Forth and Tay

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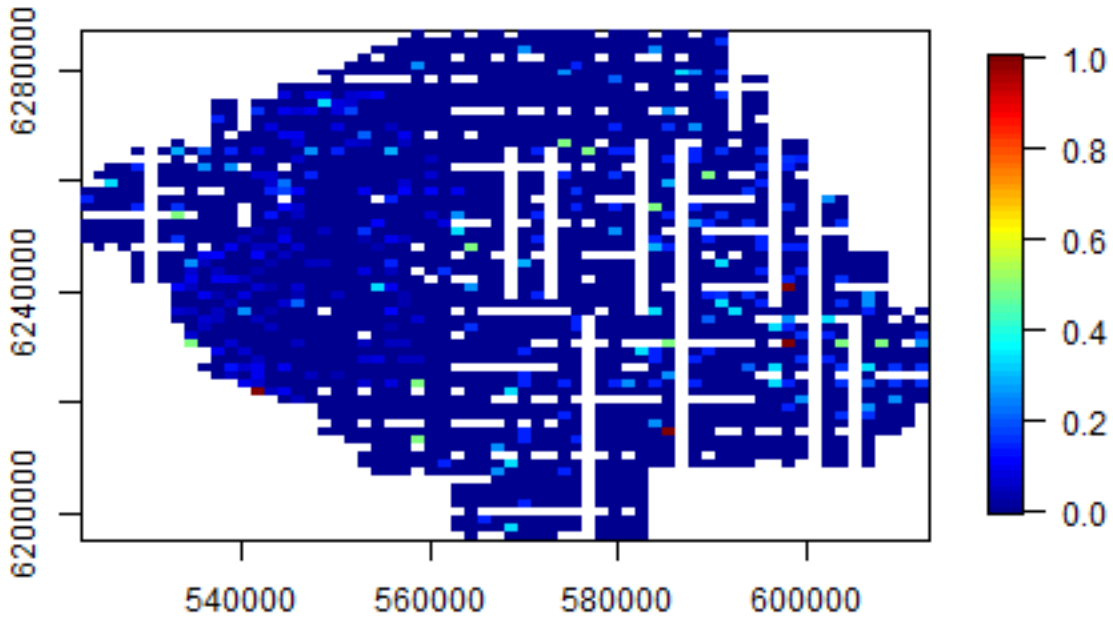
Real Data: Falls of Warness

Fit Initial Model

Owing to the very low mean, the data are converted to presence/absence data and fitted using the binomial family. The panel column is created to identify each individual transect.

```
# convert data to presence/absence
fat$response<-ifelse(fat$response>0, 1, 0)
fat$panel<-as.numeric(as.factor(paste(fat$survey, fat$trip.code, sep='')))
fat$foldid<-getCVids(fat, 5, 'panel')
```

```
require(fields)
quilt.plot(fat$x.pos, fat$y.pos, fat$response)
```




```
init_glm<-glm(response ~ as.factor(year), data=fat, family=binomial)
```

Run SALSA1D

```
factorlist<-'year'
varlist<-c('depth', 'month', 'x.pos', 'y.pos')

salsa1dlist<-list(fitnessMeasure='AIC', minKnots_1d = c(1,1,1,1), maxKnots_1d=c(5,5,5,5), startKnots_1d

salsa1dout<-runSALSA1D_withremoval(init_glm, salsa1dlist, varlist, factorlist, varlist_cyclicSplines = c
```

```
## Loading required package: splines
```

```
## [1] "year will be fitted as a factor variable; there are non-zero counts for all levels"
```

```
## Loading required package: mgcv
```

```
## Loading required package: nlme
```

```
## This is mgcv 1.8-12. For overview type 'help("mgcv-package")'.
```

```
## [1] "Initialising..."
## Initial fit =  3121.525 -53.02739
## [1] "initialisation complete..."
## [1] "^^^^^^^^^^^Initial^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^"
## [1] 3121.525
## [1] 0
## [1] -88.330635  -5.314269
## [1] "Exchanging..."
## [1] "Locating maximum residual......"
## [1] 7530
## [1] 6
## [1] "Maximum residual found..."
## [1] "Moving knot..."
```

```
## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred
```

```
## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred
```

```
## [1] "Knot moved..."
## [1] "Locating maximum residual......"
## [1] 7530
## [1] 5
## [1] "Maximum residual found..."
## [1] "Moving knot..."
```

```
## Warning: glm.fit: algorithm did not converge
```

```
## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred
```

```
## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred
```

```
## [1] "Knot moved..."
## [1] "Exchanging done..."
## [1] 198
## [1] 198
## [1] "^^^^^^^^^^^Exchange^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^"
## [1] "Improving..."
## [1] "Shifting up..."

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

## [1] "Up done..."
## [1] "Shifting down..."

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

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## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

## [1] "Down done..."
## [1] "Shifting up..."

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."

## Warning: glm.fit: algorithm did not converge

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred
```

```
## [1] "Down done..."
## [1] "Improving complete..."
## [1] "^^^^^^^^^^^^Improve^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^"
## [1] 198
## [1] 198
## [1] "Dropping..."

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

## [1] "Dropped..."
## [1] 198
## [1] 198
## [1] "Exchanging..."
## [1] "Locating maximum residual......"
## [1] 6642
## [1] 8
## [1] "Maximum residual found..."
## [1] "Moving knot..."

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

## [1] "Knot moved..."
## [1] "Exchanging done..."
## [1] 198
## [1] 198
## [1] "Improving..."
## [1] "Shifting up..."

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."

## Warning: glm.fit: algorithm did not converge

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

## [1] "Down done..."
## [1] "Improving complete..."
## [1] 198
## [1] 198
## [1] "Dropping..."

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred
```

```
## [1] "Dropped..."
## [1] 198
## [1] 198
## [1] "And we're done..."

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

## Fitting Linear Model...Choosing smooth vs linear model...[1] "Initialising..."
## Initial fit =  3182.808 3 6 8
## [1] "initialisation complete..."
## [1] "^^^^^^^^^^^^Initial^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^"
## [1] 3182.808
## [1] 0
## [1]  1 12
## [1] "Exchanging..."
## [1] "Locating maximum residual......"
## [1] 5219
## [1] 7
## [1] "Maximum residual found..."
## [1] "Moving knot..."
## [1] "Knot moved..."
## [1] "Locating maximum residual......"
## [1] 10527
## [1] 2
## [1] "Maximum residual found..."
## [1] "Moving knot..."
## [1] "Knot moved..."
## [1] "Locating maximum residual......"
## [1] 8660
## [1] 1
## [1] "Maximum residual found..."
## [1] "Moving knot..."
## [1] "Knot moved..."
## [1] "Exchanging done..."
## [1] 5
## [1] 5
## [1] "^^^^^^^^^^^^Exchange^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^"
## [1] "Improving..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Shifting up..."
## [1] "Up done..."
```

```
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
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## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Improving complete..."
## [1] "^^^^^^^^^^^Improve^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^"
## [1] 5
## [1] 5
## [1] "Dropping..."
## [1] "Dropped..."
## [1] "^^^^^^^^^^^Drop^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^"
## [1] 6
## [1] 6
## [1] "Exchanging..."
## [1] "Locating maximum residual......"
## [1] 1904
```

```
## [1] 3
## [1] "Maximum residual found..."
## [1] "Moving knot..."
## [1] "Knot moved..."
## [1] "Exchanging done..."
## [1] 6
## [1] 6
## [1] "Improving..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Improving complete..."
## [1] 6
## [1] 6
## [1] "Dropping..."
## [1] "Dropped..."
## [1] 6
## [1] 6
## [1] "And we're done..."
## Fitting Linear Model...Choosing smooth vs linear model...[1] "Initialising..."
## Initial fit =  3127.45 548557.3
## [1] "initialisation complete..."
## [1] "^^^^^^^^^^^Initial^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^"
## [1] 3127.45
## [1] 0
## [1] 523588.3 612267.8
## [1] "Exchanging..."
## [1] "Locating maximum residual......"
## [1] 7530
## [1] 178
## [1] "Maximum residual found..."
## [1] "Moving knot..."
## [1] "Knot moved..."
## [1] "Locating maximum residual......"
## [1] 7530
## [1] 178
## [1] "Maximum residual found..."
## [1] "Moving knot..."
## [1] "Knot moved..."
## [1] "Exchanging done..."
## [1] 198
```

```
## [1] 198
## [1] "^^^^^^^^^^^Exchange^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^"
## [1] "Improving..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Shifting up..."
## [1] "Up done..."
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## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
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## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
```

```
## [1] "Down done..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Improving complete..."
## [1] "^^^^^^^^^^^Improve^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^"
## [1] 198
## [1] 198
## [1] "Dropping..."
## [1] "Dropped..."
## [1] 198
## [1] 198
## [1] "Exchanging..."
## [1] "Locating maximum residual......"
## [1] 7530
## [1] 177
## [1] "Maximum residual found..."
## [1] "Moving knot..."
## [1] "Knot moved..."
## [1] "Exchanging done..."
## [1] 198
## [1] 198
## [1] "Improving..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Improving complete..."
## [1] 198
## [1] 198
## [1] "Dropping..."
## [1] "Dropped..."
## [1] 198
## [1] 198
## [1] "And we're done..."
## Fitting Linear Model...Choosing smooth vs linear model...[1] "Initialising..."
## Initial fit =  3115.325 6243351
## [1] "initialisation complete..."
## [1] "^^^^^^^^^^^Initial^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^"
## [1] 3115.325
## [1] 0
## [1] 6195841 6286543
## [1] "Exchanging..."
## [1] "Locating maximum residual......"
## [1] 7530
```

```
## [1] 190
## [1] "Maximum residual found..."
## [1] "Moving knot..."
## [1] "Knot moved..."
## [1] "Locating maximum residual......"
## [1] 5219
## [1] 9
## [1] "Maximum residual found..."
## [1] "Moving knot..."
## [1] "Knot moved..."
## [1] "Exchanging done..."
## [1] 199
## [1] 199
## [1] "^^^^^^^^^^^Exchange^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^"
## [1] "Improving..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Improving complete..."
## [1] "^^^^^^^^^^^Improve^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^"
## [1] 199
## [1] 199
## [1] "Exchanging..."
## [1] "Locating maximum residual......"
## [1] 5219
## [1] 9
## [1] "Maximum residual found..."
## [1] "Moving knot..."
## [1] "Knot moved..."
## [1] "Exchanging done..."
## [1] 199
## [1] 199
## [1] "Improving..."
## [1] "Shifting up..."
## [1] "Up done..."
## [1] "Shifting down..."
## [1] "Down done..."
## [1] "Improving complete..."
## [1] 199
## [1] 199
## [1] "And we're done..."
## Fitting Linear Model...Choosing smooth vs linear model...
```

```
summary(salsa1dout$bestModel, varshortnames=varlist)
```

```
##
## Call:
## glm(formula = response ~ as.factor(year) + bs(depth, knots = splineParams[[2]]$knots,
##     degree = splineParams[[2]]$degree, Boundary.knots = splineParams[[2]]$bd) +
```

```
##     smooth.construct(s(month, bs = "cc", k = (length(splineParams[[3]]$knots)) +
##         2), knots = list(month = as.numeric(c(splineParams[[3]]$bd[1],
##         splineParams[[3]]$knots, splineParams[[3]]$bd[2]))),
##         data = data.frame(month))$X[, -1] + bs(x.pos, knots = splineParams[[4]]$knots,
##     degree = splineParams[[4]]$degree, Boundary.knots = splineParams[[4]]$bd) +
##     bs(y.pos, knots = splineParams[[5]]$knots, degree = splineParams[[5]]$degree,
##         Boundary.knots = splineParams[[5]]$bd), family = binomial(link = logit),
##     data = fat)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.5363  -0.2400  -0.1828  -0.1390   3.3712
##
## Coefficients:
##                     Estimate Std. Error Robust S.E. z value Pr(>|z|)
## (Intercept)          -7.5455     1.8898      1.6154  -4.671    3e-06 ***
## as.factor(year)2010  -0.5352     0.1855      0.1908  -2.805 0.005037 **
## as.factor(year)2011   0.3382     0.1758      0.1842   1.836 0.066412 .
## s(depth)1             2.6083     1.7447      1.5105   1.727 0.084220 .
## s(depth)2             1.9428     1.4498      1.2905   1.505 0.132219
## s(depth)3             1.1483     2.9355      2.4584   0.467 0.640422
## s(month)1             0.7014     0.1985      0.1936   3.623 0.000291 ***
## s(month)2             0.5627     0.1702      0.1720   3.271 0.001071 **
## s(month)3             1.5485     0.1790      0.1757   8.811  < 2e-16 ***
## s(month)4            -0.4673     0.1695      0.1805  -2.588 0.009644 **
## s(x.pos)1             1.3746     1.4865      1.3233   1.039 0.298918
## s(x.pos)2            -0.6156     1.0439      0.9020  -0.682 0.494926
## s(x.pos)3             0.6939     1.1726      1.0420   0.666 0.505469
## s(x.pos)4             1.0987     1.0864      0.9554   1.150 0.250179
## s(y.pos)1             1.1022     0.7394      0.7036   1.567 0.117210
## s(y.pos)2             0.9575     0.3503      0.3547   2.699 0.006947 **
## s(y.pos)3            -0.8490     1.3068      1.3330  -0.637 0.524175
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 3268.8  on 15140  degrees of freedom
## Residual deviance: 3079.4  on 15124  degrees of freedom
## AIC:  3113.4
##
## Max Panel Size = 1; Number of panels = 15141
## Number of Fisher Scoring iterations: 7
```

```
anova(salsa1dout$bestModel, varshortnames=varlist)
```

```
## Analysis of 'Wald statistic' Table
## Model: binomial, link: logit
## Response: response
## Marginal Testing
## Max Panel Size = 1; Number of panels = 15141
##
##                  Df     X2 P(>|Chi|)
## as.factor(year)  2 25.490 2.917e-06 ***
```

```
## s(depth)         3  4.382   0.22309
## s(month)         4 94.617 < 2.2e-16 ***
## s(x.pos)         4 55.605 2.426e-11 ***
## s(y.pos)         3  9.124   0.02768 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```