Figure S1a. Matrix of scatterplots for the explanatory variables in the Firth of Forth grab surveys and Pearson correlation coefficients.
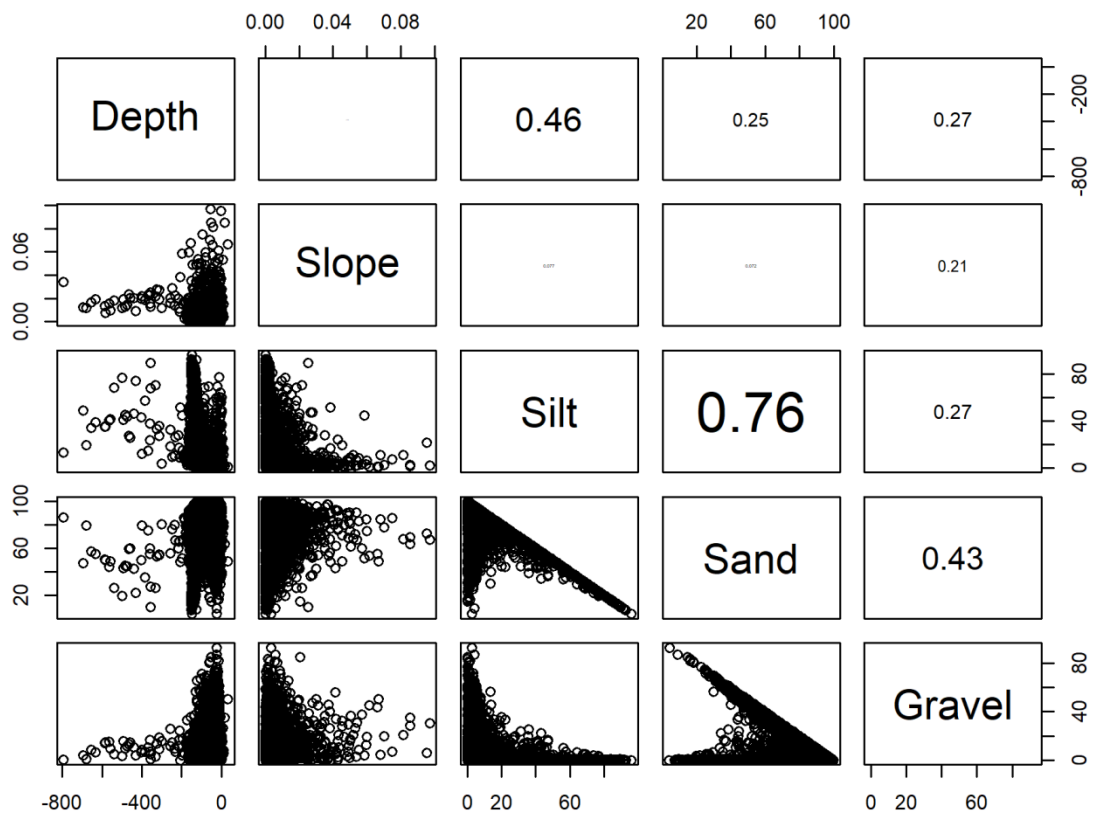
Figure S1b. Matrix of scatterplots for the explanatory variables in the North Sea study region and Pearson correlation coefficients based on random sample of 10 000 point locations.
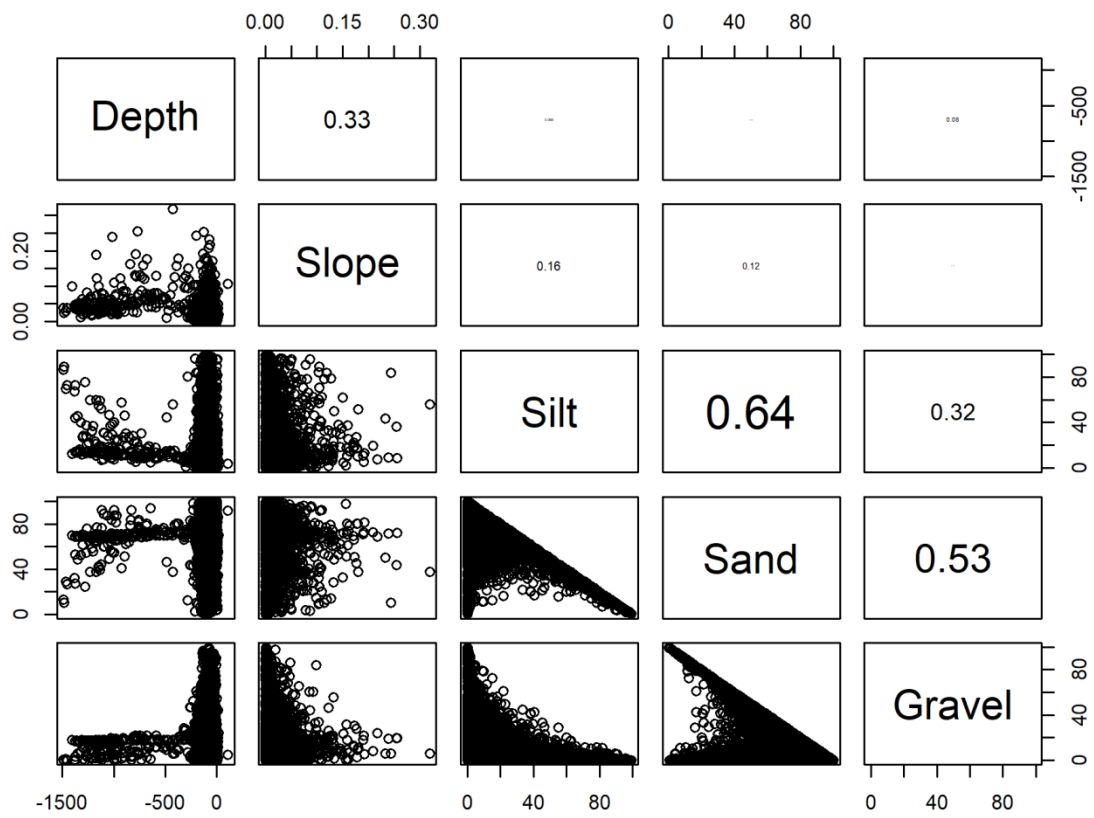
Figure S1c. Matrix of scatterplots for the explanatory variables in the Celtic Seas study region and Pearson correlation coefficients based on random sample of 10 000 point locations.
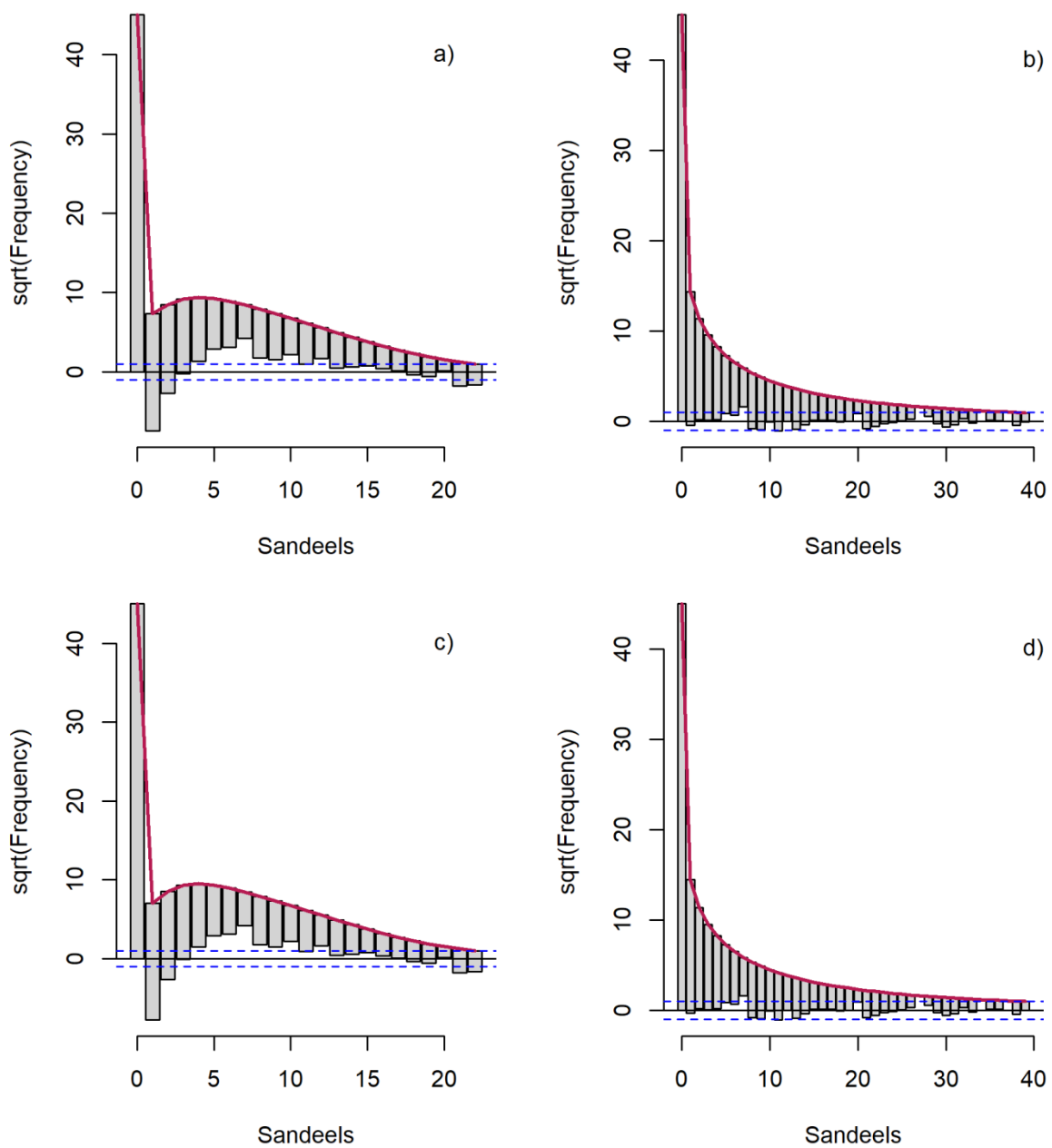
Figure S2. Hanging rootograms for a) hurdle model fitted using a poisson distribution for the count component, b) hurdle model fitted using a negative binomial distribution for the count component, c) zero-inflated model fitted using a poisson distribution for the count component and d) zero inflated model using a negative binomial distribution for the count component. Horizontal lines are confidence intervals based on rule of thumb of ± 1 (Kleiber & Zeileis 2016).
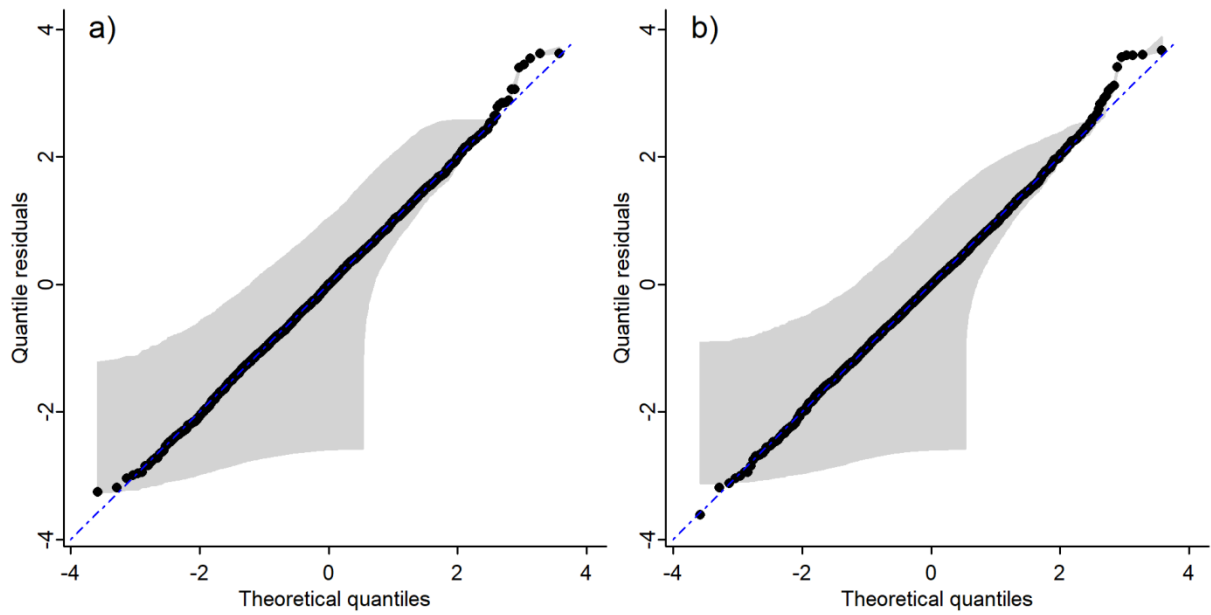
Figure S3. Q-Q plot based on randomised quantile residuals for a) the hurdle model with negative binomial distribution and b) the zero inflated model with negative binomial distribution.
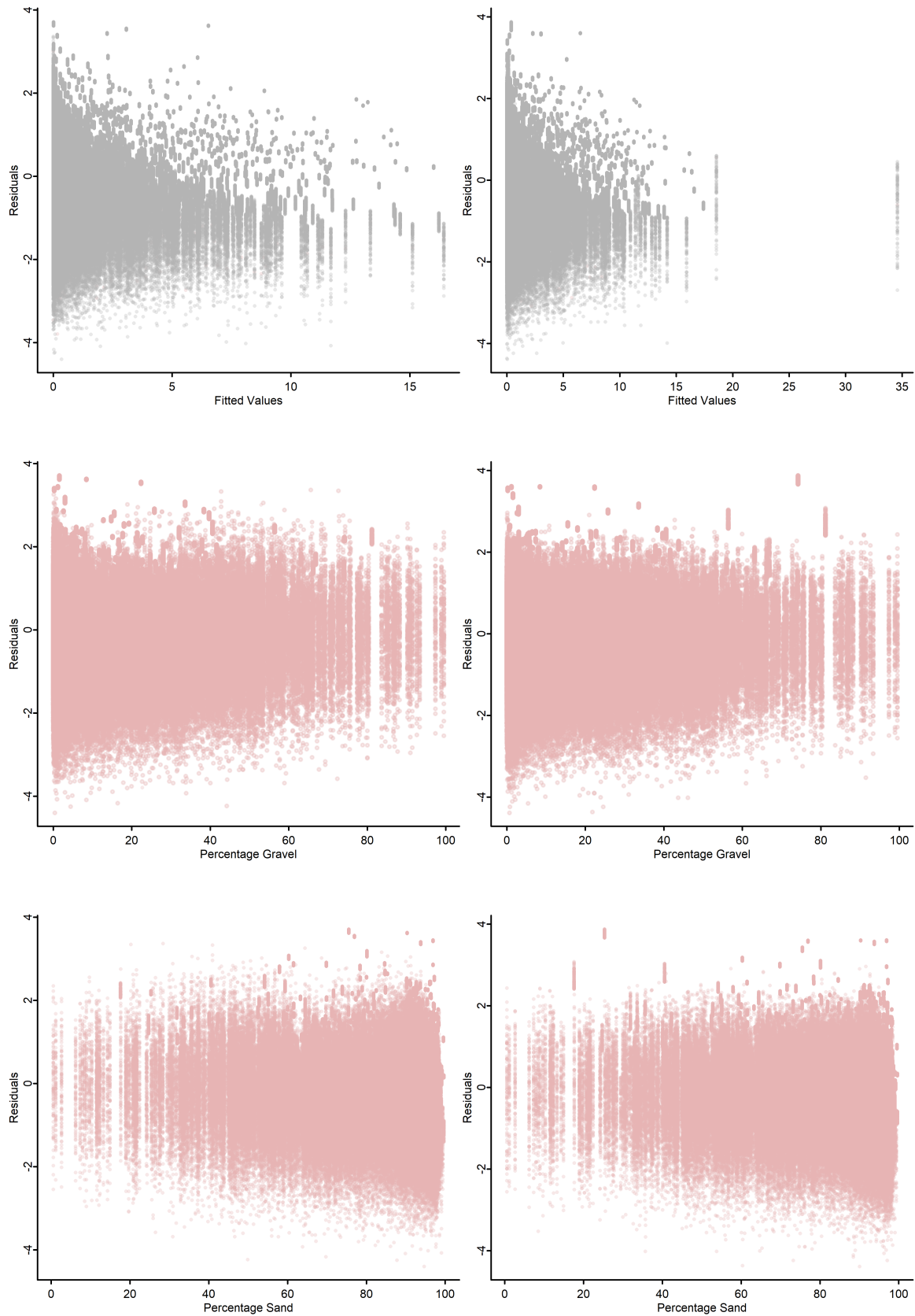
Figure S4. Scatter plots of randomised quantile residuals from 100 simulations and fitted values or explanatory variables. The left hand column is the hurdle model and the right hand column is the zero-inflated model.
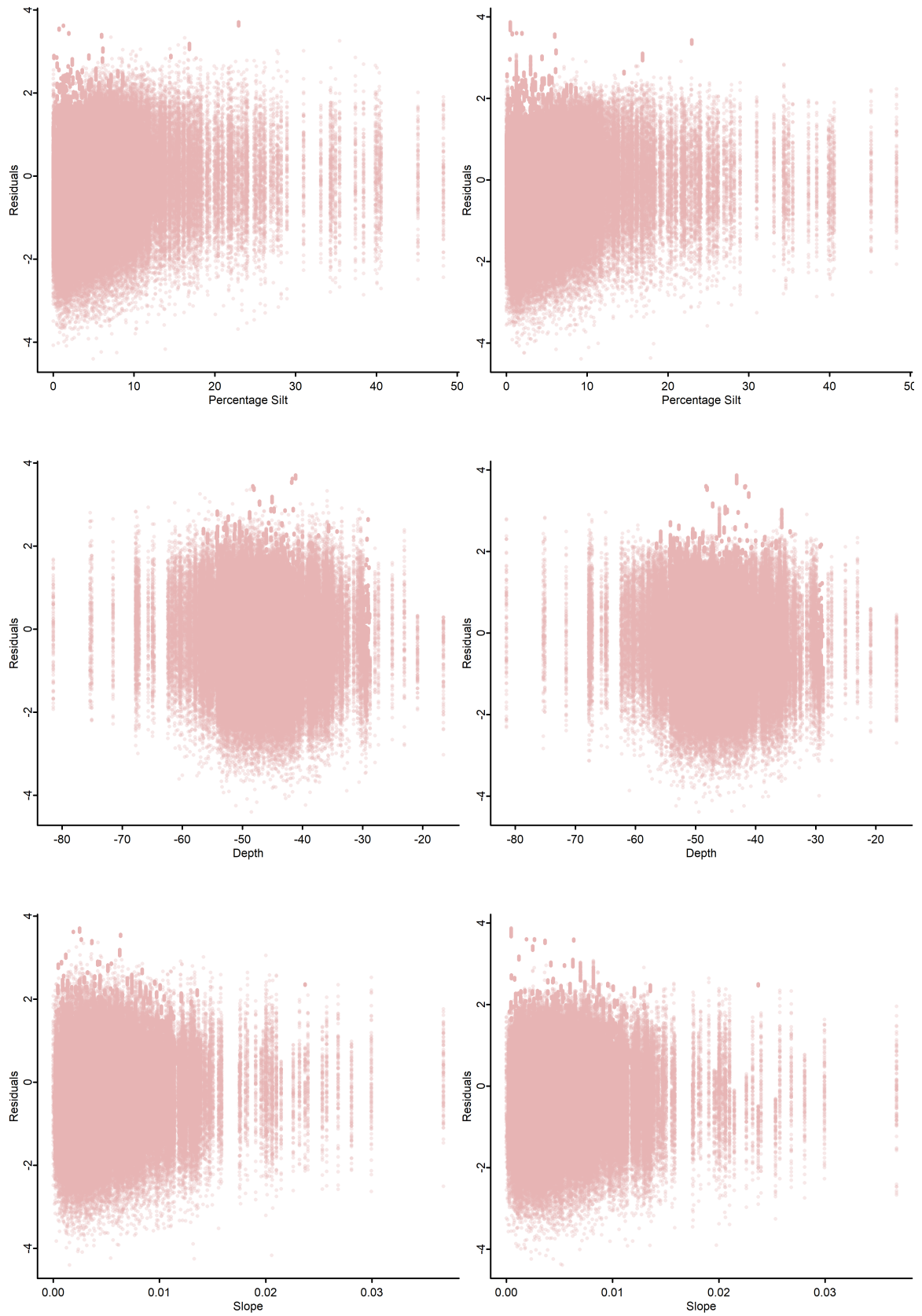
Figure S4 cont.

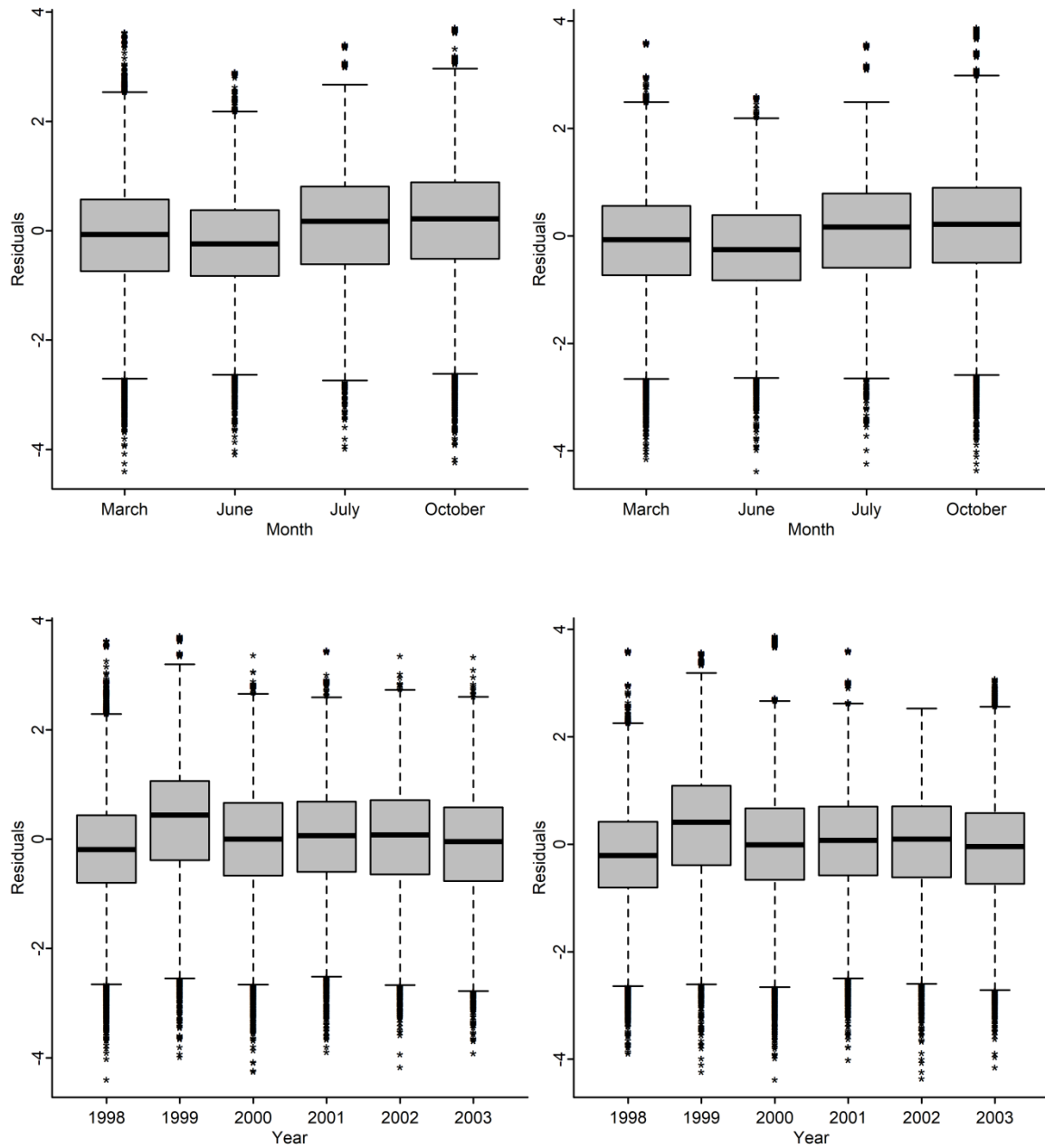**Figure S5.** Box-and-whisker plots of randomised quantile residuals from 100 simulations and survey month or year. The left hand column is the hurdle model and the right hand column is the zero-inflated model.
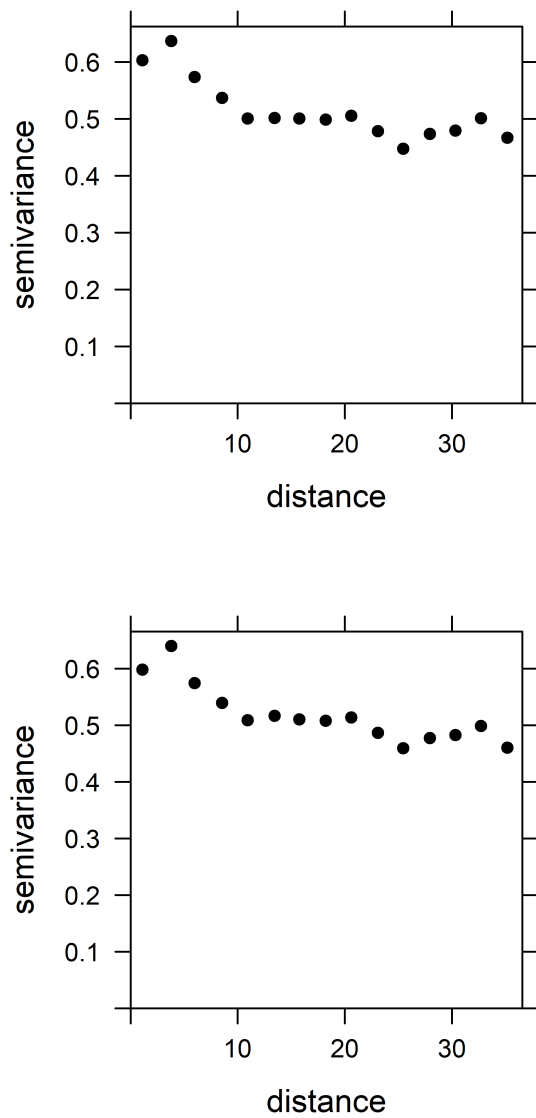
Figure S6. The semi-variograms of median quantile residuals for a) the hurdle model and b) the zero-inflated model indicating little spatial structure in the model fit for either model.
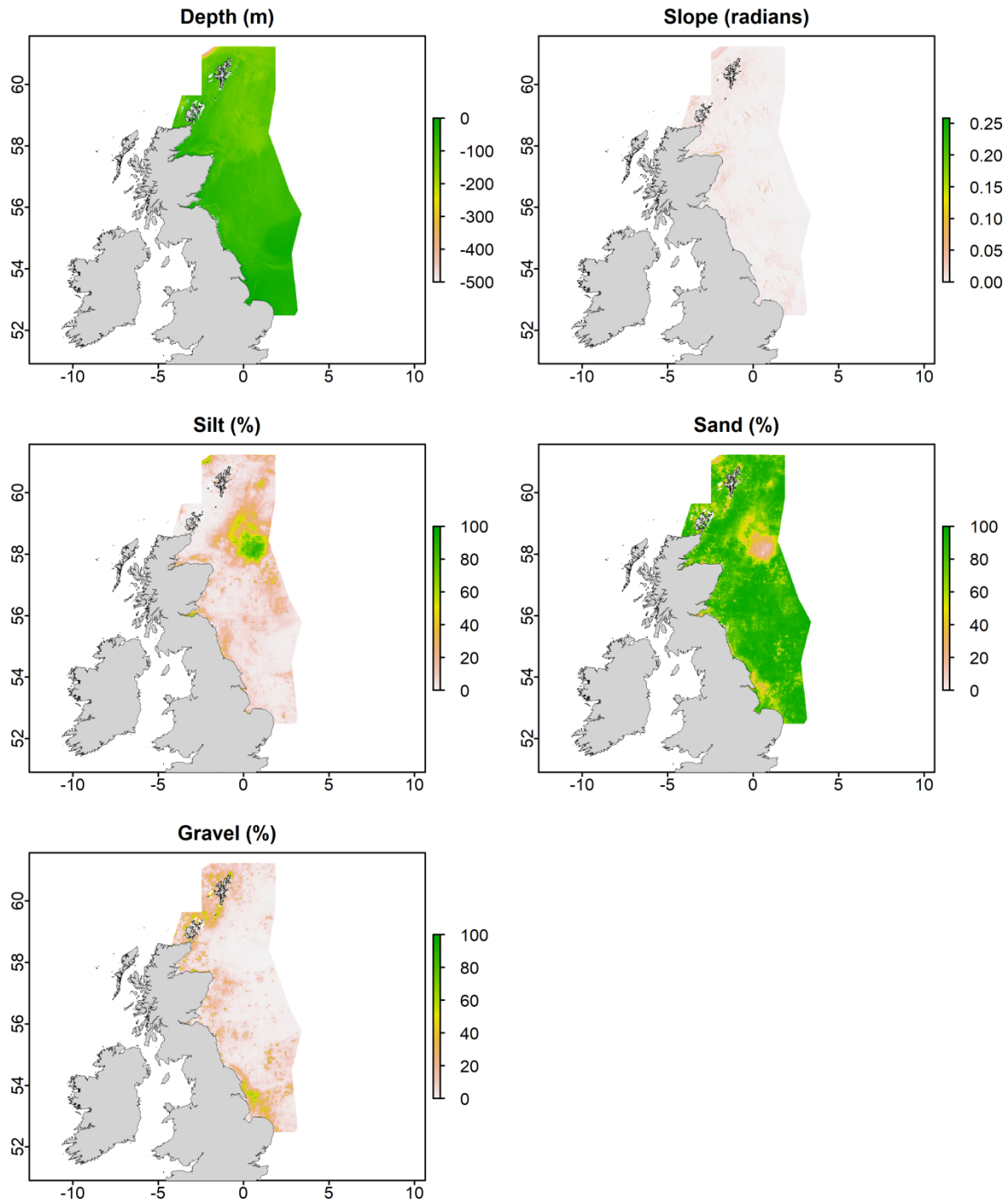
Figure S7a. Maps showing the depth (EMODnet Bathymetry Consortium 2018), slope and sediment layers used to make the predictions for the Greater North Sea region
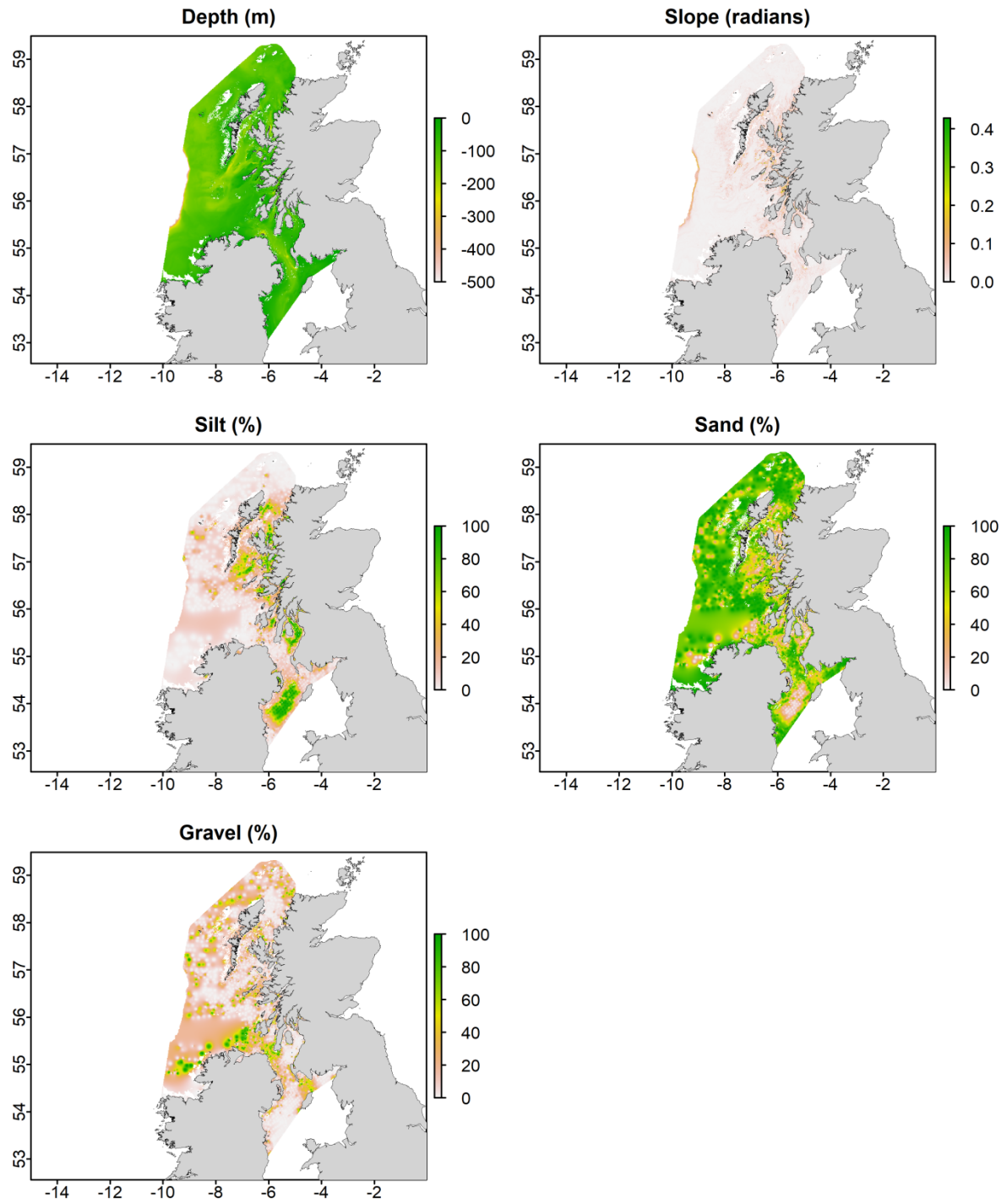
Figure S7b. Maps showing the depth (EMODnet Bathymetry Consortium 2018), slope and sediment layers used to make the predictions for the Celtic Seas region
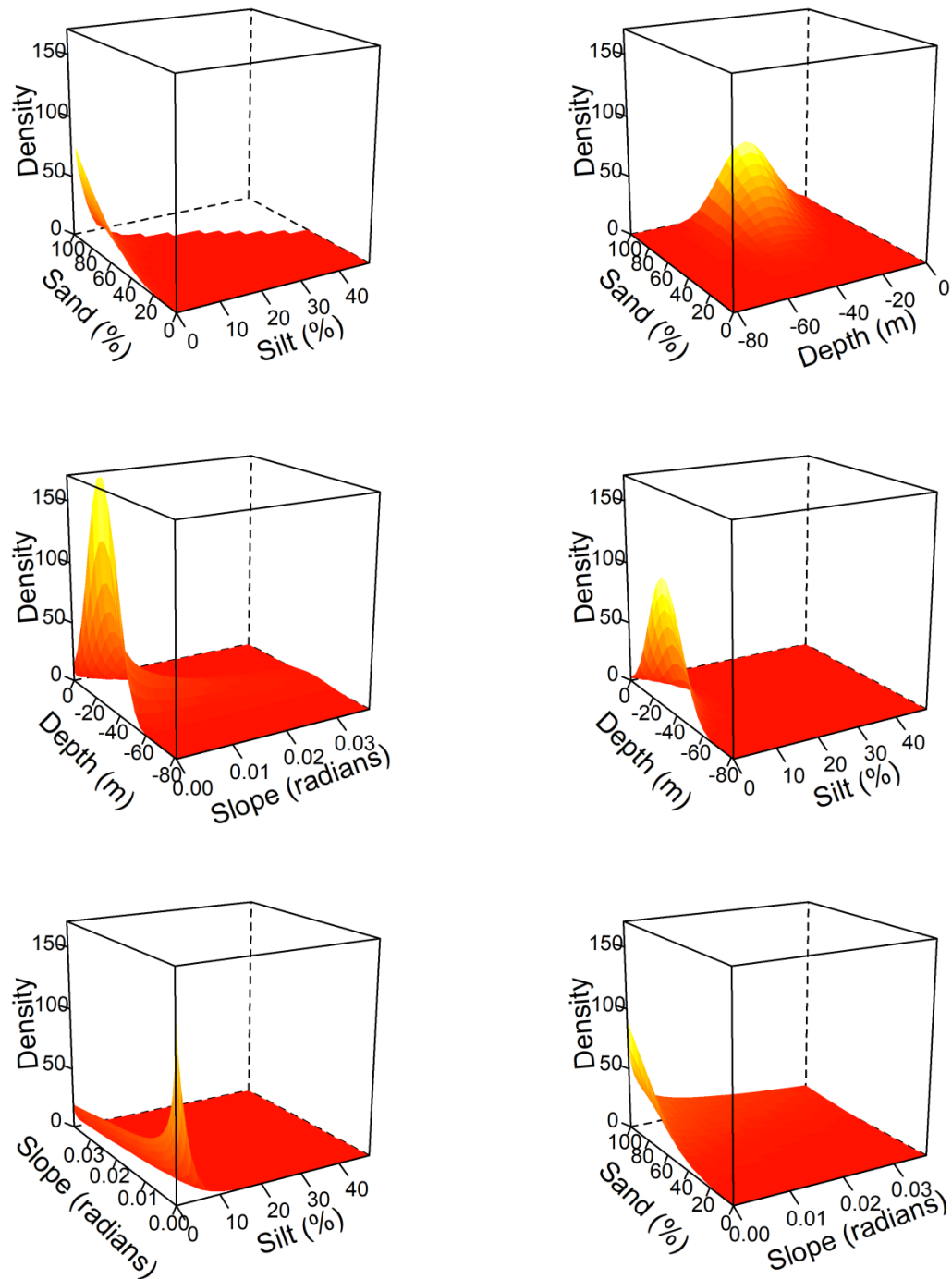
Figure S8. The partial response plots for the predicted density of sandeels (no. m^{-2}) by the hurdle model as two explanatory variables vary across their range. Predictions were made for all records in the Firth of Forth survey data for each combination. The mean prediction is displayed.

Figure S9a. Yellow areas show the parts of the North Sea study region that are outside the range recorded in the Firth of Forth grab survey used to build the model, for each of the explanatory variables.

Sand

Silt

Depth

Slope

Figure S9b. Yellow areas show the parts of the Celtic Seas study region that are outside the range recorded in the Firth of Forth grab survey used to build the model, for each of the explanatory variables.

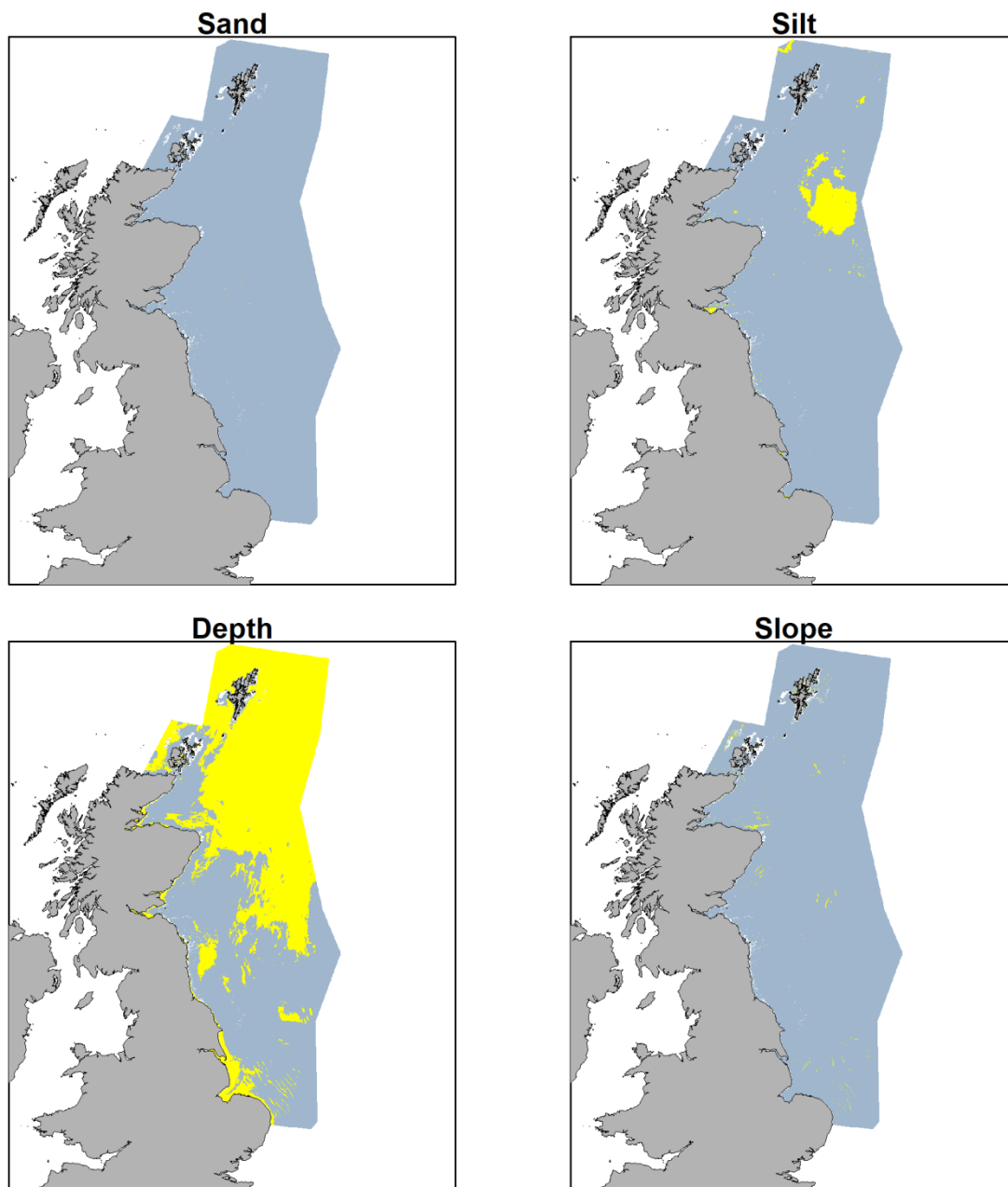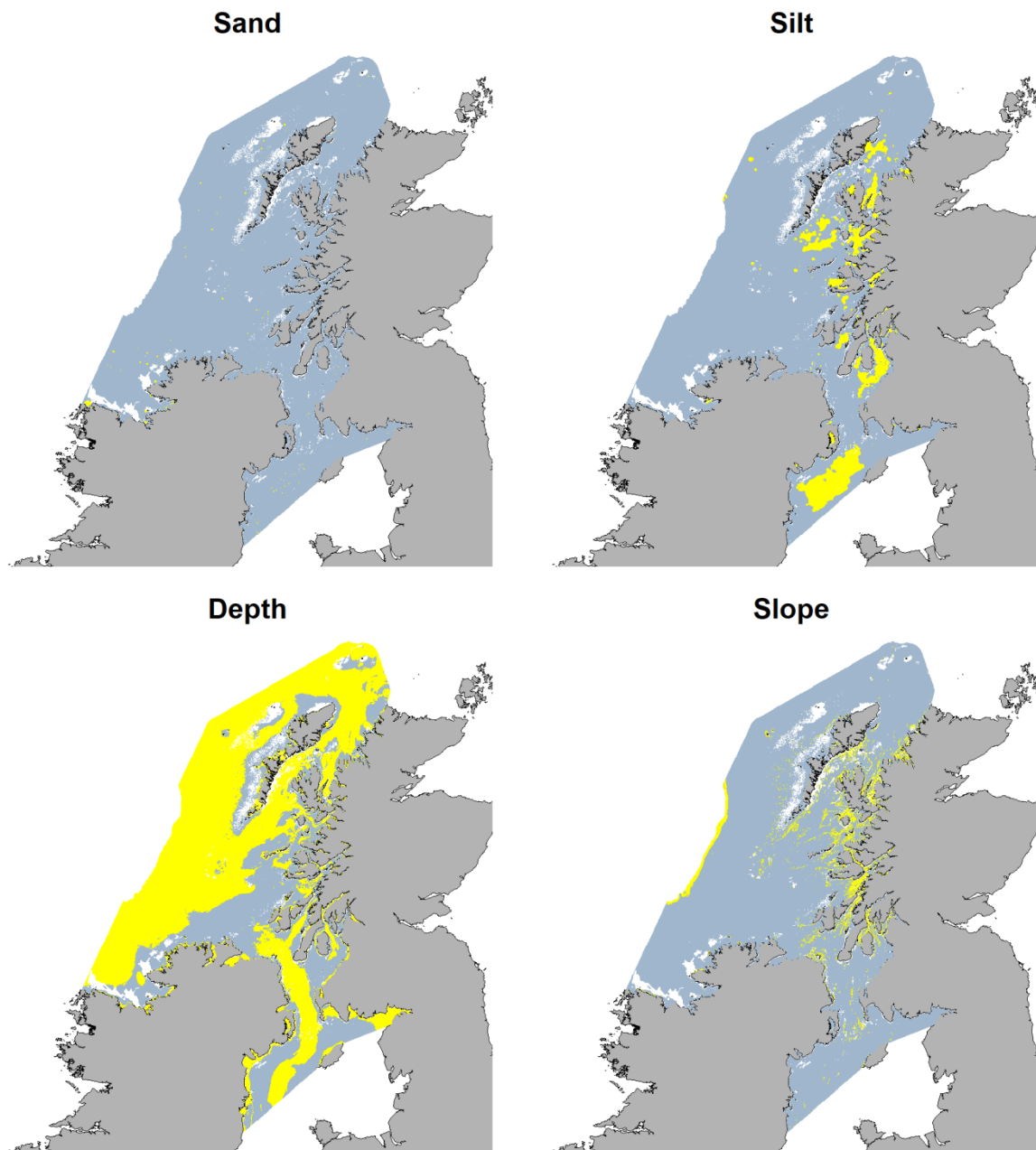**Table S1a)** Summary statistics for the count model coefficients from the hurdle model. *** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$. The silt and slope values were square root transformed prior to analysis and orthogonal polynomials were used in the model.

	Estimate	Std.Error	zvalue	Pr(>|z|)	
Intercept	0.7343	0.1068	6.877	6.13E-12	***
Silt	-16.7111	4.9464	-3.378	0.000729	***
Sand	26.4785	4.0219	6.584	4.59E-11	***
Depth	25.6257	4.2097	6.087	1.15E-09	***
$Depth^2$	-9.3201	4.0917	-2.278	0.022739	*
$Slope^2$	-14.4273	3.1616	-4.563	5.03E-06	***
Slope	7.2626	3.2568	2.23	0.02575	*
Log(ø)	-0.694	0.1408	-4.928	8.30E-07	***

Table S1b) Summary statistics for the zero hurdle model coefficients. *** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$. The silt and slope values were square root transformed prior to analysis and orthogonal polynomials were used in the model.

	Estimate	Std.Error	zvalue	Pr(>|z|)	
Intercept	-2.038	0.1697	-12.009	<2e-16	***
Silt	-145.505	16.9627	-8.578	<2e-16	***
$Silt^2$	-43.757	11.7331	-3.729	0.000192	***
Sand	41.4212	11.6795	3.546	0.00039	***
$Sand^2$	-59.5477	12.8274	-4.642	3.45E-06	***
Depth	30.503	4.1072	7.427	1.11E-13	***
$Depth^2$	-18.2887	4.5244	-4.042	5.30E-05	***
Slope	-8.4989	3.0402	-2.796	0.005181	**
$Slope^2$	-6.7433	3.3478	-2.014	0.043983	*
Sand × Depth	834.0693	234.0105	3.564	0.000365	***
Depth × Slope	-664.835	183.1559	-3.63	0.000284	***
Silt × Sand	1162.334	1166.477	0.996	0.319032	
$Silt^2$ × Sand	779.1326	755.9085	1.031	0.30267	
Silt × $Sand^2$	-4116.98	1226.481	-3.357	0.000789	***
$Silt^2$ × $Sand^2$	-1844.13	728.814	-2.53	0.011396	*
Null Deviance:	3511.9 on 2884 degrees of freedom				
Residual Deviance:	2448.1 on 2870 degrees of freedom				

Literature Cited

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https://doi.org/10.12770/18ff0d48-b203-4a65-94a9-5fd8b0ec35f6

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