Juvenile proportion models

Linear models

- `glmer(propjuv ~ zone*Breeding_year+ zone* month + (1|Food_type) + (1|Observer) + (1|flocksize), data = geese, family = "binomial")`

Breeding year and month are significant predictors

```
## Analysis of Deviance Table (Type II Wald chisquare tests)
##
## Response: propjuv
##                      Chisq Df Pr(>Chisq)
## zone                5.3346  3   0.148872
## Breeding_year       9.3274  1   0.002258 **
## month               5.6004  1   0.017956 *
## zone:Breeding_year 2.6821  3   0.443277
## zone:month          0.3027  3   0.959523
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Random effects don't explain much variance

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula:
## propjuv ~ zone * Breeding_year + zone * month + (1 | Food_type) +
##     (1 | Observer) + (1 | flocksize)
##    Data: geese
##
##      AIC      BIC   logLik deviance df.resid
##    430.3    522.8   -200.1    400.3     3519
##
## Scaled residuals:
##    Min     1Q Median     3Q    Max
## -0.223  1.113  1.876  3.041 23.171
##
## Random effects:
##  Groups    Name        Variance  Std.Dev.
##  flocksize (Intercept) 3.859e-08 0.0001964
##  Observer  (Intercept) 1.754e-07 0.0004188
##  Food_type (Intercept) 1.918e-08 0.0001385
## Number of obs: 3534, groups:  flocksize, 711; Observer, 29; Food_type, 19
##
## Fixed effects:
##                                Estimate Std. Error z value Pr(>|z|)
## (Intercept)                   493.03310  779.49658   0.632    0.527
```

Additive models

- `propjuv ~ s(as.numeric(time))`
- `propjuv ~ s(Breeding_year)`
- `propjuv ~ ti(Breeding_year) + ti(winter_month) + ti(Breeding_year, winter_month)`
- `propjuv ~ ti(rand.lon) + ti(rand.lat) + ti(rand.lon, rand.lat)`

Time is a significant predictor

```
##
## Family: binomial
## Link function: logit
##
## Formula:
## propjuv ~ s(as.numeric(time))
##
## Parametric coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept) -1.48345    0.03888  -38.16   <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(as.numeric(time)) 6.702  7.809  83.93 9.38e-15 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.297   Deviance explained = 30.4%
## UBRE = -0.94929  Scale est. = 1         n = 4567
```

Breeding year has a significant effect

```
##
## Family: binomial
## Link function: logit
##
## Formula:
## propjuv ~ s(Breeding_year)
##
## Parametric coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept) -1.48452    0.03892  -38.14   <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(Breeding_year) 6.729  7.837  85.87 3.83e-15 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.304   Deviance explained =   31%
## UBRE = -0.94973  Scale est. = 1         n = 4567
```

Month doesn't have a significant effect

```
##
## Family: binomial
## Link function: logit
##
## Formula:
## propjuv ~ ti(Breeding_year) + ti(winter_month) + ti(Breeding_year,
##     winter_month)
##
## Parametric coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept) -1.47111    0.03852  -38.19   <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
## ti(Breeding_year)               3.719  3.949 47.666 6.52e-10 ***
## ti(winter_month)                1.298  1.531  0.369    0.614
## ti(Breeding_year,winter_month) 2.089  2.558  4.718    0.120
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =   0.19   Deviance explained = 19.5%
## UBRE = -0.94171  Scale est. = 1         n = 4567
```

Model fits

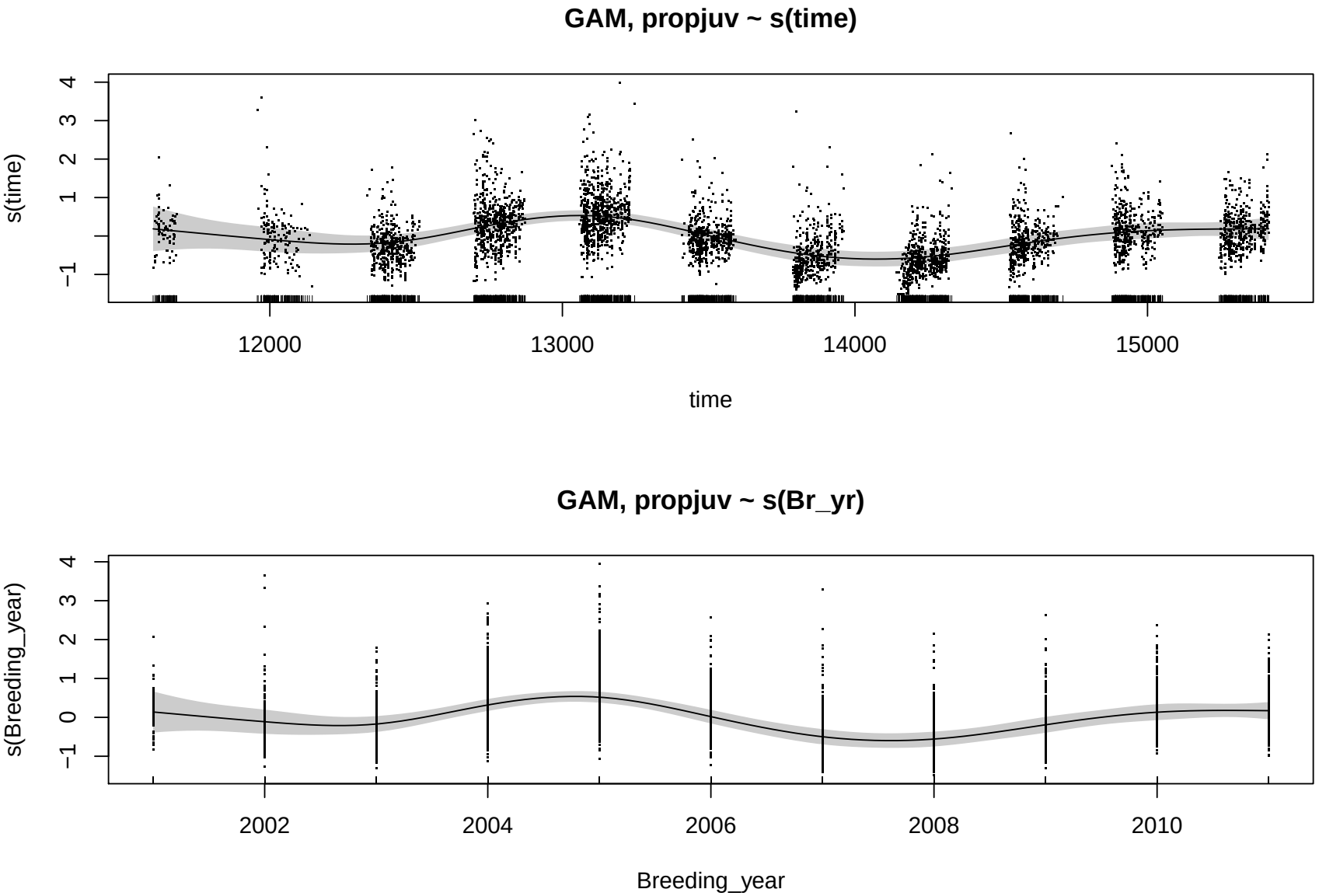

Figure 1: Breeding year is the major component determing the GAM fit.

Model response ~ year*month

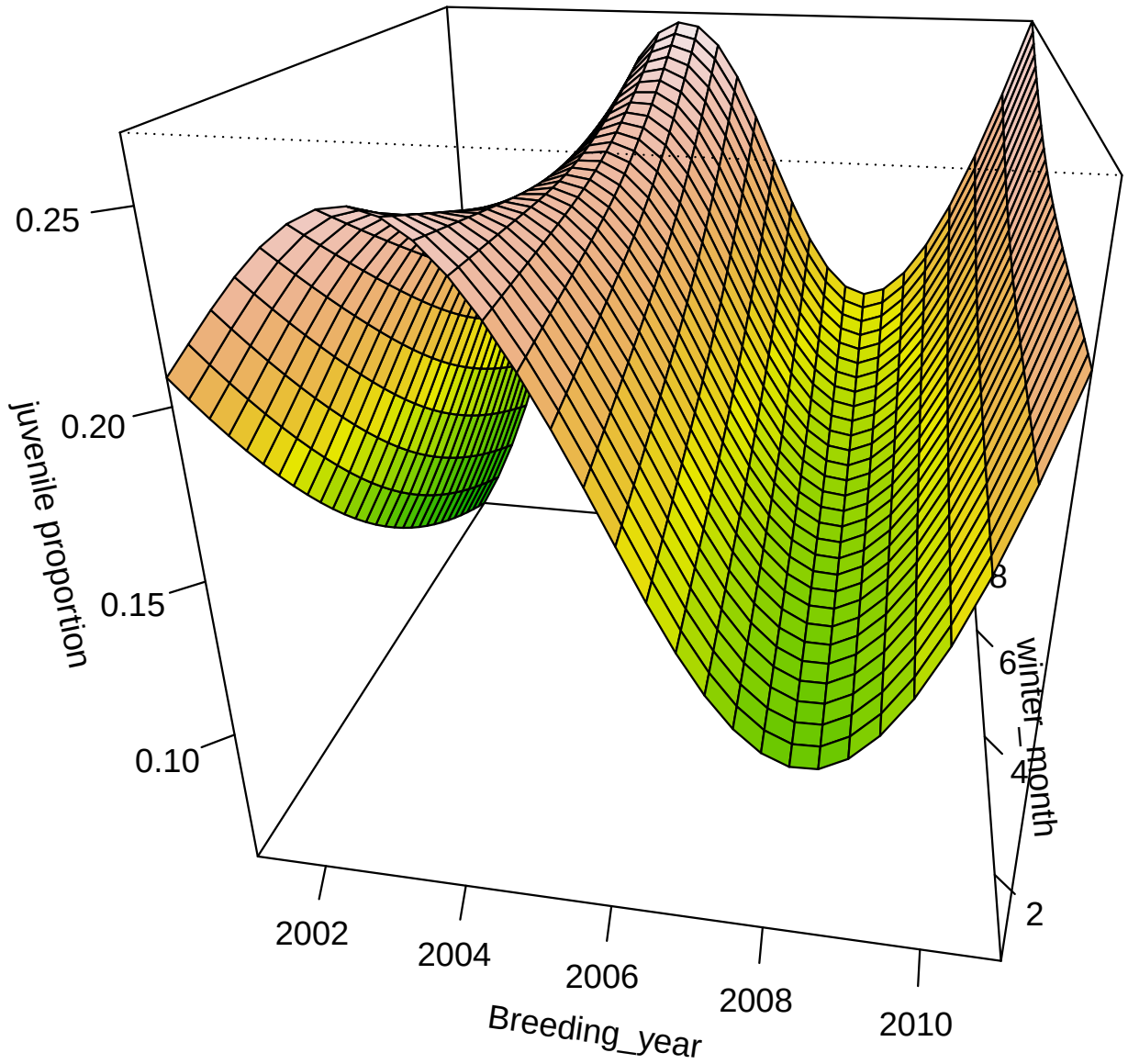

Figure 2: GAM fitted surface. The main feature is the likely response to the lemming cycle. From 2003-4, juvenile proportion rises with winter.

Location does not have an effect

```
##
## Family: binomial
## Link function: logit
##
## Formula:
## propjuv ~ ti(rand.lon) + ti(rand.lat) + ti(rand.lon, rand.lat)
##
## Parametric coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept) -1.45695    0.04018  -36.26   <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
## ti(rand.lon)            1.000  1.000  1.210   0.271
## ti(rand.lat)            1.000  1.000  0.117   0.733
## ti(rand.lon,rand.lat) 1.001  1.001  0.556   0.456
##
## R-sq.(adj) =  0.00586   Deviance explained = 0.665%
## UBRE = -0.93072  Scale est. = 1         n = 4567
```

Model surface

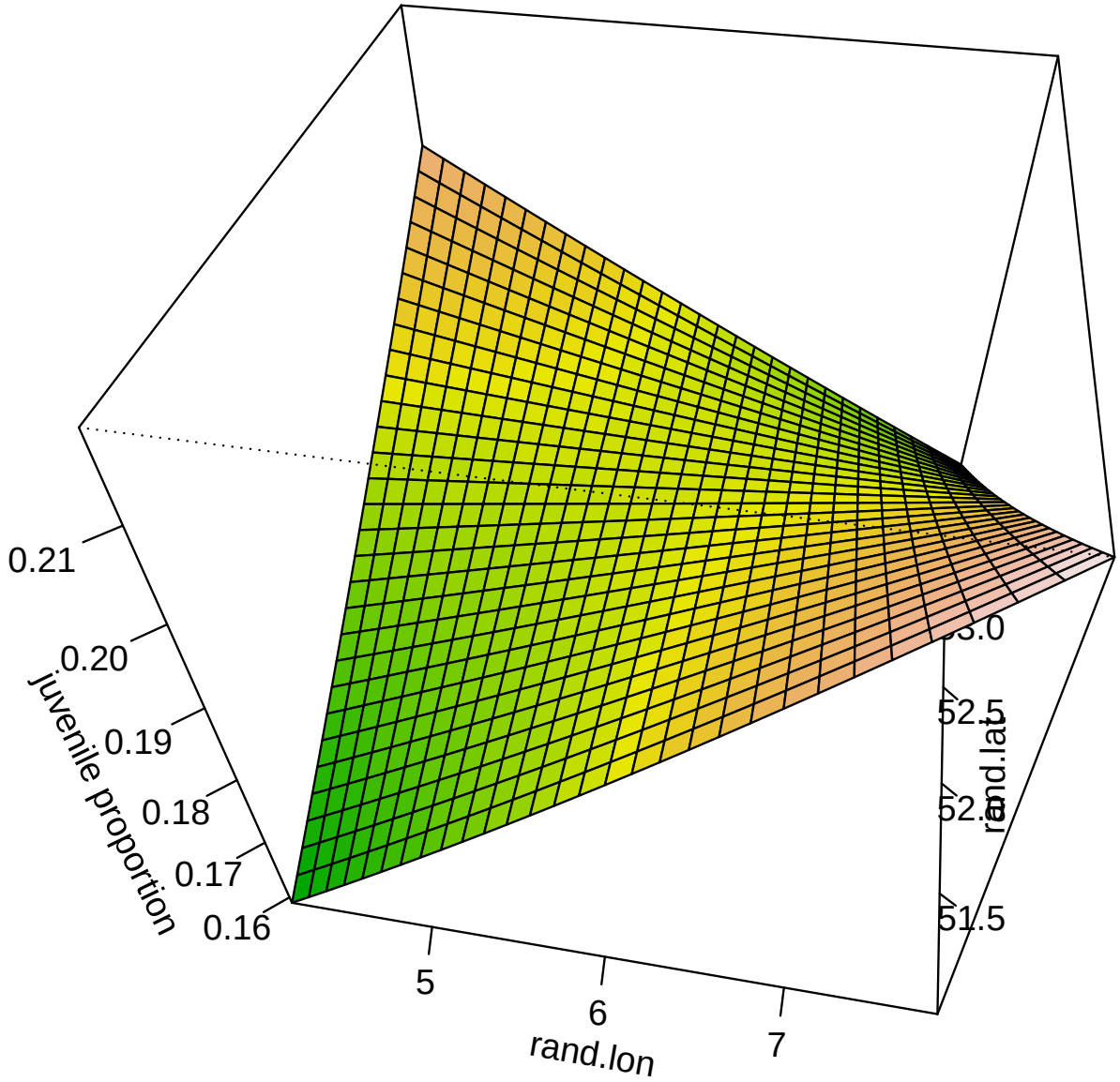

Figure 3: Proportions are higher in the northwest and southeast, but not significantly.