

**Appendix 11:** Consideration of seabed sediment type, depth and fishing effort within The WNNC SAC shrimp fishery area, and interactions of these with species diversity.

This document presents an examination of species diversity and shrimp beam trawling activity within and beyond the Wash & North Norfolk Coast SAC, against a background of seabed sediment type and depth information. Diversity is compared in areas of higher and lower fishing intensity, to ascertain whether shrimp fishing is the dominant factor affecting diversity, or whether sediment type and depth are more important.

Appendix 9 (Natural Disturbance) examines the interaction of measures of natural disturbance and both diversity and faunal cluster, as derived from Cooper & Barry (2017). The current examination considers variations in seabed sediment / depth (there is a tendency for the two to show correlation) and levels of shrimp beam trawl fishing activity, and examines how species diversity (Cooper & Barry 2017) responds to variations in these metrics. This is presented as a visual examination of graphically-presented data, rather than a quantitative analysis, since Eastern IFCA do not have access to the data from which the diversity ranks were derived.

Seabed sediment types are obtained from the Natural England habitat extent data (January 2018), depth data is digitised from UK Hydrographic Office charts. Cooper & Barry (2017) present a diversity rank (derived from comparison of species diversity within a huge dataset of UK grab sample data). Levels of shrimp beam trawling activity are derived from Eastern IFCA shrimp “returns” for 2016, quality assured through different sources as explained below.

### **Correlation between depth, seabed sediment type and species diversity**

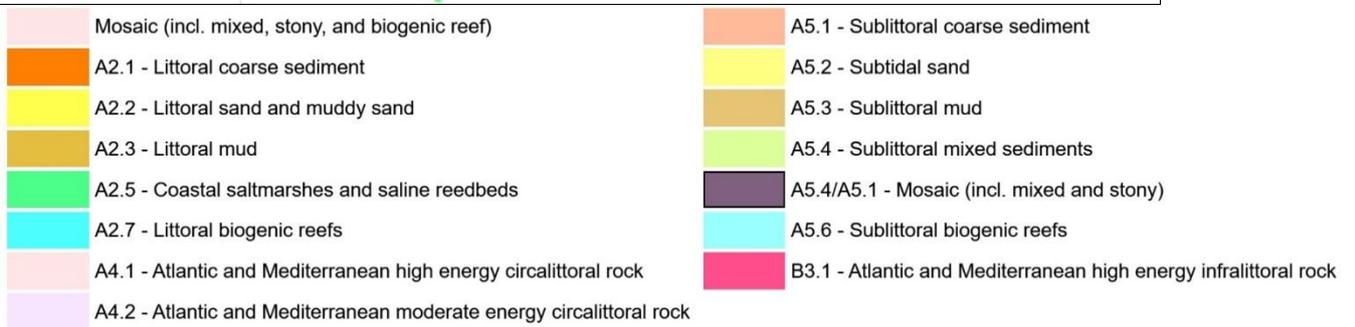
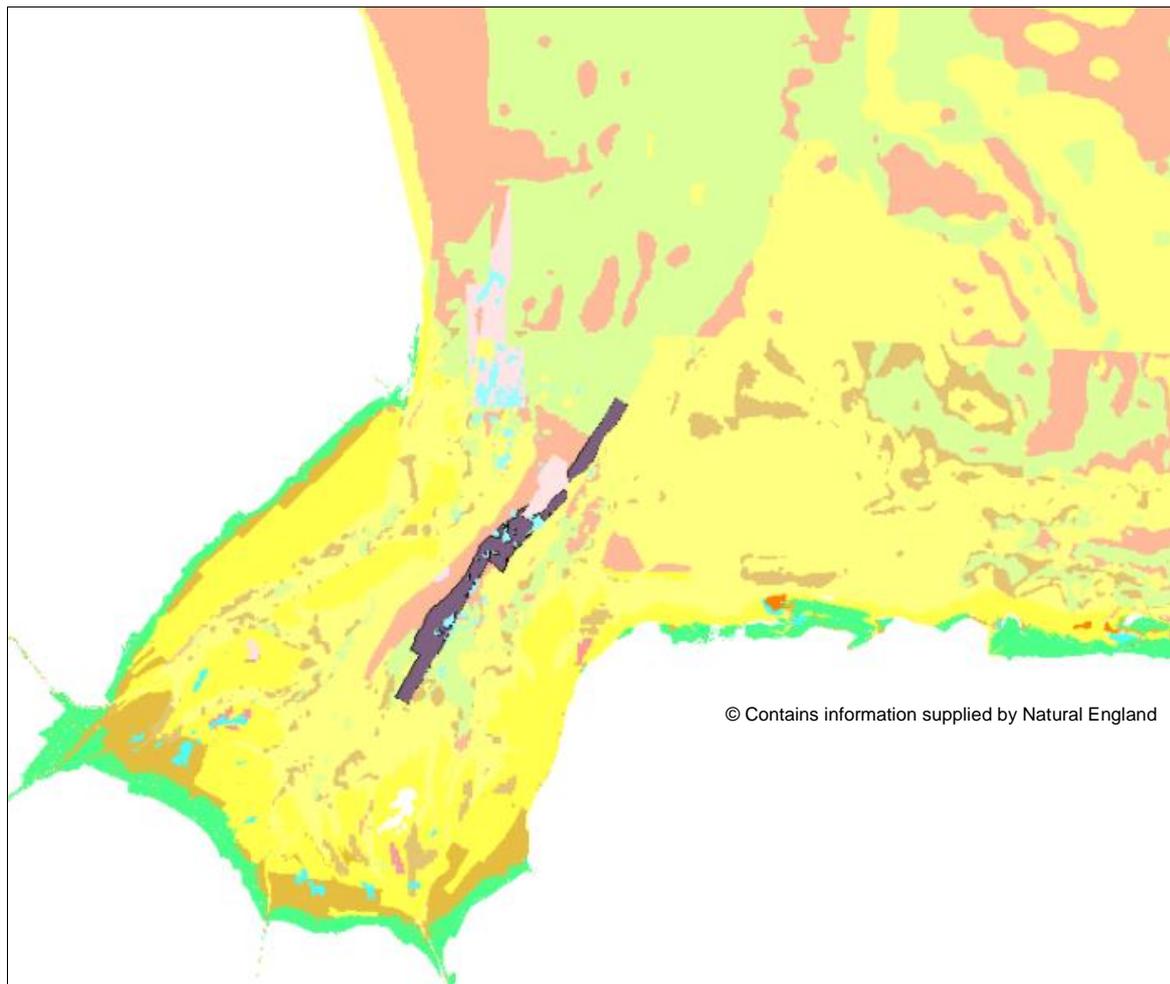
**Figure 1** shows the seabed sediment types across the WNNC SAC and adjacent areas, and **Figure 2** overlays ranked species diversity information from Cooper & Barry (2017) onto the seabed sediment data. (The overlay is achieved by manually geo-referencing an image of the diversity data to create a raster layer as the GI shapefiles are not

currently available to Eastern IFCA). Figure 3 repeats Figure 2 with the addition of a depth layer: it highlights areas deeper than ten metres below chart datum. (Note that all depths within this document refer to depths below chart datum, unless otherwise stated).

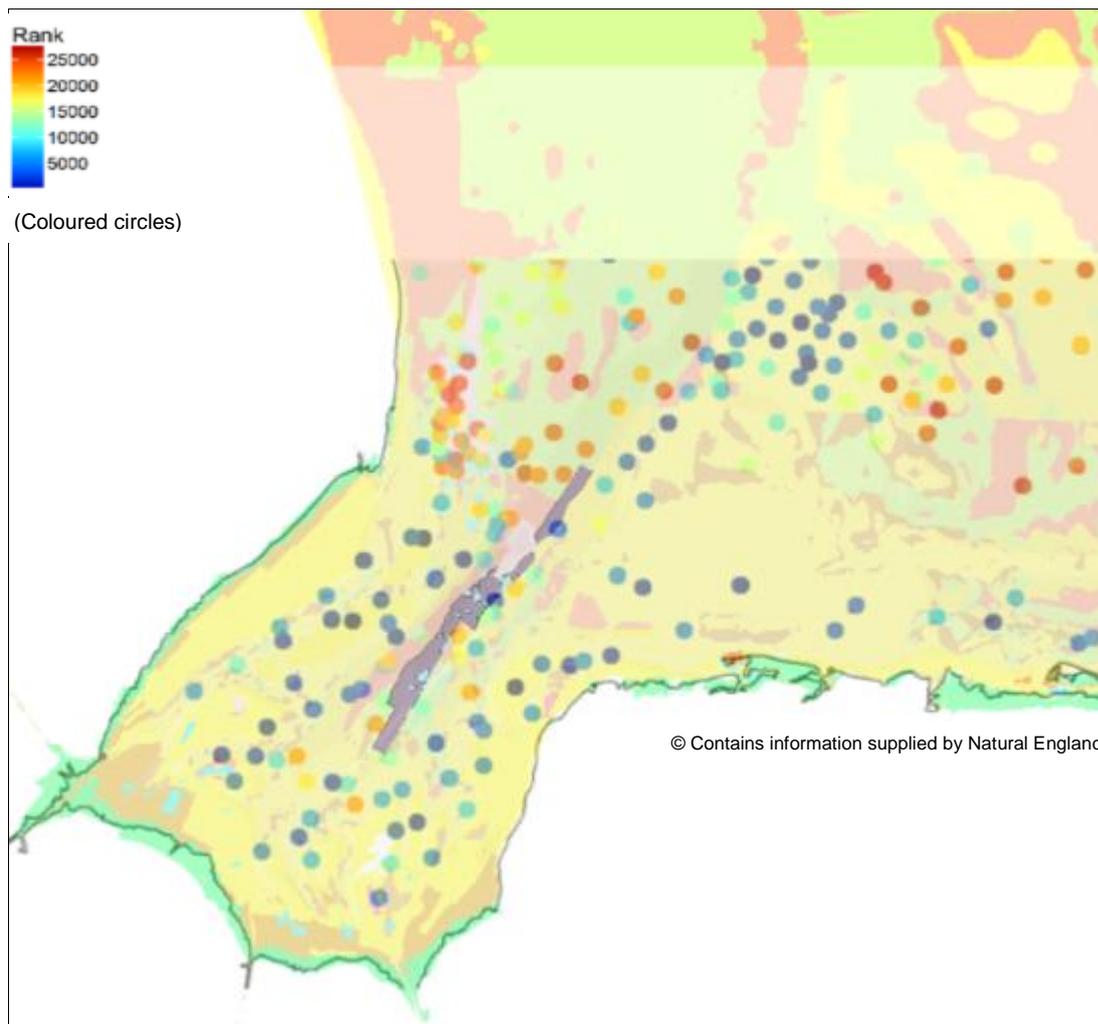
The examination shows that lower diversity is consistent with intertidal and subtidal sand areas (shown in yellow in Figure 1, EUNIS codes A2.2 and A5.2), within the WNNC, these sandy habitats generally coincide with the 0-10m depth range<sup>1</sup>. This is unsurprising given that sand-dominated habitats typically support impoverished communities with a low species diversity (Sanders 1968; Snelgrove, 1999, Kaiser *et al.*, 2002; Dornie *et al.*, 2003; Hall *et al.*, 2008; Bolam *et al.*, 2010). There is an exception to this at the north of The Wash, where an area of sediments other than sand (shown in pink (no EUNIS code but described as Mosaic (including mixed, stony and biogenic reef) and turquoise (EUNIS code A5.6, described as sublittoral biogenic reef) in water shallower than ten metres coincides with point records of elevated diversity.

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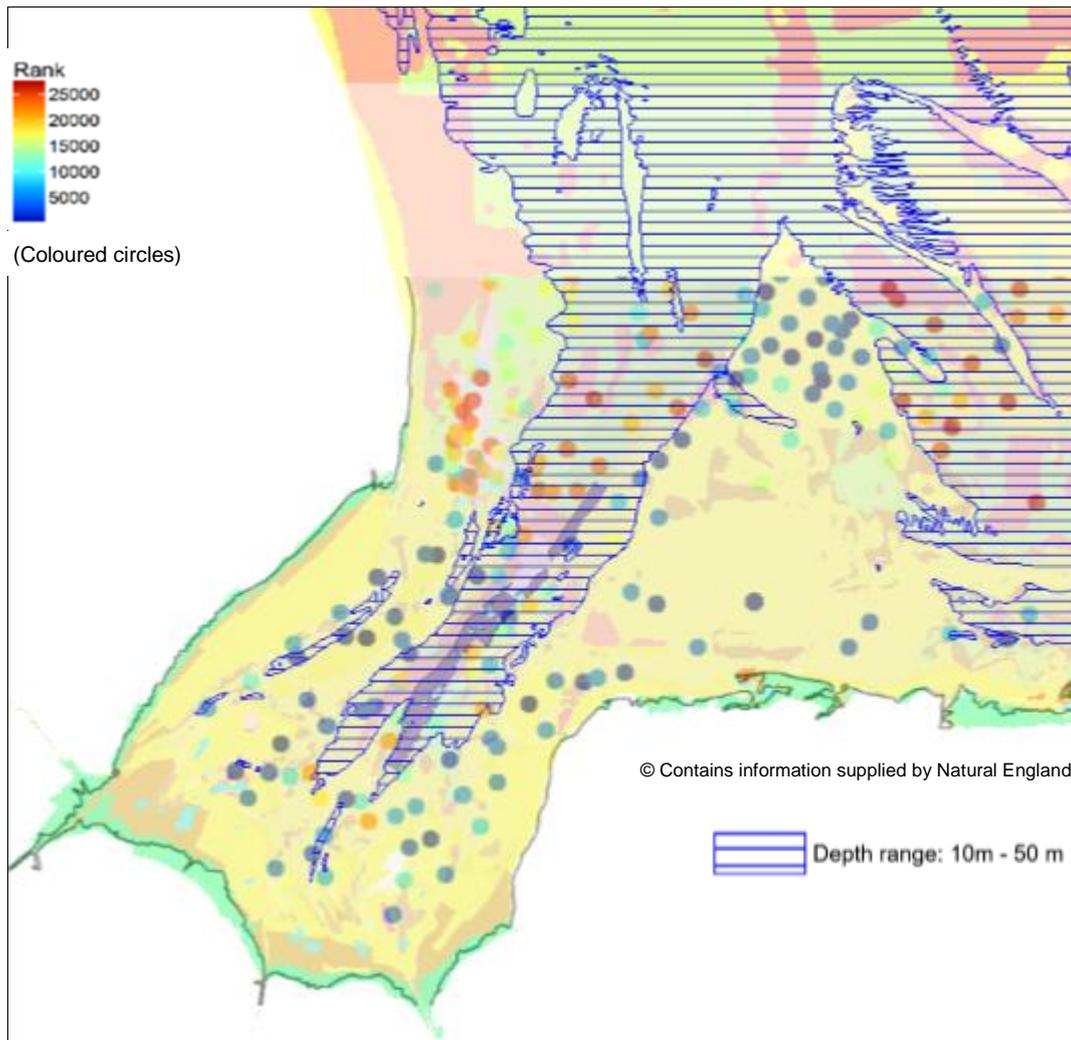
<sup>1</sup> Appendix 9 sets out why the 10m depth contour has been identified as most relevant to this shrimp fishing impact assessment



**Figure 1.** The Wash, North Norfolk and Lincolnshire coast — EUNIS sediment types. (Source: NE data release 2018\_01 (special release version containing non-designated extents)).



**Figure 2.** Cefas Diversity raster data (from Cooper & Barry 2017), overlaid with sediment types (Source: NE 2018\_01 special EIFCA release).



**Figure 3.** Cefas Diversity raster data (from Cooper & Barry 2017) overlaid with sediment types (Source: NE 2018\_01 special EIFCA release.) and 10m- 50m depth contour.

## **Correlation between shrimp beam trawl fishing effort, seabed sediment type and species diversity**

Shrimp fishers operating within the WNNC SAC and some adjacent areas are required by Eastern IFCA (under byelaw 11 – see section 3.2) to provide a monthly record of fishing activity. Figure 4 shows the grid pattern used to identify location of fishing activity, overlaid onto the local seabed sediment. One of the factors fishers are obliged to declare is the number of individual tows for shrimp conducted in each grid square. Figure 5 shows this information for 2016 (January to December inclusive), the latest year for which full information is available.

The fishing intensity data presented in Figure 5 has been compared with other sources of information on the spatial distribution of fishing activity in the WNNC, to assess the level of confidence in the returns data. The other sources of information include:

- VMS data (available for larger vessels (>12m) within the shrimp fishing fleet)
- EIFCA sightings data (primary observations recorded by EIFCA officers)
- Expert opinion from EIFCA officers with long experience in The Wash
- Anecdotal evidence from fishers
- the as-yet unprocessed data set for EIFCA obligatory returns for 2017.

These sources confirm that the 2016 shrimp returns data illustrated in Figure 5 represent with a high level of confidence those areas most and least used by the shrimp fishing fleet over time. It is therefore appropriate to use the spatial patterns of shrimp fishing in 2016 as an illustration of typical fishing patterns within the past 20 years or more (i.e. since the SAC was designated). Although on a small scale, shrimp fishing boats move to “follow the shrimp”, there are known grounds where brown shrimp fishing is targeted more than others, and the returns data correlates well with the known areas. The most commonly fished area (red and orange cells F13 to I13, H14 to I14 and H15) occurs in the eastern part of The Wash, a traditional brown shrimp fishing ground known as “the Common”. Two other favoured grounds (depicted by the orange cells) are the Boston Deepes (F9 and E10), which is a channel between the extensive foreshore flats and an offshore bank, and parts of the Burnham Flats/Docking Shoal (L9, K10 to M10 and N6).

Confidence in the spatial data for fishing intensity reflecting typical fishing patterns over longer time periods is important as the Cooper & Barry (2017) diversity data are derived from many surveys over a multi-decadal time period. As the patterns of relative shrimp fishing intensity are not likely to have changed significantly over this time, it is reasonable to compare species diversity with relative shrimp fishing intensity at different locations within the site, to investigate whether there is a correlation.

A red box has been drawn into the upper part of the grid in Figure 5 (cells I1 to I5 in the west to T1 to T5 in the east). This highlights an area of very low fishing pressure

(shown by dark blue and turquoise cells), and contains a range of seabed sediment types and depths. Within the 60 cells inside that box, the specific numbers of tows recorded throughout the whole of 2016 was:

2 tows	occurred in 2 cells
1 tow	occurred in 6 cells
0 tows	occurred in 52 cells

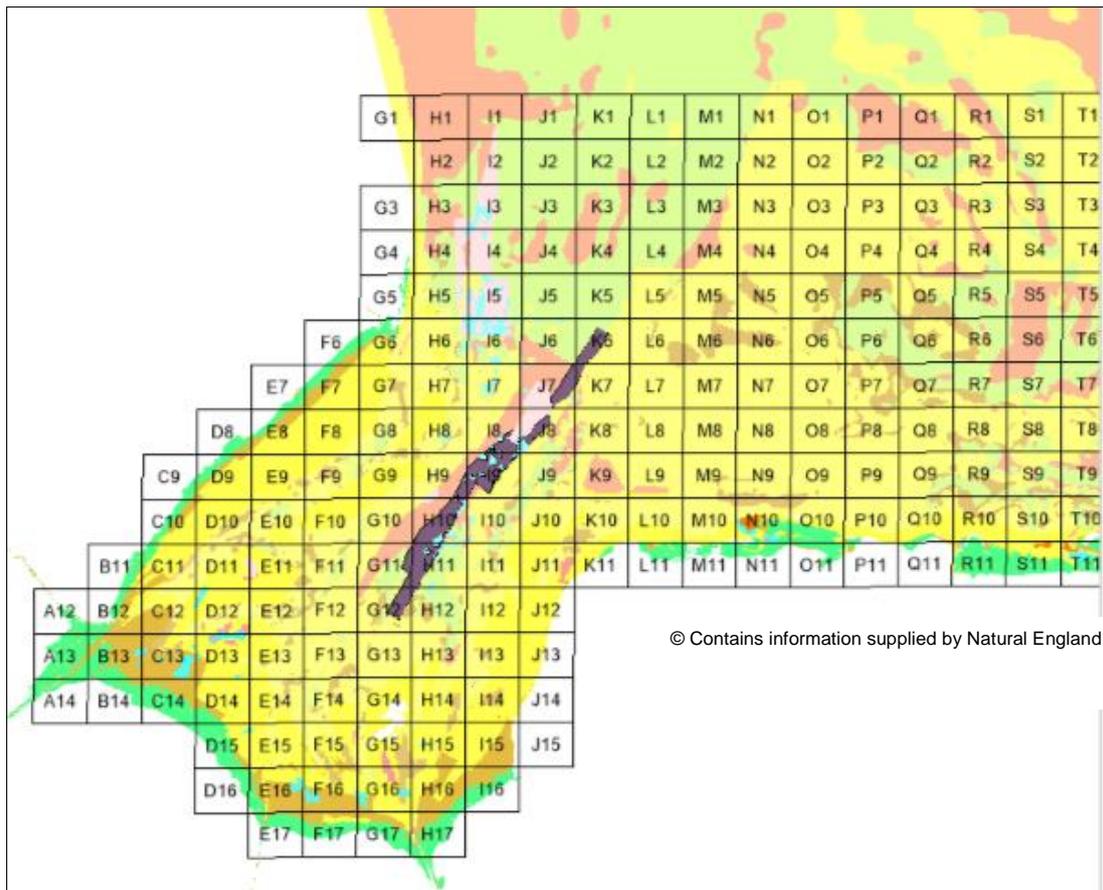
Figure 6 overlays the same “red box” onto seabed sediment types and the point indications of species diversity. Although the fishing effort (largely unfished) is generally consistent in this area, the diversity rank varies considerably. The diversity in this area appears to correlate with the sediment types and depth range (low diversity in shallow and sandy sediment areas, higher diversity in deeper and mixed sediment areas) rather than fishing pressure (or lack of fishing).

There is no apparent difference between the diversity in shallow sand areas between those areas subject to very low levels of fishing (e.g. Docking shoal at cells N2, N3, O2 and O3), and the diversity in locations with the same characteristics of shallow sand areas in those areas subject to the highest levels of fishing activity recorded (e.g. H13 and H14). Cell G13, which records the highest density of fishing and occurs on shallow subtidal sand, contains three diversity data points including one relatively high-ranking result. Neither is there an apparent difference between the diversity in deeper areas subject to no or very low levels of fishing (e.g. I9 and J8) and the diversity in deeper areas subject to higher levels of fishing activity (e.g. G12, H11) (although there are fewer points available from which to make this observation).

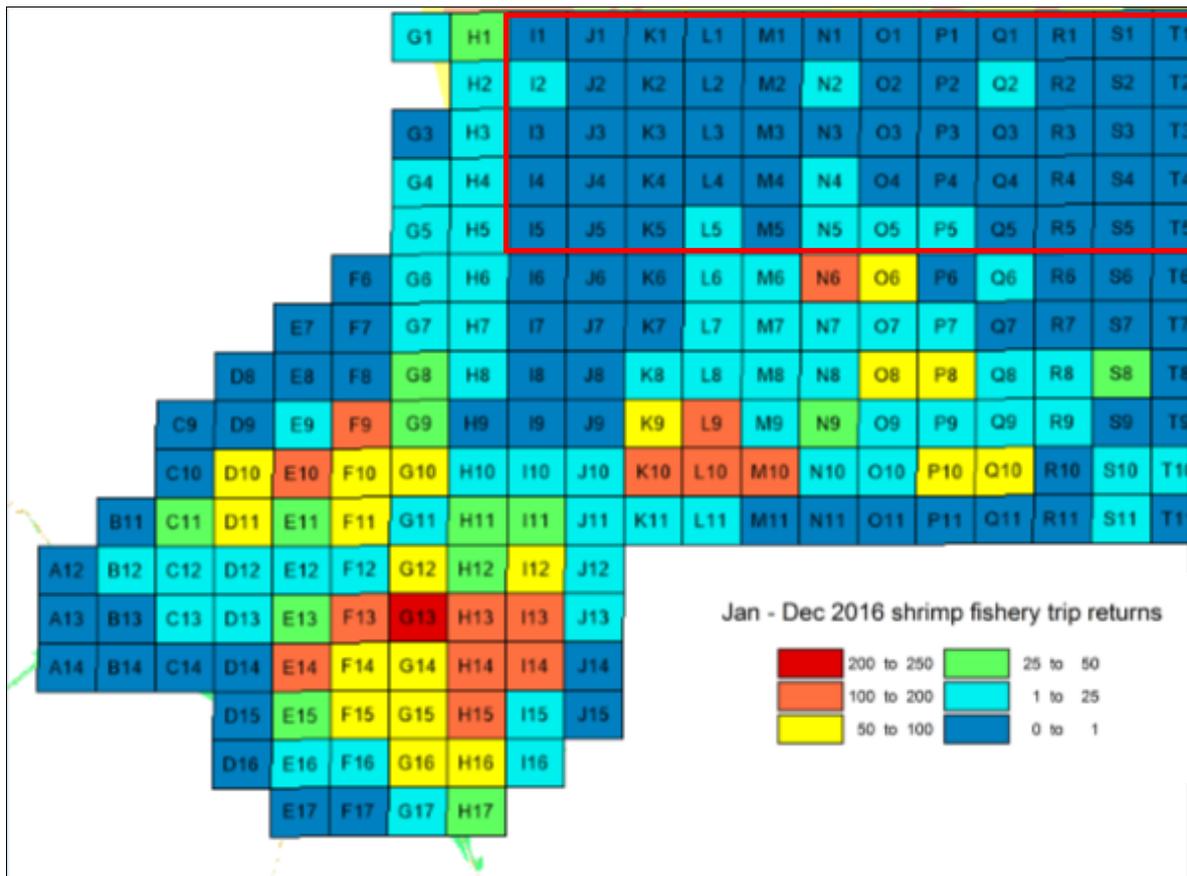
A shallow area to the north of The Wash (cells H4-H5 and I2-I6) exhibits multiple high diversity scores. The seabed habitat in this area is notably different from the sandy seabed habitats more typical of the shallow areas of Wash and North Norfolk Coast: it contains mosaic habitat that includes mixed, stony and biogenic reef. A part of this area is not fished (cells I3 to I6) but a low level of fishing is recorded in other parts of this area (cells H4, H5 and I2). [Towed demersal fishing activity is prohibited from areas of stony and biogenic reef habitat in the Wash & North Norfolk Coast SAC under Eastern IFCA’s Marine Protected Areas byelaw; outside of the site, brown shrimp fishermen avoid stony and biogenic reef areas since this seabed type can interfere with the smooth passage of light beam trawls and if dislodged, can clog the shrimp nets<sup>2</sup>.] The higher diversity in mosaic habitat areas is assigned to greater heterogeneity in sediment type and rugosity (surface roughness).

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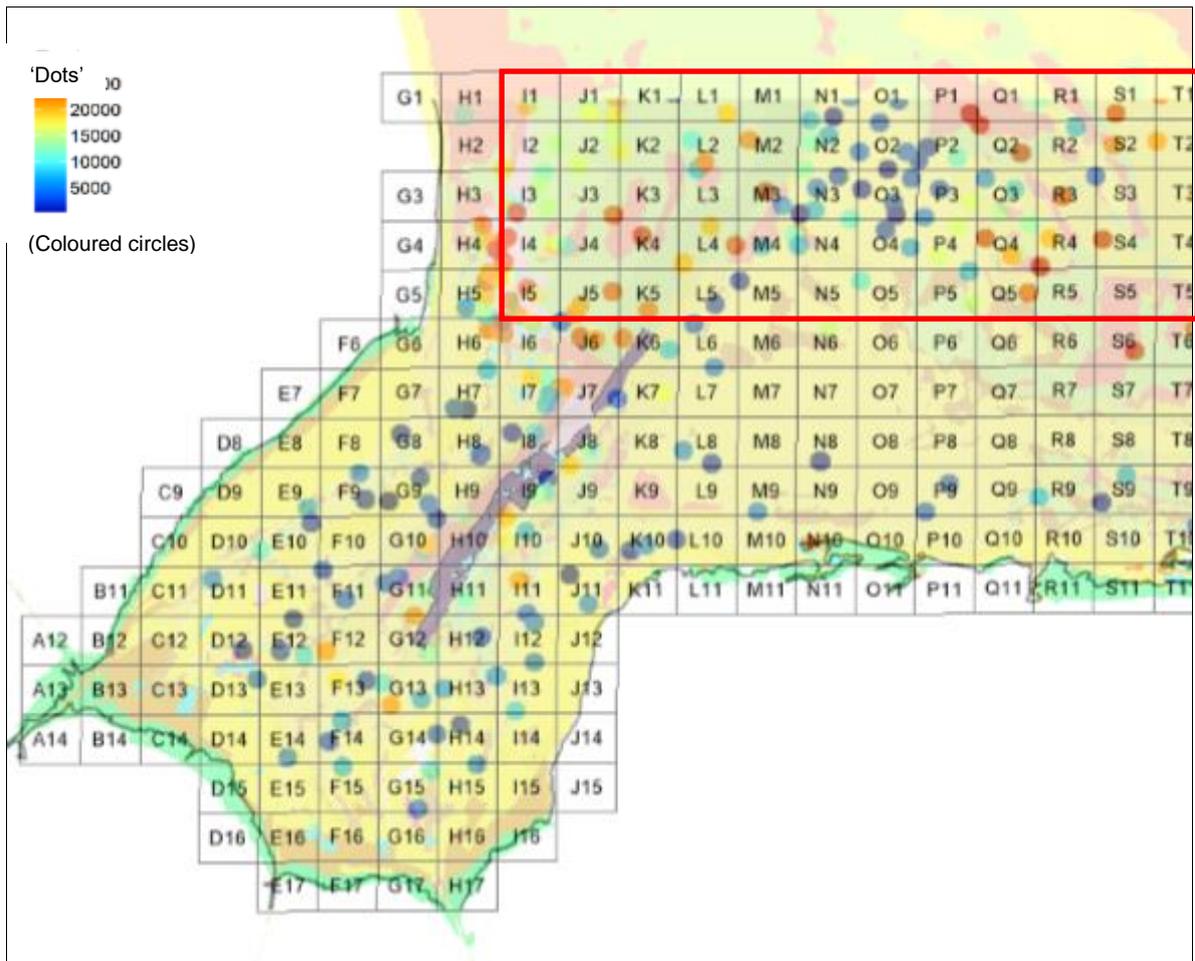
<sup>2</sup> The area referred to above is outside Eastern IFCA’s current management area, but is being considered for management within the adjacent Inner Dowsing, Race Bank & North Ridge SAC



**Figure 4** EUNIS sediment types (Source: NE 2018\_01 special EIFCA release.) overlaid with EIFCA shrimp fishery returns grid.



**Figure 5** EIFCA shrimp fishery returns grid, thematically mapped to indicate number of fishing tows in each grid cell during 2016.



**Figure 6** EIFCA shrimp fishery return grid overlaid with Cefas diversity raster data (from Cooper & Barry 2017)

## References

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