Supplementary Materials – Continuation Ratio Logit Model results

Several CR models were tested for each age/cohort using Vector Generalized Linear Models (VGLM) and Vector Generalized Additive Models (VGAM) with increased complexity, these models can be written as follows:

$$logit\ P(Y = a|Y \geq a) = \alpha_a + \beta_a \text{Julian week} \quad (1)$$

$$logit\ P(Y = a|Y \geq a) = \alpha_a + \beta_1 \text{Julian week} + \beta_{2a} \text{area} \quad (2)$$

$$logit\ P(Y = a|Y \geq a) = \alpha_a + \beta_{1,a} \text{Julian week} + \beta_{2,a} \text{area} + \beta_{3,a} \text{depth} \quad (3)$$

$$logit\ P(Y = a|Y \geq a) = \alpha_a + s_a(\text{Julian week}) + \beta_{1,a} \text{area} + \beta_{2,a} \text{depth} \quad (4)$$

$$logit\ P(Y = a|Y \geq a) = \alpha_a + \beta_{1,a} \text{Julian week} + \beta_{2,a} \text{area} + s_a(\text{depth}) \quad (5)$$

$$logit\ P(Y = a|Y \geq a) = \alpha_a + \beta_a \text{area} + s_a(\text{Julian week}) + s(\text{depth}) \quad (6)$$

Table S1. Summary of CR models tested with VGLM and VGAM functions. Model structure summarizes the predictor variables included at each step specifying if the linear predictor depends on a smooth function. The number of estimated parameters, deviance explained (1 - deviance/null deviance) and the "AIC decrease" represents the decrease in AIC compared to Model 1 at each step.

Modelling functions	Model structure	Model	Number parameters	Deviance explained	AIC decrease
VGLM	time (week)	1	18	0.14	0
	time (week) + spatial (area) Non-parallel effects	2	27	0.92	308628
	time (week) + spatial (area + depth) Non-parallel effects	3	36	1.07	367463
VGAM	time (*s*(week)) + spatial (area + depth) Non-parallel effects	4	53.7	1.26	444201
	time (week) + spatial (area + *s*(depth)) Non-parallel effects	5	53	1.27	448275
	spatial (area) + time (s(week)) + spatial (*s*(depth)) partial parallel effects in depth	6	47.6	1.36	483642

Table S2. Detailed results of the VGAM function for the selected Model 6. Parameter estimates, significance and model diagnostics (combined outputs from several VGAM functions).

```
vgam(formula = cbind(age1, age2, age3, age4, age5, age6, age7, age8, age9, age10)
~ area + s(jweek)+ s(depth), family = sratio(parallel = TRUE ~ s(depth)), data =
horsemackerel)

Names of predictors: logitlink(P[Y=1|Y>=1]), logitlink(P[Y=2|Y>=2]),
logitlink(P[Y=3|Y>=3]), logitlink(P[Y=4|Y>=4]), logitlink(P[Y=5|Y>=5]),
logitlink(P[Y=6|Y>=6]), logitlink(P[Y=7|Y>=7]), logitlink(P[Y=8|Y>=8]),
logitlink(P[Y=9|Y>=9])

Parametric coefficients:
                     Estimate Std. Error z value   p-value
(Intercept):1       -1.237e+00  2.847e-03 -434.70   <2e-16 ***
(Intercept):2       -8.097e-01  2.827e-03 -286.39   <2e-16 ***
(Intercept):3       -4.799e-01  2.901e-03 -165.43   <2e-16 ***
(Intercept):4       -4.438e-01  3.128e-03 -141.91   <2e-16 ***
(Intercept):5       -3.456e-01  3.501e-03  -98.73   <2e-16 ***
(Intercept):6       -3.432e-01  4.006e-03  -85.67   <2e-16 ***
(Intercept):7       -3.216e-01  4.430e-03  -72.60   <2e-16 ***
(Intercept):8        1.264e-01  4.897e-03   25.81   <2e-16 ***
(Intercept):9        1.049e+00  6.259e-03  167.52   <2e-16 ***
areaSW:1            -4.703e-01  2.208e-03 -212.99   <2e-16 ***
areaSW:2            -4.153e-01  2.057e-03 -201.93   <2e-16 ***
areaSW:3            -1.792e-01  2.043e-03  -87.72   <2e-16 ***
areaSW:4             1.869e-01  2.237e-03   83.55   <2e-16 ***
areaSW:5             3.917e-01  2.648e-03  147.95   <2e-16 ***
areaSW:6             3.336e-01  3.205e-03  104.11   <2e-16 ***
areaSW:7             2.051e-01  3.578e-03   57.34   <2e-16 ***
areaSW:8             2.827e-01  4.020e-03   70.32   <2e-16 ***
areaSW:9             3.122e-01  5.277e-03   59.16   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
             edf   Chi.sq  p-value
s(jweek):1     2     13041   <2.2e-16 ***
s(jweek):2     2     6260    <2.2e-16 ***
s(jweek):3     2     3331    <2.2e-16 ***
s(jweek):4     2     261     <2.2e-16 ***
s(jweek):5     1.9   5048    <2.2e-16 ***
s(jweek):6     1.9   7443    <2.2e-16 ***
s(jweek):7     2     524     <2.2e-16 ***
s(jweek):8     2     671     <2.2e-16 ***
s(jweek):9     2     1568    <2.2e-16 ***
s(depth)       2     104859  <2.2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual deviance: 39122637 on 103983 degrees of freedom

Log-likelihood: -19561319 on 103983 degrees of freedom

Number of Fisher scoring iterations: 8

No Hauck-Donner effect found in any of the estimates
```

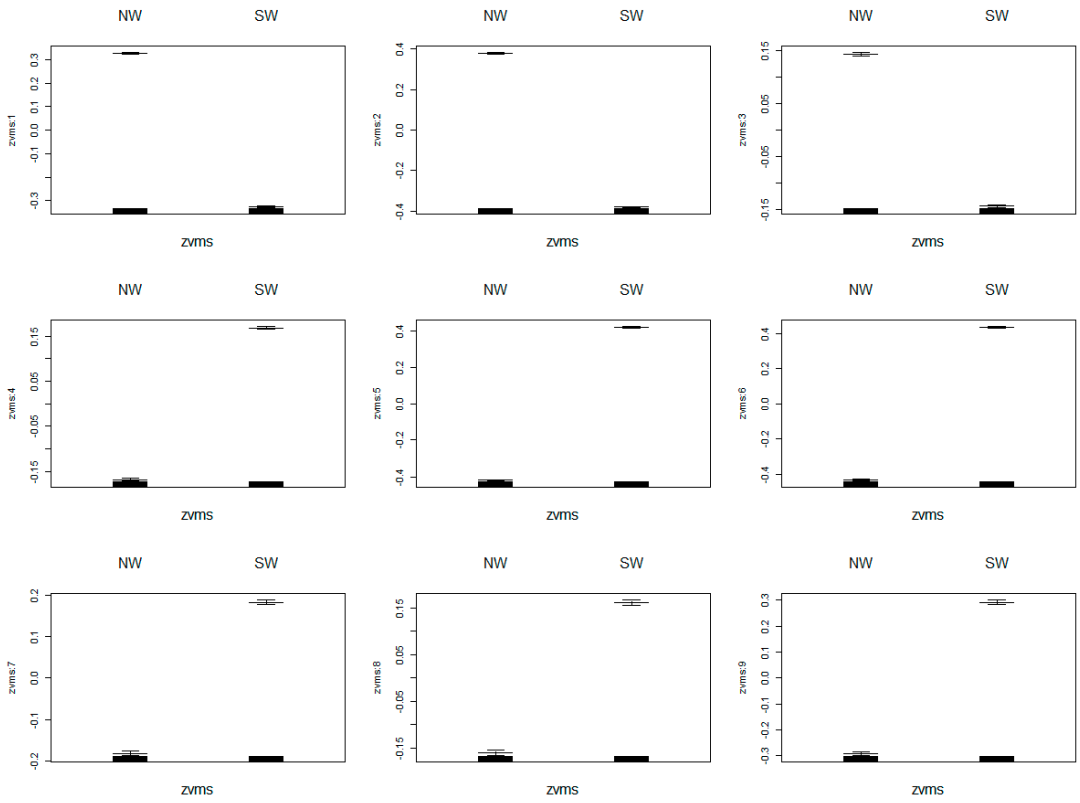

Figure S9 – Partial effect for categorical variable *area* for each level of the response variable (logitlinkP[age=1|age>=1],…,logitlinkP[age=9|age>=9] from top left to the bottom right).

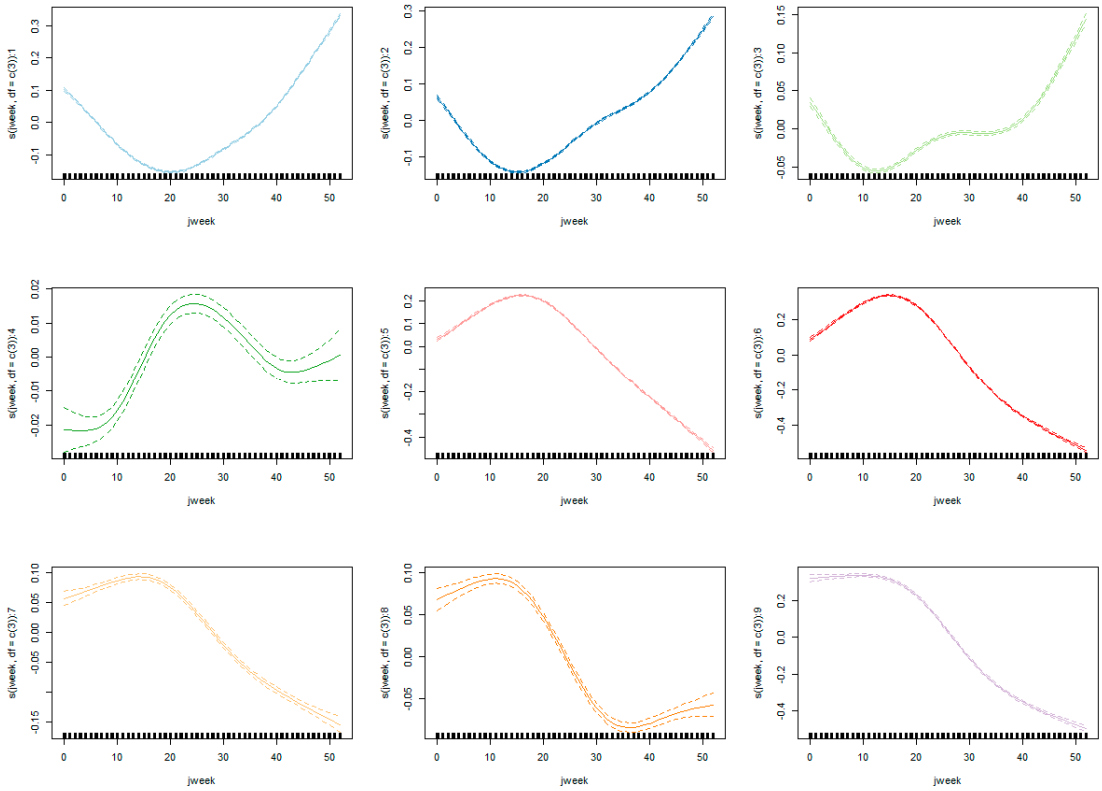

Figure S10 – Partial effect for variable *Julian week* for each level of the response variable (logitlinkP[age=1|age>=1],…,logitlinkP[age=9|age>=9] from top left to the bottom right).

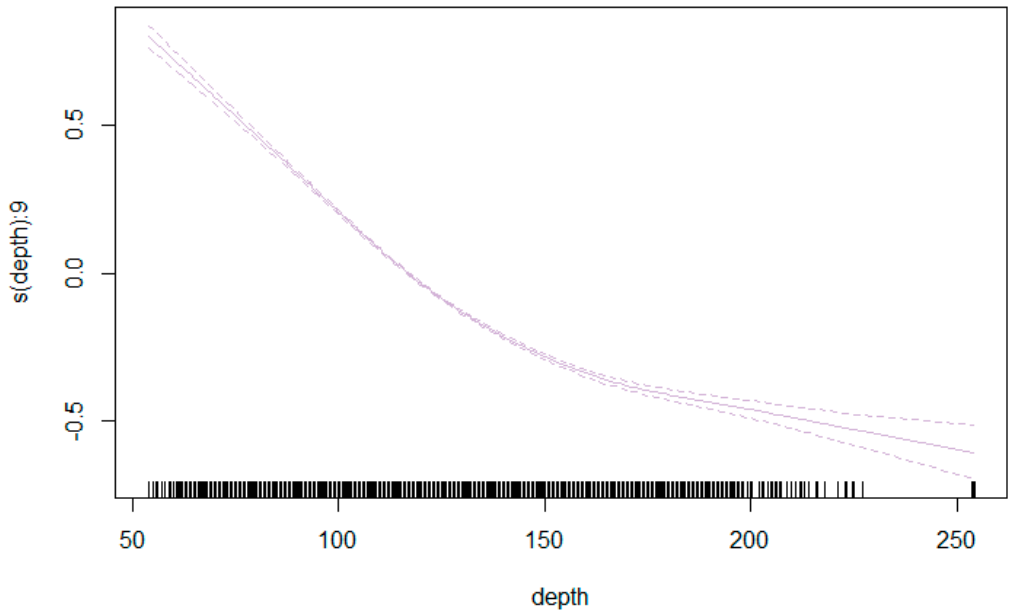

Figure S11 – Partial effect for variable *depth* for each level of the response variable (parallel effect for all levels of logitlink(P[age=a|age>=a))