

ACTIVITIES, IMPACTS AND MANAGEMENT MEASURES

Table A: Ecosystem components of potential site consultation areas (habitats only)

Ecosystem component	Puffin Island	North East Menai Strait	North Llyn Peninsula	Bardsey Island	St Tudwals East & Llanbedrog	Aber Afon Dwyfor	New Quay	SW Strumble Head	Skomer	Dale
Important Habitats										
Fragile sponge & anthozoan communities on subtidal rocky habitats			Y	Y				Y	Y	
Intertidal boulder communities	Y		Y	Y		Y			Y	Y
Intertidal mudflats		Y			Y					
Sediment habitats with long-lived bivalves				Y			Y			
Maerl beds										
Horse mussel (<i>Modiolus modiolus</i>) beds			Y							
Mud habitats in deep water							Y		Y	
Blue mussel (<i>Mytilus edulis</i>) beds	Y				Y	Y				Y
Oyster (<i>Ostrea edulis</i>) beds										
Subtidal rock with Ross 'coral' <i>Pentapora fascialis/fofiacea</i>			Y		Y			Y	Y	
Honeycomb worm (<i>Sabellaria alveolata</i>) reefs						Y				
Seagrass beds						Y			Y	
Sheltered muddy gravels		Y			Y					Y
Subtidal mixed muddy sediments	Y	Y	Y		Y	Y			Y	Y
Tide swept channels	Y	Y							Y	
Broadscale habitats										
High energy deeper water rock	Y		Y	Y	Y			Y	Y	Y
Moderate energy deeper water rock	Y	Y	Y	Y	Y			Y	Y	Y
High energy intertidal rock	Y	Y	Y	Y	Y	Y		Y	Y	
Low energy intertidal rock	Y		Y	Y						
Moderate energy intertidal rock	Y		Y	Y	Y			Y	Y	Y
High energy shallow water rock	Y	Y	Y	Y	Y	Y		Y	Y	Y
Low energy shallow water rock	Y	Y	Y	Y	Y	Y		Y	Y	Y

Ecosystem component	Puffin Island	North East Menai Strait	North Llyn Peninsula	Bardsey Island	St Tudwals East & Llanbedrog	Aber Afon Dwyfor	New Quay	SW Strumble Head	Skomer	Dale
Moderate energy shallow water rock	Y	Y	Y	Y	Y	Y		Y	Y	Y
Intertidal biogenic reefs	Y				Y	Y				Y
Intertidal coarse sediment	Y	Y	Y	Y	Y	Y		Y	Y	Y
Intertidal seagrass beds										
Intertidal mud										
Intertidal mixed sediments		Y								Y
Intertidal sand	Y	Y	Y	Y	Y	Y		Y	Y	Y
Subtidal biogenic reefs			Y						Y	
Subtidal coarse sediment			Y	Y	Y		Y	Y	Y	Y
Subtidal macrophyte	Y	Y	Y	Y	Y				Y	Y
Subtidal mud	Y				Y	Y	Y		Y	Y
Subtidal mixed sediments	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Subtidal sand	Y	Y	Y	Y	Y	Y	Y	Y	Y	

Table B: Summary of appropriate management measures for extractive and depositional activities

Activity	Management measure	Responsible Authority
Commercial fishing; recreational fishing and recreational sea angling (including catch and release angling)	Fishery Order	WG
Bait collection	Fishery Order	WG
Collection of flora and fauna (including hunting)	Fishery Order; Nature Conservation Order SSSI third party legislation if area overlaps with SSSI Policy not to give new or renew wildfowling leases	WG CCW CE
Collection/use of natural materials/substrates (including curio collection/ beach combing)	Nature Conservation Order; Wider legislation	WG
Anchoring	Nature Conservation Order	WG
Dredging	Licensing Authority Policy	WG
Construction of structures	Licensing Authority Policy	WG / MMO
Aquaculture	Licensing Authority Policy; Nature Conservation Order; Fisheries Order; Several/Regulating Order	WG EA
Petroleum/gas operation	Licensing Authority Policy	WG
Discharges (into site)	Licensing Authority Policy	EA

Table C: Summary of appropriate management measures for activities that are potentially damaging and disturbing to habitats

Notes:

1. Many of the activities listed here may not need active management at the time of site designation if they are occurring at levels low enough not to cause an impact.
2. Ecosystem components follow the broadscale and important habitat categories used for highly protected MCZ site selection (see Table A above).

Activity	Circumstances where activity may be disturbing or damaging	Sensitive ecosystem component(s) (Habitats only)	Management measure and possible mitigation	Management authority
Scientific research and education	<p>Damage to sensitive habitats e.g. by trampling</p> <p>Experimental adjustment of physical parameters or distribution of habitats</p>	<p>Various – dependent on form of research to be undertaken.</p> <p>For ecosystem components sensitive to trampling see 'Walking/hiking'</p>	<p>Nature conservation order setting out need for a permit to undertake research/ monitoring/ surveillance of the site.</p> <p>Code of conduct setting out appropriate behaviour to minimise impacts (e.g. such as from trampling and boulder turning)</p>	WG
Navigation/ transit of vessels, including use of motorised and non-motorised vessels.	Fuelling/ refuelling on shore; potential vehicular access	For ecosystem components sensitive to vehicular access see 'vehicular access'	<p>Nature conservation order or local byelaw to set out seasonal access restrictions/ permit schemes/ prevention of re-fuelling from shore as necessary</p> <p>Codes of conduct</p>	WG

Activity	Circumstances where activity may be disturbing or damaging	Sensitive ecosystem component(s) (Habitats only)	Management measure and possible mitigation	Management authority
<p>Maintenance and operation of existing structures</p> <p>(e.g. moorings and navigation buoys)</p>	<p>Scour and physical damage e.g. from moorings</p>	<p>Seagrass beds; Blue mussel beds; Low energy intertidal rock; Fragile sponge & anthozoan communities on subtidal rocky habitats ; Intertidal under boulder communities; Maerl beds; Horse mussel (<i>Modiolus modiolus</i>) beds; Mud habitats in deep water; Oyster beds; Honeycomb worm reefs; Sheltered muddy gravels; Subtidal mixed muddy sediments; Tide-swept channels; Low, moderate and high energy intertidal rock (in part); High and moderate energy deep water rock (in part); Subtidal coarse sediments (in part); Low, moderate and high energy shallow water rock (in part); Subtidal macrophyte dominated sediments (in part); Subtidal biogenic reef (in part); Intertidal sand (in part);</p>	<p>Nature conservation order with permit scheme</p> <p>Codes of conduct</p>	<p>WG</p>

Activity	Circumstances where activity may be disturbing or damaging	Sensitive ecosystem component(s) (Habitats only)	Management measure and possible mitigation	Management authority
		Intertidal and subtidal mixed sediments (in part).		
Vehicular access	Sensitive habitats in intertidal zone	Seagrass beds; Intertidal biogenic reefs; Intertidal sediments; Some subtidal sediments; Some intertidal and shallow water rock communities.	Nature conservation order setting out seasonal closures, restriction or banning of vehicle use / setting out zoning / specifying access routes Supporting voluntary approaches; signage	WG
Scuba diving and snorkelling	High numbers of divers/snorkellers - trampling/sediment stirring/abrasion Low skill level of divers	Reef habitats supporting sensitive species such as Pink Sea Fan (<i>Eunicella</i>), Ross Coral (<i>Pentapora</i>) and erect species of fragile sponges and anthozoans. For ecosystem components sensitive to trampling see 'Walking/hiking'	Nature conservation order -issue permits to regulate numbers of divers; code of conduct, zoning Signs to raise awareness; specified areas for beginners, zoning Seasonal closures, code of conduct	WG
Swimming	Trampling of sensitive intertidal populations	For ecosystem components sensitive to trampling see 'Walking/hiking'	Avoid damage to sensitive habitats and species through zoning with a nature conservation order and/or code of conduct/local authority Byelaw	WG; Local Authority

Activity	Circumstances where activity may be disturbing or damaging	Sensitive ecosystem component(s) (Habitats only)	Management measure and possible mitigation	Management authority
Walking/ hiking, coast steering, climbing	Trampling of sensitive intertidal populations	Seagrass beds; Intertidal and some subtidal biogenic reefs; Intertidal and some subtidal sediments; Some intertidal and shallow water rock communities.	Nature conservation order - access restrictions Well marked paths, code of conduct Removal or re-routing of coastal paths near highly protected MCZs	WG
Other recreational pursuits	Horse riding - disturbance to wildlife/trampling of sensitive habitats	For ecosystem components sensitive to trampling see 'Walking/hiking'	Nature conservation order (Seasonal closures, code of conduct, zoning)	WG

Table D. Potential impact on MCZs from activities occurring outside sites

Key to likelihood of impact if activity occurred:

H = highly likely;

P = possible;

U = unlikely, although still possible;

blank = no impact

Notes:

1. This table is **indicative only**. Further work would be needed to categorise likelihood of impacts on a site by site basis.

2. At this stage extractive and depositional impacts have been considered and potentially damaging impacts to habitats; potentially damaging or disturbing impacts on highly mobile species will be considered following this first consultation.

Activity	Potential impact within MCZ	Potential impact from activity occurring adjacent to site	Potential impact from activity occurring at a distance
Aggregate dredging	Deposition of sediment	H	P
	Alteration of sediment supply	H	P
	Change in flow regime	P	P
Dredge spoil disposal	Deposition of sediment	H	P
Maintenance dredging	Deposition of sediment	H	P
	Alteration of sediment supply	H	P
	Change in flow regime	H	P
Anchoring	Physical damage	P	
	Deposition of sediment	U	
Discharges	Change to water quality	H	P
Construction	Deposition of sediment	H	P
	Alteration of sediment supply	H	P
	Change in flow regime	H	P
Maintenance and operation of existing structures	Discharges	P	U
Commercial fishing, towed gear	Physical damage	P	
	Species extraction from within the site	P	
	Deposition of sediment	P/H	
Commercial fishing, pelagic gear	Species extraction from within the site	P	
Commercial fishing, static gear	Physical damage	P	
	Species extraction from within the site	P	

Activity	Potential impact within MCZ	Potential impact from activity occurring adjacent to site	Potential impact from activity occurring at a distance
	Deposition of sediment	U	
Recreational fishing	Physical damage	U	
	Species extraction	P	
Vehicular access	Deposition and/or erosion of sediment	P	
Recreational activities	Physical damage	P	

IDENTIFYING THE FOCUS SITES

CCW was tasked with selecting between 15-25 Focus Sites based on the ecological guidance developed by the Technical Advisory Group and published by the Welsh Government. The selection process was undertaken in four steps, with the computer software 'Marxan' used to focus in on possible areas for sites, and with expert judgement (informed by the ecological criteria) used to set boundaries for the sites.

A5.1 Identifying high scoring areas.

The site selection guidelines outlines that sites are to be scored according to their habitat heterogeneity and therefore it was decided that selecting some sites because of their high score for habitat heterogeneity was an appropriate first step.

Welsh waters were divided up into a series of hexagonal grids for the purpose of selecting Focus Sites. Each hexagon was 5km² (500 ha), in line with the recommendation in the site selection guidance (WAG, 2010) to use this site size for the first two stages of the site selection process. Hexagons were used because they tend to fit the coast better than squares and also have lower edge to area ratios (Warman et al. 2004) – example at Figure 1. Four of these hexagonal grids were produced, each offset from the other. The purpose of this was to examine whether exact placement of the hexagons produced different results. Areas that were considered permanently modified were excluded from the analysis.

Each hexagon was scored following the guidelines in the site selection guidance. This meant that a count was made of the number of broadscale habitats, with a point allocated to each with the exception of four habitats which received half a point (High energy intertidal rock, Intertidal coarse sediment, Low energy shallow water rock and Low energy deeper water rock). A count was also made of the number of important habitats and the presence of high productivity areas, with a point being given to each of the important habitats and another point given if a high productivity area was present (for more details see the Site Selection Guidance, WAG 2010). CLUZ software (Conservation Land-Use Zoning software see <http://www.kent.ac.uk/dice/cluz/>) was

used for this analysis. The overall scores were determined by allocating a 'high', 'medium' or 'low' score for broadscale habitats and another score (again, 'high', 'medium' or 'low') for important habitats on a percentile basis (i.e. the top third scoring 'high', the bottom third scoring 'low' etc). Then the scores for broadscale habitats and important habitats were combined to produce a single score as shown below:

Combining broadscale habitat scores and important habitat scores to give an overall score for hexagons throughout Welsh waters.

		Important habitats and high productivity areas score			
		High (>=3)	Medium (2)	Low (1)	Zero
Broadscale Habitats score	High (>=4.5)	high	medium high	medium	medium
	Medium (1.5-4)	medium high	medium	medium low	low
	Low (0.5-1)	medium	medium low	low	low
	Zero	medium	low	low	zero

Therefore a "high" score was obtained where a 5 km² (or smaller) polygon achieved a score of 4.5 or more for broadscale habitats and 3 or more for important habitats and productive areas. All hexagons with a score of "high" (in any of the four grids) were automatically included in the list of Focus Sites; this resulted in 13 areas being selected (see Figure 2).

Figure 1. Hexagonal grid over Welsh waters displaying high to low scoring areas.

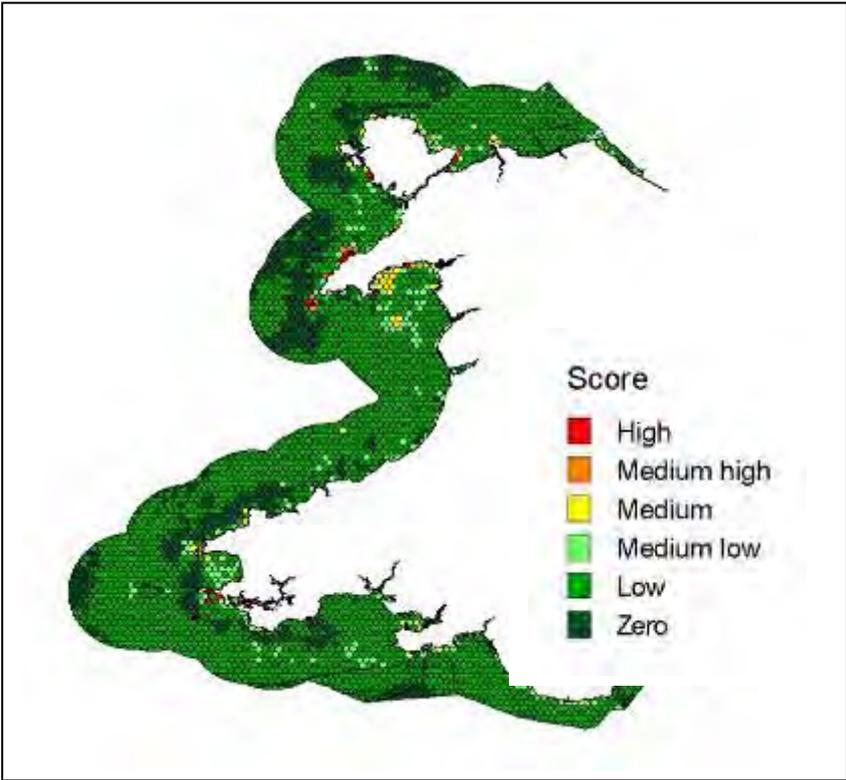
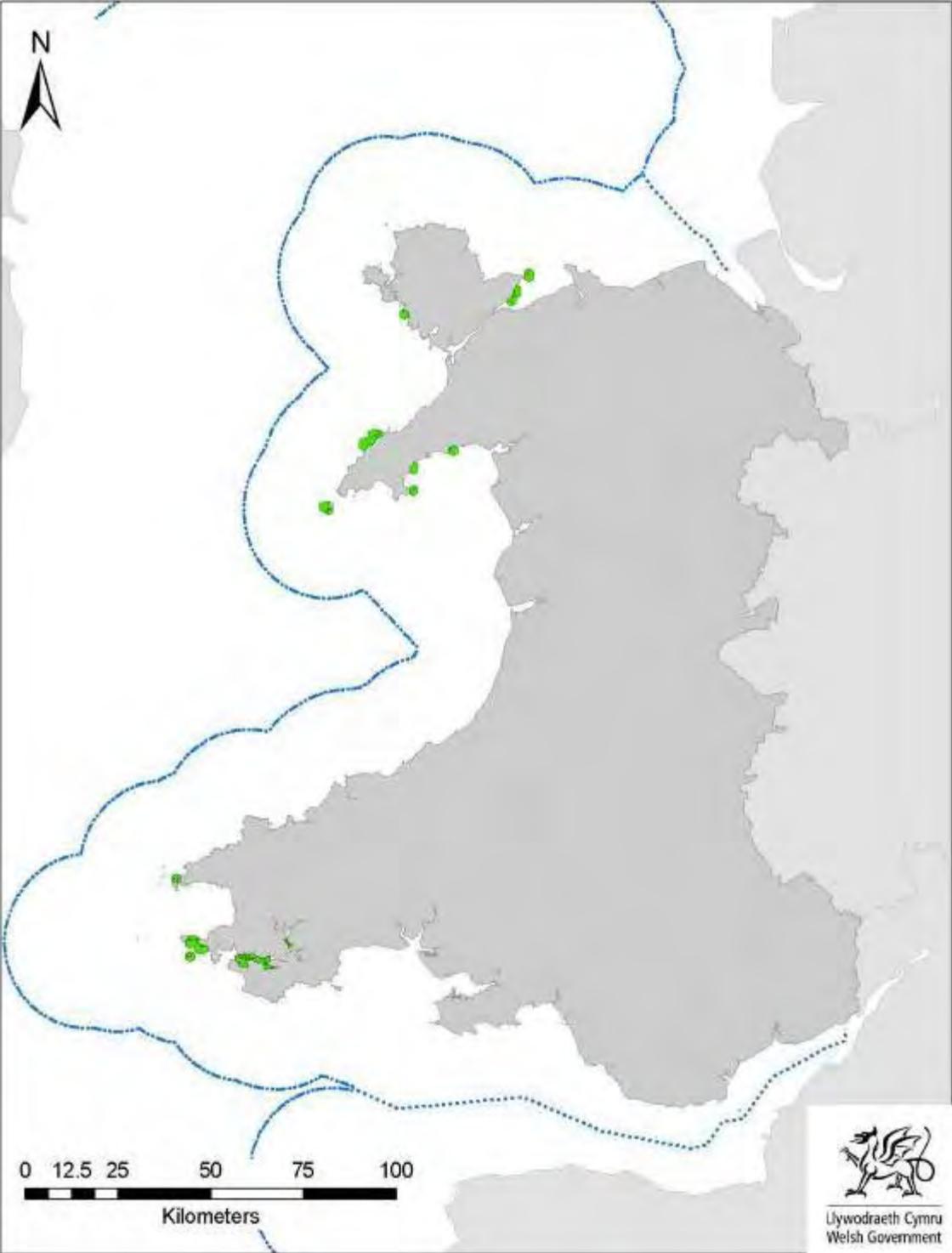


Figure 2. Sites chosen due to high habitat heterogeneity scores (in green).



© British Crown and SeaZone Solutions Limited. All rights reserved. Products Licence No. 032009.011 (April 2011)
© Crown Copyright and database right (2012). All rights reserved. Welsh Government. Licence number 100017916

A5.2 Using Marxan to identify additional areas

The site selection guidelines outline a list of 21 broadscale habitats and 15 important habitats that must be included in the list of Focus Sites. The output from the first step of the selection process identified sites with high habitat heterogeneity, but these 13 areas selected did not include all of the habitats. The habitats that were missing after the high habitat heterogeneity sites had been selected were intertidal biogenic reefs, intertidal mixed sediments, intertidal seagrass beds, subtidal mud and subtidal biogenic reefs (within broadscale habitats); and Horse mussel (*Modiolus modiolus*) beds, Honeycomb worm (*Sabellaria alveolata*) reefs, seagrass beds, oyster beds, mud habitats in deep water and sediment with long-lived bivalves (within important habitats).

We used the conservation planning decision support software tool Marxan (Ball & Possingham, 2000) to provide an indication of possible 'Focus Sites' that would incorporate the habitats missing from the first step of the process. Marxan is a computer programme that is used to aid the selection of protected area networks. One way in which it does this is by identifying site areas which contain specific attributes (in this case a range of defined broadscale and important habitat types).

For the Marxan analysis, the planning units were the 5km² (500 ha) hexagonal grids described earlier, again with four offset hexagonal grids. Areas that were considered permanently modified were separate Planning Units set as excluded in the Marxan analysis (i.e. these polygons were set as unavailable to the software in terms of choosing sites).

The selection guidelines provide recommended minimum patch sizes for different habitats. For some habitats the targets are linear (e.g. 500-1km length of intertidal rock habitat). However, to define linear distances automatically is difficult, so these linear targets were converted to areas by examining the habitat maps and estimating an average width of the habitat and converting the linear distance to an area. To overcome the problem of Marxan potentially selecting patches of habitat that were smaller than the viable patch size (as defined in the selection guidelines), any habitats that had an area below the target viable size within each Planning Unit were deleted from that Planning Unit. This ensured that the data analysis was only carried out on habitats that reached the target patch size within each Planning Unit. An initial trial of this technique revealed

that some of the viable patch sizes were unrealistically large given that actual distribution and patch sizes of that habitat in Welsh waters. This particularly applied to some of the intertidal habitats that had been given area target sizes (i.e. 0.5 – 1km diameter of linear target lengths of 0.5-1km). In the selection guidelines intertidal rock habitats have linear targets, whereas intertidal sediments have area targets. However, this caused problems for those intertidal sediments that tend to have a more linear distribution, i.e. LS.LCS Intertidal coarse sediment, Blue mussel (*Mytilus edulis*) beds and Sheltered muddy gravels. Therefore the target areas for these habitats were adjusted to 2.5 ha, to be consistent with the most similar rocky habitats. Other habitats that were not generally present in large enough patch sizes were Oyster (*Ostrea edulis*) beds (maximum patch size 0.4 ha) and Intertidal boulder communities (patch size generally around 0.2 ha). Table 1 shows the original guidance, the conversions of linear targets to areas and the adjusted areas. The target for each habitat was then set to be the same as the patch size value (adjusted target area in Table 1). For habitats where there was point data only the target was set to 2. This was to ensure that Planning Units were not selected that contained only a single record of a habitat.

Table 1. Habitat patch sizes

Habitat name	Original target	Linear targets adjusted to areas (ha)	Adjusted target area (ha)	Comments
High energy intertidal rock	0.5 – 1km linear	0.5	0.5	assumes 10 m width
Moderate energy intertidal rock	0.5 – 1km linear	0.5	0.5	assumes 10 m width
Low energy intertidal rock	0.5 – 1km linear	2.5	2.5	assumes 50 m width
Intertidal coarse sediment	0.5 – 1km diameter		2.5	Adjusted to be consistent with other linear targets
Intertidal sand	0.5 – 1km diameter		25	
Intertidal mud	0.5 – 1km diameter		25	
Intertidal mixed sediments	0.5 – 1km diameter		25	
Intertidal seagrass beds	0.5 – 1km diameter		25	
Intertidal biogenic reefs	0.5 – 1km diameter		25	
High energy shallow water rock	0.5 – 1km linear	2.5	2.5	assumes 50 m width
Moderate energy shallow water rock	0.5 – 1km linear	2.5	2.5	assumes 50 m width
Low energy shallow water rock	0.5 – 1km linear	0.5	0.5	assumes 10 m width
High energy deeper water rock	0.5 – 1km diameter		25	
Moderate energy deeper water rock	0.5 – 1km diameter		25	
Low energy deeper water rock	0.5 – 1km diameter			No area data available for this habitat
Subtidal coarse sediment	0.5 – 1km diameter		25	
Subtidal sand	0.5 – 1km diameter		25	
Subtidal mud	0.5 – 1km diameter		25	
Subtidal mixed sediments	0.5 – 1km diameter		25	
Subtidal biogenic reefs	0.5 – 1km diameter		25	
Subtidal macrophyte communities			25	Omitted from selection guidance
Blue mussel (<i>Mytilus edulis</i>) beds	0.5 – 1km diameter		2.5	Adjusted to be consistent with other linear targets
Horse mussel (<i>Modiolus modiolus</i>) beds	0.5 – 1km diameter		25	
Honeycomb worm (<i>Sabellaria alveolata</i>) reefs	0.5 – 1km linear	2.5	2.5	assumes 50 m width
Maerl beds	0.5 – 1km diameter		25	
Oyster (<i>Ostrea edulis</i>) beds	0.5 – 1km diameter		0.4	Reflects largest existing patch size
Fragile sponge & anthozoan communities on subtidal rocky habitats	0.5 – 1km linear			No area data available for this habitat
Seagrass beds	0.5 – 1km diameter		25	
Intertidal boulder communities	0.5 – 1km linear		0.2	Reflects largest existing patch size
Intertidal mudflats	0.5 – 1km diameter		25	
Sheltered muddy gravels	0.5 – 1km diameter		2.5	Adjusted to be consistent with other linear targets
Tide swept channels	0.5 – 1km diameter		25	
Mud habitats in deep water	0.5 – 1km diameter		25	
Subtidal mixed muddy sediments	0.5 – 1km diameter		25	
Subtidal rock with Ross 'coral' <i>Pentapora fascialis/foliacea</i>	0.5 – 1km diameter			No area data available for this habitat
Sediment habitats with long-lived bivalves	0.5 – 1km diameter			No area data available for this habitat
Highly productive areas			25	No size target in selection guidelines

Initially, sites were scored following the guidelines in the site selection guidance. All sites with a score of “high” were automatically included in the list of Focus sites. A “high” score was obtained where a 5 km² (or smaller) polygon (planning unit) achieved a

score of 4.5 or more for broadscale habitats and 3 or more for important habitats and productive areas, as described earlier. This generally meant that the site contained at least 5 broadscale habitats and at least 3 important/productive habitats. Marxan was then used to select additional sites in such a way that at least two sites were chosen for each habitat, the sites chosen were fairly evenly distributed spatially and preference was given to higher scoring sites.

To give preference to higher scoring sites, the Costs feature of Marxan was used. This feature allows the user to minimise socio-economic costs by entering a cost for each cell (planning unit), after which the software will find a solution that achieves the targets whilst minimising the costs. In this instance the Costs feature was used to enable the software to preferentially select those areas that scored more highly for habitat heterogeneity. This was because the process in Welsh waters specifies that a habitat heterogeneity scoring will be partly used to select the Potential Sites. It therefore ensured that Marxan produced a network of high scoring sites as opposed to a network of sites that ultimately achieved the ecological guidelines, but where individual focus sites might be very low scoring. The habitat heterogeneity scores as calculated in the first step (described in Section 4.1.1) were used to set Costs for the Marxan analysis with the following Costs assigned to each combined score:

High	1
Medium high	10
Medium	100
Medium low	1000
Low	10000
Zero	100000

Using this feature Marxan will seek to choose a network of sites that minimises cost and will therefore give preference to the higher scoring sites.

In order to achieve an even spatial distribution of sites, Welsh waters were split into different areas. This was found to be necessary, as when the analysis was run on all of Welsh waters as a single block the process tended to choose sites predominantly around the Pembrokeshire Islands, Milford Haven and the Llyn Peninsula. As the site selection guidance outlines that good geographic coverage of sites should be an aim,

the site selection process was modified to result in a better spread of sites. Welsh waters were divided into several areas and a target was set in Marxan for each of these areas. Initially the 'areas of search' used for assessments of Sites of Scientific Interest was used. These four areas are based on coastal cells, which was considered to be appropriate, as most of the sites suggested by Marxan were inshore (i.e. including both intertidal and subtidal). The JNCC Regional Seas boundaries were also considered but rejected as these are more oceanic in their definition and would therefore have been more appropriate for offshore sites.

However, running the analysis with these four areas still resulted in an uneven spread of sites, with no sites in the main part of Cardigan Bay. Therefore the central area was split just south of Tremadog Bay, so that the main part of Cardigan Bay was an area in itself (thus effectively forcing Marxan to select sites there). In addition, the Marxan results had been choosing a disproportionate number of sites in Milford Haven and to attempt to address this, Milford Haven was also defined as a separate site. The targets for each area were set after first allocating a total target area of 75 km² for the Marxan analysis (based on 15 sites each with a size of 5 km² - the overall aim being to suggest 15-25 Focus Sites with a minimum size of 5 km², as per the site selection guidelines). The values for each area were calculated on a proportional basis. For example if there had been 2 areas one of which was twice as big as the other, the target for the bigger area would be 50 km² and for the other area 25 km². Figure 5 shows the six areas used for the final analysis and Table 2 shows the minimum targets for each area.

Figure 3. Areas used in Marxan analysis.

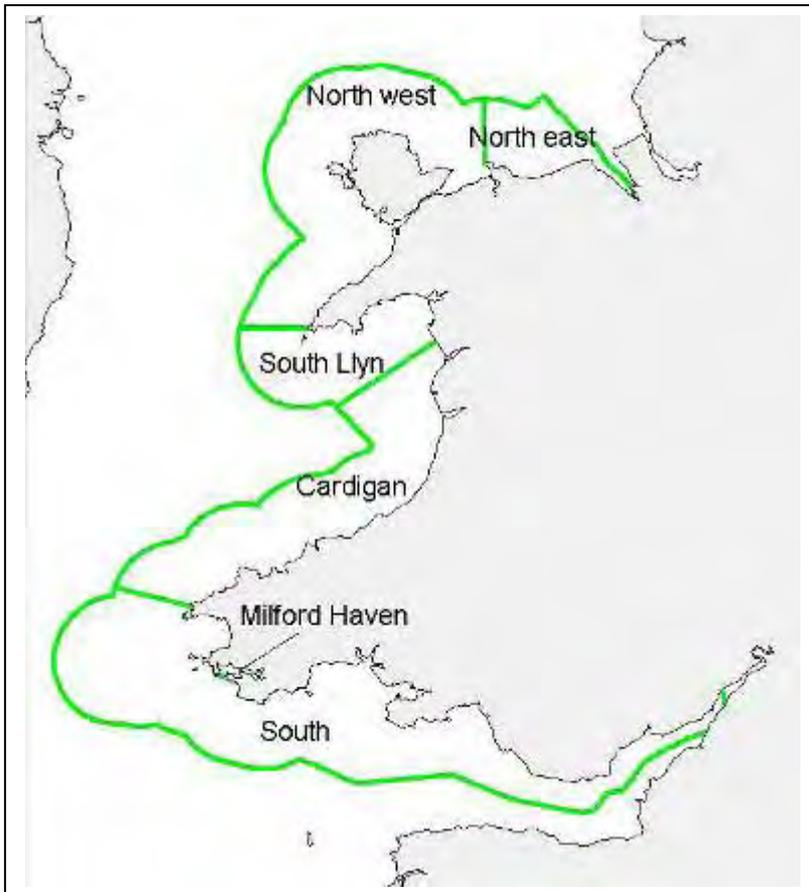


Table 2. Targets for each area.

Area	Target (ha)
North east	413
North west	1851
South Llyn	775
Cardigan	1623
Milford Haven	25
South	2814

In addition, targets were set such that two separate sites would be selected for each habitat. This was done to allow a degree of choice between sites when the TAG had to choose 6-12 Potential Sites from the 15-25 Focus Sites.

Because each analysis was run on four grids, there were four possible site network solutions to choose from. Rather than choosing a single network, sites were chosen from all four of the networks by assessing how each site contributed to the overall

result. In this process the high scoring sites were firstly assessed to see how many habitats they contributed. Additional sites were then chosen for habitats that were either not represented or only represented once. In doing this the first sites chosen were those adjacent to existing sites. Next, sites that were selected in more than one of the grids were assessed and those that contained under-represented habitats were added to the list of sites. There were a few habitats for which two examples could not be found, these were:

- LS.LMx (Littoral mixed sediments) – Only one site had sufficiently large enough areas of this habitat to meet the patch viability targets. However, another site did contain this habitat in smaller amounts.
- Maerl beds – There is only one example of this habitat in Welsh waters
- Oyster beds – CCW only have data for one area of oyster bed in Welsh waters

In addition, the second site chosen for *Modiolus* bed habitat by Marxan was considered to be too close to the first site to represent a true choice between sites. Therefore the only other accurately mapped area of *Modiolus* beds in Welsh waters was added to the list of sites. This process resulted in 24 sites being chosen. The sites chosen and the reasons for each site choice are shown in Table 3.

Table 3. Focus Sites submitted to TAG

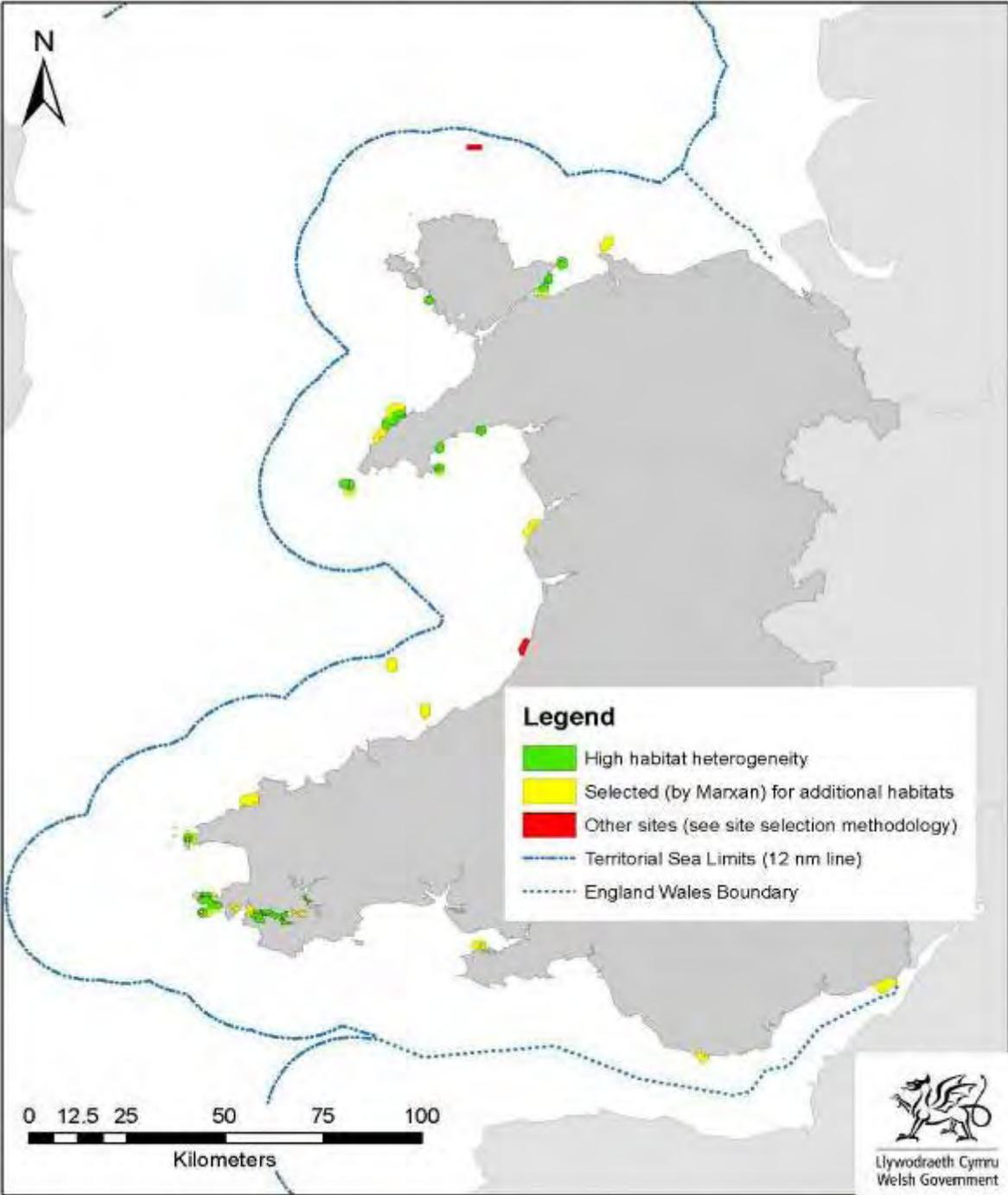
Site name	Reason for site choice
1. North Anglesey Modiolus	Site chosen by CCW as an alternative <i>Modiolus</i> bed area to North Llyn <i>Modiolus</i> (see text)
2. Great Orme	Site chosen by Marxan primarily due to being in the North East Wales region
3. Puffin Island	High habitat heterogeneity area
4. Menai Strait	High habitat heterogeneity area
5. Porth Nobla	High habitat heterogeneity area
6. North Llyn	High habitat heterogeneity area
7. Bardsey island	High habitat heterogeneity area
8. Tudwals	High habitat heterogeneity area
9. Llanbedrog	High habitat heterogeneity area
10. Traeth Afon Wen	High habitat heterogeneity area
11. South of Aberystwyth	Originally a site was chosen by Marxan near Llwyngwriil due to <i>Sabellaria alveolata</i> reef habitat, however, it was felt that the original site had modifications to the upper shore that had not been captured by the permanently modified substrata layer. CCW staff therefore proposed a site South of Aberystwyth with the same habitats.
12. Cardigan offshore	Site chosen by Marxan which added the following missing habitat to the Focus Site list:: Sediment habitats with long-lived bivalves
13. New Quay offshore	Site chosen by Marxan which added the following missing habitats to the Focus Site list:: Mud habitats in deep water, Sediment habitats with long-lived bivalves
14. SW of Strumble Head	Site chosen by Marxan in all four grids primarily due to being in the Cardigan region.
15. Ramsey island	High habitat heterogeneity area
16. Skomer island	High habitat heterogeneity area
17. Skokholm island	High habitat heterogeneity area
18. Beggars Reach	High habitat heterogeneity area
19. Pembroke	Site chosen by Marxan which added the following missing habitat to the Focus Site list:: oyster beds
20. Milford Haven central	High habitat heterogeneity area

21. Dale	Site chosen by Marxan which added the following missing habitats to the Focus Site list:: intertidal mixed sediment, Subtidal mud
22. Whitford Point	Site chosen by Marxan which added the following missing habitats to the Focus Site list:: Intertidal biogenic reefs, blue mussel beds
23. Aberthaw	Site chosen by Marxan which added the following missing habitat to the Focus Site list:: <i>Sabellaria alveolata</i> reefs
24. Severn	Site chosen by Marxan which added the following missing habitat to the Focus Site list:: seagrass beds

Figure 4 shows the locations of each of these sites.

Figure 4. Areas with high habitat heterogeneity and areas chosen by Marxan

Sites initially selected using a hexagonal grid



© British Crown and SeaZone Solutions Limited. All rights reserved. Products Licence No. 032009.011 (April 2011)
© Crown Copyright and database right (2012). All rights reserved. Welsh Government. Licence number 100017916

A5.3 Setting boundaries for Focus Sites

The outputs from the site selection process set out above were hexagonal shaped, or groups of hexagons, but a simpler shape is generally preferred. Therefore, following selection of sites using a combination of identification of the most heterogeneous sites (highest scoring) and using Marxan, revised site boundaries were proposed. The boundaries at sea were often drawn along straight North-South and East-West lines for simplicity the exception to this is where boundaries were drawn in straight lines in other directions as this better incorporated the relevant habitats. For some sites, additional areas were included where it was thought that this would improve ecological integrity (for example, to include whole habitat patches, or the entirety of a physical feature such as a sound or reef). Other sites were altered slightly to create a less complex boundary in areas where permanently modified areas had been excluded. One site (Traeth Afon Wen) was altered due to the presence of a permanently modified area that had not been sufficiently represented on the permanently modified areas mapping layer. The Skomer Focus Site boundary was altered to follow the Marine Nature Reserve boundary for a large part of the site. Figure 5 shows the original hexagons and the boundaries drawn around each site. These boundaries were intended as provisional and they were further revised later in the process for the Potential Sites.

Figure 5 A & B. Focus Site boundaries and original hexagons selected. Scale varies between maps.

Copyright Statement: Derived, in part, from Crown Copyright Material with the permission of the UK Hydrographic Office and the Controller of Her Majesty's Stationery Office (www.ukho.gov.uk). All rights reserved.

WARNING: The UK Hydrographic Office has not verified the information within this product and does not accept liability for the accuracy of reproduction of any modifications made thereafter. NOT TO BE USED FOR NAVIGATION

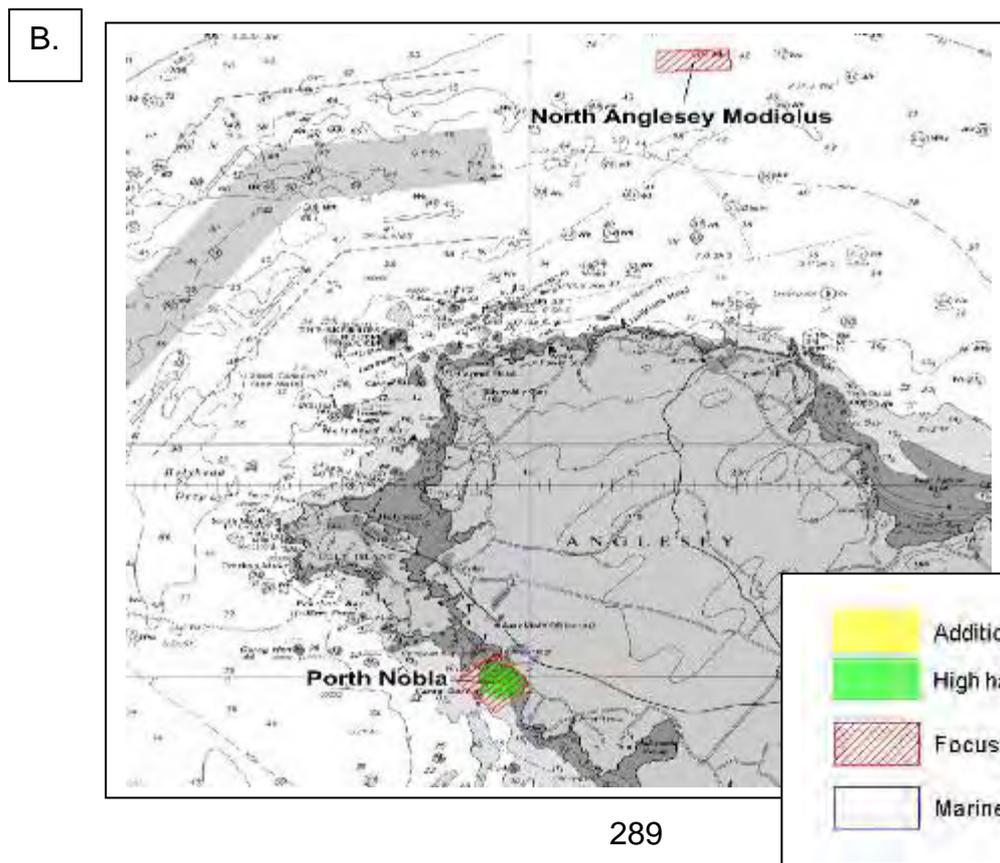
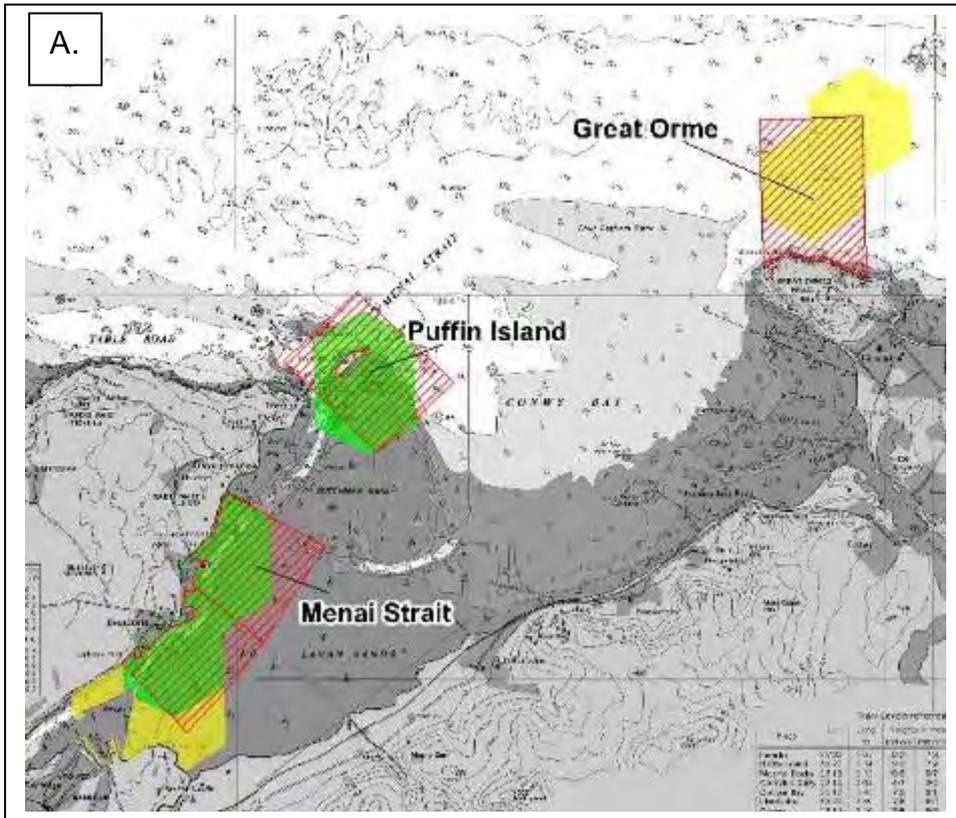


Figure 5 C & D. Focus Site boundaries and original hexagons selected. Scale varies between maps.

Copyright Statement: Derived, in part, from Crown Copyright Material with the permission of the UK Hydrographic Office and the Controller of Her Majesty's Stationery Office (www.ukho.gov.uk). All rights reserved.

WARNING: The UK Hydrographic Office has not verified the information within this product and does not accept liability for the accuracy of reproduction of any modifications made thereafter. NOT TO BE USED FOR NAVIGATION

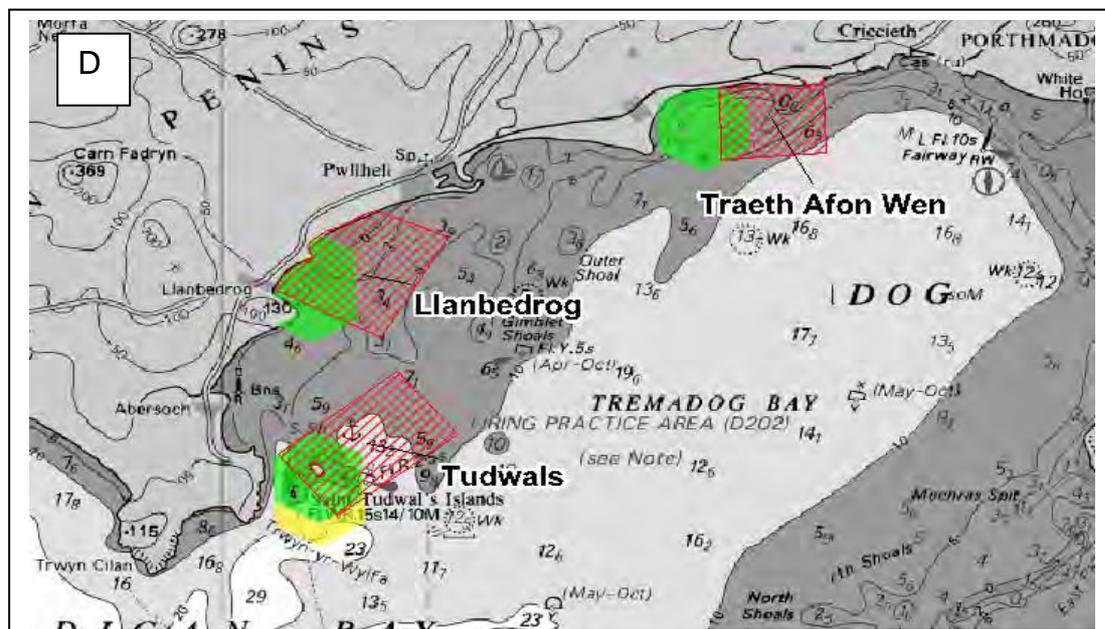
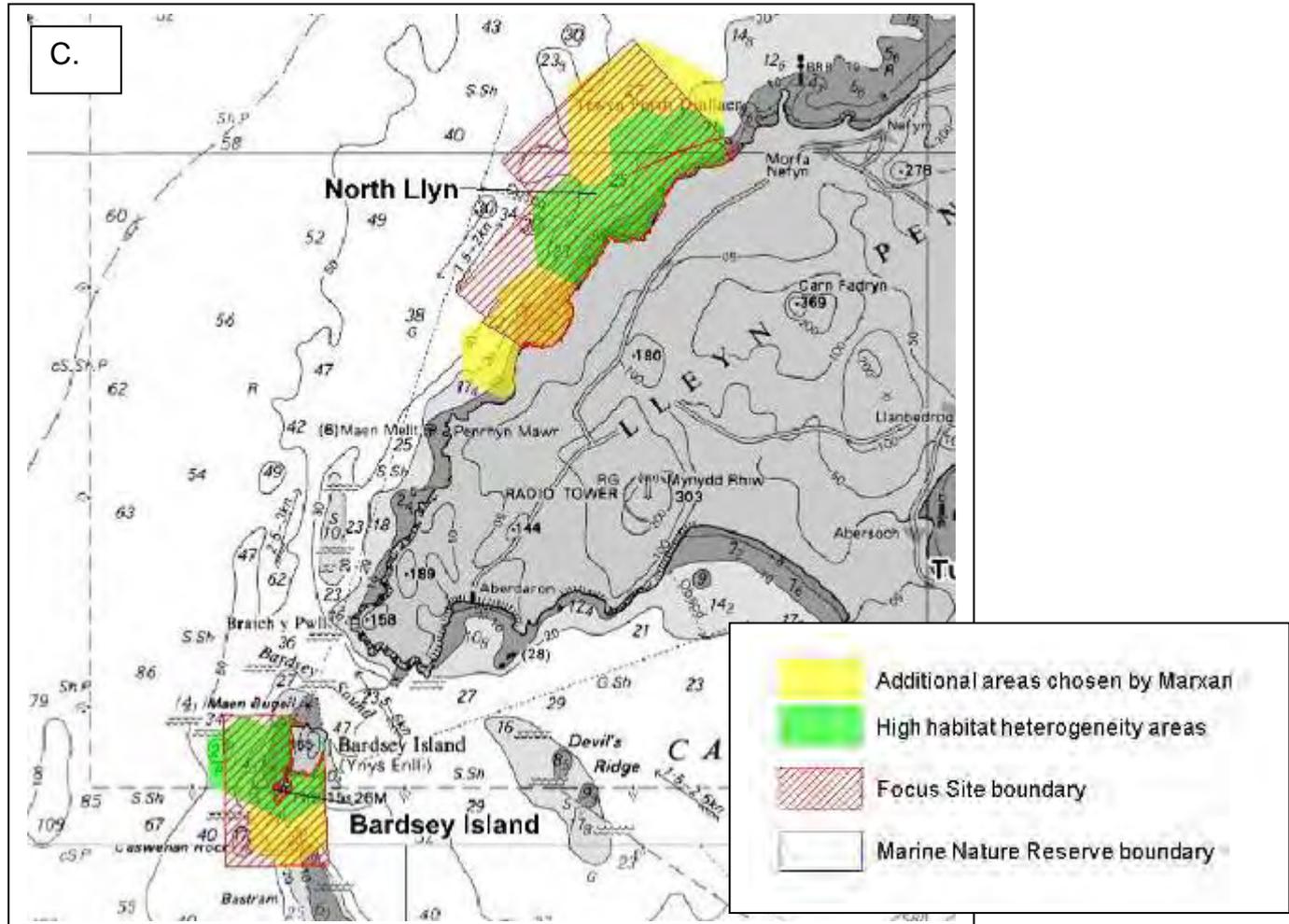


Figure 5 E & F. Focus Site boundaries and original hexagons selected. Scale varies between maps.

Copyright Statement: Derived, in part, from Crown Copyright Material with the permission of the UK Hydrographic Office and the Controller of Her Majesty's Stationery Office (www.ukho.gov.uk). All rights reserved.

WARNING: The UK Hydrographic Office has not verified the information within this product and does not accept liability for the accuracy of reproduction of any modifications made thereafter. NOT TO BE USED FOR NAVIGATION

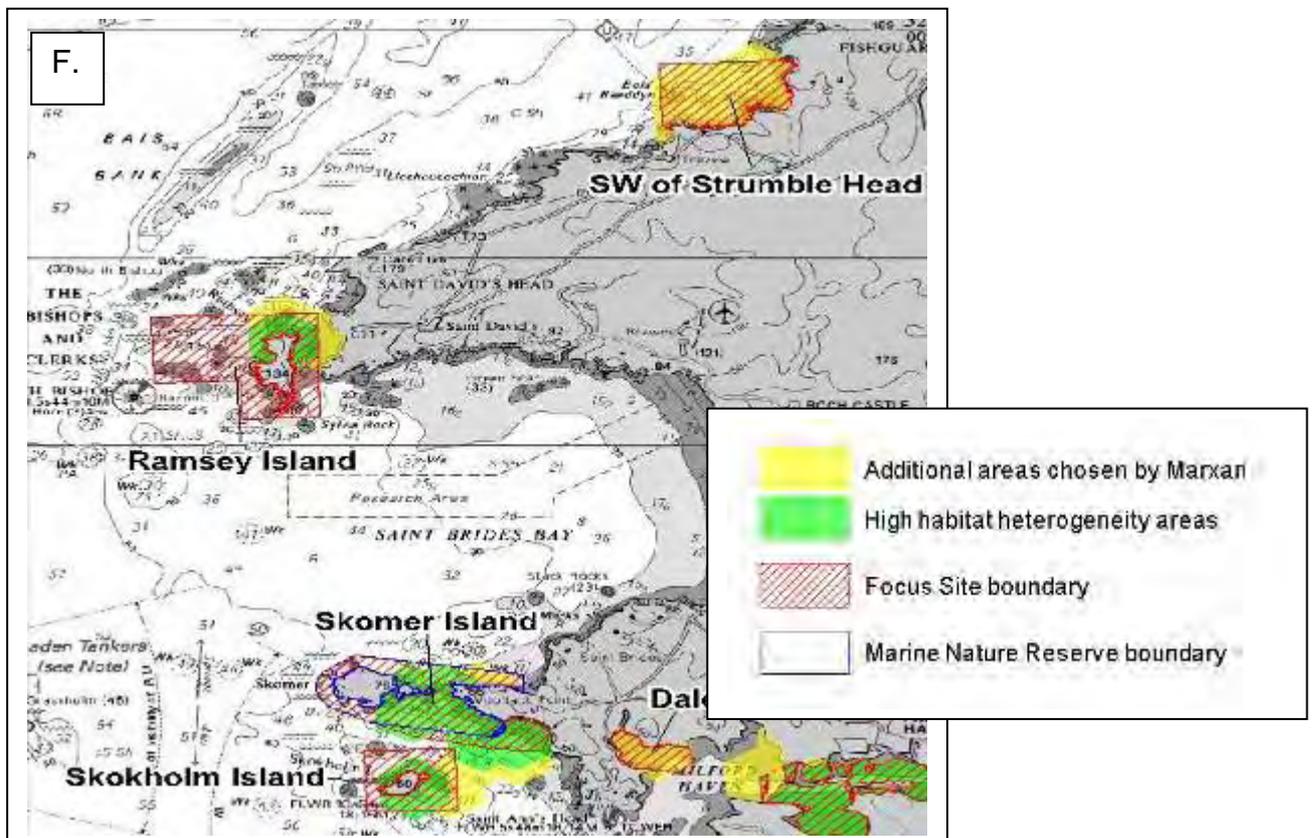
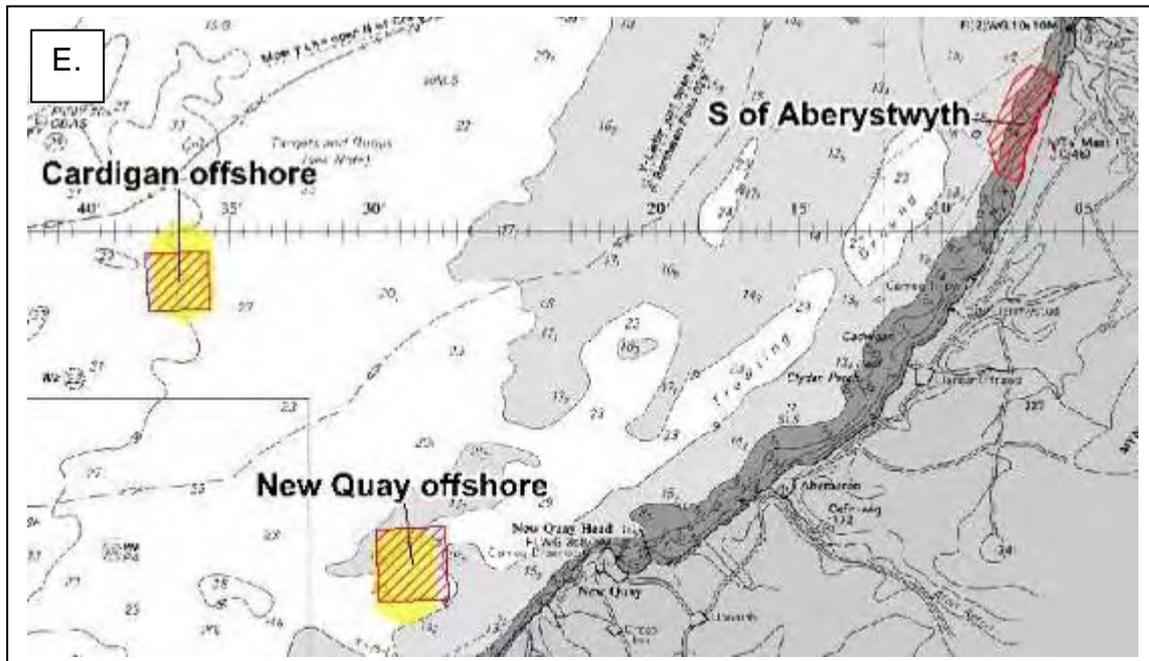
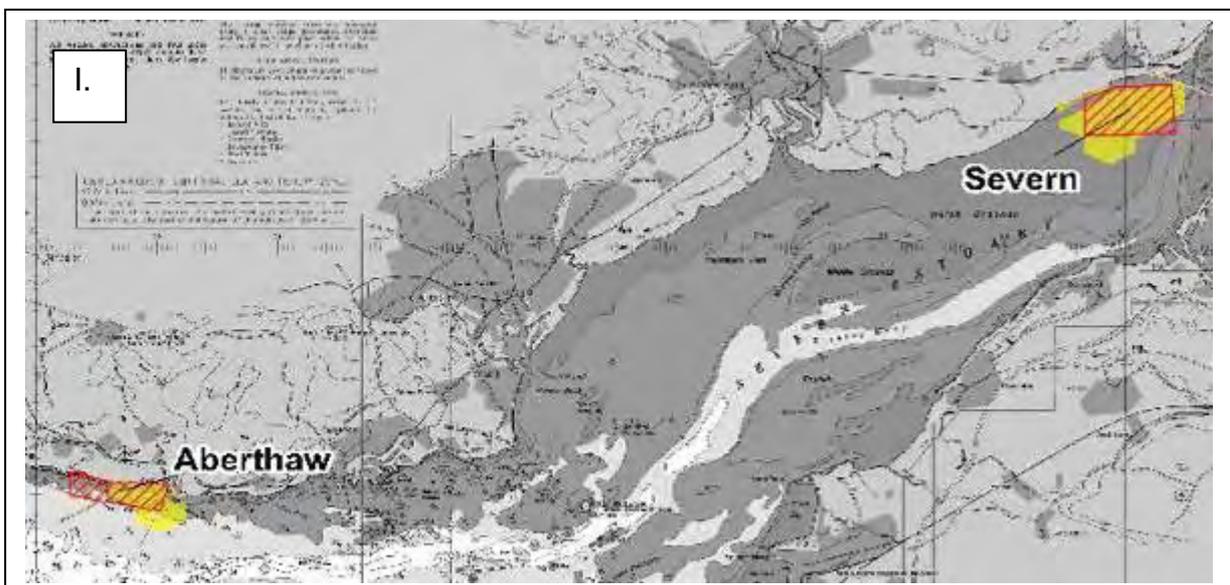
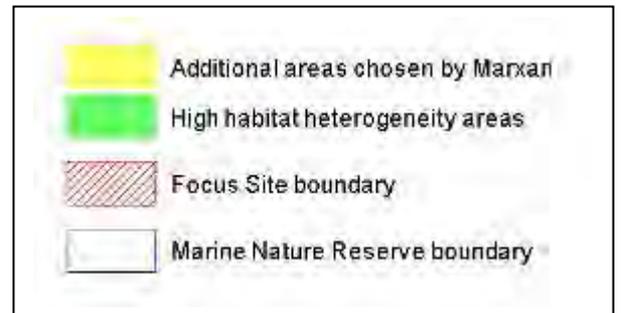
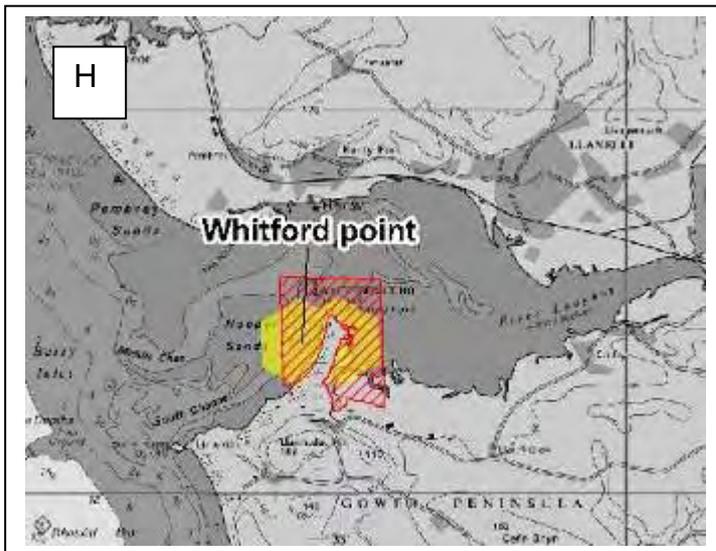
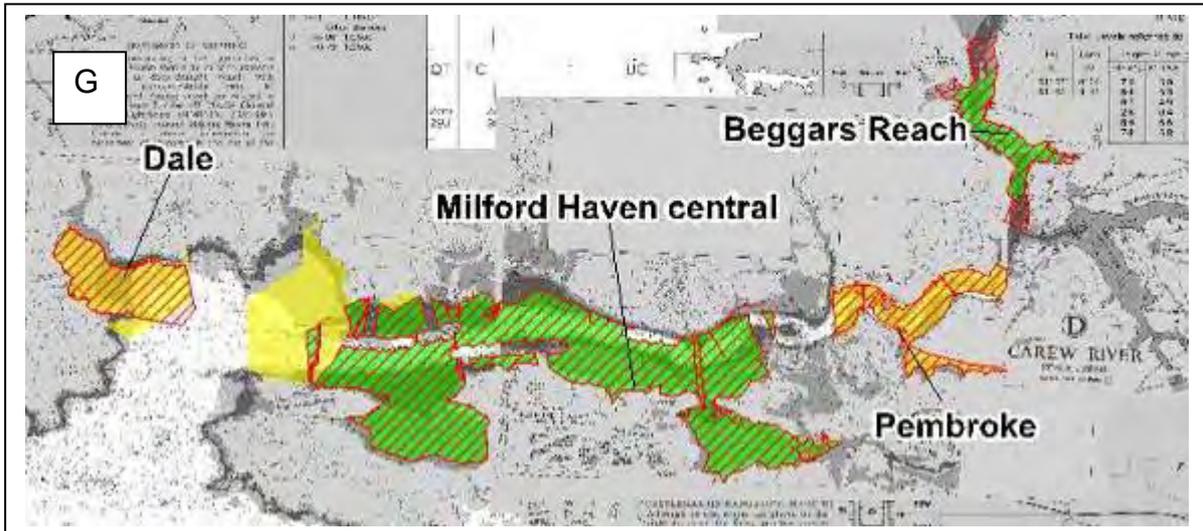


Figure 5 G, H & I. Focus Site boundaries and original hexagons selected. Scale varies between maps.

Copyright Statement: Derived, in part, from Crown Copyright Material with the permission of the UK Hydrographic Office and the Controller of Her Majesty's Stationery Office (www.ukho.gov.uk). All rights reserved.

WARNING: The UK Hydrographic Office has not verified the information within this product and does not accept liability for the accuracy of reproduction of any modifications made thereafter. NOT TO BE USED FOR NAVIGATION



A5.4 Scoring and reports for Focus Sites

In order to compare sites the TAG needed to compare habitat heterogeneity scores. The scores as described earlier were created to compare all the hexagons in Welsh waters with each other. From the Focus Sites that were selected, the majority (14) had scores of 'High'. In order to enable the TAG to distinguish between these higher scoring sites a revised scoring system was devised, using a similar process as described earlier. Therefore sites were once again allocated scores for broadscale habitats and important habitats on a percentile basis (but this time using only the 24 selected Focus Sites to calculate the scores). This resulted in the following system for scoring habitat heterogeneity for the Focus Sites.

Table 4. Combining broadscale habitat score and important habitat scores to produce an overall score for the Focus Sites

		Important habitats and high productivity areas score		
		High (>=4)	Medium (3)	Low (1-2)
Broadscale Habitats score	High (>=6)	High	Medium	Medium
	Medium (4.5-5.5)	Medium	Medium	Low
	Low (0-4)	Medium	Low	Low

Table 5 shows the habitats for which each site has been selected, along with the habitat heterogeneity score

Table 5. Focus Sites and habitats within each site (only habitats with an area reaching the viable habitat patch size have been included)

	Site Number (see key below for site names)																							
Habitat	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
LR.LLR			X	X	X		X		X	X	X						X	X	X	X		X	X	
LR.MLR			X	X	X	X	X	X			X			X	X	X	X		X	X	X	X		X
LR.HLR			X	X	X	X	X	X	X	X	X			X	X	X	X	X	X		X	X		X
LS.LBR				X							X										X			
LS.LSa				X	X				X						X		X				X		X	
LS.LCS				X					X	X	X				X		X		X			X		X
LS.LMu																	X	X		X			X	
LS.LMx																			X					
LS.LMp																	X						X	
IR.LIR						X		X																
IR.MIR			X		X	X	X	X		X				X	X	X		X		X				X
IR.HIR						X	X	X						X	X	X								X
CR.MCR						X		X												X				X
CR.HCR							X	X						X	X	X								X
SS.SSa	X		X	X		X	X			X			X		X	X	X				X			
SS.SCS						X							X		X									
SS.SMx	X					X	X	X	X	X		X	X		X		X	X	X					
SS.SMu											X		X				X		X					
SS.SMp							X	X	X								X		X					

SS.SBR		X				X																		
Blue mussel								X								X				X				
Fragile sponge					X	X	X							X	X	X								X
Tideswept			X	X										X	X		X	X	X					
Horse mussel		X				X																		
Maerl																	X							
Sabellaria											X											X		
Seagrass																	X						X	
Oyster																				X				
Boulder			X		X					X	X						X					X		
Mudflats				X													X	X		X	X		X	
Mud deep													X		X									
Muddy gravel				X					X								X	X	X	X				
Mixed muddy	X					X	X	X	X	X		X					X		X					
Pentapora						X		X						X	X	X								X
Bivalves							X					X	X											
Productive area	X		X	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X		X	X	X
Score	L	L	M	M	M	H	H	M	M	M	L	L	L	H	H	M	H	M	M	H	M	L	L	M

Key

Site numbers:

1	Great Orme
2	North Anglesey
3	Puffin
4	Menai
5	Porth Nobla
6	North Llyn
7	Bardsey
8	Tudwals
9	Llanbedrog
10	Traeth Afon Wen
11	S Aberystwyth
12	Cardigan
13	New Quay
14	Ramsey
15	Skomer
16	Skokholm
17	Milford Haven Central
18	Beggars Reach
19	Dale
20	Pembroke
21	Whitford Point
22	Aberthaw
23	Severn
24	SW Strumble Head

Score:

L	Low
M	Medium
H	High

Habitat names:

LR.LLR	Low energy intertidal rock
LR.MLR	Moderate energy intertidal rock
LR.HLR	High energy intertidal rock
LS.LBR	Intertidal biogenic reefs
LS.LSa	Intertidal sand
LS.LCS	Intertidal coarse sediment
LS.LMu	Intertidal mud
LS.LMx	Intertidal mixed sediments
LS.LMp	Intertidal seagrass beds
IR.LIR	Low energy shallow water rock
IR.MIR	Moderate energy shallow water rock
IR.HIR	High energy shallow water rock
CR.MCR	Moderate energy deeper water rock
CR.HCR	High energy deeper water rock
SS.SSa	Subtidal sand
SS.SCS	Subtidal coarse sediment
SS.SMx	Subtidal mixed sediments
SS.SMu	Subtidal mud
SS.SMp	Subtidal seaweed dominated sediments
SS.SBR	Subtidal biogenic reefs
Blue mussel	Blue mussel (<i>Mytilus edulis</i>) beds
Fragile sponge	Fragile sponge and anthozoan communities on subtidal rocky habitats
Tideswept	Tideswept channels
Horse mussel	Horse mussel (<i>Modiolus modiolus</i>) beds
Maerl	Maerl beds
Sabellaria	Honeycomb worm (<i>Sabellaria alveolata</i>) reefs
Seagrass	Seagrass beds
Oyster	Oyster (<i>Ostrea edulis</i>) beds
Boulder	Intertidal boulder communities
Mudflats	Intertidal mudflats
Mud deep	Mud habitats in deep water
Muddy gravel	Sheltered muddy gravels
Mixed muddy	Subtidal mixed muddy sediments
Pentapora	Subtidal rock with Ross 'coral' <i>Pentapora fascialis/foliacea</i>
Bivalves	Sediment habitats with long-lived bivalves
Productive area	Area with high levels of productivity

THE DATA SOURCES

The ecological selection process outlines that the 15-25 Focus Sites should be selected based on the following factors:

- Presence of 21 broadscale habitats (Table 1)
- Presence of 15 important habitats (Table 2)
- Presence of areas of high productivity
- Permanently modified areas will be avoided
- Geographical spread of sites (spatial coverage)
- Ecological viability
- Site size

Additional factors that can be considered only during the second stage of site selection (the selection of 6-12 Potential Sites) are:

- Presence of non-mobile species of conservation concern (Table 3)
- Presence of habitats important for mobile species
- Connectivity between sites within the entire MPA network

Therefore the datalayers that were required for selecting Focus Sites are as follows:

- Broadscale habitats
- Other important habitats
- Areas with high levels of productivity
- Permanently modified areas

The following additional datalayers may also have been required for selecting Potential Sites:

- Habitats important for mobile species
- Species of conservation concern (non mobile)

Table 1. List of broadscale habitats

Broad scale habitats
High energy intertidal rock
Moderate energy intertidal rock

Low energy intertidal rock
 Intertidal coarse sediment
 Intertidal sand
 Intertidal mud
 Intertidal mixed sediments
 Intertidal seagrass beds
 Intertidal biogenic reefs
 High energy shallow water rock
 Moderate energy shallow water rock
 Low energy shallow water rock
 High energy deeper water rock
 Moderate energy deeper water rock
 Low energy deeper water rock
 Subtidal coarse sediment
 Subtidal sand
 Subtidal mud
 Subtidal mixed sediments
 Subtidal biogenic reefs
 Subtidal seaweed dominated communities on sediment

These broadscale habitats have been derived from the EUNIS and JNCC biotope¹ classifications. For further details see section A2.2 of the Site Selection Guidelines.

Table 2. List of important habitats

Other important habitats
Blue mussel (<i>Mytilus edulis</i>) beds
Horse mussel (<i>Modiolus modiolus</i>) beds
Honeycomb worm (<i>Sabellaria alveolata</i>) reefs
Maerl beds
Oyster (<i>Ostrea edulis</i>) beds
Fragile sponge & anthozoan communities on subtidal rocky habitats
Seagrass beds
Intertidal boulder communities
Intertidal mudflats
Sheltered muddy gravels

¹ Biotopes are a classification of benthic marine habitats in terms of seashore and seabed habitats and their associated communities of species. More information is available from: <http://jncc.defra.gov.uk/default.aspx?page=3073>

Tide swept channels
Mud habitats in deep water
Subtidal mixed muddy sediments
Subtidal rock with Ross 'coral' *Pentapora fascialis/foliacea*
Sediment habitats with long-lived bivalves

Table 3. List of (non-mobile) species of conservation concern

Species	Common name
Invertebrates	
<i>Arctica islandica</i>	Icelandic Cyprine or Ocean Quahog
<i>Atrina fragilis</i>	Fan Mussel
<i>Edwardsia timida</i>	Burrowing Anemone
<i>Eunicella verrucosa</i>	Pink Sea –fan
<i>Halicystus auricula</i>	A Stalked Jellyfish
<i>Lucernariopsis campanulata</i>	A Stalked Jellyfish
<i>Ostrea edulis</i>	Native Oyster
<i>Callista chione</i>	Smooth venus clam
Marine Algae and plants	
<i>Anotrichium barbatum</i>	Bearded Red Seaweed
<i>Cruoria cruoriaeformis</i>	Burgundy maerl paint weed
<i>Grateloupia montagnei</i>	Grateloup's little-lobed weed
<i>Lithothamnion corallioides</i>	Coral Maerl
<i>Padina pavonica</i>	Peacock's Tail
<i>Phymatolithon calcareum</i>	Common Maerl

For more information about the lists of important habitats and species of conservation concern see sections A2.6 and A2.10 of the Site Selection Guidelines (WAG, 2011).

Data collation and interpretation

The following sections describe the data used, its interpretation and rationale for use. Further information about some of the source datasets is in Appendices 1-7.

A6.1 BROADSCALE HABITATS

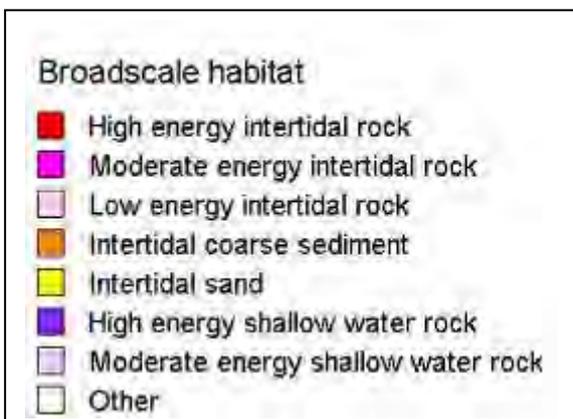
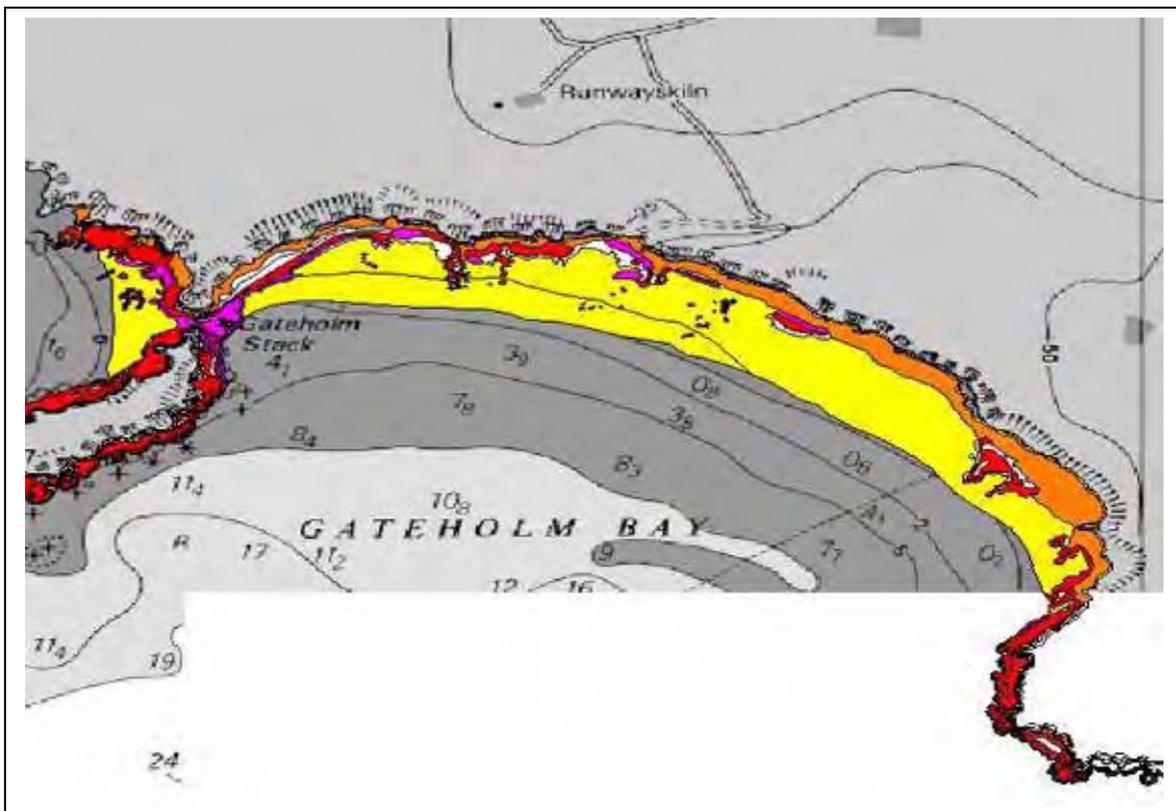
Data used

Intertidal

CCW carried out a 10 year survey of the Welsh coastline, resulting in biotope maps that cover the entire intertidal zone in Wales (Brazier et al. 2007 and Appendix 1). The survey used aerial photography and extensive survey work to assess and map the biotopes present in the intertidal zone (example at Figure 1). The biotopes recorded can be directly correlated with the listed broadscale habitats.

Figure 1. Example map Intertidal Phase 1 survey showing broadscale habitats.

Copyright: Derived, in part, from Crown Copyright Material with the permission of the UK Hydrographic Office and the Controller of Her Majesty's Stationery Office (www.ukho.gov.uk). All rights reserved. WARNING: The UK Hydrographic Office has not verified the information within this product and does not accept liability for the accuracy of reproduction of any modifications made thereafter. NOT TO BE USED FOR NAVIGATION



Subtidal

Subtidal

The dataset used for the subtidal broadscale habitats was a combination of data from the Marine Recorder database and the HABMAP habitat mapping project.

The Marine Recorder database (Appendix 2) holds data from a wide range of sources, including surveys carried out by the Joint Nature Conservation Committee (JNCC) Marine Nature Conservation Review team¹, CCW surveys, National Museum of Wales surveys², joint CCW and Environment Agency surveys, Seasearch³ data and data collated from Universities⁴ and occasionally impact assessments (see Appendix 3 for a full list of surveys used). Additional records provided by Cefas were also added to this dataset. This data is generally 'point' data, that is, it is linked to a single geographical location and does not provide any indication of the extent of each habitat (Figures 2 & 3). Biotopes have been assigned to many of these data points, either by JNCC or by expert surveyors. These biotopes correlate exactly with the broadscale habitats. Further details regarding the biotope classification and assigning biotopes are given in Appendix 2.

The second dataset was the HABMAP dataset (Robinson et al. 2009 and Appendix 4). HABMAP (Habitat Mapping for Conservation and Management of the southern Irish sea) is a predictive modelling project that uses the relationship between physical information (e.g. sediment type, water depth, tidal flow, wave exposure, salinity, water turbidity) and biological data (i.e. biotope) to predict the biotope in areas for which there is no biological survey information. Each polygon (or cell) in the HABMAP dataset is created by combining the physical datalayers and identifying those areas that have the same physical conditions (illustrated in Figure 4). The advantage of the HABMAP dataset is that it provides continuously mapped polygon data and can therefore be used to estimate the extent of a patch of a broadscale habitat. The disadvantage is that, as with any modelled data, it will not always be correct.

¹ The MNCR was carried out between 1987 and 1998 to provide a comprehensive baseline of information on marine habitats and species throughout Great Britain. For more information see <http://jncc.defra.gov.uk/page-1596>

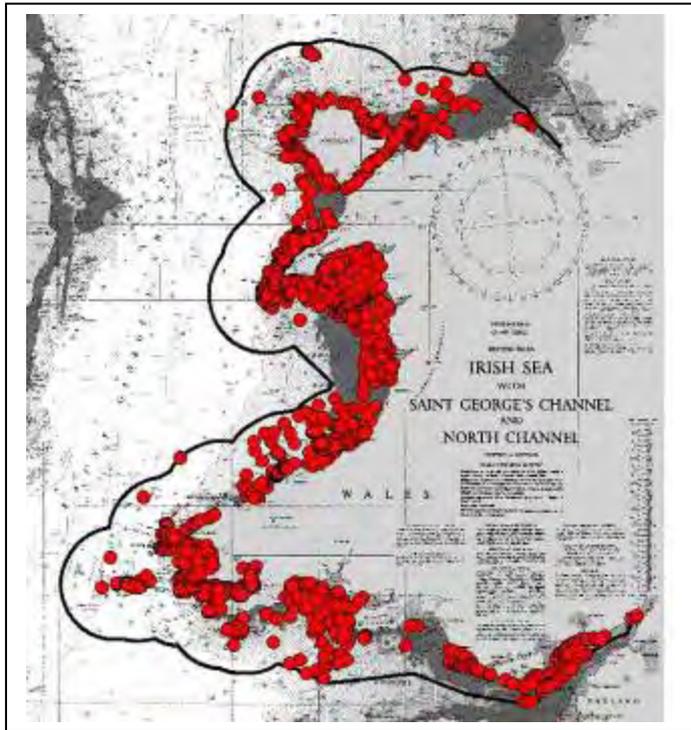
² See <http://www.museumwales.ac.uk/en/biosyb/marine/> for more details.

³ Seasearch is a project for volunteer divers to provide information about seabed habitats and species. Seasearch is co-ordinated by the Marine Conservation Society. For more details see <http://www.seasearch.org.uk>

⁴ Generally surveys of specific areas carried out by either Bangor University or Cardiff University.

Figure 2. Marine Recorder database – biotope records in Welsh waters to 12nm.

Copyright: Derived, in part, from Crown Copyright Material with the permission of the UK Hydrographic Office and the Controller of Her Majesty's Stationery Office (www.ukho.gov.uk). All rights reserved. WARNING: The UK Hydrographic Office has not verified the information within this product and does not accept liability for the accuracy of reproduction of any modifications made thereafter. NOT TO BE USED FOR NAVIGATION



Note that the symbol size on this map is potentially misleading, as in reality some of the survey points may relate to a very small area, e.g. a single grab sample of 0.1 m². Therefore an impression is given of a more extensive survey coverage than is actually the case.

Figure 3. Marine Recorder database, example of biotope information.

Copyright: Derived, in part, from Crown Copyright Material with the permission of the UK Hydrographic Office and the Controller of Her Majesty's Stationery Office (www.ukho.gov.uk). All rights reserved. WARNING: The UK Hydrographic Office has not verified the information within this product and does not accept liability for the accuracy of reproduction of any modifications made thereafter. NOT TO BE USED FOR NAVIGATION

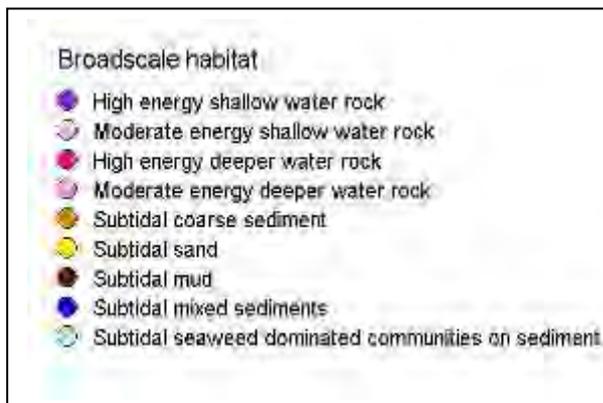
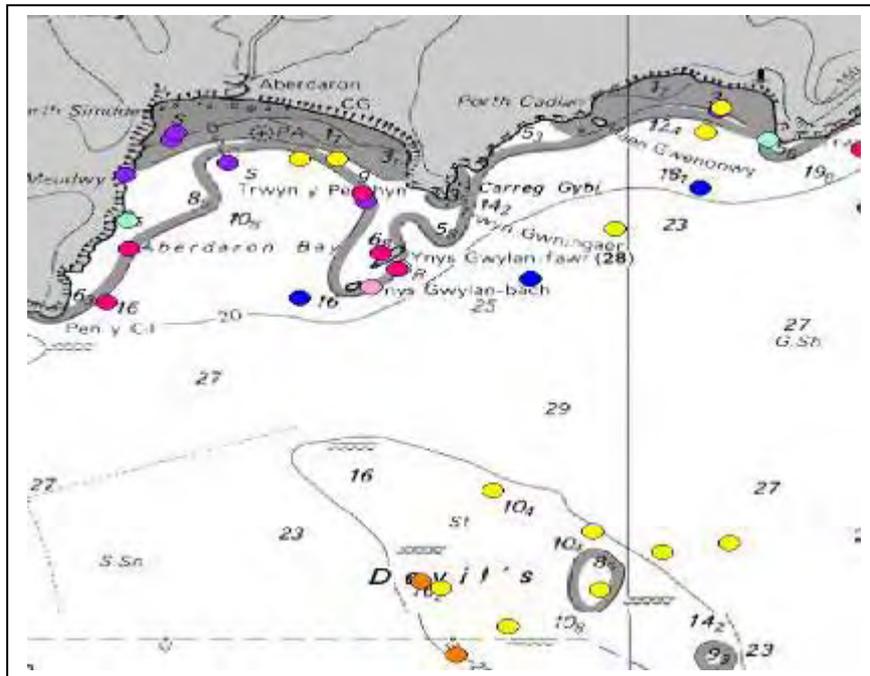
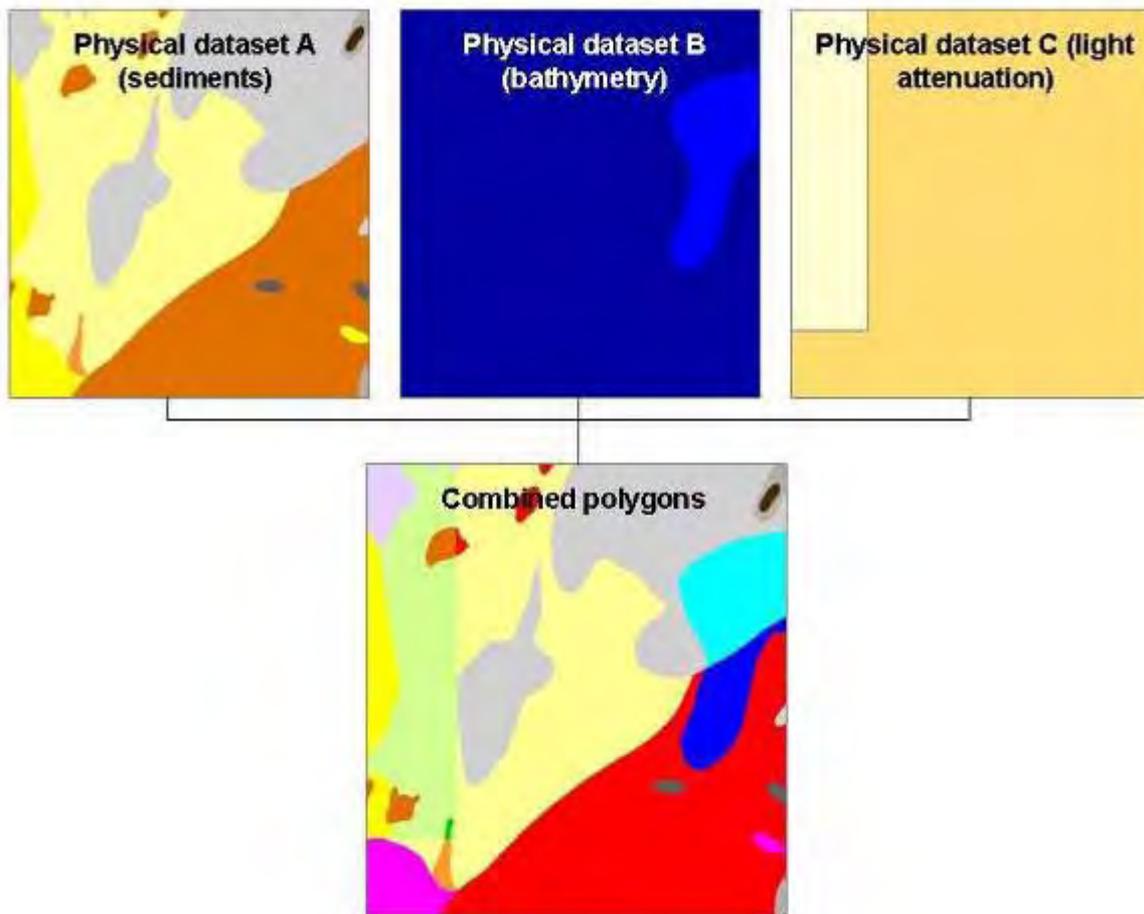


Figure 4. Illustration of the way in which polygons were created by the HABMAP project by combining physical datasets.

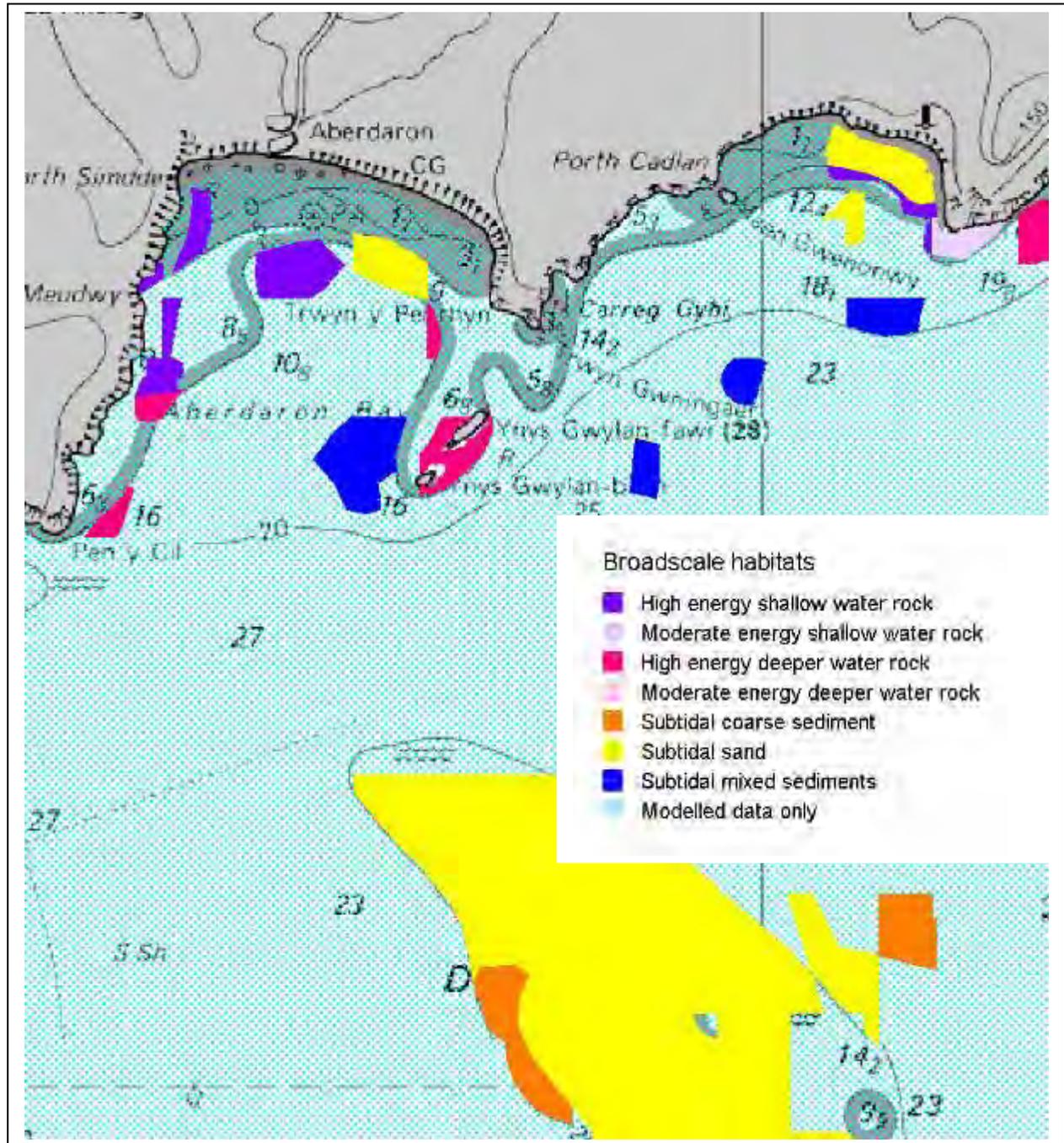


For the MCZ project the Marine Recorder point data was combined with the HABMAP spatial (polygon) data and only those polygons (or cells) that actually contained biotope point data were used for the site selection process (as illustrated in Figure 5). Where more than one habitat had been recorded in a polygon (e.g. where the seabed was a complex mosaic of small habitat patches), the habitat that best fitted the physical characteristics of the polygon was used for calculations of area. The extent of each habitat polygon in the subtidal is determined by physical datalayers (which themselves vary in accuracy) and should be considered an estimate, rather than a precise measurement (in contrast to the intertidal data where the extent values for each polygon will be much more accurate).

Figure 5. HABMAP data, example of a broadscale habitat map.

Modelled data was not used in the site selection process and therefore has been represented as a single colour (pale blue). This map has been derived from physical data (as described in the text) and also the biotope data shown in Figure 3.

Copyright: Derived, in part, from Crown Copyright Material with the permission of the UK Hydrographic Office and the Controller of Her Majesty's Stationery Office (www.ukho.gov.uk). All rights reserved. WARNING: The UK Hydrographic Office has not verified the information within this product and does not accept liability for the accuracy of reproduction of any modifications made thereafter. NOT TO BE USED FOR NAVIGATION



Interpretation of data

Intertidal

The Phase 1 intertidal survey maps originally used the 1997 biotope classification. This was later converted to 2004 and EUNIS codes by the MESH project in conjunction with intertidal experts in CCW. The confidence in this data is good, although it is possible that there have been temporal changes in biotopes in some areas since the survey was carried out.

Subtidal

Sites were selected based on HABMAP data but only using those polygons for which there is actual survey data (i.e. the modelled predictions were not used for site selection). This provides an indication as to whether the habitat is present in a viable patch size. The results of HABMAP modelled predictions have been included in the MCZ web application to provide additional information but have been clearly marked as modelled outputs. It is important to note that the polygons created by the HABMAP process are based on a collation of physical datasets of varying quality (but in each case the best available data at the time) and therefore do not have the accuracy of the intertidal broadscale habitat polygons.

Rationale for choice of data source and other possible data sources

Intertidal

The Phase 1 intertidal dataset is the most detailed and accurate dataset for the intertidal zone in Wales. The only way to improve on it would be to carry out repeat surveys in areas likely to have changed and the resources have not been available to do this.

Subtidal

As there were no resources available for survey work, it was decided to select sites only on the basis of actual biological survey data. This will have the disadvantage that site selection will be biased towards inshore areas, where the density of data is greatest (Figure 2). However, the alternative to this would be using modelled data, which might not be correct. Modelled data could be more acceptable if resources were available to ground truth (surveys) the areas selected.

Other possible data sources include the UKSeaMap data (Connor et al. 2006). This mapping project was carried out by JNCC. The principles are similar to those of HABMAP, although the maps do not incorporate biological data. The maps were created by combining physical information to predict biotopes, but unlike HABMAP they do not give any indication of where a biotope might actually have been recorded, as all

polygons have been predicted by modelling. In addition, the modelling was done on a grid square basis, whereas HABMAP uses unequal size polygons which are created by the shapes of the underlying physical datasets.

A6.2 IMPORTANT HABITATS

Data used

CCW have, over several years, developed maps for most of the habitats on the important habitats list. For most habitats the maps were originally produced for the Wales Marine BAP Atlas and drew on a variety of sources, including data in the Marine Recorder database (Appendix 2) and data gathered from experts. Data were subsequently incorporated from more recent records in the Marine Recorder database and data from the Defra-funded biophysical datalayers project (Appendix 5). A full list of the surveys and data sources used for these data layers is given in Appendix 7. The data tend to be a mixture of point data (e.g. records from a dive survey with a single position) and polygon data (e.g. mapped data from interpretation of multibeam or sidescan survey in the case of *Modiolus* beds, or mapped data resulting from extensive diver surveys for the extent of seagrass beds). The definitions of each habitat to be used in creating maps were those used in the UK Biodiversity Action Plans, the Section 42 list or the OSPAR habitat list¹ (for more detailed descriptions of each habitat see Appendix 6). Maps were also developed for the two habitats that are not included on any of these lists ('*Subtidal rock with Ross 'coral' Pentapora (foliacea) fascialis*' and '*Sediment habitats with long-lived bivalves*'), following consultation by email with the TAG. Some important habitats are defined more by physical characteristics (e.g. *Mud Habitats in Deep Water* and *Tideswept Channels*) and in these instances other data sources were used, such as the British Geological Survey seabed sediment maps combined with bathymetry information, or Admiralty Charts.

Interpretation of data

The datasets held by CCW include data that are a poor fit for the habitat description (e.g. data where species indicative of a habitat have been recorded but there is no

¹ UK Biodiversity Action Plan. More information available from:

<http://www.ukbap.org.uk/newprioritylist.aspx>

Section 42 of the NERC Act (2006) Biodiversity Duty . More information available from:

http://www.biodiversitywales.org.uk/bap_in_wales-27.aspx#S42Targ

OSPAR list of Threatened and/or Declining Habitats. More information available from:

http://www.ospar.org/documents/DBASE/DECRECS/Agreements/08-06e_OSPAR%20List%20species%20and%20habitats.doc

definitive record of the habitat itself) and historical data. For selection of MCZs, only data collected since 1970 was used. This means that only records from the last 40 years (and after the cold winter of 1963) were included, as at some sites habitats that were once recorded may no longer be present. Data that did not fit the habitat definition very well were also removed from the dataset. This included data where the presence of only a few species had been used as an indicator of the habitat (e.g. for the fragile sponge and anthozoan communities on subtidal rock habitat) and data where it was suspected that records related to juvenile individuals rather than adults (e.g. horse mussel *Modiolus modiolus* bed habitat).

Rationale for choice of data source and other possible data sources

These datasets are the most accurate available for these habitats. Other known sources of data have been incorporated where appropriate into these layers (e.g. Defra biophysical datalayers project (Appendix 5), Marine Recorder data (Appendix 2)).

A6.3 AREAS OF HIGH PRODUCTIVITY

Data used

Three data layers were developed to indicate areas of high productivity. These indicate areas with persistent fronts, areas with communities indicative of high benthic primary productivity and areas with high concentrations of Chlorophyll *a* in the water column.

The source data for determining areas of persistent fronts was produced as part of the Defra biophysical datalayers project (Task 2F - Appendix 5) that used oceanic thermal fronts from earth observation data as a proxy for pelagic productivity (Miller et al. 2010).

Areas with communities indicative of high benthic primary productivity include areas with furoid dominated communities, kelp dominated communities and seagrass beds. The data sources for these maps are the same as those used for the broadscale and important habitats.

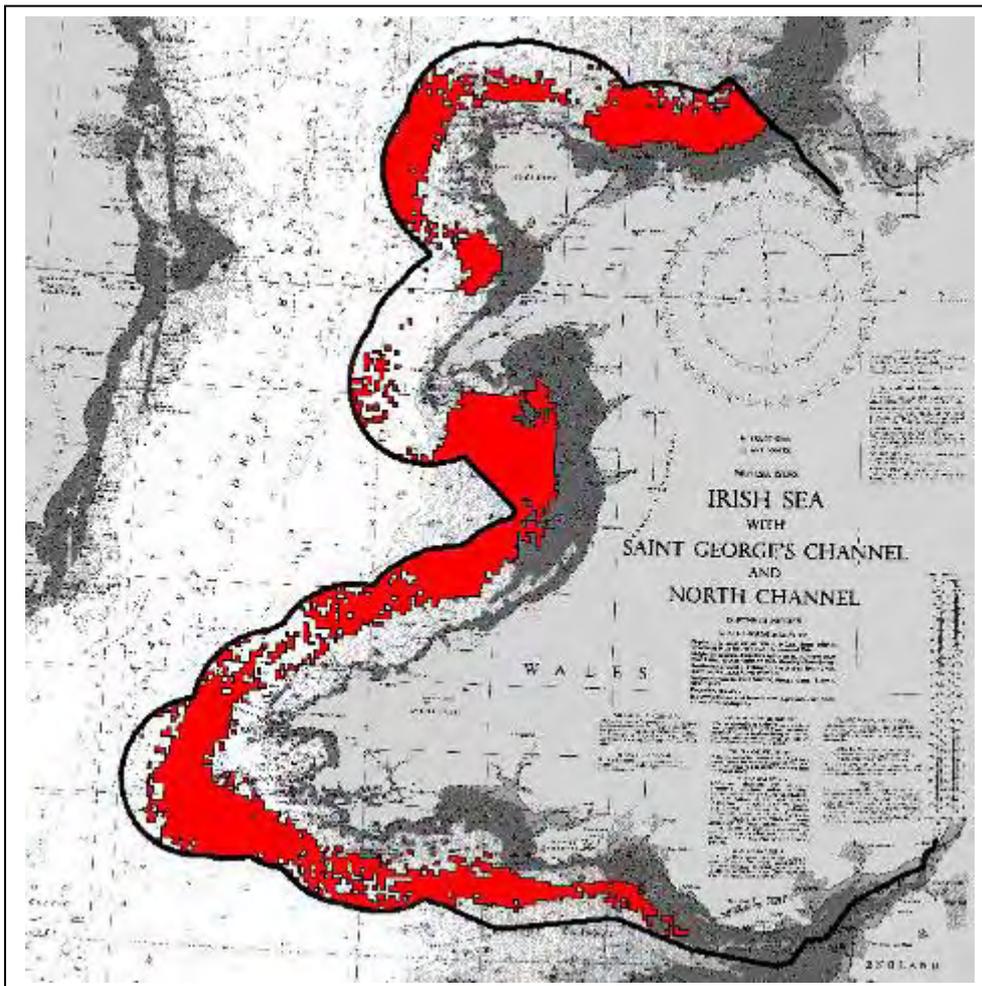
To determine areas with high levels of Chlorophyll, a series of SeaWifs maps were examined, available from the following website:

(http://www.neodaas.ac.uk/data/comp_browse/index.php?dir=seawifs/time_series/zx/monthly_all/chlor/2010/).

Example map

Figure 6. Pelagic productivity: Approximate position of persistent thermal fronts (based on presence through different seasons using data within 4.8 x 4.8 km grid squares).

Copyright: Derived, in part, from Crown Copyright Material with the permission of the UK Hydrographic Office and the Controller of Her Majesty's Stationery Office (www.ukho.gov.uk). All rights reserved. WARNING: The UK Hydrographic Office has not verified the information within this product and does not accept liability for the accuracy of reproduction of any modifications made thereafter. NOT TO BE USED FOR NAVIGATION



Interpretation of data

Persistent fronts

Gridded datalayers (4.8x4.8km window) for seasonal frequent fronts were used to produce a single GIS layer showing the location of persistent pelagic fronts (i.e. where fronts are present for at least 40% of the year).

High benthic primary productivity

For maps of areas with high levels of primary productivity, the CCW intertidal Phase 1 dataset, the seagrass important habitat datalayer and the HABMAP dataset (restricted to polygons with survey data) were queried for the following biotopes:

- LR.HLR.MusB.Sem.FvesR - *Semibalanus balanoides*, *Fucus vesiculosus* and red seaweeds on exposed to moderately exposed eulittoral rock
- LR.HLR.FR- Robust furoid and/or red seaweed communities
- LR.HLR.FT - Fucoids in tide-swept conditions
- LR.MLR.BF – Barnacles and fucoids on moderately exposed shores
- LR.MLR.MusF - Mussels and fucoids on moderately exposed shores
- LR.LLR.F - Fucoids on sheltered marine shores
- LR.LLR.FVS – Fucoids in variable salinity
- IR.HIR.KFaR - Kelp with cushion fauna and/or foliose red seaweeds
- IR.HIR.KSed - Sediment-affected or disturbed kelp and seaweed communities
- IR.MIR.KR - Kelp and red seaweeds (moderate energy infralittoral rock)
- IR.MIR.KT - Kelp and seaweed communities in tide-swept sheltered conditions
- IR.LIR.K - Silted kelp communities (sheltered infralittoral rock)
- SS.SMp.SSgr – Subtidal seagrass beds
- LS.LMp.LSgr – Intertidal seagrass beds

Chlorophyll

It was not possible to obtain the Seawifs data in the time available and therefore a subjective examination of a series of maps for 2009 and 2010 was made by CCW. Areas that had high values for Chlorophyll were digitised into a GIS layer. In general, areas of high chlorophyll were in Liverpool Bay (plus north west Anglesey) and the Bristol Channel, with another area that occurred once in 2010 and also in 2009 in Tremadog Bay.

Rationale for choice of data source and other possible data sources

The Defra led data represents 10 years of accumulated satellite observation data and as such is the most extensive set available.

Both the persistent front data and the chlorophyll *a* data have the disadvantage that they indicate pelagic productivity, rather than benthic productivity, although there may,

in some cases, be a positive correlation between the two. For benthic productivity the Defra biophysical datalayers project (Task 2H - Appendix 5) assessed four approaches to mapping benthic productivity using soft sediment macrofaunal secondary production and concluded, through review (Tillin *et al.* 2009) and pilot study (Tillin *et al.* 2010), that the modelling approaches developed to date are not reliable when applied to areas outside of those for which the model was developed. Tillin *et al.* (2010) concluded that the best practical approach would be to seek to use productivity values (estimated using the Brey model) that are based on benthic biomass sampling. Unfortunately such data appear to be too sparsely distributed in the Irish Sea to be useful in selecting highly protected MCZs (which were initially selected at a spatial scale of around 5 km² and thus a high resolution of data was required).

A6.4 PERMANENTLY MODIFIED AREAS

Data used

Data was collated from the Phase 1 intertidal survey, aerial photography (COWI 2006) and Seazone data to identify areas of artificial substrata. This includes information about structures such as windfarms, cables and pipelines, jetties, harbours, groynes, etc. In addition the Environment Agency supplied information relating to discharges and Shoreline Management Plans were used to identify locations with 'Hold the line' policy (combined with sea defences).

Interpretation of data

The site selection guidelines specify that "Areas that have been permanently modified in some way, with a very low potential to ever return to a natural or semi-natural state (e.g. areas with large amounts of artificial structures, or areas with major problems with invasive non-native species) should be avoided, or in many cases, excluded". CCW interpreted this as areas that have been modified to an extent that they would not recover within a timescale of roughly 50+ years. In addition areas where there are fixed point impacts will be continuing for the foreseeable future (e.g. discharges) were also included. Therefore physical structures such as jetties, cables, pipelines, windfarms etc were included, along with discharges. In addition, areas of the coast that have been and will continue to be modified by coastal defences were included. Shorter-term impacts were not added to this layer.

In order to create a mapped layer of polygon data it was necessary to edit some of the source data and apply buffers around some structures. The following rules were used.

- Structures in or extending into the water - 10 metre buffer unless rules below for any other structure apply.
- Structures on Mean High Water level and below or those involving activities that could influence the environment below Mean High Water - 10 metre buffer unless rules below for any other structure apply.
- Cables and pipelines (currently most cables and pipelines are included, with the exception of a few that were marked as disused) -10 metre buffer
- Jetty (if extending perpendicular from the coast by ≤ 100 metres) -10 metre buffer; (by >100 metres) - 50 metre buffer
- Oil extraction or energy production structures - 100 metre buffer
- Explosive dumping grounds - 100 metre buffer
- If the buffer overlapped any other feature that is not to be buffered, polygons were combined to form one polygon.
- If the buffer overlapped the buffer of another feature (e.g. Slipway, pier, jetty), polygons were combined to form one polygon.
- For large areas e.g. Holyhead Harbour, the whole area was digitised with one polygon incorporating all features with buffers according to above rules.
- A buffer of 100 m radius was applied around each discharge (from EA advice). The buried pipeline to a discharge point has not necessarily been identified.
- Areas where maintenance dredging is required and is thought to have resulted in long-term alteration of the habitat – no buffer (applies to Milford Haven only at present as CCW was unable to obtain data for other areas).

For areas with coastal defences, the draft shoreline management plans (North West England and North Wales Shoreline Management Plan 2, West of Wales SMP, Lavernock Point to St Ann's Head Shoreline Management Plan (SMP2), Severn Estuary Shoreline Management Plan Review (SMP2)) were used to identify those areas where the intention is to maintain the coastal defences. For these areas, the area of the intertidal that was considered effected by the sea defences was mapped as an area to avoid.

Rationale for choice of data source and other possible data sources

The main data sources for artificial substrata have been investigated. Further information might be gathered through the consultation process.

Figure 7. Example map showing areas of artificial substratum.

Copyright: Derived, in part, from Crown Copyright Material with the permission of the UK Hydrographic Office and the Controller of Her Majesty's Stationery Office (www.ukho.gov.uk). All rights reserved. WARNING: The UK Hydrographic Office has not verified the information within this product and does not accept liability for the accuracy of reproduction of any modifications made thereafter. NOT TO BE USED FOR NAVIGATION



A6.5 INVASIVE NON NATIVE SPECIES AREAS

The following datasets were not used for the initial selection of Focus Sites but were incorporated into the Focus Site reports for consideration of the TAG.

Data used

CCW compiled data for a range of non-native species. This data was sourced from the Marine Recorder database (Appendix 2), the Defra biophysical datalayers project (Appendix 5) and other records including individual observations reported to CCW. The species used for the MCZ project were *Crepidula fornicata*, *Sargassum muticum* and *Crassostrea gigas*. These were chosen due to their known ability to modify marine communities and habitats.

Interpretation of data

Records with low confidence were not used. For some records the species is now thought to be no longer present (e.g. *Crepidula fornicata* in the Menai Strait) and where there was reasonable evidence that this is the case then that record was removed from the dataset.

Rationale for choice of data source and other possible data sources

CCW believe that this dataset is the most comprehensive for these species in Welsh waters. Data have been collated from a range of sources to create this dataset. The species chosen are those with a limited distribution that are known to cause ecological changes at the level of the biological community.

A6.6 HABITATS IMPORTANT FOR MOBILE SPECIES

The following datasets were not used for the initial selection of Focus Sites but were incorporated into the Focus Site reports for consideration of the TAG.

Data used

Fish nursery areas

As part of the Defra biophysical datalayers project (Appendix 5), Cefas compiled maps of fish nursery areas. The species for which there was data in Welsh waters are Anglerfish, Cod, European Hake, Herring, Mackerel, Plaice, Sandeel, Sole, Spotted Ray, Spurdog, Thornback ray, Tope shark and Whiting.

Estuarine areas are also generally considered to be important fish nursery areas. A layer was also created that indicates estuaries in Welsh waters. This was created from the UKSeaMap physiographic features map (<http://www.jncc.gov.uk/page-5018>).

Fish spawning grounds

As part of the Defra biophysical datalayers project (Appendix 5), Cefas compiled maps of fish spawning areas. The species for which there was data in Welsh waters are Cod, Hake, Horse Mackerel, Ling, Mackerel, Plaice, Sandeel, Sole and Whiting.

Bird areas

For the intertidal, data from the British Trust for Ornithology (BTO) low tide surveys were used. The Wetland Bird Survey (WeBS) is the scheme which monitors non-breeding

waterbirds in the UK. Low tide counts have taken place since the winter of 1992/93 across varying estuaries in the UK. Co-ordinated counts of waterbirds are made by volunteers each month between November and February on pre-established subdivisions (count sectors) of the inter-tidal habitat in the period two hours either side of low tide. For birds at sea two datasets were used. The European Seabirds at Sea (ESAS) dataset from JNCC and the foraging range data set from Birdlife International. The JNCC Seabirds at Sea Team (SAST) has carried out a programme of survey and research on seabirds and cetaceans in the marine environment in the north-east Atlantic since 1979, and in the south-west Atlantic between 1998 and 2002. Data from SAST's boat and aerial surveys carried out from 1979-2002 is contained within the European Seabirds at Sea (ESAS) database, hosted by JNCC. The BirdLife Seabird Foraging Database contains over 1700 entries for 230 species from more than 700 references, with information for every seabird family.

Aggregations of marine mammals

In 2009 CCW ran a project to compile effort based sightings data for marine mammals in the southern Irish Sea (Baines & Evans 2009). Data from this project were used to create layers showing areas important for Harbour porpoise, Bottlenose dolphin, Short-beaked common dolphin, Risso's dolphin, Minke whale and Grey seals.

Crayfish

CCW compiled data for the listed species of conservation concern including crayfish (*Palinurus elephas*), which the TAG agreed should be considered a mobile species. This data was sourced from the Marine Recorder database (Appendix 2) and the Defra biophysical datalayers project (Appendix 5).

Interpretation of data

Fish nursery areas

Only the areas marked as high density for juvenile fish were included in the highly protected MCZ layers. These were defined by Cefas staff by non-quantitative interpretation of the available data. This means that the species list for Welsh waters was reduced to Cod, Herring, Sole, Spurdog and Whiting.

Fish spawning grounds

Only the areas marked as high density for nursery grounds were included in the highly protected MCZ layers. These were defined by Cefas staff by non-quantitative interpretation of the available data. This means that the species list for Welsh waters was reduced to Cod, Plaice, Sandeel and Sole.

Bird feeding areas

For each of the Wetland Bird Survey (WeBS) count sectors in Wales the data for the maximum number of birds present were used as well as the maximum number of species present for a winter period. The maximum was used as if an average had been used over all the years, data would have had to be discarded as not all the months had been covered in all years. Also in some years when only three months had been covered a higher number of birds and species were present than in those years when four months had been covered. Once the maximums were collected for each count sector, the data was then divided into three equal groups of high, medium or low. An important area was defined as one scoring either high or medium.

Data from the European Seabirds at Sea (ESAS) database were plotted as densities (birds per km²), by summing the number of birds recorded in transect, both on the water and flying, in each 1/4 ICES rectangle (5' Lat by 10' long), and dividing this by the area surveyed in that rectangle (only birds seen in strip transects were analysed). This was done for each month of the year for each 1/4 rectangle from 1978 - 2002. To account for variations in the detection of birds on the water at different distances from the ship, the numbers of birds (excluding those flying) were multiplied by a factor according to species and width of the strip transect. The different survey results in each 1/4 ICES rectangle were amalgamated for each species to show how many of each species had been seen within that area. As much of the data was not species specific e.g. Auk species, large gull species, the data was then aggregated into species groupings to allow that amorphous data to be used.

These groupings are:

- Auks species: (razorbill, puffin, guillemot, little auk)
- Terns species: (Common tern, Arctic Tern, Sandwich tern, Black tern)
- Shearwaters species: (Manx shearwater, Mediterranean shearwater)
- Petrels species: (European storm petrel, Leaches storm petrel)

- Gulls species: (Lesser Black-backed gull, Greater Black-backed gull, Common gull, Sabines gull)
- Cormorant species: (Cormorant, Shag)
- Scoter species: (Common scoter, velvet scoter)
- Diver species: (Red-throated diver, Great-northern diver, Black-throated diver)
- Gannet
- Fulmar

For many of these groups the majority are made up of the species which breed in Wales such as Manx shearwater and European storm petrel, with Mediterranean shearwater and Leaches storm petrel in these groups making up a minute portion of the data. Once the data was aggregated, each 1/4 ICES square was given a score based on three equal groups of high, medium or low for each species aggregation. If the square had none of a species aggregation within it got no score. If it was in the bottom third of all the squares then it got a low score, if it was the middle third a score of medium and if it was the top third a score of high. All the scores for each species aggregation can be added together to give a final score for the 1/4 ICES rectangle. The rectangles scoring high or medium were defined as 'important'.

Foraging radii data were supplied by the RSPB. The map was created by combining the probable densities of the following 17 species of foraging seabirds:

- Arctic Tern
- Arctic Skua
- Atlantic Puffin
- Black Guillemot
- Blacklegged Kittiwake
- Common Guillemot
- Common Tern
- European Shag
- Great Cormorant
- Great Skua
- Little Tern
- Manx Shearwater
- Northern Fulmar

- Northern Gannet
- Razorbill
- Roseate Tern
- Sandwich Tern

Point locations (taken from seabird colonies counted during Seabird 2000) were buffered by the mean, maximum mean and maximum foraging distances taken from the Birdlife Seabird Foraging Range Database for each species. The areas created by the buffers were divided by the count at the colony. A percentage probability was worked out for each species of seabird to be in their mean, maximum mean and maximum foraging areas from graphs showing cumulative frequencies and proportions of birds found foraging at different distances from the colony. This percentage was used as a weight to the probable seabirds densities. All the seabird densities were then added together to produce the final dataset. Those areas with a score of 5 or above were retained as important areas.

Aggregations of marine mammals

The data used was the original effort-corrected sightings data, rather than interpolated data. The species mapped were Harbour porpoise, Bottlenose dolphin, Short-beaked common dolphin, Risso's dolphin, Minke whale and Grey seals because of their relative abundance in Welsh waters. For harbour porpoise an important area was considered anything with an adult sightings level of over 1 per hour. For bottlenose dolphins an important area was considered anything with a count rate of greater than 0.2 per hour. For short-beaked common dolphins, Risso's dolphins and minke whale an important area was over 0.15 sightings per hour. For grey seals pupping beaches and non breeding haulouts were included.

Crayfish

Records of species that date from earlier than 1970 were removed from the dataset to be used for the highly protected MCZ site selection. This means that only records from the last 40 years (and after the cold winter of 1963) have been included, as at some sites this species may no longer be present.

Rationale for choice of data source and other possible data sources

Fish nursery areas

CCW were unable to find any alternative higher resolution datasets for fish nursery areas that cover all Welsh waters in a consistent manner. It is important to note that the Cefas data only covers certain commercial fish species. Therefore there are likely to be areas that are important nursery areas for non commercial species that are not represented on these maps.

Fish spawning grounds

CCW were unable to find any alternative higher resolution datasets for fish spawning grounds that cover all Welsh waters in a consistent manner.

Bird feeding areas

The data used represent a collation of the main sources of bird aggregation and feeding area data available for the Welsh coast and waters.

Aggregations of marine mammals

The Welsh Marine Mammal Atlas (Baines & Evans, 2009) dataset to be used represents the best resolution data available in Welsh waters covering a comprehensive collation of eighteen years worth of data. An alternative dataset exists in the *Atlas of cetacean distribution in north-west European waters* (Reid et al 2003), however, this data is presented at a lower level of resolution. It is also worth noting that the data from Reid et al (2003) has been incorporated into the report by Baines & Evans (2009).

Crayfish

CCW believe that this dataset is the most comprehensive for these species in Welsh waters. Data have been collated from a range of sources to create this dataset.

A6.7 SESSILE SPECIES OF CONSERVATION CONCERN

The following datasets were not used for the initial selection of Focus Sites but were incorporated into the Focus Site reports for consideration of the TAG.

Data used

CCW compiled data for the listed species of conservation concern (Table 3). These data were sourced from the Marine Recorder database (Appendix 2) and the Defra biophysical datalayers project (Appendix 5).

Interpretation of data

Records of species that date from earlier than 1970 were removed from the dataset to be used for the MCZ site selection. This means that only records from the last 40 years (and after the cold winter of 1963) have been included, as at some sites, species that were once recorded may be no longer present.

Rationale for choice of data source and other possible data sources

This dataset is the most comprehensive for these species in Welsh waters. Data have been collated from a range of sources to create this dataset.

References

- Baines, M. E. & P.G.H. Evans, (2009) *Welsh Marine Mammal Atlas*. Countryside Council for Wales, Sea Watch Foundation, Caernarfon.
- Ball, I. R. & H. P. Possingham, (2000). *MARXAN (V1.8.2): Marine Reserve Design Using Spatially Explicit Annealing, a Manual*. Great Barrier Reef Marine Park, Queensland http://www.uq.edu.au/marxan/docs/marxan_manual_1_8_2.pdf
- Baines, M.E. and Evans, P.G.H. (2009). Atlas of the Marine Mammals of Wales. CCW Monitoring Report No. 68.
- Brazier, P., Birch K., Brunstrom, A., Bunker, A., Jones, M., Lough, N., Salmon, L. & Wyn, G. (2007). *When the Tide Goes Out: The biodiversity and conservation of the shores of Wales – results from a 10 year intertidal survey of Wales*. Countryside Council for Wales.
- Connor, D.W., Gilliland, P.M., Golding, N, Robinson, P., Todd, D., & Verling, E. (2006). *UKSeaMap: the mapping of seabed and water column features of UK seas*. Joint Nature Conservation Committee, Peterborough.
- Langmead, O., Jackson, E.L., Griffiths, C., Wilkes, P., Neilly, M., Lear, D., Luckraft, I., Foggo, A., Tyler-Walters, H., 2010. UK marine benthic diversity layer. Report to the Department of Environment, Food and Rural Affairs from the Marine Life Information Network (MarLIN) Plymouth: Marine Biological Association of the UK, subcontracted by ABPmer, Southampton. Defra Contract No. MB0102 Task 2F, Report No. 20.
- Miller, P. I., Christodoulou, S. and Saux Picart, S. (2010). MB0102: Report No 20 Task 2F: *Oceanic thermal fronts from Earth observation data - a potential surrogate for pelagic diversity. Summary Document*. Plymouth Marine Laboratory.
- Rackham L, Walker R (2006): Metadata Guidelines for Geospatial Datasets in the UK. Part 3 Metadata Quality commissioned by the Department for Communities and Local Government, Department for Communities and Local Government, London
- Reid, J.B., Evans, P.G.H. & Northridge, S.P. (2003) Atlas of cetacean distribution in north-west European waters. Joint Nature Conservation Committee, Peterborough.
- Robinson, K. A., Ramsay, K., Lindenbaum, C., Frost, N., Moore, J., Petrey, D. & Darbyshire, T. (2009). Habitat Mapping for Conservation and Management of the Southern Irish Sea (HABMAP). II: Modelling and Mapping. *Studies in Marine Biodiversity and Systematics from the National Museum of Wales*. BIOMOR Reports 5(2): 210pp & DVD.

Tillin, H. M., Frost, N.J. & Hull S.C. (2009). *MB0102: Report No 4: Task 2H. Development of a Benthic Productivity Datalayer: Assessing the Available Approaches*. ABP Marine Environmental Research Ltd., Southampton.

Tillin, H. M., Bollam, S. & Hiddink, J. (2010) *MB0102: Report No 21: Task 2H. Benthic Productivity Data Layer Development - North Sea Pilot Study*. ABP Marine Environmental Research Ltd., Southampton.

Warman, L.D., A.R.E. Sinclair, G.G.E. Scudder, B. Klinkenberg, and R.L. Pressey. 2004. Sensitivity of systematic reserve selection to decisions about scale, biological data, and targets: Case study from southern British Columbia. *Conservation Biology* 18(3):655–666.

Welsh Assembly Government (2010). *Site Selection Guidance for Highly Protected Marine Conservation Zones*
<http://wales.gov.uk/topics/environmentcountryside/consmanagement/marinefisheries/conservation/protected/conservationzones/project/siteselection/;jsessionid=7VK2McVStcGWV0I0IN7ZXtZRsY9r5lpGBvDhMsJHGpTvBn53Q4qJ!1792442942?lang=en>