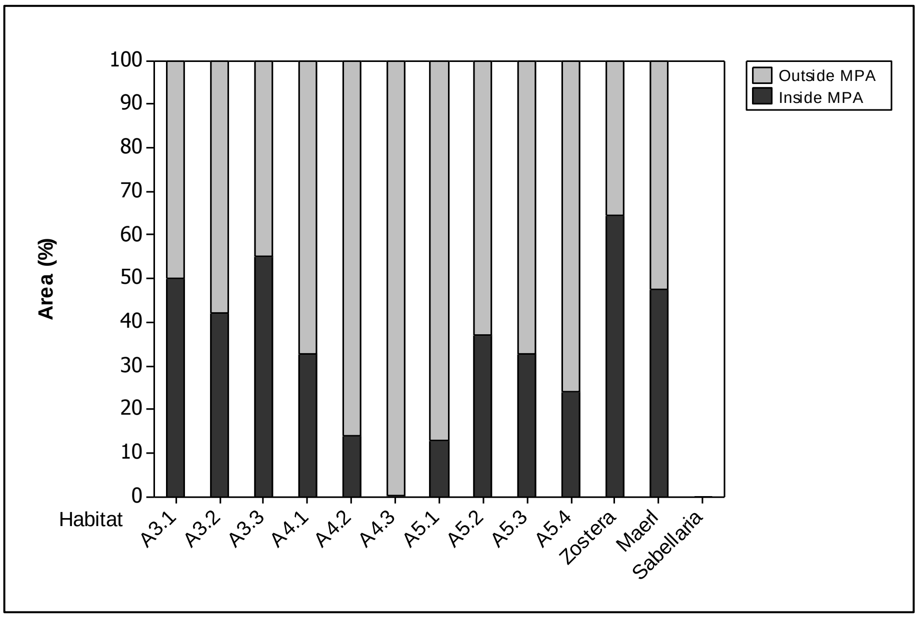


Figure 32*: Distribution of EUNIS Level 3 habitats and habitats of conservation importance inside and outside the Channel MPA network. EUNIS Level 3 habitat abbreviations provided in table 12.*

3.4.3 Discussion

The recommended thresholds for the proportion of each habitat to be incorporated within MPA networks has yet to be clearly defined, with suggested values ranging from 10% to 66% (Airame et al., 2003; HELCOM, 2010; Jackson et al., 2008; Rondinini, 2010). Rondinini (2010) used species-area curves to estimate the proportion of habitat necessary to represent increasing percentages of species within EUNIS Level 3 habitats, with values ranging from 25% to 59% of the extent of the habitat to represent between 80% and 90% of the species associated with the habitat. In many cases, representing 90% of species within a habitat required almost double the area compared with representing 80% of species within a habitat (Rondinini, 2010). Here, we apply three different thresholds (at the scale of the PANACHE study area) from the literature:

a) habitat-specific threshold values based on Rondinini (2010): 25%-33% of the extent of a habitat to represent 80% of species and 52%-59% of the extent of a habitat to represent 90% of species;
b) < 20% of a habitat considered inadequate; 20 – 60% of a habitat as questionable, and > 60% of a habitat as adequate (HELCOM, 2010); and
c) 30-50% of each habitat (Airame et al., 2003).

When the thresholds recommended by Rondinini (2010) are applied, none of the EUNIS Level 3 habitats has adequate area within the MPA network to represent 90% of the species associated with the habitat, and only six of the 10 habitats (high energy infralittoral rock (A3.1), moderate energy infralittoral rock (A3.2), low energy infralittoral rock (A3.3), high energy circalittoral rock (A4.1), sublittoral sand (A5.2), sublittoral mud (A5.3)) have sufficient area within the network to represent 80% of the species associated with the habitat (Table 12). Similar results are obtained when the thresholds put forward by Airame et al. (2003) are applied, with four of the ten EUNIS Level 3 habitats (moderate energy circalittoral rock (A4.2), low energy circalittoral rock (A4.3), sublittoral coarse sediment (A5.1) and sublittoral mixed sediments (A5.4)) falling below the 30% threshold and eight of the ten EUNIS Level 3 habitats (A3.2, A4.1, A4.2, A4.3, A5.1, A5.2, A5.3 and A5.4) and Maerl beds falling below the 50% threshold. Furthermore, if the targets put forward by HELCOM (2010) are applied, only *Zostera* is considered to have an adequate amount of area within the MPA network, with the area of the remaining habitats falling within the thresholds of 'questionable' or 'inadequate'. However, this estimate is likely flawed due to insufficient data for the study region. Overall, these results suggest that the MPA network does not enclose sufficient areas of habitats, and their associated species, present within the Channel to ensure ecological viability and integrity of associated populations and species.

3.5 Connectivity

Populations of marine organisms are typically much more open than terrestrial populations as a result of dispersive pelagic larval stages (Roberts, 1997). Thus, populations of many marine organisms can be viewed as metapopulations: a system of discrete local populations, each of which determines its own internal dynamics but is influenced to some degree by the dispersal of individuals from other populations (Kritzer and Sale, 2004). Connectivity describes the extent to which the populations in different parts of a species' range are linked by the exchange of eggs, larvae or other propagules, juveniles or adults (Palumbi, 2003). Understanding the extent to which populations and sites are connected by larval dispersal, adult movement, and/or through functional linkages between communities, ecosystems and ecological processes is critical both for the design of MPA networks to protect biodiversity, and for the development of conservation strategies to protect species associated with degrading and fragmenting habitats (Jones et al., 2008; Kritzer and Sale, 2004; UNEP-WCMC, 2008). Strong connectivity among populations implies that local populations may depend on processes occurring elsewhere and this needs to be considered when applying management initiatives (Roberts, 1997). Identification and inclusion of both source and sink populations within an MPA network can provide a potential buffer in the event of a catastrophic event by providing sources of larvae to replenish degraded areas and enhance recovery, both within and outside the MPA network.

Connectivity among populations is influenced by a variety of factors including, (i) the larval characteristics of the species (e.g. duration of the planktonic stage and drifting behaviour of propagules), (ii) the abundance of the source population, (iii) the availability and suitability of surrounding habitat and (iv) the characteristics of the physical environment (e.g. speed and direction of ocean currents, temperature, salinity) (Shanks et al., 2003; Treml et al., 2008). To fully evaluate the connectivity of an MPA network, these factors need to be considered. In the assessment presented here, such a comprehensive approach was not feasible. Thus, connectivity was assessed using a simplified model approach based on geographical distance among habitat patches and MPAs in order to provide preliminary information on the most- and least-connected areas of the MPA network.

The connectivity of MPAs within the network based on the oceanography of the Channel and the life history characteristics of early life stages of particular species will be assessed in a separate study being conducted as part of PANACHE WP1 and a separate report will be published. Briefly, this separate connectivity study will utilise a Lagrangian model of passive larval dispersal to assess MPAs within the network as possible sources or sinks of larvae using oceanographic data for the Channel, spawning times and planktonic larval duration. The results generated in this separate study will be utilised to highlight clusters of highly connected MPAs, as well as areas of cross-Channel connectivity.

In this study, our approach used a theoretical model and followed the methodology described by Estrada and Bodin (2008), where the landscape of scattered habitat patches within the study area is presented as a network consisting of nodes and links. A node represents each habitat patch and a link between any two nodes represents connectivity between the two corresponding habitat patches. If two habitat patches are connected, the target species are able to move between these two patches, thus, implying that there is a potential flow of individuals (adults and/or larvae). In this study, when referring to a habitat patch we are referring specifically to the habitat patch that a species can inhabit, not the habitat patch itself. Thus, habitat patch refers solely to the realised niche (area that a species occupies) of the species that are characteristic of that habitat.

In this analysis, effective distance between any two habitat patches was used as a surrogate for connectivity, where a greater effective distance equals less connectivity (flow of individuals) (Estrada and Bodin, 2008). In order to maintain simplicity due to time constraints, geographic distance between any two habitat patches was used as the effective distance. However, calculating effective distance in future analyses could be improved by taking into account the permeability of specific habitat types that separate patches, dominant currents, and species behaviour (Estrada and Bodin, 2008). The network of habitat patches in the PANACHE study area was represented by an unweighted-undirected network, thus, it was assumed that any two habitat patches were connected if the distance between them fell below a predefined threshold distance, irrespective of the direction of the movement of individuals (Estrada and Bodin, 2008). The number of individuals moving from patch *i* to patch *j* was assumed to be equal to the number of individuals moving from patch *j* to patch *i*.

Connectivity was assessed among:

1) MPAs within the Channel network where any one of the habitats of interest was present (e.g. EUNIS Level 3 habitat, *Zostera* beds, Maerl beds, *Sabellaria* reefs).
2) Patches of habitats of interest (e.g. EUNIS Level 3 habitat, *Zostera* beds, Maerl beds, *Sabellaria* reefs) that occur within the PANACHE study area.
3) Patches of habitats of interest (e.g. EUNIS Level 3 habitat, *Zostera* beds, Maerl beds, *Sabellaria* reefs) that occur within the Channel MPA network.

3.5.1 Methodology

a) Habitat Patch (polygon) Aggregation

Adjacent habitat patches that shared at least one common edge were aggregated into a single habitat patch (particularly common for EUNIS Level 3 habitats extracted from the EUSeaMap). *Zostera* patches were aggregated together when the distance between patches was less than or equal to 150 m to account for differences in map scale and resolution among the data layers obtained from different sources. Similarly, habitat patches of Maerl were aggregated together when they occurred within 50 m of each other. Aggregation of habitat patches was necessary, as those patches from high-resolution maps would appear better connected than habitat patches from lower resolution maps simply because there are many more habitat patches within higher resolution maps.

b) Minimum Habitat Patch Size

Thresholds for minimum habitat patch size for *Zostera*, Maerl beds and *Sabellaria* reefs were obtained from Hill et al. (2010), who used species densities reported in the literature and/or derived from the Marine Ecological Surveys Limited (MESL) database to convert minimum viable population (MVP) size into the habitat patch size required to support it. The MVP for a species is defined as the population size required to ensure the persistence of populations for a given period of time, and to protect against in-breeding and genetic mutations (Hill et al., 2010). Although Hill et al. (2010) found studies of MVP relating specifically to marine invertebrates were few in number, they observed that an MVP of 5000 individuals had been estimated for a wide range of taxa, and this value was also in agreement with MVPs recommended by Traill et al. (2007) and Frankham (1995). Thus, an MVP of 5000 was used in this study. Using the best available data, Hill et al. (2010) suggested an area of 188 m^2 would be sufficient to support an MVP of *Zostera* and an area of 500 m^2 would be sufficient to support species associated with Maerl beds. Therefore, prior to the connectivity analysis, any Zostera and Maerl habitat patches smaller than 188 m^2 (0.000188 km^2) and 500 m^2 (0.0005 km^2) were removed from the habitat data layer. The data layer for *Sabellaria* reefs was primarily composed of point data so no data processing was performed prior to analysis.

c) Maximum Dispersal Distance

Threshold values used to assess the potential connectivity of different habitats were based solely on the larval dispersal distances of characteristic species occurring within the habitats and were taken from the literature. Threshold values for *Zostera* beds, Maerl beds and *Sabellaria* reefs were taken from Hill et al. (2010), and were 50 km, 40 km and 45 km, respectively (Table 14). To the best of our knowledge, there is no literature available specifying larval dispersal distances for the vast array of species occurring within EUNIS Level 3 habitats. Therefore, a threshold distance of 40 km, based on information from Roberts et al. (2010), was used to define the maximum effective distance between two habitat patches.

Table 14*: Habitat type, area within PANACHE study region, area within MPAs in the network, minimum patch size and maximum dispersal distance used for calculating degree centrality and buffers. Values in parentheses denote EUNIS habitat code (European Environment Agency, 2007). NB: the minimum patch size for EUNIS Level 3 habitats is the minimum cell size from the EUSeaMap.*

Habitat	Area of habitat within PANACHE study region (km^2)	Area of habitat within MPAs in the Channel network (km^2)	Minimum patch size (km^2)	Maximum dispersal distance (km)
High energy infralittoral rock (A3.1)	1993	1000	0.12	40
Moderate energy infralittoral rock (A3.2)	1055	446	0.12	40
Low energy infralittoral rock (A3.3)	10	6	0.12	40
High energy circalittoral rock (A4.1)	1659	546	0.12	40
Moderate energy circalittoral rock (A4.2)	9996	1389	0.12	40
Low energy circalittoral rock (A4.3)	601	1.5	0.12	40
Sublittoral coarse sediment (A5.1)	44971	5866	0.12	40
Sublittoral sand (A5.2)	9652	3583	0.12	40
Sublittoral mud (A5.3)	1099	361	0.12	40
Sublittoral mixed sediments (A5.4)	13079	3152	0.12	40
Maerl	1037		0.0005	40
Sabellaria			-	45
Zostera	69*		0.000188	50

*The area is an underestimate of the actual *Zostera* presence in the Channel because of the lack of spatial data for France in the east Channel and lack of polygon data for some of the UK sites.

d) Analyses

In ArcGIS, the central point (centroid) of each MPA and each habitat patch of interest was generated. The distance between each pair of MPA centroids, and between each pair of habitat centroids, was calculated to generate two adjacency matrices (one for MPAs and one for habitats of interest). The adjacency matrices were converted into binary symmetric matrices, where one indicates a link between habitat patch *i* and habitat patch *j* (or MPA*i* and MPA*j*) and zero indicates no link. The matrices were then used to calculate degree centrality (DC(*i*)) (connectivity) among MPAs and among habitat patches. DC(*i*) is simply the number of patches that a habitat patch is connected to, or the number of MPAs that an MPA is connected to, based on the distance threshold (Table 14). The degree centrality calculations and binary matrices were used to address the following questions:

1) How well connected (in terms of degree centrality) are MPAs within the Channel network for each of the habitats examined?
2) What proportion of connected habitat patches fall inside the MPA network and what proportion fall outside the MPA network?
3) Are ‘connectivity-hotspots’ enclosed within the MPA network?
4) How does connectivity of habitat patches within a single MPA compare to connectivity of habitat patches within different MPAs?

In ArcGIS, buffers (with a width half the maximum dispersal distance specified in Table 14) were created around patches of habitats of interest to highlight possible areas of connectivity. Overlapping buffers indicate potential connectivity (through the movements of characteristic species) among habitat patches and/or MPAs within the Channel MPA network.

3.5.2 Results

a) Connectivity among MPAs within the Network

Degree centrality was used to assess the potential connectivity of specific habitats within MPAs in the Channel network. A degree centrality of zero implies that the MPA containing a particular habitat type is not linked to any other MPA where patches of the same habitat occur. Conversely, a degree centrality of greater than zero implies that the MPA in which the habitat patch is located is linked to at least one other MPA where patches of the same habitat occur (the value of degree centrality = the number of connections).

Within the Channel MPA network, MPAs are typically connected to two or three other MPAs (Figure 33). Although this indicates some degree of potential connectivity among MPAs within the network, connectivity of habitats (and their characteristic species) across the entire study area is relatively low given that a habitat may be present in 20 MPAs but in 65% of cases only habitats within one or two MPAs are connected (e.g. moderate energy circalittoral rock (A4.2), Figure 33). The greatest number of MPAs that are potentially connected within the network for any of the habitats considered is six, which is relatively low considering that there are a total of 89 MPAs comprising the entire network (after overlaps among different MPA types are taken into account). Based solely on the distance between the centres of habitat patches, low energy infralittoral rock (A3.3) and low energy circalittoral rock (A4.3) are potentially the least connected habitats within the network, and sublittoral sand (A5.2) is potentially the most connected habitat (Figure 33). Patches of sublittoral sand (A5.2) are found within 46 MPAs within the network and nine of these MPAs are close enough to five or six other MPAs for the habitat patches to be potentially connected (Figure 33).

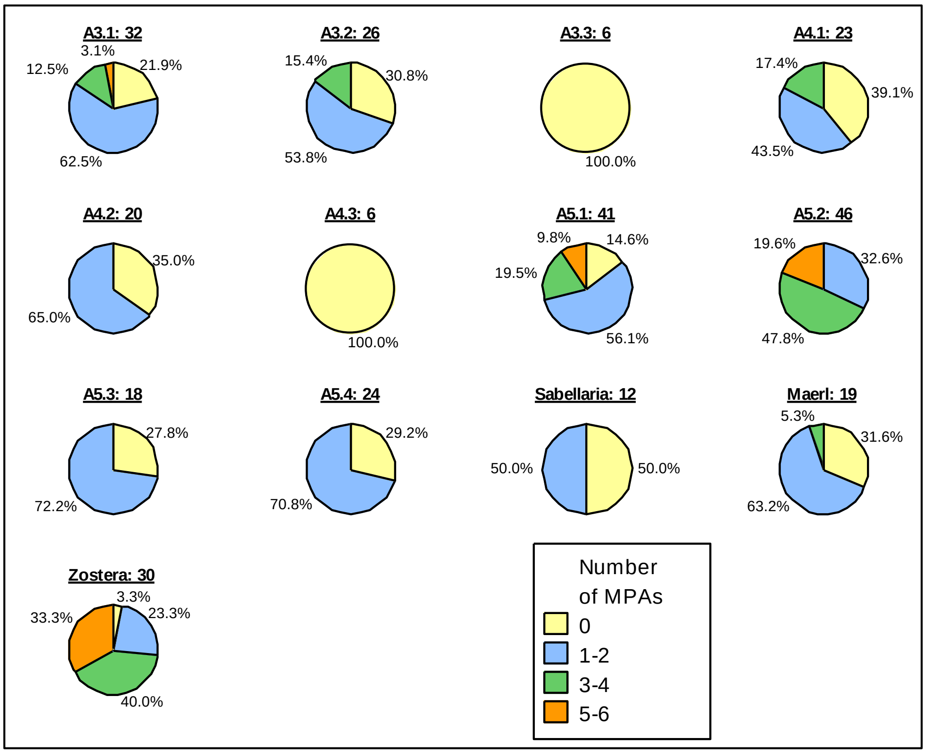


Figure 33: *The number of MPAs connected throughout the Channel MPA network for each of the EUNIS Level 3 habitats, Maerl beds, Sabellaria reefs and Zostera beds. The total number of MPAs in which each habitat occurs is provided next to habitat type. EUNIS Habitat abbreviations defined in Table 14.*

b) Habitat connections within and outside the MPA network

Potential 'connectivity hotspots' for EUNIS Level 3 habitats, *Zostera* beds, Maerl beds and *Sabellaria* reefs were identified and their occurrence within the boundaries of MPAs in the Channel network was determined. Potential connections among habitat patches that occur within MPAs in the network were compared to the potential connections among habitat patches that occur outside the network. The number of connections among habitats that occur within MPAs in the network ranged from 14% to 74% (Figure 34). Of the connections identified among patches of sublittoral coarse sediment (A5.1), only 14% of these occurred among habitat patches located within MPAs, which is not surprising given that a large portion of this habitat is located in offshore areas where few MPAs are located (Figure 35). In contrast, of the connections identified among patches of *Zostera* beds, 74% of these occurred among *Zostera* beds located within MPAs (Figure 34).

It is important to note that a high percentage of connections among patches located within the MPA network does not necessarily mean that the habitat is well connected across the MPA network. For example, low energy infralittoral (A3.3) and circalittoral (A4.3) rocky habitats appear to have a high percentage of potential connections among habitat patches within the network (Figure 34); however, Figures 36 and 37 indicate that there are very few connections among habitat patches inside and outside the network. The total coverage of a habitat, and the distribution and size of individual habitat patches must be taken into account. There is limited coverage of both low energy infralittoral (A3.3) and circalittoral (A4.3) rocky habitats within the PANACHE study area and the patches that do exist are very fragmented, which influences the results. Nevertheless, the results do demonstrate to what extent the network captures the maximum connectivity among patches of habitat. If a habitat is naturally patchy with large distances among patches, there will never be connectivity irrespective of the location of MPAs.

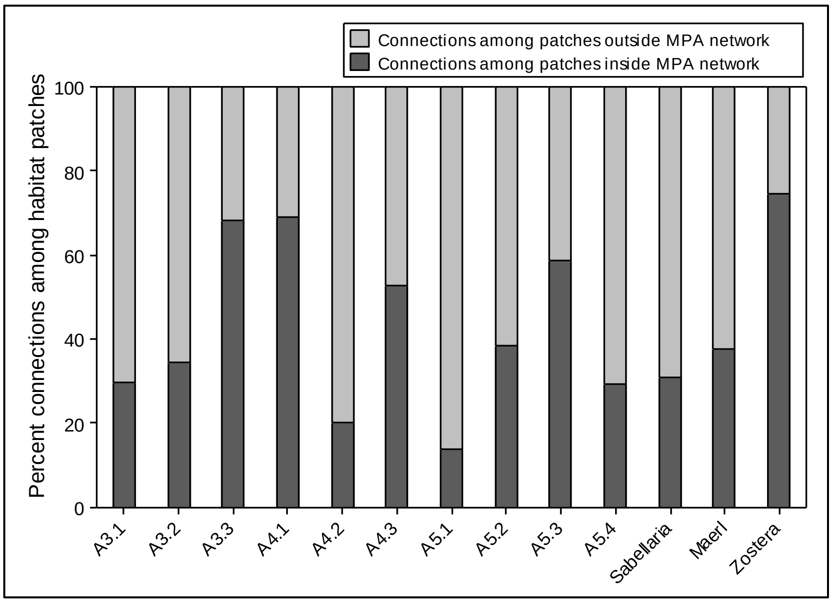


***Figure 34**: Number of connections among habitat patches located inside and outside the MPA network (one connection represents two connected habitat patches). EUNIS Habitat abbreviations defined in Table 14.*

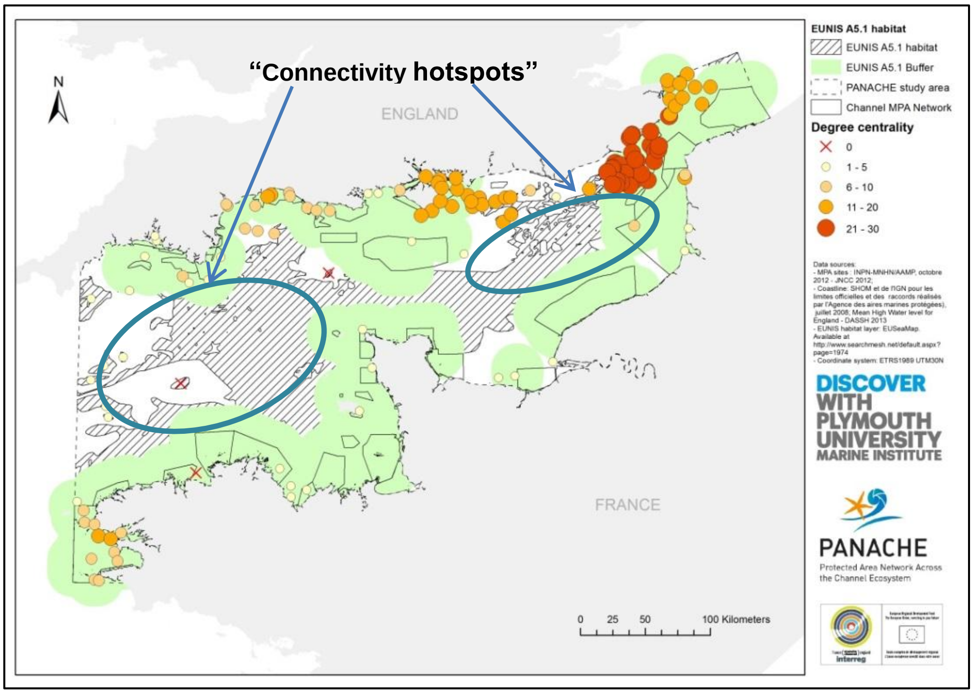


***Figure 35**: Potential number of connections (degree centrality) among habitat patches of EUNIS Level 3 sublittoral coarse sediment (A5.1) using a maximum connection distance of 40 km, overlaid with the Channel MPA network. 20 km buffers around MPAs containing A5.1 habitat patches are also shown (green shading)*

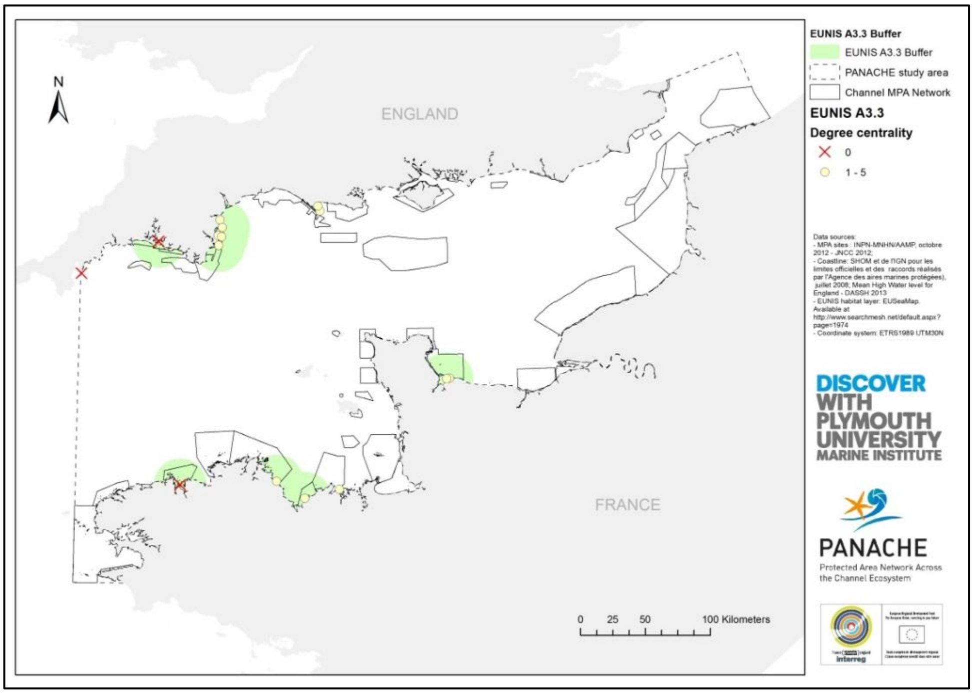


Figure 36: *Potential number of connections (degree centrality) among habitat patches of EUNIS Level 3 low energy infralittoral rock (A3.3) using a maximum connection distance of 40 km, overlaid with the Channel MPA network. 20 km buffers around MPAs containing A3.3 habitat patches are also shown (green shading).*

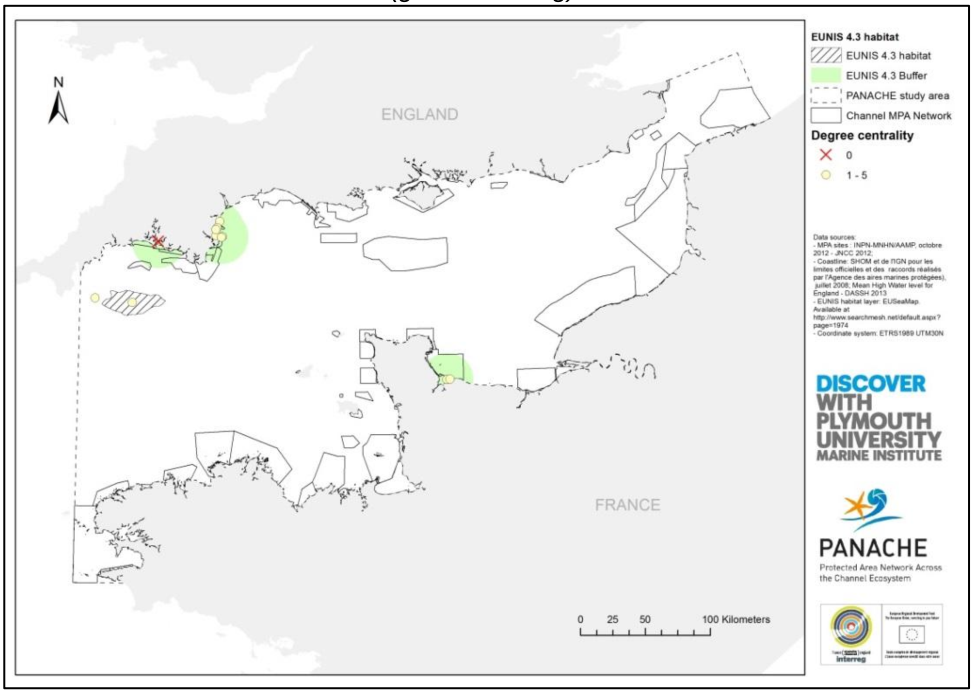


Figure 37: *Potential number of connections (degree centrality) among habitat patches of EUNIS Level 3 low energy circalittoral rock (A4.3) using a maximum connection distance of 40 km, overlaid with the Channel MPA network; 20 km buffers around MPAs containing A4.3 habitat patches are also shown (green shading).*

c) Within-MPA versus among-MPA Connectivity

The analysis presented here includes both within-MPA and among-MPA connectivity of habitat patches. Both are important for a network to be considered well connected; among-MPA connectivity is particularly important for large-scale dispersal among MPAs. When examining the number of connected habitat patches and the number of MPAs in which these habitat patches occur (Figure 38), it is clear that connectivity of habitats patches among MPAs is greater than connectivity of habitat patches within a single MPA. However, in most cases, the number of connected MPAs is limited to two or three for most of the habitat types examined. Zostera beds and sublittoral sand (A5.2) are the only exceptions, with connected habitat patches occurring within >8 MPAs (Figure 38, Figure 39). As mentioned above, the maximum number of MPAs that are connected within the network for any of the habitats examined is relatively low considering that there are a total of 89 MPAs comprising the entire network (after overlaps among different MPA designation types are taken into account).

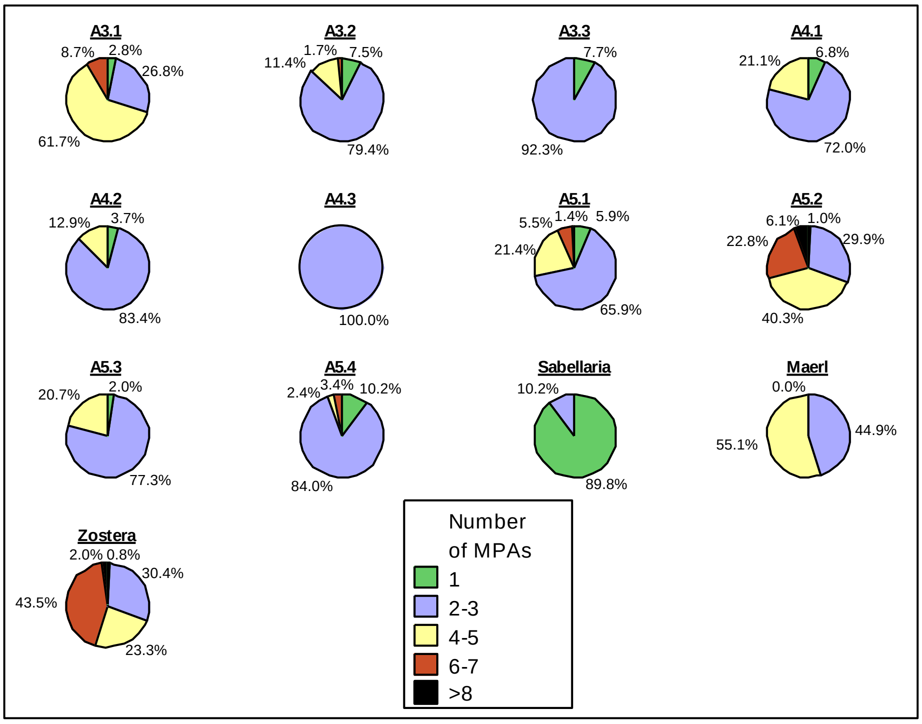


Figure 38: *The proportion of connected habitat patches occurring within one (within-site connectivity) or several (between-site connectivity) MPA sites in the Channel MPA network for EUNIS Level 3 habitats, Sabellaria reefs, Maerl beds and Zostera bed. EUNIS Habitats defined in Table 14.*

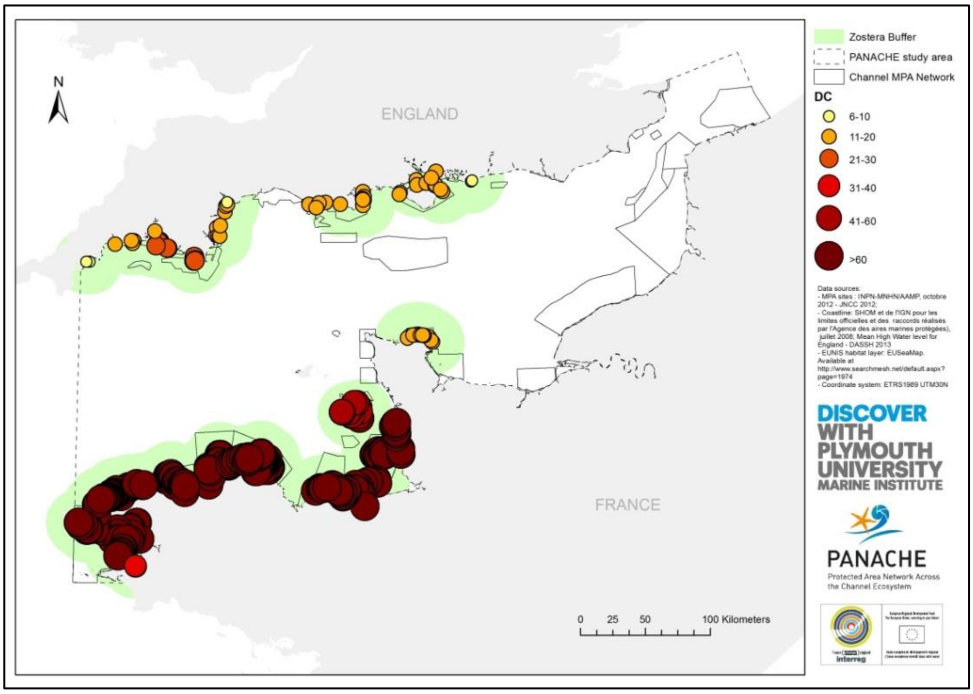


Figure 39: *Potential number of connections (degree centrality) among habitat patches of Zostera using a maximum connection distance of 40 km, overlaid with the Channel MPA network; 20 km buffers around MPAs containing Zostera habitat patches are also shown (green shading). No data available for France in the East Channel.*

d) Habitat Buffers

The creation of buffers around habitat patches enclosed within the boundaries of MPAs within the Channel network was carried out to provide a visual display of habitat patches within the network that are likely to be connected. Overlapping adjacent buffers would suggest some level of connectivity among habitat patches, and their characteristic species, and corresponding MPAs. Based on this assessment, cross Channel connectivity appears to be virtually non-existent for organisms with dispersal distances ranging up to 40 km; however, potential connectivity along the French and English coast is relatively good. The only habitat to have good cross Channel connectivity is sublittoral sand (A5.2) in the Eastern Channel, where habitat patches are potentially connected both within and outside MPAs (Figure 40). However, this cross Channel connectivity is likely a result of the narrow width of the Channel in this area, rather than the specific location of MPAs and habitat patches.

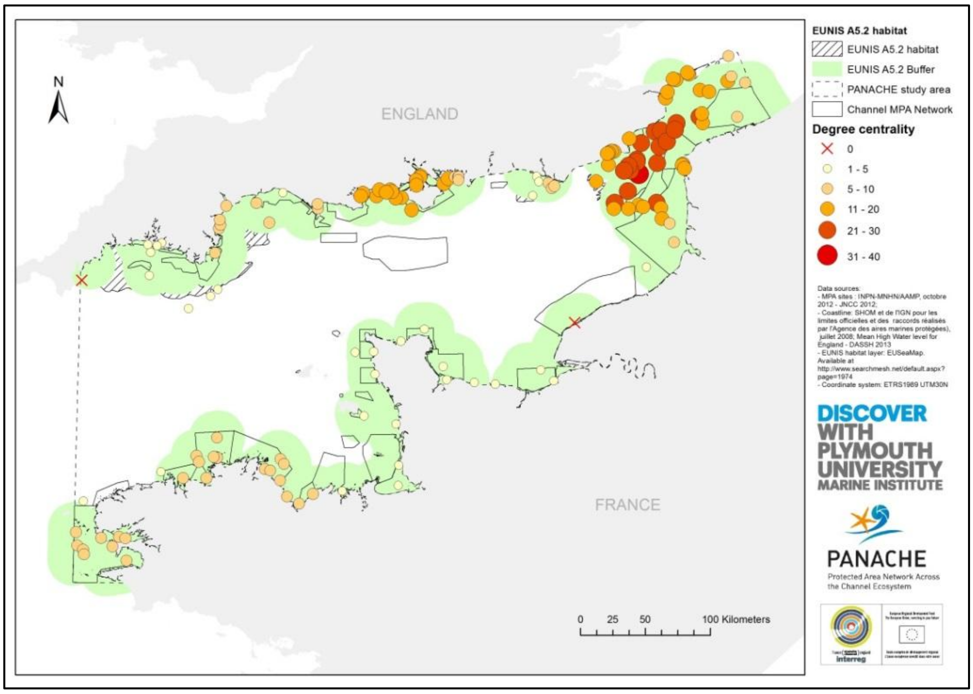


***Figure 40**: Potential number of connections (degree centrality) among habitat patches of sublittoral sand (A5.2) using a maximum connection distance of 40 km; 20 km buffer around A5.2 habitat type contained with MPA Network.*

e) Summary of Connectivity

Based on the potential dispersal distances of characteristic species within habitats, connectivity among habitat patches within MPAs along the French and English coasts, respectively, appears to be relatively good. However, cross Channel connectivity appears to be virtually non-existent for characteristic species with dispersal distances ranging up to 40 km. Patches of moderate energy circalittoral rock (A4.2) and sublittoral mixed sediments (A5.4) were found to be poorly connected, despite high occurrence of the habitats within MPAs in the network. Low energy infralittoral rock (A3.3) and low energy circalittoral rock (A4.3) are also very poorly connected but this is primarily due to the scarcity of the habitat within the PANACHE study area and the MPA network. Moderate energy infralittoral rock (A3.2) and sublittoral mud (A5.3) are moderately connected even though the habitats are not very abundant, and sublittoral coarse sediment (A5.1) and sublittoral sand (A5.2) are the most frequently connected and the most abundant habitats within the MPA network. Zostera beds appear to be well connected along the French and English coast, although additional data for French waters in the eastern Channel is still required. However, connectivity of Maerl beds and *Sabellaria* reefs appears to be principally limited by the scarcity of both habitats.

3.5.3 Discussion

By assessing the potential connectivity of habitats and MPAs within the Channel network, we are trying to understand if habitats and populations within MPAs are close enough together to maintain connections and act as sources and sinks of larvae for neighbouring habitats and populations, both within and outside the network. If habitats and populations are not close enough together for exchange of adults and larvae to occur, then if a habitat or population becomes significantly degraded it has no chance of recovery as replenishment from neighbouring populations cannot occur if they are too far away. It is generally assumed that the establishment of MPAs helps to maintain connectivity through the conservation of habitats and species.

Over 30% of the MPAs within the Channel network are smaller than 4 km^2, and while small MPAs have been shown to benefit the populations within them (Halpern, 2003), they will only function if essential linkages to other habitats (and source populations) exist (Roberts et al., 2003a). Thus, the connectivity of habitats, and the MPAs they reside in, was assessed within the Channel MPA network. The most frequent number of connections among MPAs containing the same habitats was two to three and the maximum number of connections was six. Given that patches of habitat were frequently distributed among 20 or more MPAs, the number of connections was low and indicates that connectivity of habitats within MPAs of the Channel network may not be sufficient to support the functioning of these habitats and the populations within them, or to enable replenishment of these populations should a catastrophic event occur. Patches of low energy infralittoral rock (A3.3) and low energy circalittoral rock (A4.3) were not connected among any MPAs within the network, implying that sources of larvae for populations within these habitats may be located outside the MPA network. The total area of these habitats within the PANACHE study area and within the MPA network was found to be small, which further highlights the necessity to ensure that viable, well-connected areas of these habitats are represented within the network.

During the evaluation of connectivity, a substantial proportion of the connected habitat patches for moderate energy circalittoral rock (A4.2) and sublittoral coarse sediment (A5.1) were found to occur outside the MPA network. Inclusion of some of these regions within the MPA network may potentially increase the connectivity of the network, thus, contributing towards an ecologically coherent network.

Connectivity of habitat patches was found to be greater among MPAs than within MPAs, which may be due to the overall small size of MPAs within the network. Nevertheless, this indicates the potential for replenishment of habitats and species from within the MPA network should an area of habitat become degraded. However, given that there are 89 MPA polygons within the network (after overlaps have been accounted for), the number of MPA connections was low, typically just two to three MPAs. This leads further support to the results above, that habitats within the MPA network are poorly connected, and thus, the network cannot be assumed to be ecologically coherent.

The results of creating buffers around habitat patches within MPAs in the network also leads further support to the conclusion that populations of species and habitats within the Channel network have limited connections. While the buffers demonstrate that potential connectivity among MPAs along the French and English coasts is good, connectivity among MPAs across the Channel appears to be virtually non-existent for organisms with dispersal distances ranging up to 40 km. The Channel MPA network is characterised by lots of areas of well-connected habitat patches, i.e. patchy or clustered connectivity, which may be a reflection of the distribution of the habitat rather than the ill placement of

MPAs. However, both moderate energy circalittoral rock (A4.2) and sublittoral coarse sediment (A5.1) are common and very well distributed across the Channel, yet connectivity was still limited. Therefore, the lack of a well-connected network across the Channel for these two habitats is due to the lack of French and English MPAs in offshore areas of the Channel rather than due to habitat distribution and availability. The only habitat to have potential cross Channel connectivity is sublittoral sand (A5.2) in the Eastern Channel, where habitat patches both within and outside MPAs appear to be connected based on the effective distance method used here. Although this is likely a result of the narrow width of the Channel in this region rather than well-placed MPAs.

IV. Matrix Approach

Using the matrix approach proposed by OSPAR (2008b), representativity and replication of the habitats and species within the MPA network were assessed. Representativity refers to the inclusion of the full range of ecosystems, habitats, biotic diversity, ecological processes, and environmental gradients (e.g. depth, wave exposure) within the MPA network (HELCOM, 2010; OSPAR, 2006; Roberts et al., 2003b; Rondinini, 2010; UNEP-WCMC, 2008). The objective in applying this criterion to MPA networks is to ensure representative coverage of all biodiversity and biogeographic regions within the network (Jackson et al., 2008; Roberts et al., 2003b). Representativity of EUNIS Level 3 habitats, habitats of conservation importance and species of conservation importance within the Channel MPA network was assessed using the matrix approach (OSPAR, 2008b).

To ensure natural variation and to minimise the effects of damaging events and long-term changes, adequate replication of all habitats and species is recommended within MPA networks (HELCOM, 2010; OSPAR, 2007b). Replication enhances the resilience of ecosystems to change and reduces the possibility that catastrophic events may wipe out entire populations of species or habitats within the network (HELCOM, 2010; OSPAR, 2007b; Roberts et al., 2003b). Furthermore, replication can increase representation and connectivity by adding to the number of possible connections between MPAs (HELCOM, 2010; OSPAR, 2007b). Replication of EUNIS Level 3 habitats, habitats of conservation importance and species of conservation importance within the Channel MPA network was assessed using the matrix approach (OSPAR, 2008b).

4.1 Methodology

Detailed methods are provided in OSPAR (2008b), but briefly, matrices were created by tabulating the species and habitats for which an MPA was established, against the MPAs in which they occur. Thus, the conservation objectives of the MPAs were taken into account, a factor not considered in the previous spatial analysis. Lists of species and habitats were extracted from MPA regulation/advice documents and listed vertically within the matrices, with geographic regions (eastern/western Channel and France/England) listed laterally. Habitat and species data were entered into the matrices as qualifying species, qualifying habitats, associated species, and associated habitats for each MPA within the network. Qualifying species and habitats are those features for which the MPA was designated. Associated species and habitats are those features that may receive benefits indirectly through the protection of qualifying species and habitats. The distinction between qualifying and associated features was only possible for English SACs and SPAs as these features were listed explicitly in the Regulation 33/35 advice documents. For the remaining MPA categories, only qualifying species and habitats were available.

The matrix analysis was completed four times for the Channel network using qualifying species, EUNIS Level 3 habitats, OSPAR threatened and declining habitats, and Annex 1 habitats from the Habitats Directive. Data from the EUSeaMap were used to determine which EUNIS Level 3 habitats are present within the study area. JNCC correlation tables were then used to cross-reference the EUNIS Level 3 habitats and those habitats listed for protection within the objectives/management advice documents of MPAs within the Channel network (JNCC, 2010). Terrestrial and freshwater species were removed so that only marine and coastal species were included in the analysis. The results were organised geographically (western/eastern Channel), then subdivided by country (England/France), and then by MPA designation type to determine the occurrence of qualifying habitats and species within the Channel MPA network.

The recommended thresholds for the replication of species and habitats within MPA networks has yet to be clearly defined, with suggested values ranging from one replicate of each to five or more (HELCOM, 2010; Jackson et al., 2008; OSPAR, 2008a; Roberts et al., 2003c). For the replication analysis here, we apply three different thresholds from the literature (at the scale of the PANACHE study area):

a) at least two MPAs for each EUNIS Level 3 habitat and at least three MPAs for OSPAR threatened and declining habitats and species (OSPAR, 2008a);
b) five replicates for priority species and habitats (BAP, OSPAR threatened or declining and cNIMF) (Jackson et al., 2008);
c) at least three, and preferably five or more replicates of each habitat (Roberts et al., 2003c).

4.2 Representativity

4.2.1 Results

a) Qualifying Species

A total of 121 qualifying species are listed within the conservations objectives of MPA designations within the Channel network, spanning 11 taxonomic groups (Figure 41). Over 50% of the species listed are birds and the remaining 50% of species include marine mammals (8.3%), bony fish (Actinopterygii; 9.9%), molluscs (6.6%) and crustaceans (1.7%) (Figure 41).

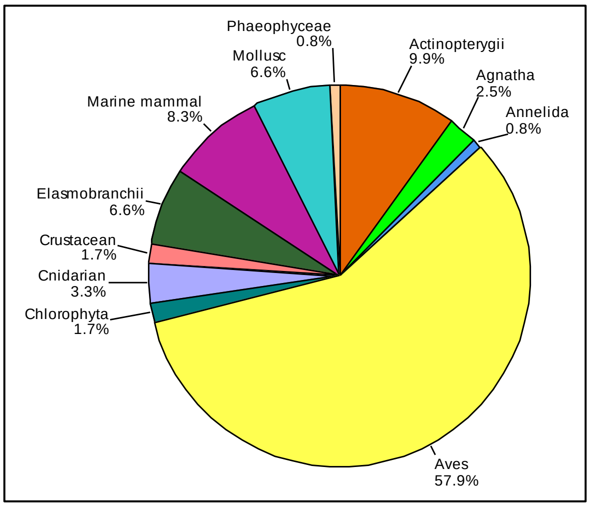


Figure 41: *Proportions of the 11 taxonomic groups listed within MPAs within the Channel network.*

b) EUNIS Level 3 Habitats

Of the 52 marine EUNIS Level 3 habitats (excluding ice-associated habitats), 39 are listed as qualifying habitats within MPAs in the Channel network, covering a broad range of habitat types (Appendix 2, Figure 43). All 39 habitats are listed within MPAs in both the eastern and western Channel (Appendix 2).

c) OSPAR Habitats

Of the 11 habitats listed by OSPAR as under immediate threat and/or decline present within the Channel, six of these are listed as conservation targets of MPAs in the Channel network (Table 15). All six habitats are found within MPAs in the eastern Channel and four of the six habitats occur within MPAs in the western Channel (Table 15).

Table 15: *Number of MPAs in which OSPAR threatened and declining habitats are named as conservation targets in the Channel network. Values represent minimum occurrences where 100% and partial MPA overlap are accounted for. Blank cells denote a habitat or species is not listed as a qualifying feature in the MPAs in that region of the Channel. Values meeting threshold of three replicates shaded in green, those below threshold in red.*

	Number of MPAs						Total Number of MPAs
Species	East Channel		East Channel Total	West Channel		West Channel Total	
	England	France		England	France		
Intertidal mudflats/mud		6	6	4	7	11	17
Littoral chalk communities	1	2	3				3
Maerl beds		1	1	1	4	5	6
Seagrass beds/ Zostera beds	6	3	9	2	11	13	22
Sabellaria spinulosa reefs	1		1				1
Sea-pen and burrowing megafauna communities	1		1	1		1	2

d) Annex 1 Habitats (Habitats Directive)

A total of seven habitats listed in Annex 1 of the Habitats Directive are named as conservation targets of MPAs in the Channel network (Table 16, Figure 45). All seven of the habitats occur within MPAs in both the eastern and western regions of the Channel (Table 16).

Table 16*: Number of MPAs in which Annex 1 habitats (Habitats Directive) are named as conservation targets in the Channel network. Values represent minimum occurrence where 100% and partial MPA overlap are accounted for. Blank cells denote that a habitat or species is not listed as a qualifying feature in the MPAs in that region of the Channel. Values meeting threshold of three replicates shaded in green.*

		Number of MPAs						Total Number of MPAs
Habitat		East Channel		East Channel Total	West Channel		West Channel Total	
		England	France		England	France		
1150	Coastal lagoons	11	3	14	1	8	9	23
1130	Estuaries	2	8	10	1	16	17	27
1160	Large shallow inlets and bays		2	2	1	10	11	13

1410	Mediterranean salt meadows (*Juncetalia maritimi*)		1	1		4	4	5
1170	Reefs	7	14	21	3	20	23	44
1110	Sandbanks which are slightly covered by sea water all the time	3	11	14	1	19	20	34
8330	Submerged or partially submerged sea caves	2		2	1	1	8	10

4.3 Replication

4.3.1 Results

a) Qualifying Species

Of the 121 qualifying species listed within MPAs in the Channel network, 82 are listed in three or more MPAs, 70 are listed in five or more MPAs and 32 are listed within just a single MPA (Appendix 3). There are 70 species of birds listed as qualifying species within the MPA network, and 51 of these are listed in five or more MPAs, with only eight listed in a single MPA (*Calidris temminckii, Sterna caspia, Bulbulcus ibis, Larus sabini, Puffinus griseus, Stercorarius longicaudus, Uria lomvia* and *Xenus cinereus*). Two species of bird (*Sterna sandvicensis* and *Sterna hirundo*) are listed as qualifying species in over 35 MPAs (including SPAs, MCZs, Ramsar sites and OSPAR sites) within the Channel network. Of the eight species of molluscs listed as qualifying species within the Channel MPA network (*Ostrea edulis, Arctica islandica, Nucella lapillus, Caecum armoricum, Hydrobia ulvae, Lacuna crassior, Ocenebrina aciculate* and *Paludinella littorina*) just three of these are listed in more than one MPA. *N. lapillus* and *A. islandica* are both listed as qualifying species in four MPAs within the Channel network and *O. edulis* is listed in six MPAs. Of the four cnidarian species listed as qualifying species within the MPA network (*Nematostella vectensis, Eunicella verrucosa, Amphianthus dohrnii, Haliclystus auricular*), *N. vectensis, E. verrucosa* are listed within five and three MPAs, respectively, and *A. dohrnii* and *H. auricular* are listed within just a single MPA.

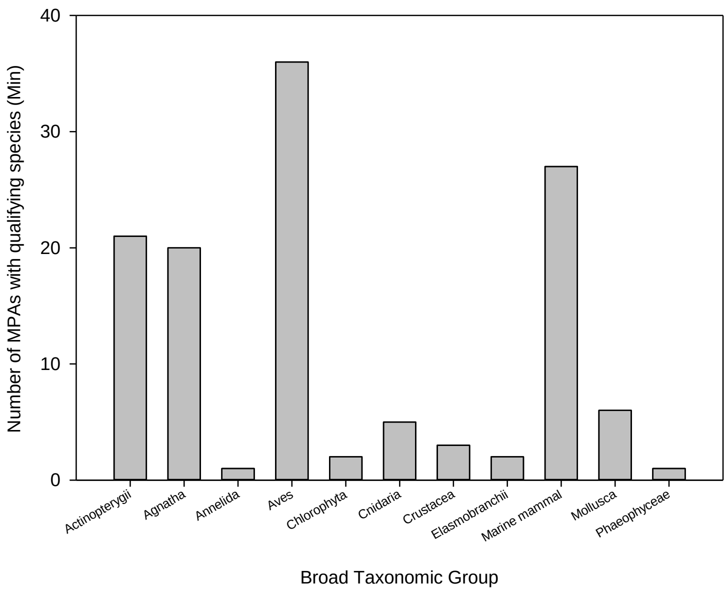


Figure 42: *Frequency of occurrence of Taxonomic Groups within MPAs in the Channel network.*

b) EUNIS Level 3 Habitats

All 39 EUNIS Level 3 marine habitats listed as qualifying habitats within MPAs in the Channel network are listed in 35 or more MPAs (Figure 43). Nearly half of the EUNIS Level 3 habitats are listed within 50 or more MPAs within the Channel network (Figure 43).

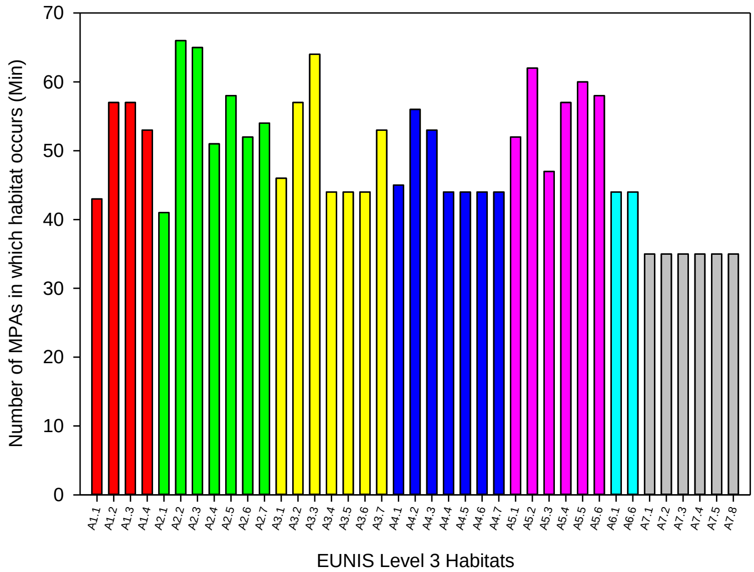


Figure 43*: Frequency of occurrence of EUNIS Level 3 Habitats within MPAs in the Channel network. EUNIS Level 3 habitat abbreviations are defined in Appendix 2.*

c) OSPAR Habitats

Of the six OSPAR threatened and/or declining habitats listed as qualifying habitats within MPAs in the Channel network, replication ranges from one to 22 MPAs (Figure 44). *Sabellaria spinulosa* reefs and Sea-pen and burrowing megafauna communities are listed as qualifying habitats in one MPA and two MPAs, respectively (Table 15). Intertidal mudflats/mud and Marine beds/*Zostera* communities are listed as qualifying habitats within 17 and 22 MPAs, respectively (Figure 44, Table 15).

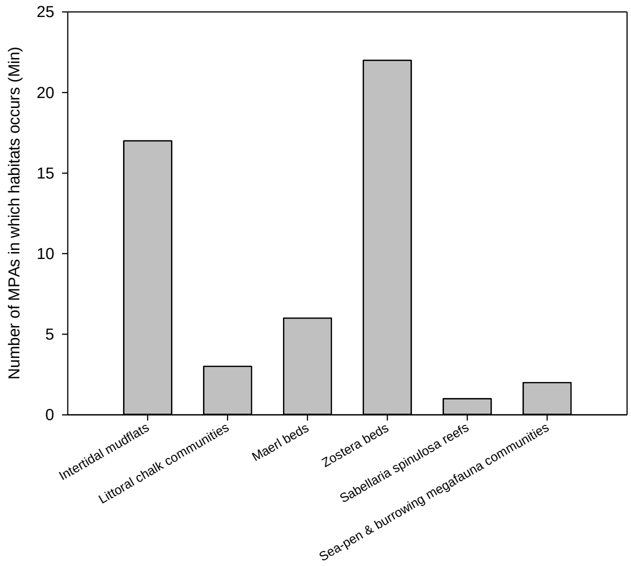


Figure 44*: Frequency of occurrence of OSPAR Habitats within MPAs in the Channel network.*

d) Annex 1 Habitats (Habitats Directive)

Replication of the seven Annex 1 Habitats listed as qualifying habitats within MPAs in the Channel network ranges from five to 44 MPAs (Table 16, Figure 45). Six of the seven habitats are listed within 10 or more MPAs within the Channel network, with Reefs (1170) being listed within 44 MPAs (Figure 45).

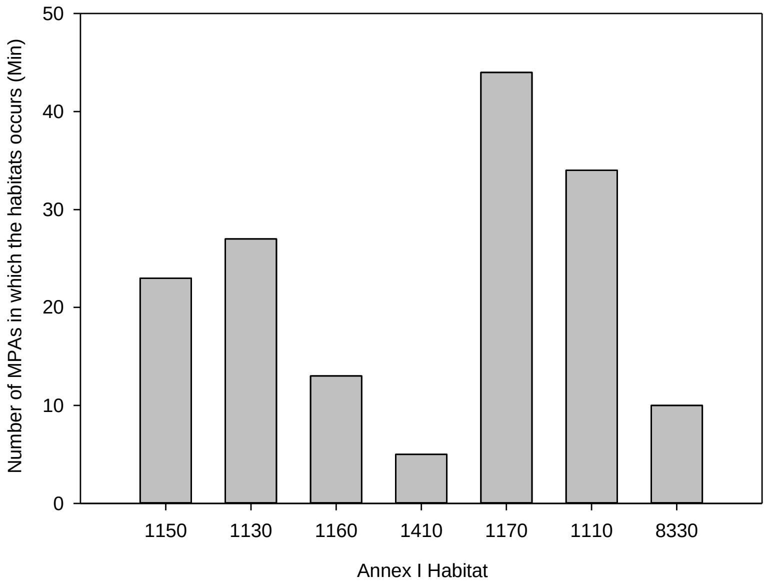


Figure 45*: Frequency of occurrence of Annex 1 Habitats within MPAs in the Channel network. Habitat abbreviations are defined in Table 16.*

4.4 Discussion

Based on the matrix approach, the results suggest that there is good representativity of qualifying species, EUNIS Level 3, OSPAR and Annex I habitats within MPAs in the Channel network, with a broad range of species and habitats listed within MPA objectives. However, the assessment did not consider the absolute area of the habitats (or the size of populations) enclosed in the MPAs (they could all be very small sites), or the proportion of the overall occurrence of the habitat to come under an MPA management scheme.

The recommended thresholds for the replication of species and habitats within MPA networks has yet to be clearly defined, with suggested values ranging from one replicate of each to five or more (HELCOM, 2010; Jackson et al., 2008; OSPAR, 2008a; Roberts et al., 2003c). Here, we apply three different thresholds from the literature (at the scale of the PANACHE study area):

a) at least two MPAs for each EUNIS Level 3 habitat and at least three MPAs for OSPAR threatened and declining habitats and species (OSPAR, 2008a);
b) five replicates for priority species and habitats (BAP, OSPAR threatened or declining and cNIMF) (Jackson et al., 2008);
c) at least three, and preferably five or more replicates of each habitat (Roberts et al., 2003c).

Overall, the results of the matrix analysis demonstrate that there is sufficient replication of broad-scale EUNIS Level 3 and Annex 1 habitats within the Channel network to meet the minimum threshold of five replicates suggested by Jackson et al. (2008) and exceed the minimum thresholds recommended by OSPAR (2008a) and Roberts et al. (2003c). However, replication of three of the six OSPAR habitats (*Sabellaria* reefs, sea-pen and burrowing megafauna communities and littoral chalk communities) is insufficient to meet the threshold recommended by Jackson et al. (2008), with these habitats being listed in three or fewer MPAs. Furthermore, *Sabellaria* reefs are listed in just a single MPA within the network, failing to meet any of the thresholds proposed in the literature.

Of the 121 qualifying species, 82 are considered to be adequately replicated within the Channel network based on the thresholds put forward by OSPAR (2008a) and Roberts et al. (2003c) (i.e. three or more MPAs). However, when considering the thresholds put forward by Jackson et al. (2008), only 70 of the 121 qualifying species were found to be adequately replicated within the Channel MPA network. Thirty-two of the species are listed within just a single MPA within the network and are, thus, considered to be inadequately replicated within the network. Occurrence of species or habitats within a single MPA is precarious. While it is hoped that an MPA will conserve the habitats and species within its boundaries catastrophes can and do happen. Thus, replication of habitats and species within MPAs in the network is good practise and helps to spread the risk should a catastrophic event occur. It is recommended that the 32 species listed within just a single MPA be investigated further to determine if the species is at the edge of its distribution range in the Channel, which may explain the lack of replication of these species within the Channel MPA network. It may not be possible to protect at least three examples of a species if three examples do not exist within the area being assessed. Interestingly, two species of birds (*Sterna sandvicensis* and *Sterna hirundo*) are listed within the conservation objectives of 35 MPAs within the Channel network, and are considered to be very well replicated.

V. Expert-based Knowledge Questionnaire

Management effectiveness generally refers to the concept of ensuring that adequate management and effective enforcement are in place to ensure successful performance of MPAs, and thus, effective management at the scale of individual MPAs is the basis for an ecologically coherent network (Hockings et al., 2006). In this assessment, the status of the management capacity of individual MPAs within the network (referred to hereafter as 'management status') was used as a proxy for management effectiveness. The Channel MPA network includes a range of management and conservation objectives, typically specified by the MPA designation; therefore, it is essential to assess existing impacts, threats and related measures against the conservation objectives of each MPA to determine if the current management is appropriate for the protection and conservation of features within the MPA. Factors, such as the activities occurring within the MPA, the management measures in place to control or mitigate these activities, and enforcement or policing levels within each MPA will influence whether features specific to an MPA are maintained at, or restored to, favourable conditions. If activities and impacts within individual MPAs are not adequately managed, then the MPA network is unlikely to meet ecological coherence even if the spatial configuration of the network is adequate. The management status conferred by individual MPAs in the network is, thus, important to include among other criteria when assessing ecological coherence of an MPA network.

It was not feasible in the timeframe of the project to collate the conservation objectives for each individual MPA within the network, nor is anything known about the pressures or the current conservation status of the MPAs. However, as a first step towards assessing the respective management systems, an inquiry was made among the relevant management authorities to investigate the degree to which the individual sites are already subject to a management system and general measures (including fisheries measures applicable at that site). Three fundamental questions were considered when assessing the management status of individual MPAs within the Channel network:

1) **Adaptive management** – Is a management plan in place and is the MPA able to incorporate changes into its management system when new information (biological and socio-economic) becomes available?
2) **Management measures** – What management measures are in place? Are these measures effective in reducing pressures within the MPA and ensuring the persistence of populations and ecosystems for which the MPA was established?
3) **Enforcement** – is there an effective enforcement and policing system in place to minimise/prevent illegal infringements?

5.1 Methodology

5.1.1 Expert-based Knowledge Questionnaire

A questionnaire was developed as a simple tool to provide a quick assessment of the management efforts being undertaken by individual MPAs within the Channel network. In particular, the management framework and measures currently in place within each MPA for conserving, maintaining or restoring qualifying features were addressed. The questionnaire was compiled after consulting a number of references (Coyle and Wiggins, 2010; Defra, 2011; Ervin, 2003; MarLIN, 2014; MMO, 2014; Natural England and the Joint Nature Conservation Committee, 2010; NOAA, 2010; OSPAR, 2007a; Pomeroy et al., 2004; SI, 2010; Staub and Hatziolos, 2004; Tyler-Walters et al., 2001) and following discussions with Jen Ashworth from Natural England and Kaja Curry, the European Marine Site Officer for the Tamar Estuaries Complex.

The questionnaire covered a number of assessment areas regarding the management of MPAs: Legislative & regulatory framework for the MPA; management measures for extractive & depositional activities; management measures for damaging & disturbing activities; on-site management; and enforcement. The questionnaire was designed using a tiered ranking approach with the first tier reflecting little to no management capacity for the assessment area in question and the third, fourth and fifth tiers reflecting higher management capacity for the assessment area in question. The participant was asked to choose one tier for each assessment area. Guidance notes (Appendix 4) were available for each assessment area to assist participants in the selection of a specific tier by providing clarification and definition of terms.

The questionnaire (Appendix 5) was disseminated via email to key staff either involved in providing advice for the management of the MPA or involved in the actual management of the MPA. Representatives from NE were contacted regarding cSACs, SCIs, SACs, SPAs and SSSIs; the Joint Nature Conservation Committee were contacted regarding offshore SACs; Inshore Fisheries and Conservation Authorities were contacted regarding cSACs, SCIs, SACs and SPAs; Marine Management Organizations were contacted regarding cSACs, SCIs, SACs and SPAs; European Marine Site (EMS) Officers were contacted regarding cSACs, SCIs, SACs and SPAs; the French Agency for Marine Protected Areas was contacted regarding MPA sites in France; and relevant local authorities were contacted for the RAMSAR sites in the Channel Islands. All UK OSPAR sites and RAMSAR sites are also designated as SACs and/or SPAs and receive protection through the management measures and schemes for SACs and/or SPAs (pers. comm. Jen Ashworth), thus, no questionnaires were sent out for UK OSPAR and RAMSAR sites. Additionally, because Marine Conservation Zones were not established at the time the questionnaire was disseminated, it was not possible to gain information about their management status.

In England, NE and JNCC are the authorities that designate MPAs (SACS, SCIs, SPAs and SSSIs) and provide statutory advice to MPA managing bodies (or landowners in the case of SSSIs) on how they should manage the sites in inshore and offshore areas, respectively. Whereas, IFCA and the

MMO are two of the management authorities responsible for the MPA sites (SACs, SCIs and SPAs) and they pass regulations on which extractive activities can occur and where, provide licences for different activities and are ultimately responsible for enforcement inside the MPAs (i.e. patrolling sites, issuing fines for breach of regulations) in inshore and offshore sites, respectively. In France, the AAMP is the main body responsible for designating MPAs and providing support to MPA managers. Managers of MPAs in France were not directly contacted for this assessment.

5.1.2 Questionnaire Scoring System

Based on the answers provided to the questionnaire, a score was assigned to each MPA as follows. Each of the five questions was assigned a score equivalent to the tier chosen by the respondent. For example, if the respondent selected Tier 2 for question one, then question one was assigned a score of two. The final score for each MPA was calculated by summing the scores from each of the five questions. Based on its final score, each MPA was categorised into very high (score of more than 17), high (score of 15 to 17), medium (score of 9 to 14) and low (score of less than 8) management status. Questions 2 and questions 5 carry more weighting. When no response was received from any of the organisations contacted for a particular MPA, the MPA was categorised as 'no response'. The full scoring system is detailed in Appendix 6, with examples of responses and scores from a selection of MPAs.

A map of the PANACHE study area was created detailing all the MPAs within the network and their associated management status category. A bar chart of the percentage of MPAs within each management status category was plotted and pie charts detailing the responses to specific questions were created.

5.2 Results

5.2.1 Questionnaire

The questionnaire was sent to the management authorities for 183 MPAs within the Channel network and responses were received for 149 MPAs. The overall results presented here are based on the responses received from the AAMP for French MPAs and NE for English MPAs because these are the authorities that provided the greatest number of responses and so the sample size is the largest.

Based on the responses received for the 149 MPAs, the scoring (Appendix 6) indicated that 11% of the MPAs have a high level of management status, 87% have a medium level of management status and 2% have a low level of management status (Figure 46). None of the MPAs within the network was assessed as having a very high level of management status. Those MPAs with a high level of management status tend to have statutory advice available and implemented, measures in place to manage most (>90%) or all of the extractive activities, measures in place to manage some (<90%) or most (>90%) of the damaging activities, full-time on-site management personnel and consistent enforcement. Those MPAs with medium management status typically have statutory advice available but not always implemented, measures in place to manage some (<90%) of the extractive activities, measures in place to manage some (<90%) of the damaging activities, some on-site management personnel and inconsistent enforcement. Those MPAs with low management status typically have no statutory advice available (or if it is available it is not implemented), no measures in place to manage the extractive activities, no or some measures in place to manage the damaging activities, little on-site management personnel and no enforcement. The management status of the MPAs assessed was very similar for MPAs on either side of the Channel (Figure 46, Figure 47).

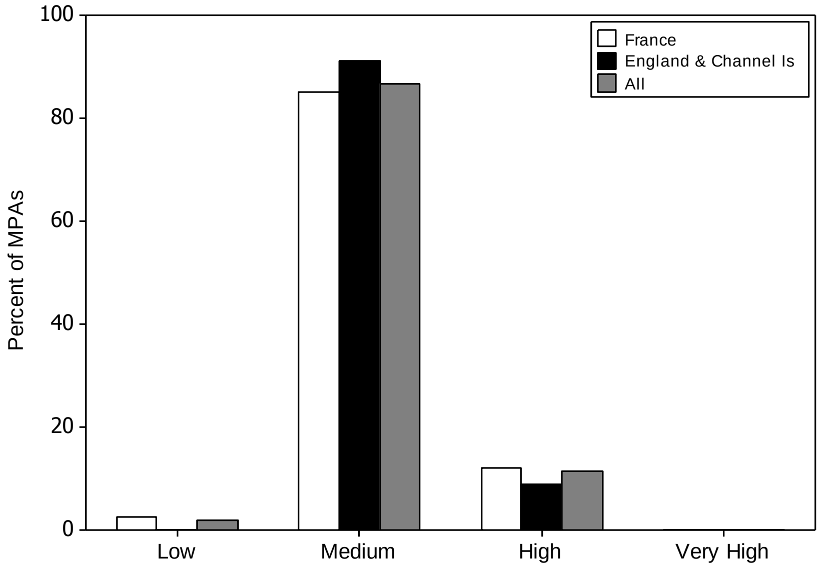


***Figure 46**: Level of management status assigned to individual MPAs in France, England and the Channel Islands.*

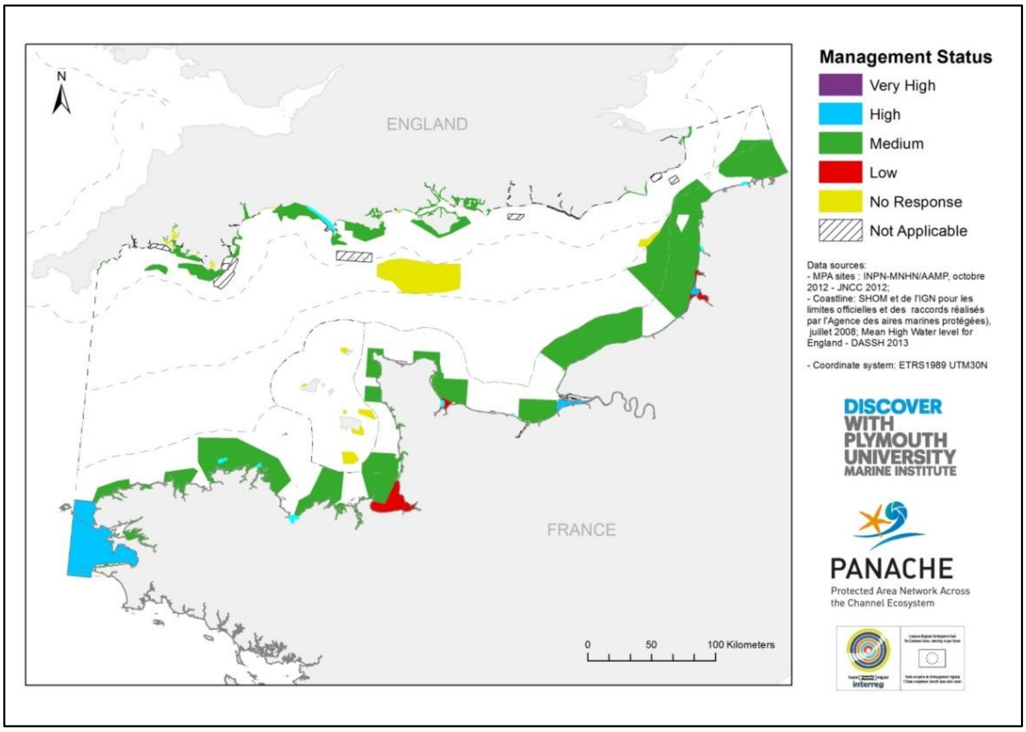
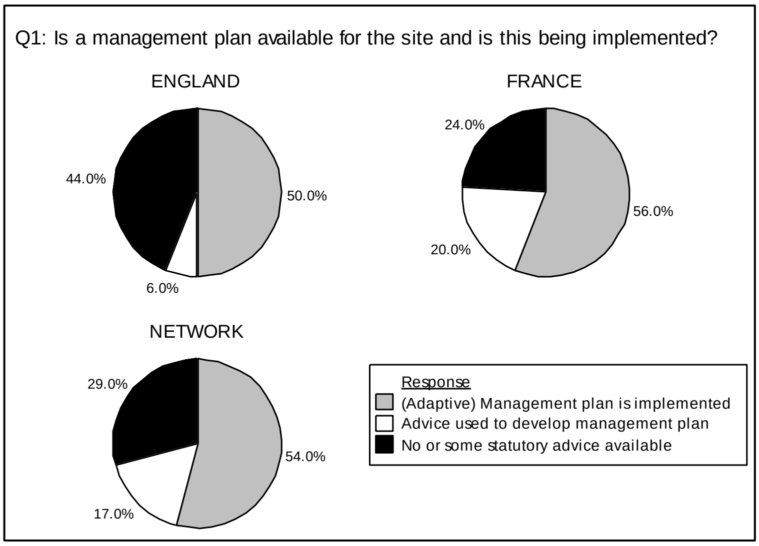
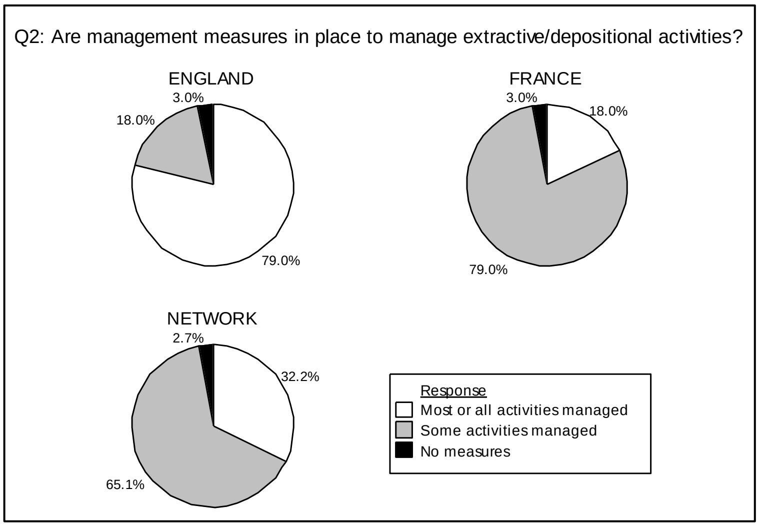


__Figure 47:__ Level of management status assigned to MPAs within the Channel MPA network.

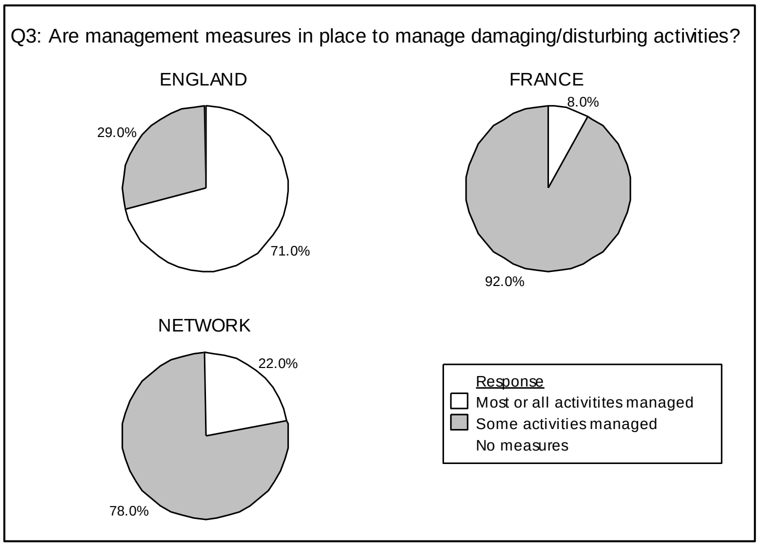
5.2.2 Assessment of the MPAs' Management Capacity

The responses to the five questions posed in the questionnaire, detailed in Figure 48, provide more insight into the management status of MPAs within the Channel MPA network. Over 50% of MPAs within the network have implemented a management plan or have adaptive management in place (Question 1, Figure 48). Over 65% of MPA managers said management measures were in place to mange some (<90%) of the extractive/depositional activities taking place, while 32% said management measures were in place to manage most (>90%) or all extractive/depositional activities taking place (Question 2, Figure 48). Seventy-eight percent of MPA managers said management measures were in place to manage some (<90%) of the damaging/disturbing activties taking place, while a further 22% said management measures were in place to manage most (>90%) or all of the damaging/disturbing activties taking place (Question 3, Figure 48). Over 80% of MPA managers said that some management personnel are assigned to their site (Question 4, Figure 48). Nearly 80% of MPA managers said they have some level of enforcement but that it is inconsistent, but only 17% of MPAs said they have active and consistent enforcement (Question 5, Figure 48).

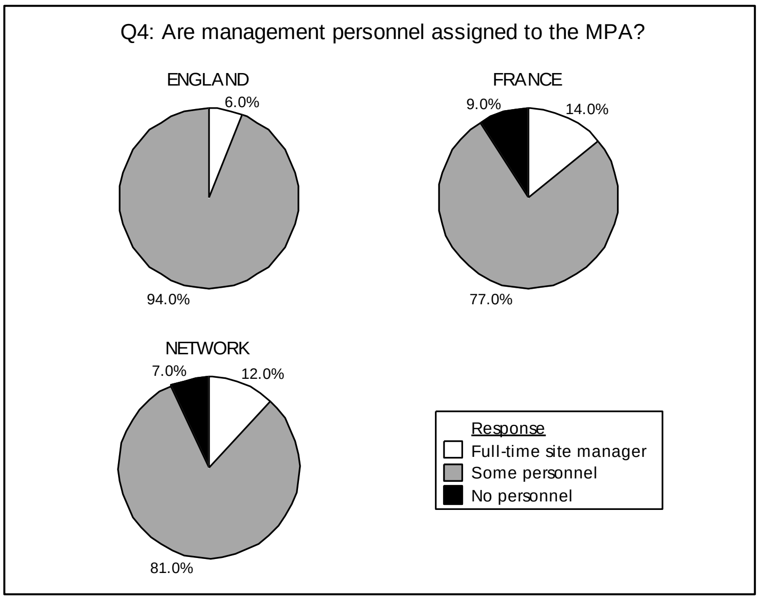




Q2: Are management measures in place to manage extractive/depositional activities?
ENGLAND
3.0%
18.0%
79.0%
FRANCE
3.0%
18.0%
79.0%
NETWORK
2.7%
32.2%
65.1%
Response
Most or all activities managed
Some activities managed
No measures



Q3: Are management measures in place to manage damaging/disturbing activities?
ENGLAND
29.0%
71.0%
FRANCE
8.0%
92.0%
NETWORK
22.0%
78.0%
Response
Most or all activitites managed
Some activities managed
No measures



Q4: Are management personnel assigned to the MPA?
ENGLAND
6.0%
94.0%
FRANCE
9.0%
14.0%
77.0%
NETWORK
7.0%
12.0%
81.0%
Response
Full-time site manager
Some personnel
No personnel

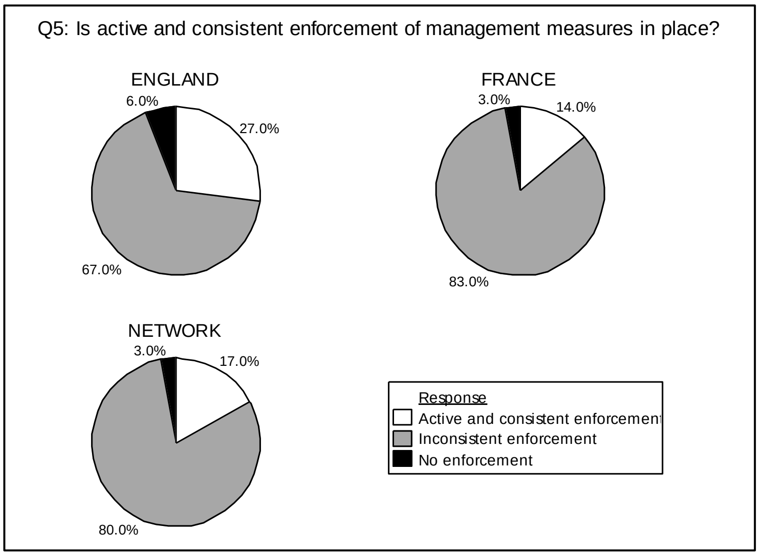


***Figure 48**: Detailed responses to the five questions posed in the management status questionnaire for MPAs within the Channel network.*

5.2.3 Responses from other authorities

The responses for the majority of English MPAs came from NE and the MMO and 100% of responses for French MPAs came from AAMP (Table 17). However, in England, where responses were provided by different statutory bodies for a single MPA, the results were sometimes different, and in a few cases, these differences were striking (Table 18). For example, the Chesil and the Fleet SAC and SPA were listed in the high management status category based on responses from NE; however, both of these MPAs were listed in the low management status category based on responses from the MMO (Table 18). A further 11 MPAs classed within the medium management status category based on responses from NE were also listed in the low management status category based on responses from the MMO (Table 18). Although five MPAs listed in the medium management status category by NE were listed in the high management status category by the MMO. Furthermore, while Thanet Coast (SAC) and Thanet Coast and Sandwich Bay (SPA) MPAs were listed in the low or medium management category by the MMO and NE, respectively, the EMS Officer listed both of these MPAs in the high management status category.

***Table 17**: Satutory bodies contacted and number of questionnaires returned for the assessment of MPA management status of MPAs within the Channel network.*

Statutory Body	Total MPAs contacted about	Total questionnaires returned
Natural England	68	34 (50%)
IFCA	23	5 (22%)
MMO	25	25 (100%)
JNCC	2	0 (0%)
EMS Officer	9	5 (56%)
AAMP	115	115 (100%)

Table 18: *Total score and management status category for English MPAs with multiple questionnaire responses. For MMO scores, + denotes Q1 was excluded. NA denotes questionnaire not sent to authority, NR denotes no response received.*

MPA Name (Designation Category)	NE		IFCA		MMO		EMS Officer	
	Score	Category	Score	Category	Score	Category	Score	Category
Chesil and the Fleet (SAC)	16	High	X	NR	6+	Low	NA	NA
Chesil Beach and The Fleet (SPA)	16	High	X	NR	6+	Low	NA	NA
Chichester and Langstone Harbours (SPA)	10	Medium	14	Medium	10+	High	NA	NA
Dungeness (SAC)	15	Medium	11	Medium	6+	Low	NA	NA
Dungeness to Pett Level (SPA)	15	Medium	11	Medium	6+	Low	NA	NA
Exe Estuary (SPA)	12	Medium	X	NR	6+	Low	NA	NA
Fal and Helford (SAC)	14	Medium	X	NR	9+	Medium	NA	NA
Folkestone Warren (SSSI)	10	Medium	NA	NR	NA	Na	9	Medium
Isle of Portland to Studland Cliffs (SAC)	13	Medium	X	NR	6+	Low	NA	NA
Lyme Bay and Torbay (SCI)	13	Medium	X	NR	10+	High	NA	NA
Pagham Harbour (SPA)	15	Medium	14	Medium	6+	Low	NA	NA
Plymouth Sound and Estuaries (SAC)	13+	Medium	X	NR	9+	Medium	13	Medium
Poole Harbour (SPA)	15	Medium	X	NR	6+	Low	NA	NA
Portsmouth Harbour (SPA)	10	Medium	X	NR	10+	High	NA	NA
Sidmouth to West Bay (SAC)	X	NR	X	NR	6+	Low	NA	NA
Solent and Isle of Wight Lagoons (SAC)	9	Medium	X	NR	6+	Low	X	NR
Solent and Southampton Water (SPA)	10	Medium	X	NR	10+	High	X	NR
Solent Maritime (SAC)	10	Medium	14	Medium	10+	High	X	NR
South Wight Maritime (SAC)	13	Medium	X	NR	6+	Low	X	NR
Start Point to Plymouth Sound & Eddystone (SCI)	13	Medium	X	NR	9+	Medium	NA	NA
Studland to Portland (cSAC)	13	Medium	X	NR	6+	Low	NA	NA
Thanet Coast (SAC)	14	Medium	X	NR	7	Low	17	High
Thanet Coast and Sandwich Bay (SPA)	14	Medium	X	NR	6	Low	17	High

5.3 Discussion

While establishing MPAs is a first step for marine conservation, adequate management and effective enforcement are important if MPAs are to be successful (Cinner et al., 2006). Managers from 98% of the 149 MPAs assessed said that the MPAs have medium to high levels of management, with effective enforcement and management of some of the extractive/depositional and damaging/disturbing activities in more than 75% of the MPAs. These results indicate that in terms of management, the Channel MPA network is on its way to providing some protection to the species and habitats for which the respective sites were designated. Although none of the MPAs within the Channel network are, or will be, no-take marine reserves.

We emphasise caution when interpreting these results for a number of reasons. Firstly, the management authorities for 34 of the 68 MPAs contacted in England failed to respond to the questionnaire. It may be that the least well-managed MPAs were not evaluated during this assessment resulting in misleading results when assessing the management status of the network as a whole. Secondly, the role of the management authorities who responded to the questionnaires must also be considered. Where responses were provided by different statutory bodies for a single MPA, the results were sometimes different, and in a few cases, these differences were striking (Table 18). These results highlight the subjective nature of using a questionnaire for this type of assessment and its dependency on the role and knowledge of the participant. It may be the case that the roles and responsibilities of the management authorities that responded to the questionnaire influenced their results. For example, MPA designating authorities (NE, JNCC and AAMP) may have provided answers based on details from the management plan and conservation objectives, whereas MPA management authorities and those involved in site management (IFCA, MMO and EMS Officer) may have provided answers based on what is actually happening in the field. It is recommended that if such a questionnaire were to be repeated, questions 2, 3, 4, and 5 (relating to management measures, management personnel and enforcement) should be answered by IFCA, MMO and on-site managers of French MPAs.

The results presented here should be regarded with caution and provide only a preliminary overview of the respective management systems of MPAs within the Channel network. The UK government is currently directing efforts at re-assessing the effectiveness of MPAs and is introducing new approaches to assess the adequacy of current measures for managing activities within MPAs. One such approach is the IFCA Matrix Approach that will be used to assess the level of risk that commercial fishing activities present to the species and habitats that EMSs are designed to protect (Marine Management Organisation, 2014). However as the management of MPAs is undertaken by multiple organisations, this process is complex and time consuming.

VI. Challenges and Limitations

6.1 Data Availability and Quality

During this assessment, it became apparent that there is insufficient information on the features protected within MPAs in French, English and Channel Island waters, which limited the comprehensiveness of the analysis. The main aim of the project was to fully evaluate the ecological coherence of the Channel MPA network and an assessment of this type should be based on all the features for which the network is established. However, this proved to be a major challenge because of the lack of data and resources available. Comprehensive spatial data is not available for the majority of species and habitats within the Channel, which limited the spatial analyses that could be undertaken. Further, there is no standardised method of reporting for features of conservation importance among the different MPA designations and for the different countries. The assessment of ecological coherence for habitats of conservation importance was particularly difficult as the habitat classification system used differed both within and between countries for the different MPA designation categories. Thus, it was difficult to determine with certainty the features for which MPAs have been designated.

Due the lack of comprehensive polygon data for the distribution of OSPAR threatened and declining habitats (Contracting Parties are only required to submit point data) it was not possible to evaluate the proportions of these habitats protected within OSPAR MPAs in the study area or determine the maximum or minimum habitat areas occurring within OSPAR MPAs (as was conducted for EUNIS Level 3 habitats). This highlights the need for detailed data on the distribution and extent of OSPAR habitats in order to be able to carry out assessments of adequacy and viability.

The EUSeaMap, which was used in this assessment, is a valuable tool, nevertheless, it relies on several assumptions. As noted by OSPAR (2013), at best, this broad-scale habitat map is a useful amalgamation of many disparate datasets into a single readily interpretable product that highlights physical environmental differences from one EUNIS habitat to the next. However, this type of map may provide a false sense of assurance that these coarsely modelled physical parameters translate to genuinely distinct ecological communities on a fine scale (OSPAR, 2013). Therefore, whereas these maps can aid assessment of coherence on a wide scale, we strongly recommend a cautionary approach when using and interpreting the results.

It is recommended that efforts be focused on improving data coverage, quality and consistency in order to contribute to future MPA planning and designation. Until this is achieved, assessments will have to reply on more basic methodologies and broad-scale datasets, including proxies and surrogates. Also, in order to make consistent decisions regarding which EUNIS Level 3 habitats are protected by the designated features of different MPA categories, it is recommended that correlation tables detailing the relationships between marine habitat classifications and habitats that are listed for protection be selected for use (similar to the JNCC habitat correlation table (JNCC, 2010)).

6.2 Matrix Approach

A number of challenges and limitations were experienced during implementation of the matrix approach for assessing representativity and replication of features of conservation importance. Difficulties were experienced in obtaining information on French MPAs as not all the DOCOBs are available and there is variation in the type and level of detail of information provided as the DOCOBs do not follow a single universal format. Information for some OSPAR sites was not available in the OSPAR database, and no information was available for associated species for some MPA designations in England and France. Information on OSPAR threatened and declining species and habitats within OSPAR MPAs can be obtained from the OSPAR MPA database (where it has been provided by Contracting Parties); however, there are currently no fields in the database for Contracting Parties to provide information on the EUNIS Level 3 habitats that are also listed. It would be valuable if future development work on the OSPAR MPA database includes adding further fields to the database to capture this information. There is no standardised reporting system across countries or across different MPA designations within the same country, which made collating qualifying species and habitat information extremely difficult. Qualifying habitats were reported using different habitat classification systems, different levels of the EUNIS classification system and using different directives and conventions. Thus, collating the necessary information to assess the MPA network as a whole was challenging.

Furthermore, there are a large number of full and partial overlaps between two or more MPA designations within the Channel MPA network. Unless spatial overlaps among MPAs are taken into account, counts of the number of MPAs that confer protection to different features will be over-estimated. Thus, spatial data for the MPAs and mapping of the MPA network are required to account for overlapping MPAs prior to conducting the matrix analysis.

While the matrix approach is suitable for assessing replication and representativity of the network, it cannot be used to assess adequacy or connectivity. Adequacy is typically assessed in terms of the proportion of habitat that occurs within the boundaries of MPAs and connectivity is assessed in terms of the distance among MPAs, both of which require spatial data. It has been suggested that connectivity can be addressed by looking at how many areas of ecological importance (e.g. breeding or nesting areas for birds) occur within the network. However, this information is not reported for all MPA designations within the Channel network in either the standard reporting forms or the databases, making this type of assessment unfeasible.

6.3 Assessment of Connectivity

A number of limitations were experienced during the connectivity analyses. Firstly, connectivity was assessed among broad-scale habitat classes, which have limited ecological relevance. A more detailed investigation to determine features within these broad-scale categories that may be considered for connectivity would be beneficial. Alternatively, assessing connectivity using finer-scale habitat classifications, as was undertaken from Maerl and *Zostera,* would provide more ecologically meaningful results. Secondly, estimation of connectivity of habitat patches using the distance between centroids of two independent habitat patches was found to be inadequate for very large habitat patches. A large habitat patch may appear unconnected to other habitat patches when the distance between the habitat patches is measured from the centre of the patch, as the centroid in the large patch is consequently very far from centroids in surrounding habitat patches. However, if the distance between the patches is measured from the edge of the patches, they may appear much closer together or even connected. Thus, connectivity of large habitat patches is likely to be underestimated when using polygon centroids to estimate connectivity among habitat patches. For this reason, connectivity of habitat patches was also assessed using a 20 km buffer plotted along the perimeter of the habitat patch to highlight possible areas of connections among habitat patches within the MPA network.

Furthermore, if there are many small habitat patches (a consequence of using the EUSeaMap), as opposed to one large habitat patch, of an area equal to the size of the large habitat patch, connectivity will appear to be higher. For example, within an area of 500 km^2, if there is 100 km^2 of habitat divided into two patches each of 50 km^2, there will be just two connections within the model. However, if the 100 km^2 of habitat is divided into 20 patches each of 5 km^2, assuming that they are all within 40 km of each other, there would be 380 connections within the model. Within our study, this has led to estimates of high amount of connectivity among patches of certain habitats, such as moderate energy circalittoral rock (A4.2). This bias towards increased connectivity for smaller habitat patches is counter to the assumption that larger habitat patches can support a larger population, if equal resources, and therefore equal population density, is assumed. We assumed that an area of 0.12 km^2 would be sufficient to support a minimum viable population, but we did not account for the increased probability of the species within an area of that habitat type surviving and spreading beyond this threshold area (Estrada and Bodin, 2008). Rather than the two-classed weighting model (Estrada and Bodin, 2008) used here, which determines whether a habitat patch is used or not, it may be more useful to develop a graded weighting. Another alternative solution to this problem, suggested by Tischendorf and Fahrig (2000), is to use grid cells to divide the given habitat into fixed-size patches. While this would also decrease the resolution, it would resolve the problematic conclusion that habitat fragmentation increases landscape connectivity.

Connectivity of habitat patches will naturally be reduced towards the seaward (east and west) boundaries of the study area. For example, at the western boundary by Falmouth, a habitat patch of sublittoral mixed sediments (A5.4) shows no connectivity to other habitat patches. This is because habitat patches can only exist to the east, and any patches beyond the study boundary (to the west) are not counted. While this may seem trivial, it also means that the Falmouth Helford SAC was not included within the connectivity analysis, thus, MPA connectivity around the south Cornwall coast may be higher than estimated in this study. Nevertheless, this problem would occur no matter where the boundary was drawn. One possible solution would be to use habitat patches that are the maximum dispersal distance of the habitat type from the boundary when calculating degree centrality and buffer zones of MPAs.

6.4 A cautionary note: Conservation objectives

It is important to note that features of conservation importance may not necessarily be conserved or managed even if they occur within the boundaries of an MPA. Management is normally in place to conserve or restore features that have justified the designation of an MPA (i.e. those features listed in the conservation objectives of MPAs, in Regulation 33/35 advice packages, or on the websites of statutory organisations). Therefore, unless the MPA has been designated for a particular feature, that feature may not be conserved even if it occurs within the MPA boundary. Assuming that the MPAs are being well managed and the features for which they were designated are being conserved, features within MPAs may be split into two groups:

1) Features that occur within MPAs and that are listed in the conservation objectives of the MPA (i.e. the MPA has been set up specifically to protect these features)
2) Features that occur within MPAs, BUT these features are NOT listed in the conservation objectives of the MPA

Figure 49 shows the MPAs in which Maerl beds occur, but also highlights those MPAs that have been specifically designated to conserve Maerl beds. There is a substantial reduction in the percentage of Maerl beds within MPAs when features listed in the conservation objectives of the MPAs are taken into consideration (Table 19).

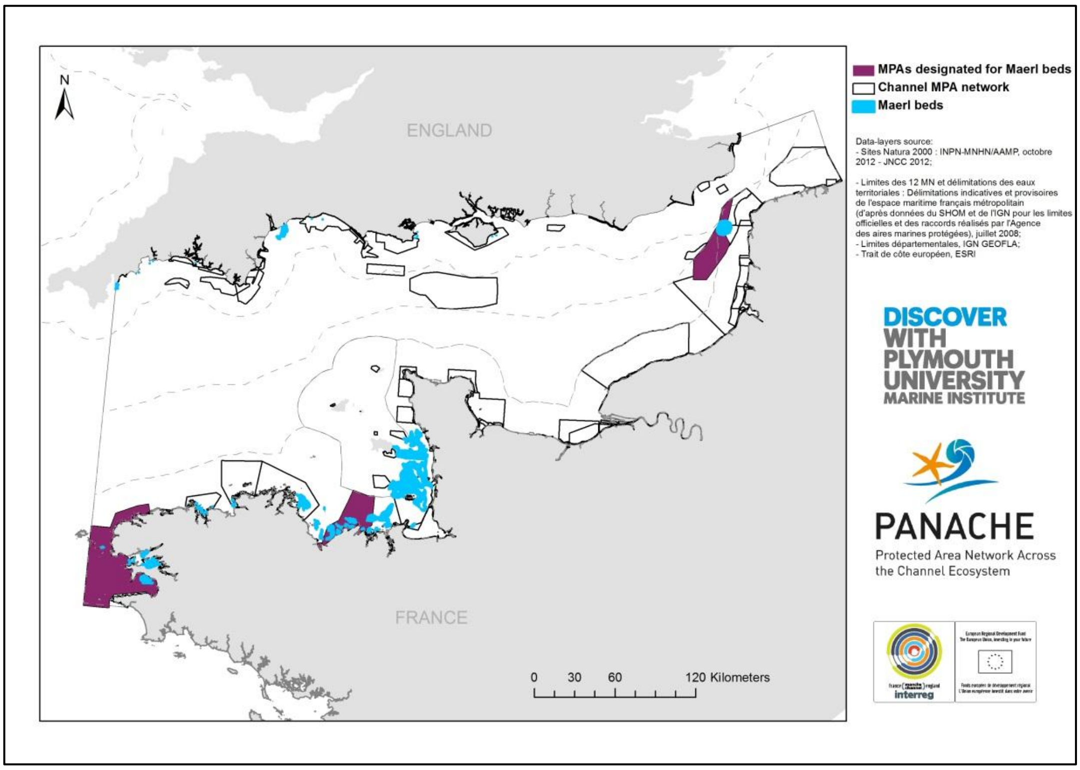


Figure 49: Distribution of Maerl beds within the Channel MPA network.

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***Table 19**: The proportion of Maerl beds within MPAs which have been specifically designated to conserve Maerl beds (+ Designated features) and those which have not been (- Designated features).*

	Number of MPAs habitat occurs in	**Area of habitat inside PANACHE study region (km^2)**	**Total area enclosed within boundaries of MPAs in network (km^2)**	**% habitat enclosed within boundaries of MPAs in network**
- Designated features	18	1037	495	48%
+ Designated features	14	1037	200	19%

VII. Conclusions

Ecological coherence is an holistic concept, yet achieving it relies on the network of MPA sites meeting a number of different criteria, thus, it is much easier to prove that a network is not ecologically coherent than to provide evidence to support its ecological coherence (HELCOM, 2010; OSPAR, 2007b). The challenges and limitations associated with a lack of universal terminology, a lack of universal reporting systems for habitats and species and limited availability of spatial data during this assessment have made it difficult to fully assess the ecological coherence of the Channel MPA network. Further, as mentioned in the introduction, the MPAs that form the Channel network were designated for a variety of different reasons, thus, achieving ecological coherence will always be challenging. Nevertheless, the results of this assessment provide valuable insights into the state of the Channel MPA network and identify gaps in the network where improvements can be made to move the network towards the goal of achieving ecological coherence.

It is also important to note that within this assessment, the six ecological criteria selected were applied to the PANACHE study area as a whole, but different results may be obtained if the criteria were applied using a different geographical area or were applied beyond the study boundaries. For example, if the criteria were applied to each of the Dinter biogeographic regions within the study area (as recommended by OSPAR (2006)), rather than the study area as a whole, the results may be more comprehensive and they would likely indicate that the network is even further from achieving ecological coherence than the current assessment. Unfortunately, a lack of data prevented an assessment at the scale of biogeographic regions. Furthermore, while the study is limited by the extent of the PANACHE boundaries, the biogeographic regions it reports on are not and there are MPAs affording protection to features outside the PANACHE study area within these biogeographic regions. Consequently, the results do not provide a comprehensive assessment of the MPA network across the full extent of these biogeographic regions.

A summary of conclusions is provided in Table 20, with positive results highlighted in green, intermediate areas, where further improvements could be made, highlighted in yellow and areas that represent significant gaps in the network highlighted in red.

Table 20: *Summary of the main conclusions of the ecological coherence assessment of the Channel MPA network. Positive results highlighted in green, intermediate results highlighted in yellow and gaps in the network highlighted in red.*

Assessment Type & Criteria	Feature	Results
Spatial – representativity	Geographical	• 20% of PANACHE study area within MPA network • 10% of English waters within MPA network • 30% of French waters within MPA network • 3% of Channel Island waters within MPA network • 218 MPAs within 12 nm of shore (inshore) • 4 MPAs beyond 12 nm of shore (offshore) • 16% of western Channel within MPA network • 26% of eastern Channel within MPA network
	Biogeographical	• 24% of Lusitanian-Boreal province within MPA network • 26% of Boreal province within MPA network • 5% of Boreal-Lusitanian province within network • 19% of cool-temperate province within network • 24% of warm-temperate province within network
	Bathymetric	• Only 14% of network occurs in water deeper than 60 m (despite 42% of study area having water deeper than 60 m)
	Marine Mammals and Seabirds	• Gaps in the network were noticeable for offshore or partially offshore species (cetaceans and seabirds with pelagic behaviour)
	Cuttlefish spawning grounds	• Spawning grounds for the cuttlefish well-represented within MPA network along the western Channel and along French coast • Spawning grounds for the cuttlefish poorly-represented within MPAs along the English coastline in the eastern Channel
	Breeding areas for seabirds	• Breeding populations of key bird species adequately represented in French MPAs (with bird specific objectives) • Breeding populations along English coastline occur predominantly outside MPAs or within the boundaries of SACs (no bird specific objectives)
Spatial - replication	EUNIS Level 3 habitats Habitats and species of conservation importance	• Habitats and species occur in 4 to 52 MPAs
Spatial - viability	MPA size Compactness Edge-to-area ratio	• Only 33% of MPAs in the optimal size range of 10-100 km^2 • 40% of MPAs are smaller than 10 km^2 • Only 8 MPAs exceed 1000 km^2 • Network unlikely to support highly mobile or migratory species • Majority of MPAs not circular and have small edge-to-area ratios – less export of individuals
	Size of EUNIS Level 3 habitats	• 79% of habitat patches within the network are 0-10 km^2 in size – only likely to support low mobility species • Just 21% of habitat patches in study area are greater than 10 km^2 – but good proportions of these within network • 67% of 10-100 km^2 patches are within the network and 59% of patches >100km^2 are within the network
Spatial - adequacy	Area of EUNIS Level 3 habitats Area of habitats of conservation importance	• Four habitats have <30% of their area within the MPA network • Six habitats have >30% of their area within the MPA network • 65% of *Zostera* beds occur within the MPA network • 48% of Maerl beds occur within the MPA network
Spatial - connectivity	Connectivity among MPAs Habitat connections Within versus among MPAs Habitats buffers	• MPAs containing the same habitat typically connected to just 2 or 3 other MPAs • Connectivity of habitat patches was found to be greater among MPAs than within MPAs, highlighting potential for replenishment of habitats and species from within the MPA network • Good connectivity among habitats within MPAs along the French and English coasts, respectively • Cross Channel connectivity virtually non-existent
Matrix Approach - representativity	Qualifying species, EUNIS Level 3 habitats OSPAR habitats Annex I habitats	• Good representativity of qualifying species, EUNIS Level 3 habitats, OSPAR habitats and Annex I habitats
Matrix Approach - replication	EUNIS Level 3 habitats OSPAR habitats Annex I habitats	• EUNIS Level 3 and Annex 1 habitats listed in 5 or more MPAs within the Channel network • Maerl beds, intertidal mudflats, littoral chalk communities and *Zostera* beds listed in 3 or more MPAs • *Sabellaria* reefs, and sea-pen and burrowing megafauna communities listed in 2 or fewer MPAs
	Qualifying species	• 68% of species listed in 3 or more MPAs • 27% of species listed in 1 MPA • 5% of species listed in 2 MPAs

Self-assessment – management status	• Medium to high level of management status reported for 98% of MPAs assessed • 75% of the MPAs reported effective enforcement and management of some of the extractive/depositional and damaging/disturbing activities • Answers varied depending on respondent – more positive responses from MPA designating authorities than MPA management authorities

Overall, the results of the assessment suggest that the main geographical and biogeographical aspects of the PANACHE study region are captured by the Channel MPA network. In particular, the high number of inshore and coastal MPAs and the good coverage of the biogeographical provinces contribute to this result. Combined, the MPAs of the Channel network enclose on average 20% of the PANACHE study region, with 31% of French waters, 10% of English's waters and 3% of Channel Island waters within the boundaries of MPAs. Therefore, in the PANACHE study region, the current global marine protection target of 10% (CBD, 2010) is met in French and English waters, but not in Channel island waters. Significant gaps were also identified in the network with only four MPAs in the offshore area, beyond 12 nm of the shore, despite open waters frequently being highlighted as areas of importance for a number of species. Further, only 14% of the MPA network occurs in areas of water deeper than 60 m. The size of MPAs is also of concern, with only 33% in the optimal size range of 10-100 km^2 (Halpern and Warner, 2003) and only 4% greater than the 1000 km^2 recommended to support viable self-seeding populations (Hill et al., 2010). In particular, the MPAs designated by England are of small size and are often limited to inshore areas, whereas the sites designated by France are generally quite large and therefore embrace a wider bathymetric and habitat range. These results imply that the Channel MPA network does not adequately represent habitats and species within deeper waters or support highly mobile or migratory species, or those species with widely dispersing planktonic larvae (Roberts et al., 2010; Shanks et al., 2003). Designation of larger MPAs in deeper, offshore areas of the Channel would offer significant improvements to the MPA network in terms of representativity of the region and a move towards ecological coherence based on the viability criteria.

In terms of habitats and species, there is good replication and representativity in the Channel MPA network of EUNIS Level 3 habitats, habitats and species of conservation importance, OSPAR threatened and declining habitats and Annex I habitats. However, the Matrix Approach did highlight a number of gaps in the network, with a third of qualifying species listed in only one or two MPAs, and two of the OSPAR threatened and declining habitats (*Sabellaria* reefs, and sea-pen and burrowing megafauna communities) listed in two or fewer MPAs. Extension of existing management measures and/or conservation objectives in the existing MPAs, to include those species and habitats present but not yet considered, may go some way to improving this situation.

The area coverage of EUNIS Level 3 habitats and habitats of conservation importance within the MPA network was found to be good, with the exception of moderate energy circalittoral rock (A4.2), low energy circalittoral rock (A4.3), sublittoral coarse sediment (A5.1) and sublittoral mixed sediments (A5.4). However, as the assessment of adequacy was a purely spatial analysis, it is important to remember that while a significant area of a habitat occurs within the boundaries of MPAs this does not necessarily confer protection, as that habitat may not be listed within the conservation objectives or management measures of the MPA in question. Thus, it is recommended for future assessments of adequacy that MPA objectives be taken into consideration and results be presented for area coverage within all MPAs and area coverage within MPAs designated for the habitat under assessment.

We assessed the location of areas of ecological importance in relation to the Channel MPA network. There is good coverage of cuttlefish spawning grounds by the Channel network along the French coast and in the western Channel along the English coast (though these areas are not part of any MPA conservation objectives). The nesting sites of breeding populations of seabirds are well captured by bird-specific MPAs along the French coastline and in the Channel Islands. However, a number of gaps were identified in the network. In particular, breeding populations of some seabirds that are more dispersed along the English coastline (e.g. Fulmars) occur predominantly outside MPAs or within the boundaries of MPAs without bird specific objectives, and there are gaps in the representation of offshore or partially offshore species of marine mammals and seabirds within the MPA network. Designation of additional SSSIs along the English coastline may improve the conservation of breeding pairs of seabirds, and, as mentioned previously, designation of MPAs in offshore areas (particularly foraging/feeding sites) may benefit a number of marine mammal and seabird species.

The potential connectivity of habitat patches and MPAs was assessed using a theoretical approach based on the effective distance among sites. MPAs along the coastlines of each respective country were found to be potentially connected based on geographic distance, although MPAs containing the same habitat are typically only connected to two or three other MPAs within the network. Improved connectivity of habitat patches within the network would be beneficial to ensure source and sink populations are included within the network and that MPAs are close enough that populations are connected. This would require further evaluation to identify habitat patches that may serve as stepping stones for dispersal and that could be enclosed within the boundaries of MPAs. Furthermore, potential connectivity of MPAs across the Channel appeared to be virtually non-existent, further highlighting the need for additional MPA designations within offshore areas of the Channel.

In terms of the preliminary assessment of the management systems implemented in MPAs within the Channel network, the designating authorities reported a medium to high level of management status for 98% of the MPAs assessed. Furthermore, 75% of the MPAs are reported to have some type of effective enforcement and management of some of the extractive/depositional and damaging/disturbing activities that take place within their boundaries. Nevertheless, it is important to remember that these results varied depending on the role and responsibilities of the respondent. The authorities responsible for the management of the MPAs (in England) considered the level of management status in 25 MPAs to be low for 14 sites, to be high rather than medium in five MPAs and only came to the same conclusion as the designating body for three MPAs. This indicates that likely realistic assessments of management status can only be acquired from MPA managers directly, be it site managers as in France or management authorities, such as IFCA and the MMO, in England.

During this assessment, three methodologies were used to assess various criteria of ecological coherence: spatial analysis, a matrix approach and the self-assessment questionnaire. The criteria of replication and representativity (of habitats and species) was assessed using two different methodologies allowing a comparison of both of these methods. There were notable differences in the results of the replication assessment within the MPA network when using the matrix approach and the spatial analysis. The spatial approach shows all species and habitats to be well replicated within the network but the matrix approach identifies a number of species and habitats that do not meet the replication thresholds. These differences are likely due to the fact that the spatial approach only takes into consideration the distribution of habitats and species in relation to the location of MPAs within the network, whereas the matrix approach incorporates the conservation objectives of the MPAs (only features listed as qualifying features in the MPA regulations are recorded as occurring within the MPAs). Thus, in terms of more accurate results of which species and habitats are more adequately replicated than others, the matrix approach is more effective than the spatial approach as the species and habitats included in the analysis are those listed in the MPAs' conservation objectives. Furthermore, spatial data for most species and habitats of conservation importance across the entire Channel area is minimal and in most cases lacking. Nevertheless, both methodologies complement one another, and the spatial approach can be used to highlight gaps in the network, where habitats and species are present but are not included within an MPA, or highlight MPAs where features occur but are not listed within the conservation objectives. It is recommended that both these approaches be used together in future assessments of ecological coherence.

Overall, the assessment of ecological coherence of the Channel MPA network provides evidence of a number of positive aspects, including good representation and replication of inshore and coastal (within 12 nm of the shore) habitats and species within its boundaries. However, the network cannot yet be considered ecologically coherent. During this assessment, areas for improvement were highlighted and countries with jurisdiction within the Channel are requested to consider the recommendations put forward in this report. In particular, the viability and adequacy of the network is insufficient due to the small size of many of the MPAs. A number of large MPAs are present in French waters and this needs to be emulated in English and Channel Island waters. Offshore areas (beyond 12 nm from shore) were repeatedly highlighted during the assessment as important areas for a number of species and habitats, yet only four MPAs from the Channel network are designated within offshore areas. The quality and availability of data also affected the ability to fully assess ecological coherence of the network and this situation needs to improve if future assessments are to be useful. The Channel Islands were highlighted as key sites for a number of species during the assessment and these Islands are ideally located in the Channel to play a crucial role in the ecological coherence of the MPA network. Therefore, it is essential that the Channel Islands are integrated into the processes of developing an ecologically coherent MPA network in the Channel and to further strengthen cross-border cooperation. Cross-border cooperation is fundamental in an assessment of this type, since the MPAs under evaluation protect similar ecosystems in the waters of all countries involved. Further cross-border cooperation at the management stage would be beneficial in the move towards an ecologically coherent and adequately managed MPA network in the Channel. The future designation of proposed MCZs in the Channel may also go some way to addressing a number of gaps highlighted in this assessment. For example, the 'western Channel MCZ' will enclose important offshore areas in the western Channel. The recommendations presented below provide information on what steps may be taken to move the Channel MPA network towards becoming ecologically coherent, and they also provide suggestions on how to improve future assessments of ecological coherence.

VIII. Recommendations

Based on the outcomes of the assessment of ecological coherence of the Channel MPA network, the following recommendations are made with regard to improvements in the status of the Channel MPA network and to future assessments of ecological coherence of MPA networks in general.

1. Improvements towards making the existing Channel MPA network ecologically coherent in terms of the criteria used for this assessment:
   a. Designate MPAs within offshore areas (beyond 12 nm of the shore) of the Channel, particularly the western region of the Channel, to improve protection of offshore species and enhance cross Channel connectivity
   b. Designate MPAs within deeper waters of the Channel
   c. Designate larger MPAs (10 km^2 to >1000 km^2), particularly in English waters
   d. Designate MPAs within the Boreal-Lusitanian province (western Channel)
   e. Improve overall functionality of the existing and planned MPAs for migratory and wider ranging species, such as cetaceans, seabirds at sea, basking sharks and turtles, by considering seasonal density hotspots in relation to water column features, e.g. frontal areas
   f. Encourage the Channel Islands to contribute to the regional/OSPAR network of MPAs by designating additional sites, which will also increase the proportion of their waters within MPAs
   g. Designate additional MPAs with bird-specific objectives (SPAs, SSSIs) to enclose breeding populations of seabirds along the English coastline and foraging areas offshore
   h. Enclose at least 30% of the known extent of habitats (EUNIS Level 3, habitats of conservation importance) within MPAs in the network, with appropriate conservation objectives
   i. Ensure habitats and species occur within at least three MPAS (with appropriate conservation objectives) within the network

2. Improvements in the assessment of ecological coherence of MPA networks
   a. A formal, widely accepted definition of ecological coherence needs to be agreed upon
   b. Data coverage, availability, quality and consistency for habitats and species needs to be vastly improved:
      i. Use universal reporting systems and standardised databases across different MPA designation categories and different countries that are accessible to all parties (see, for example, the OSPAR MPA database, which will also be used for MSFD implementation[1])
      ii. Ensure MPA databases are kept up-to-date with all data

[1] http://mpa.ospar.org/home_ospar

iii. Include additional fields in the MPA databases to allow entry of key information required for analysing ecological coherence, including the conservation objectives, threats, key measures and a valuation of effectiveness of conservation
iv. Enter polygon data into the shared databases
v. Assign an IUCN management category to all MPAs to allow for grouping and standardisation of management aims
vi. Improve available data layers and indicators. To date, neither pelagic features, benthic/pelagic complexity, habitat heterogeneity nor ecosystem processes have been considered, although the aims of the OSPAR network of MPAs include such features. Thus, appropriate data layers and indicators are required

c. Use agreed correlation tables to determine the relationships between marine habitat classifications and habitats that are listed for protection in the designated features of different MPA categories
i. To be more comprehensive, develop further (and use in assessments) a seascape classification of pelagic-benthic seascapes incorporating the different classified habitats

d. Following an initial assessment of ecological coherence, an incremental set of indicators ready to use in the next ecological coherence assessment should be deposited in a regional database

e. Methodology:
i. Assess the criteria within defined biogeographic (sub-) provinces (e.g. Dinter provinces in the Channel), rather than the study area as a whole
ii. Use EUNIS Level 4 classification and lower to compare comparable biotopes
iii. Include pelagic classifications and water column classifications into the assessment
iv. Give more consideration to the needs of migratory species – assessment of frontal areas that are important for feeding; can migratory species be practically included within an MPA network?
v. Use both the matrix approach and spatial analysis during assessments of ecological coherence for complementary analyses
vi. In the long-term, the criteria should be assessed as an interlinked set to cumulatively provide the ecological coherence assessment result. Methods should be developed to this end

f. Criteria limitations:
i. Consistent, formal definitions of each criteria should be agreed upon to ensure assessment of ecological coherence is taking place at the same level
ii. Indicators and formal thresholds should be agreed upon for each criteria so that these can be used to assess the success of the network for each criteria
iii. Apply caution when assessing the criteria of adequacy. The assessment of adequacy should take into consideration the conservation objectives of the MPAs, otherwise the

habitats shown as occurring within MPAs may not necessarily be receiving protection even if they occur within the boundaries of an MPA

iv. Establish network level conservation objectives that the criteria, indicators and thresholds can be applied to

It is important to remember that the ecological coherence assessment above is limited in its applicability. Ecological coherence is a prerequisite for an effective MPA network but it is not sufficient, as adequate management must also be in place. Very few MPAs within the Channel network have been designated as marine reserves (no-take areas) and as such, threats to many of the components within these sites remain. Further, while we advocate the designation of large MPAs, which are more viable for protecting self-seeding populations and those species with widely dispersing larvae, these also require greater resources and will only be effective if the whole area is well managed. It has to be assumed, therefore, that the MPAs designated and managed to date in the Channel area may be less effective in achieving ecological coherence than indicated in the assessment results.

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Appendices

Appendix 1 – Marine Protected Areas

***Table 21**: Name, designation, location and area of all Marine Protected Areas within the PANACHE study area as of December 2013. † denotes MCZ not yet designated; * denotes MCZs used only in marine mammal and cetacean analysis.*

MPA Code	MPA Name	Designation Type	France / England	Inshore / Offshore	West / East Channel	National / International	Area (clipped to PANACHE study area) km^2
	Alderney West Coast & the Burhou Island	RAMSAR	Channel Islands	Inshore	W	international	18.10
	Gouliot Caves & Headland, Sark	RAMSAR	Channel Islands	Inshore	W	international	0.05
	Les Ecrehou & Les Divouilles, Jersey	RAMSAR	Channel Islands	Inshore	W	international	54.59
	Les Minquiers, Jersey	RAMSAR	Channel Islands	Inshore	W	international	95.75
	Les Pieers de Lecq, Jersey	RAMSAR	Channel Islands	Inshore	W	international	5.12
	Lihou Island and L'Eree headland, Guernsey	RAMSAR	Channel Islands	Inshore	W	international	3.92
	SeCoast, Jersey	RAMSAR	Channel Islands	Inshore	W	international	32.1
	Adur Estuary	SSSI	EN	Inshore	E	national	0.53
UK0030368	Bassurelle Sandbank	SCI	EN	Offshore	E	international	67.19
	Beachy Head West	MCZ	EN	Inshore	E	national	23.56
	Bouldnor And Hamstead Cliffs	SSSI	EN	Inshore	E	national	0.22
	Brading Marshes to St Helen's Ledges	SSSI	EN	Inshore	E	national	1.49
	Brighton To Newhaven Cliffs	SSSI	EN	Inshore	E	national	1.25
	Carricknath Point To Porthbean Beach	SSSI	EN	Inshore	W	national	0.30
O-UK0017076	Chesil and the Fleet	OSPAR	EN	Inshore	W	international	12.55
UK0017076	Chesil and the Fleet	SAC	EN	Inshore	W	international	12.55
	Chesil beach & The Fleet	SSSI	EN	Inshore	W	national	5.53
	Chesil Beach and Stennis Ledges	MCZ	EN	Inshore	W	national	37.68
UK11012	Chesil Beach and The Fleet	RAMSAR	EN	Inshore	W	international	5.18
UK9010091	Chesil Beach and The Fleet	SPA	EN	Inshore	W	international	5.18
UK11013	Chichester and Langstone Harbours	RAMSAR	EN	Inshore	E	international	51.06
UK9011011	Chichester and Langstone Harbours	SPA	EN	Inshore	E	international	51.06
	Chichester Harbour	SSSI	EN	Inshore	E	national	32.19
	Christchurch Harbour	SSSI	EN	Inshore	E	national	1.65
	Climping Beach	SSSI	EN	Inshore	E	national	0.21
	Compton Chine To Steephill Cove	SSSI	EN	Inshore	E	national	1.09
	Dawlish Warren	SSSI	EN	Inshore	E	national	1.21
UK0013059	Dungeness	SAC	EN	Inshore	E	international	7.34
UK11023	Dungeness to Pett Level	RAMSAR	EN	Inshore	E	international	2.04
UK9012091	Dungeness to Pett Level	SPA	EN	Inshore	E	international	2.04
	Dungeness, Romney Marsh and Rye Bay	SSSI	EN	Inshore	E	national	10.77
	Erme Estuary	SSSI	EN	Inshore	W	national	1.56
O-UK9010081	Exe Estuary	OSPAR	EN	Inshore	E	international	18.56
UK11025	Exe Estuary	RAMSAR	EN	Inshore	E	international	18.56
	Exe Estuary	SSSI	EN	Inshore	E	national	18.56
UK9010081	Exe Estuary	SPA	EN	Inshore	E	international	17.53
O-UK0013112	Fal and Helford	OSPAR	EN	Inshore	W	international	0.69
UK0013112	Fal and Helford	SAC	EN	Inshore	W	international	0.69

	Folkestone Pomerania	MCZ	EN	Inshore	E	national	33.76
	Folkestone Warren	SSSI	EN	Inshore	E	national	0.84
	Gilkicker Lagoon	SSSI	EN	Inshore	E	national	0.0003
	Highcliffe To Milford Cliffs	SSSI	EN	Inshore	E	national	0.45
	Hurst Castle And Lymington River Estuary	SSSI	EN	Inshore	E	national	7.42
	Hythe Bay†	MCZ	EN	Inshore	E	national	41.57
UK0019861	Isle of Portland to Studland Cliffs	SAC	EN	Inshore	E	international	0.49
	Kingmere	MCZ	EN	Inshore	E	national	47.84
	King's Quay Shore	SSSI	EN	Inshore	E	national	0.52
	Lee-on-the Solent To Itchen Estuary	SSSI	EN	Inshore	E	national	4.53
O-UK0030372	Lyme Bay and Torbay	OSPAR	EN	Inshore	W	international	312.37
UK0030372	Lyme Bay and Torbay	SCI	EN	Inshore	W	international	312.37
	Lynher Estuary	SSSI	EN	Inshore	W	national	4.93
	Newtown Harbour	SSSI	EN	Inshore	E	national	1.92
	North Solent	SSSI	EN	Inshore	E	national	4.25
	Otter Estuary	SSSI	EN	Inshore	W	national	0.10
	Pagham Harbour	MCZ	EN	Inshore	E	national	2.58
O-UK9012041	Pagham Harbour	OSPAR	EN	Inshore	E	international	3.50
UK11052	Pagham Harbour	RAMSAR	EN	Inshore	E	international	3.50
UK9012041	Pagham Harbour	SPA	EN	Inshore	E	international	3.50
	Pagham Harbour	SSSI	EN	Inshore	E	national	3.41
O-UK0013111	Plymouth Sound and Estuaries	OSPAR	EN	Inshore	W	international	56.84
UK0013111	Plymouth Sound and Estuaries	SAC	EN	Inshore	W	international	56.84
	Plymouth Sound Shores And Cliffs	SSSI	EN	Inshore	W	national	0.35
	Poole Harbour	SSSI	EN	Inshore	E	national	13.75
O-UK9010111	Poole Harbour	OSPAR	EN	Inshore	E	international	13.35
UK11054	Poole Harbour	RAMSAR	EN	Inshore	E	international	13.35
UK9010111	Poole Harbour	SPA	EN	Inshore	E	international	13.35
	Portland Harbour Shore	SSSI	EN	Inshore	E	national	0.11
	Poole Rocks*	MCZ	EN	Inshore	E	national	3.8
O-UK9011051	Portsmouth Harbour	OSPAR	EN	Inshore	E	international	12.20
UK11055	Portsmouth Harbour	RAMSAR	EN	Inshore	E	international	12.20
UK9011051	Portsmouth Harbour	SPA	EN	Inshore	E	international	12.20
	Portsmouth Harbour	SSSI	EN	Inshore	E	national	12.25
	Ryde Sands & Wootton Creek	SSSI	EN	Inshore	E	national	3.87
	Salcombe to Kingsbridge Estuary	SSSI	EN	Inshore	E	national	6.04
	Seaford To Beachy Head	SSSI	EN	Inshore	E	national	2.26
UK0019864	Sidmouth to West Bay	SAC	EN	Inshore	W	international	1.69
	Skerries Bank and surrounds	MCZ	EN	Inshore	W	national	249.47
UK0017073	Solent and Isle of Wight Lagoons	SAC	EN	Inshore	E	international	0.0004
O-UK9011061	Solent and Southampton Water	OSPAR	EN	Inshore	E	international	32.98
UK11063	Solent and Southampton Water	RAMSAR	EN	Inshore	E	international	32.98
UK9011061	Solent and Southampton Water	SPA	EN	Inshore	E	international	32.98
O-UK0030059	Solent Maritime	OSPAR	EN	Inshore	E	international	104.14
UK0030059	Solent Maritime	SAC	EN	Inshore	E	international	104.14
	South Dorset	MCZ	EN	Inshore	E	national	192.65
O-UK0030061	South Wight Maritime	OSPAR	EN	Inshore	E	international	196.09
UK0030061	South Wight Maritime	SAC	EN	Inshore	E	international	196.09
	St John's Lake	SSSI	EN	Inshore	W	national	2.47

O-UK0030373	Start Point to Plymouth Sound and Eddystone	OSPAR	EN	Inshore	W	international	340.74
UK0030373	Start Point to Plymouth Sound and Eddystone	SCI	EN	Inshore	W	international	340.73
UK0030382	Studland to Portland	candidate SAC	EN	Inshore	E	international	328.99
	Tamar - Tavy Estuary	SSSI	EN	Inshore	W	national	10.13
	Tamar Estuaries Complex	RAMSAR	EN	Inshore	W	international	16.35
UK9010141	Tamar Estuaries Complex	SPA	EN	Inshore	W	international	16.35
	Tamar Estuary Sites	MCZ	EN	Inshore	W	national	15.14
UK0013107	Thanet Coast	SAC	EN	Inshore	E	international	11.63
	Thanet Coast*	MCZ	EN	Inshore	E	National	64.0
O-UK9012071	Thanet Coast and Sandwich Bay	OSPAR	EN	Inshore	E	international	7.27
UK11070	Thanet Coast and Sandwich Bay	RAMSAR	EN	Inshore	E	international	7.27
UK9012071	Thanet Coast and Sandwich Bay	SPA	EN	Inshore	E	international	7.27
	Thorness Bay	SSSI	EN	Inshore	E	national	0.46
	Torbay	MCZ	EN	Inshore	W	national	19.83
	Upper Fowey and Pont Pill	MCZ	EN	Inshore	W	national	1.94
	Wembury Point	SSSI	EN	Inshore	W	national	0.60
	Whitecliff Bay And Bembridge Ledges	SSSI	EN	Inshore	E	national	1.13
	Whitsand and Looe Bay	MCZ	EN	Inshore	W	national	51.45
UK0030380	Wight-Barfleur Reef	candidate SAC	EN	Offshore	E	international	1373.44
	Yar Estuary	SSSI	EN	Inshore	E	national	0.33
	Yealm Estuary	SSSI	EN	Inshore	W	national	0.82
O-FR5300017	Abers - Côtes des légendes	OSPAR	FR	Inshore	W	international	213.61
FR5300017	Abers - Côtes des légendes	SCI	FR	Inshore	W	international	213.61
FR5300016	Anse de Goulven, dunes de Keremma	SAC	FR	Inshore	W	international	18.02
FR2502019	Anse de Vauville	SCI	FR	Inshore	W	international	130.36
FR3600087	baie de Canche	RNN	FR	Inshore	E	national	0.27
FR3102005	Baie de canche et couloir des trois estuaires	SCI	FR	Inshore	E	international	332.13
FR5312003	Baie de Goulven Dune Kerema	SPA	FR	Inshore	W	international	21.36
FR5300012	Baie de Lancieux, baie de l'Arguenon, archipel de saint Malo et Dinard	SCI	FR	Inshore	W	international	40.56
FR	baie de Morlaix	OSPAR	FR	Inshore	W	international	258.05
FR5300015	Baie de Morlaix	SCI	FR	Inshore	W	international	258.05
FR5310073	Baie de Morlaix	SPA	FR	Inshore	W	international	265.39
O-FR5300066	baie de Saint-Brieuc	OSPAR	FR	Inshore	W	international	10.43
FR3600140	baie de Saint-Brieuc	RNN	FR	Inshore	W	national	10.03
FR5300066	Baie de Saint-Brieuc - est	SCI	FR	Inshore	W	international	137.08
FR5310050	Baie de Saint-Brieuc - est	SPA	FR	Inshore	W	international	133.98
FR	baie de Seine occidentale	OSPAR	FR	Inshore	E	international	454.54
FR2502020	Baie de seine occidentale	SCI	FR	Inshore	E	international	454.54
FR2510047	Baie de Seine occidentale	SPA	FR	Inshore	E	international	443.77
FR2502021	Baie de seine orientale	SCI	FR	Inshore	E	international	443.87
FR	baie de Somme	OSPAR	FR	Inshore	E	international	34.15
FR7200018	baie de Somme	RAMSAR	FR	Inshore	E	international	108.73
FR3600118	baie de Somme	RNN	FR	Inshore	E	national	31.33
FR2510048	Baie du Mont Saint Michel	SPA	FR	Inshore	W	international	396.84
FR7200009	baie du Mont Saint-Michel	RAMSAR	FR	Inshore	W	international	360.13
FR2500077	Baie du mont saint-michel	SCI	FR	Inshore	W	international	378.45
FR2502018	Banc et récifs de Surtainville	SCI	FR	Inshore	W	international	140.34
FR	bancs des Flandres	OSPAR	FR	Inshore / Offshore	E	international	1125.41
FR3102002	Bancs des Flandres DH	SCI	FR	Inshore	E	international	1125.41

FR3112006	Bancs des Flandres do	SPA	FR	Inshore	E	international	1166.32
FR2510046	Basses Vallées du Cotentin et Baie des Veys	SPA	FR	Inshore	E	international	46.30
FR5312004	Camaret	SPA	FR	Inshore	W	international	12.11
FR5300011	Cap d'Erquy-cap Fréhel	SCI	FR	Inshore	W	international	541.35
FR5310095	Cap d'Erquy-cap Fréhel	SPA	FR	Inshore	W	international	387.02
FR3110085	Cap gris-nez	SPA	FR	Inshore	E	international	560.30
FR5310055	Cap Sizun	SPA	FR	Inshore	W	international	4.96
FR5300020	Cap Sizun, Ile de Sein	SCI	FR	Inshore	W	international	6.36
FR2500079	Chausey	SCI	FR	Inshore	W	international	827.27
FR2510037	Chausey	SPA	FR	Inshore	W	international	822.11
FR5302007	Chaussée de Sein	SCI	FR	Inshore	W	international	176.66
FR3800638	cordon de galets de la Mollière	APPB	FR	Inshore	E	national	1.43
FR3800070	cordons dunaires à Chou marin	APPB	FR	Inshore	E	national	0.27
FR5300052	Cote de Cancale à Parame	SCI	FR	Inshore	W	international	10.63
FR	côte de granit - Sept-Iles	OSPAR	FR	Inshore	W	international	715.08
FR5310011	côte de granit - Sept-Iles	SPA	FR	Inshore	W	international	693.96
FR	côte de granit rose - Sept-Iles	OSPAR	FR	Inshore	W	international	693.96
FR5300009	Cote de granit rose-sept-iles	SCI	FR	Inshore	W	international	715.08
FR5302006	Côtes de Crozon	SCI	FR	Inshore	W	international	102.03
O-FR2510046	domaine de Beauguillot	OSPAR	FR	Inshore	E	international	3.88
FR3600042	domaine de Beauguillot	RNN	FR	Inshore	E	national	3.88
FR3100474	Dunes de la plaine maritime flamande	SCI	FR	Inshore	E	international	36.05
FR3100482	Dunes de l'Authie et mollières de Berck	SCI	FR	Inshore	E	international	0.35
FR3110038	Estuaire de la canche	SPA	FR	Inshore	E	international	45.29
FR3100480	Estuaire de la canche, dunes picardes plaquées sur l'ancienne falaise, foret d'Hardelot et falaise d'Equihen	SCI	FR	Inshore	E	international	0.56
FR5300061	Estuaire de la Rance	SCI	FR	Inshore	W	international	9.50
O-FR2300121	estuaire de la Seine	OSPAR	FR	Inshore	E	international	87.65
FR3600137	estuaire de la Seine	RNN	FR	Inshore	E	national	60.23
FR2300121	Estuaire de la seine	SCI	FR	Inshore	E	international	87.65
FR2510059	Estuaire de l'Orne	SPA	FR	Inshore	E	international	5.57
FR2310044	Estuaire et marais de la basse seine	SPA	FR	Inshore	E	international	64.30
FR2200346	Estuaires et littoral picards (baies de somme et d'Authie)	SCI	FR	Inshore	E	international	106.51
FR2210068	Estuaires picards : baie de somme et d'Authie	SPA	FR	Inshore	E	international	149.16
FR9100005	Estuaires picards et mer d'Opale	PNM	FR	Inshore / Offshore	E	national	2344.18
FR	falaise du Bessin occidental	OSPAR	FR	Inshore	E	international	11.96
FR2510099	Falaise du Bessin Occidental	SPA	FR	Inshore	E	international	11.96
FR3600069	falaise du Cap-Romain	RNN	FR	Inshore	E	national	0.19
FR3100478	Falaises du cran aux œufs et du cap gris-nez, dunes du Chatelet, marais de Tardinghen et dunes de Wissant	SCI	FR	Inshore	E	international	8.32
FR3100479	Falaises et dunes de Wimereux, estuaire de la Slack, garennes et communaux d'Ambleteuse-Audresselles	SCI	FR	Inshore	E	international	0.24
FR3100477	Falaises et pelouses du cap blanc nez, du mont d'hubert, des noires mottes, du fond de la forge et du mont de couple	SCI	FR	Inshore	E	international	3.18

FR5300043	Guisseny	SAC	FR	Inshore	W	international	3.72
FR2512003	Havre de la sienne	SPA	FR	Inshore	W	international	19.19
FR2500081	Havre de saint-germain-sur-ay et landes de Lessay	SCI	FR	Inshore	W	international	10.60
FR3800298	île de la Colombière	APPB	FR	Inshore	W	national	0.07
FR1100472	îles Chausey	DPM	FR	Inshore	W	national	49.74
FR5310052	Iles de la Colombier, de la Nellière et des haches	SPA	FR	Inshore	W	international	16.67
FR5310054	Ilôt du Trévors	SPA	FR	Inshore	W	international	3.99
FR3800640	îlots de la baie de Morlaix (marin)	APPB	FR	Inshore	W	national	0.18
O-FR009	Iroise	OSPAR	FR	Inshore	W	international	1688.99
FR9100001	Iroise	PNM	FR	Inshore	W	national	1688.99
FR2512002	Landes et dunes de la Hague	SPA	FR	Inshore	E	international	26.83
FR1100139	le platier d'Oye	DPM	FR	Inshore	E	national	1.27
FR2512001	littoral augeron	SPA	FR	Inshore	E	international	214.94
FR	littoral cauchois	OSPAR	FR	Inshore	E	international	36.16
FR2300139	Littoral cauchois	SCI	FR	Inshore	E	international	36.16
FR2500080	Littoral ouest du cotentin de Bréhal a Pirou	SCI	FR	Inshore	W	international	27.78
FR2500082	Littoral ouest du cotentin de Saint-Germain-sur-Ay au Rozel	SCI	FR	Inshore	W	international	7.49
FR2310045	Littoral seino-marin	SPA	FR	Inshore	E	international	1766.15
FR2300137	L'Yeres	SCI	FR	Inshore	E	international	0.37
FR2500090	Marais arrière-littoraux du Bessin	SCI	FR	Inshore	E	international	0.55
FR	marais du Cotentin et du Bessin - baie des Veys	OSPAR	FR	Inshore	E	international	28.76
FR2500088	Marais du cotentin et du Bessin - baie des Veys	SCI	FR	Inshore	E	international	28.76
FR7200001	marais du Cotentin et du Bessin, Baie des Veys	RAMSAR	FR	Inshore	E	international	48.87
FR2500083	Massif dunaire de Heauville à Vauville	SCI	FR	Inshore	W	international	0.30
FR5300018	Ouessant - Molène	SCI	FR	Inshore	W	international	428.12
FR5310072	Ouessant - Molène	SPA	FR	Inshore	W	international	428.28
FR3600086	platier d'Oye	RNN	FR	Inshore	E	national	2.00
FR3110039	Platier d'oye	SPA	FR	Inshore	E	international	2.03
FR5300045	POINTE DE CORSEN, LE CONQUET	SCI	FR	Inshore	E	international	2.55
FR5300019	PRESQU'ILE DE CROZON	SCI	FR	Inshore	W	international	10.92
FR5310071	Rade de Brest : Baie de Daoulas, Anse de Poulmic	SPA	FR	Inshore	W	international	80.11
FR5300046	Rade de Brest, Estuaire de l'Aulne	SCI	FR	Inshore	W	international	75.27
FR2500084	Récifs et landes de la Hague	SCI	FR	Inshore	E	international	76.22
FR	Récifs et marais arrière-littoraux du cap Levi a la pointe de Saire	OSPAR	FR	Inshore	E	international	146.88
FR2500085	Récifs et marais arrière-littoraux du cap Levi a la pointe de Saire	SCI	FR	Inshore	E	international	146.88
FR3102003	Récifs gris-nez blanc-nez	SCI	FR	Inshore	E	international	290.60
FR3102004	Ridens et dunes hydrauliques du détroit du pas de calais	SCI	FR	Inshore / Offshore	E	international	680.42
FR5300024	RIVIERE ELORN	SAC	FR	Inshore	W	international	5.41
FR5300008	Rivière Leguer, forets de Beffou, coat an noz et coat an hay	SAC	FR	Inshore	W	international	1.63
O-FR5310011	Sept-Iles	OSPAR	FR	Inshore	W	international	3.23
FR3600032	Sept-Iles	RNN	FR	Inshore	W	national	3.23
FR1100713	sillon de Talbert	DPM	FR	Inshore	W	national	1.85
FR3600182	sillon de Talbert	RNR	FR	Inshore	W	national	2.01
FR	Tatihou Saint-Vaast-la-Hougue	OSPAR	FR	Inshore	E	international	8.07

FR2500086	Tatihou Saint-Vaast-la-Hougue	SCI	FR	Inshore	E	international	8.07
FR	Trégor Goëlo	OSPAR	FR	Inshore	W	international	884.29
FR5300010	Trégor Goëlo	SCI	FR	Inshore	W	international	884.26
FR5310070	Trégor Goëlo	SPA	FR	Inshore	W	international	884.29

Appendix 2 – EUNIS Level 3 Habitats

***Table 22**: Occurrence of EUNIS Level 3 habitats within the Channel MPA network. Values represent minimum occurrence where 100% and partial MPA overlap are accounted for. Blank cells denote that a habitat or species is not listed as a qualifying feature in the MPAs that region of the Channel*

EUNIS Category		Number of MPAs						
		Eastern Channel		Eastern Channel Total	Western Channel		Western Channel Total	Whole Channel Total
Code	Habitat	England	France		England	France		
A1.1	High energy littoral rock	7	14	21	4	18	22	43
A1.2	Moderate energy littoral rock	12	17	29	4	24	28	57
A1.3	Low energy littoral rock	11	17	28	5	24	29	57
A1.4	Features of littoral rock	9	17	26	3	24	27	53
A2.1	Littoral coarse sediment	10	8	18	7	16	23	41
A2.2	Littoral sand and muddy sand	19	18	37	6	23	29	66
A2.3	Littoral mud	18	18	36	6	23	29	65
A2.4	Littoral mixed sediments	17	10	27	5	19	24	51
A2.5	Coastal saltmarshes and saline reedbeds	19	12	31	5	22	27	58
A2.6	Littoral sediments dominated by aquatic organisms	10	16	26	3	23	26	52
A2.7	Littoral biogenic reefs	10	17	27	3	24	27	54
A3.1	Atlantic and Mediterranean high energy infralittoral rock	8	14	22	4	20	24	46
A3.2	Atlantic and Mediterranean moderate energy infralittoral rock	12	17	29	4	24	28	57
A3.3	Atlantic and Mediterranean low energy infralittoral rock	1	17	36	4	24	28	64
A3.4	Baltic exposed infralittoral rock	7	14	21	3	20	23	44
A3.5	Baltic moderately exposed infralittoral rock	7	14	21	3	20	23	44
A3.6	Baltic sheltered infralittoral rock	7	14	21	3	20	23	44
A3.7	Features of infralittoral rock	9	17	26	3	24	27	53
A4.1	Atlantic and Mediterranean high energy circalittoral rock	8	14	22	3	20	23	45
A4.2	Atlantic and Mediterranean moderate energy circalittoral rock	12	17	29	3	24	27	56
A4.3	Atlantic and Mediterranean low energy circalittoral rock	9	17	26	3	24	27	53
A4.4	Baltic exposed circalittoral rock	7	14	21	3	20	23	44
A4.5	Baltic moderately exposed circalittoral rock	7	14	21	3	20	23	44
A4.6	Baltic sheltered circalittoral rock	7	14	21	3	20	23	44

A4.7	Features of circalittoral rock	7	14	21	3	20	23	44
A5.1	Sublittoral coarse sediment	10	15	25	4	23	27	52
A5.2	sublittoral sand	17	15	32	6	24	30	62
A5.3	Sublittoral mud	15	10	25	3	19	22	47
A5.4	Sublittoral mixed sediments	17	14	31	2	24	26	57
A5.5	Sublittoral macrophyte-dominated sediment	17	16	33	3	24	27	60
A5.6	Sublittoral biogenic reefs	12	17	29	5	24	29	58
A6.1	Deep-sea rock and artificial hard substrata	7	14	21	3	20	23	44
A6.6	Deep-sea bioherms	7	14	21	3	20	23	44
A7.1	Neuston	6	8	14	2	19	21	35
A7.2	Completely mixed water column with reduced salinity	6	8	14	2	19	21	35
A7.3	Completely mixed water column with full salinity	6	8	14	2	19	21	35
A7.4	Partially mixed water column with reduced salinity and medium or long residence times	6	8	14	2	19	21	35
A7.5	Unstratified water column with reduced salinity	6	8	14	2	19	21	35
A7.8	Unstratified water column with full salinity	6	8	14	2	19	21	35

Appendix 3 – Qualifying Species

***Table 23**: Qualifying species and number of MPAs in which they are listed as conservation objectives within the MPA network.*

Taxonomic Group	Species	Number of MPAs Listed within
Aves	*Actitis hypoleucos*	7
Aves	*Alca torda*	17
Actinopterygii	*Alosa alosa*	16
Actinopterygii	*Alosa fallax*	18
Cnidarian	*Amphianthus dohrnii*	1
Actinopterygii	*Anguilla anguilla*	14
Mollusc	*Arctica islandica*	4
Aves	*Ardea cinerea*	9
Aves	*Ardea purpurea*	6
Aves	*Arenaria interpres*	14
Marine mammal	*Balaenoptera acutorostrata*	1
Marine mammal	*Balaenoptera musculus*	1
Aves	*Botaurus stellaris*	11
Aves	*Bulbulcus ibis*	1
Mollusc	*Caecum armoricum*	1
Aves	*Calidris alba*	20
Aves	*Calidris alpina alpina*	28
Aves	*Calidris canutus*	12
Aves	*Calidris ferruginea*	2
Aves	*Calidris maritima*	4
Aves	*Calidris minuta*	4
Aves	*Calidris temminckii*	1
Aves	*Calonectris diomedea*	2
Aves	*Catharacta skua*	5
Elasmobranchii	*Centroscymnus coelolepis*	2
Elasmobranchii	*Cetorhinus maximus*	1
Aves	*Charadrius alexandrinus*	18
Aves	*Charadrius dubius*	6
Aves	*Charadrius hiaticula*	29
Aves	*Chlidonias hybridus*	4
Actinopterygii	*Cottus gobio*	9
Marine mammal	*Delphinus delphis*	6
Actinopterygii	*Dicentrarchus labrax*	1
Elasmobranchii	*Dipturus batis*	1
Cnidarian	*Eunicella verrucosa*	3
Aves	*Fratercula arctica*	5
Aves	*Fulmarus glacialis*	10
Aves	*Gallinago gallinago*	4
Crustacean	*Gammarus insensibilis*	3
Aves	*Gavia arctica*	18
Aves	*Gavia immer*	12
Aves	*Gavia stellata*	19
Aves	*Gelochelidon nilotica*	2
Marine mammal	*Globicephala melas*	6
Actinopterygii	*Gobius cobitis*	1
Marine mammal	*Grampus griseus*	5
Aves	*Haematopus ostralegus*	22
Marine mammal	*Halichoerus grypus*	27
Cnidarian	*Haliclystus auricula*	1
Aves	*Himantopus himantopus*	11
Actinopterygii	*Hippocampus guttulatus*	6
Actinopterygii	*Hippocampus hippocampus*	5
Annelida	*Hirudo medicinalis*	1

Aves	*Hydrobates pelagicus*	9
Mollusc	*Hydrobia ulvae*	1
Mollusc	*Lacuna crassior*	1
Elasmobranchii	*Lamna nasus*	1
Agnatha	*Lampetra fluviatilis*	14
Agnatha	*Lampetra planeri*	7
Chlorophyta	*Lamprothamnium papulosum*	2
Aves	*Larus argentatus*	21
Aves	*Larus canus*	9
Aves	*Larus fuscus*	19
Aves	*Larus hyperboreus*	3
Aves	*Larus marinus*	22
Aves	*Larus melanocephalus*	24
Aves	*Larus minutus*	9
Aves	*Larus ridibundus*	17
Aves	*Larus sabini*	1
Aves	*Limosa lapponica*	19
Aves	*Limosa limosa islandica*	21
Aves	*Melanitta fusca*	7
Aves	*Melanitta nigra*	13
Aves	*Morus bassanus*	14
Cnidarian	*Nematostella vectensis*	5
Mollusc	*Nucella lapillus*	4
Aves	*Numenius phaeopus*	12
Aves	*Oceanodroma leucorhoa*	3
Mollusc	*Ocenebrina aciculata*	1
Actinopterygii	*Osmerus eperlanus*	1
Mollusc	*Ostrea edulis*	6
Phaeophyceae	*Padina pavonica*	1
Crustacean	*Palinurus elephas*	1
Mollusc	*Paludinella littorina*	1
Agnatha	*Petromyzon marinus*	20
Aves	*Phalacrocorax aristotelis*	19
Aves	*Phalacrocorax carbo*	27
Aves	*Phalaropus lobatus*	4
Aves	*Philomachus pugnax*	16
Marine mammal	*Phoca vitulina*	24
Marine mammal	*Phocoena phocoena*	25
Aves	*Platalea leucorodia*	12
Aves	*Puffinus griseus*	1
Aves	*Puffinus puffinus mauretanicus*	12
Elasmobranchii	*Raja clavata*	1
Elasmobranchii	*Raja montagui*	2
Aves	*Recurvirostra avosetta*	20
Aves	*Rissa tridactyla*	11
Actinopterygii	*Salmo salar*	21
Actinopterygii	*Salmo truttat*	3
Aves	*Somateria mollissima*	11
Actinopterygii	*Spondyliosoma cantharus*	1
Elasmobranchii	*Squalus acanthias*	1
Elasmobranchii	*Squatina squatina*	1
Marine mammal	*Stenella coeruleoalba*	1
Aves	*Stercorarius longicaudus*	1
Aves	*Stercorarius parasiticus*	8
Aves	*Stercorarius pomarinus*	6
Aves	*Stercorarius skua*	2
Aves	*Sterna albifrons*	28
Aves	*Sterna caspia*	1
Aves	*Sterna dougallii*	8

Aves	*Sterna hirundo*	36
Aves	*Sterna paradisaea*	12
Aves	*Sterna sandvicensis*	36
Aves	*Tadorna tadorna*	22
Marine mammal	*Tursiops truncatus*	22
Chlorophyta	*Ulva lactuca*	1
Aves	*Uria aalge*	15
Aves	*Uria lomvia*	1
Aves	*Xenus cinereus*	1

Appendix 4 - Guidance notes for questionnaire participants

Guidance notes for question 1 (Q1)

This assessment area aims to evaluate the regulatory framework for the site.

The term '**legally established nationally (or regionally)**' assumes that the MPA has been designated under:

i. national legislation (e.g. Arrêté Préfectoral de Protection du Biotope in France, Sites of Special Conservation Importance in the UK); OR

ii. in the case of MPAs established under international legislation or convention (e.g. Site d'Importance Communautaire, Special Areas of Conservation, Special Protection Areas, OSPAR sites) it is assumed that these have been transposed into national legislation, hence enabling national or local authorities to regulate and manage the MPA sites.

Examples of the 'statutory advice' mentioned in Tier 1 – Tier 3 include:

'Regulation 33/35 advice packages' for European Marine Sites and 'Reasons for designation the SSSI' & 'Views about management' for Sites of Special Scientific Importance provided by Natural England in the UK. 'Les documents d'objectifs (DOCOB)' for N2000 sites provided by Direction Régionale de l'Environnement, de l'Aménagement et du Logement in France.

Tier 3 states that the MPA site is legally established and an action plan that identifies issues and management solutions that support the MPA goals and objectives is in place. For example, in the UK, the action plan for European Marine Sites is provided in the Management Scheme, which details actions to be undertaken by the individual relevant authorities, either working alone or in partnership, to manage the MPA. In France, the action plan is detailed in the management plan devised by individual site-specific MPA managers.

Tier 4 states that the action plan exists and is being implemented. The site managers/site staff or responsible authorities are referring to the plan and making strategic decisions about the implementation of management activities in the site.

In addition to the action plan being implemented, Tier 5 implies that a framework for adaptive management is in place whereby the action plan is reviewed every so often to incorporate new information gathered for the site and update and/or adapt the management plan if necessary.

Guidance notes for questions 2 and 3 (Q2, Q3)

Definitions for Q2

(1) **Extractive activities** are acts that involve the temporary or permanent removal, by intentional or unintentional means, of any living organisms or non-living materials or natural features from the marine environment.

(2) **Depositional activities** are acts that involve the intentional or unintentional laying down, movement or discharge of living or non-living materials or substances into the marine environment. This includes deposition of materials such as rocks, gravel or sand, building of structures, and release of any polluting or toxic or chemical substances, as well as discharge of ballast, untreated human waste, biodegradable and industrial waste and the discard of fish offal and by-catch.

Examples of extractive / depositional activities:

Aquaculture, Beachcombing, Catch-and-release angling, Collection of flora & fauna, Commercial fishing, Construction of structures, Dredging, Disposal of dredge spoil, Recreational angling, Deposition of gravel / rock

Petroleum / gas exploration & operation

(3) Definitions for Q3

Disturbing activities are intentional or unintentional acts that interfere directly or indirectly with the normal functioning of populations beyond the natural variability of the ecosystem. Disturbing activities may result in distress to a population or longer-term deterioration in a population's fitness (e.g. ability to feed or reproduce successfully). This may then impact upon future abundance, reproduction or distribution of protected populations.

Examples of disturbing and/or damaging activities:

Anchoring / mooring, Maintenance and operation of existing structures, Navigation / transit of vessels, Motorized boating, Non-motorized boating, Point source discharges, Ports and harbours, SCUBA diving and snorkelling, Swimming, Vehicular access, Walking/hiking/camping/wildlife observation, Scientific research and education

(4) The term **'Management measures / regulations**' refers to activity-specific measures that are in place for managing activities at MPA sites.

Examples of activity-specific measures include:

i. under the UK Habitats Regulation 2010 any 'plans and projects' (e.g. construction of a wind farm) in SAC and SPA sites need to have an impact assessment carried out before consent is given for the activity to take place.
ii. the owner or occupier of SSSI will have to gain consent from the relevant statutory nature conservation agency before any of the operations listed under the 'Operations requiring Natural England's consent' is permitted to be carried out.
iii. Commercial fishing in the UK is primarily regulated through byelaws generated by the Inshore Fisheries and Conservation Authorities and the Marine Management Organization. For example, these byelaws may regulate the impact of fishing on conservation features
iv. through limitations on quota or catch size or by establishing temporal or permanent area closures for particular fishing activities (e.g. scallop dredging exclusion area).

(5) **High risk** to site features: Key structural or functional species in the biotope are likely to be killed and, or the habitat is likely to be destroyed by the activity under consideration

(6) **Moderate risk** to site features: The population(s) of key structural or functional species in the biotope may be reduced by the activity under consideration, the habitat may be partially destroyed or the viability of a species population, diversity and function of a community
may be reduced.

(7) In Tier 2*, **SOME** implies that **LESS than 90%** of the activities that pose moderate to high risk are managed.

(8) In Tier 3, **MOST** implies that **MORE than 90%** of the activities that pose moderate to high risk are managed.

Guidance notes for question 4 (Q4)

This assessment area evaluates the physical absence or presence of staff at the MPA site.

In Tier 1 sites there are no specific staff or community members responsible for the oversight of the MPA.

In Tier 2 sites there may be staff that work out of a central office and visit the MPA site occasionally to carry out activities, but there are no "on-site staff" physically stationed at the site. For example, Natural England members of staff that deal with site development proposals or carry out site monitoring when required, and Inshore Fisheries and Conservation Authorities staff that pass on fisheries byelaws would fall under Tier 2.

In Tier 3 sites there is a full-time site manager who is able to formally carry out management activities including outreach, surveillance, monitoring, etc. This would include European Marine Site officers that are responsible for the development of management schemes, assist in the implementation of site management for a particular EMS, enhance public awareness of the marine environment amongst the local community and involved in the day-to-day running of the MPA.

Guidance notes for question 5 (Q5)

The intent of this assessment area is to understand whether statutory tools (such as byelaws, orders, etc) are being applied and enforced successfully within the MPA.

In Tier 1 sites, there is an overall lack of enforcement. This may be because there are no statutory tools governing specific activities within the MPA, or due to a lack of enforcement staff and/or resources to monitor compliance with existing regulations.

Tier 2 and 3 explore varying degrees of enforcement of the site with the only difference being that Tier 2 has inconsistent enforcement activity (lack of regularly scheduled patrols, lack of a regular presence at the site, etc.) and Tier 3 has deliberate and regular enforcement activity.

Appendix 5 – Questionnaire

Questionnaire for assessing the degree of protection conferred by MPAs within PANACHE study area

Key objectives for PANACHE Work Package 1

On a national level, France and England have designated Natura 2000 sites and national MPAs, however it is important to ask the question whether the combination of sites meets ecological coherence criteria on a transnational level. Using a number of criteria to evaluate ecological coherence in MPA networks, a retrospective analysis of the existing and proposed MPA sites in the Channel area will be carried out to determine whether the current and planned MPA network meets ecological coherence criteria and to identify any gaps in the network.

Purpose of questionnaire

This questionnaire was developed as a simple tool to provide a quick assessment of the degree of protection conferred by individual MPAs within the network. The management framework and measures currently in place within each MPA for conserving, maintaining or restoring qualifying features in the designated MPAs are addressed.

Justification for looking at the 'degree of protection conferred by individual MPAs in the network'

Factors such as the activities occurring within the MPA, the management measures in place to control or mitigate these activities and enforcement or policing degree at each MPA will influence whether or not site features – species, communities, biotopes – within an MPA are maintained at or restored to favourable condition. If individual MPAs do not provide adequate protection to features for which the MPA is designated, then the MPA network is unlikely to meet ecological coherence even if the spatial configuration of the network is adequate. The degree of protection conferred by individual MPAs in the network is thus important to include among other criteria (such as representativity, replication, adequacy, connectivity) used for assessing ecological coherence within an MPA network.

Approach

(i) The information is gathered either by emailing the questionnaire or through telephone interviews (depending on the individual's preference) with key staff involved in providing advice for the management of the MPAs or involved in the actual management of the site. Representatives from Natural England, Inshore Fisheries and Conservation Authorities, Marine Management Organization and European Marine Site officers are being contacted.

(ii) Assessment Areas:

Legislative & regulatory framework of MPA site;
Management measures for extractive & depositional activities;
Management measures for damaging & disturbing activities;
On-site management;
Enforcement

(iii) Tiered Ranking - The questionnaire was designed using a tiered ranking approach with the first tier reflecting little to no capacity in an individual assessment area and the third/fourth tier reflecting high capacity in the assessment area. The participant is expected to choose one tier for each assessment area, and include comments to justify his/her response or to highlight any other points or issues in the spaces provided.

(iv) The participant is strongly advised to consult the guidance notes available for each question. These notes aim to assist participants in the selection of a specific tier for each assessment area by providing clarification of terms, etc.

(v) The questionnaire should be completed for each individual MPA within the study area and is aimed to assess the PRESENT management situation in the MPA.

Question 1

Q1. Legislative & regulatory framework of MPA site: Choose one N.B. It is assumed that the MPA site has been legally established nationally or regionally (see below for definition)	
Tier 1	NO statutory advice to inform and guide site management is currently available
Tier 2	Statutory advice to inform and guide site management is available
Tier 3*	Statutory advice has been used to develop an action plan that identifies issues and management solutions
Tier 4**	The action plan that identifies issues and management solutions IS BEING IMPLEMENTED
Tier 5***	In addition to the action plan being implemented, there is a system in place to ASSESS, REVIEW AND UPDATE the action plan on a regular basis

***** If your response above is Tier 3, please indicate the year when the action plan (final version) was written:
****** If your response above is Tier 4, please indicate the year when the action plan came into force:
******* If your response above is Tier 5, please indicate:
(i) the year when the action plan came into force:
(ii) how often is the plan reviewed and updated (e.g. every 6 years):

Question 2

Q2. Management measures for extractive & depositional activities: Choose one	
Tier 1	There are **NO** management measures / regulations (e.g. prohibition or restriction of particular activities through licensing or temporal fishing closures) in place to manage ANY of the extractive and/or depositional activities that pose moderate to high risk to the *features (or sub-features) for which the MPA is designated*
Tier 2*****	There are management measures / regulations (e.g. prohibition or restriction of particular activities through licensing or temporal fishing closures) in place to manage **SOME** of the extractive and/or depositional activities that pose moderate to high risk to the *features (or sub-features) for which the MPA is designated*
Tier 3	There are management measures / regulations (e.g. prohibition or restriction of particular activities through licensing or temporal fishing closures) in place to manage **MOST or ALL** of the extractive and/or depositional activities that pose moderate to high risk to the *features (or sub-features) for which the MPA is designated*
NA	No extractive and/or depositional activities occur at the MPA site

* If your response above is Tier 2, please check the boxes provided below to indicate which of the extractive / depositional activities (that pose moderate to high risk to MPA features) are managed and unmanaged within the MPA:

Managed activities	Unmanaged activities
Aquaculture	Aquaculture
Commercial fishing	Commercial fishing
Recreational fishing	Recreational fishing
Collection of flora & fauna	Collection of flora & fauna
Construction of structures	Construction of structures
Dredging	Dredging
Disposal of dredge spoil	Disposal of dredge spoil
Deposition of gravel / rock	Deposition of gravel / rock
Petroleum / gas operation	Petroleum / gas operation

Question 3

Q3. Management measures for damaging & disturbing activities: Choose one	
Tier 1	There are **NO** management measures / regulations (e.g. by regulating site access) in place to manage ANY of the potentially damaging and/or disturbing activities that pose moderate to high risk to the features (or sub-features) for which the MPA is designated
Tier 2*	There are management measures / regulations (e.g. by regulating site access) in place to manage **SOME** of the potentially damaging and/or disturbing activities that pose moderate to high risk to the features (or sub-features) for which the MPA is designated
Tier 3	There are management measures / regulations (e.g. by regulating site access) in place to manage **MOST or ALL** of the potentially damaging and/or disturbing activities that pose moderate to high risk to the features (or sub-features) for which the MPA is designated
NA	No damaging and/or disturbing activities occur at the MPA site

* If your response above is Tier 2, please check the boxes provided below to indicate which of the potentially damaging and/or disturbing activities (that pose moderate to high risk to MPA features) are managed and unmanaged within the MPA:

Managed activities	Unmanaged activities
Anchoring / mooring	Anchoring / mooring
Maintenance / operation of existing structures	Maintenance / operation of existing structures
Navigation / transit of vessels	Navigation / transit of vessels
Motorized boating	Motorized boating
Non-motorized boating	Non-motorized boating
Point source discharges	Point source discharges
Ports and harbours	Ports and harbours
SCUBA diving and snorkelling	SCUBA diving and snorkelling
Swimming	Swimming
Vehicular access	Vehicular access
Walking/hiking/camping/wildlife observation	Walking/hiking/camping/wildlife observation
Scientific research & education	Scientific research & education

Question 4

Q4. On-site management: Choose one	
Tier 1	No management personnel is assigned to MPA site
Tier 2*	Some management personnel is assigned to MPA site
Tier 3	Full-time site manager is assigned to MPA site who is able to dedicate sufficient time to the management of the site and able to formally carry out management activities including outreach, surveillance and monitoring

Question 5

Q5. Enforcement: Choose one	
Tier 1	No enforcement of existing statutory tools (such as byelaws, orders, regulations, etc) occurs
Tier 2	Inconsistent enforcement of statutory tools (such as byelaws, orders, regulations, etc)

Tier 3	Active and consistent enforcement of statutory tools (such as byelaws, orders, regulations, etc)

Appendix 6 - Scoring System for Questionnaire

Low management status (final scores ranging from 5 to 8)

Final score	Statutory advice available (Q1)	Measures for extractive activities (Q2)	Measures for damaging activities (Q3)	On-site management personnel available (Q4)	Enforcement of statutory tools (Q5)
5	No	No	No	No	No
6	Yes	No	No	No	No
6	No	No	No	Yes	No
6	No	No	Some	No	No
7	Yes	No	No	Yes	No
7	Yes	No	Some	No	No
8	Yes	No	Yes	Yes	No

Medium management status (final scores ranging from 9 to 14/15, some score 7 as detailed in table)

Final score	Statutory advice available (Q1)	Measures for extractive activities (Q2)	Measures for damaging activities (Q3)	On-site management personnel available (Q4)	Enforcement of statutory tools (Q5)
7	Avail + impl	Some	Some	No	Inconsistent
7	Stat. advice	No	Some	Some	Inconsistent
10	Avail + impl	Some	Some	No	Inconsistent

High management status (final scores ranging from 14 to 16)

Final score	Statutory advice available (Q1)	Measures for extractive activities (Q2)	Measures for damaging activities (Q3)	On-site management personnel available (Q4)	Enforcement of statutory tools (Q5)
14	Avail + impl	Most/All	Some	Some	Consistent
15	Stat. advice	Most/All	Most/All	FT	Consistent
15	Avail + impl	Most/All	Most/All	Some	Consistent
15	Avail + impl	Most/All	Some	FT	Consistent
15	Impl + adapt	Most/All	Some	Some	Consistent
16	Avail + Impl	Most/All	Most/All	FT	Consistent
16	Impl + adapt	Most/All	Most/All	Some	Consistent

Very high management status (final scores ranging >18)

Final score	Statutory advice available (Q1)	Measures for extractive activities (Q2)	Measures for damaging activities (Q3)	On-site management personnel available (Q4)	Enforcement of statutory tools (Q5)
18	Impl + adapt	Most/All	Most/All	FT	Consistent

Appendix 7 – Management Status Scores

***Table 24:** Questionnaire scores and management status category for MPAs within the Channel Network. X denotes no response. NA denotes questionnaire not sent.*

	Q1	Q2	Q3	Q4	Q5	Total Score	Category
French MPAs	**Respondent - AAMP**						
baie de Somme	1	1	2	1	1	6	LOW
baie du Mont Saint-Michel	1	1	2	1	1	6	LOW
marais du Cotentin et du Bessin, Baie des Veys	1	1	2	1	1	6	LOW
Abers - Côtes des légendes	2	2	2	2	2	10	MEDIUM
baie de Morlaix	2	2	2	2	2	10	MEDIUM
baie de Seine occidentale	2	2	2	2	2	10	MEDIUM
bancs des Flandres	2	2	2	2	2	10	MEDIUM
côte de granit - Sept-Iles	2	2	2	2	2	10	MEDIUM
côte de granit rose - Sept-Iles	2	2	2	2	2	10	MEDIUM
falaise du Bessin occidental	2	2	2	2	2	10	MEDIUM
littoral cauchois	2	2	2	2	2	10	MEDIUM
marais du Cotentin et du Bessin - baie des Veys	2	2	2	2	2	10	MEDIUM
Récifs et marais arrière-littoraux du cap Levi a la pointe de Saire	2	2	2	2	2	10	MEDIUM
Tatihou Saint-Vaast-la-Hougue	2	2	2	2	2	10	MEDIUM
Trégor Goëlo	2	2	2	2	2	10	MEDIUM
Baie de seine orientale	2	2	2	1	2	9	MEDIUM
Anse de Vauville	2	2	2	2	2	10	MEDIUM
Banc et récifs de Surtainville	2	2	2	2	2	10	MEDIUM
Cap Sizun, Ile de Sein	2	2	2	2	2	10	MEDIUM
littoral augeron	2	2	2	1	2	9	MEDIUM
Littoral seino-marin	2	2	2	1	2	9	MEDIUM
Cap Sizun	2	2	2	2	2	10	MEDIUM
Estuaires picards : baie de somme et d'Authie	2	2	2	2	2	10	MEDIUM
Havre de la sienne	2	2	2	2	2	10	MEDIUM
cordon de galets de la Mollière	2	3	2	1	2	10	MEDIUM
cordons dunaires à Chou marin	2	3	2	1	2	10	MEDIUM
île de la Colombière	2	3	2	1	2	10	MEDIUM
îlots de la baie de Morlaix (marin)	2	3	2	1	2	10	MEDIUM
Baie de Lancieux, baie de l'Arguenon, archipel de saint Malo et Dinard	3	2	2	2	2	11	MEDIUM
Baie de Morlaix	3	2	2	2	2	11	MEDIUM
Baie de seine occidentale	3	2	2	2	2	11	MEDIUM
Chausey	3	2	2	2	2	11	MEDIUM
Cote de Cancale à Parame	3	2	2	2	2	11	MEDIUM
Rade de Brest, Estuaire de l'Aulne	3	2	2	2	2	11	MEDIUM
Récifs et landes de la Hague	3	2	2	2	2	11	MEDIUM
Récifs et marais arrière-littoraux du cap Levi a la pointe de Saire	3	2	2	2	2	11	MEDIUM
Baie de canche et couloir des trois estuaires	3	2	2	2	2	11	MEDIUM
Bancs des Flandres DH	3	2	2	2	2	11	MEDIUM
Dunes de l'Authie et mollières de Berck	3	2	2	2	2	11	MEDIUM
Estuaire de la canche, dunes picardes plaquées sur l'ancienne falaise, foret d'Hardelot et falaise d'Equihen	3	2	2	2	2	11	MEDIUM
Récifs gris-nez blanc-nez	3	2	2	2	2	11	MEDIUM
Ridens et dunes hydrauliques du détroit du pas de calais	3	2	2	2	2	11	MEDIUM
Baie de Goulven Dune Kerema	3	2	2	2	2	11	MEDIUM
Baie de Morlaix	3	2	2	2	2	11	MEDIUM
Baie de Seine occidentale	3	2	2	2	2	11	MEDIUM
Bancs des Flandres do	3	2	2	2	2	11	MEDIUM
Cap gris-nez	3	2	2	2	2	11	MEDIUM
Ilôt du Trévors	3	2	2	2	2	11	MEDIUM
Landes et dunes de la Hague	3	2	2	2	2	11	MEDIUM
Estuaire de la canche	3	2	2	2	2	11	MEDIUM
Estuaires picards et mer d'Opale	3	2	2	3	3	13	MEDIUM
Anse de Goulven, dunes de Keremma	4	2	2	2	2	12	MEDIUM
Guisseny	4	2	2	2	2	12	MEDIUM
RIVIERE ELORN	4	2	2	2	2	12	MEDIUM
Rivière Leguer, forets de Beffou, coat an noz et coat an hay	4	2	2	2	2	12	MEDIUM
Abers - Côtes des légendes	4	2	2	2	2	12	MEDIUM
Baie de Saint-Brieuc - est	4	2	2	2	2	12	MEDIUM
Baie du mont saint-michel	4	2	2	2	2	12	MEDIUM
Cap d'Erquy-cap Fréhel	4	2	2	2	2	12	MEDIUM
Cote de granit rose-sept-iles	4	2	2	2	2	12	MEDIUM

Dunes de la plaine maritime flamande	4	2	2	2	2	12	MEDIUM
Estuaire de la Rance	4	2	2	2	2	12	MEDIUM
Estuaire de la seine	4	2	2	2	2	12	MEDIUM
Estuaires et littoral picards (baies de somme et d'Authie)	4	2	2	2	2	12	MEDIUM
Falaises du cran aux œufs et du cap gris-nez, dunes du Chatelet, marais de Tardinghen et dunes de Wissant	4	2	2	2	2	12	MEDIUM
Falaises et dunes de Wimereux, estuaire de la Slack, garennes et communaux d'Ambleteuse-Audresselles	4	2	2	2	2	12	MEDIUM
Falaises et pelouses du cap blanc nez, du mont d'hubert, des noires mottes, du fond de la forge et du mont de couple	4	2	2	2	2	12	MEDIUM
Havre de saint-germain-sur-ay et landes de Lessay	4	2	2	2	2	12	MEDIUM
Littoral cauchois	4	2	2	2	2	12	MEDIUM
Littoral ouest du cotentin de Bréhal a Pirou	4	2	2	2	2	12	MEDIUM
Littoral ouest du cotentin de Saint-Germain-sur-Ay au Rozel	4	2	2	2	2	12	MEDIUM
L'Yeres	4	2	2	2	2	12	MEDIUM
Marais arrière-littoraux du Bessin	4	2	2	2	2	12	MEDIUM
Marais du cotentin et du Bessin - baie des Veys	4	2	2	2	2	12	MEDIUM
Massif dunaire de Heauville à Vauville	4	2	2	2	2	12	MEDIUM
POINTE DE CORSEN, LE CONQUET	4	2	2	2	2	12	MEDIUM
PRESQU'ILE DE CROZON	4	2	2	2	2	12	MEDIUM
Tatihou Saint-Vaast-la-Hougue	4	2	2	2	2	12	MEDIUM
Trégor Goëlo	4	2	2	2	2	12	MEDIUM
Baie de Saint-Brieuc - est	4	2	2	2	2	12	MEDIUM
Baie du Mont Saint Michel	4	2	2	2	2	12	MEDIUM
Basses Vallées du Cotentin et Baie des Veys	4	2	2	2	2	12	MEDIUM
Cap d'Erquy-cap Fréhel	4	2	2	2	2	12	MEDIUM
Chausey	4	2	2	2	2	12	MEDIUM
côte de granit - Sept-Iles	4	2	2	2	2	12	MEDIUM
Estuaire de l'Orne	4	2	2	2	2	12	MEDIUM
Estuaire et marais de la basse seine	4	2	2	2	2	12	MEDIUM
Falaise du Bessin Occidental	4	2	2	2	2	12	MEDIUM
Iles de la Colombier, de la Nellière et des haches	4	2	2	2	2	12	MEDIUM
Rade de Brest : Baie de Daoulas, Anse de Poulmic	4	2	2	2	2	12	MEDIUM
Trégor Goëlo	4	2	2	2	2	12	MEDIUM
îles Chausey	4	3	2	3	2	14	MEDIUM
Chaussée de Sein	5	2	2	2	2	13	MEDIUM
Côtes de Crozon	5	2	2	2	2	13	MEDIUM
Ouessant - Molène	5	2	2	2	2	13	MEDIUM
Platier d'oye	5	2	2	2	2	13	MEDIUM
Camaret	5	2	2	2	2	13	MEDIUM
Ouessant - Molène	5	2	2	2	2	13	MEDIUM
le platier d'Oye	5	3	2	2	2	14	MEDIUM
sillon de Talbert	5	3	2	2	2	14	MEDIUM
Iroise	5	2	2	3	3	15	MEDIUM
baie de Saint-Brieuc	5	3	2	3	3	16	HIGH
domaine de Beauguillot	5	3	2	3	3	16	HIGH
estuaire de la Seine	5	3	2	3	3	16	HIGH
Iroise	5	3	2	3	3	16	HIGH
Sept-Iles	5	3	2	3	3	16	HIGH
falaise du Cap-Romain	5	3	3	2	3	16	HIGH
baie de Canche	5	3	3	3	3	17	HIGH
baie de Saint-Brieuc	5	3	3	3	3	17	HIGH
baie de Somme	5	3	3	3	3	17	HIGH
domaine de Beauguillot	5	3	3	3	3	17	HIGH
estuaire de la Seine	5	3	3	3	3	17	HIGH
platier d'Oye	5	3	3	3	3	17	HIGH
Sept-Iles	5	3	3	3	3	17	HIGH
sillon de Talbert	5	3	3	3	3	17	HIGH

	Q1	Q2	Q3	Q4	Q5	Total Score	Category
English & Channel Island MPAs	**Respondent - NE**						
Adur Estuary (SSSI)	4	3	3	2	2	14	MEDIUM
Bassurelle Sandbank (SCI)						NA	NA
Bouldnor And Hamstead Cliffs (SSSI)	X	X	X	X	X	X	No response
Brading Marshes to St Helen's Ledges (SSSI)	X	X	X	X	X	X	No response
Brighton to Newhaven Cliff SSSI	4	3	3	2	2	14	MEDIUM
Carricknath Point To Porthbean Beach (SSSI)	X	X	X	X	X	X	No response
Chesil & The Fleet (SSSI)	2	3	3	3	3	14	HIGH

Chesil and the Fleet (SAC)	5	3	3	2	3	16	HIGH
Chesil Beach and The Fleet (SPA)	5	3	3	2	3	16	HIGH
Chichester and Langstone Harbours (SPA)	2	2	2	2	2	10	MEDIUM
Chichester Harbour (SSSI)	5	3	3	2	2	15	MEDIUM
Christchurch Harbour (SSSI)	X	X	X	X	X	X	No response
Climping Beach (SSSI)	4	3	3	2	2	14	MEDIUM
Compton Chine To Steephill Cove (SSSI)	X	X	X	X	X	X	No response
Dawlish Warren (SSSI)	X	X	X	X	X	X	No response
Dungeness (SAC)	5	3	3	2	2	15	MEDIUM
Dungeness to Pett Level (SPA)	5	3	3	2	2	15	MEDIUM
Dungeness, Romney Marsh and Rye Bay SSSI	5	3	3	2	2	15	MEDIUM
Erme Estuary (SSSI)	X	X	X	X	X	X	No response
Exe Estuary (SPA)	3	2	3	2	2	12	MEDIUM
Exe estuary (SSSI)	X	X	X	X	X	X	No response
Fal and Helford (SAC)	4	3	3	2	2	14	MEDIUM
Folkestone Warren (SSSI)	3	1	2	2	2	10	MEDIUM
Gilkicker Lagoon (SSSI)	X	X	X	X	X	X	No response
Highcliffe To Milford Cliffs (SSSI)	2	3	2	2	2	11	MEDIUM
Hurst Castle And Lymington River Estuary (SSSI)	2	3	2	2	2	11	MEDIUM
Isle of Portland to Studland Cliffs (SAC)	2	3	3	2	3	13	MEDIUM
King's Quay Shore (SSSI)	X	X	X	X	X	X	No response
Lee-on-the Solent To Itchen Estuary (SSSI)	X	X	X	X	X	X	No response
Lyme Bay and Torbay (SCI)	2	3	3	2	3	13	MEDIUM
Lynher Estuary (SSSI)	X	X	X	X	X	X	No response
North Solent (SSSI)	2	3	2	2	2	11	MEDIUM
Otter estuary	X	X	X	X	X	X	No response
Pagham Harbour (SPA)	5	3	3	2	2	15	MEDIUM
Pagham Harbour (SSSI)	5	3	3	2	2	15	MEDIUM
Plymouth Sound and Estuaries (SAC)	5	3	2	3	X	13+	MEDIUM
Plymouth Sound Shores And Cliffs (SSSI)	X	X	X	X	X	X	No response
Poole Harbour (SPA)	5	3	3	2	2	15	MEDIUM
Poole Harbour (SSSI)	X	X	X	X	X	X	No response
Portland Harbour Shore (SSSI)	2	3	3	2	3	13	MEDIUM
Portsmouth Harbour (SPA)	2	2	2	2	2	10	MEDIUM
Portsmouth Harbour (SSSI)	X	X	X	X	X	X	No response
Ryde Sands and Wootton Creek (SSSI)	X	X	X	X	X	X	No response
Salcombe to Kingsbridge Estuary (SSSI)	X	X	X	X	X	X	No response
Seaford To Beachy Head (SSSI)	4	3	3	2	2	14	MEDIUM
Sidmouth to West Bay (SAC)	X	X	X	X	X	X	No response
Solent and Isle of Wight Lagoons (SAC)	1	2	2	2	2	9	MEDIUM
Solent and Southampton Water (SPA)	2	2	2	2	2	10	MEDIUM
Solent Maritime (SAC)	2	2	2	2	2	10	MEDIUM
South Wight Maritime (SAC)	2	3	3	2	3	13	MEDIUM
St John's Lake (SSSI)	X	X	X	X	X	X	No response
Start Point to Plymouth Sound and Eddystone (SCI)	2	3	3	2	3	13	MEDIUM
Studland to Portland (cSAC)	2	3	3	2	3	13	MEDIUM
Tamar - Tavy Estuary (SSSI)	X	X	X	X	X	X	No response
Tamar Estuaries Complex (SPA)	X	X	X	X	X	X	No response
Thanet Coast (SAC)	5	3	3	2	1	14	MEDIUM
Thanet Coast and Sandwich Bay (SPA)	5	3	3	2	1	14	MEDIUM
Thorness Bay (SSSI)	X	X	X	X	X	X	No response
Wembury Point (SSSI)	X	X	X	X	X	X	No response
Whitecliff Bay And Bembridge Ledges (SSSI)	X	X	X	X	X	X	No response
Wight-Barfleur Reef (cSAC)						NA	NA
Yar Estuary (SSSI)	X	X	X	X	X	X	No response
Yealm Estuary (SSSI)	X	X	X	X	X	X	No response
Les Ecrehou and Les Dirouilles, Jersey	X	X	X	X	X	X	No response
Les Minquiers, Jersey	X	X	X	X	X	X	No response
Les Pierres de Lecq, Jersey	X	X	X	X	X	X	No response
Alderney West Coast and the Burhou Islands	X	X	X	X	X	X	No response
Gouliot Caves and Headland, Sark	X	X	X	X	X	X	No response
Lihou Island and L`Erée Headland, Guernsey	X	X	X	X	X	X	No response
SECoast, Jersey	X	X	X	X	X	X	No response

Appendix 8 - Additional marine mammal and seabird results

***Table 25**: Number of sightings of marine mammals during aerial surveys of the Channel in winter 2011-2012 and summer 2012. Please note: A sighting of 1 denotes a single sighting irrespective of the number of individuals present.*

Species (or groups)	**Total number of sightings in PANACHE study region during winter survey**	**Total number of sightings in PANACHE study region during summer survey**
Rorqual	1	1
Sperm whales, kogias, beaked whales	0	0
Pilot whales	1	0
Harbour porpoise	245	173
Seals	29	21
Small oceanic dolphins	46	9
Common bottlenose dolphin	5	10

***Table 26**: Number of sightings of seabirds during aerial surveys of the Channel in winter 2011-2012 and summer 2012. Please note: A sighting of 1 denotes a single sighting irrespective of the number of individuals present.*

Species (or groups)	**Total number of sightings in PANACHE study region during winter survey**	**Total number of sightings in PANACHE study region during summer survey**
Common murre or razorbill	3657	163
Black-headed gull or Mediterranean gull	931	283
Great Skua	49	20
Northern fulmar	218	99
European herring gull or Yellow-legged gull	428	933
Great or lesser black-backed gull	611	422
Large shearwaters (Calonectris diomedea/Puffinus gravis/Puffinus griseus)	0	0
Little gull	96	2
Storm petrels (Hydrobates pelagicus / Oceanites oceanicus / Oceanodroma castro / Oceanodroma leucorhoa)	5	49
Small shearwaters (Puffinus yelkouan / Puffinus puffinus / Puffinus mauretanicus / Puffinus assimilis)	1	78
Black-legged kittiwake	1128	40
Terns	14	499
Gannet	1999	1751

Seals

The observation of seals within the PANACHE study area was restricted mainly to the eastern Channel, with 34% and 18% of observations occurring within MPAs in winter and summer, respectively (Table 7, Figure 50). The number of observations within MPAs declined in summer because the Thanet MCZ covered only a limited part of the cell where the highest density was observed. It would be interesting to look at point data to assess whether observations of seals occurred in coastal areas, which is likely as it was difficult to observe seals at sea.

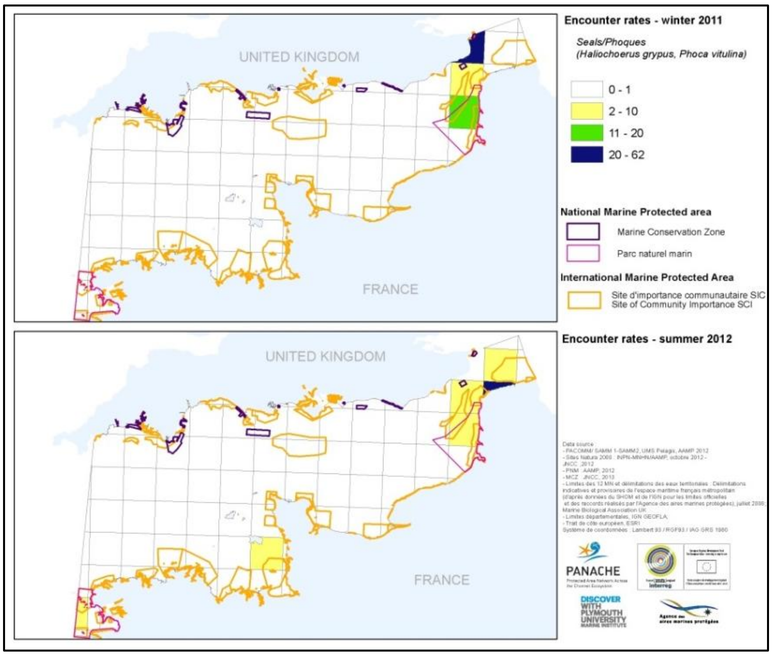

Figure 50*: Encounter rates of Seals (Halichoerus grypus and Phoca vitulina) in winter 2011-2012 (top panel) and summer 2012 (bottom panel) in the English Channel.*

Small Oceanic Dolphins

Nine percent of Small Oceanic Dolphins were observed within the boundaries of MPAs in winter (and 18% in summer, but with very weak encounter rates). The relative concentration in winter in the western and central part of the Channel may indicate that this area has some importance.

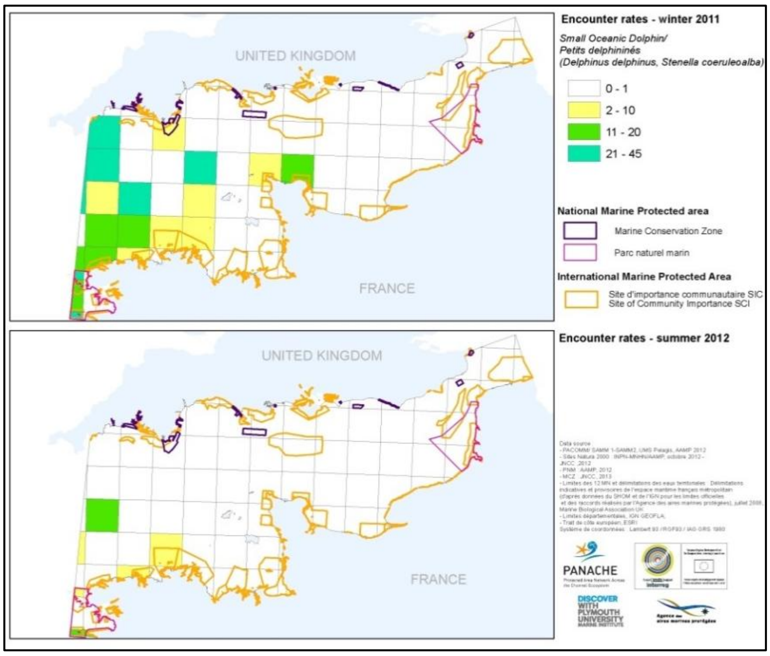

Figure 51*: Encounter rates of Small Oceanic Dolphins (Delphinus delphis, Stenella coeruleoalba) in winter 2011-2012 (top panel) and in summer 2012 (bottom panel) in the English Channel).*

Pilot whales

Pilot Whales are very rare in the Channel, with the few encounters occurring in the central western Channel.

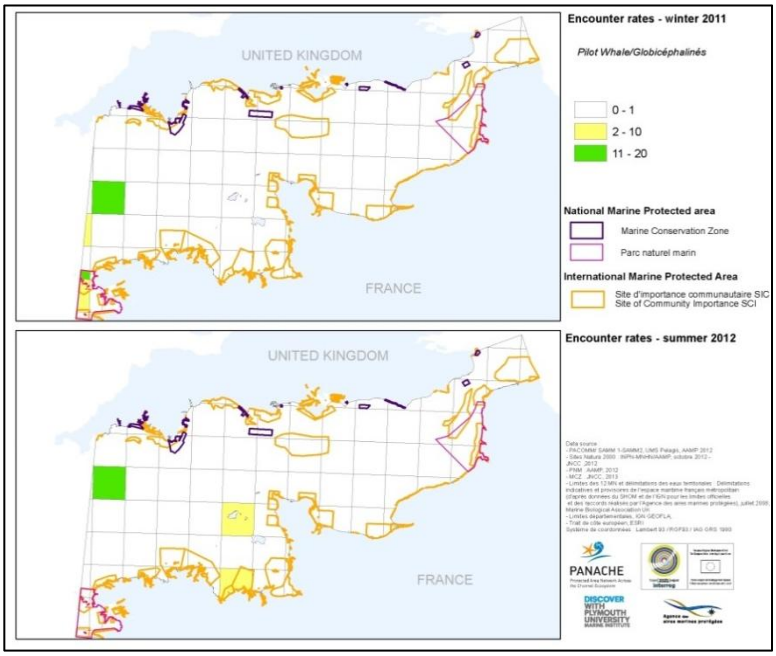

Figure 52*: Encounter rates of Pilot Whales in winter 2011-2012 (top panel) and in summer 2012 (bottom panel) in the English Channel.*

<u>Rorquals</u>

The Rorquals are not typically present in the channel except the common Minke Whale, which has a few occurrences. A notable hotspot emerged in summer in the very western Channel, but this was beyond the PANACHE study area.

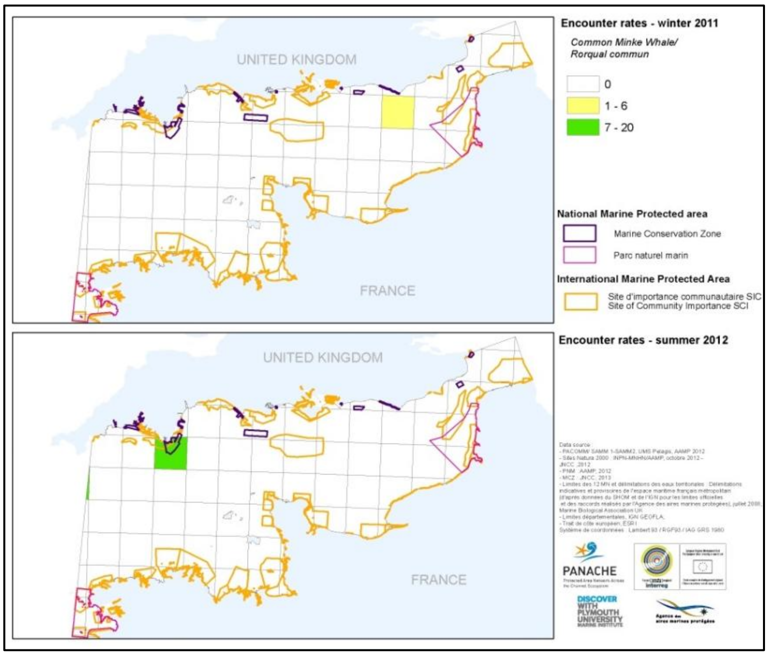

Figure 53*: Encounter rates of Rorquals (the common Minke Whale in the Channel) in winter 2011-2012 (top panel) and in summer 2012 (bottom panel) in the English Channel.*

<u>Great Skuas</u>

This species is not predominantly present in the Channel; however, some areas of moderate concentration exist on the eastern French coast in winter and around southern Cornwall in summer (even if the cell with the highest rate is outside the study area). Although the coverage seems correct (18% and 24%), it may be worth ensuring that the Great Skua is correctly taken into consideration in those areas.

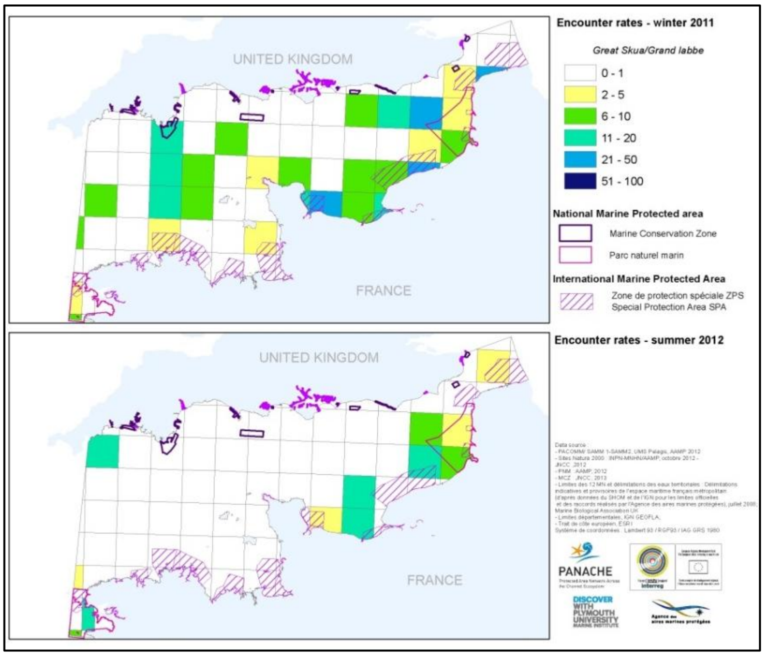

***Figure 54**: Encounter rates of the Great Skua in winter 2011-2012 (top panel) and in summer 2012 (bottom panel) in the English Channel.*

Black-headed Gulls or Mediterranean Gulls

The representativity of these two gull species within the MPA network is quite good in both winter and summer (26% and 32%, respectively). The Channel has an important (winter) and a major (summer) role for these species. In both seasons, the very western Channel, Strait of Dover and North Sea are very dense areas, but Seine Bay and Brighton's coast (and Beachy Head) are also key areas. The western Channel along the French coast also has high concentrations of these birds in winter. In general, those hotspots seem to be at least partially enclosed by the MPA network.

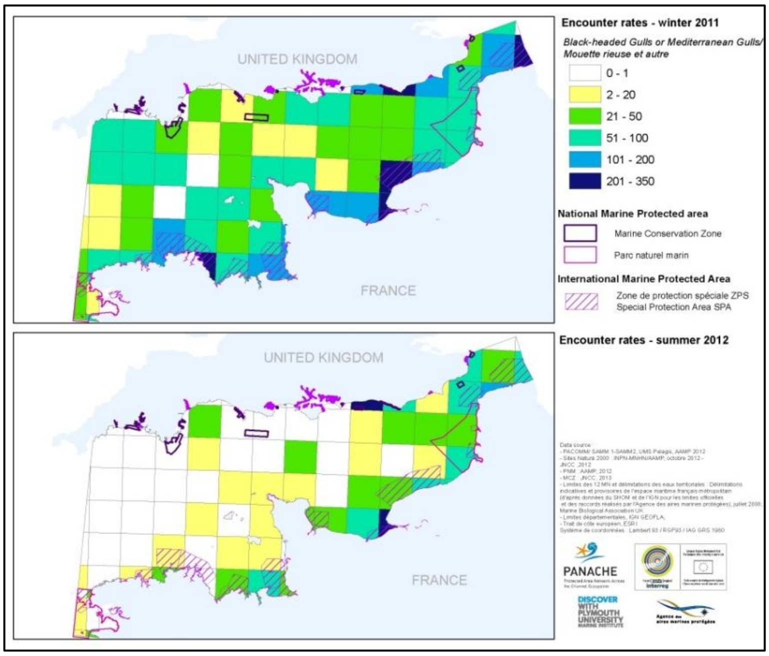

***Figure 55:** Encounter rates of Black-headed and Mediterranean Gulls in winter 2011-2012 (top panel) and in summer 2012 (bottom panel) in the English Channel.*

European Herring Gulls or Yellow-legged Gulls

Thirty-one percent of observations for these species occurred within MPA networks during both seasons suggesting that these species seem to be rather adequately covered by the MPA network.

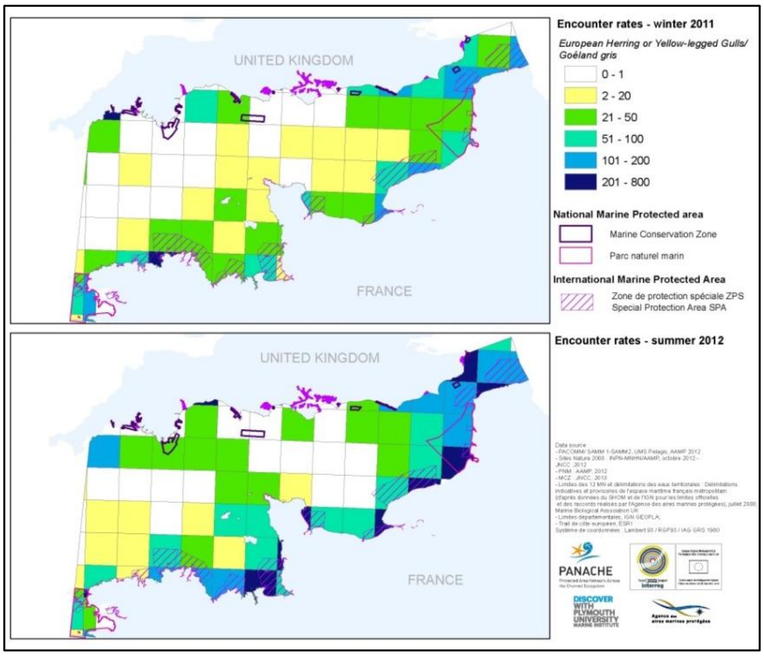

***Figure 56**: Encounter rates of European Herring or Yellow-legged in winter 2011-2012 (top panel) and in summer 2012 (bottom panel) in the English Channel.*

<u>Little Gulls</u>

The presence of the Little Gull is almost negligible in winter and very scarce in summer (but there are a few occurrences in the very western central Channel).

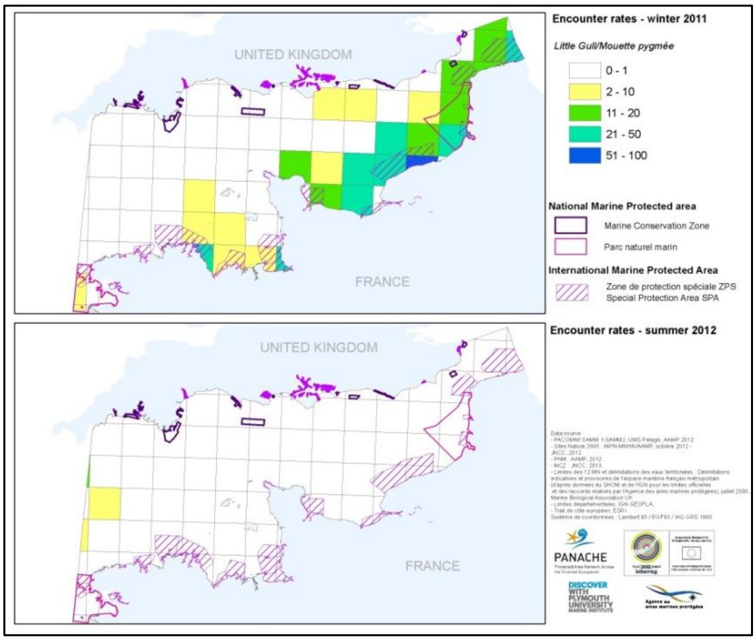

***Figure 57:** Encounter rates of the Little Gull in winter 2011-2012 (top panel) and in summer 2012 (bottom panel) in the English Channel.*

<u>Storm Petrels</u>

The Storm Petrels are almost non-existent in winter, but some individuals appear in the western (and mainly central) Channel in summer. This may be another indication of the role of the western central Channel, once again poorly covered by MPAs (13%).

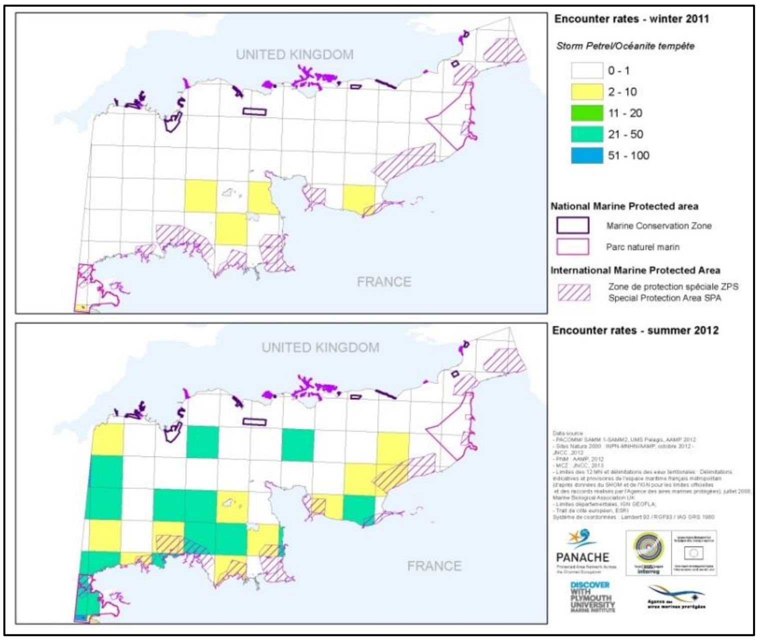

***Figure 58**: Encounter rates of Storm Petrels in winter 2011-2012 (top panel) and in summer 2012 (bottom panel) in the English Channel.*

<u>Small Shearwaters</u>

Small Shearwaters (mainly the Manx Shearwater) are mainly present in the western Channel, when they tend to be more coastal. However, occurrence in MPAs remains low and potential areas of interest for these species may not be adequately taken into account by the network.

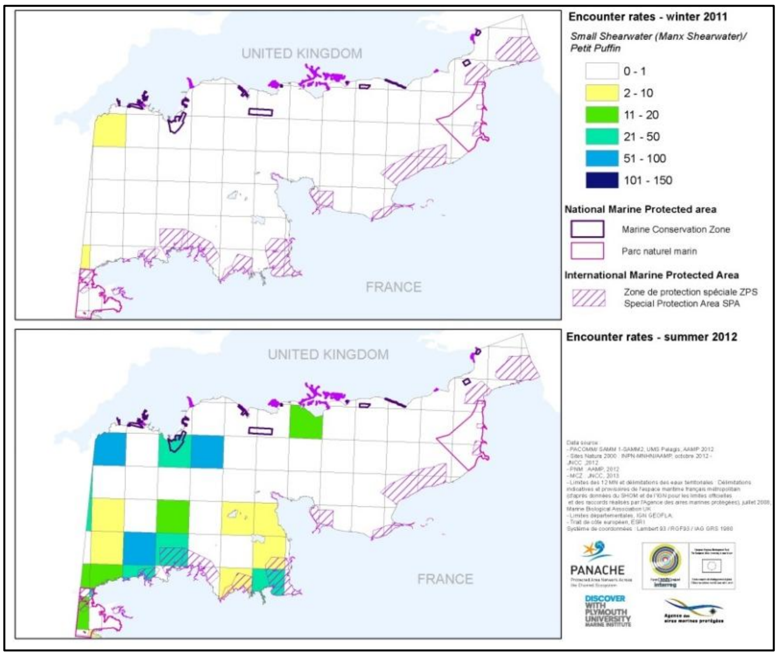

***Figure 59**: Encounter rates of Small Shearwaters (mainly the Manx Shearwater) in winter 2011-2012 (top panel) and in summer 2012 (bottom panel) in the English Channel.*

PANACHE

Protected Area Network Across the Channel Ecosystem

PANACHE is a project in collaboration between France and Britain. It aims at a **better protection** of the Channel marine environment through the **networking** of existing marine protected areas.

The project's five objectives:

- **Assess** the existing marine protected areas network for its ecological coherence.
- **Mutualise** knowledge on monitoring techniques, share positive experiences.
- **Build** greater coherence and foster dialogue for a better management of marine protected areas.
- **Increase** general awareness of marine protected areas: build common ownership and stewardship, through engagement in joint citizen science programmes.
- **Develop** a public GIS database.

France and Great Britain are facing similar challenges to protect the marine biodiversity in their shared marine territory: PANACHE aims at providing **a common, coherent and efficient reaction**.

PANACHE est un projet franco-britannique, visant à une **meilleure protection** de l'environnement marin de la Manche par la **mise en réseau** des aires marines protégées existantes.

Les cinq objectifs du projet :

- **Étudier** la cohérence écologique du réseau des aires marines protégées.
- **Mutualiser** les acquis en matière de suivi de ces espaces, partager les expériences positives.
- **Consolider** la cohérence et encourager la concertation pour une meilleure gestion des aires marines protégées.
- **Accroître** la sensibilisation générale aux aires marines protégées : instaurer un sentiment d'appartenance et des attentes communes en développant des programmes de sciences participatives.
- **Instaurer** une base de données SIG publique.

France et Royaume-Uni sont confrontés à des défis analogues pour protéger la biodiversité marine de l'espace marin qu'ils partagent : PANACHE vise à apporter **une réponse commune, cohérente et efficace**.

- www.panache.eu.com -

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