UKSeaMap 2010 Technical Report 1

Bathymetry

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June 2011

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1 Rationale

This technical report gives an overview of the construction of the bathymetry and bathymetric confidence layers. Work was completed by ABPmer under Task 1C of the MB0102 Defra data layers contract. Greater technical detail can be found in Frost & Swift, (2010). Additional work on deep sea bathymetric layers was completed by ABPmer under contract to JNCC.

2 Data sources

Bathymetry data from the SeaZone coastal 30m Digital Elevation Model (DEM) and from the General Bathymetric Chart of the Oceans (GEBCO) 30 minute grid (~0.76km) were used in UKSeaMap 2010. Both datasets were gridded to the UKSeaMap 2010 cell size of 0.0025 decimal degrees (~300m at the Thames estuary) (Frost & Swift, 2010).

The SeaZone 30m DEM was mainly derived from modern ship soundings. The GEBCO dataset combines quality controlled depth soundings with interpolation between sounding points guided by gravity data recorded from satellites (Figure 2).

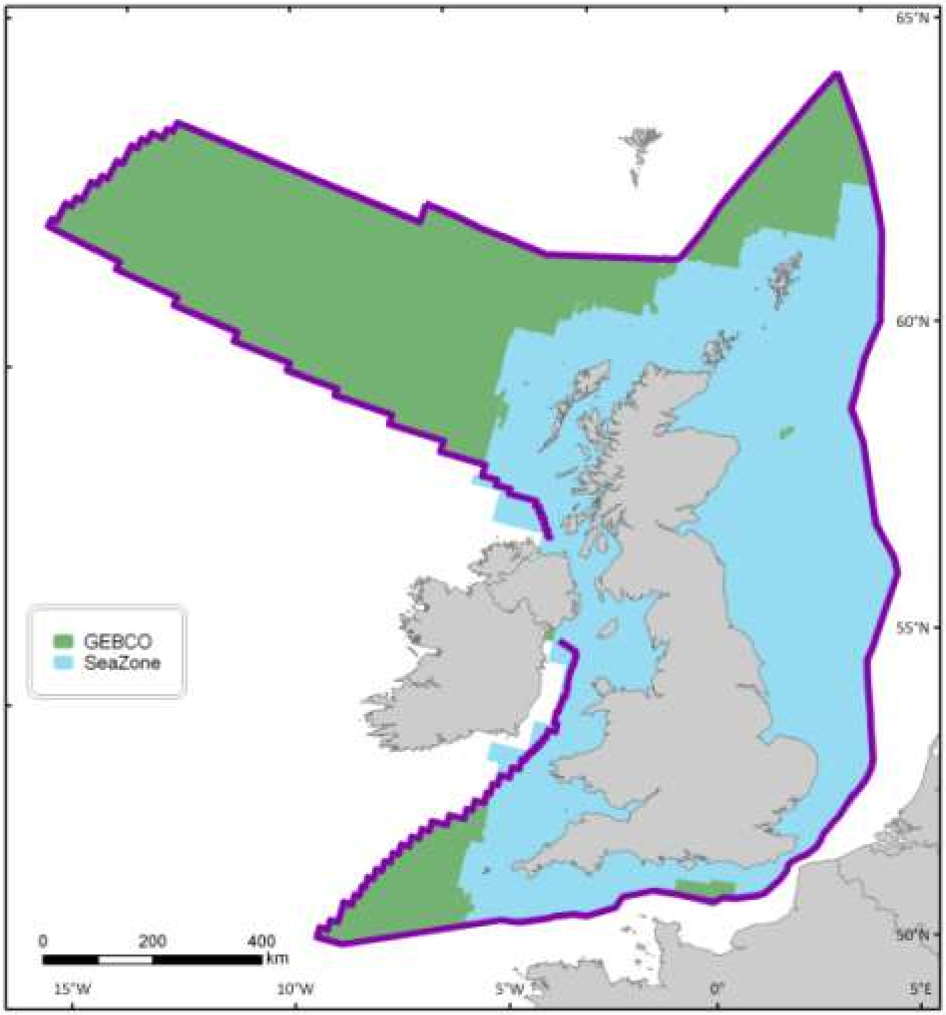

Figure 1: Map showing the areas covered by the coastal SeaZone DEM and the GEBCO 30" grid used in the UKSeaMap 2010 bathymetry layer.

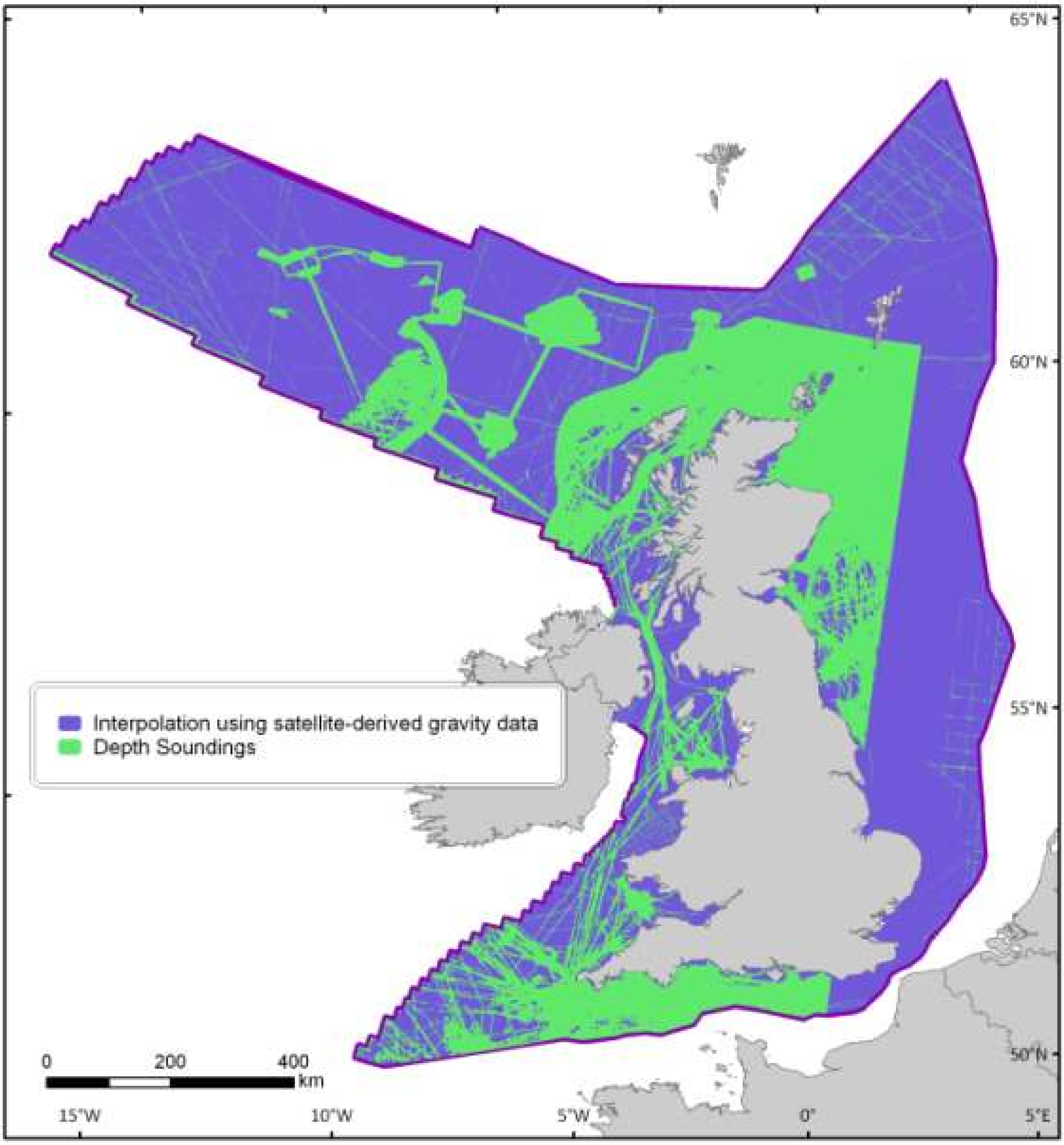

Figure 2: GEBCO SID[1] values showing how information was derived for the GEBCO 30" bathymetry dataset (2009).

3 Data Processing

The 30m SeaZone DEM and GEBCO 30" grid were gridded to the project resolution of 300m and combined to produce a single bathymetric layer of the UK marine area (see Figure 3) (Frost & Swift, 2010). In areas of overlap the higher resolution SeaZone dataset was used in preference to the GEBCO dataset (January 2009 version); in parts of the UKSeaMap 2010 area not covered by the SeaZone dataset, the GEBCO dataset was used.

[1] Source Identifier (used to delineate GEBCO data types)

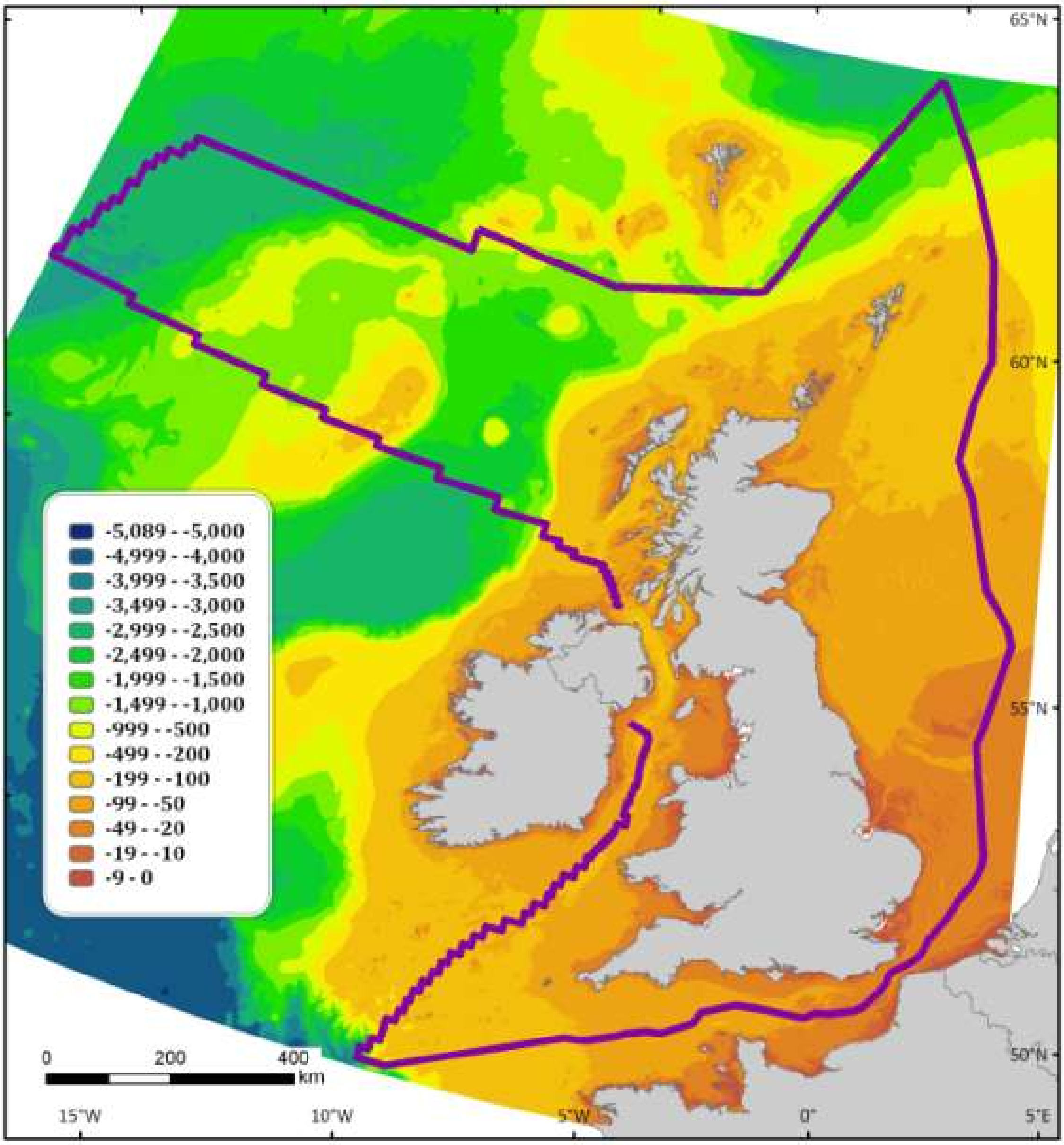

Figure 3: UKSeaMap 2010 bathymetry layer.

4 Confidence

Where a biological zone is defined in the UKSeaMap model purely in terms of depth, the confidence assessment of the bathymetry layer assigns, to each grid cell, the probability that the grid cell occurs within a particular biological zone. For example, the probability that the depth measured in a grid cell is within the depth range defined as abyssal. In the UKSeaMap 2010 model, only the Deep Sea biological zones are defined purely in terms of depth, hence confidence assessments of Deep Sea zones are the only ones described here. The confidence used to define the other biological zones, requiring integration of bathymetry confidence with light confidence (infralittoral – circalittoral boundary) and wave disturbance confidence (circalittoral – deep circalittoral boundary), are described elsewhere (see UKSeaMap Technical Reports 2 and 4).

The bathymetric confidence layers were initially produced for the deep sea depth zones used in the MESH project: 200 – 1000m and > 1000m (Coltman *et al*, 2008; Frost & Swift, 2010). These zones were subsequently changed to reflect the new Deep Sea biological zones recommended by Howell (2010) (Table 1).

Table 1: Deep Sea biological zone classification (Howell, 2010)

Deep sea zones	Depth bands
Upper slope	200 – 750
Upper bathyal	750 – 1,100
Mid bathyal	1,100 – 1,800
Lower bathyal	1,800 – 2,700
Abyssal	> 2,700

4.1 Confidence in SeaZone data

The confidence of SeaZone bathymetry data was produced by assessing the variation in depth values between the grid cells from the SeaZone 30 m DEM that contribute to each 300m (UKSeaMap model) grid cell. Mean and standard deviation values were used to assess the variation. SeaZone data was produced from modern ship soundings which are highly accurate. The mean value of SeaZone depth values for a 300m cell was taken as the depth value for that cell. Ninety-five percent of standard deviation values (associated with these means) throughout the SeaZone area were less than 1.8m and 50% were less than 0.2m. Standard deviations were used to indicate the probability value of a cell, e.g a cell with no standard deviation value would have a probability value of 1.0 as we could be highly confident that the depth value is correct.

4.2 Confidence in GEBCO data

The GEBCO and the SeaZone datasets overlap in many areas. These overlapping regions were used to assess differences between the GEBCO and SeaZone data. It was assumed that due to the higher resolution of the SeaZone data that it was also of higher quality than the GEBCO data. The data published by SeaZone are deemed to be in accordance with the IHO S44 standards for Hydrographic Surveys published by the International Hydrographic Organisation. Fluctuations in the accuracy of water depth measurements in respect of the GEBCO data, were derived partly from depth soundings and partly by interpolation between depth soundings guided by satellite gravity measurements. These fluctuations were quantified by making comparisons of the two data subsets of GEBCO water depths against SeaZone data, in areas where the two products overlapped. The output from this part of the study was a set of standard deviations of water depth related differences between the GEBCO and SeaZone products.

Each cell of the GEBCO 30¨ data grid contained approximately 3x3 cells of the 300m model grid. A grid was made with each GEBCO point surrounded by nine SeaZone 300m cells (Figure 4). The mean water depth in each of the surrounding SeaZone cells was obtained and then compared to the GEBCO value. The majority of the GEBCO water depth cell values had differences of ±2m with the SeaZone water depth cell value but in some areas there were considerable differences. This issue was resolved by considering two sub-sets of the GEBCO data: those based on ship soundings and those interpolated between ship soundings, guided by satellite data.

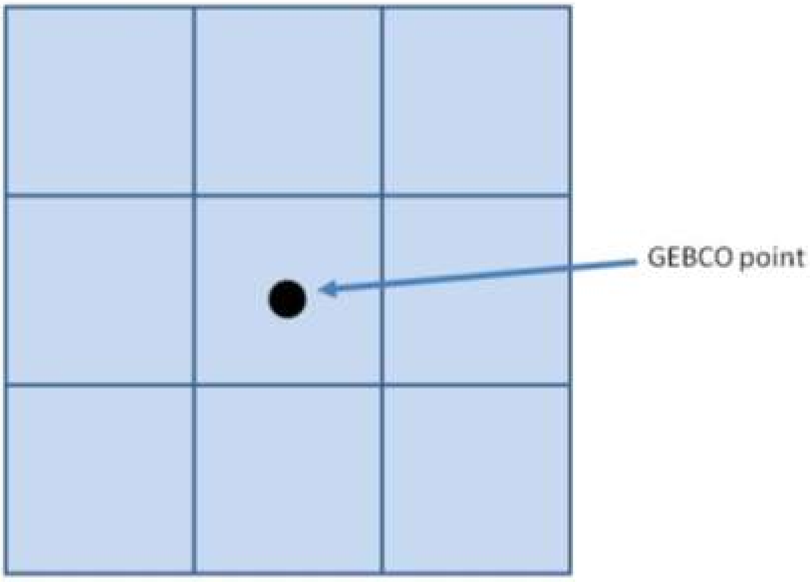

Figure 4: GEBCO point surrounded by SeaZone cells. Each blue cell represents a Seazone value.

The confidence of the GEBCO bathymetry data was thus assessed using a combination of two different methods where appropriate:

- Comparisons of the GEBCO water depths from depth soundings against SeaZone data to produce standard deviation values which were applied to GEBCO areas containing depth soundings (approximately 25% of the area). These values had lower standard deviations.
- Comparisons of the GEBCO water depths from the interpolation between dept h soundings guided by satellite gravity measurements and SeaZone data which were applied to GEBCO areas where interpolations were used. These values had higher standard deviations.

The standard deviations for each method were used separately to calculate probability values for each 300m cell (Frost & Swift, 2010). Standard deviations of these values were then used to assess the probability of the value of each cell being correct. The standard deviation values increased with depth indicating that the differences between GEBCO and SeaZone data could be depth-related, however they could also be a function of the reduced number of data points available with increasing depth. For depths greater than 250m, the maximum standard deviation values were applied.

The probability values for data derived by Seazone data, GEBCO data derived from ship soundings and GEBCO data from the interpolation between depth soundings and satellite gravity measurements were all combined into individual probability layers for each of the biological zones which used depth to define the boundary are shown in Figure 5 – Figure 10. These layers were combined with probability maps for the infralittoral and circalittoral zone to create a single biological zones probability map for the UKSeaMap 2010 project area (see UKSeaMap 2010 Final Report).

4.3 Confidence tool

An automated tool has been created which will allow each stage in the confidence assessment process to be repeatable using bathymetry data and standard deviation values associated with the bathymetry dataset. This tool will be made freely available.

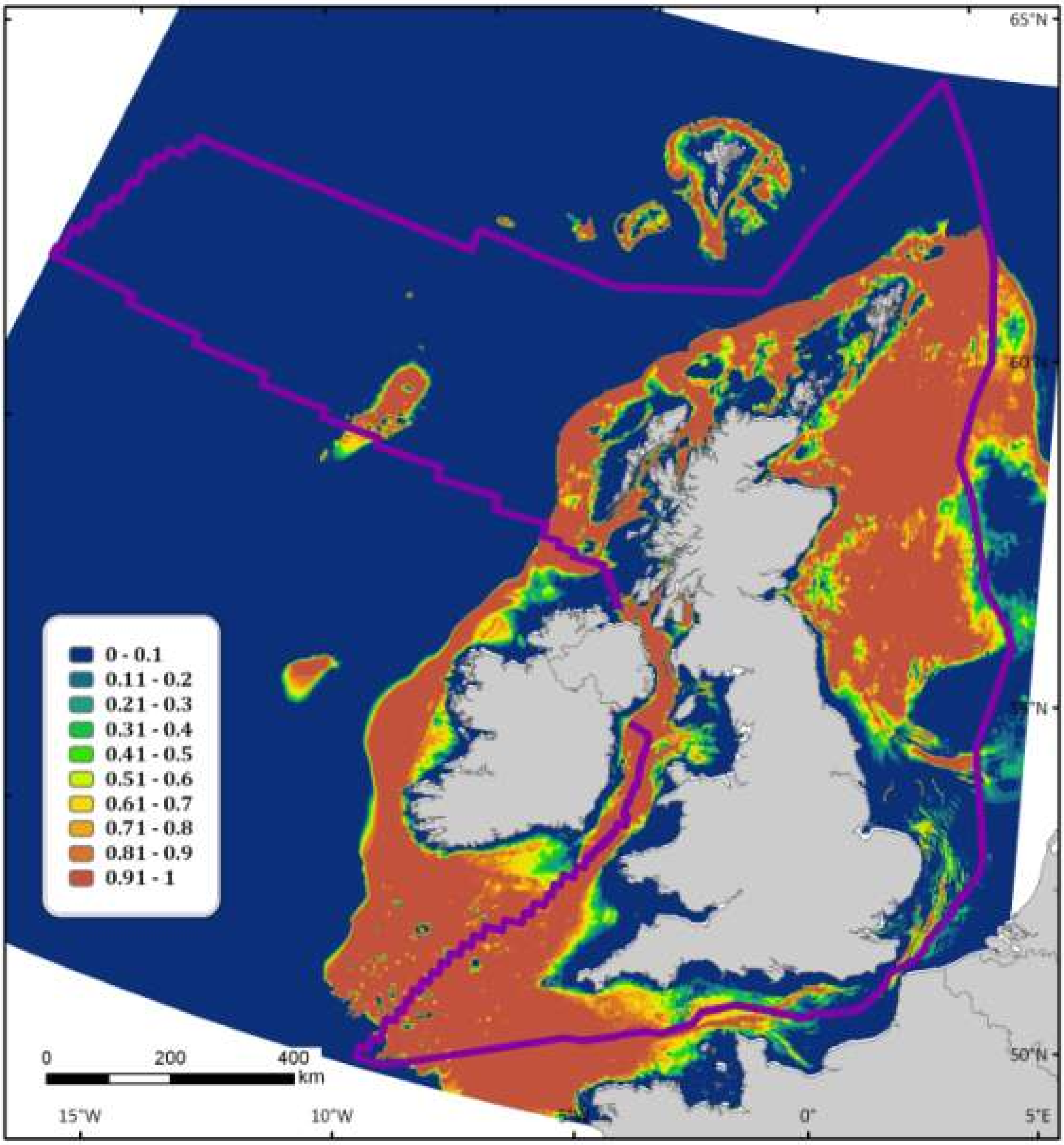

Figure 5: Probability that cells occur in the Deep Circalittoral zone. The lower limit of the Deep Circalittoral zone is defined as the 200m depth contour. The upper limit, defined by the wavebase, is discussed in UKSeaMap 2010 Technical Report 4.

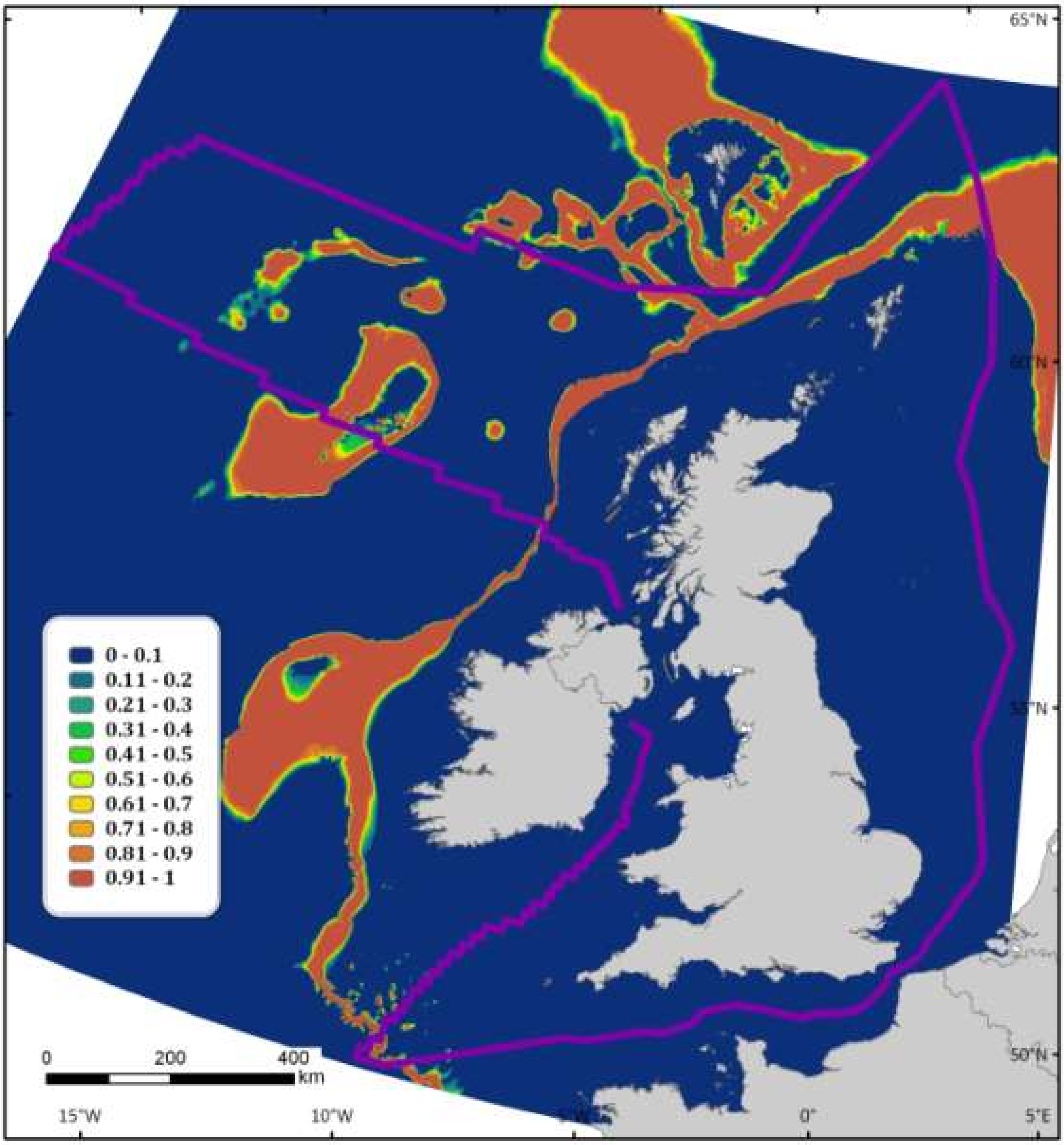

Figure 6: Probability that cells occur in the Upper slope zone (200m – 750m).

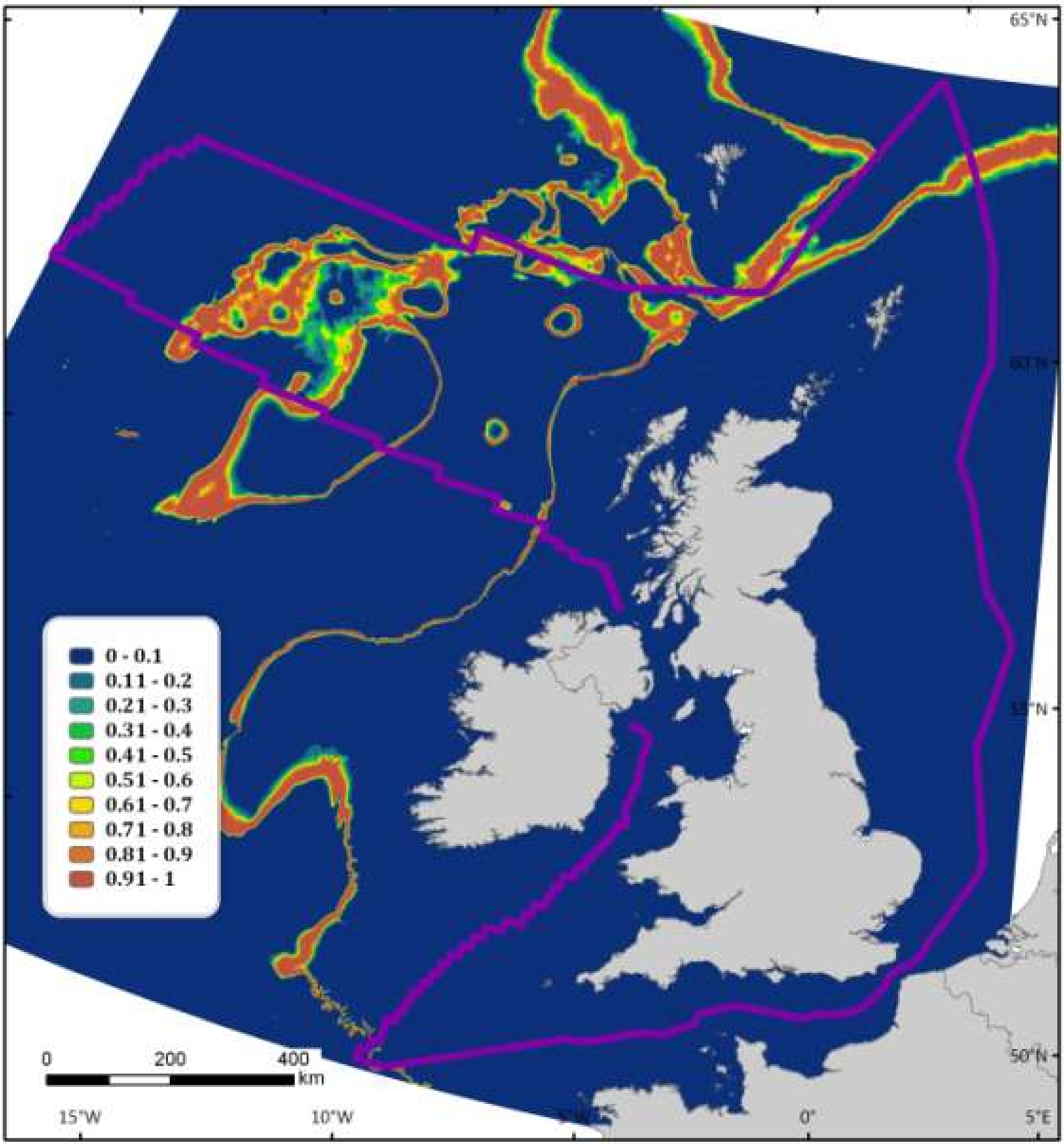

Figure 7: Probability that cells occur in the Upper Bathyal zone (750m – 1,100m).

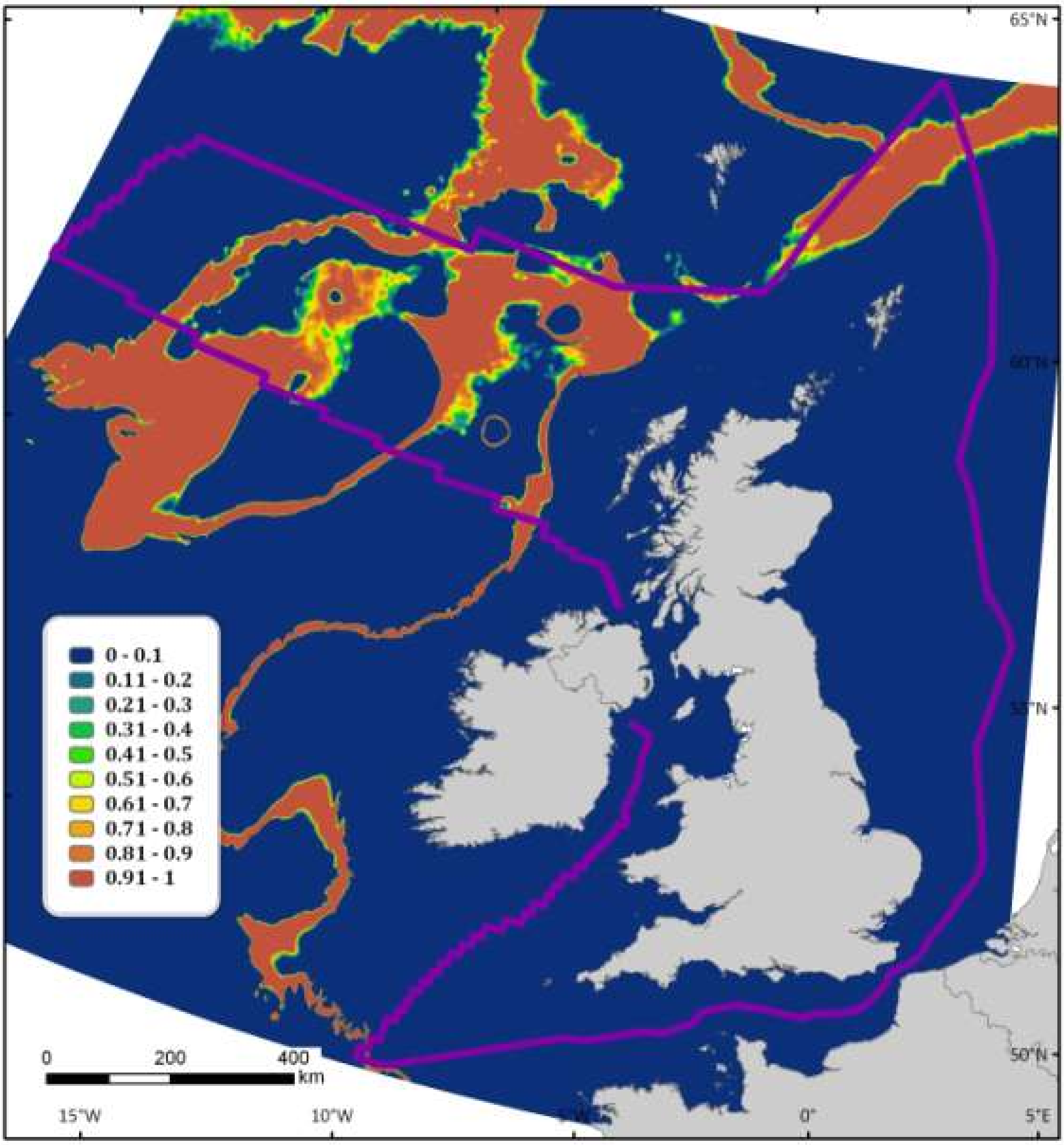

Figure 8: Probability that cells occur in the Mid Bathyal zone (1,100 – 1,800m).

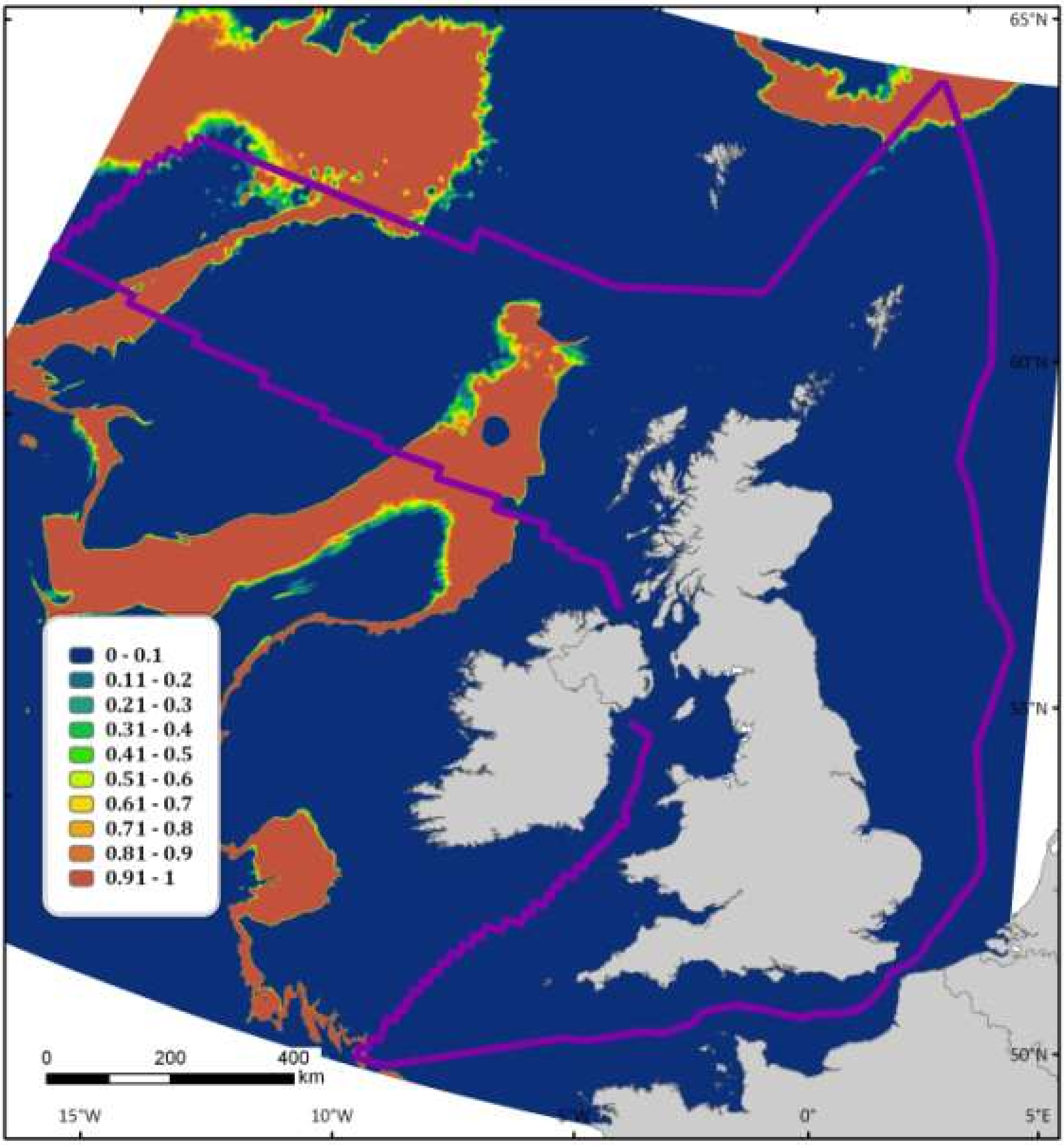

Figure 9: Probability that cells occur in the Lower Bathyal zone (1,800m – 2,700m).

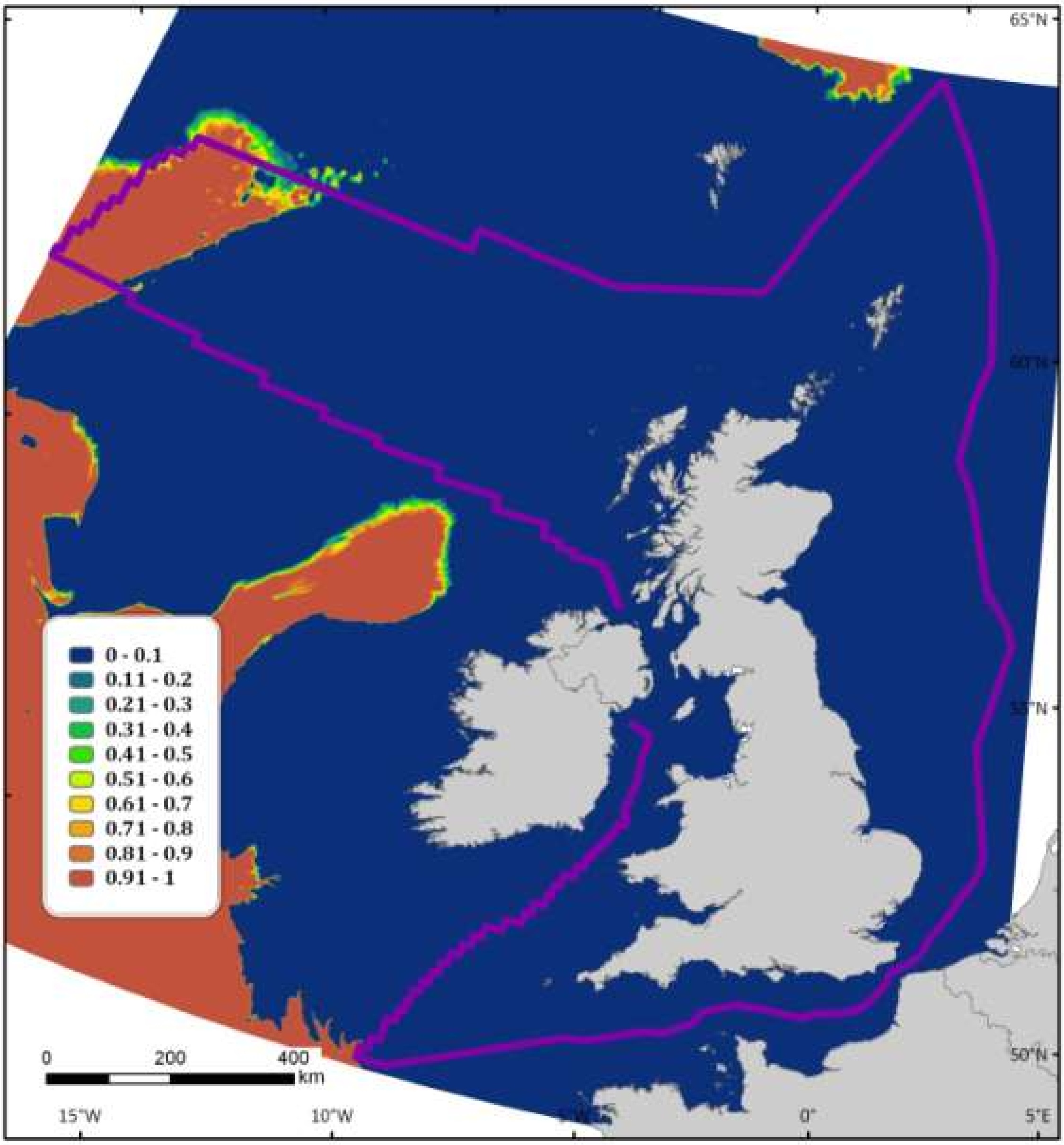

Figure 10: Probability that cells occur in the Abyssal zone (>2,700m).

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