**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* | (1) |
| *logit* | (2) |
| *logit* | (3) |
| *logit* | (4) |
| *logit* | (5) |
| *logit* | (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*  time (week) + spatial (area + depth)  *Non-parallel effects* | 2 | 27 | 0.92 | 308628 |
| 3 | 36 | 1.07 | 367463 |
| VGAM | time (*s*(week)) + spatial (area + depth)  *Non-parallel effects*  time (week) + spatial (area + *s*(depth))  *Non-parallel effects* | 4 | 53.7 | 1.26 | 444201 |
| 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 7. 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 \*\*\*

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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 \*\*\*

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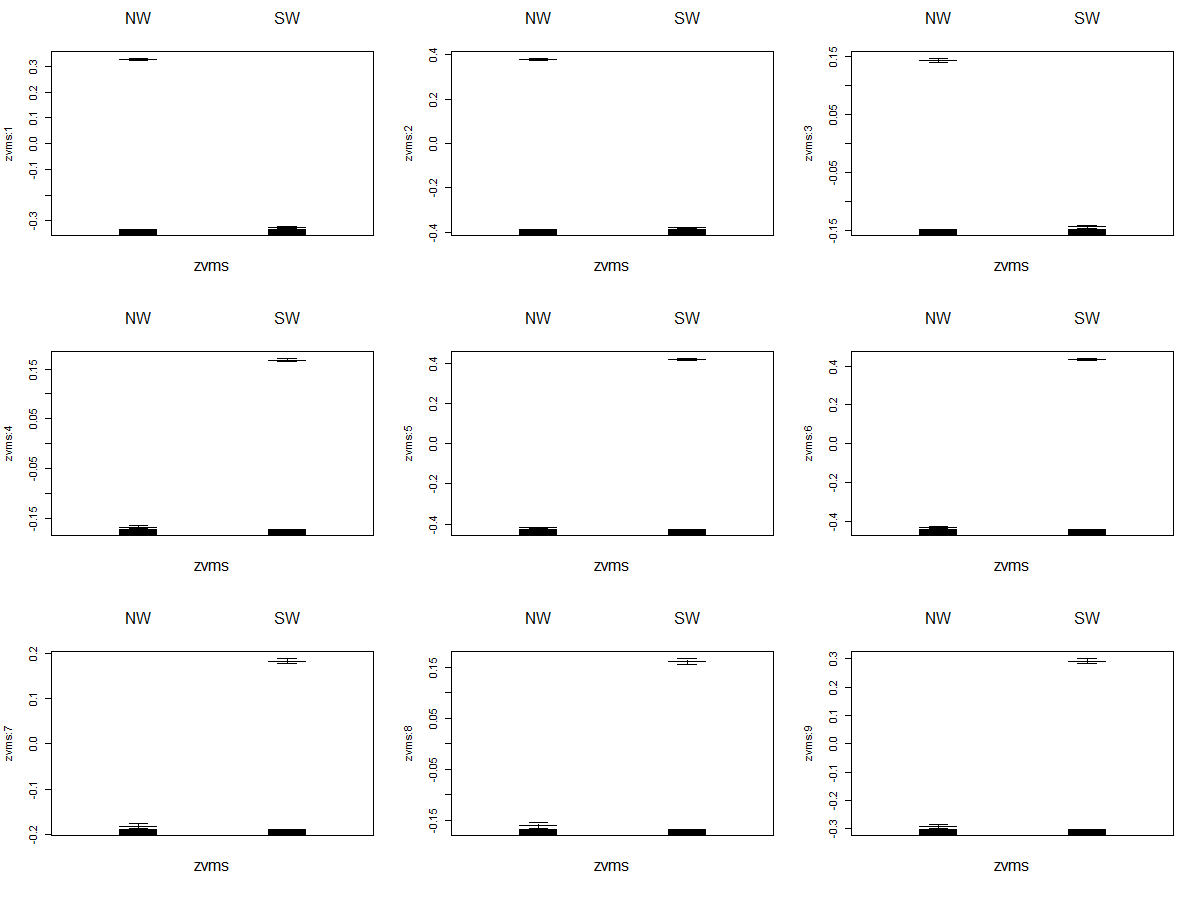
Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual deviance: 39122637 on 103983 degrees of freedom

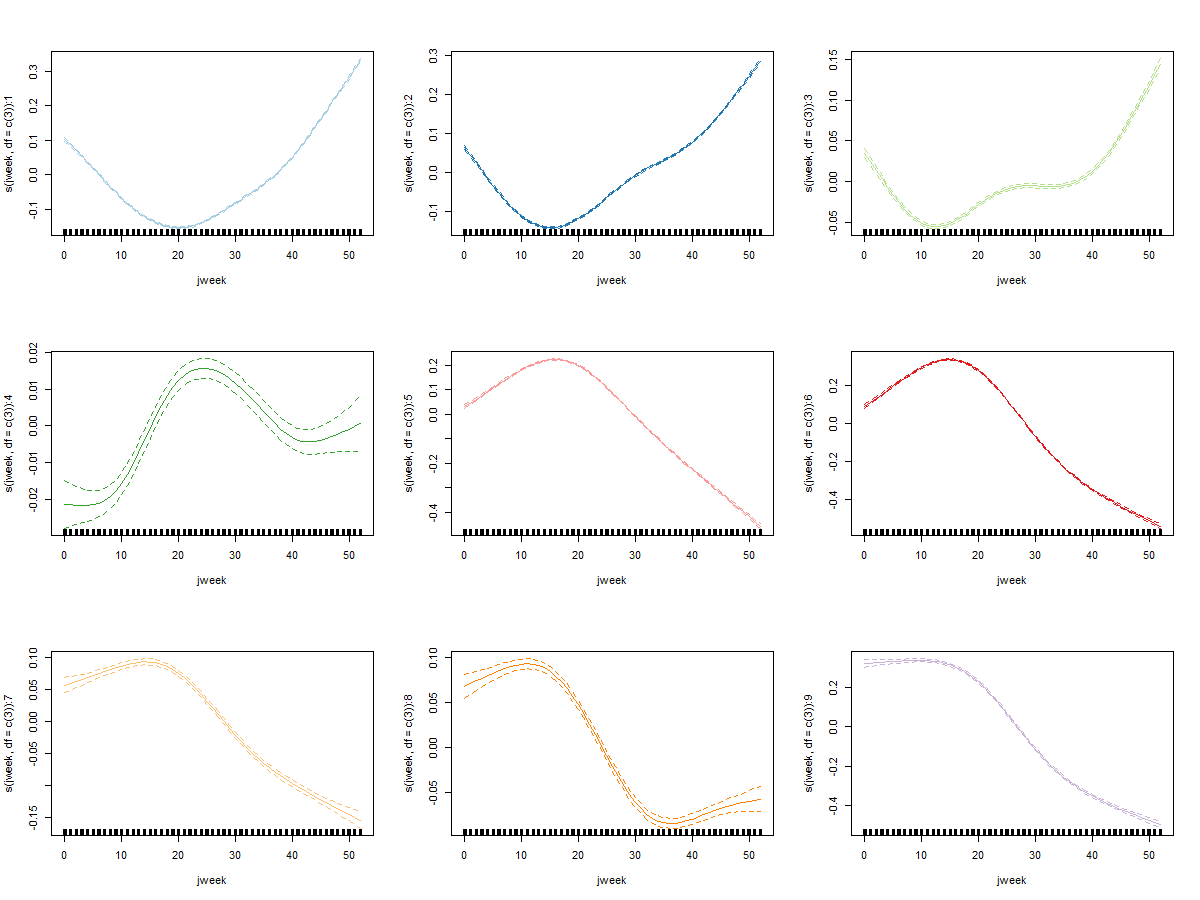
Log-likelihood: -19561319 on 103983 degrees of freedom

Number of Fisher scoring iterations: 8

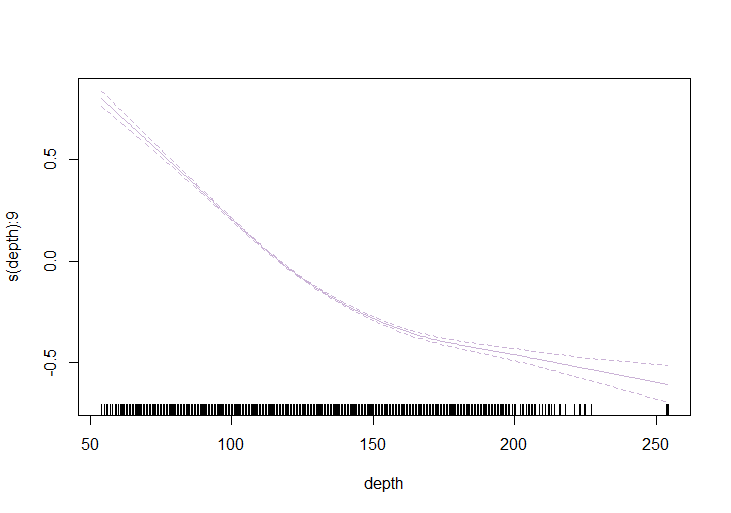
No Hauck-Donner effect found in any of the estimates



**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))