

Litter Index Calculations for the Baltic Sea.

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August 18, 2021

1 Introduction

2 Data

The data have been analyzed in R using [3] and [1].

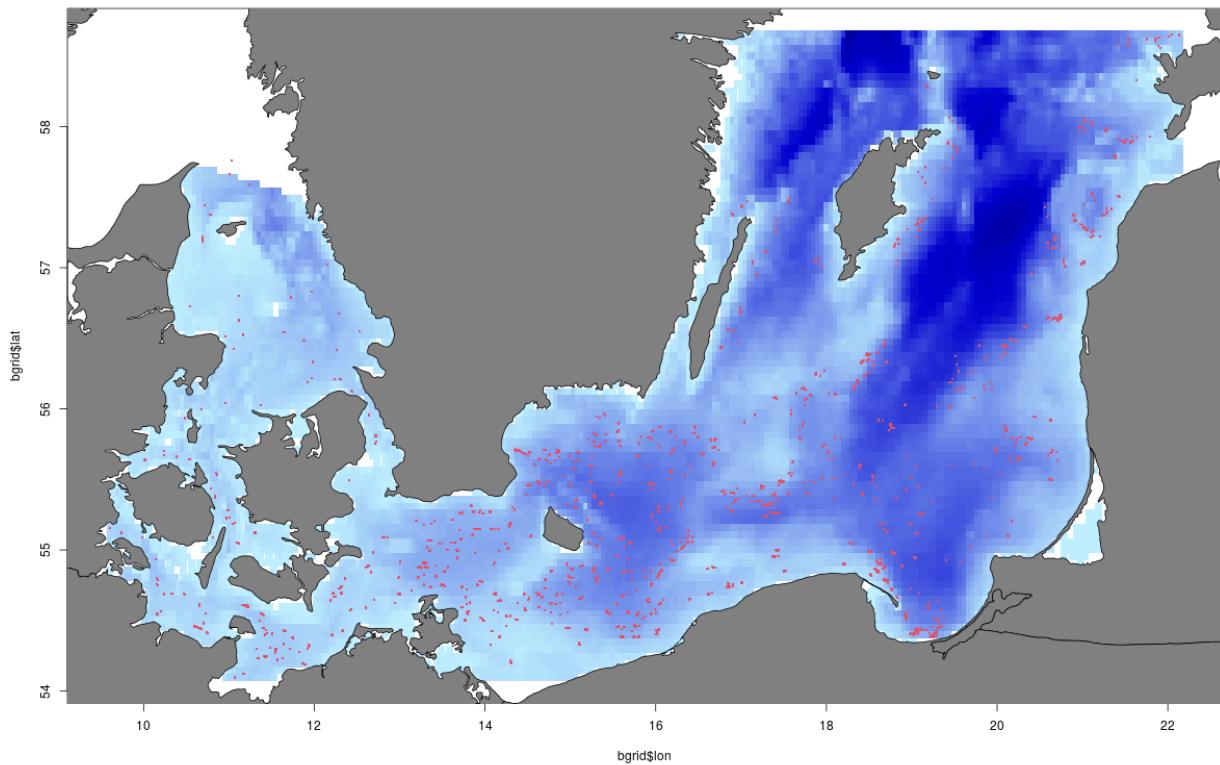


Figure 1: Bathymetric map. Red points are trawl hauls. This map is used as the spatial prediction grid for all standardized maps and indices.

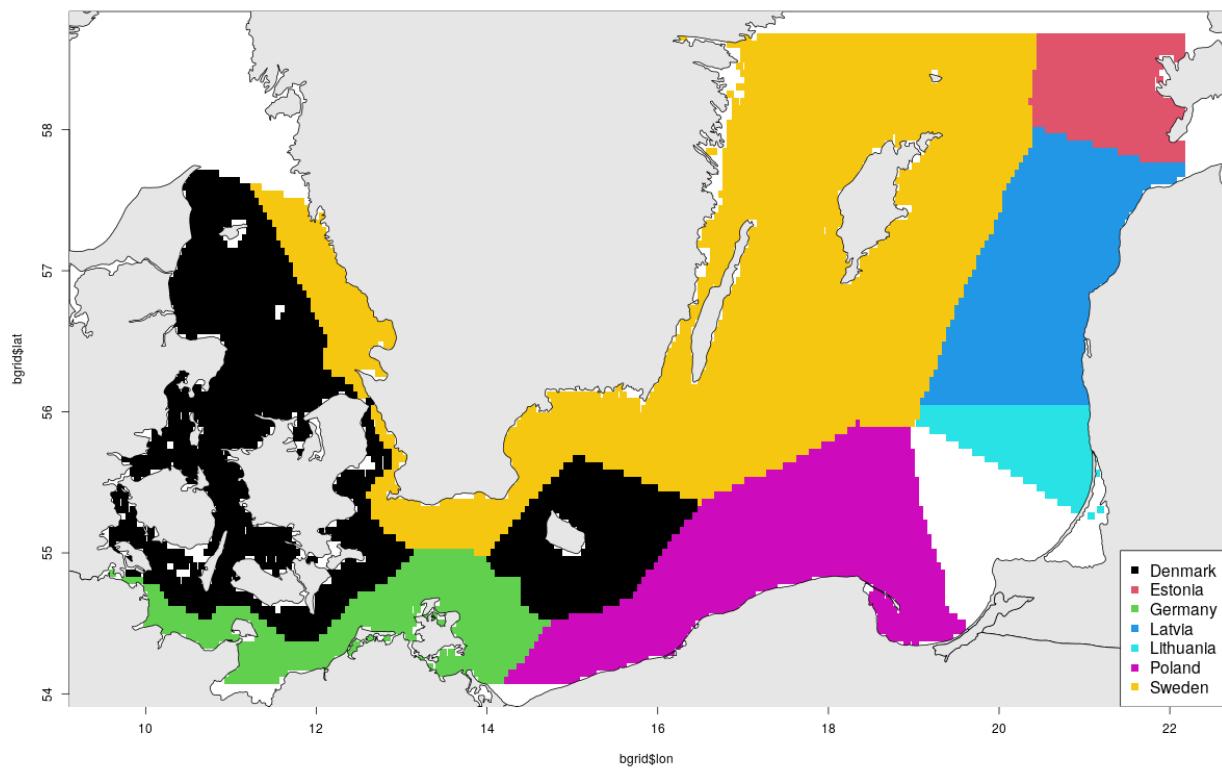


Figure 2: Map of EEZs

	Litter name	C.TS	C.TS.REV	Type	SUP	Fishing.related
1	Plastic	A	A	Plastic		
2	Plastic bottle	A1	A1	Plastic	Yes	
3	Plastic sheet	A2	A2	Plastic	Yes	
4	Plastic bag	A3	A3	Plastic	Yes	
5	Plastic caps	A4	A4	Plastic	Yes	
6	Plastic fishing line (monofilament)	A5	A5	Plastic		Yes
7	Plastic fishing line (entangled)	A6	A6	Plastic		Yes
8	Synthetic rope	A7	A7	Plastic		
9	Fishing net	A8	A8	Plastic		Yes
10	Plastic cable ties	A9	A9	Plastic		
11	Plastic strapping band	A10	A10	Plastic		
12	Plastic crates and containers	A11	A11	Plastic	Yes	
13	Plastic diapers	B1	A12	Plastic	Yes	
14	Sanitary towel/tampon	B6	A13	Plastic	Yes	
15	Other plastic	A12	A14	Plastic		
16	Sanitary waste (unspecified)	B		Plastic	Yes	
17	Cotton buds	B2		Plastic	Yes	
18	Cigarette butts	B3		Plastic	Yes	
19	Condoms	B4		Plastic	Yes	
20	Syringes	B5		Plastic	Yes	
21	Other sanitary waste	B7		Plastic	Yes	
22	Metals	C	B	Metal		
23	Cans (food)	C1	B1	Metal		
24	Cans (beverage)	C2	B2	Metal		
25	Fishing related metal	C3	B3	Metal		
26	Metal drums	C4	B4	Metal		
27	Metal appliances	C5	B5	Metal		
28	Metal car parts	C6	B6	Metal		
29	Metal cables	C7	B7	Metal		
30	Other metal	C8	B8	Metal		
31	Rubber	D	C	Rubber		
32	Boots	D1	C1	Rubber		
33	Balloons	D2	C2	Rubber	Yes	
34	Rubber bobbins (fishing)	D3	C3	Rubber		Yes
35	Tyre	D4	C4	Rubber		
36	Glove	D5	C5	Rubber		
37	Other rubber	D6	C6	Rubber		
38	Glass/Ceramics	E	D	Glass		
39	Jar	E1	D1	Glass		
40	Glass bottle	E2	D2	Glass		
41	Glass/ceramic piece	E3	D3	Glass		
42	Other glass or ceramic	E4	D4	Glass		
43	Natural products	F	E	Natural		
44	Wood (processed)	F1	E1	Natural		
45	Rope	F2	E2	Natural		Yes
46	Paper/cardboard	F3	E3	Natural		
47	Pallets	F4	E4	Natural		
48	Other natural products	F5	E5	Natural		
49	Miscellaneous	G	F	Other		
50	Clothing/rags	G1	F1	Other		
51	Shoes	G2	F2	Other		
52	Other	G3	F3	Other		

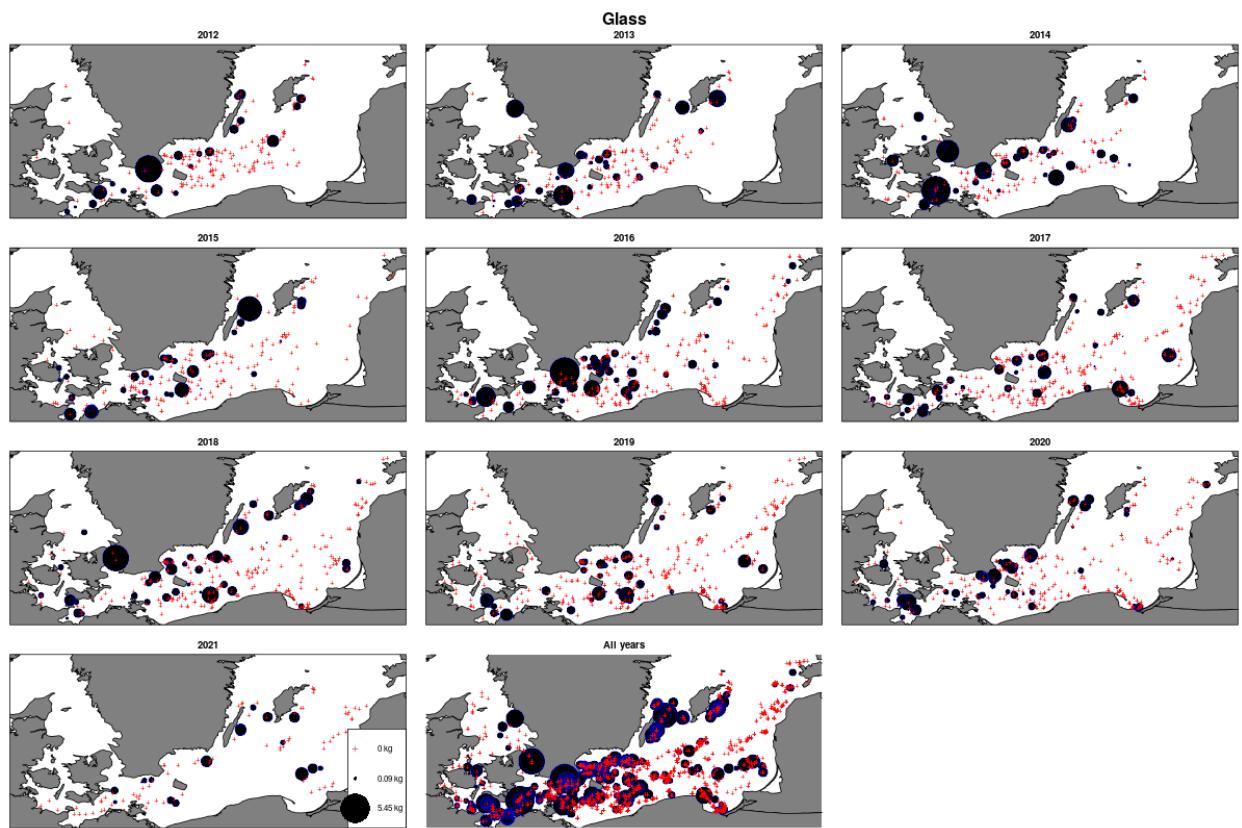


Figure 3: Litter pr. haul. The black bubbles are given a thin blue edge to distinguish overlap.

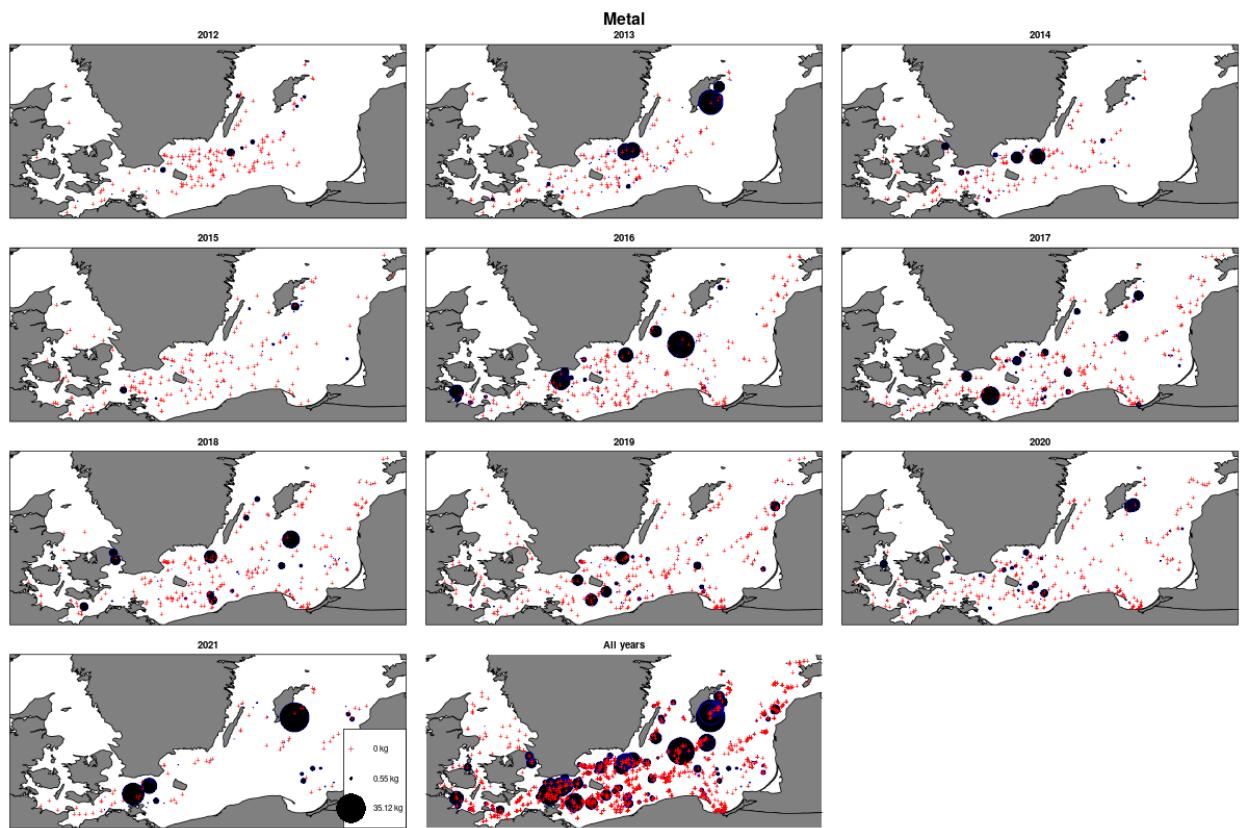


Figure 4: Litter pr. haul. The black bubbles are given a thin blue edge to distinguish overlap.

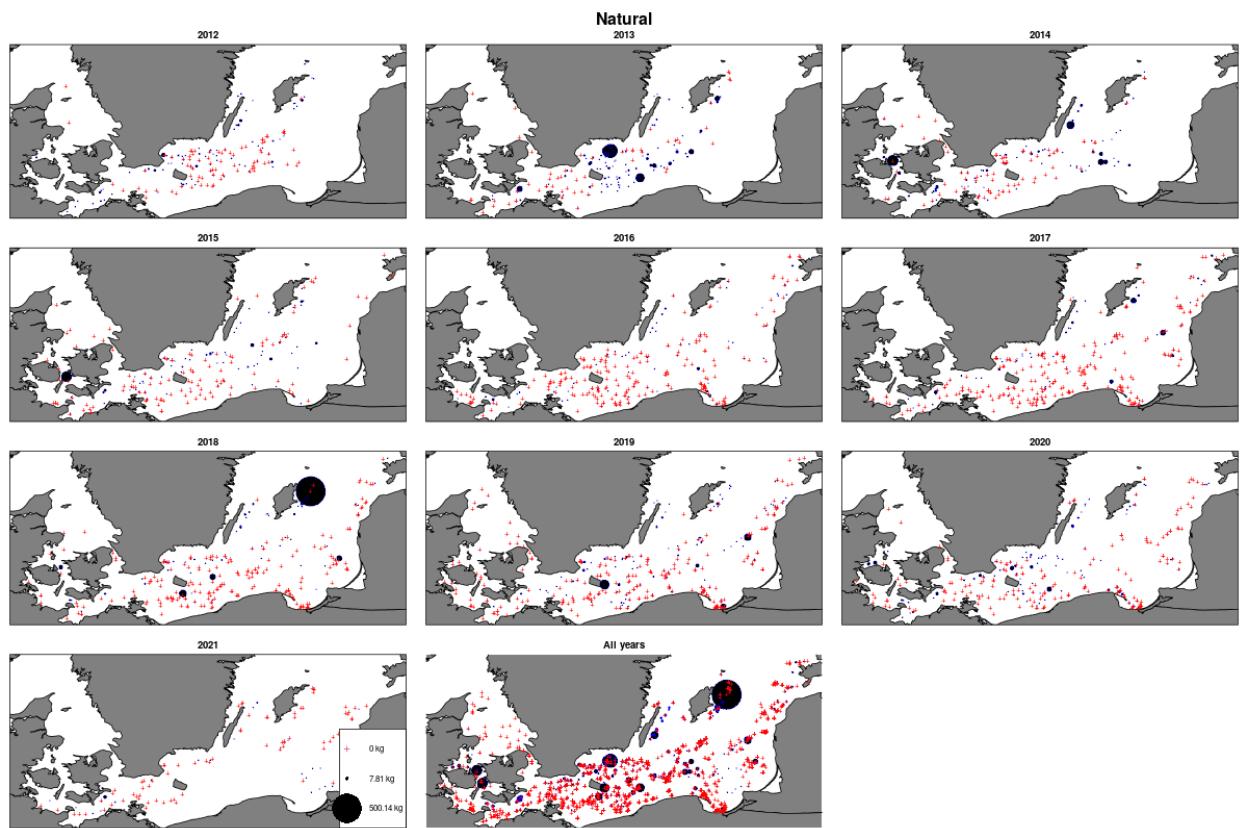


Figure 5: Litter pr. haul. The black bubbles are given a thin blue edge to distinguish overlap.

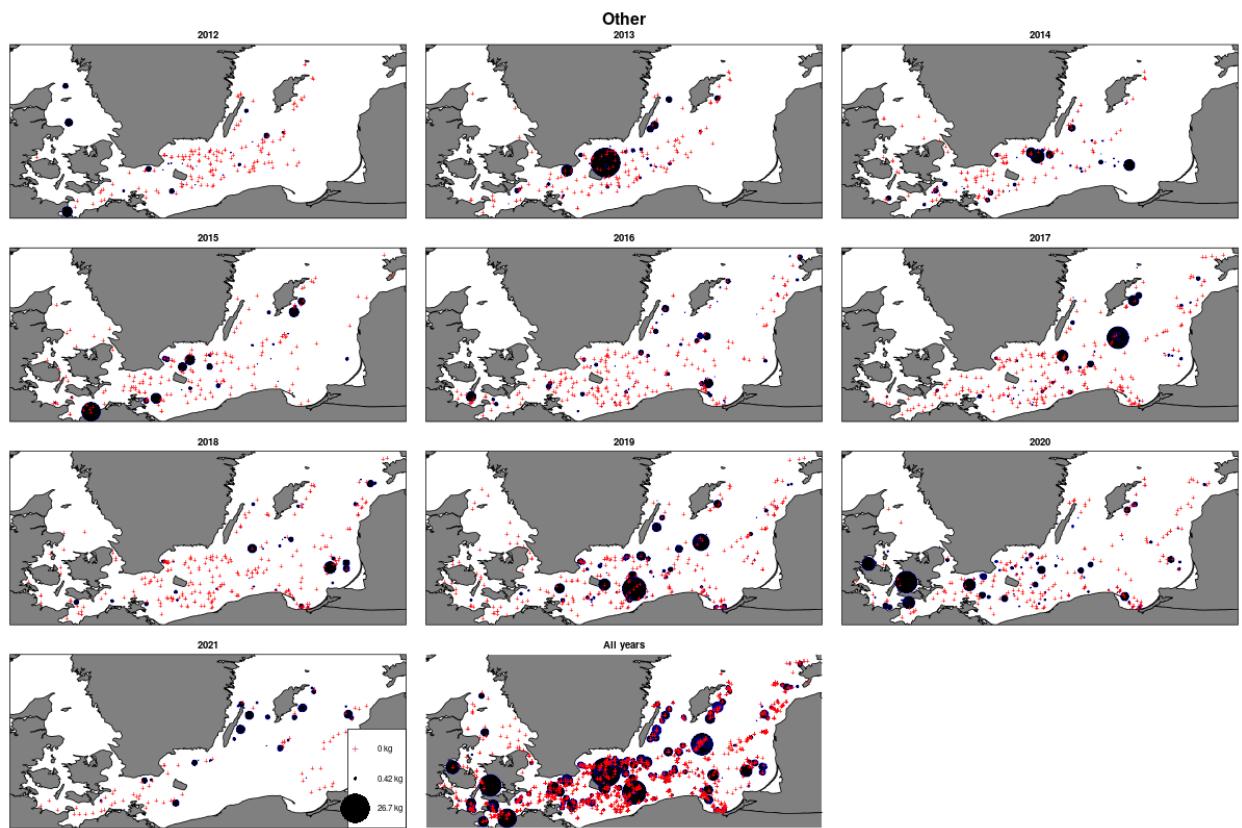


Figure 6: Litter pr. haul. The black bubbles are given a thin blue edge to distinguish overlap.

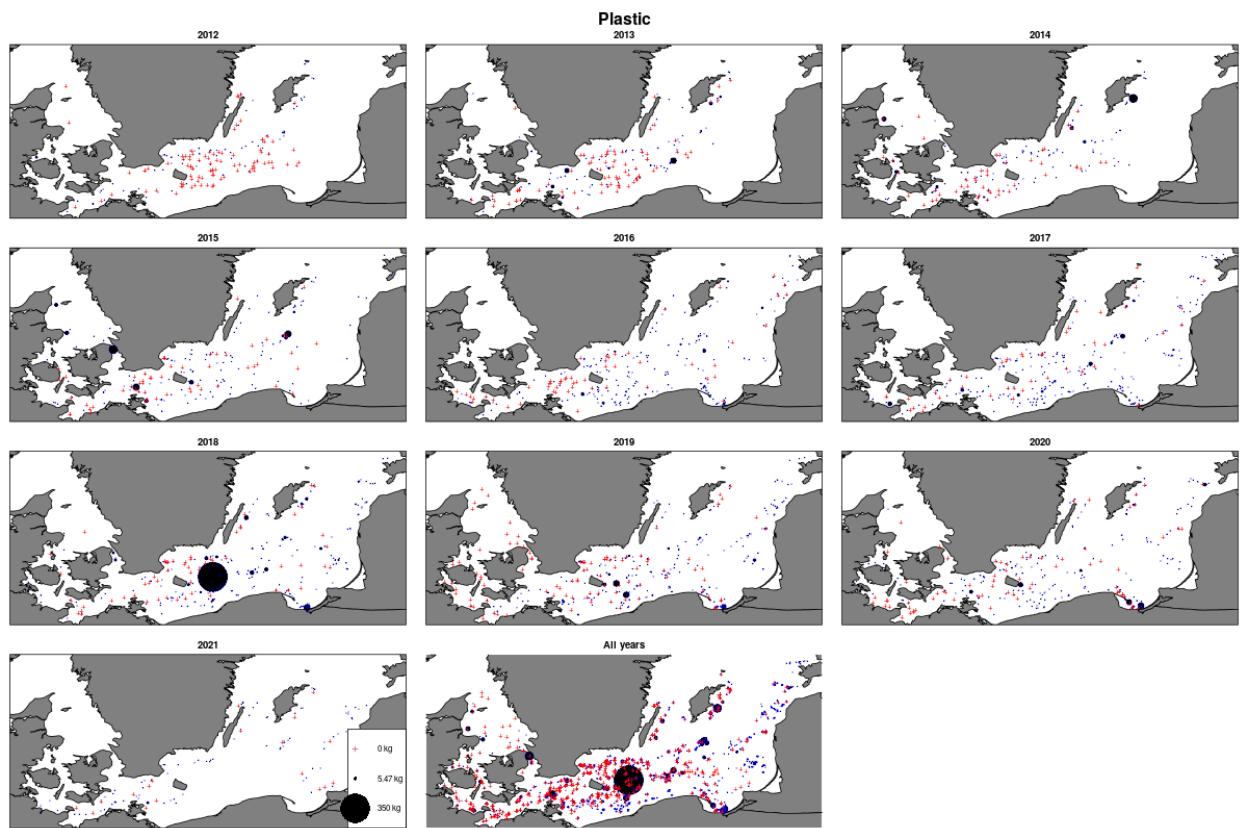


Figure 7: Litter pr. haul. The black bubbles are given a thin blue edge to distinguish overlap.

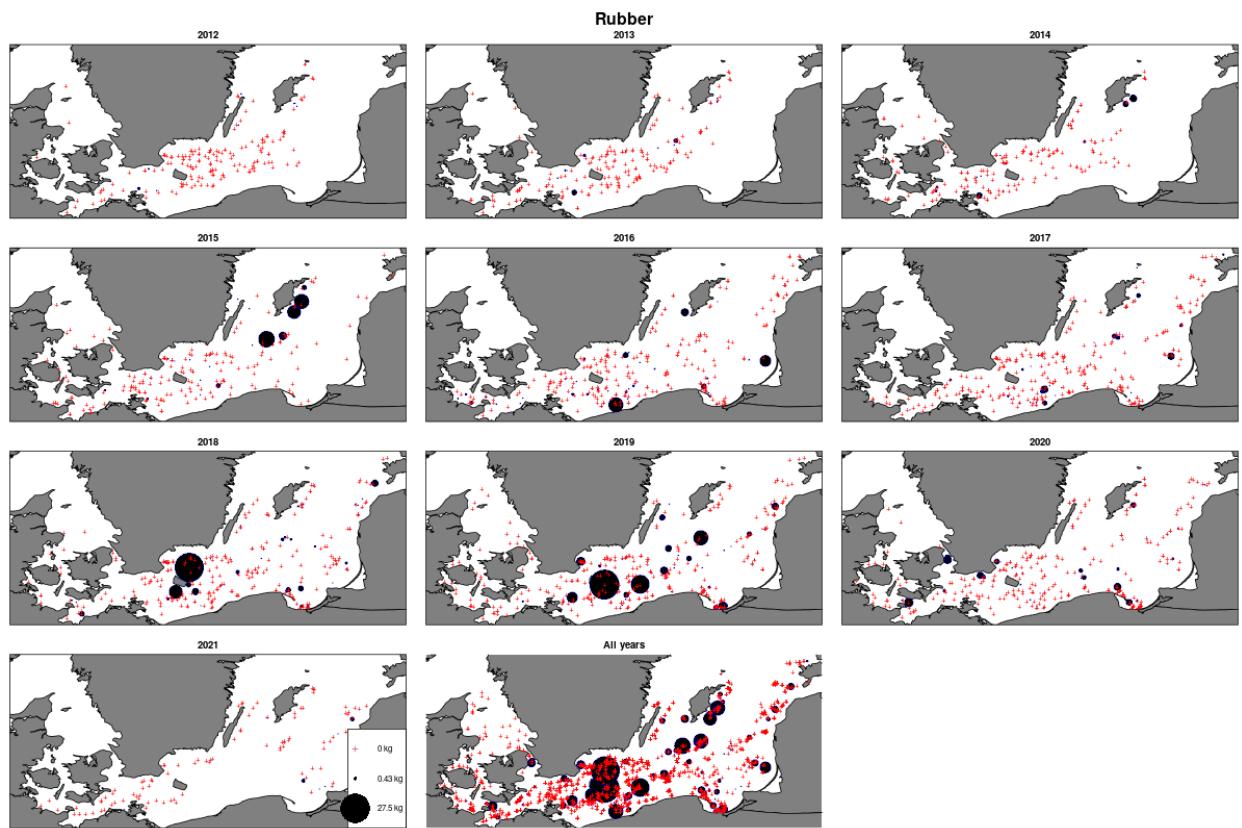


Figure 8: Litter pr. haul. The black bubbles are given a thin blue edge to distinguish overlap.

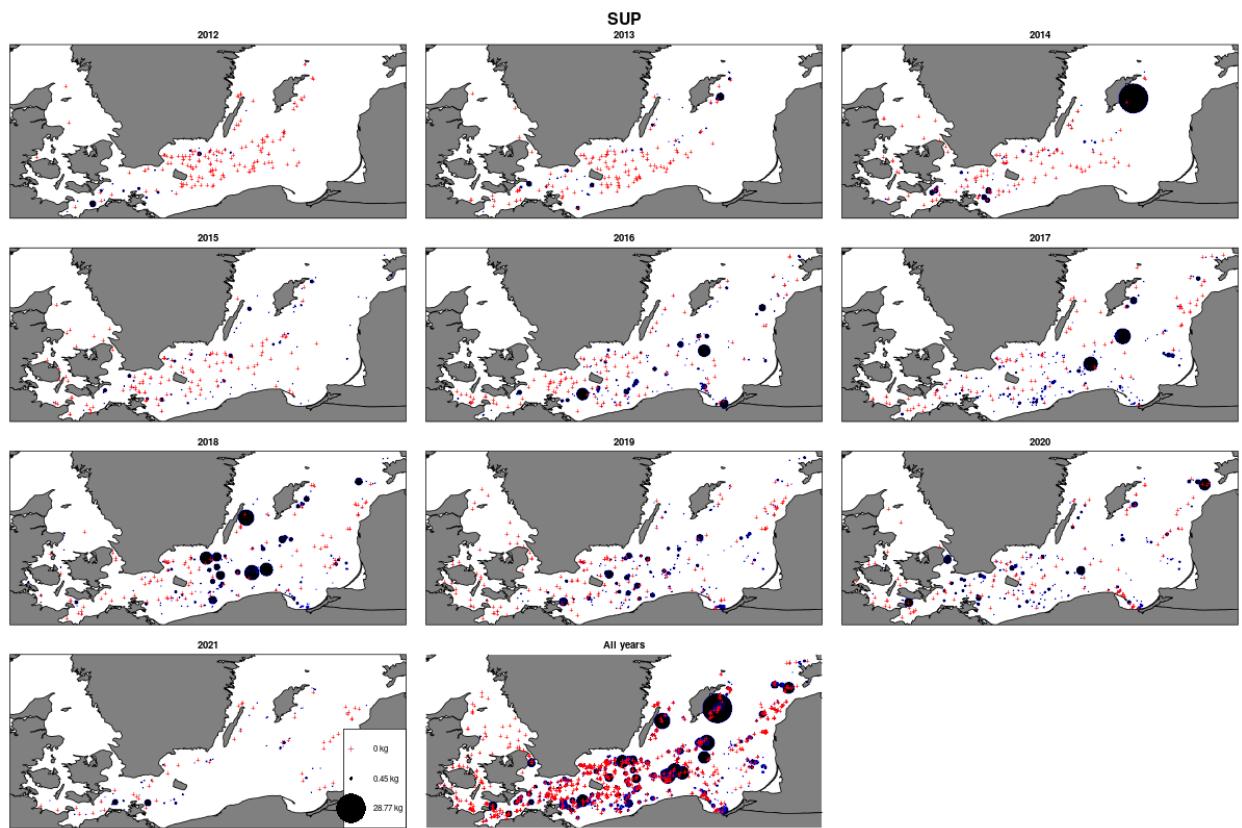


Figure 9: Litter pr. haul. The black bubbles are given a thin blue edge to distinguish overlap.

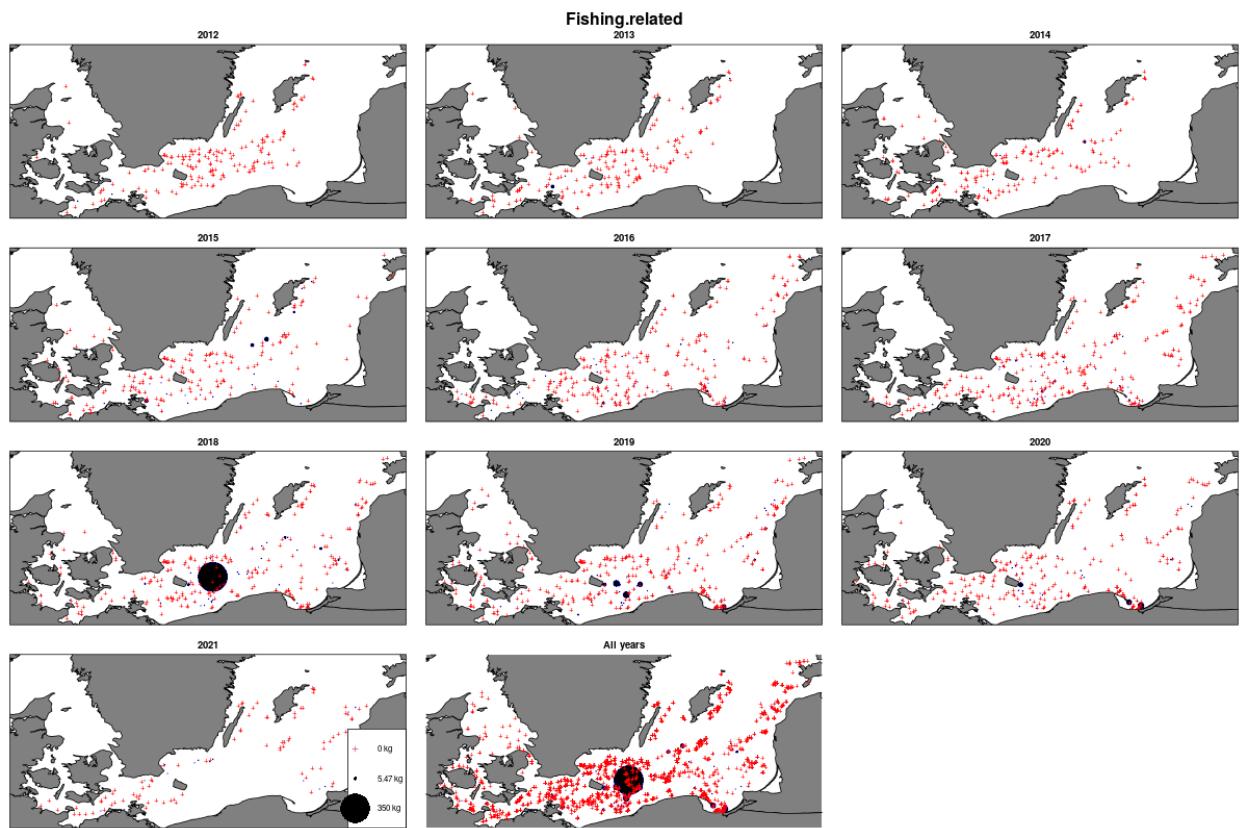


Figure 10: Litter pr. haul. The black bubbles are given a thin blue edge to distinguish overlap.

3 Survey Indices

Survey indices are calculated using the methodology described in [2]. Three models are fitted for each type of litter. The following equations describe the models:

$$g(\mu_i) = f_1(\text{time}_i) + f_1(\text{lon}_i, \text{lat}_i) + \log(\text{effort}_i) \quad (1)$$

$$g(\mu_i) = \text{Year}_i + f_1(\text{lon}_i, \text{lat}_i) + \log(\text{effort}_i) \quad (2)$$

$$g(\mu_i) = \alpha \text{time}_i + f_1(\text{lon}_i, \text{lat}_i) + \log(\text{effort}_i) \quad (3)$$

The models differ in how the time effect is specified. The first model uses a smooth time effect, the second model uses independent year effects, whereas the last model estimates a log-linear time effect (overall trend, α). An offset is used for the effect of effort ($\log(\text{effort}_i)$), i.e. the coefficient is not estimated but taken to be 1, which corresponds to the assumption that the catch is proportional to effort. All splines used are Duchon splines with first derivative penalization.

The swept area for a 30 min haul is assumed to be 68184 m² for the TVS gear and 87163 m² for the TVL (approx. 0.78 ratio, [4]).

The models are fitted using both numbers and mass as the response variable. For models using mass only the Tweedie distribution (compound Poisson-Gamma) is considered, because it is simpler and easier to work with, and has a more consistent interpretation when sampling effort is not constant (see e.g. [5]). For models using numbers the negative binomial distribution is used. Maps and EEZ specific estimates are only shown for the models using mass. All indices using are standardized to a unit of kg / km² or numbers / km².

4 Results

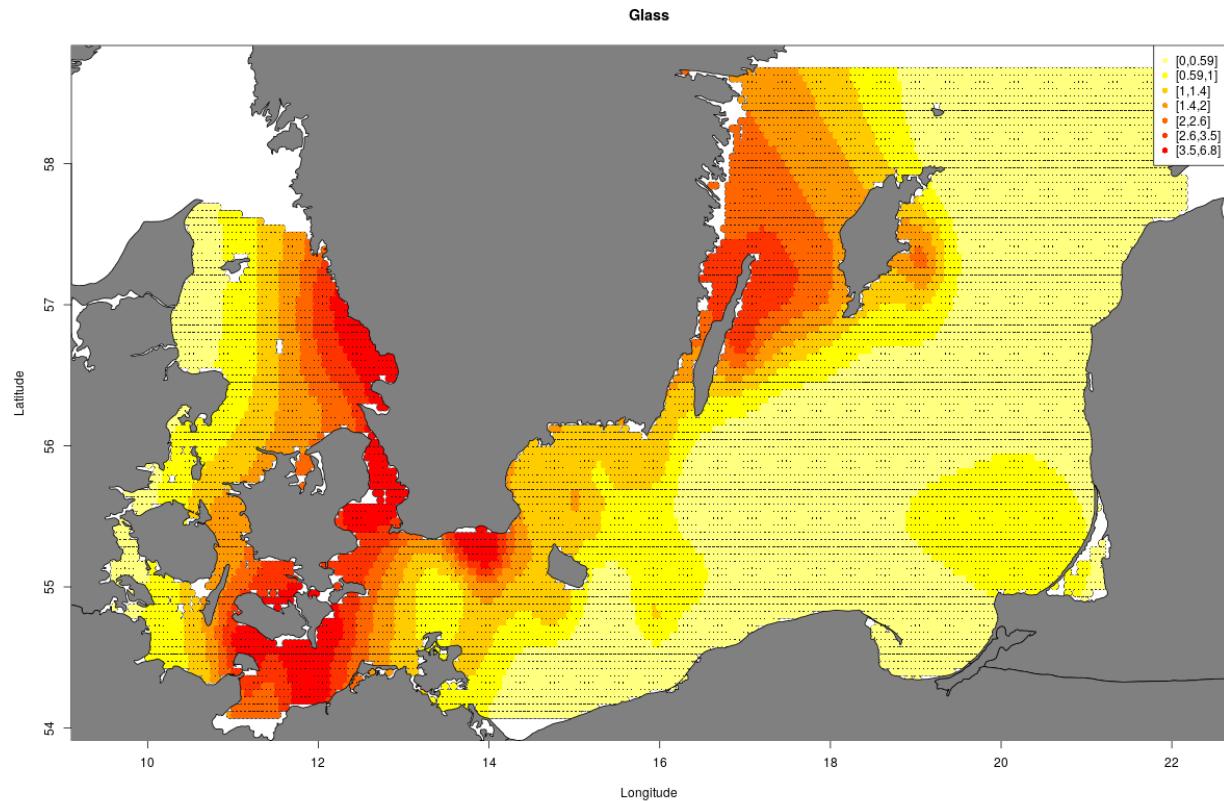


Figure 11: Distribution map. Note that the unit is relative litter abundance (1 = average).

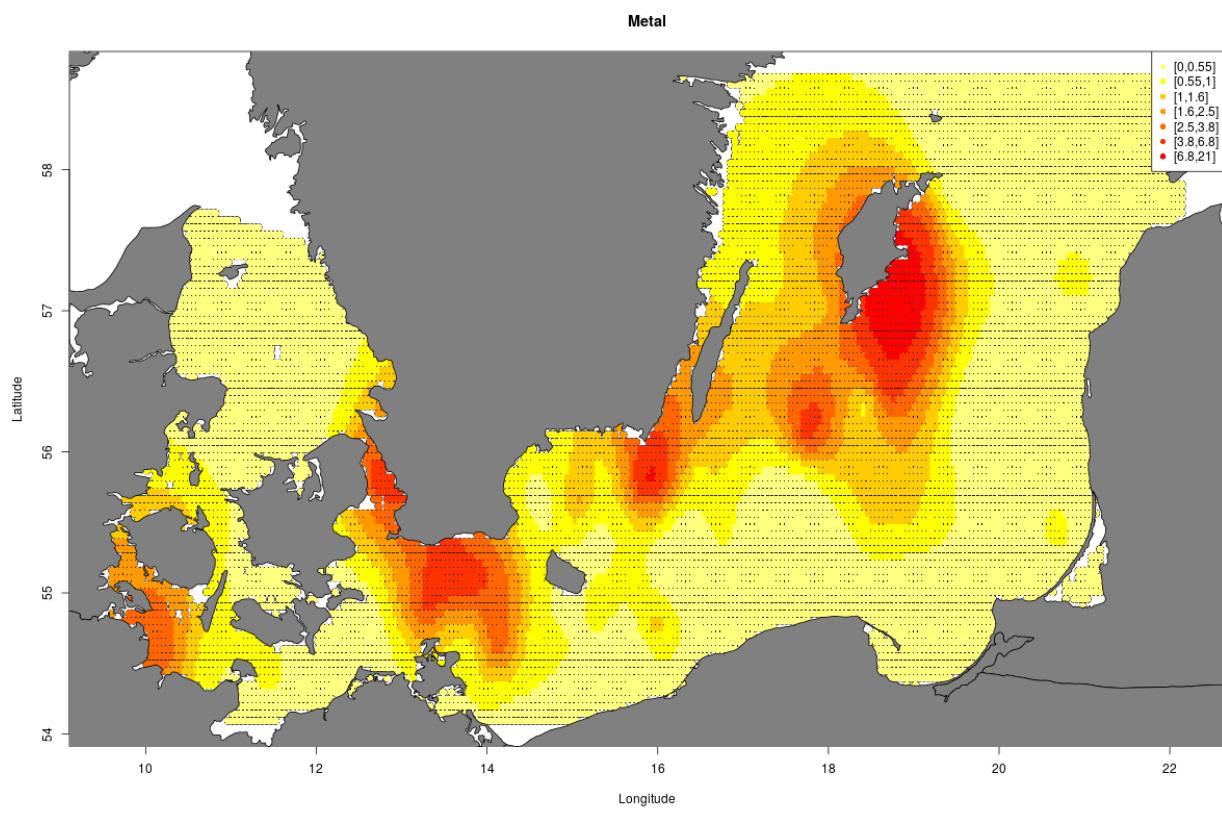


Figure 12: Distribution map.

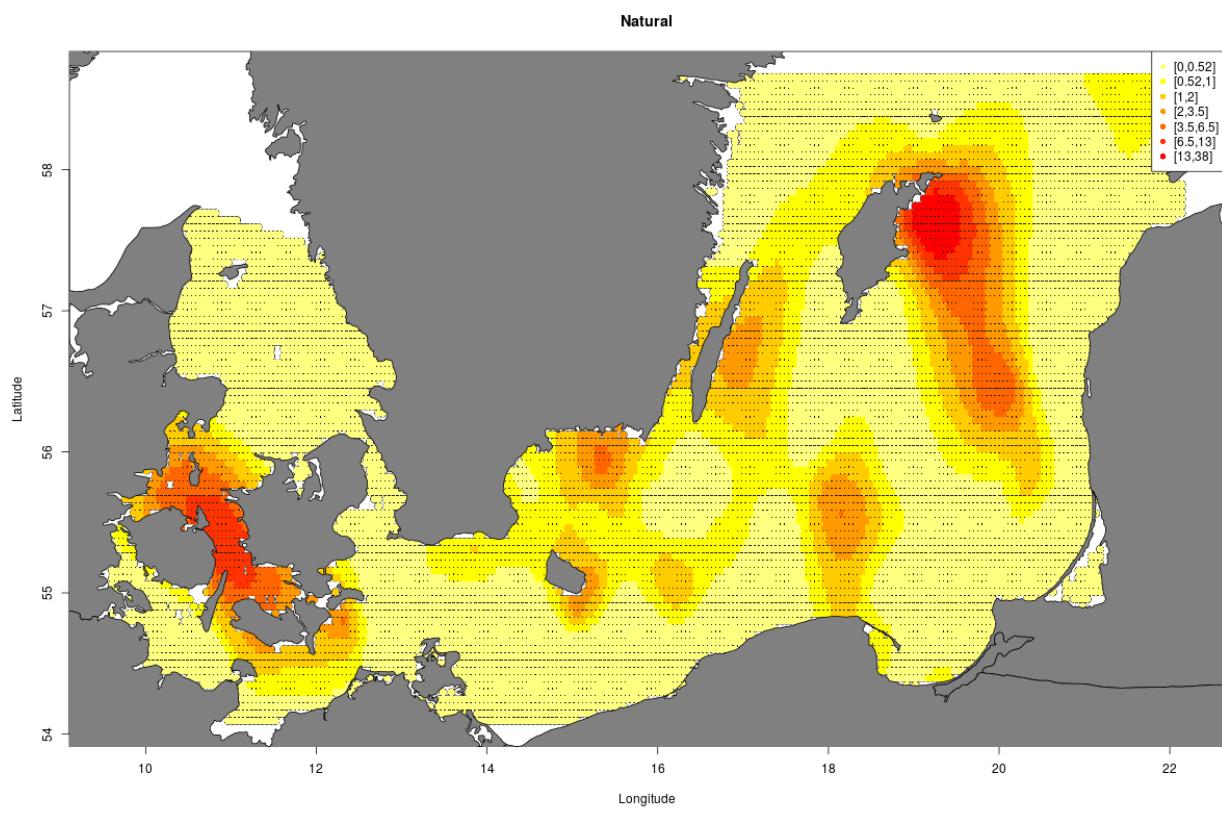


Figure 13: Distribution map.

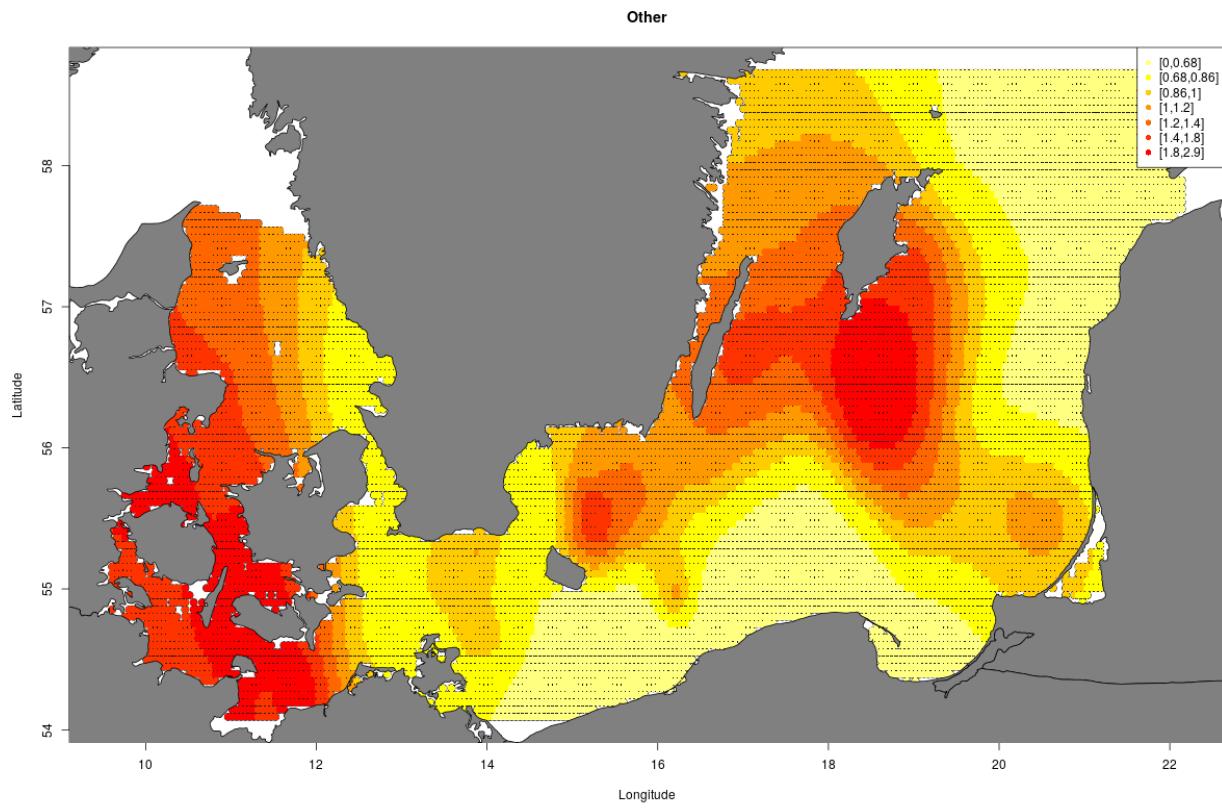


Figure 14: Distribution map.

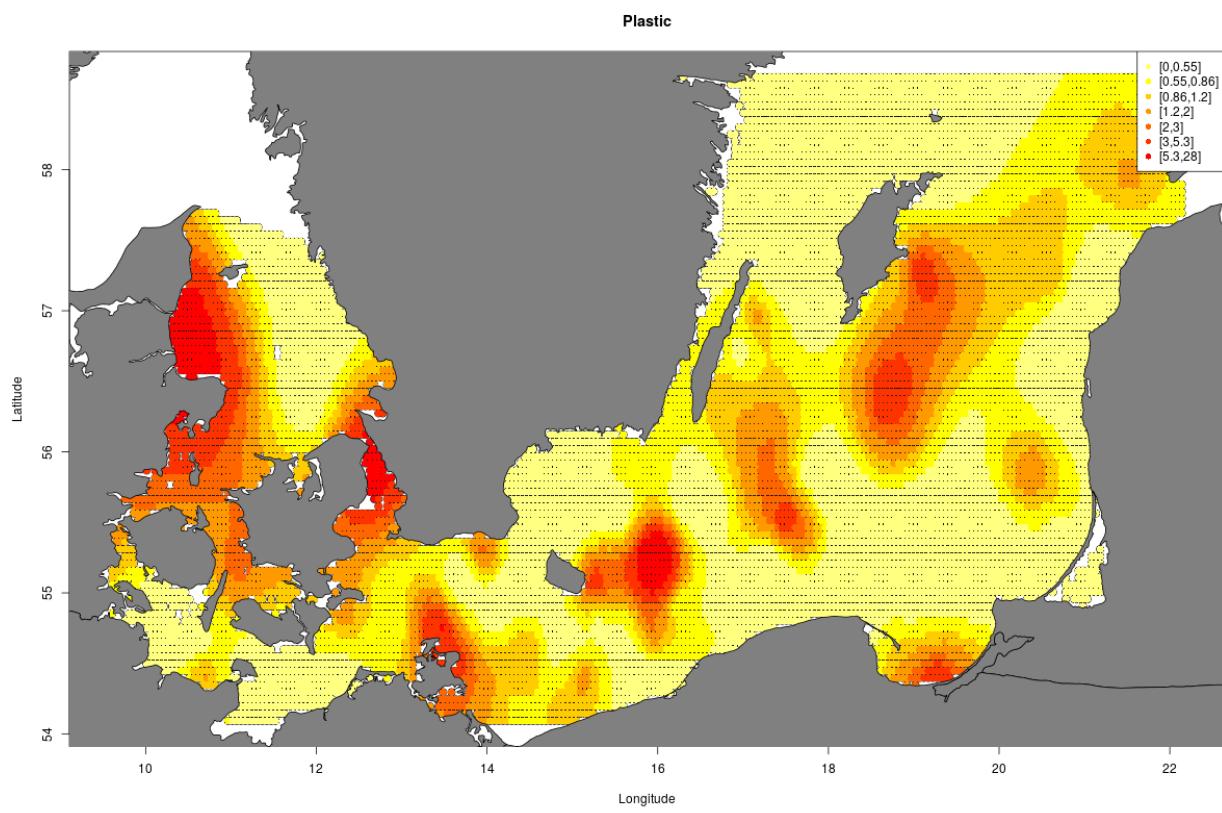


Figure 15: Distribution map.

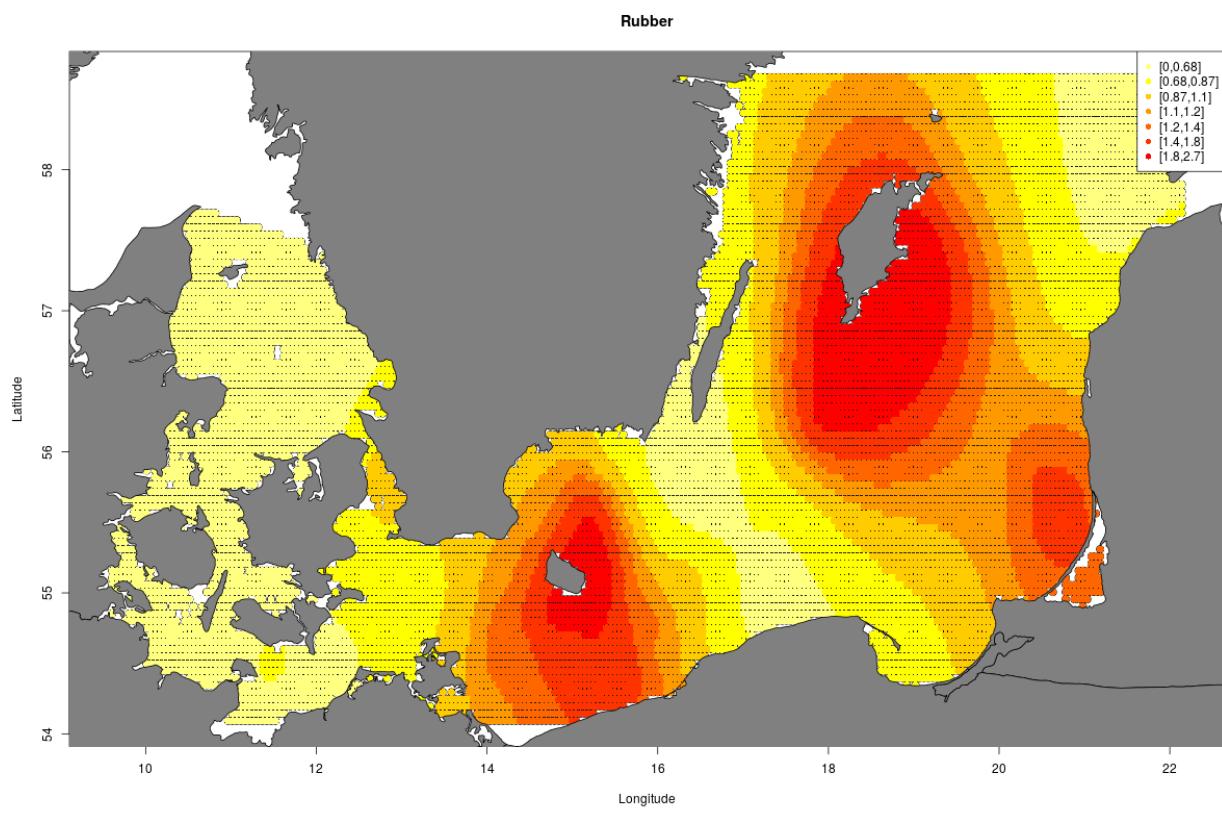


Figure 16: Distribution map.

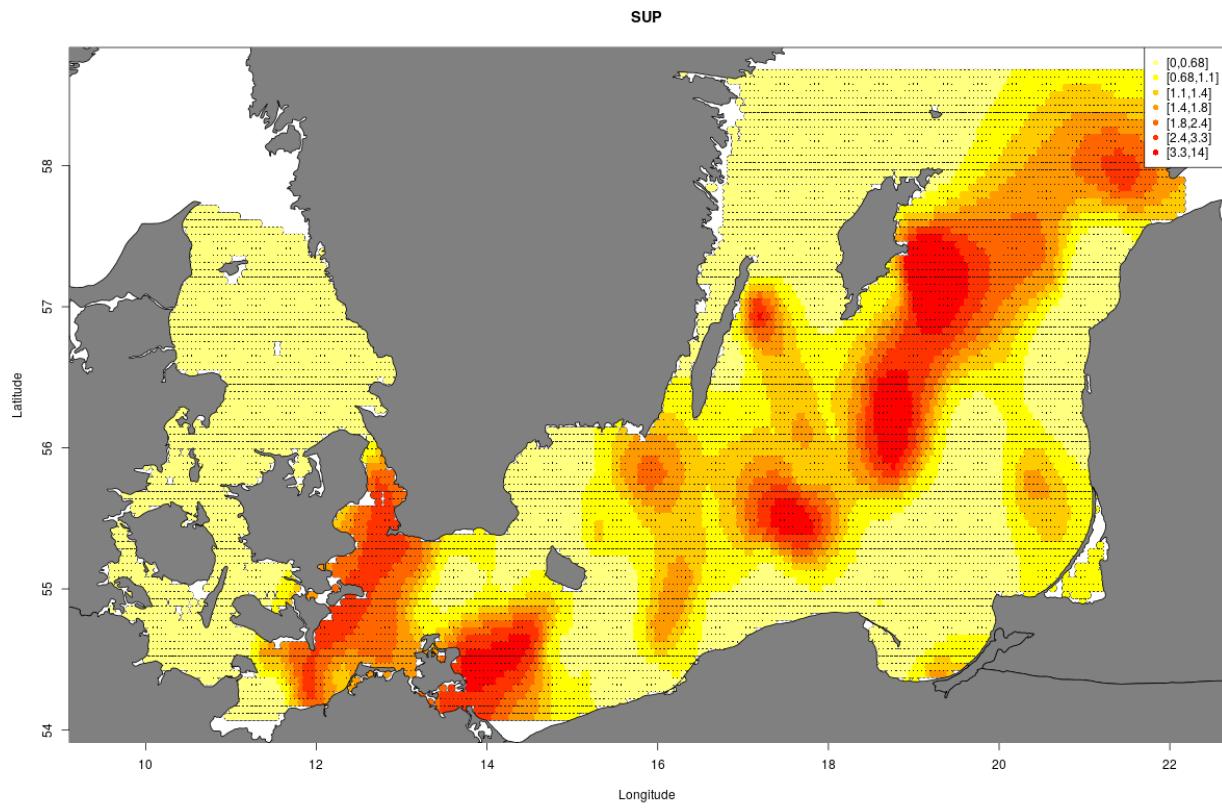


Figure 17: Distribution map.

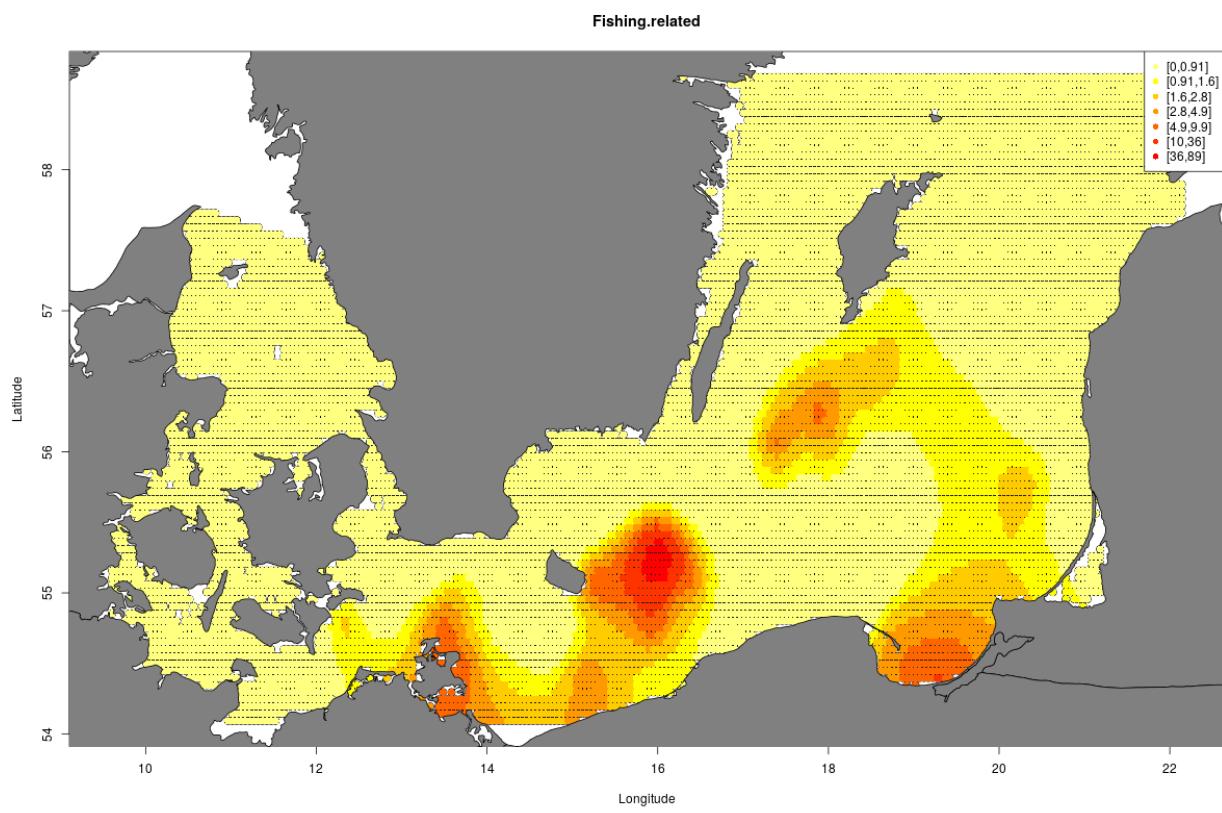


Figure 18: Distribution map.

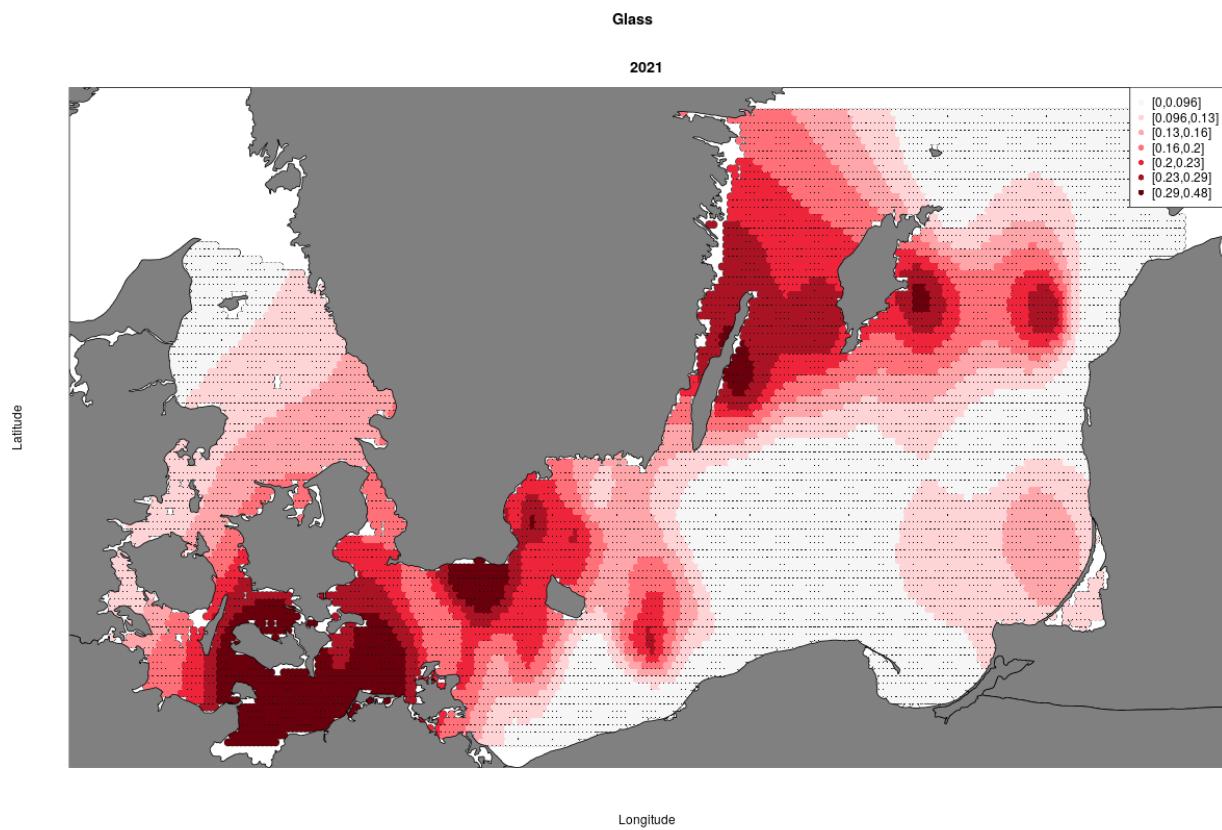


Figure 19: Probability of encounter for a standard haul (30 min TVL).

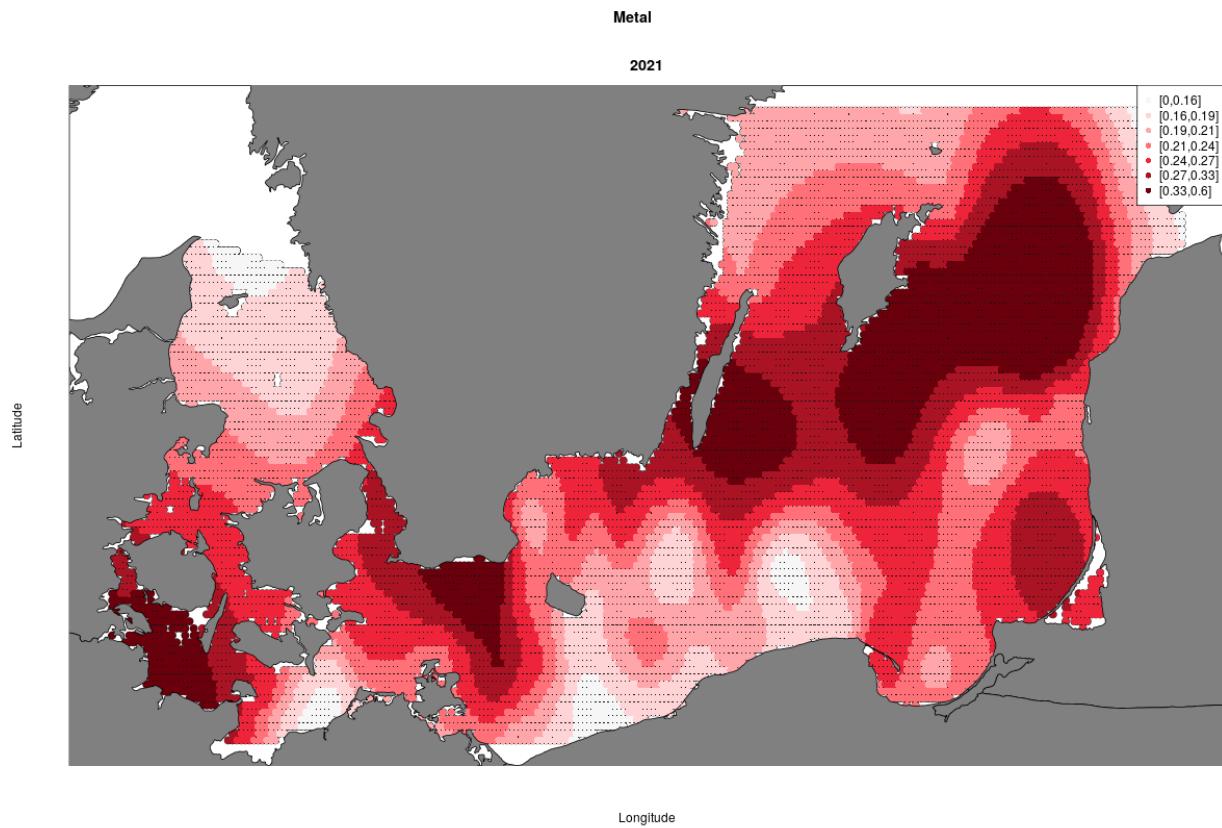


Figure 20: Probability of encounter for a standard haul (30 min TVL).

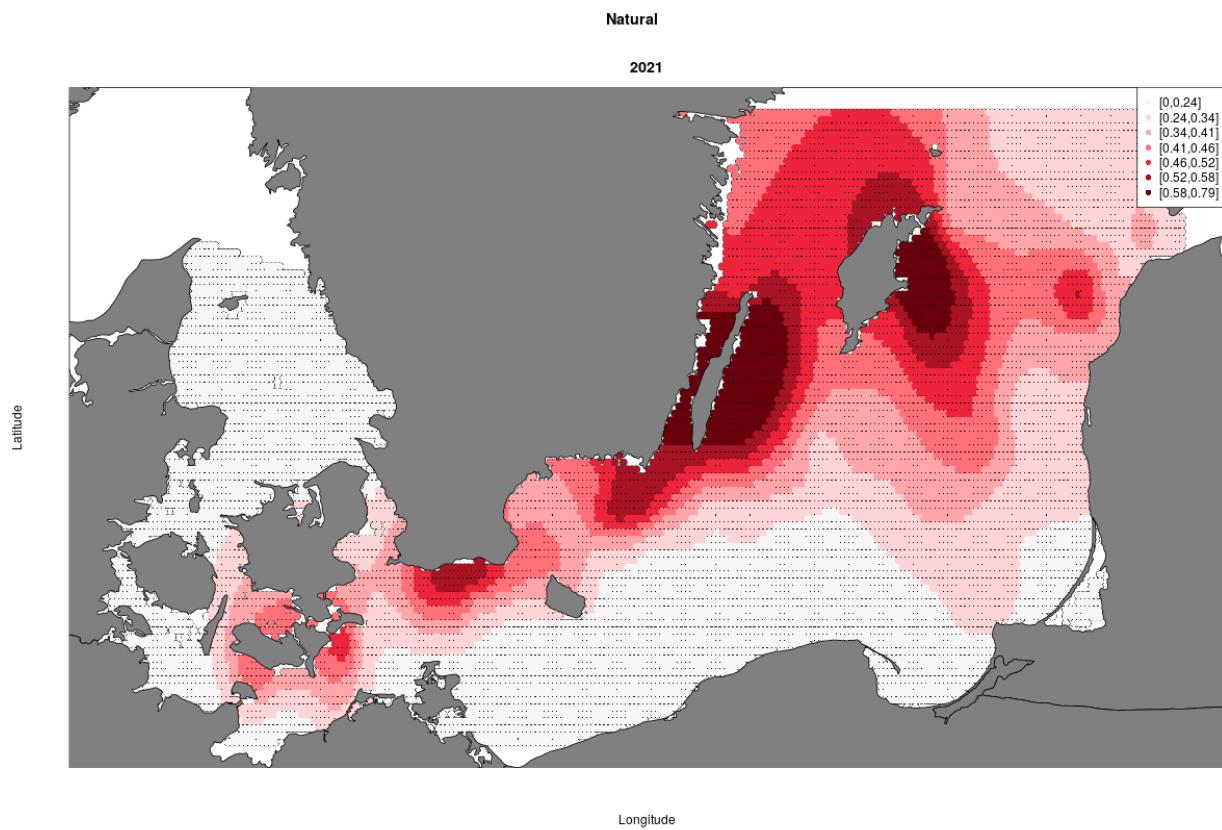


Figure 21: Probability of encounter for a standard haul (30 min TVL).

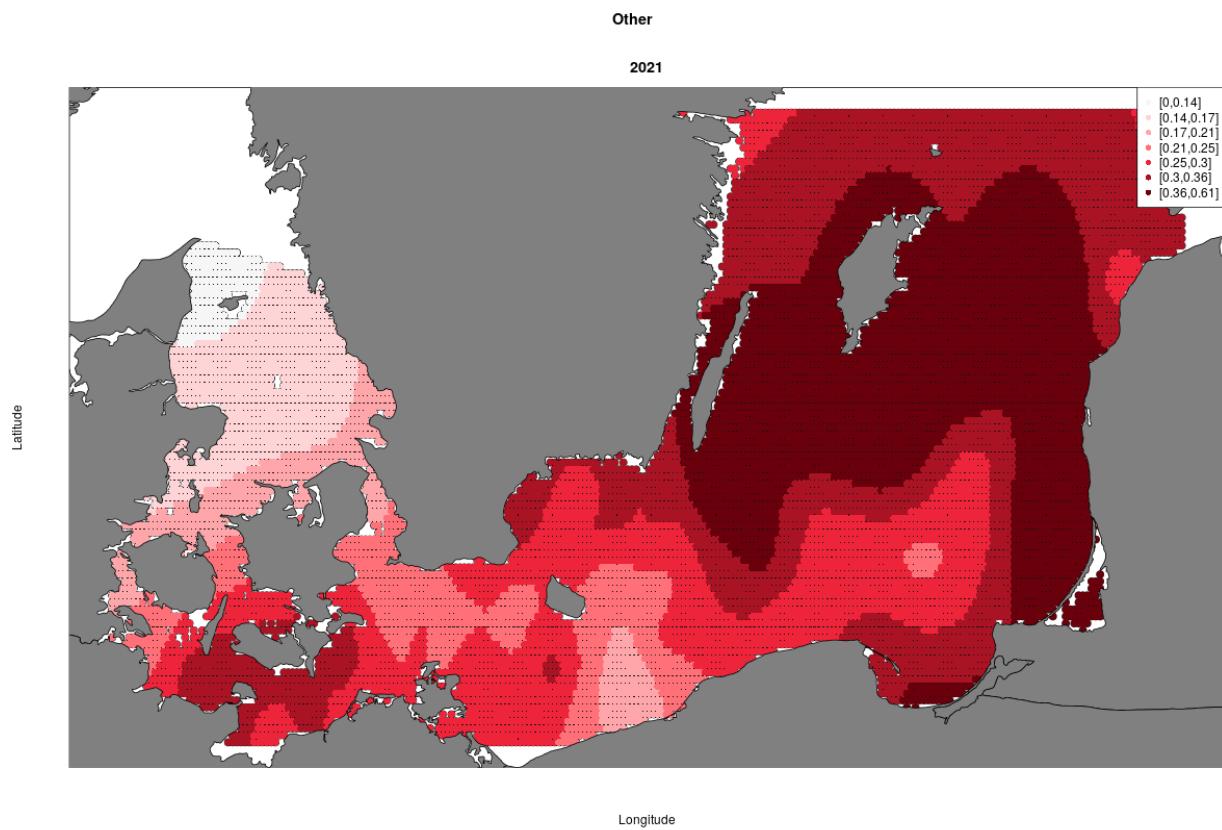


Figure 22: Probability of encounter for a standard haul (30 min TVL).

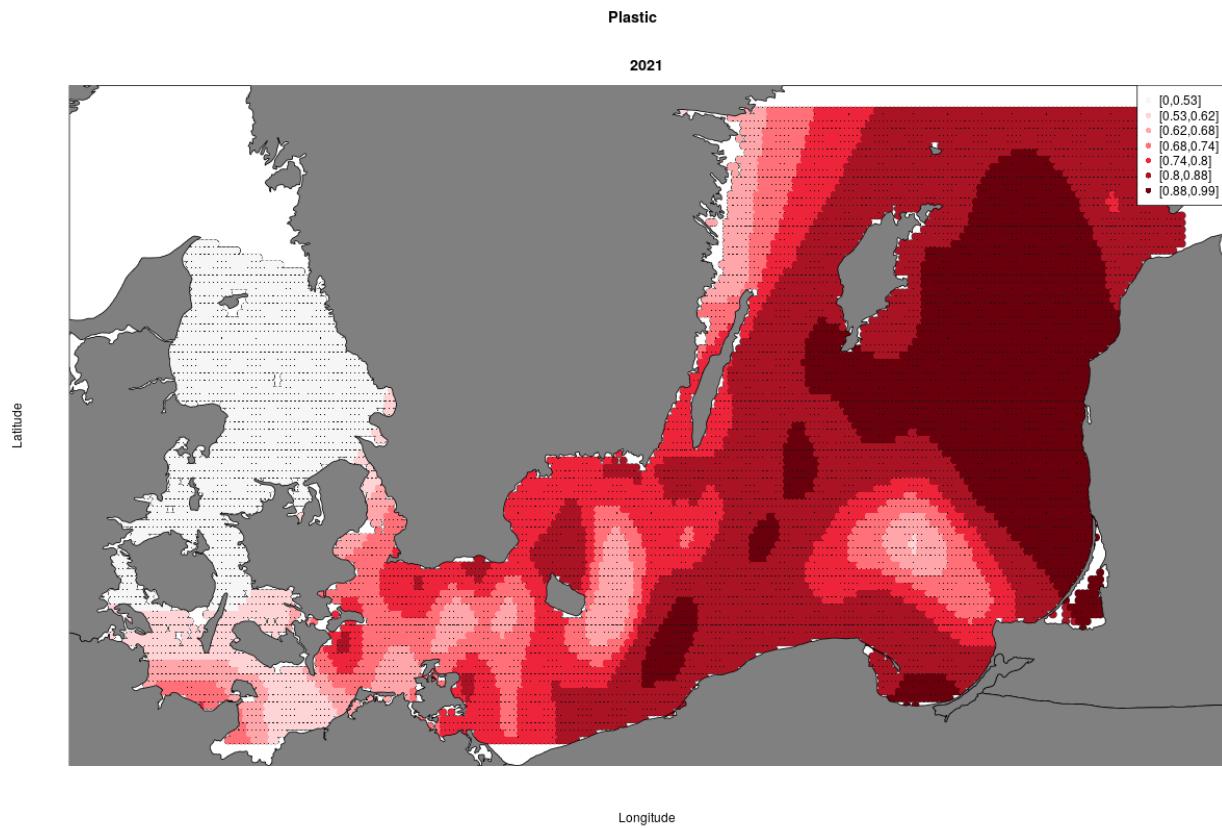


Figure 23: Probability of encounter for a standard haul (30 min TVL).

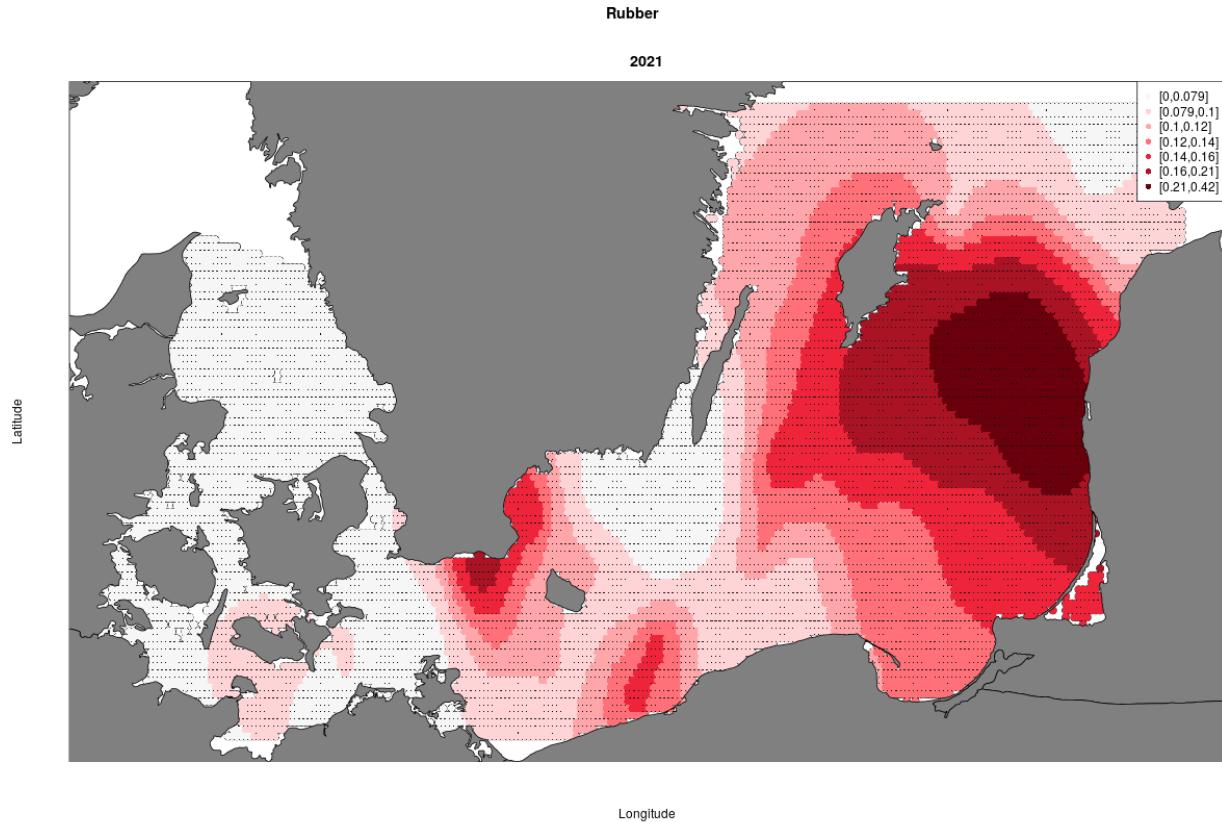


Figure 24: Probability of encounter for a standard haul (30 min TVL).

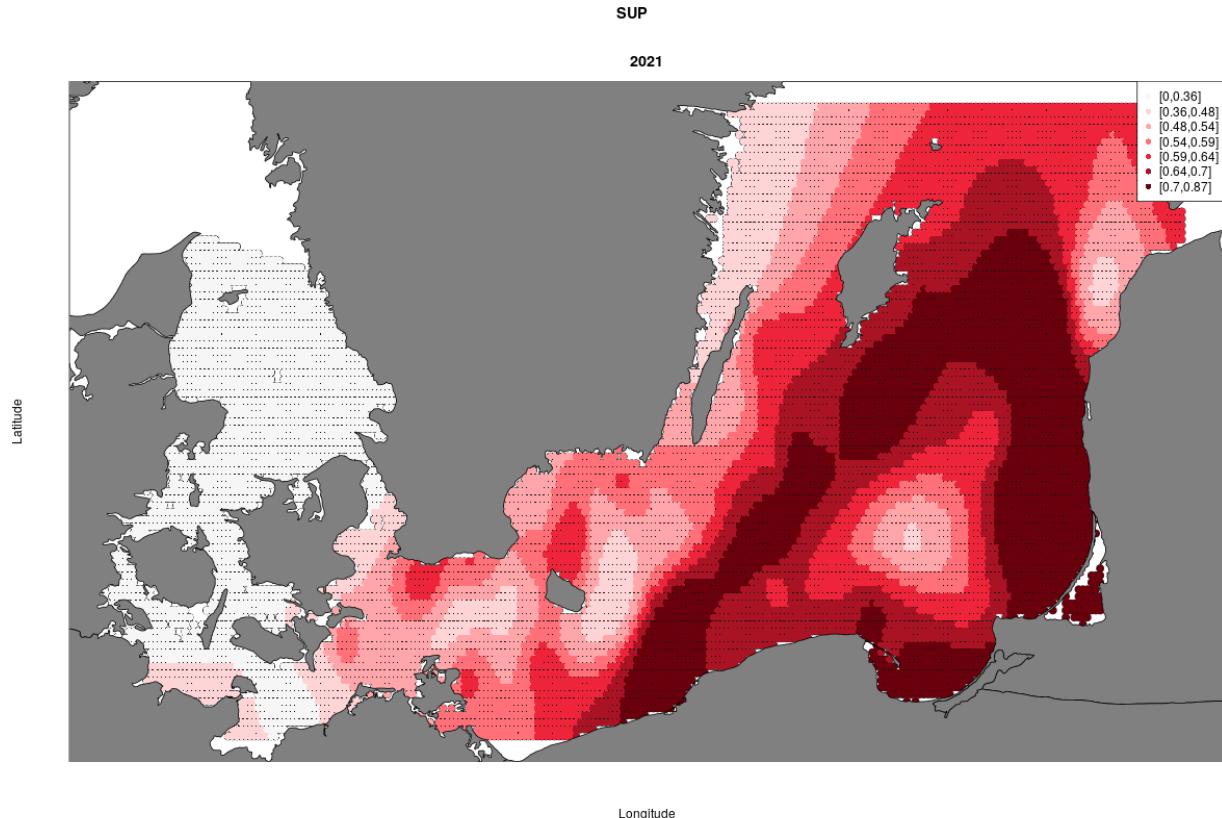


Figure 25: Probability of encounter for a standard haul (30 min TVL).

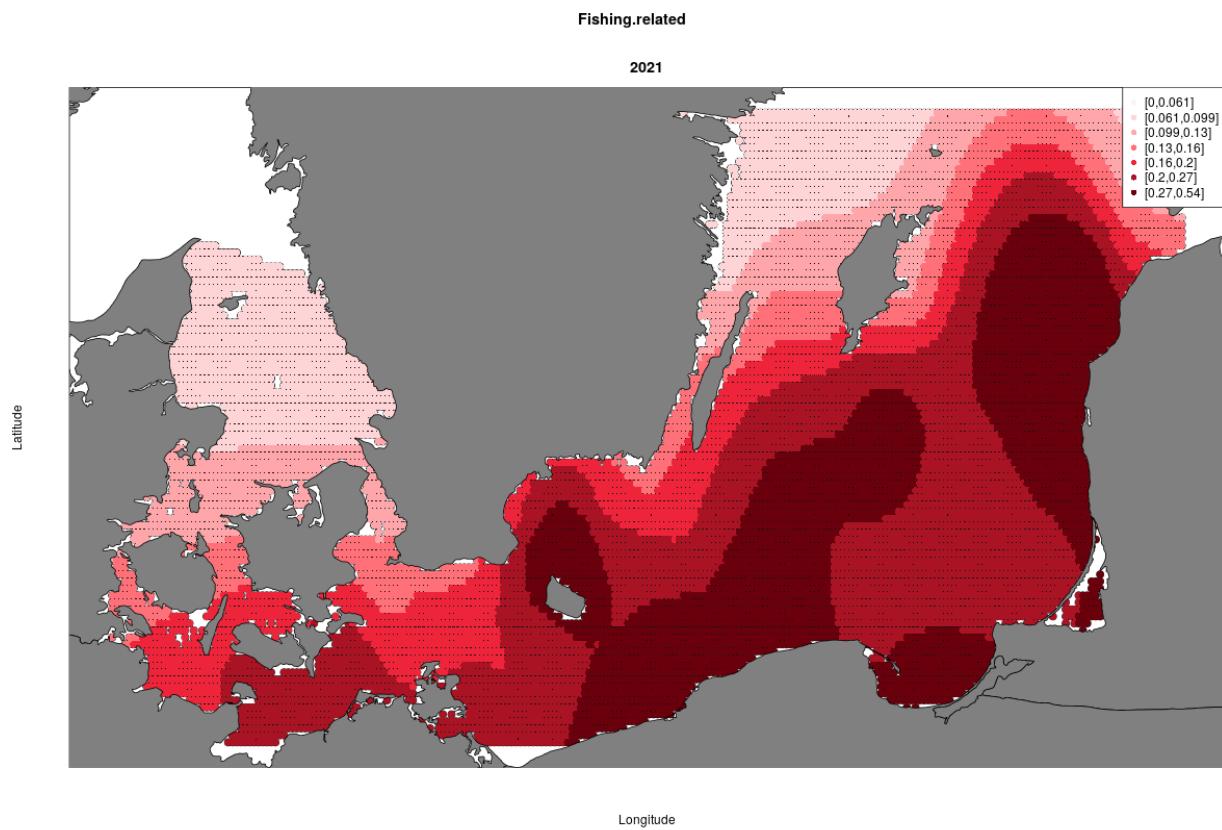


Figure 26: Probability of encounter for a standard haul (30 min TVL).

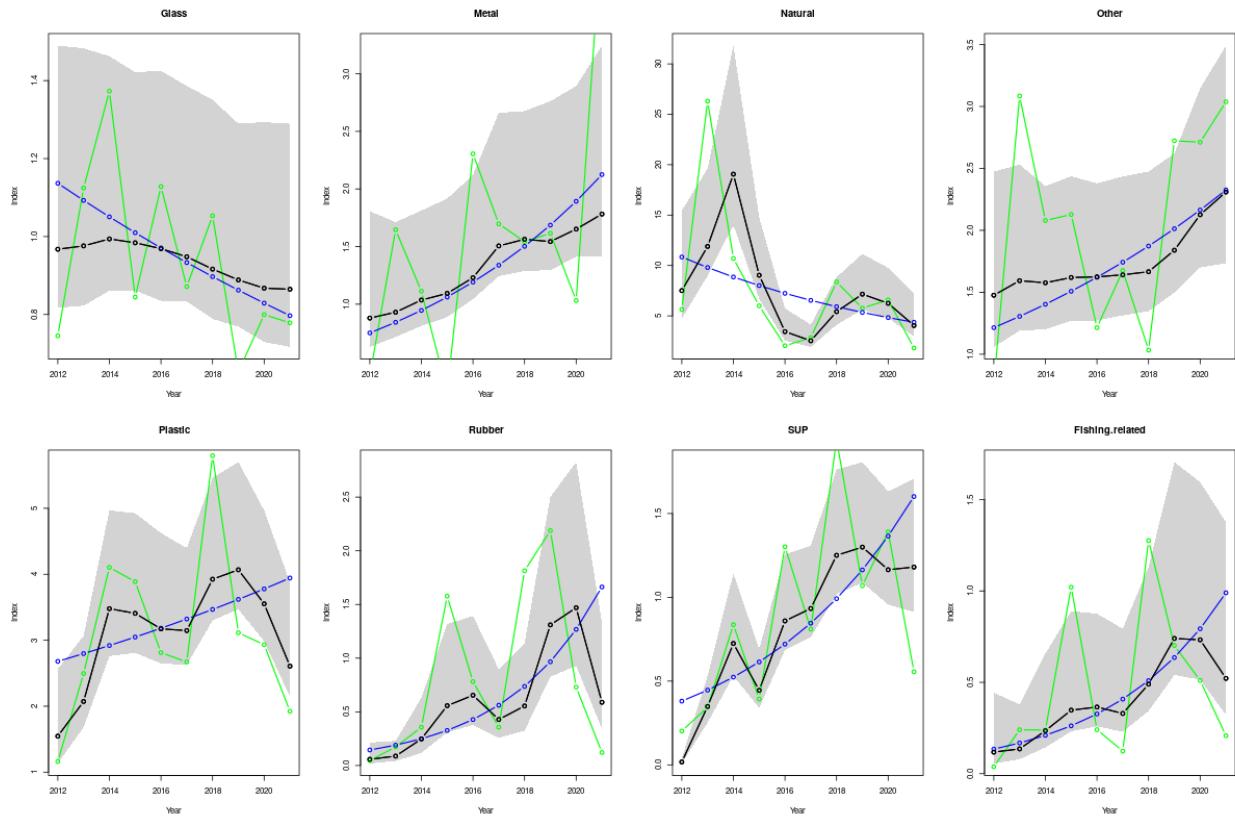


Figure 27: All litter indices and all models (mass). Black is model 1, green is model 2, and blue is model 3. Shaded area is 95% confidence area of model 1. Units are kg / km² in all plots.

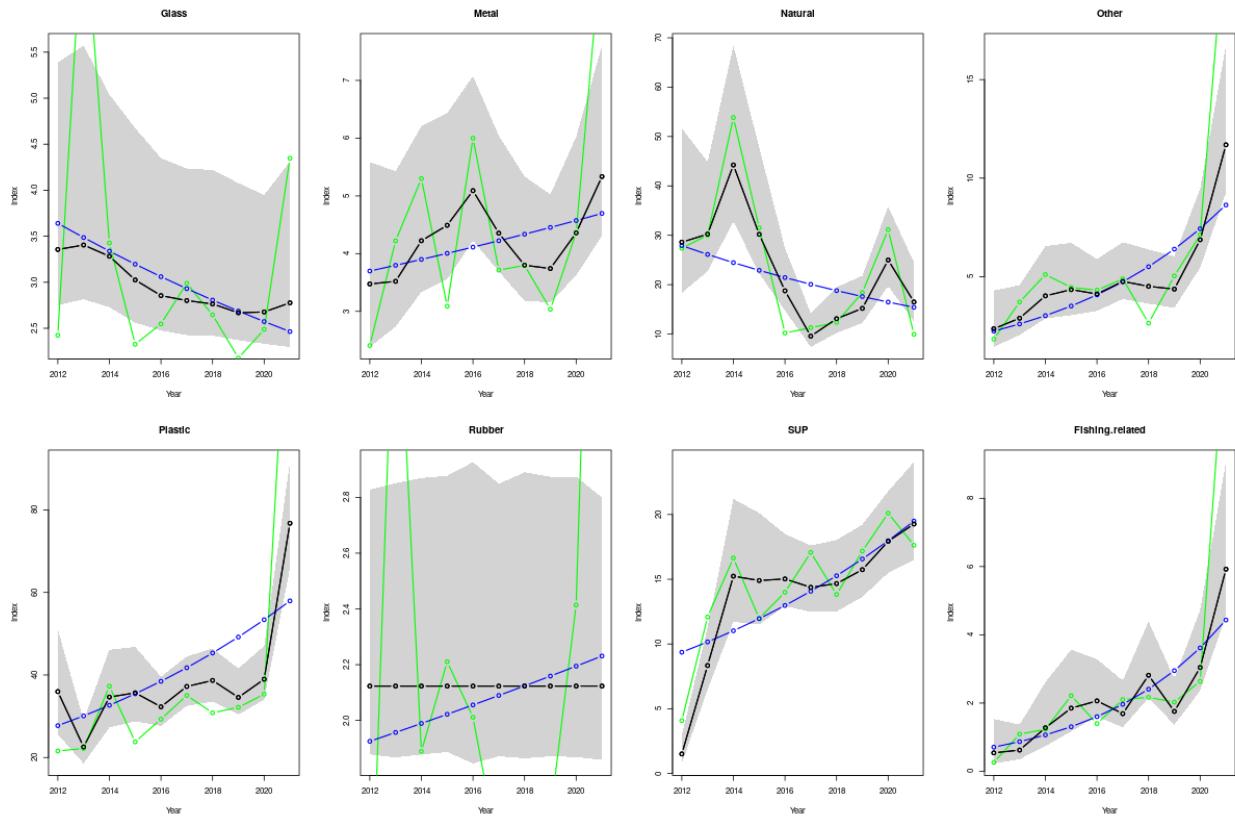


Figure 28: All litter indices and all models (numbers). Black is model 1, green is model 2, and blue is model 3. Shaded area is 95% confidence area of model 1. Units are numbers / km^2 in all plots.

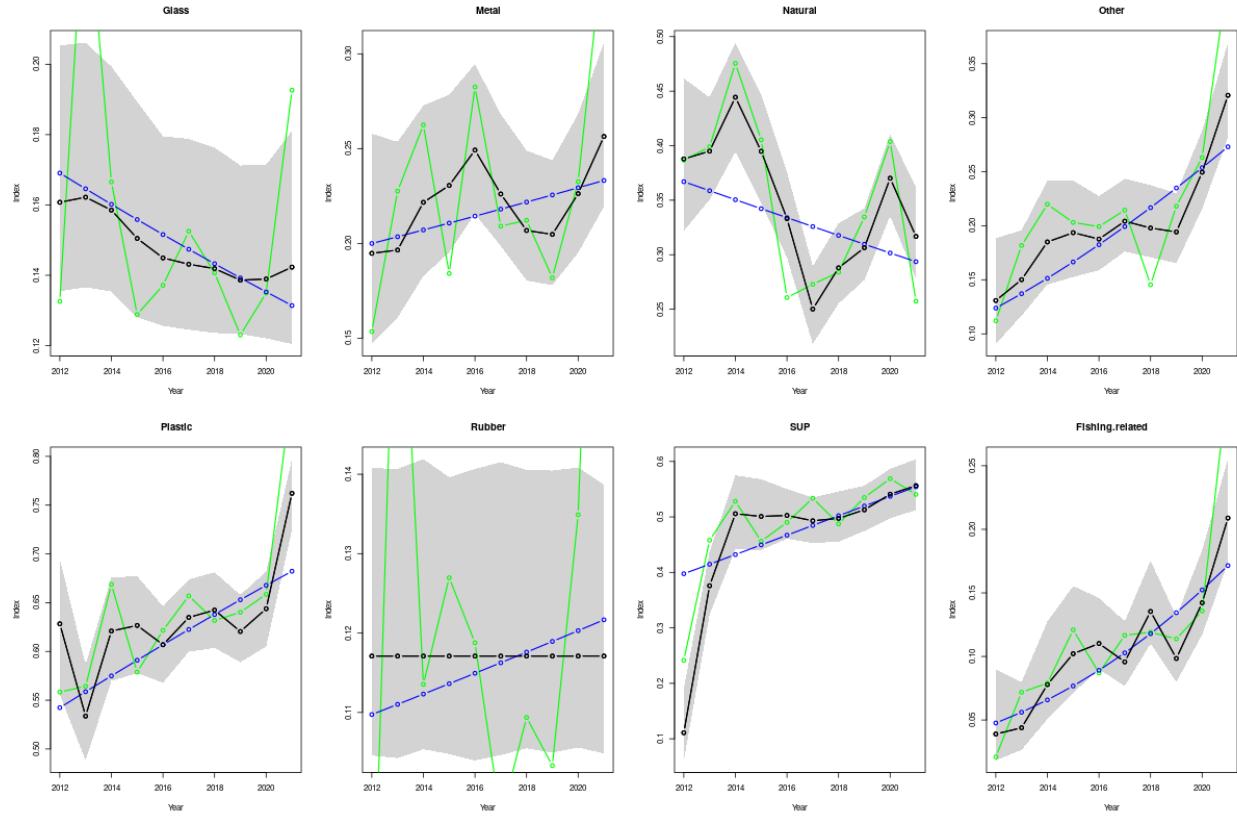


Figure 29: All litter indices and all models (probability of encounter). Black is model 1, green is model 2, and blue is model 3. Shaded area is 95% confidence area of model 1. Units are probability per standard haul (30 min TVL) in all plots.

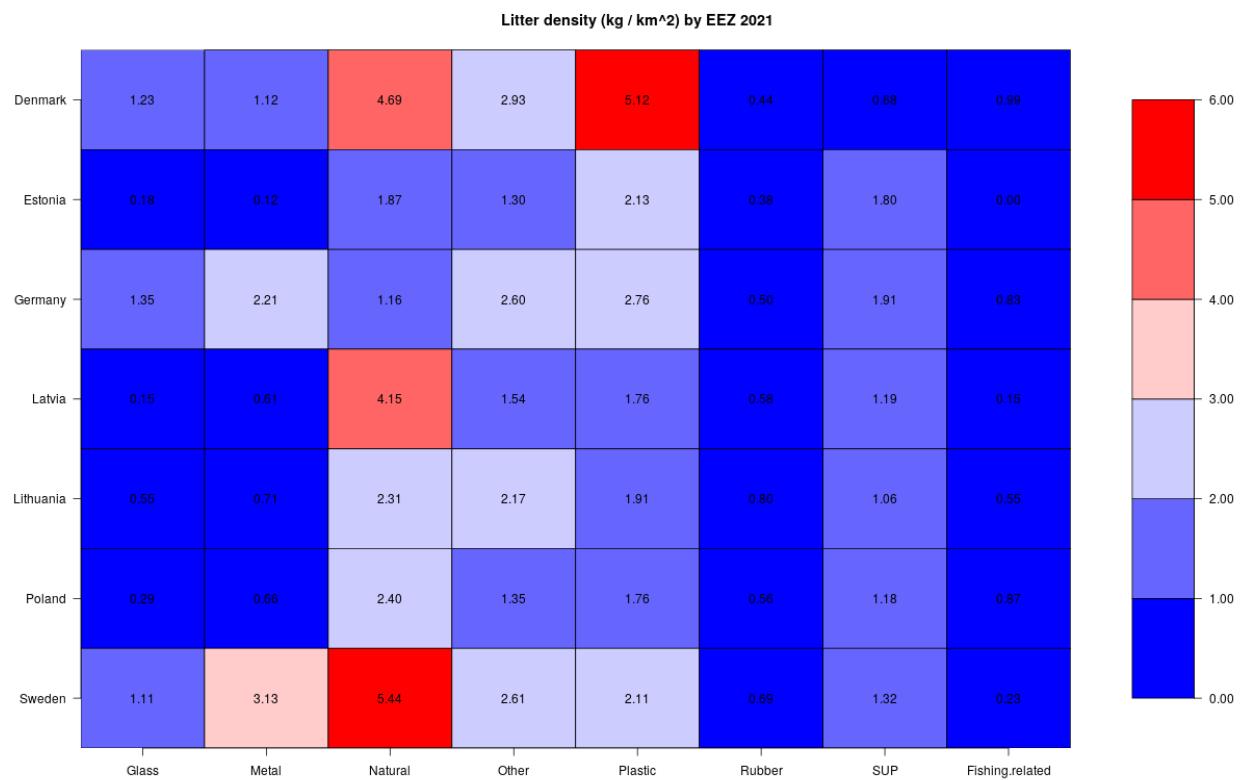


Figure 30: Litter density by EEZ



Figure 31: Uncertainty of litter density estimates by EEZ

4.1 Model summaries (mass)

```
$Glass

Family: Tweedie(p=1.428)
Link function: log

Formula:
A1 ~ s(ctime, k = 10, bs = "ds", m = c(1, 0)) + s(lon, lat, bs = "ds",
m = c(1, 0.5), k = 128) + offset(log(EFFORT))

Parametric coefficients:
Estimate Std. Error t value Pr(>|t|)
(Intercept) -14.32211 0.07536 -190.1 <2e-16 ***
---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
edf Ref.df F p-value
s(ctime) 0.8252 9 0.175 0.102
s(lon,lat) 43.1784 127 1.974 <2e-16 ***
---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) = 0.0993 Deviance explained = 25.2%
-ML = 757.34 Scale est. = 2.0126 n = 2297

$Metal

Family: Tweedie(p=1.758)
Link function: log

Formula:
A1 ~ s(ctime, k = 10, bs = "ds", m = c(1, 0)) + s(lon, lat, bs = "ds",
m = c(1, 0.5), k = 128) + offset(log(EFFORT))

Parametric coefficients:
Estimate Std. Error t value Pr(>|t|)
(Intercept) -13.96543 0.09032 -154.6 <2e-16 ***
---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
edf Ref.df F p-value
s(ctime) 2.262 9 0.914 0.00429 **
s(lon,lat) 50.691 127 2.066 < 2e-16 ***
---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) = 0.0275 Deviance explained = 24%
-ML = 774.15 Scale est. = 9.4786 n = 2297

$Natural

Family: Tweedie(p=1.716)
Link function: log

Formula:
A1 ~ s(ctime, k = 10, bs = "ds", m = c(1, 0)) + s(lon, lat, bs = "ds",
m = c(1, 0.5), k = 128) + offset(log(EFFORT))

Parametric coefficients:
Estimate Std. Error t value Pr(>|t|)
(Intercept) -12.81546 0.06363 -201.4 <2e-16 ***
---
```

```

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
      edf Ref.df   F p-value
s(ctime)    7.127     9 9.591 <2e-16 ***
s(lon,lat) 73.087   127 4.407 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) = -0.00272  Deviance explained = 35.5%
-ML = 1547.8  Scale est. = 5.6245   n = 2297

$Other

Family: Tweedie(p=1.71)
Link function: log

Formula:
A1 ~ s(ctime, k = 10, bs = "ds", m = c(1, 0)) + s(lon, lat, bs = "ds",
m = c(1, 0.5), k = 128) + offset(log(EFFORT))

Parametric coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -13.39630   0.07912 -169.3 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
      edf Ref.df   F p-value
s(ctime)    1.932     9 0.580  0.026 *
s(lon,lat) 22.081   127 0.513 3.83e-09 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.00506  Deviance explained = 8.34%
-ML = 939.64  Scale est. = 7.691   n = 2297

$Plastic

Family: Tweedie(p=1.807)
Link function: log

Formula:
A1 ~ s(ctime, k = 10, bs = "ds", m = c(1, 0)) + s(lon, lat, bs = "ds",
m = c(1, 0.5), k = 128) + offset(log(EFFORT))

Parametric coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -13.01328   0.04297 -302.9 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
      edf Ref.df   F p-value
s(ctime)    5.829     9 3.798 2.15e-07 ***
s(lon,lat) 88.225   127 5.817 < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.00506  Deviance explained = 30.7%
-ML = 176.44  Scale est. = 2.9817   n = 2297

$Rubber

Family: Tweedie(p=1.751)

```

```

Link function: log

Formula:
A1 ~ s(ctime, k = 10, bs = "ds", m = c(1, 0)) + s(lon, lat, bs = "ds",
m = c(1, 0.5), k = 128) + offset(log(EFFORT))

Parametric coefficients:
Estimate Std. Error t value Pr(>|t|)
(Intercept) -14.460     0.128 -112.9 <2e-16 ***
---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
edf Ref.df F p-value
s(ctime) 5.495 9 5.006 1.84e-10 ***
s(lon,lat) 12.540 127 0.210 0.000962 ***
---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) = 0.00545 Deviance explained = 13.5%
-ML = 524.69 Scale est. = 16.656 n = 2297

$SUP

Family: Tweedie(p=1.722)
Link function: log

Formula:
A1 ~ s(ctime, k = 10, bs = "ds", m = c(1, 0)) + s(lon, lat, bs = "ds",
m = c(1, 0.5), k = 128) + offset(log(EFFORT))

Parametric coefficients:
Estimate Std. Error t value Pr(>|t|)
(Intercept) -14.18049 0.04988 -284.3 <2e-16 ***
---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
edf Ref.df F p-value
s(ctime) 8.438 9 16.762 <2e-16 ***
s(lon,lat) 72.660 127 3.463 <2e-16 ***
---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) = 0.00382 Deviance explained = 23.5%
-ML = 218.73 Scale est. = 2.419 n = 2297

$Fishing.related

Family: Tweedie(p=1.788)
Link function: log

Formula:
A1 ~ s(ctime, k = 10, bs = "ds", m = c(1, 0)) + s(lon, lat, bs = "ds",
m = c(1, 0.5), k = 128) + offset(log(EFFORT))

Parametric coefficients:
Estimate Std. Error t value Pr(>|t|)
(Intercept) -15.4981 0.1395 -111.1 <2e-16 ***
---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
edf Ref.df F p-value
s(ctime) 3.885 9 2.132 3.86e-05 ***

```

```

s(lon,lat) 44.223    127 1.916 < 2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) =  0.00722  Deviance explained = 42.5%
-ML = 418.24  Scale est. = 17.042   n = 2297

=====
$Glass

Family: Tweedie(p=1.425)
Link function: log

Formula:
A1 ~ Year + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
Estimate Std. Error t value Pr(>|t|)
(Intercept) -14.52428  0.25875 -56.133 <2e-16 ***
Year2013     0.41114  0.33187  1.239  0.2155
Year2014     0.61088  0.32911  1.856  0.0636 .
Year2015     0.12514  0.34335  0.364  0.7155
Year2016     0.41446  0.32002  1.295  0.1954
Year2017     0.15630  0.32645  0.479  0.6321
Year2018     0.34576  0.32128  1.076  0.2820
Year2019    -0.13289  0.32454 -0.409  0.6822
Year2020     0.07021  0.32409  0.217  0.8285
Year2021     0.04373  0.40602  0.108  0.9142
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:
edf Ref.df      F p-value
s(lon,lat) 41.99    127 1.815 <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) =  0.102  Deviance explained = 23.5%
-ML = 753.56  Scale est. = 2.0706   n = 2297

$Metal

Family: Tweedie(p=1.758)
Link function: log

Formula:
A1 ~ Year + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
Estimate Std. Error t value Pr(>|t|)
(Intercept) -15.1720  0.3667 -41.376 < 2e-16 ***
Year2013     1.4789  0.4664  3.171 0.001539 **
Year2014     1.0870  0.4851  2.241 0.025136 *
Year2015    -0.4334  0.5121 -0.846 0.397523
Year2016     1.8154  0.4396  4.130 3.76e-05 ***
Year2017     1.5090  0.4401  3.429 0.000616 ***
Year2018     1.4137  0.4457  3.171 0.001537 **
Year2019     1.4596  0.4309  3.387 0.000718 ***
Year2020     1.0113  0.4518  2.238 0.025293 *
Year2021     2.4333  0.5163  4.713 2.59e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

Approximate significance of smooth terms:
      edf Ref.df   F p-value
s(lon,lat) 43.06     127 1.592 <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) =  0.0597  Deviance explained =  24%
-ML = 760.97  Scale est. = 9.4907    n = 2297

$Natural

Family: Tweedie(p=1.711)
Link function: log

Formula:
A1 ~ Year + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -12.82617   0.21911 -58.537 < 2e-16 ***
Year2013     1.53941   0.27213   5.657 1.74e-08 ***
Year2014     0.63929   0.29389   2.175 0.029714 *
Year2015     0.06139   0.29938   0.205 0.837546
Year2016    -1.01750   0.30065  -3.384 0.000726 ***
Year2017    -0.68622   0.29061  -2.361 0.018296 *
Year2018     0.39442   0.27527   1.433 0.152047
Year2019     0.02243   0.26993   0.083 0.933785
Year2020     0.15540   0.27727   0.560 0.575215
Year2021    -1.13579   0.40335  -2.816 0.004907 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:
      edf Ref.df   F p-value
s(lon,lat) 72.15     127 4.162 <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) = -0.00244  Deviance explained = 36.1%
-ML = 1527.1  Scale est. = 5.5141    n = 2297

$Other

Family: Tweedie(p=1.712)
Link function: log

Formula:
A1 ~ Year + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -14.2949   0.3291 -43.432 < 2e-16 ***
Year2013     1.4032   0.4182   3.356 0.000805 ***
Year2014     1.0088   0.4366   2.311 0.020928 *
Year2015     1.0318   0.4224   2.443 0.014646 *
Year2016     0.4704   0.4117   1.143 0.253254
Year2017     0.7928   0.4011   1.976 0.048238 *
Year2018     0.3089   0.4146   0.745 0.456352
Year2019     1.2786   0.3834   3.335 0.000868 ***
Year2020     1.2741   0.3959   3.218 0.001309 **
Year2021     1.3880   0.4818   2.881 0.004000 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

Approximate significance of smooth terms:
edf Ref.df   F p-value
s(lon,lat) 17.02    127 0.393 1.35e-07 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.00339  Deviance explained = 8.27%
-ML = 931.29  Scale est. = 7.8197 n = 2297

$Plastic

Family: Tweedie(p=1.806)
Link function: log

Formula:
A1 ~ Year + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
Estimate Std. Error t value Pr(>|t|)
(Intercept) -13.9702  0.1728 -80.847 < 2e-16 ***
Year2013     0.7650  0.2292  3.337  0.00086 ***
Year2014     1.2624  0.2325  5.430  6.25e-08 ***
Year2015     1.2083  0.2246  5.379  8.29e-08 ***
Year2016     0.8842  0.2156  4.101  4.26e-05 ***
Year2017     0.8328  0.2123  3.922  9.04e-05 ***
Year2018     1.6079  0.2097  7.666  2.65e-14 ***
Year2019     0.9860  0.2057  4.793  1.75e-06 ***
Year2020     0.9261  0.2135  4.337  1.51e-05 ***
Year2021     0.5043  0.2821  1.787  0.07401 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
edf Ref.df   F p-value
s(lon,lat) 86.38    127 5.295 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.0126  Deviance explained = 31.1%
-ML = 159.52  Scale est. = 2.9605 n = 2297

$Rubber

Family: Tweedie(p=1.762)
Link function: log

Formula:
A1 ~ Year + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
Estimate Std. Error t value Pr(>|t|)
(Intercept) -16.8931  0.6406 -26.372 < 2e-16 ***
Year2013     1.3242  0.8375  1.581 0.113983
Year2014     2.0471  0.8210  2.494 0.012718 *
Year2015     3.5334  0.7551  4.680 3.04e-06 ***
Year2016     2.8306  0.7360  3.846 0.000123 ***
Year2017     2.0477  0.7463  2.744 0.006124 **
Year2018     3.6733  0.7190  5.109 3.51e-07 ***
Year2019     3.8605  0.6999  5.516 3.86e-08 ***
Year2020     2.7627  0.7347  3.760 0.000174 ***
Year2021     0.9669  0.9840  0.983 0.325906
---

```

```

Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:
          edf Ref.df F p-value
s(lon,lat) 0.0006072    127 0   0.411

R-sq.(adj) =  0.00272  Deviance explained = 8.61%
-ML =  513.8  Scale est. = 18.526    n = 2297

$SUP

Family: Tweedie(p=1.72)
Link function: log

Formula:
A1 ~ Year + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -15.5599    0.2134 -72.911 < 2e-16 ***
Year2013     0.5343    0.2835   1.885  0.0596 .
Year2014     1.4213    0.2775   5.121 3.30e-07 ***
Year2015     0.6657    0.2817   2.363  0.0182 *
Year2016     1.8637    0.2527   7.375 2.32e-13 ***
Year2017     1.3892    0.2529   5.494 4.39e-08 ***
Year2018     2.2626    0.2476   9.138 < 2e-16 ***
Year2019     1.6668    0.2462   6.769 1.66e-11 ***
Year2020     1.9299    0.2522   7.651 2.95e-14 ***
Year2021     1.0123    0.3272   3.094  0.0020 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:
          edf Ref.df F p-value
s(lon,lat) 67.41    127 3.217 <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) =  0.00987  Deviance explained = 22.8%
-ML = 196.78  Scale est. = 2.4154    n = 2297

$Fishing.related

Family: Tweedie(p=1.792)
Link function: log

Formula:
A1 ~ Year + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -17.6701    0.6106 -28.938 < 2e-16 ***
Year2013     1.8477    0.7732   2.390 0.016942 *
Year2014     1.8400    0.8135   2.262 0.023812 *
Year2015     3.2926    0.7363   4.472 8.14e-06 ***
Year2016     1.8494    0.7288   2.537 0.011235 *
Year2017     1.1798    0.7349   1.605 0.108538
Year2018     3.5157    0.6986   5.032 5.23e-07 ***
Year2019     2.9178    0.6896   4.231 2.42e-05 ***
Year2020     2.5990    0.7155   3.632 0.000287 ***
Year2021     1.7030    0.9441   1.804 0.071379 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

Approximate significance of smooth terms:
      edf Ref.df      F p-value
s(lon,lat) 37.5     127 1.617 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.00928  Deviance explained = 41.2%
-ML = 408.68  Scale est. = 17.912   n = 2297

=====
$Glass

Family: Tweedie(p=1.428)
Link function: log

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) 65.23603  51.88755  1.257   0.209
ctime       -0.03944   0.02572 -1.533   0.125

Approximate significance of smooth terms:
      edf Ref.df      F p-value
s(lon,lat) 42.85    127 1.949 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.101  Deviance explained = 25.1%
-ML = 756.67  Scale est. = 2.0197   n = 2297

$Metal

Family: Tweedie(p=1.758)
Link function: log

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -247.17161  71.27617 -3.468 0.000535 ***
ctime        0.11560   0.03533  3.272 0.001084 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
      edf Ref.df      F p-value
s(lon,lat) 50.62    127 2.103 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.0275  Deviance explained = 23.8%
-ML =  772.3  Scale est. = 9.4998   n = 2297

$Natural

Family: Tweedie(p=1.721)
Link function: log

Formula:

```

```

A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) 190.98425   48.65222   3.925 8.92e-05 ***
ctime       -0.10097    0.02412  -4.186 2.95e-05 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
            edf Ref.df      F p-value
s(lon,lat) 72.86     127 4.415 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.00165  Deviance explained = 32.6%
-ML = 1560.6  Scale est. = 5.9245    n = 2297

$Other

Family: Tweedie(p=1.71)
Link function: log

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -159.10150   63.80050  -2.494  0.0127 *
ctime        0.07223    0.03163   2.284  0.0225 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
            edf Ref.df      F p-value
s(lon,lat) 22.71     127 0.546 8.19e-10 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.0053  Deviance explained = 8.32%
-ML = 938.52  Scale est. = 7.6992    n = 2297

$Plastic

Family: Tweedie(p=1.809)
Link function: log

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -99.59402   35.51052  -2.805  0.00508 **
ctime        0.04293    0.01760   2.439  0.01481 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
            edf Ref.df      F p-value
s(lon,lat) 88.24     127 6.018 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

```

```

R-sq.(adj) =  0.00195  Deviance explained = 29.9%
-ML =  179.3  Scale est. = 3.0256    n = 2297

$Rubber

Family: Tweedie(p=1.755)
Link function: log

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
             Estimate Std. Error t value Pr(>|t|)    
(Intercept) -561.80300 105.14100 -5.343 1.00e-07 ***
ctime        0.27138   0.05211  5.208 2.08e-07 ***  
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
          edf Ref.df      F p-value    
s(lon,lat) 14.23     127 0.266 4.95e-05 ***  
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.00203  Deviance explained = 10.4%
-ML = 525.24  Scale est. = 17.597    n = 2297

$SUP

Family: Tweedie(p=1.724)
Link function: log

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
             Estimate Std. Error t value Pr(>|t|)    
(Intercept) -336.2852  40.3538 -8.333 < 2e-16 ***
ctime        0.1597   0.0200  7.985 2.23e-15 ***  
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
          edf Ref.df      F p-value    
s(lon,lat) 73.57     127 3.651 <2e-16 ***  
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) = -0.00976  Deviance explained = 21.6%
-ML = 222.42  Scale est. = 2.4877    n = 2297

$Fishing.related

Family: Tweedie(p=1.789)
Link function: log

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
             Estimate Std. Error t value Pr(>|t|)    

```

```
(Intercept) -462.42654 109.65045 -4.217 2.57e-05 ***
ctime         0.22156   0.05435  4.077 4.73e-05 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
      edf Ref.df    F p-value
s(lon,lat) 44.76     127 1.989 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.00646  Deviance explained = 41.7%
-ML = 417.14  Scale est. = 17.345  n = 2297
```

4.2 Model summaries (numbers)

```
===== Models on numbers =====
$Glass

Family: Negative Binomial(0.284)
Link function: log

Formula:
A1 ~ s(ctime, k = 10, bs = "ds", m = c(1, 0)) + s(lon, lat, bs = "ds",
m = c(1, 0.5), k = 128) + offset(log(EFFORT))

Parametric coefficients:
Estimate Std. Error z value Pr(>|z|)
(Intercept) -12.9597    0.0724   -179   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
edf Ref.df Chi.sq p-value
s(ctime)    1.409      9   3.19  0.0607 .
s(lon,lat) 47.357    127 234.96 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.0749  Deviance explained = 31.9%
-ML = 889.47  Scale est. = 1          n = 2065

$Metal

Family: Negative Binomial(0.433)
Link function: log

Formula:
A1 ~ s(ctime, k = 10, bs = "ds", m = c(1, 0)) + s(lon, lat, bs = "ds",
m = c(1, 0.5), k = 128) + offset(log(EFFORT))

Parametric coefficients:
Estimate Std. Error z value Pr(>|z|)
(Intercept) -12.46915   0.05351   -233   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
edf Ref.df Chi.sq p-value
s(ctime)    3.753      9  11.39  0.00509 **
s(lon,lat) 39.778    127 142.45 < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.0614  Deviance explained = 19.8%
-ML = 1098.3  Scale est. = 1          n = 2065

$Natural

Family: Negative Binomial(0.295)
Link function: log

Formula:
A1 ~ s(ctime, k = 10, bs = "ds", m = c(1, 0)) + s(lon, lat, bs = "ds",
m = c(1, 0.5), k = 128) + offset(log(EFFORT))

Parametric coefficients:
Estimate Std. Error z value Pr(>|z|)
(Intercept) -11.59347   0.05358  -216.4   <2e-16 ***
```

```

---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
          edf Ref.df Chi.sq p-value
s(ctime)    6.755      9  69.83 2.4e-15 ***
s(lon,lat) 58.923   127 610.77 < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.0753  Deviance explained = 48.9%
-ML = 1921.4  Scale est. = 1           n = 2065

$Other

Family: Negative Binomial(0.295)
Link function: log

Formula:
A1 ~ s(ctime, k = 10, bs = "ds", m = c(1, 0)) + s(lon, lat, bs = "ds",
m = c(1, 0.5), k = 128) + offset(log(EFFORT))

Parametric coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept) -12.41799   0.05914   -210 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
          edf Ref.df Chi.sq p-value
s(ctime)    5.25      9  53.13 4.43e-13 ***
s(lon,lat) 37.55   127 182.23 < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.056  Deviance explained = 28.9%
-ML = 1146.2  Scale est. = 1           n = 2065

$Plastic

Family: Negative Binomial(1.014)
Link function: log

Formula:
A1 ~ s(ctime, k = 10, bs = "ds", m = c(1, 0)) + s(lon, lat, bs = "ds",
m = c(1, 0.5), k = 128) + offset(log(EFFORT))

Parametric coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept) -10.56191   0.02825  -373.8 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
          edf Ref.df Chi.sq p-value
s(ctime)    7.425      9  114.8 <2e-16 ***
s(lon,lat) 70.266   127 853.0 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.177  Deviance explained = 53.3%
-ML = 2986.9  Scale est. = 1           n = 2065

$Rubber

```

```

Family: Negative Binomial(0.249)
Link function: log

Formula:
A1 ~ s(ctime, k = 10, bs = "ds", m = c(1, 0)) + s(lon, lat, bs = "ds",
m = c(1, 0.5), k = 128) + offset(log(EFFORT))

Parametric coefficients:
Estimate Std. Error z value Pr(>|z|)
(Intercept) -13.25316 0.07683 -172.5 <2e-16 ***
---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
edf Ref.df Chi.sq p-value
s(ctime) 7.692e-04 9 0.001 0.487
s(lon,lat) 2.733e+01 127 100.754 1.04e-15 ***
---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) = 0.00557 Deviance explained = 21.6%
-ML = 661.33 Scale est. = 1 n = 2065

$SUP

Family: Negative Binomial(0.936)
Link function: log

Formula:
A1 ~ s(ctime, k = 10, bs = "ds", m = c(1, 0)) + s(lon, lat, bs = "ds",
m = c(1, 0.5), k = 128) + offset(log(EFFORT))

Parametric coefficients:
Estimate Std. Error z value Pr(>|z|)
(Intercept) -11.19187 0.03315 -337.6 <2e-16 ***
---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
edf Ref.df Chi.sq p-value
s(ctime) 8.036 9 69.73 5.25e-13 ***
s(lon,lat) 58.750 127 404.55 < 2e-16 ***
---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) = 0.124 Deviance explained = 26.5%
-ML = 2265.2 Scale est. = 1 n = 2065

$Fishing.related

Family: Negative Binomial(0.246)
Link function: log

Formula:
A1 ~ s(ctime, k = 10, bs = "ds", m = c(1, 0)) + s(lon, lat, bs = "ds",
m = c(1, 0.5), k = 128) + offset(log(EFFORT))

Parametric coefficients:
Estimate Std. Error z value Pr(>|z|)
(Intercept) -13.10953 0.07801 -168 <2e-16 ***
---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
edf Ref.df Chi.sq p-value

```

```

s(ctime)      5.905      9  57.92 4.38e-13 ***
s(lon,lat)   32.878    127 138.47  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.0398  Deviance explained = 39.6%
-ML =  795.4  Scale est. = 1          n = 2065

=====
$Glass

Family: Negative Binomial(0.297)
Link function: log

Formula:
A1 ~ Year + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
Estimate Std. Error z value Pr(>|z|)
(Intercept) -13.09964  0.26396 -49.627 < 2e-16 ***
Year2013     1.07937  0.34684  3.112  0.00186 **
Year2014     0.34619  0.36170  0.957  0.33850
Year2015    -0.04116  0.35511 -0.116  0.90773
Year2016     0.04965  0.31690  0.157  0.87551
Year2017     0.20929  0.32047  0.653  0.51370
Year2018     0.08740  0.32225  0.271  0.78621
Year2019    -0.10757  0.31813 -0.338  0.73526
Year2020     0.02589  0.32223  0.080  0.93595
Year2021     0.58383  0.36524  1.598  0.10994
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
edf Ref.df Chi.sq p-value
s(lon,lat) 44.86     127 214.2 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.0894  Deviance explained = 32.5%
-ML = 881.23  Scale est. = 1          n = 2065

$Metal

Family: Negative Binomial(0.447)
Link function: log

Formula:
A1 ~ Year + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
Estimate Std. Error z value Pr(>|z|)
(Intercept) -13.0072    0.2443 -53.237 < 2e-16 ***
Year2013     0.5615    0.3354  1.674 0.094142 .
Year2014     0.7892    0.3200  2.466 0.013650 *
Year2015     0.2496    0.3212  0.777 0.437151
Year2016     0.9130    0.2736  3.337 0.000846 ***
Year2017     0.4338    0.2890  1.501 0.133257
Year2018     0.4556    0.2862  1.592 0.111389
Year2019     0.2321    0.2842  0.817 0.414039
Year2020     0.5952    0.2859  2.082 0.037348 *
Year2021     1.3657    0.3124  4.372 1.23e-05 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

```

```

Approximate significance of smooth terms:
edf Ref.df Chi.sq p-value
s(lon,lat) 34.38     127 110.6 5.6e-15 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.0692  Deviance explained = 19.6%
-ML =    1086  Scale est. = 1          n = 2065

$Natural

Family: Negative Binomial(0.306)
Link function: log

Formula:
A1 ~ Year + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
Estimate Std. Error z value Pr(>|z|)
(Intercept) -11.20058   0.18647 -60.065 < 2e-16 ***
Year2013      0.09258   0.27499   0.337 0.736357
Year2014      0.67618   0.26544   2.547 0.010853 *
Year2015      0.14081   0.25376   0.555 0.578953
Year2016     -0.98625   0.23533  -4.191 2.78e-05 ***
Year2017     -0.88605   0.24155  -3.668 0.000244 ***
Year2018     -0.79536   0.23858  -3.334 0.000857 ***
Year2019     -0.39722   0.22606  -1.757 0.078888 .
Year2020      0.12894   0.23009   0.560 0.575214
Year2021     -1.01347   0.29611  -3.423 0.000620 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
edf Ref.df Chi.sq p-value
s(lon,lat) 59.13     127 631.9 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.0789  Deviance explained = 49.8%
-ML = 1904.2  Scale est. = 1          n = 2065

$Other

Family: Negative Binomial(0.311)
Link function: log

Formula:
A1 ~ Year + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
Estimate Std. Error z value Pr(>|z|)
(Intercept) -13.3804   0.2865 -46.697 < 2e-16 ***
Year2013      0.7086   0.3922   1.807 0.07083 .
Year2014      1.0272   0.3761   2.732 0.00630 **
Year2015      0.8905   0.3569   2.495 0.01258 *
Year2016      0.8586   0.3239   2.651 0.00803 **
Year2017      0.9840   0.3270   3.009 0.00262 **
Year2018      0.3668   0.3375   1.087 0.27710
Year2019      1.0134   0.3183   3.184 0.00145 **
Year2020      1.3600   0.3230   4.210 2.55e-05 ***
Year2021      2.5384   0.3506   7.241 4.47e-13 ***
---

```

```

Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:
    edf Ref.df Chi.sq p-value
s(lon,lat) 35.43     127 165.2 <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) =  0.0508  Deviance explained = 30.1%
-ML = 1129.6  Scale est. = 1          n = 2065

$Plastic

Family: Negative Binomial(1.075)
Link function: log

Formula:
A1 ~ Year + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
              Estimate Std. Error z value Pr(>|z|)
(Intercept) -10.99510   0.11993 -91.679 < 2e-16 ***
Year2013      0.02801   0.18354   0.153 0.878688
Year2014      0.54659   0.17014   3.213 0.001315 **
Year2015      0.09775   0.16242   0.602 0.547263
Year2016      0.30603   0.13977   2.189 0.028565 *
Year2017      0.48474   0.14175   3.420 0.000627 ***
Year2018      0.35672   0.14165   2.518 0.011790 *
Year2019      0.39915   0.13776   2.898 0.003761 **
Year2020      0.49332   0.14226   3.468 0.000525 ***
Year2021      1.90588   0.16160   11.794 < 2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:
    edf Ref.df Chi.sq p-value
s(lon,lat) 69.02     127 714.8 <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) =  0.265  Deviance explained = 54.6%
-ML = 2955.1  Scale est. = 1          n = 2065

$Rubber

Family: Negative Binomial(0.254)
Link function: log

Formula:
A1 ~ Year + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
              Estimate Std. Error z value Pr(>|z|)
(Intercept) -13.8460   0.3624 -38.203 < 2e-16 ***
Year2013      1.2364   0.4672   2.646 0.008139 **
Year2014      0.5492   0.5004   1.097 0.272427
Year2015      0.7065   0.4494   1.572 0.115919
Year2016      0.6120   0.4093   1.495 0.134852
Year2017      0.3317   0.4281   0.775 0.438409
Year2018      0.4977   0.4169   1.194 0.232618
Year2019      0.4203   0.4101   1.025 0.305451
Year2020      0.7944   0.4127   1.925 0.054241 .
Year2021      1.5974   0.4469   3.574 0.000351 ***

```

```

---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
    edf Ref.df Chi.sq p-value
s(lon,lat) 19.13     127   62.91 5.6e-10 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.0108  Deviance explained = 20.3%
-ML = 654.09  Scale est. = 1          n = 2065

$SUP

Family: Negative Binomial(0.952)
Link function: log

Formula:
A1 ~ Year + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
Estimate Std. Error z value Pr(>|z|)
(Intercept) -12.4509    0.1815 -68.619 < 2e-16 ***
Year2013      1.0844    0.2403   4.513 6.39e-06 ***
Year2014      1.4041    0.2294   6.122 9.23e-10 ***
Year2015      1.0755    0.2201   4.886 1.03e-06 ***
Year2016      1.2308    0.1988   6.191 5.98e-10 ***
Year2017      1.4298    0.2005   7.131 9.97e-13 ***
Year2018      1.2189    0.2009   6.067 1.30e-09 ***
Year2019      1.4359    0.1963   7.315 2.58e-13 ***
Year2020      1.5931    0.2000   7.964 1.66e-15 ***
Year2021      1.4618    0.2317   6.308 2.82e-10 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
    edf Ref.df Chi.sq p-value
s(lon,lat) 57.03     127   388.9 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.129  Deviance explained = 25.9%
-ML = 2250.6  Scale est. = 1          n = 2065

$Fishing.related

Family: Negative Binomial(0.256)
Link function: log

Formula:
A1 ~ Year + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
Estimate Std. Error z value Pr(>|z|)
(Intercept) -15.0862   0.5968 -25.280 < 2e-16 ***
Year2013      1.4265    0.7416   1.923 0.054424 .
Year2014      1.5481    0.7161   2.162 0.030644 *
Year2015      2.1360    0.6502   3.285 0.001020 **
Year2016      1.6761    0.6260   2.678 0.007414 **
Year2017      2.0830    0.6265   3.325 0.000884 ***
Year2018      2.1136    0.6239   3.388 0.000705 ***
Year2019      2.0473    0.6191   3.307 0.000944 ***
Year2020      2.3104    0.6238   3.704 0.000212 ***

```

```

Year2021      3.9202     0.6425   6.101 1.05e-09 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
    edf Ref.df Chi.sq p-value
s(lon,lat) 31.06     127   115.5 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.0572  Deviance explained = 39.7%
-ML = 783.61  Scale est. = 1          n = 2065

=====
$Glass

Family: Negative Binomial(0.285)
Link function: log

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept) 74.52818   53.81737   1.385   0.166
ctime       -0.04336    0.02668  -1.626   0.104

Approximate significance of smooth terms:
    edf Ref.df Chi.sq p-value
s(lon,lat) 47.96     127   239.2 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.0763  Deviance explained = 31.9%
-ML = 888.79  Scale est. = 1          n = 2065

$Metal

Family: Negative Binomial(0.424)
Link function: log

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept) -66.01773   45.36620  -1.455   0.146
ctime        0.02654    0.02248   1.180   0.238

Approximate significance of smooth terms:
    edf Ref.df Chi.sq p-value
s(lon,lat) 41.88     127   159.7 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.0556  Deviance explained = 19.3%
-ML = 1098.7  Scale est. = 1          n = 2065

$Natural

Family: Negative Binomial(0.279)
Link function: log

```

```

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept) 121.41310   43.01266  2.823  0.00476 **
ctime       -0.06589    0.02132 -3.091  0.00200 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
        edf Ref.df Chi.sq p-value
s(lon,lat) 59.97    127 655.1 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.0548  Deviance explained = 46.3%
-ML = 1933.2  Scale est. = 1          n = 2065

$Other

Family: Negative Binomial(0.29)
Link function: log

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept) -315.36278  50.99017 -6.185 6.22e-10 ***
ctime        0.15016   0.02527  5.942 2.81e-09 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
        edf Ref.df Chi.sq p-value
s(lon,lat) 39.22    127 196.9 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.0572  Deviance explained = 27.9%
-ML = 1146.3  Scale est. = 1          n = 2065

$Plastic

Family: Negative Binomial(0.974)
Link function: log

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept) -175.85222  25.03421 -7.024 2.15e-12 ***
ctime        0.08193   0.01241  6.604 4.01e-11 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
        edf Ref.df Chi.sq p-value
s(lon,lat) 73.58    127 991.1 <2e-16 ***
---

```

```

Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) =  0.101  Deviance explained = 52.2%
-ML = 2995.6  Scale est. = 1          n = 2065

$Rubber

Family: Negative Binomial(0.248)
Link function: log

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
              Estimate Std. Error z value Pr(>|z|)
(Intercept) -46.30216   64.58612 -0.717   0.473
ctime        0.01638    0.03201   0.512   0.609

Approximate significance of smooth terms:
      edf Ref.df Chi.sq p-value
s(lon,lat) 26.94     127  97.02 5.77e-15 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) =  0.00557  Deviance explained = 21.5%
-ML = 661.23  Scale est. = 1          n = 2065

$SUP

Family: Negative Binomial(0.905)
Link function: log

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
              Estimate Std. Error z value Pr(>|z|)
(Intercept) -175.50603  28.51738 -6.154 7.54e-10 ***
ctime        0.08146   0.01413   5.763 8.24e-09 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:
      edf Ref.df Chi.sq p-value
s(lon,lat) 59.03     127 399.9 <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) =  0.121  Deviance explained = 24.3%
-ML = 2267.6  Scale est. = 1          n = 2065

$Fishing.related

Family: Negative Binomial(0.235)
Link function: log

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
              Estimate Std. Error z value Pr(>|z|)
(Intercept) -424.14277  68.28161 -6.212 5.24e-10 ***

```

```
ctime          0.20374    0.03383   6.022 1.72e-09 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
      edf Ref.df Chi.sq p-value
s(lon,lat) 34.98     127  153.3 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.0328  Deviance explained = 38.1%
-ML =  795.7  Scale est. = 1           n = 2065
```

4.3 Model summaries (trend models using data from 2015 and onwards)

```
===== Trend models (2015 onwards) =====
===== Mass =====
$Glass

Family: Tweedie(p=1.01)
Link function: log

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -16.284313  55.790166 -0.292   0.770
ctime        0.001547   0.027641   0.056   0.955

Approximate significance of smooth terms:
            edf Ref.df      F p-value    
s(lon,lat) 71.3     127 4.704 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.145  Deviance explained = 34.6%
-ML = 577.38  Scale est. = 1.0219    n = 1726

$Metal

Family: Tweedie(p=1.113)
Link function: log

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -42.01423  56.55896 -0.743   0.458
ctime        0.01464   0.02802   0.522   0.601

Approximate significance of smooth terms:
            edf Ref.df      F p-value    
s(lon,lat) 53.16     127 3.431 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.0908  Deviance explained = 24.1%
-ML = 969.55  Scale est. = 1.6128    n = 1726

$Natural

Family: Tweedie(p=1.43)
Link function: log

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) 11.23975  61.49315  0.183   0.855
ctime       -0.01138   0.03047  -0.374   0.709

Approximate significance of smooth terms:
```

```

      edf Ref.df      F p-value
s(lon,lat) 55.82     127 5.898 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.215  Deviance explained = 44.2%
-ML = 1524.3  Scale est. = 4.7076    n = 1726

$Other

Family: Tweedie(p=1.336)
Link function: log

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -357.73853   70.55182 -5.071 4.40e-07 ***
ctime        0.17111    0.03495  4.896 1.07e-06 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
      edf Ref.df      F p-value
s(lon,lat) 44.75     127 2.938 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.0744  Deviance explained = 31.7%
-ML = 1098.3  Scale est. = 3.3001    n = 1726

$Plastic

Family: Tweedie(p=1.536)
Link function: log

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -317.10480   37.33222 -8.494 < 2e-16 ***
ctime        0.15192    0.01849  8.215 4.25e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
      edf Ref.df      F p-value
s(lon,lat) 69.62     127 9.832 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.13  Deviance explained = 49.9%
-ML = 2862.1  Scale est. = 2.4617    n = 1726

$Rubber

Family: Tweedie(p=1.01)
Link function: log

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +

```

```

offset(log(EFFORT))

Parametric coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -176.07002   74.48788 -2.364   0.0182 *
ctime        0.08059    0.03690   2.184   0.0291 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
          edf Ref.df   F p-value
s(lon,lat) 64.19     127 6.117 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.0801  Deviance explained = 35.5%
-ML = 490.61  Scale est. = 1.0329   n = 1726

$SUP

Family: Tweedie(p=1.213)
Link function: log

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -96.10065  35.54861 -2.703  0.00693 **
ctime        0.04213   0.01761   2.392  0.01687 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
          edf Ref.df   F p-value
s(lon,lat) 70.19     127 4.819 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.132  Deviance explained = 27.2%
-ML = 2080.8  Scale est. = 1.8896   n = 1726

$Fishing.related

Family: Tweedie(p=1.334)
Link function: log

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -502.61857  88.97160 -5.649 1.89e-08 ***
ctime        0.24263   0.04407   5.505 4.25e-08 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
          edf Ref.df   F p-value
s(lon,lat) 42.59     127 2.37 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

```

```

R-sq.(adj) =  0.0696  Deviance explained = 37.9%
-ML = 834.06  Scale est. = 3.5574      n = 1726

===== Numbers =====
$Glass

Family: Negative Binomial(0.312)
Link function: log

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept) -55.48812   83.30333 -0.666   0.505
ctime        0.02104    0.04127   0.510   0.610

Approximate significance of smooth terms:
            edf Ref.df Chi.sq p-value
s(lon,lat) 39.05     127 164.9 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.0716  Deviance explained = 27.2%
-ML = 689.29  Scale est. = 1      n = 1726

$Metal

Family: Negative Binomial(0.376)
Link function: log

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept) -34.31993   69.72507 -0.492   0.623
ctime        0.01084    0.03454   0.314   0.754

Approximate significance of smooth terms:
            edf Ref.df Chi.sq p-value
s(lon,lat) 36.4     127 122.8 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.0479  Deviance explained = 19.3%
-ML =  917.8  Scale est. = 1      n = 1726

$Natural

Family: Negative Binomial(0.267)
Link function: log

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept) -62.92226   68.65526 -0.916   0.359
ctime        0.02534    0.03401   0.745   0.456

Approximate significance of smooth terms:

```

```

      edf Ref.df Chi.sq p-value
s(lon,lat) 51.48     127  447.2 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.172  Deviance explained =  41%
-ML = 1429.7  Scale est. = 1          n = 1726

$Other

Family: Negative Binomial(0.295)
Link function: log

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
              Estimate Std. Error z value Pr(>|z|)
(Intercept) -386.06388   74.84846 -5.158 2.50e-07 ***
ctime        0.18514    0.03708  4.993 5.94e-07 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
      edf Ref.df Chi.sq p-value
s(lon,lat) 37.28     127 199.1 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.06  Deviance explained = 30.7%
-ML =  991.4  Scale est. = 1          n = 1726

$Plastic

Family: Negative Binomial(0.979)
Link function: log

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
              Estimate Std. Error z value Pr(>|z|)
(Intercept) -227.91126   36.49161 -6.246 4.22e-10 ***
ctime        0.10773    0.01808  5.959 2.54e-09 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
      edf Ref.df Chi.sq p-value
s(lon,lat) 70.78     127 941.6 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.102  Deviance explained = 54.4%
-ML = 2590.3  Scale est. = 1          n = 1726

$Rubber

Family: Negative Binomial(0.241)
Link function: log

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +

```

```

offset(log(EFFORT))

Parametric coefficients:
              Estimate Std. Error z value Pr(>|z|)
(Intercept) -92.88900   96.20395 -0.966   0.334
ctime        0.03947    0.04766   0.828   0.408

Approximate significance of smooth terms:
            edf Ref.df Chi.sq p-value
s(lon,lat) 23.05     127  76.04 1.57e-11 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.00551  Deviance explained = 21.9%
-ML =  559.7  Scale est. = 1          n = 1726

$SUP

Family: Negative Binomial(0.933)
Link function: log

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
              Estimate Std. Error z value Pr(>|z|)
(Intercept) -116.72553   40.73320 -2.866  0.00416 **
ctime        0.05234    0.02018   2.594  0.00949 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
            edf Ref.df Chi.sq p-value
s(lon,lat) 57.54     127  400.3 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.118  Deviance explained = 25.6%
-ML =  1980  Scale est. = 1          n = 1726

$Fishing.related

Family: Negative Binomial(0.243)
Link function: log

Formula:
A1 ~ ctime + s(lon, lat, bs = "ds", m = c(1, 0.5), k = 128) +
  offset(log(EFFORT))

Parametric coefficients:
              Estimate Std. Error z value Pr(>|z|)
(Intercept) -357.41649   89.40123 -3.998 6.39e-05 ***
ctime        0.17070    0.04429   3.854 0.000116 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
            edf Ref.df Chi.sq p-value
s(lon,lat) 36.41     127  163.9 <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.0295  Deviance explained = 37.7%
-ML =  741.12  Scale est. = 1          n = 1726

```


References

- [1] Casper W. Berg. `surveyIndex`: R package for calculating survey indices by age from DATRAS exchange data. <https://github.com/casperwberg/surveyIndex>, 2014.
- [2] Casper W Berg, Anders Nielsen, and Kasper Kristensen. Evaluation of alternative age-based methods for estimating relative abundance from survey data in relation to assessment models. *Fisheries Research*, 151:91–99, 2014.
- [3] Kasper Kristensen and Casper W. Berg. DATRAS package for R. <https://github.com/DTU Aqua/DATRAS>, 2012.
- [4] Anna Rindorf, Casper W. Berg, Jon Barry, and Marie Storr-Paulsen. Proposal for a HELCOM method for estimating amounts of litter on the seafloor in HOLAS III. Working Document for HELCOM litter group, 2021.
- [5] James T Thorson. Three problems with the conventional delta-model for biomass sampling data, and a computationally efficient alternative. *Canadian Journal of Fisheries and Aquatic Sciences*, 75(9):1369–1382, 2017.