Social Effects on Fitness

#Load Packages and Connections

```
# analysis
library (lme4)
library (lmerTest)
library (DHARMa)
```

Load Data

```
load("./data/Social_Fitness_Data.RData")
```

Main Analysis

Survival

```
# Survival model 1
## Table 2
# Random slopes
summary(survival.1<-glmer(survived~age+I(age^2)+grid+std_soc_surv3*mast+(std_soc_surv3||year)+(1|squirre
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula:
## survived ~ age + I(age^2) + grid + std_soc_surv3 * mast + (std_soc_surv3 ||
##     year) + (1 | squirrel_id)
##    Data: census_final
## Control: glmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 2e+05))
##
##      AIC      BIC   logLik deviance df.resid
##   5601.2   5666.1  -2790.6   5581.2     4824
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.8340 -0.9742  0.4973  0.6441  3.0373
##
## Random effects:
##  Groups      Name          Variance Std.Dev.
##  squirrel_id (Intercept)   0.08160  0.2857
##  year        std_soc_surv3 0.03082  0.1756
##  year.1      (Intercept)   0.24791  0.4979
## Number of obs: 4834, groups:  squirrel_id, 1761; year, 31
```

```
##
## Fixed effects:
##                     Estimate Std. Error z value Pr(>|z|)
## (Intercept)          0.73252    0.16351   4.480 7.46e-06 ***
## age                  0.34672    0.08392   4.131 3.61e-05 ***
## I(age^2)            -0.08738    0.01268  -6.890 5.59e-12 ***
## gridSU               0.11409    0.06867   1.661  0.09664 .
## std_soc_surv3       -0.15992    0.05363  -2.982  0.00287 **
## masty               -0.39459    0.24423  -1.616  0.10618
## std_soc_surv3:masty  0.04963    0.12261   0.405  0.68565
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) age    I(g^2) gridSU std__3 masty
## age         -0.690
## I(age^2)     0.533 -0.906
## gridSU      -0.187 -0.004 -0.020
## std_sc_srv3 -0.019 -0.015  0.053 -0.002
## masty       -0.299  0.011 -0.004  0.010  0.012
## std_sc_sr3:  0.007  0.006 -0.014  0.001 -0.437 -0.010
```

```
#summary(glmer(survived~age+I(age^2)+grid+std_soc_surv3+(std_soc_surv3||year)+(1|squirrel_id), data=cen
# Did not converge

# no random slopes for mast years individually
summary(glmer(survived~age+I(age^2)+grid+std_soc_surv3+(1|year)+(1|squirrel_id), data=census_final, fam
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: survived ~ age + I(age^2) + grid + std_soc_surv3 + (1 | year) +
##     (1 | squirrel_id)
##    Data: census_final
## Control: glmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 2e+05))
##  Subset: mast == "y"
##
##      AIC      BIC   logLik deviance df.resid
##    962.9    995.6   -474.4    948.9      788
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -1.9728 -0.7783  0.4888  0.6338  2.5518
##
## Random effects:
##  Groups      Name        Variance Std.Dev.
##  squirrel_id (Intercept) 0.5032   0.7094
##  year        (Intercept) 0.4007   0.6330
## Number of obs: 795, groups:  squirrel_id, 724; year, 6
##
## Fixed effects:
##               Estimate Std. Error z value Pr(>|z|)
## (Intercept)    0.75887    0.40267   1.885   0.0595 .
## age            0.11278    0.21082   0.535   0.5927
## I(age^2)      -0.06234    0.03103  -2.009   0.0445 *
```

```
## gridSU         0.17518    0.17629   0.994   0.3204
## std_soc_surv3 -0.12736    0.08888  -1.433   0.1519
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) age    I(g^2) gridSU
## age         -0.662
## I(age^2)     0.570 -0.961
## gridSU      -0.146 -0.045  0.020
## std_sc_srv3  0.007 -0.020  0.015 -0.002
```

```
summary(glmer(survived~age+I(age^2)+grid+std_soc_surv3+(std_soc_surv3||year)+(1|squirrel_id), data=censu
```

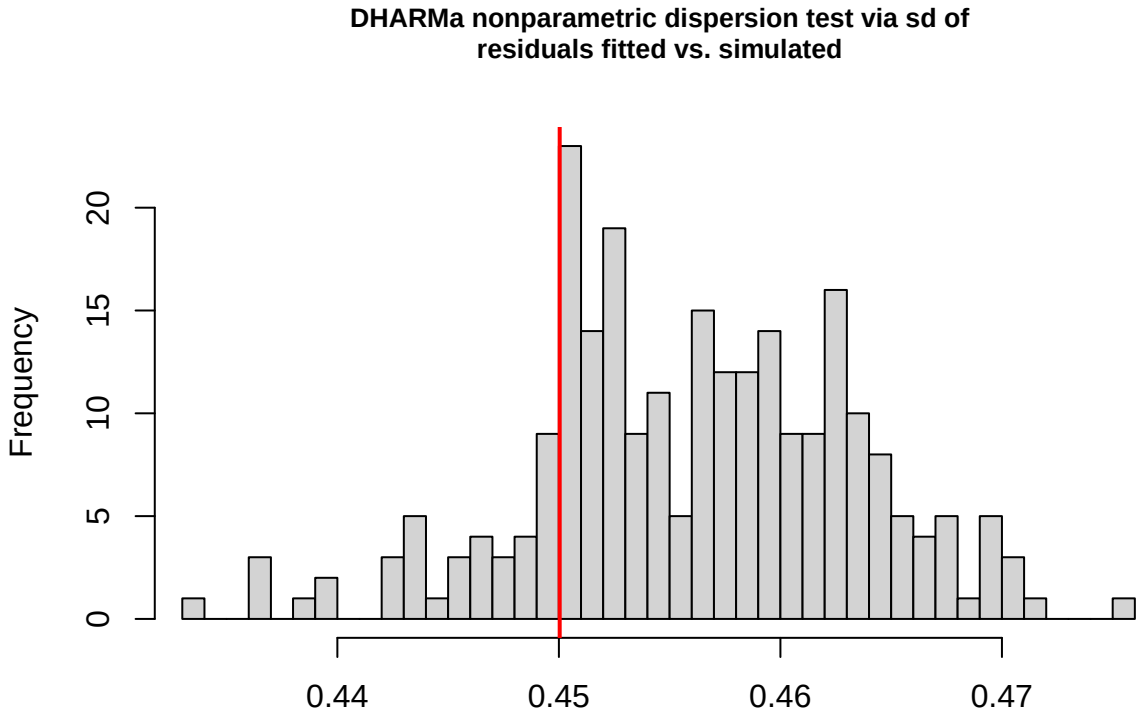
```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: survived ~ age + I(age^2) + grid + std_soc_surv3 + (std_soc_surv3 ||
##     year) + (1 | squirrel_id)
##    Data: census_final
## Control: glmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 2e+05))
##  Subset: mast == "n"
##
##      AIC      BIC   logLik deviance df.resid
##   4640.8   4691.2  -2312.4   4624.8     4031
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.8485 -1.0324  0.4982  0.6462  2.2480
##
## Random effects:
##  Groups      Name          Variance Std.Dev.
##  squirrel_id (Intercept)   0.04309  0.2076
##  year        std_soc_surv3 0.03955  0.1989
##  year.1      (Intercept)   0.21919  0.4682
## Number of obs: 4039, groups:  squirrel_id, 1654; year, 25
##
## Fixed effects:
##               Estimate Std. Error z value Pr(>|z|)
## (Intercept)    0.62424    0.16813   3.713 0.000205 ***
## age            0.41540    0.09254   4.489 7.16e-06 ***
## I(age^2)      -0.09369    0.01398  -6.702 2.05e-11 ***
## gridSU         0.10505    0.07418   1.416 0.156735
## std_soc_surv3 -0.16120    0.05681  -2.837 0.004550 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) age    I(g^2) gridSU
## age         -0.730
## I(age^2)     0.594 -0.929
## gridSU      -0.206  0.009 -0.029
## std_sc_srv3 -0.007 -0.026  0.053  0.000
```

```r
# no random slopes
summary(glmer(survived~age+I(age^2)+grid+std_soc_surv3*mast+(1|year)+(1|squirrel_id), data=census_final
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: survived ~ age + I(age^2) + grid + std_soc_surv3 * mast + (1 |
##     year) + (1 | squirrel_id)
##    Data: census_final
## Control: glmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 2e+05))
##
##      AIC      BIC   logLik deviance df.resid
##   5604.3   5662.6  -2793.1   5586.3     4825
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.9822 -0.9856  0.5011  0.6389  3.0241
##
## Random effects:
##  Groups      Name        Variance Std.Dev.
##  squirrel_id (Intercept) 0.09379  0.3063
##  year        (Intercept) 0.24581  0.4958
## Number of obs: 4834, groups:  squirrel_id, 1761; year, 31
##
## Fixed effects:
##                     Estimate Std. Error z value Pr(>|z|)
## (Intercept)          0.73739    0.16335   4.514 6.36e-06 ***
## age                  0.33963    0.08379   4.053 5.05e-05 ***
## I(age^2)            -0.08687    0.01263  -6.879 6.02e-12 ***
## gridSU               0.11388    0.06888   1.653 0.098245 .
## std_soc_surv3       -0.14158    0.03796  -3.730 0.000192 ***
## masty               -0.39117    0.24328  -1.608 0.107857
## std_soc_surv3:masty  0.01729    0.08970   0.193 0.847172
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) age    I(g^2) gridSU std__3 masty
## age         -0.692
## I(age^2)     0.532 -0.904
## gridSU      -0.188 -0.004 -0.020
## std_sc_srv3 -0.027 -0.008  0.063 -0.002
## masty       -0.298  0.011 -0.004  0.010  0.013
## std_sc_sr3:  0.008  0.002 -0.011  0.002 -0.407 -0.010
```

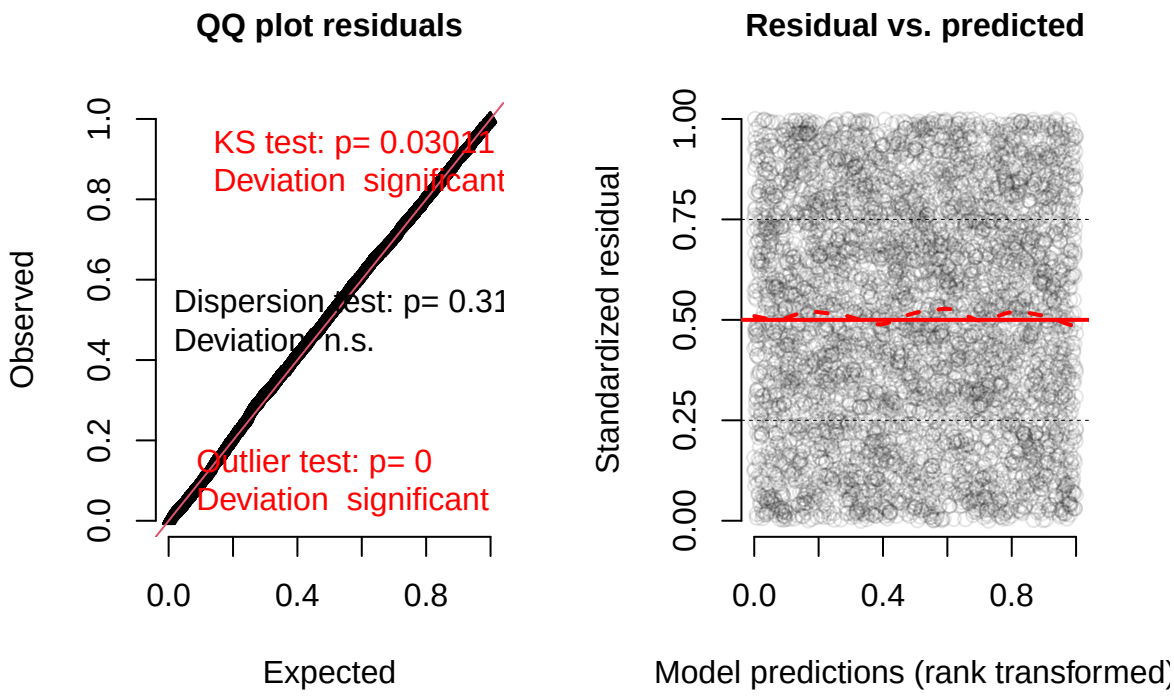
Model diagnostics

```r
# survival.1

testDispersion(survival.1)
```

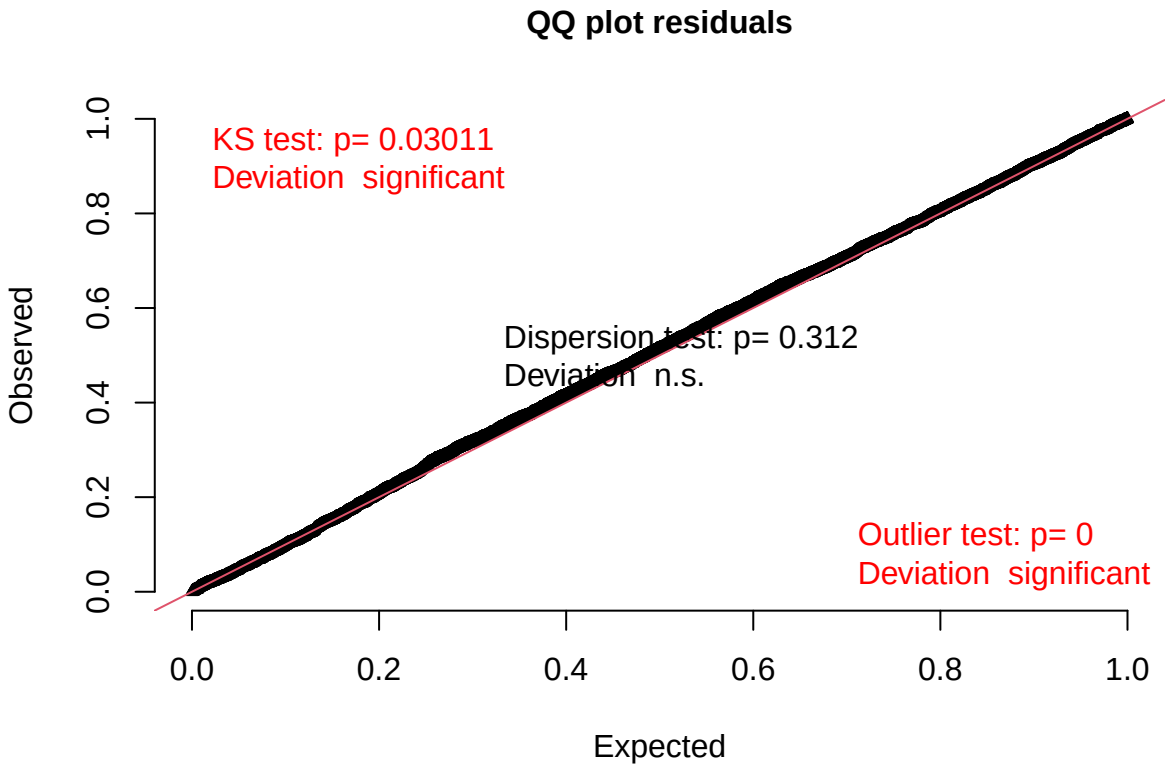



```
##
##  DHARMa nonparametric dispersion test via sd of residuals fitted vs.
##  simulated
##
## data:  simulationOutput
## ratioObsSim = 0.98677, p-value = 0.312
## alternative hypothesis: two.sided
```

```
simulation_output_survival.1<-simulateResiduals(fittedModel = survival.1, n = 250)
plot(simulation_output_survival.1)
```



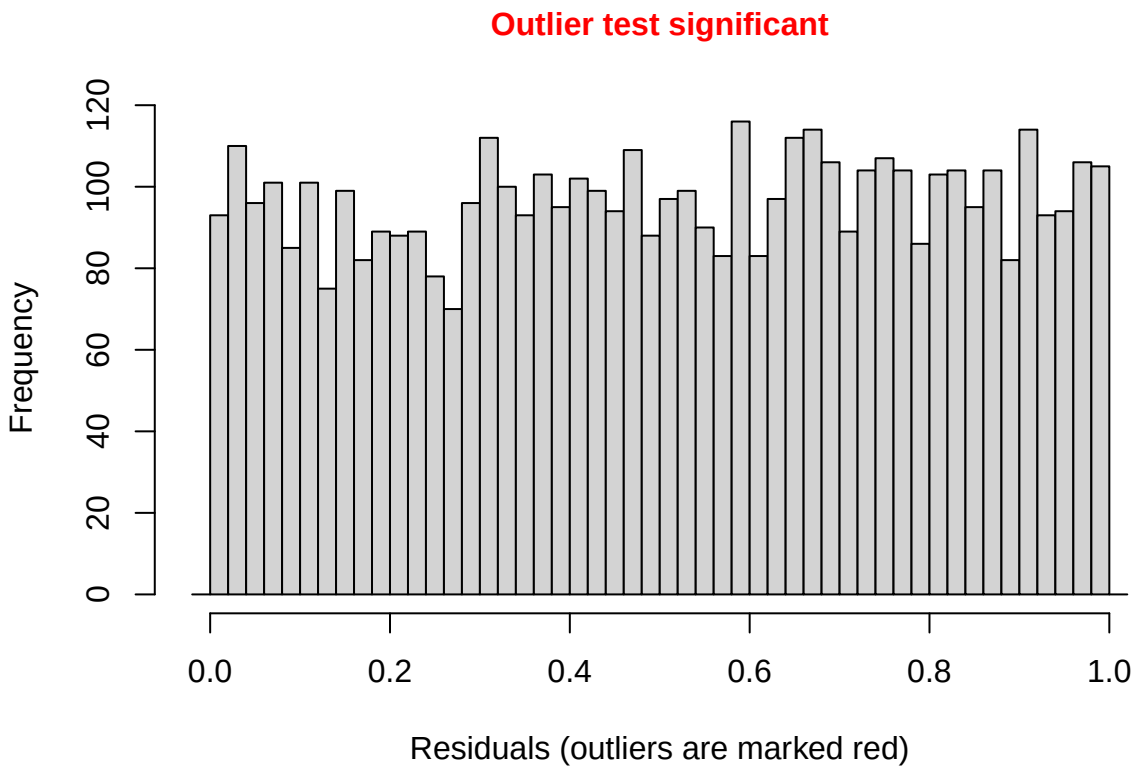

```
testUniformity(simulation_output_survival.1)
```




```
##
##  One-sample Kolmogorov-Smirnov test
##
```

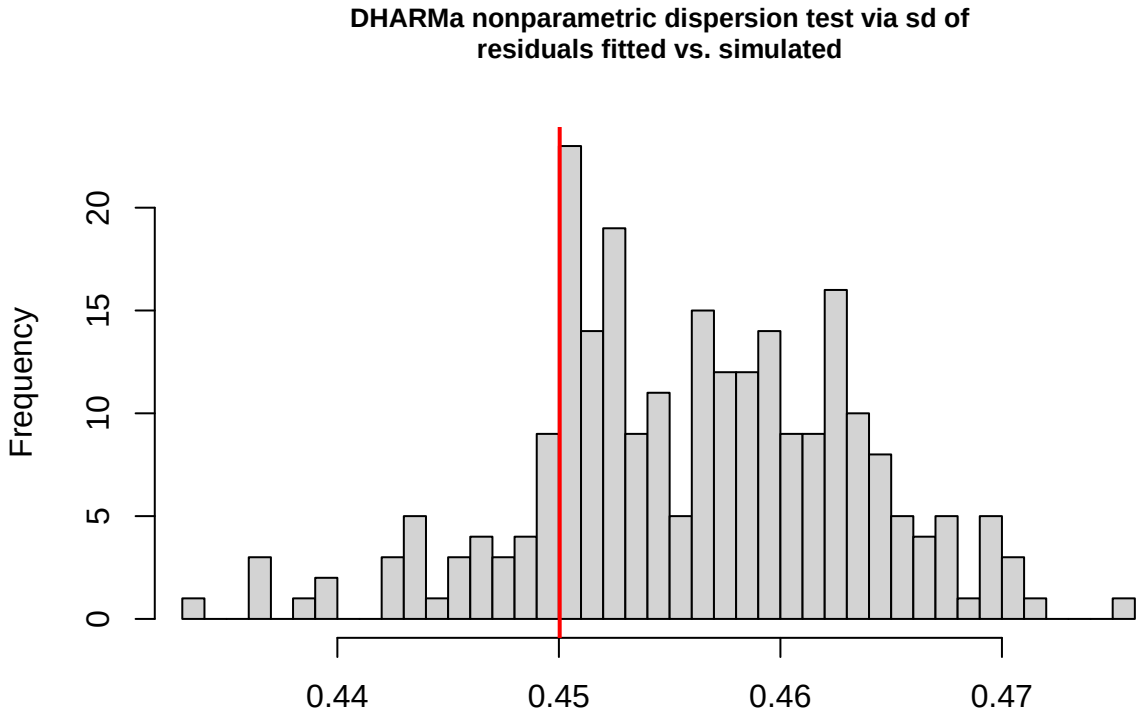
```
## data:  simulationOutput$scaledResiduals
## D = 0.020833, p-value = 0.03011
## alternative hypothesis: two-sided
```

```
testOutliers(simulation_output_survival.1)
```



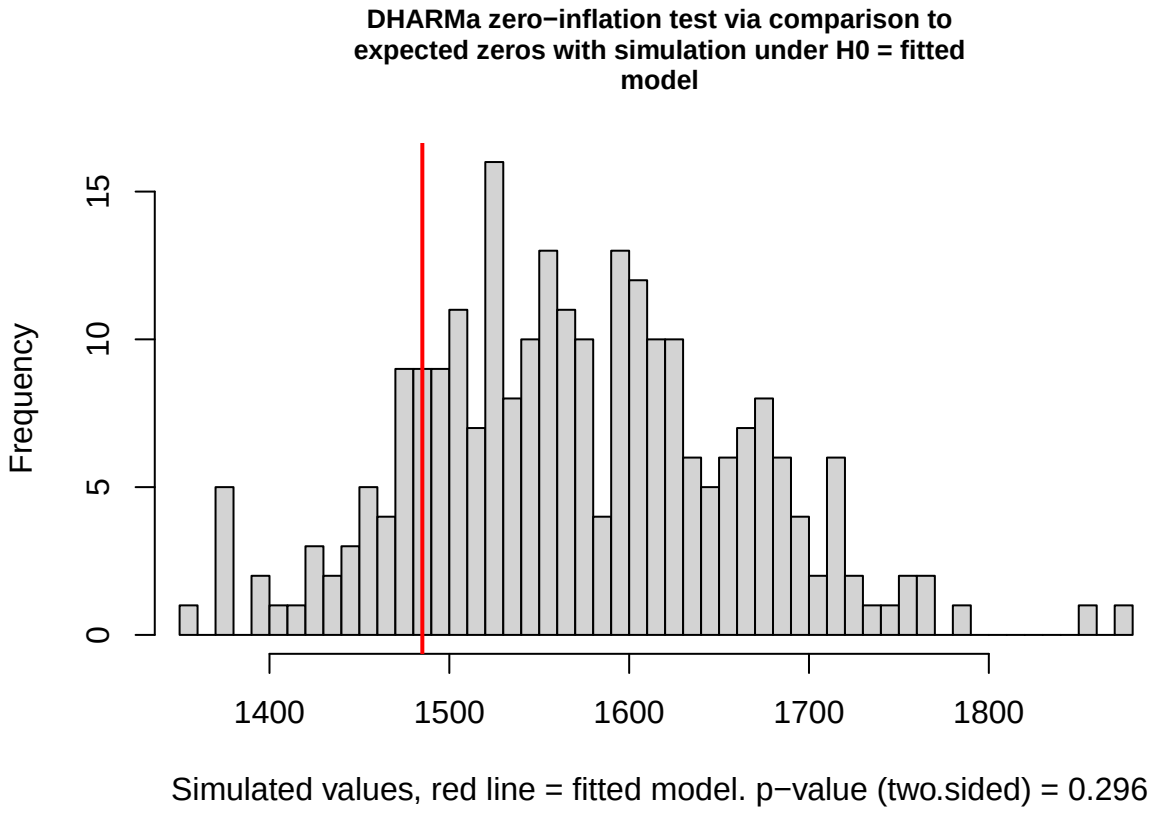

```
##
##  DHARMa outlier test based on exact binomial test
##
## data:  simulation_output_survival.1
## outliers at both margin(s) = 0, simulations = 4834, p-value < 2.2e-16
## alternative hypothesis: true probability of success is not equal to 0.007968127
## 95 percent confidence interval:
##  0.0000000000 0.0007628201
## sample estimates:
## frequency of outliers (expected: 0.00796812749003984 )
##                                                     0
```

```
# note that some of these diagnostics are significant but the same size is very large and the deviation
testDispersion(simulation_output_survival.1)
```



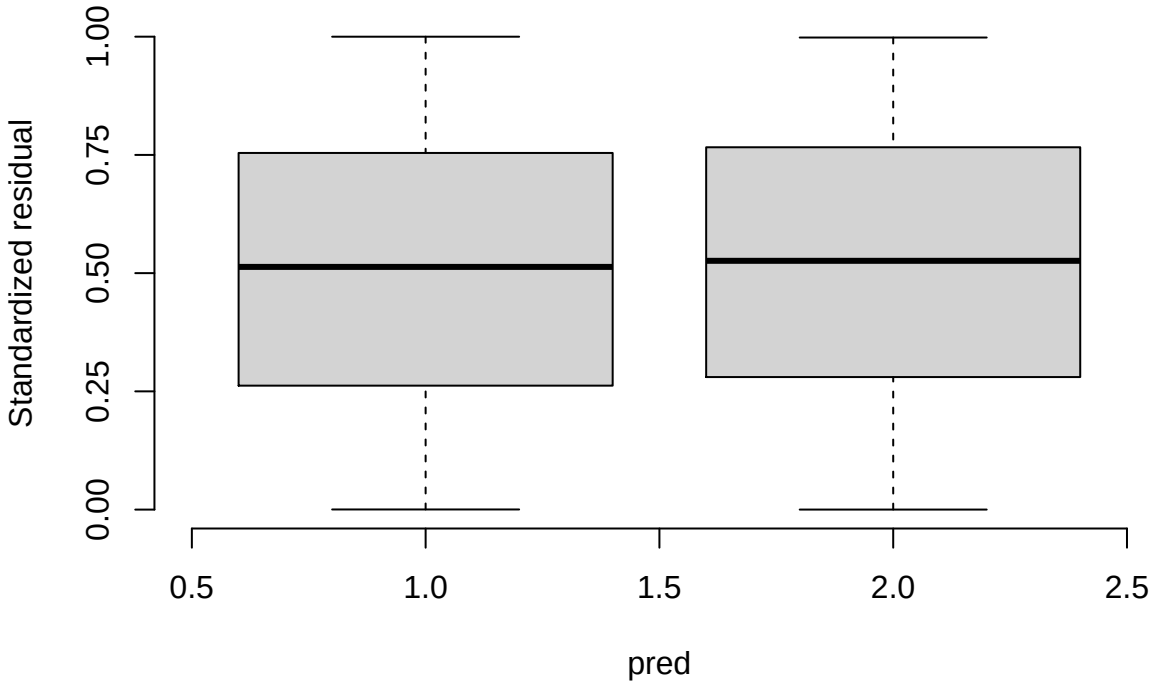

```
##
##  DHARMa nonparametric dispersion test via sd of residuals fitted vs.
##  simulated
##
## data:  simulationOutput
## ratioObsSim = 0.98677, p-value = 0.312
## alternative hypothesis: two.sided
```

```
testZeroInflation(simulation_output_survival.1)
```

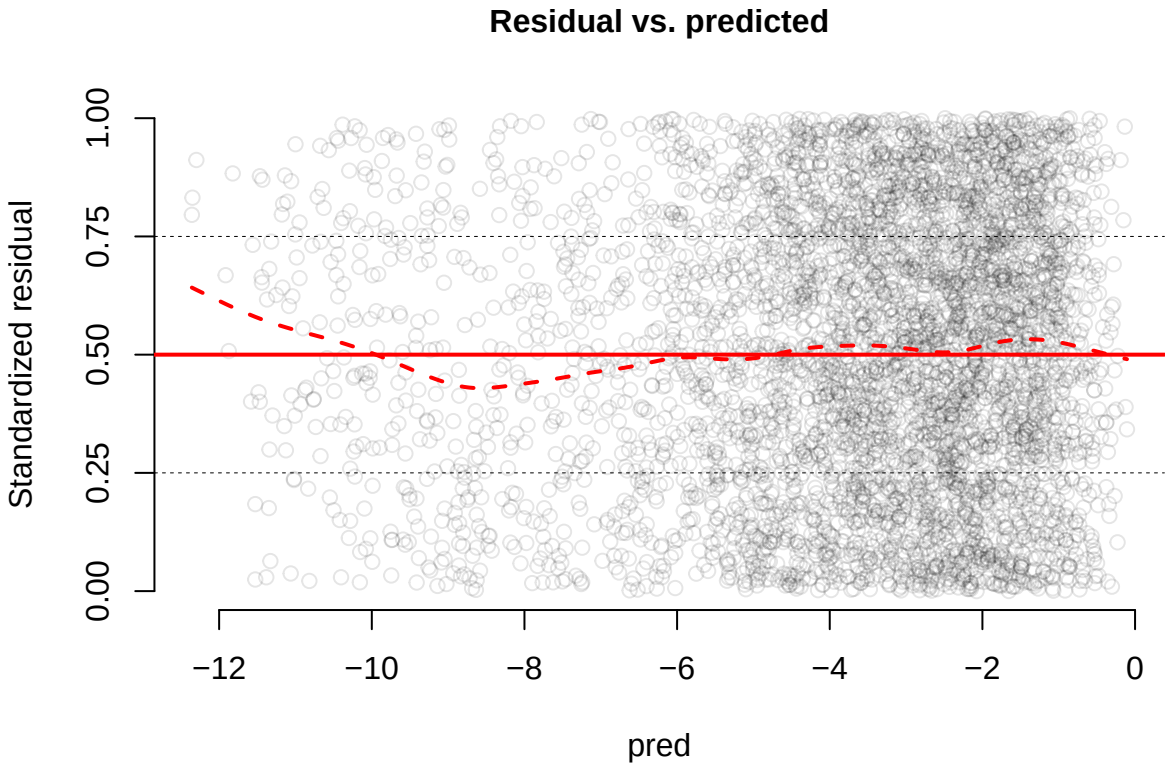



```
##
##  DHARMa zero-inflation test via comparison to expected zeros with
##  simulation under H0 = fitted model
##
## data:  simulationOutput
## ratioObsSim = 0.94465, p-value = 0.296
## alternative hypothesis: two.sided
```

```
plotResiduals(simulation_output_survival.1, form = census_final$mast)
```




```
plotResiduals(simulation_output_survival.1, form = census_final$social_survival2)
```



Reproductive Success Model

```
# Table 3
```

```
###############
# Final Model #
###############
summary(reproduction.1<-glmer(all_litters_fit~age+I(age^2)+grid+std_soc_surv3*mast+std_soc_repro*mast+(
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: poisson  ( log )
## Formula: all_litters_fit ~ age + I(age^2) + grid + std_soc_surv3 * mast +
##     std_soc_repro * mast + (std_soc_surv3 + std_soc_repro ||
##     year) + (1 | squirrel_id)
##    Data: census_final
## Control: glmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 2e+05))
##
##      AIC      BIC   logLik deviance df.resid
##   4486.2   4564.0  -2230.1   4460.2     2920
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -1.5447 -0.5264 -0.3477 -0.1706  5.5208
##
## Random effects:
##  Groups      Name          Variance Std.Dev.
##  squirrel_id (Intercept)   0.222090 0.47126
##  year        std_soc_repro 0.031587 0.17773
##  year.1      std_soc_surv3 0.002021 0.04495
##  year.2      (Intercept)   0.467442 0.68370
## Number of obs: 2933, groups:  squirrel_id, 1045; year, 31
##
## Fixed effects:
##                     Estimate Std. Error z value Pr(>|z|)
## (Intercept)         -2.52223    0.18708 -13.482  < 2e-16 ***
## age                  0.73707    0.08036   9.172  < 2e-16 ***
## I(age^2)            -0.10217    0.01215  -8.406  < 2e-16 ***
## gridSU              -0.16320    0.06841  -2.385   0.0171 *
## std_soc_surv3        0.10421    0.04534   2.299   0.0215 *
## masty                1.53121    0.31850   4.808 1.53e-06 ***
## std_soc_repro       -0.34830    0.06341  -5.493 3.95e-08 ***
## std_soc_surv3:masty -0.01633    0.07618  -0.214   0.8303
## masty:std_soc_repro  0.25678    0.11364   2.260   0.0238 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) age    I(g^2) gridSU std__3 masty  std_s_ st__3:
## age         -0.582
## I(age^2)     0.523 -0.961
## gridSU      -0.131 -0.027  0.010
## std_sc_srv3  0.015 -0.043  0.026 -0.006
## masty       -0.353  0.008 -0.011  0.005  0.016
## std_soc_rpr  0.076  0.014 -0.006  0.009 -0.316 -0.046
## std_sc_sr3:  0.009  0.022 -0.027  0.003 -0.577 -0.033  0.187
## msty:std_s_ -0.034 -0.011  0.014 -0.008  0.193  0.046 -0.520 -0.342
```

```r
# converged: random intercept and random slopes but no correlation estimated between random slopes and


##############################
# Other random slopes models #
##############################

### Full random slopes model
#summary(glmer(all_litters_fit~age+I(age^2)+grid+std_soc_surv3*mast+std_soc_repro*mast+(std_soc_surv3+s
# Did not converge: variation in soc_surv slopes is low and correlation between random slopes and rando

# Two intercepts and random slopes
#summary(glmer(all_litters_fit~age+I(age^2)+grid+std_soc_surv3*mast+std_soc_repro*mast+(std_soc_surv3|y
# Did not converge

# Random slope for soc_repro allowed to covary with the random intercept but the random slope for soc_s
summary(glmer(all_litters_fit~age+I(age^2)+grid+std_soc_surv3*mast+std_soc_repro*mast+(0+std_soc_surv3|y
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: poisson  ( log )
## Formula: all_litters_fit ~ age + I(age^2) + grid + std_soc_surv3 * mast +
##     std_soc_repro * mast + (0 + std_soc_surv3 | year) + (std_soc_repro |
##     year) + (1 | squirrel_id)
##    Data: census_final
## Control: glmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 2e+05))
##
##      AIC      BIC   logLik deviance df.resid
##   4482.8   4566.6  -2227.4   4454.8     2919
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -1.5545 -0.5266 -0.3490 -0.1502  5.4620
##
## Random effects:
##  Groups      Name          Variance  Std.Dev. Corr
##  squirrel_id (Intercept)   0.2204690 0.46954
##  year        (Intercept)   0.5130509 0.71628
##              std_soc_repro 0.0404703 0.20117  0.66
##  year.1      std_soc_surv3 0.0001518 0.01232
## Number of obs: 2933, groups:  squirrel_id, 1045; year, 31
##
## Fixed effects:
##                     Estimate Std. Error z value Pr(>|z|)
## (Intercept)         -2.52350    0.19181 -13.156  < 2e-16 ***
## age                  0.72529    0.08034   9.028  < 2e-16 ***
## I(age^2)            -0.10035    0.01215  -8.256  < 2e-16 ***
## gridSU              -0.16326    0.06834  -2.389   0.0169 *
## std_soc_surv3        0.10238    0.04435   2.308   0.0210 *
## masty                1.53145    0.33334   4.594 4.34e-06 ***
## std_soc_repro       -0.39073    0.06860  -5.696 1.23e-08 ***
## std_soc_surv3:masty -0.02164    0.07289  -0.297   0.7665
## masty:std_soc_repro  0.28623    0.12290   2.329   0.0199 *
## ---
```

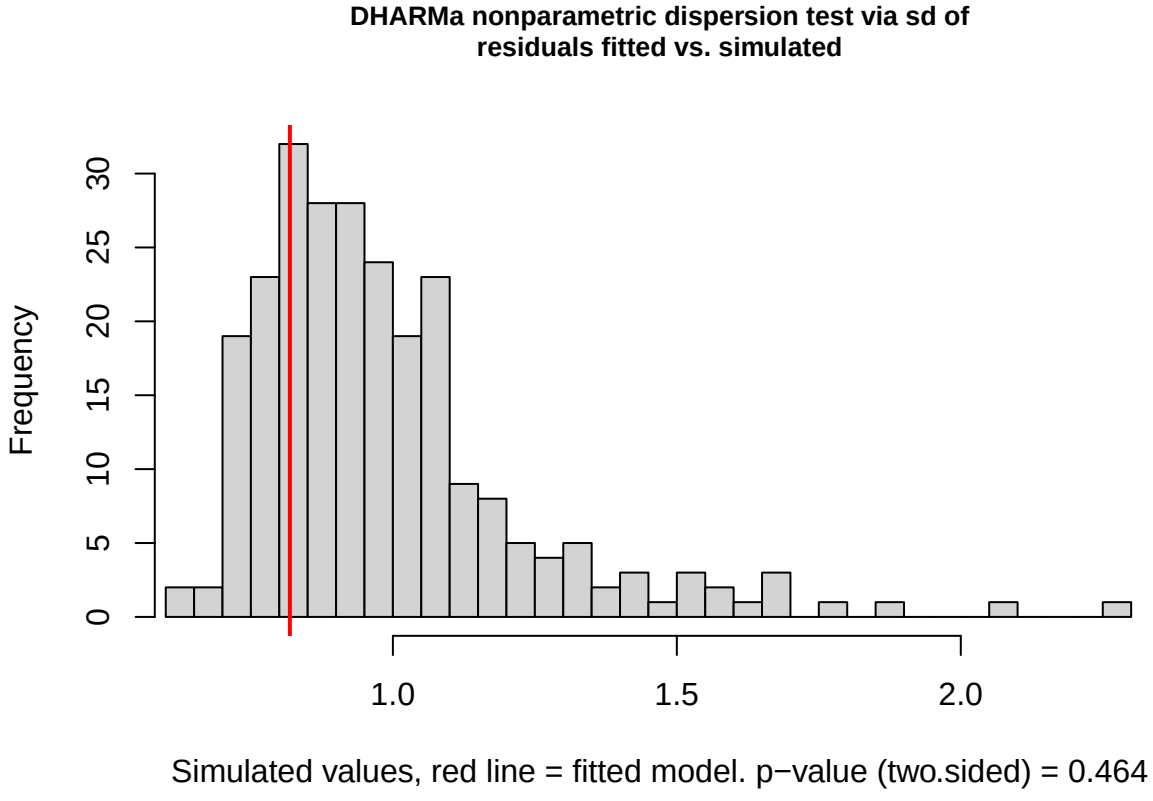
```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) age    I(g^2) gridSU std__3 masty  std_s_ st__3:
## age         -0.564
## I(age^2)     0.507 -0.961
## gridSU      -0.128 -0.027  0.010
## std_sc_srv3  0.014 -0.041  0.023 -0.009
## masty       -0.359  0.007 -0.010  0.004  0.016
## std_soc_rpr  0.366  0.029 -0.020  0.008 -0.305 -0.212
## std_sc_sr3:  0.009  0.025 -0.030  0.007 -0.586 -0.032  0.193
## msty:std_s_ -0.196 -0.018  0.022 -0.008  0.181  0.530 -0.512 -0.337
# converged


summary(glmer(all_litters_fit~age+I(age^2)+grid+std_soc_surv3*mast+std_soc_repro*mast+(std_soc_surv3|ye

## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: poisson  ( log )
## Formula: all_litters_fit ~ age + I(age^2) + grid + std_soc_surv3 * mast +
##     std_soc_repro * mast + (std_soc_surv3 | year) + (0 + std_soc_repro |
##     year) + (1 | squirrel_id)
##    Data: census_final
## Control: glmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 2e+05))
##
##      AIC      BIC   logLik deviance df.resid
##   4488.0   4571.7  -2230.0   4460.0     2919
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -1.5486 -0.5261 -0.3492 -0.1693  5.4993
##
## Random effects:
##  Groups      Name          Variance Std.Dev. Corr
##  squirrel_id (Intercept)   0.221751 0.47090
##  year        std_soc_repro 0.032692 0.18081
##  year.1      (Intercept)   0.470857 0.68619
##              std_soc_surv3 0.003274 0.05722  -0.36
## Number of obs: 2933, groups:  squirrel_id, 1045; year, 31
##
## Fixed effects:
##                     Estimate Std. Error z value Pr(>|z|)
## (Intercept)         -2.52274    0.18744 -13.459  < 2e-16 ***
## age                  0.73739    0.08035   9.177  < 2e-16 ***
## I(age^2)            -0.10223    0.01216  -8.410  < 2e-16 ***
## gridSU              -0.16345    0.06840  -2.390   0.0169 *
## std_soc_surv3        0.11068    0.04761   2.325   0.0201 *
## masty                1.53078    0.31963   4.789 1.67e-06 ***
## std_soc_repro       -0.34862    0.06385  -5.460 4.76e-08 ***
## std_soc_surv3:masty -0.02041    0.07843  -0.260   0.7947
## masty:std_soc_repro  0.25920    0.11474   2.259   0.0239 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##
## Correlation of Fixed Effects:
##             (Intr) age    I(g^2) gridSU std__3 masty  std_s_ st__3:
## age         -0.581
## I(age^2)     0.522 -0.961
## gridSU      -0.131 -0.027  0.010
## std_sc_srv3 -0.052 -0.039  0.022 -0.007
## masty       -0.354  0.008 -0.011  0.005  0.053
## std_soc_rpr  0.076  0.014 -0.005  0.010 -0.300 -0.046
## std_sc_sr3:  0.049  0.019 -0.024  0.003 -0.576 -0.150  0.181
## msty:std_s_ -0.034 -0.010  0.013 -0.009  0.193  0.045 -0.519 -0.333
```

```
# converged
```

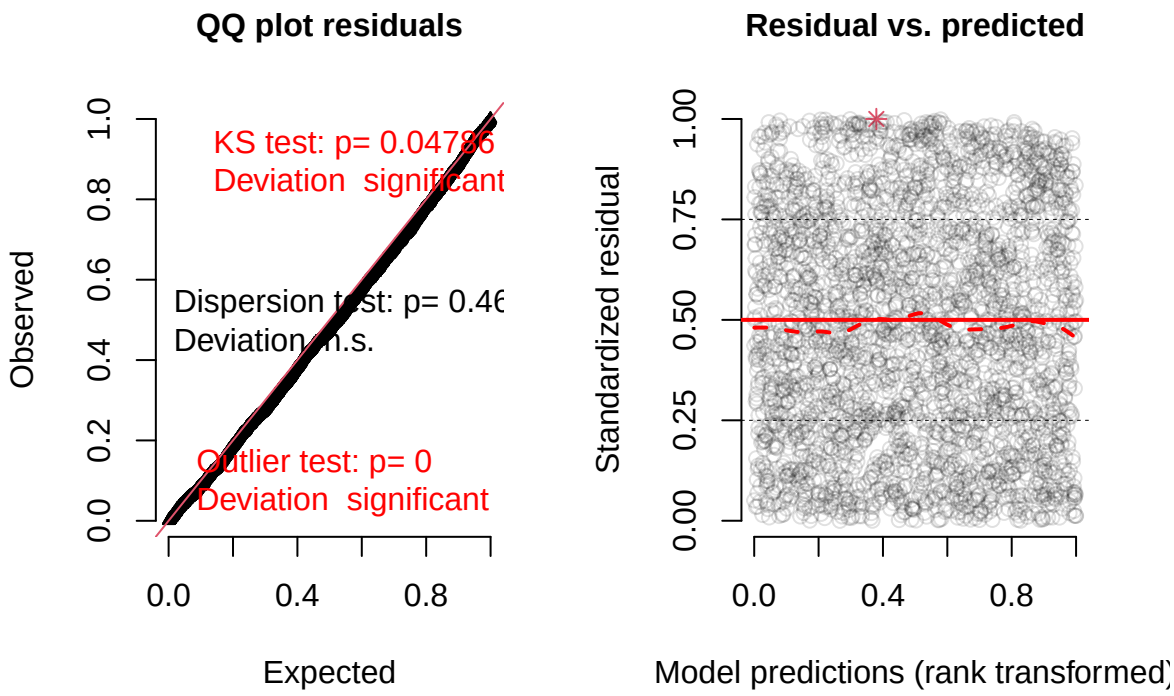
Model diagnostics

```
testDispersion(reproduction.1)
```

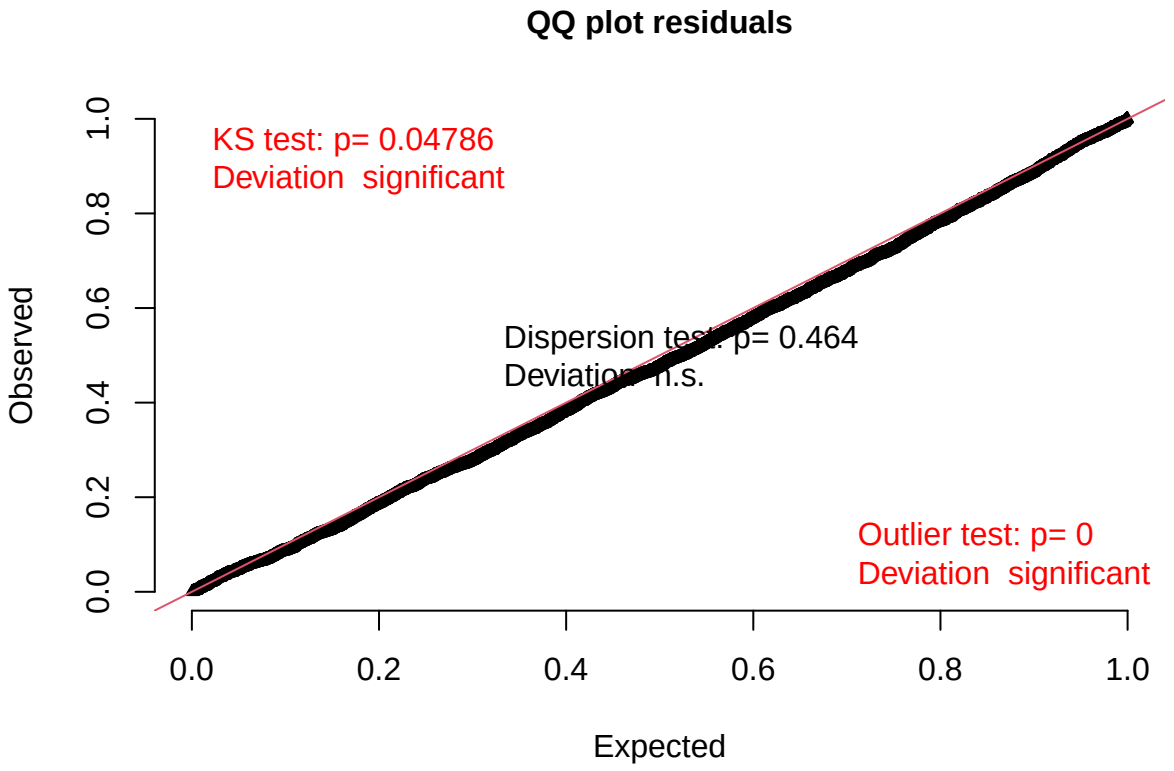



```
##
##  DHARMa nonparametric dispersion test via sd of residuals fitted vs.
##  simulated
##
## data:  simulationOutput
## ratioObsSim = 0.82924, p-value = 0.464
## alternative hypothesis: two.sided
```

```
simulation_output_reproduction.1<-simulateResiduals(fittedModel = reproduction.1, n = 250)
plot(simulation_output_reproduction.1)
```



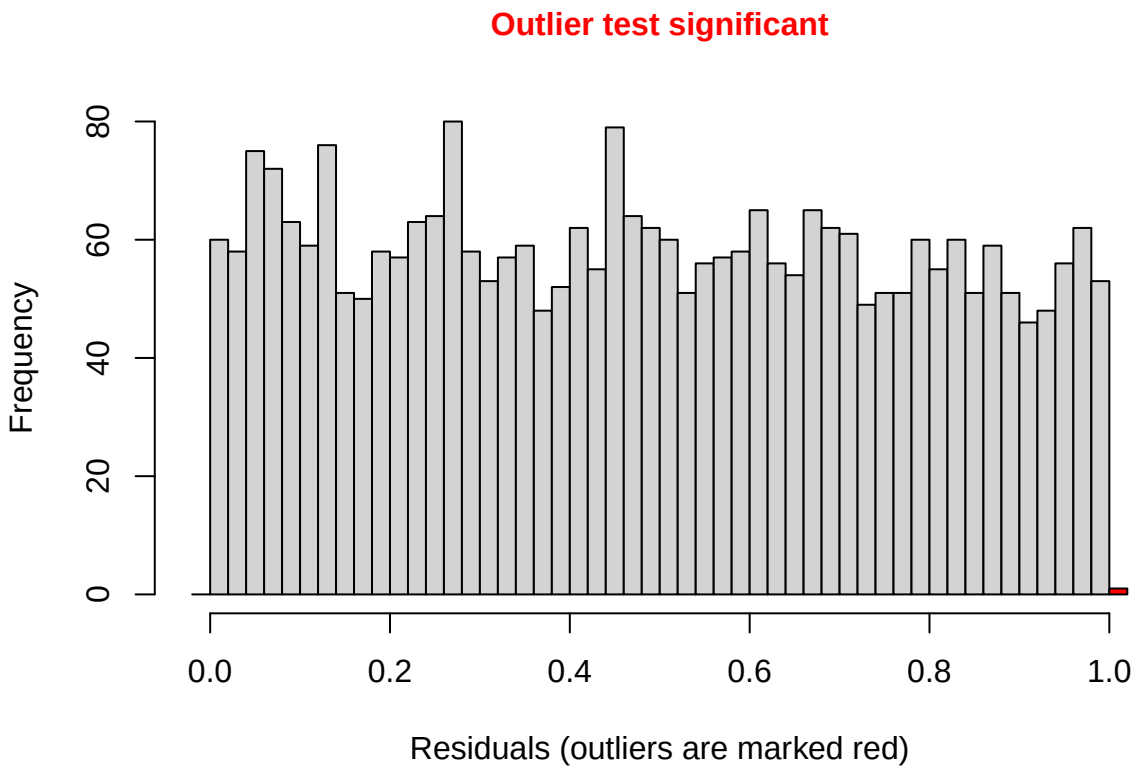

```
testUniformity(simulation_output_reproduction.1)
```




```
##
##  One-sample Kolmogorov-Smirnov test
##
```

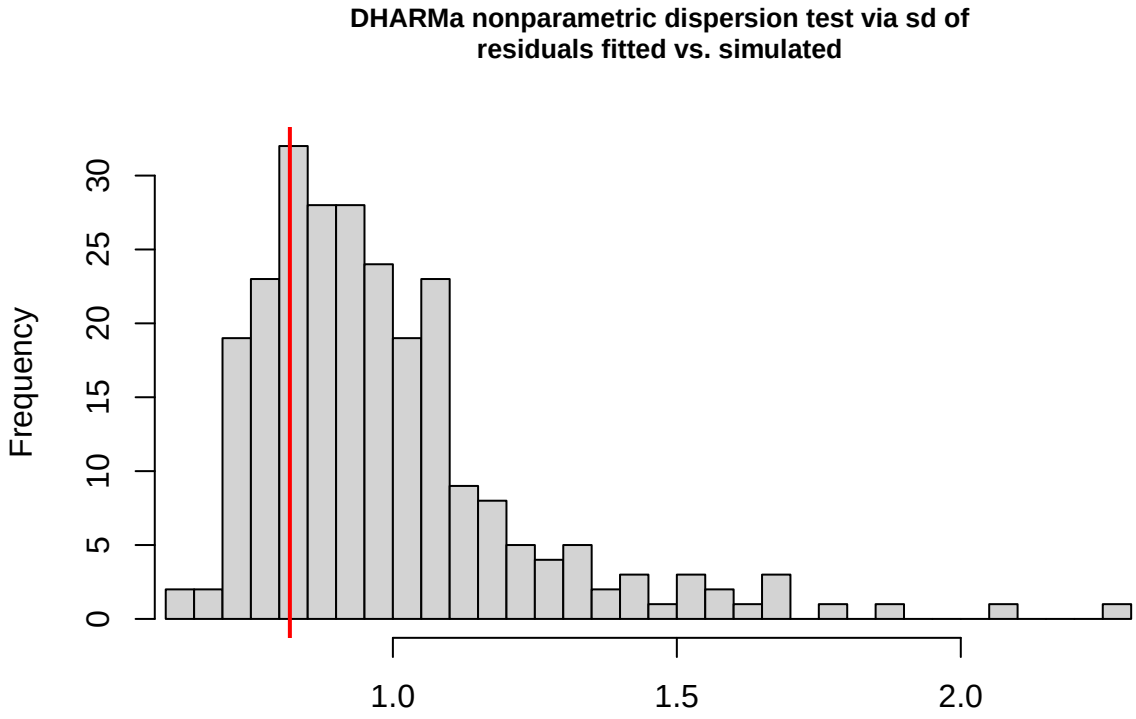
```
## data:  simulationOutput$scaledResiduals
## D = 0.025226, p-value = 0.04786
## alternative hypothesis: two-sided
```

```
testOutliers(simulation_output_reproduction.1)
```



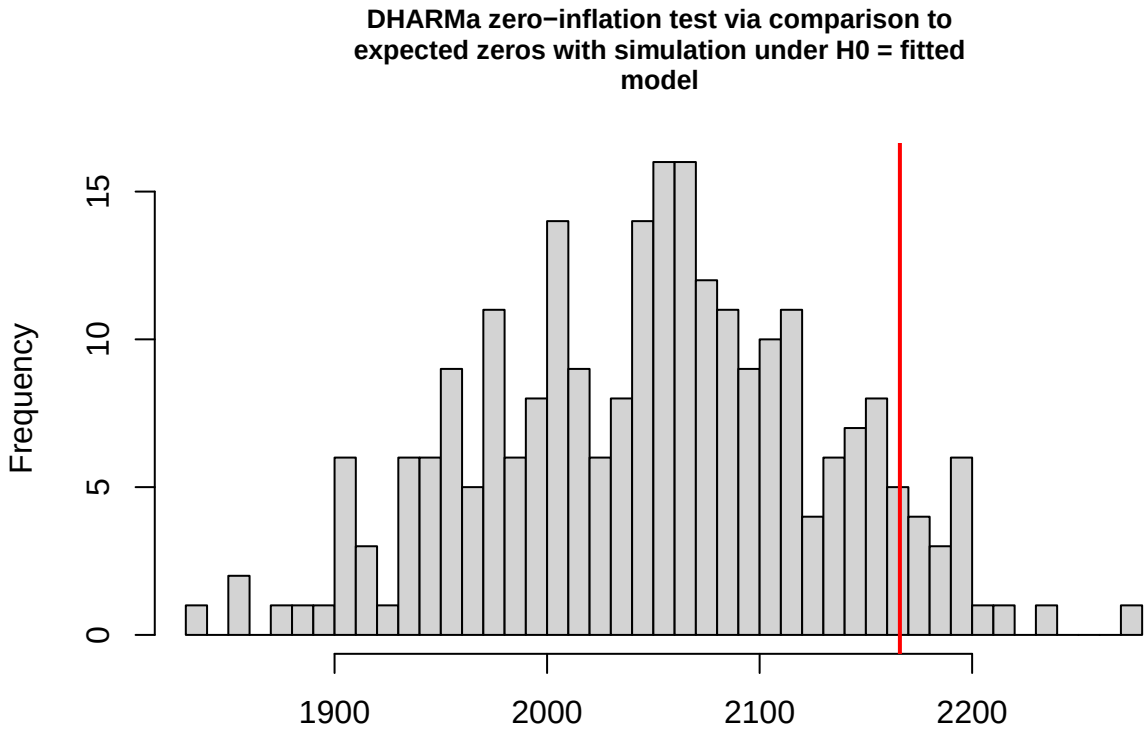

```
##
##  DHARMa outlier test based on exact binomial test
##
## data:  simulation_output_reproduction.1
## outliers at both margin(s) = 1, simulations = 2933, p-value = 4.06e-09
## alternative hypothesis: true probability of success is not equal to 0.007968127
## 95 percent confidence interval:
##  8.632015e-06 1.898160e-03
## sample estimates:
## frequency of outliers (expected: 0.00796812749003984 )
##                                           0.0003409478
```

```
testDispersion(simulation_output_reproduction.1)
```



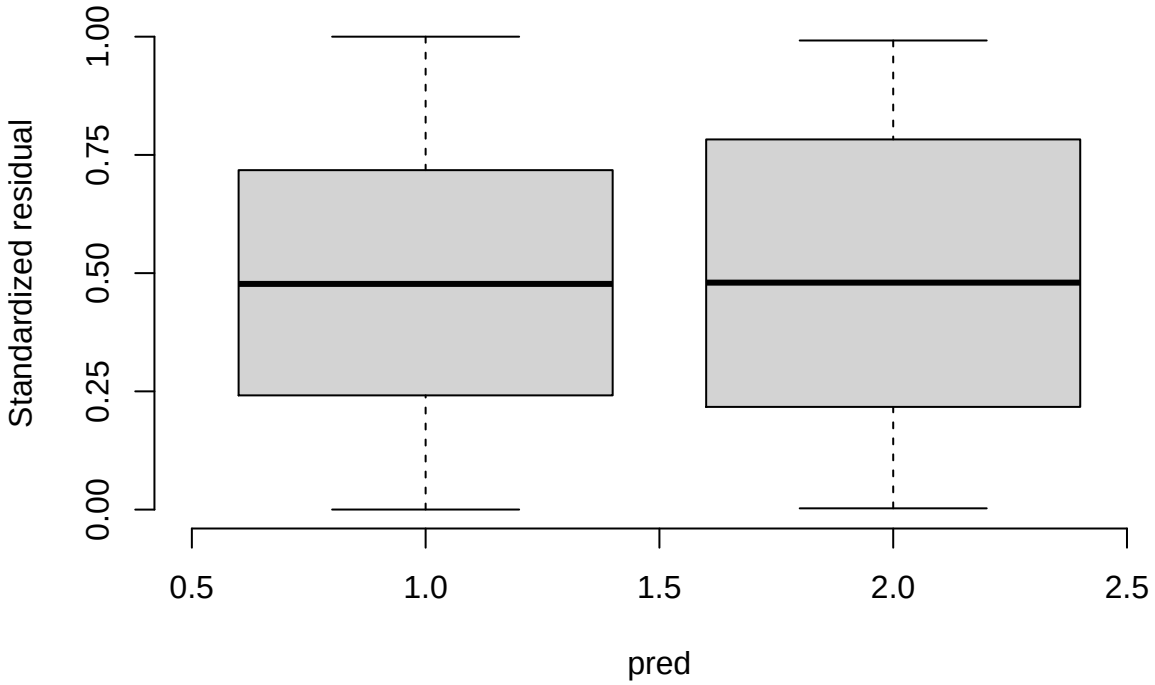

```
##
##  DHARMa nonparametric dispersion test via sd of residuals fitted vs.
##  simulated
##
## data:  simulationOutput
## ratioObsSim = 0.82924, p-value = 0.464
## alternative hypothesis: two.sided
```

```
testZeroInflation(simulation_output_reproduction.1)
```

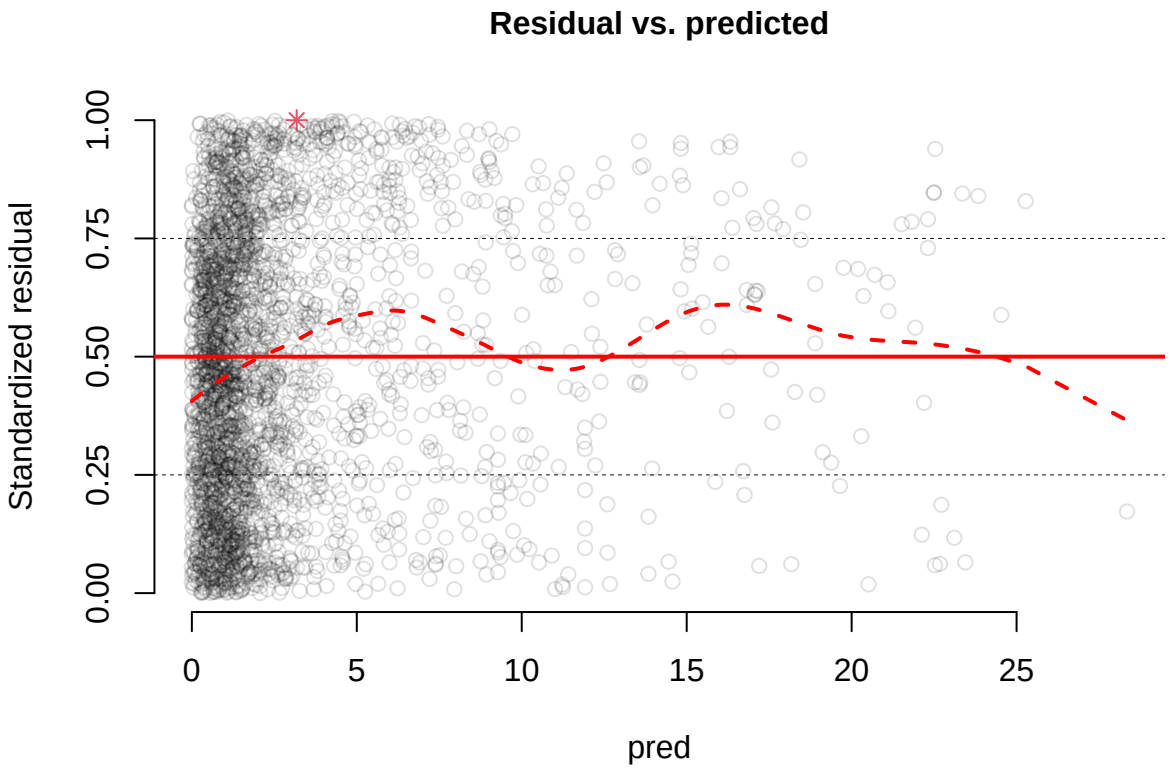



```
##
##  DHARMa zero-inflation test via comparison to expected zeros with
##  simulation under H0 = fitted model
##
## data:  simulationOutput
## ratioObsSim = 1.0562, p-value = 0.144
## alternative hypothesis: two.sided
```

```
plotResiduals(simulation_output_reproduction.1, form = subset(census_final$mast, !is.na(census_final$al
```




```
plotResiduals(simulation_output_reproduction.1, form = subset(census_final$social_repro, !is.na(census_
```



Supplemental Analyses

Distance-weighted Mortalities

```
summary(survival.S1<-glmer(survived~age+I(age^2)+grid+std_soc_surv2*mast+(1|year)+(1|squirrel_id), data=
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: survived ~ age + I(age^2) + grid + std_soc_surv2 * mast + (1 |
##     year) + (1 | squirrel_id)
##    Data: census_final
## Control: glmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 2e+05))
##
##      AIC      BIC   logLik deviance df.resid
##   5575.3   5633.6  -2778.6   5557.3     4825
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.1948 -0.9581  0.4984  0.6349  3.0335
##
## Random effects:
##  Groups      Name        Variance Std.Dev.
##  squirrel_id (Intercept) 0.07919  0.2814
##  year        (Intercept) 0.24874  0.4987
## Number of obs: 4834, groups:  squirrel_id, 1761; year, 31
##
## Fixed effects:
##                     Estimate Std. Error z value Pr(>|z|)
## (Intercept)          0.75258    0.16394   4.591 4.42e-06 ***
## age                  0.34039    0.08396   4.054 5.03e-05 ***
## I(age^2)            -0.08781    0.01269  -6.919 4.55e-12 ***
## gridSU               0.11579    0.06868   1.686   0.0918 .
## std_soc_surv2       -0.24726    0.03855  -6.414 1.41e-10 ***
## masty               -0.39590    0.24453  -1.619   0.1054
## std_soc_surv2:masty  0.13101    0.08883   1.475   0.1402
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) age    I(g^2) gridSU std__2 masty
## age         -0.690
## I(age^2)     0.530 -0.905
## gridSU      -0.190 -0.001 -0.019
## std_sc_srv2 -0.061  0.001  0.089 -0.005
## masty       -0.299  0.011 -0.003  0.010  0.018
## std_sc_sr2:  0.019 -0.005 -0.014  0.002 -0.415 -0.012
```

```
# random slopes models did not converge.  random slope variance was very low.


#summary(glmer(survived~age+I(age^2)+grid+std_soc_surv2*mast+(std_soc_surv2||year)+(1|squirrel_id), dat
# Did not converge
```

Distance-weighted Survival

```
# Table S2
summary(survival.S2<-glmer(survived~age+I(age^2)+grid+std_soc_surv*mast+(std_soc_surv||year)+(1|squirrel
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula:
## survived ~ age + I(age^2) + grid + std_soc_surv * mast + (std_soc_surv ||
##     year) + (1 | squirrel_id)
##    Data: census_final
## Control: glmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 2e+05))
##
##      AIC      BIC   logLik deviance df.resid
##   5622.2   5687.1  -2801.1   5602.2     4824
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.7426 -1.0016  0.5008  0.6407  3.0764
##
## Random effects:
##  Groups      Name         Variance Std.Dev.
##  squirrel_id (Intercept)  0.053843 0.23204
##  year        std_soc_surv 0.003166 0.05627
##  year.1      (Intercept)  0.241484 0.49141
## Number of obs: 4834, groups:  squirrel_id, 1761; year, 31
##
## Fixed effects:
##                    Estimate Std. Error z value Pr(>|z|)
## (Intercept)         0.73547    0.16178   4.546 5.47e-06 ***
## age                 0.33618    0.08317   4.042 5.30e-05 ***
## I(age^2)           -0.08537    0.01259  -6.781 1.20e-11 ***
## gridSU              0.11451    0.06769   1.692   0.0907 .
## std_soc_surv        0.01170    0.03990   0.293   0.7693
## masty              -0.38558    0.24120  -1.599   0.1099
## std_soc_surv:masty -0.05409    0.09266  -0.584   0.5594
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) age    I(g^2) gridSU std_s_ masty
## age         -0.692
## I(age^2)     0.533 -0.905
## gridSU      -0.188 -0.002 -0.022
## std_soc_srv  0.009 -0.017  0.024  0.000
## masty       -0.299  0.011 -0.004  0.010  0.003
## std_sc_srv: -0.002  0.003  0.001  0.001 -0.427 -0.004
```

```
# no random slopes
summary(glmer(survived~age+I(age^2)+grid+std_soc_surv*mast+(1|year)+(1|squirrel_id), data=census_final,
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
```

```
##  Family: binomial  ( logit )
## Formula: survived ~ age + I(age^2) + grid + std_soc_surv * mast + (1 |
##     year) + (1 | squirrel_id)
##    Data: census_final
## Control: glmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 2e+05))
##
##      AIC      BIC   logLik deviance df.resid
##   5620.3   5678.7  -2801.2   5602.3     4825
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.7391 -1.0051  0.5005  0.6411  3.0845
##
## Random effects:
##  Groups      Name        Variance Std.Dev.
##  squirrel_id (Intercept) 0.05446  0.2334
##  year        (Intercept) 0.24129  0.4912
## Number of obs: 4834, groups:  squirrel_id, 1761; year, 31
##
## Fixed effects:
##                    Estimate Std. Error z value Pr(>|z|)
## (Intercept)         0.73621    0.16171   4.553 5.30e-06 ***
## age                 0.33521    0.08308   4.035 5.46e-05 ***
## I(age^2)           -0.08525    0.01257  -6.779 1.21e-11 ***
## gridSU              0.11429    0.06769   1.689   0.0913 .
## std_soc_surv        0.01453    0.03692   0.394   0.6939
## masty              -0.38541    0.24110  -1.599   0.1099
## std_soc_surv:masty -0.05774    0.08796  -0.657   0.5115
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) age    I(g^2) gridSU std_s_ masty
## age         -0.692
## I(age^2)     0.533 -0.904
## gridSU      -0.188 -0.002 -0.022
## std_soc_srv  0.007 -0.009  0.016  0.003
## masty       -0.299  0.011 -0.004  0.010  0.002
## std_sc_srv: -0.001 -0.002  0.006 -0.001 -0.409 -0.003
```

Analyses without SU 2008 Data

```
# Table SX
summary(glmer(all_litters_fit~age+I(age^2)+grid+std_soc_surv3*mast+std_soc_repro*mast+(std_soc_repro+st
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: poisson  ( log )
## Formula: all_litters_fit ~ age + I(age^2) + grid + std_soc_surv3 * mast +
##     std_soc_repro * mast + (std_soc_repro + std_soc_surv3 ||
##     year) + (1 | squirrel_id)
##    Data: census_final
## Control: glmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 2e+05))
```

```
##  Subset: !(year == 2008 & grid == "SU")
##
##      AIC      BIC   logLik deviance df.resid
##   4470.7   4548.4  -2222.4   4444.7     2893
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -1.5404 -0.5291 -0.3491 -0.1637  5.4982
##
## Random effects:
##  Groups      Name          Variance Std.Dev.
##  squirrel_id (Intercept)   0.222512 0.47171
##  year        std_soc_surv3 0.002224 0.04716
##  year.1      std_soc_repro 0.031320 0.17698
##  year.2      (Intercept)   0.462887 0.68036
## Number of obs: 2906, groups:  squirrel_id, 1040; year, 31
##
## Fixed effects:
##                     Estimate Std. Error z value Pr(>|z|)
## (Intercept)         -2.51769    0.18672 -13.484  < 2e-16 ***
## age                  0.74003    0.08046   9.197  < 2e-16 ***
## I(age^2)            -0.10251    0.01217  -8.424  < 2e-16 ***
## gridSU              -0.15099    0.06865  -2.199   0.0278 *
## std_soc_surv3        0.10688    0.04549   2.350   0.0188 *
## masty                1.51665    0.31705   4.784 1.72e-06 ***
## std_soc_repro       -0.34679    0.06333  -5.476 4.36e-08 ***
## std_soc_surv3:masty -0.01845    0.07644  -0.241   0.8093
## masty:std_soc_repro  0.25536    0.11342   2.251   0.0244 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) age    I(g^2) gridSU std__3 masty  std_s_ st__3:
## age         -0.585
## I(age^2)     0.525 -0.961
## gridSU      -0.129 -0.027  0.010
## std_sc_srv3  0.012 -0.039  0.023 -0.007
## masty       -0.353  0.008 -0.012  0.003  0.017
## std_soc_rpr  0.077  0.013 -0.004  0.011 -0.318 -0.046
## std_sc_sr3:  0.010  0.020 -0.025  0.004 -0.576 -0.033  0.188
## msty:std_s_ -0.034 -0.010  0.013 -0.009  0.194  0.046 -0.521 -0.341
```

Permutation Tests

TO BE ADDED