Appendix 9: Natural disturbance in the WNNC SAC

Consideration of levels of natural disturbance within The WNNC SAC shrimp fishery area, and interactions of natural disturbance and fishing pressure.

The Wash is a square-shaped embayment open to the North Sea, fed by the rivers Witham, Welland, Nene and Great Ouse. It is relatively broad across its mouth compared to the length of its sides – in contrast to estuaries, which tend to be relatively narrow compared to their length. The morphology of The Wash results in strong hydrodynamic influence in the embayment from waves originating in the much more open North Sea. Because of its large tidal range (around 6.3m on spring tides), The Wash also experiences relatively strong tidal currents (Webref 1).

The data layer of Kinetic Energy due to Waves on the EMODnet website (WebRef 2) demonstrates that the wave energy experienced by seabeds in The Wash is higher than that for major UK estuaries. This is presented graphically as Figure 1. It also shows that the shallow Docking Shoal (large, triangular feature on the western part of the north Norfolk Coast) experiences high levels of wave energy.

The typical wave period for the North Norfolk coast / The Wash is of the order of four seconds (WebRef 3). The calculation for wave lengths in water where depth > half a wavelength is:

$$\textbf{Wavelength (L)} = 1.56 \times T^2$$

(where T=wave period)

generating a wavelength of 24.96m (approximately 25m) for a wave of period 4 seconds. (N.B. although in this case half the wavelength is marginally more than the water depth, it is so close as to not make a significant difference to the calculations).

Where the water depth is greater than half the wavelength, the effect of waves on the seabed is negligible – the energy from the waves does not reach the seabed (Dean Foden, Cefas, pers comm 13 May 2016, and confirmed by extensive additional sources). Thus, a typical wave of period 4 seconds will affect the seabed in a measurable manner down to depth of 25/2 = 12.5 metres. The effects of longer period – and therefore longer wavelength – waves generated during storms are felt at greater depths. For instance, a wave of period six seconds would have a wavelength of some 55m, and affect the seabed to a depth of over 25m.

The Wash has an average water depth of <10m below chart datum (unless otherwise stated, all subsequent depths are below chart datum), but contains a relatively small deeper area (40-50m depth) in the central area towards the mouth of the embayment (WebRef 4). Intertidal sandbanks and mudflats cover approximately half of The Wash.

The Docking Shoal, except for a small area on its western flank, is a shallow seabed feature with a water depth of <10m.

The level of exposure to wave energy at the seabed in The Wash and shallow parts of the north Norfolk coast leads to frequent mobilisation of the sediment, as illustrated in Figure 2.

The physical conditions – including wave and current exposure – impacting an ecosystem can have a major effect on the components making up and characteristics of the ecosystem. van Denderen *et al* (2015) identified that the effects of natural disturbance such as exposure to wave energy, and exposure to fishing pressure such as impacts from trawling, have similar effects on ecosystems in that both caused declines in long-living, hard-bodied and suspension-feeding organisms. The study reports "*Given these similar impacts, there was no detectable trawling effect on communities exposed to high natural disturbance*."

Given the differences in wave exposure of deep and shallow areas of The Wash (Figure 1) and the attendant differences in sediment mobility in those areas (Figure 2), and understanding the interrelationship between exposure and components of ecosystems, it could be anticipated that there will naturally be recognisable differences between communities found in shallow and deeper areas of The Wash. NRA (1994) does indeed detect such differences, suggesting that there are two major biological communities separated by a water depth contour of 10m.

A Cefas review compiled from fifty years of grab sample data (Cooper and Barry 2017) a total of 33,198 samples from 777 surveys (covering the whole of the UK). Analysis of the resultant dataset produced indications of diversity for each survey, and placed the sample results within one of twelve "faunal cluster groups". Results for the area encompassing the WNNC SAC are presented below as Figure 3 (Diversity) and Figure 4 (Faunal cluster).

The results show that:

- There is an area of relatively low diversity extending along the waters close to the coast, including the Docking Shoal but with an exception of an area just north of The Wash.
- Records indicate higher levels of diversity within the central part of The Wash.
- There is a common faunal cluster extending along the waters close to the coast, with an exception for the area just north of The Wash.
- Records indicate a different faunal cluster within the central part of The Wash and the area just north of The Wash from that around the (shallower) periphery of The Wash.

Eastern IFCA did not have access to the data behind the Cefas review, but has compared the diversity and faunal cluster results presented by Cefas with fishing effort data (Eastern IFCA shrimp returns data for 2016), as shown in Figure 5. The area

shown in Figure 3 and Figure 4 experiences varying levels of pressure from shrimp fishing: the main fishing effort (approx. 75%[1]) occurs in shallower waters of The Wash embayment itself, whilst the north Lincolnshire coast is subject only to occasional fishing by a much lower number of vessels. The Docking Shoal is less heavily fished than The Wash embayment, but is targeted more frequently than the north Lincolnshire coast. The Cefas maps results show there is no clear difference in either diversity or type of faunal cluster between shallow water areas of relatively high or low intensity of shrimp fishing effort.

Figures 6, 7 and 8 expand the geographical area examined in relation to diversity, faunal cluster and shrimp fishing effort respectively to areas outside of the WNNC SAC. (N.B. The Cefas figure used as the basis for Figure 7 uses a colour palette which makes it difficult to differentiate the numerous yellow points in shallow areas. This is unavoidable within the information we have available). These figures show lack of correlation between diversity / faunal cluster and fishing effort, but appreciable correlation with depth.

Within the parameters of natural disturbance and fishing activity experienced locally, the level of diversity seems to be driven by the physical conditions of the location rather than the degree of fishing pressure.

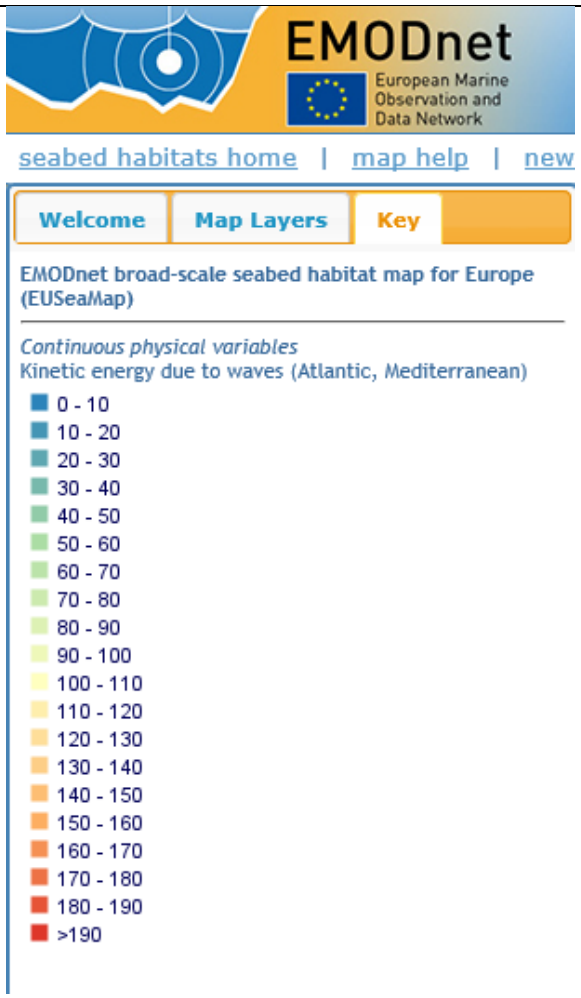
These combined sources support the following conclusions:

- The seabeds within the shallower areas of The Wash and the Docking Shoal are subject to appreciable wave energy;
- This wave energy has an effect on the seabed sediments, resulting in mobility for an appreciable proportion of the time;
- There are effects on the species composition of seabed habitats arising from such exposure, and these effects are similar to those which result from fishing (trawling) pressure;
- The wave base for the “routine” waves within The Wash is of the order of ten metres depth below chart datum. For those waves encountered occasionally due to storms the wavebase will be deeper;
- There is an identified difference between communities at depths shallower than ten metres and those at greater depths;
- There are similarities in diversity and faunal communities between sample stations in the “shallow” inshore areas of the North Norfolk, Wash and Lincolnshire coasts (with the exception of a notably different area localised just north of The Wash).
- Within those similar shallow areas identified above, the diversity is low. Within the deeper area of the Wash, and deeper waters in the North Sea beyond The Wash embayment, the diversity is appreciably higher.

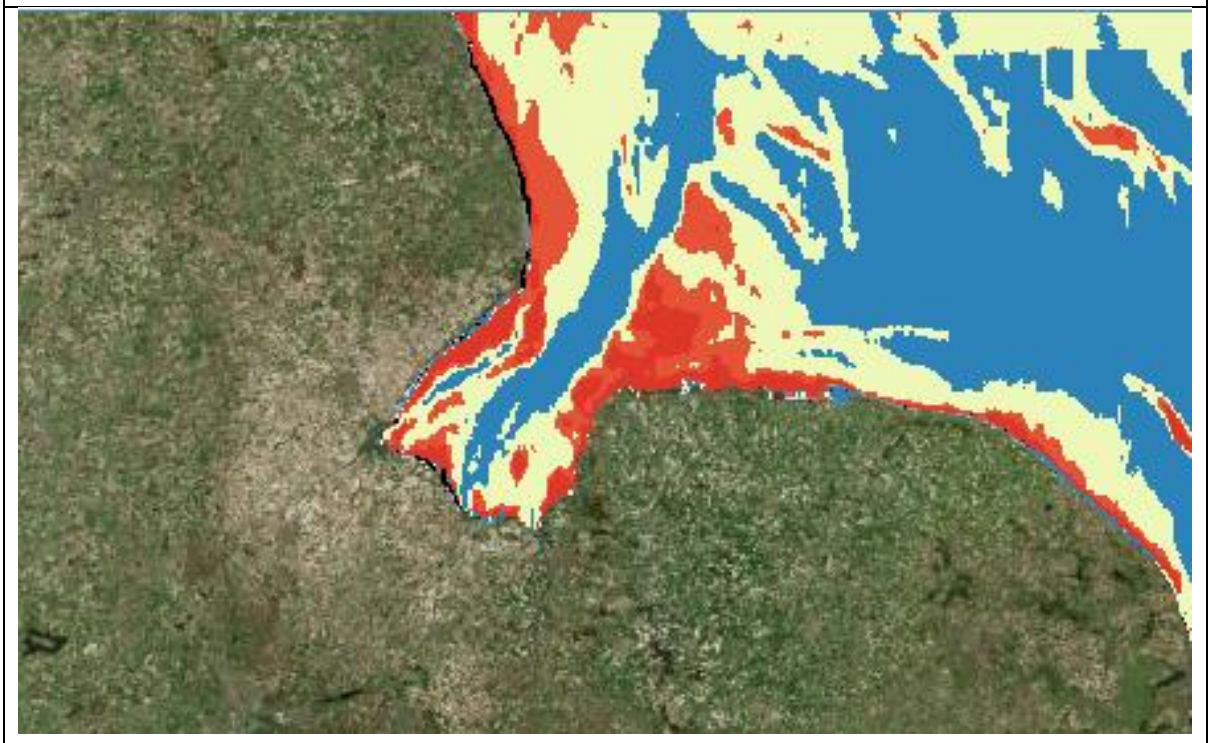
[1] Calculated from 2016 shrimp returns data

Figure 1 (Below) Seabed Kinetic Energy due to Waves for some major UK estuaries and embayments. From WebRef 2

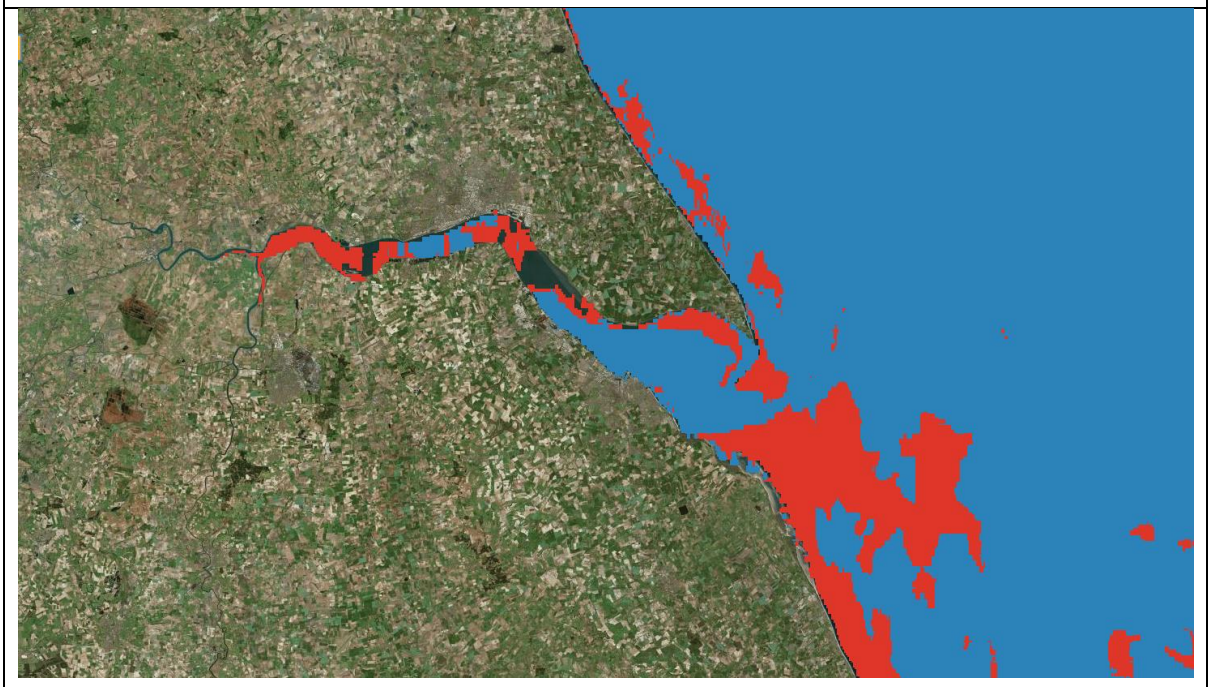
Key



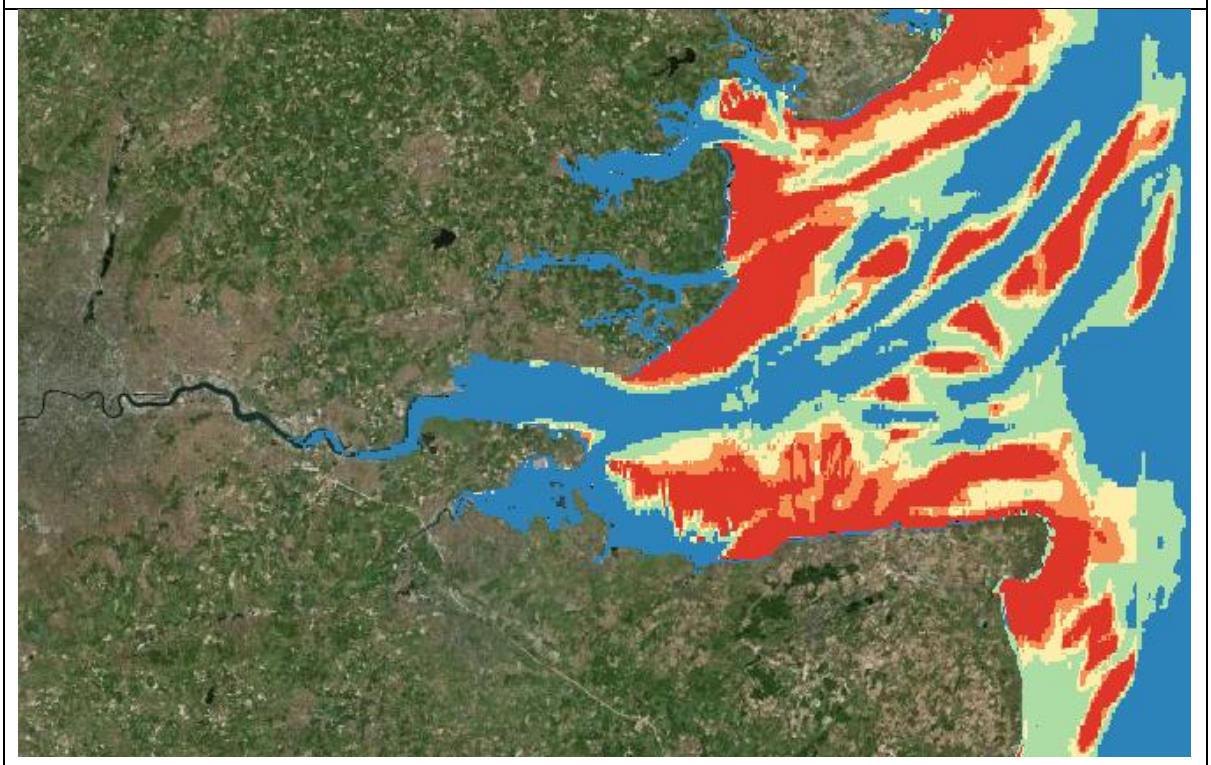
The Wash (below)



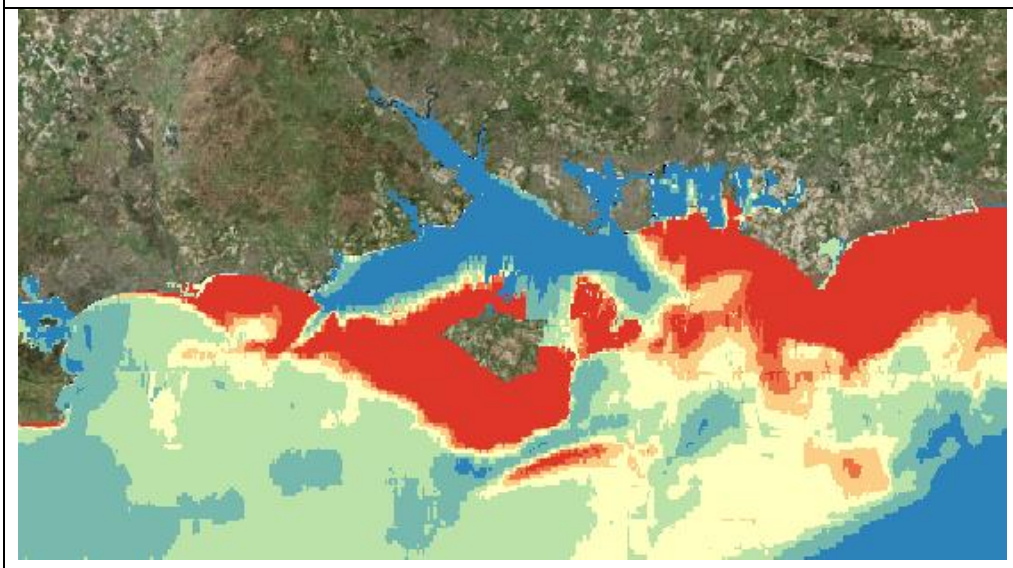
The Humber (below) (NB Appears to be a reduced palette of colours)



Thames Estuary (below)



The Solent (below)



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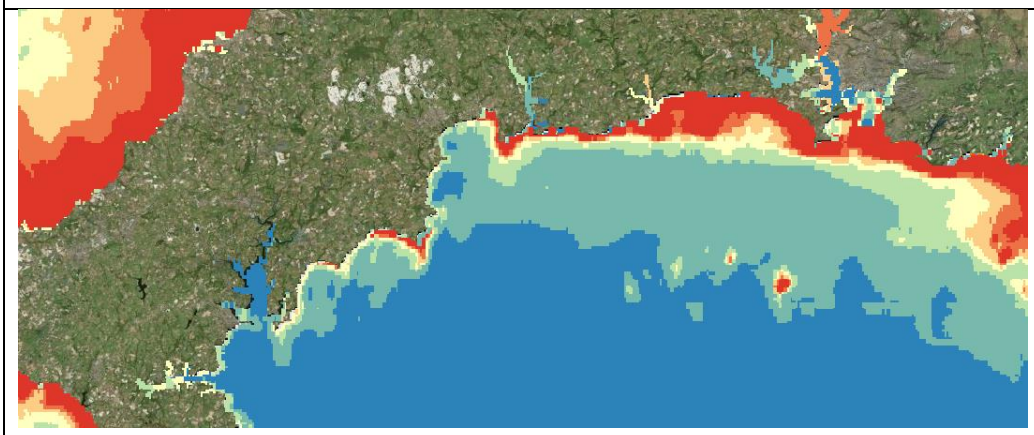
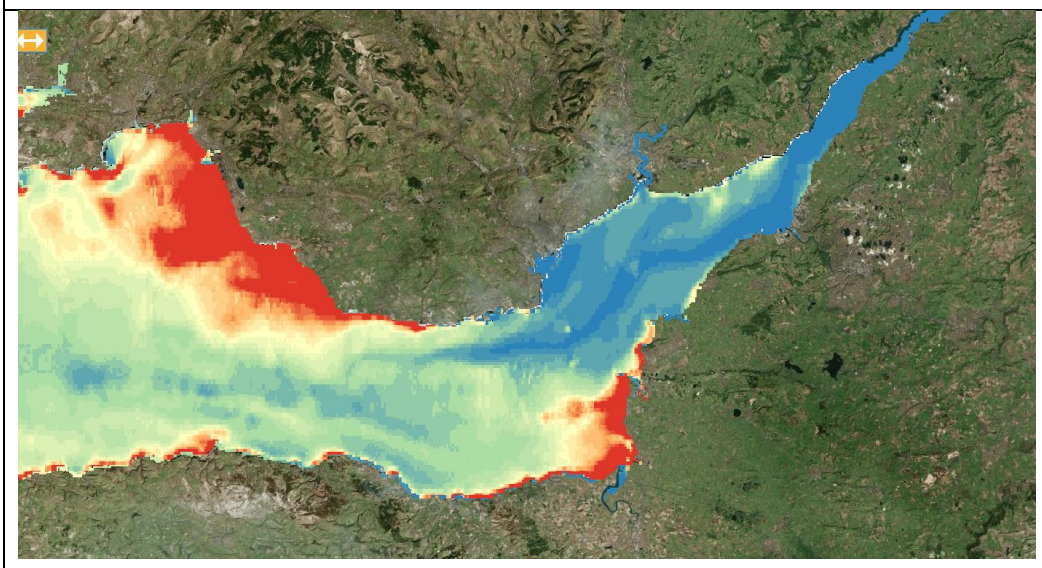
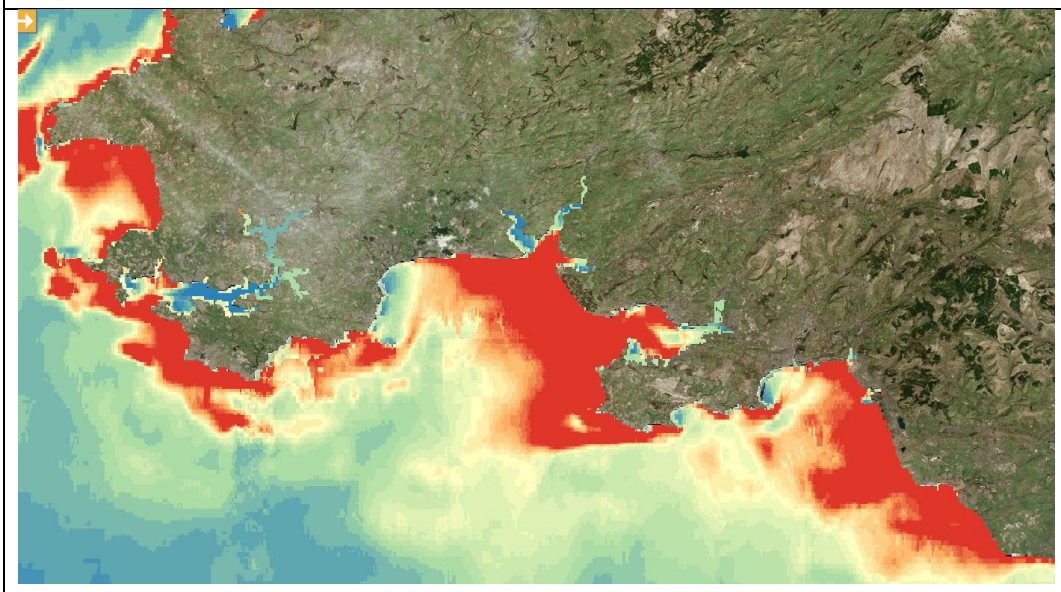
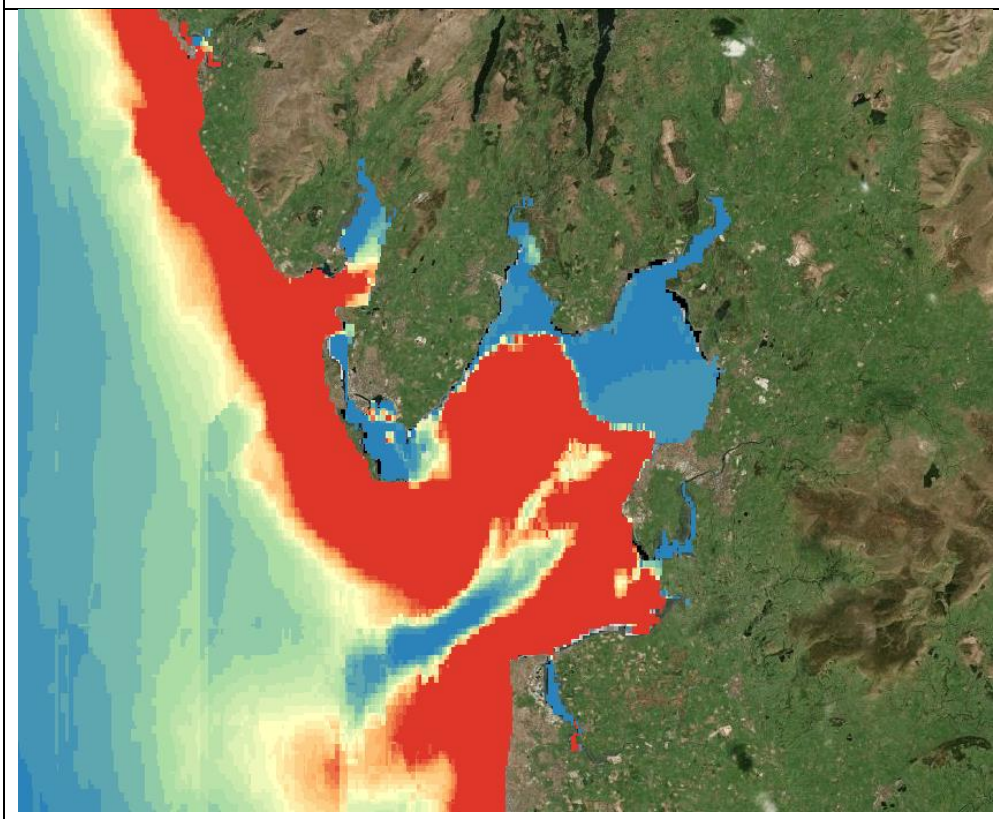
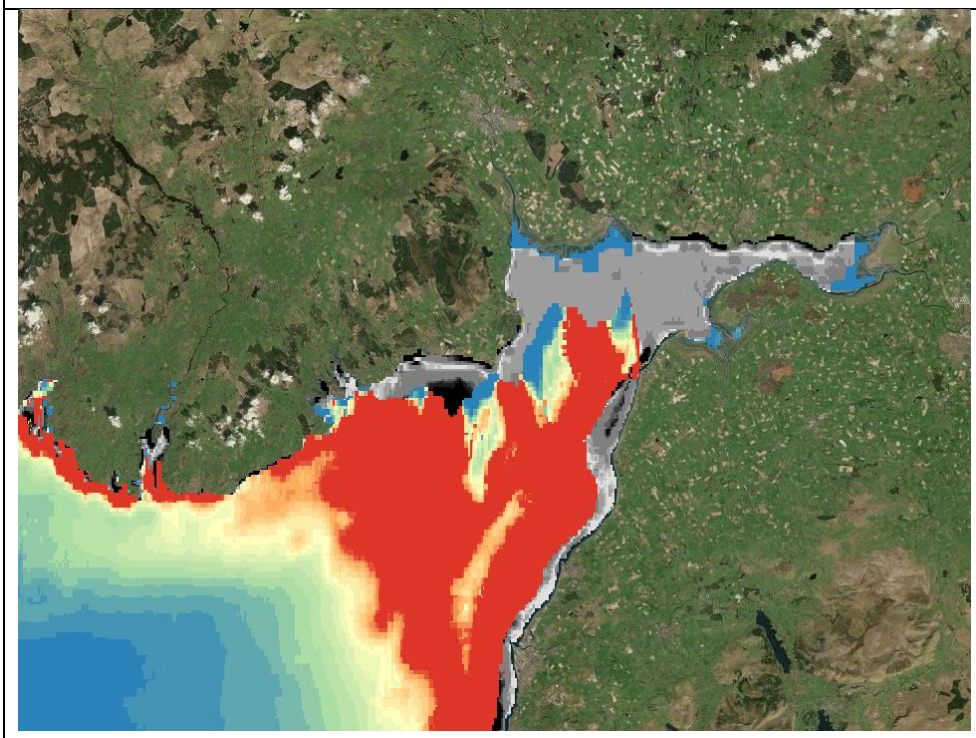
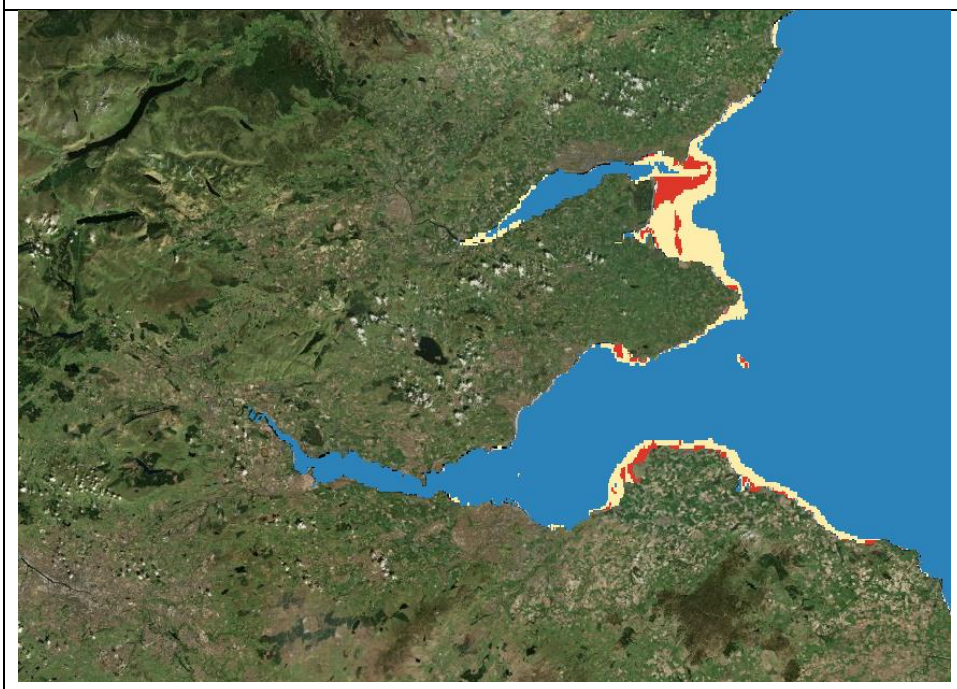

Severn Estuary (below)


South Wales estuaries (below)

Morecambe Bay (below)


Solway Firth (below)



Firth of Forth (below) (NB Appears to be a reduced palette of colours)



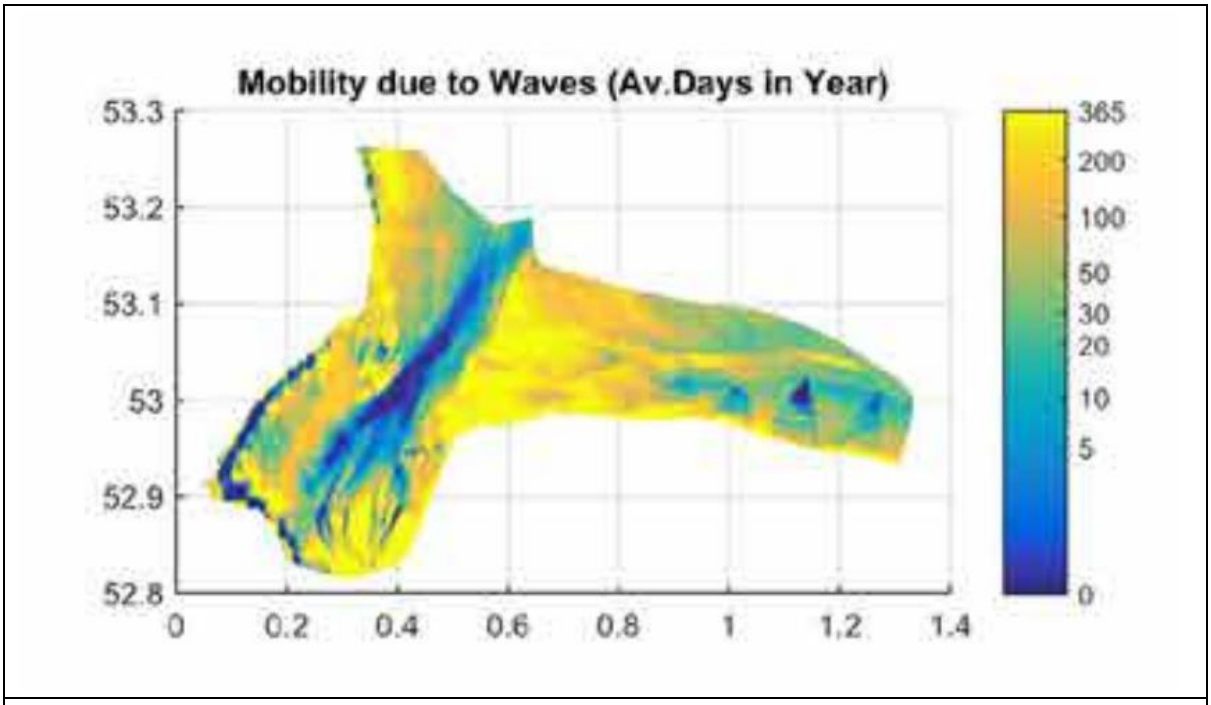


Figure 2 Number of days in the year that seabed particles of 250 µm are modelled to be mobilised due to wave energy. From ABPmer & Ichthys Marine (2015).

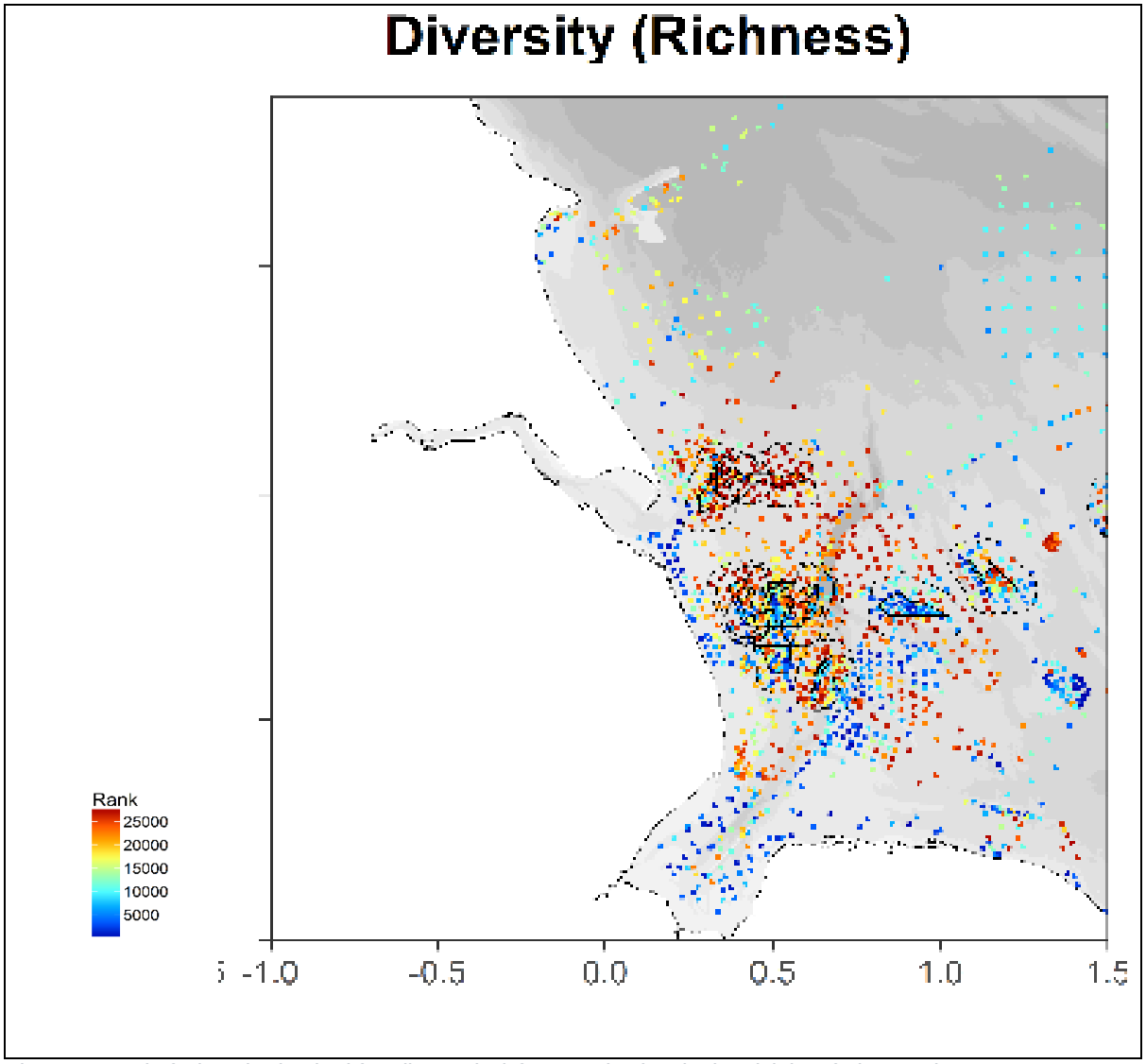


Figure 3 Level of Diversity (ranked for all samples) for sample sites in the vicinity of The Wash. From Cooper & Barry (2017)

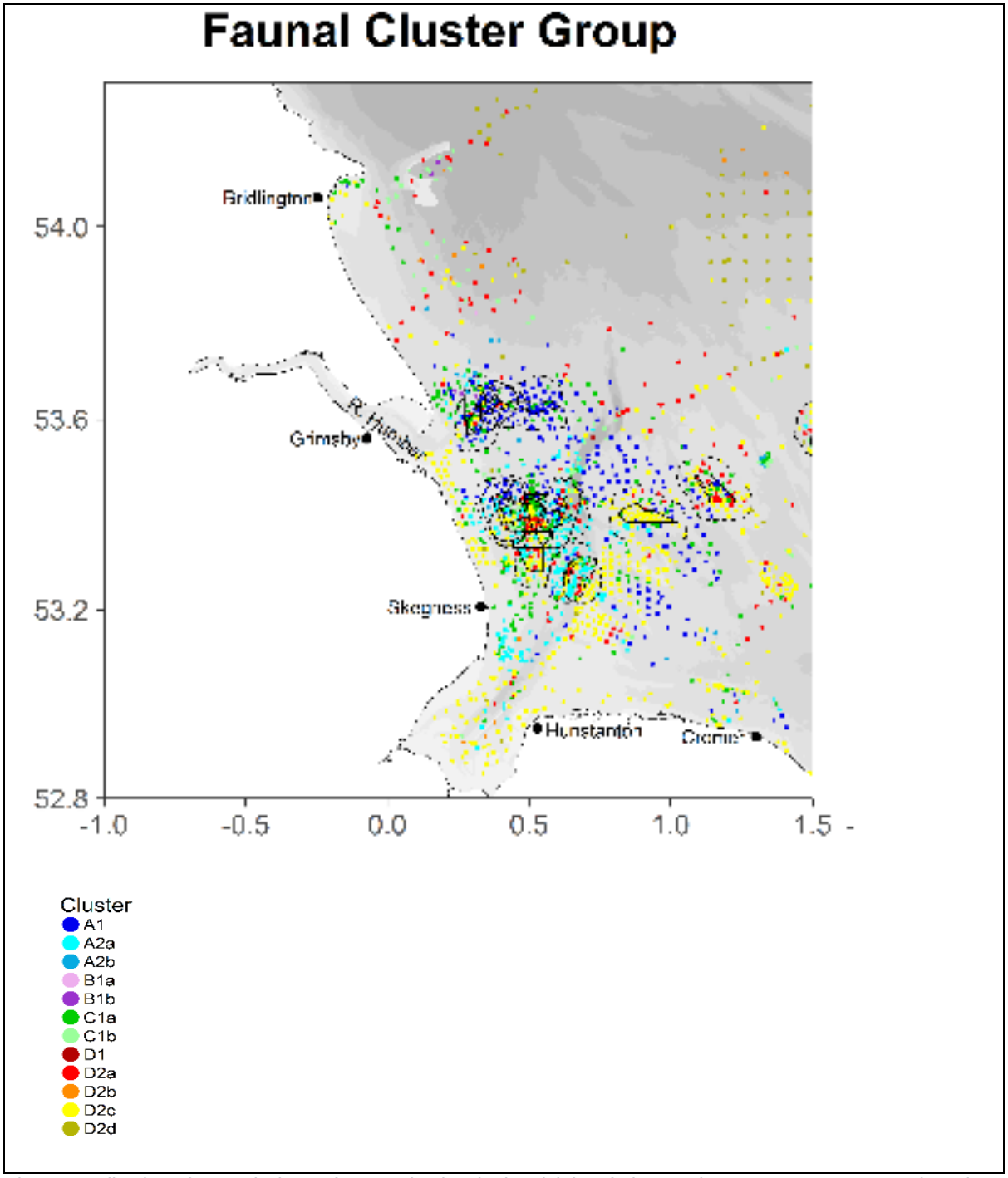


Figure 4 Indication of Faunal Cluster for sample sites in the vicinity of The Wash. From Cooper & Barry (2017)

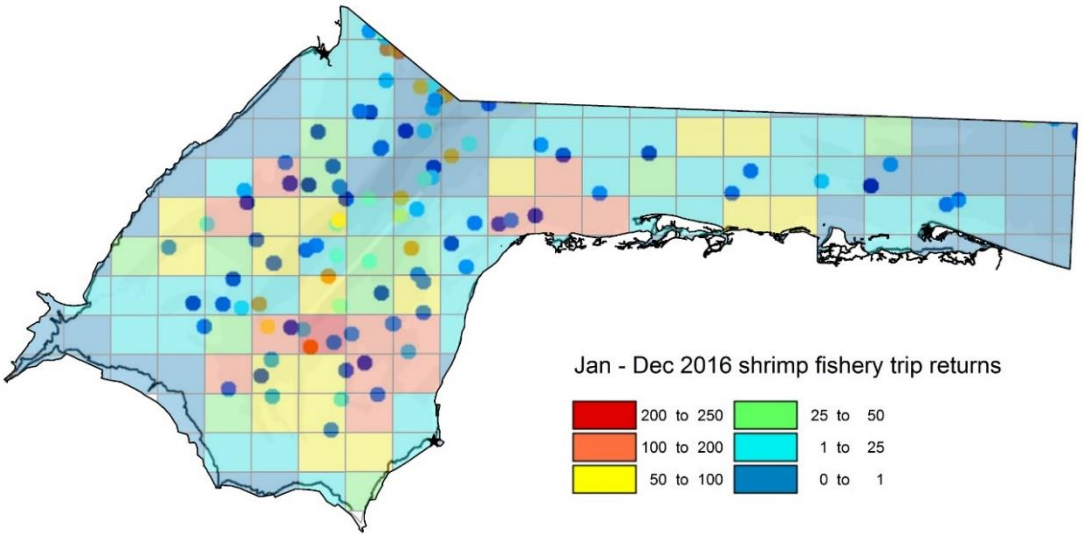


Figure 5 A high resolution image of levels of Diversity (ref details & key in Figure 3 above) has been overlaid with EIFCA's shrimp fishery trip returns data – data shown restricted to the boundary of WNNC SAC only.

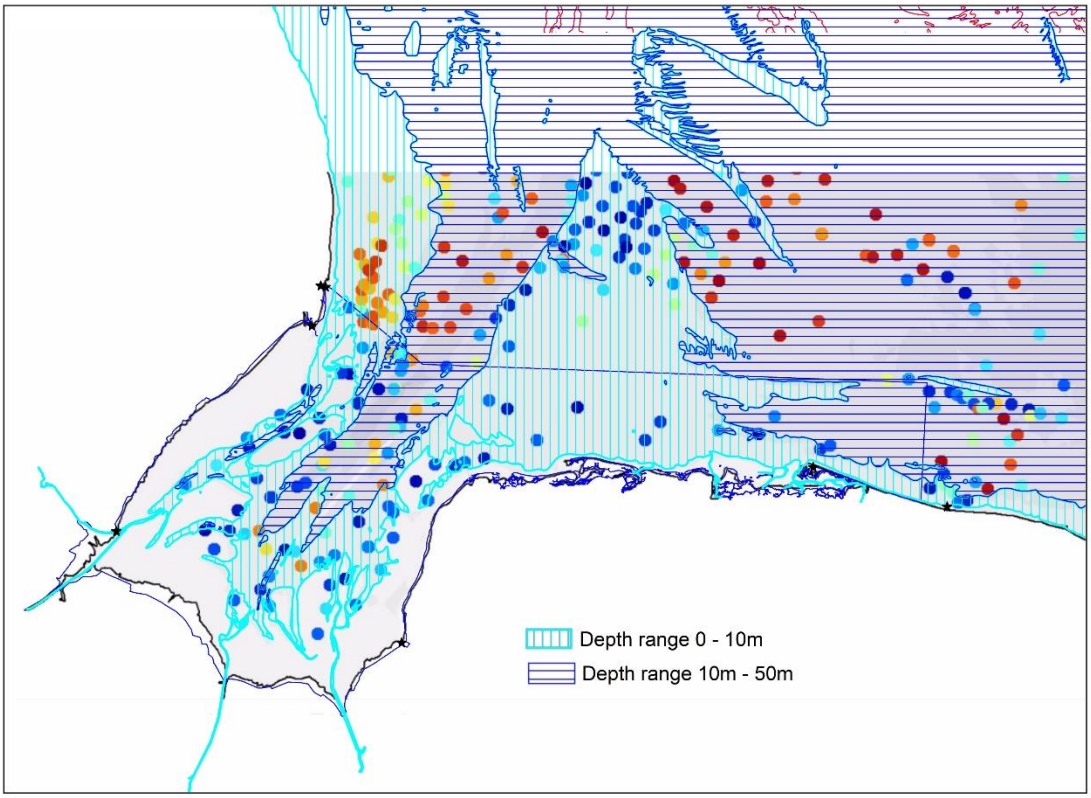


Figure 6 A high resolution Diversity image (ref details & key in Figure 3 above) has been overlaid with depth ranges. Nb. Data outside the WNNC SAC boundary has also been included.

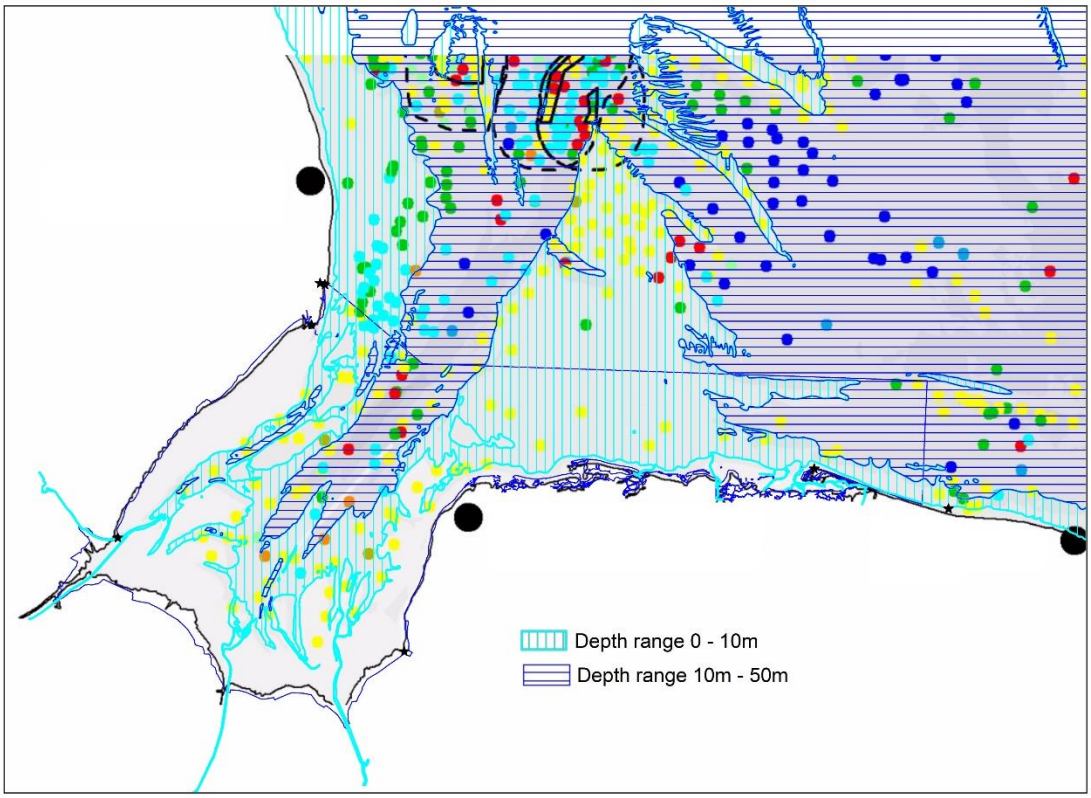


Figure 7 A high resolution image Faunal Cluster (ref details & key in Figure 4 above) has been overlaid with depth ranges. N.B. Data outside the WNNC SAC boundary has also been included.

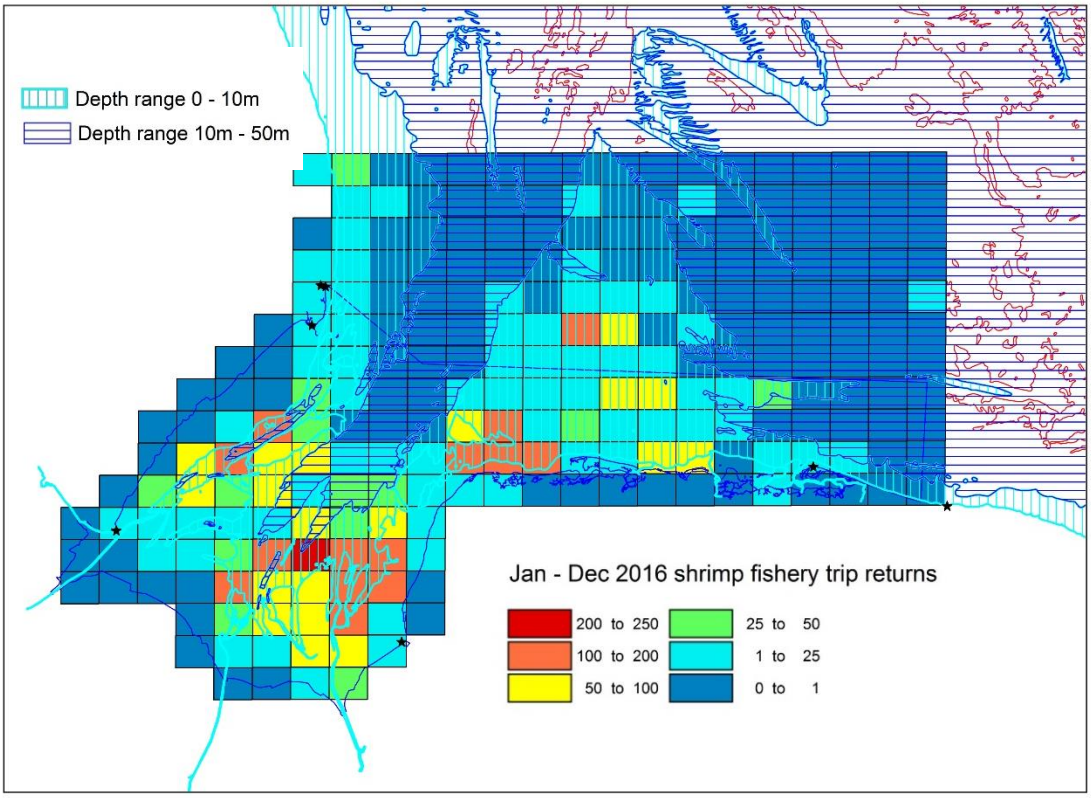


Figure 8 EIFCA's 2016 shrimp fishery trip returns data (key in Figure 5 above) has been overlaid with depth ranges. Nb. Data outside the WNNC SAC boundary has also been included.

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ABPmer & Ichthys Marine (2015). Supporting Risk-Based Assessments of Fisheries in MPAs, Final Report.ABPmer Report No. R.2551. A report produced by ABPmer for National Federation of Fishermen's Organisations, December 2015. Final Report – Appendices.

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Web References

WebRef 1	The Wash Shoreline Management Plan 2 – Appendix C – Baseline Processes. August 2010. http://www.eacg.org.uk/Docs/SMP4/Appendix%20C%20-%20Baseline%20Processes.pdf Accessed 19 Dec 2017 11:00
WebRef 2	EMODnet - Kinetic energy due to waves http://www.emodnet-seabedhabitats.eu/default.aspx?mapInstance=MESHAtlanticMap_&page=1974&LAYERS=EUSMWAVE&zoom=8&Y=52.935211160159&X=0.45382263183542 Accessed 8 Dec 2017 09:00
WebRef 3	Cefas "WaveNet interactive map" http://wavenet.cefas.co.uk/Map Accessed 17 Dec 2017 16:00
WebRef 4	Royal Haskoning Ltd (2004) Coastal Change Around The Wash: Literature Review. Final Report. https://www.researchgate.net/publication/280224696_Coastal_Change_around_The_Wash_Literature_Review Accessed 19 Dec 2017 11:30