Proyecto Beetles

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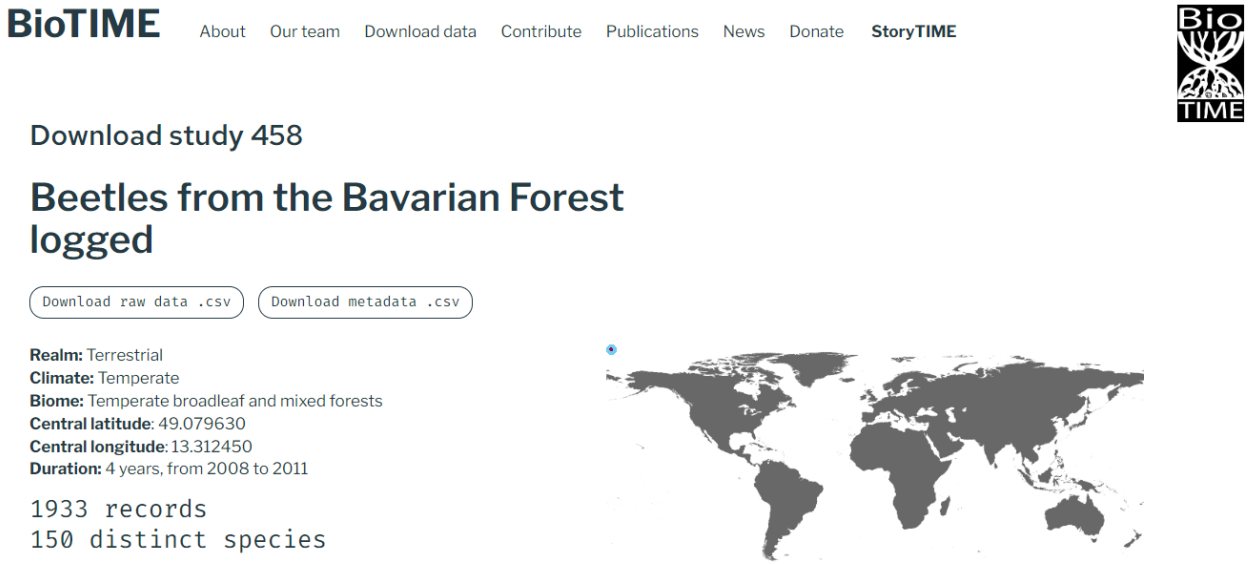
We used the metadata collected in the Bavarian Forest National Park in southeastern Germany, dominated by sub alpine forests of Picea abies. In a dead wood zone caused by the 2011 super German storm, 150 different species were monitored.Sampling season was conducted between May and September over four years (2008-2011).



The years passed but, did the forest restoration methods improved beetles richness?

First, let's calculate species richness by sampling site and year

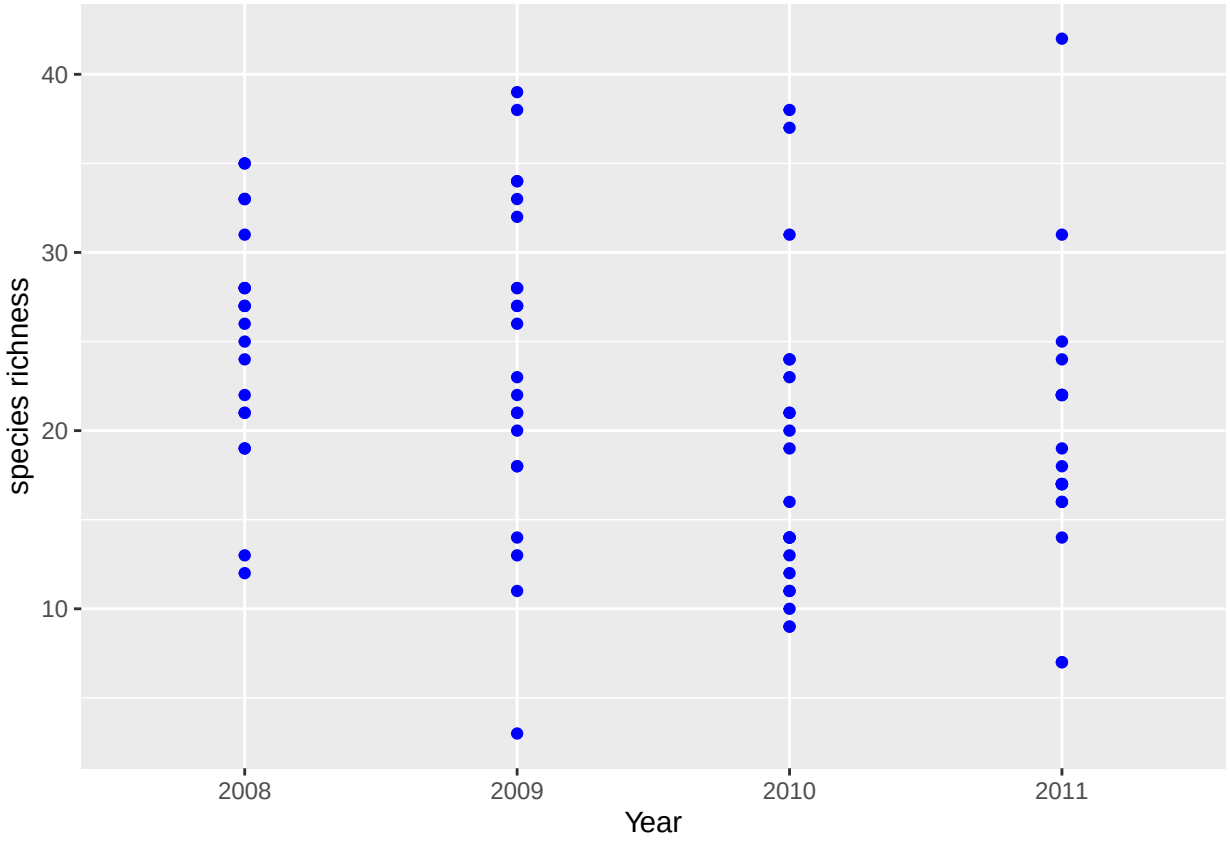
```
rawdata <- read.csv("datos/rawdata_bet.csv")
rawdata$YEAR<-as.factor(rawdata$YEAR)

bet_sum<-rawdata %>%
  group_by(PLOT, YEAR) %>%
  summarise(n_species = n(),ABUNDANCE = sum(ABUNDANCE))%>%
  rename(plot=PLOT, year=YEAR, abundance= ABUNDANCE)
```

plot	year	n_species	abundance
FAE_1	2008	12	52
FAE_11	2008	28	94
FAE_16	2008	27	125

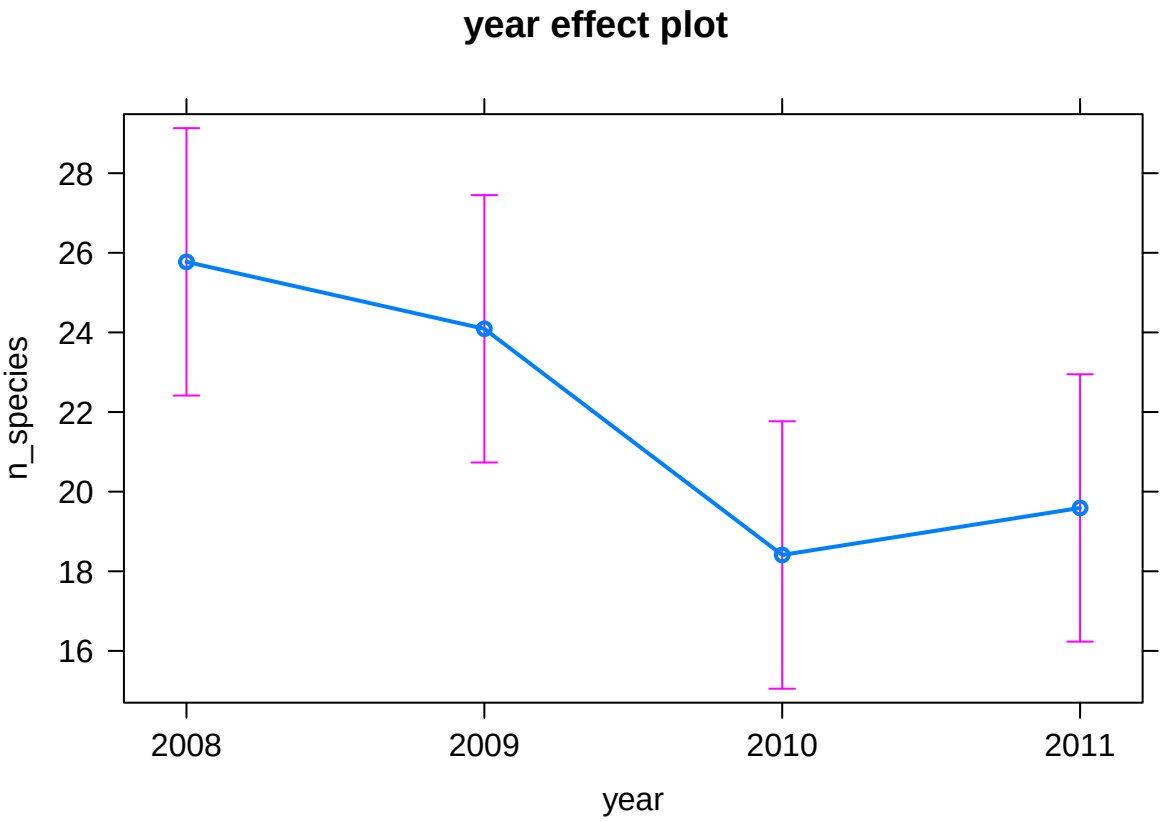
FAE_18	2008	27	123
FAE_2	2008	28	115
FAE_21	2008	33	214
FAE_24	2008	21	104
FAE_3	2008	26	50
FAE_4	2008	19	51
FAE_7	2008	28	116
FAE_9	2008	35	119
FKN_1	2008	31	86
FKN_12	2008	19	41
FKN_14	2008	33	94
FKN_15	2008	35	136
FKN_4	2008	24	53
FKN_5	2008	27	103
FKO_4	2008	33	86
FKO_6	2008	25	65
LAO_3	2008	13	20
LAW_18	2008	21	89
LAW_5	2008	22	50

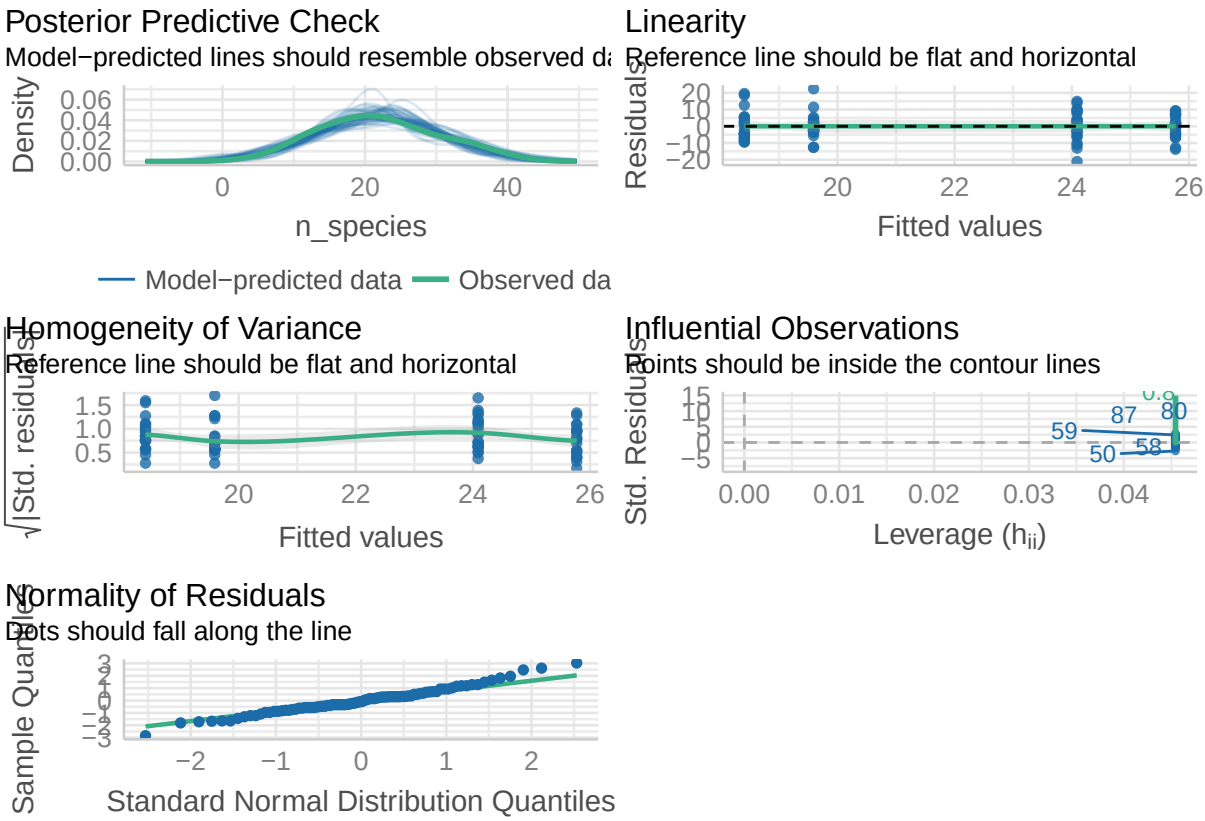
Second, plot that nice data



Is there any differences in species richness by year?

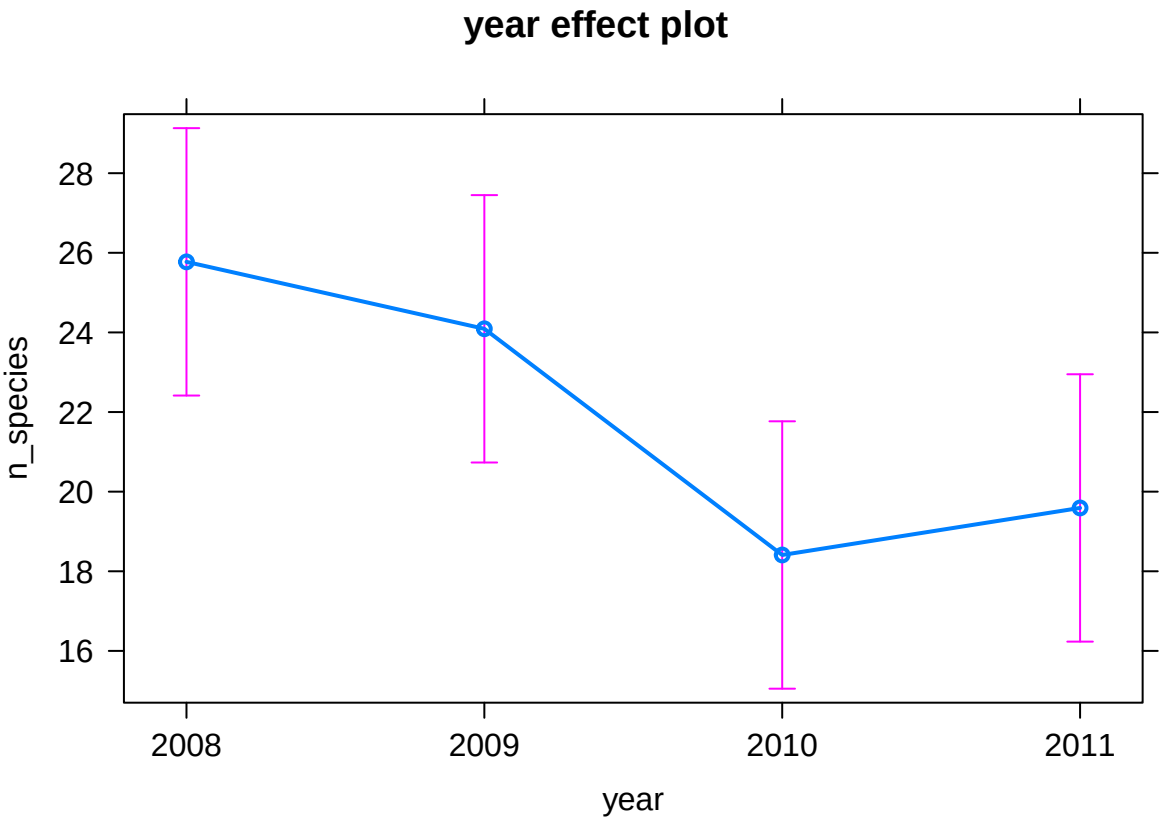
```
##
## Call:
## lm(formula = n_species ~ year, data = bet_sum)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -21.0909  -4.5000  -0.6818   4.0341  22.4091
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   25.773      1.689  15.261  < 2e-16 ***
## year2009      -1.682      2.388  -0.704  0.48326
## year2010      -7.364      2.388  -3.083  0.00277 **
## year2011      -6.182      2.388  -2.588  0.01136 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 7.921 on 84 degrees of freedom
## Multiple R-squared:  0.1347, Adjusted R-squared:  0.1038
## F-statistic:  4.36 on 3 and 84 DF,  p-value: 0.006647
```

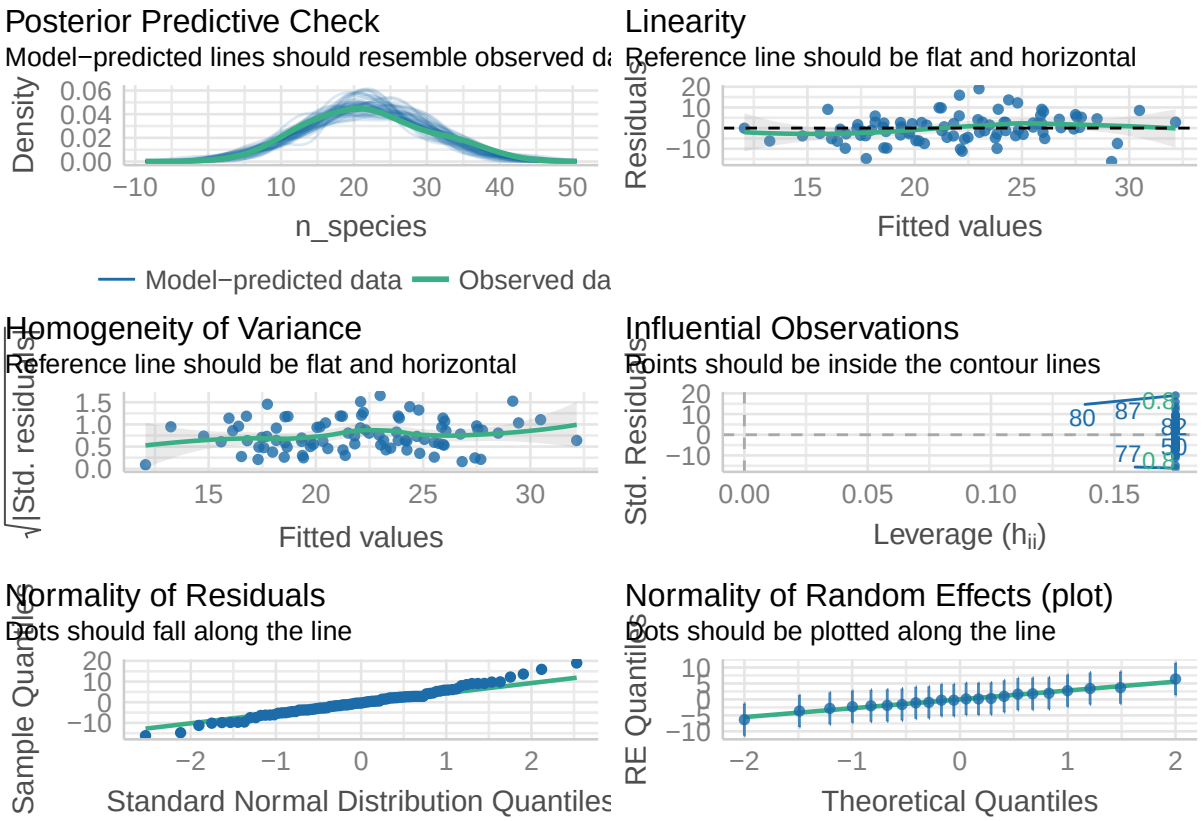

year effect plot
n_species
28
26
24
22
20
18
16
2008
2009
2010
2011
year


Posterior Predictive Check
Model−predicted lines should resemble observed da
Density
0.06
0.04
0.02
0.00
0
20
40
n_species
Model−predicted data
Observed da
Linearity
Reference line should be flat and horizontal
Residuals
20
10
0
−10
−20
20
22
24
26
Fitted values
Homogeneity of Variance
Reference line should be flat and horizontal
√|Std. residuals|
1.5
1.0
0.5
20
22
24
26
Fitted values
Influential Observations
Points should be inside the contour lines
Std. Residuals
15
10
5
0
−5
0.00
0.01
0.02
0.03
0.04
Leverage (hii)
59
87
80
50
58
Normality of Residuals
Dots should fall along the line
Sample Quantiles
3
2
1
0
−1
−2
−3
−2
−1
0
1
2
Standard Normal Distribution Quantiles

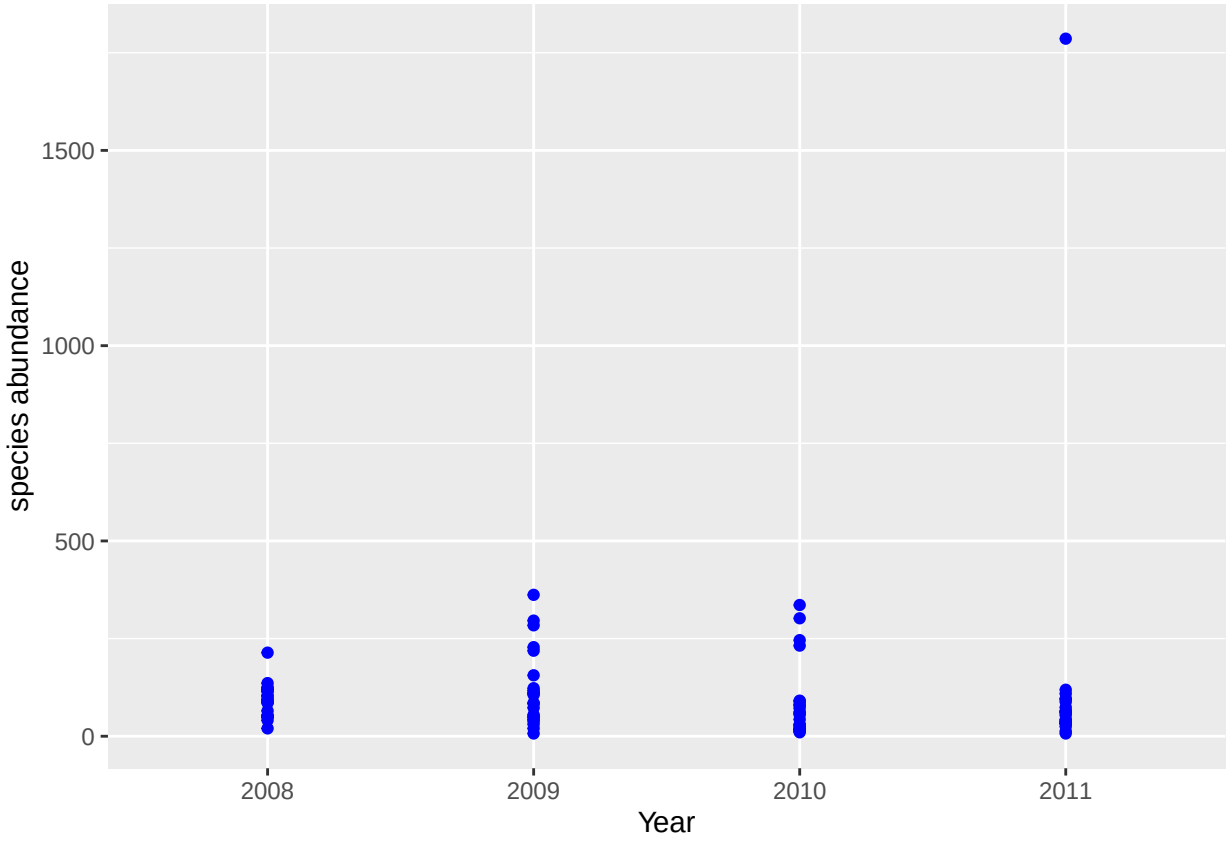
Mixed model with random = plot

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: n_species ~ year + (1 | plot)
##    Data: bet_sum
##
## REML criterion at convergence: 593.1
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -2.32520 -0.53554 -0.05196  0.40806  2.73103
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  plot     (Intercept) 14.33    3.785
##  Residual             48.42    6.958
## Number of obs: 88, groups:  plot, 22
##
## Fixed effects:
##             Estimate Std. Error t value
## (Intercept)   25.773      1.689  15.261
## year2009      -1.682      2.098  -0.802
## year2010      -7.364      2.098  -3.510
## year2011      -6.182      2.098  -2.947
##
## Correlation of Fixed Effects:
##          (Intr) yr2009 yr2010
## year2009 -0.621
## year2010 -0.621  0.500
## year2011 -0.621  0.500  0.500
```

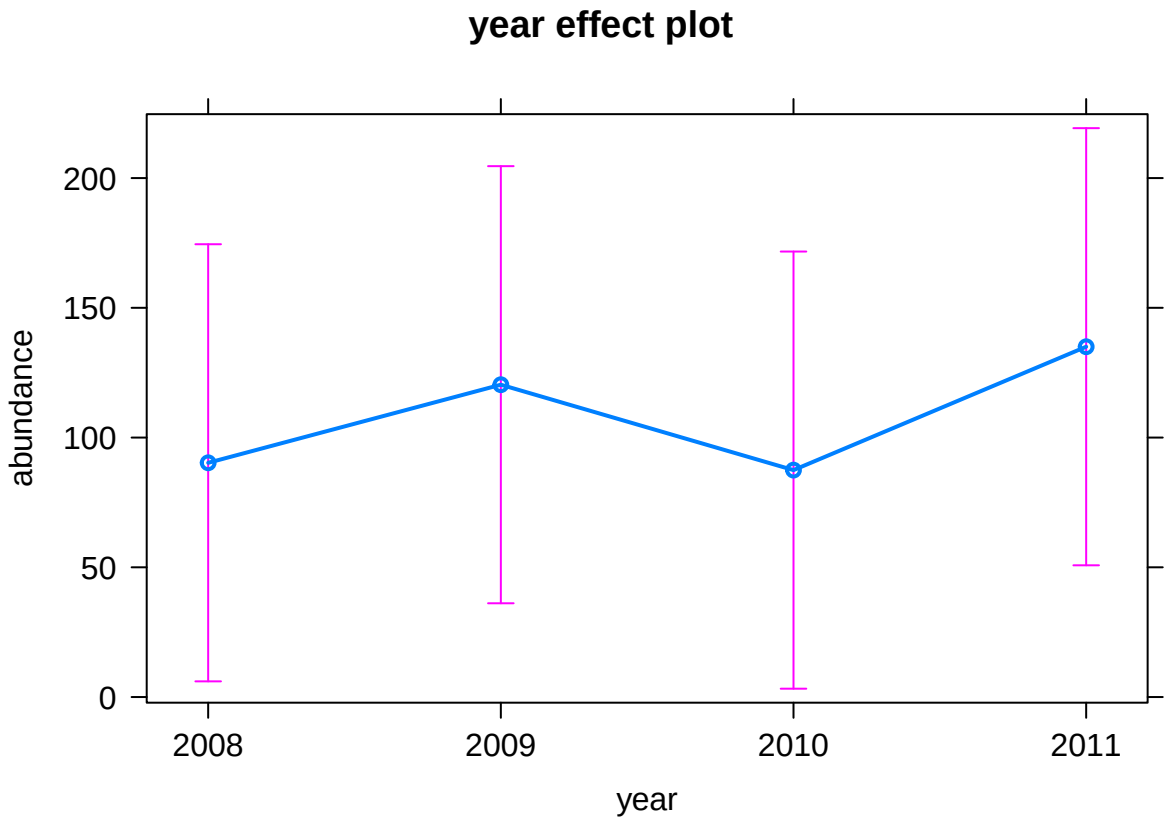

year effect plot
n_species
28
26
24
22
20
18
16
2008
2009
2010
2011
year

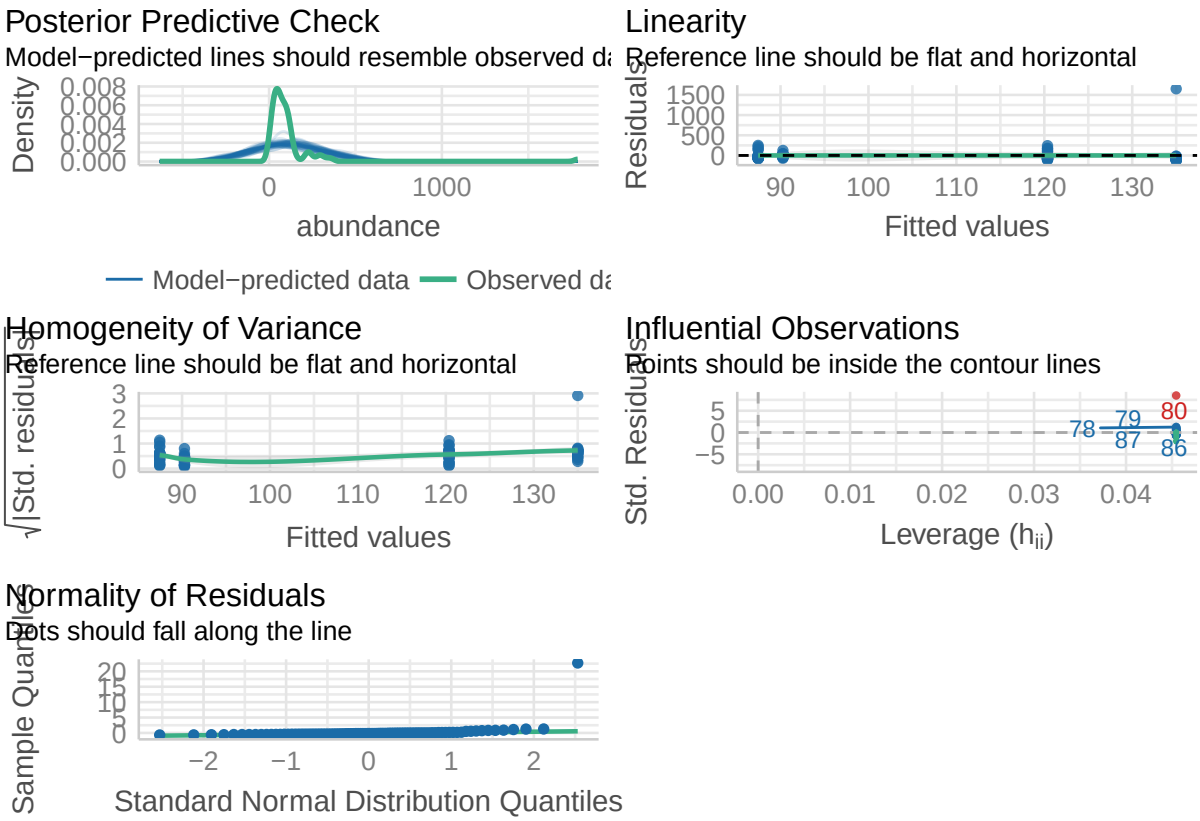

Posterior Predictive Check
Model−predicted lines should resemble observed da
Density
0.06
0.04
0.02
0.00
−10
0
10
20
30
40
50
n_species
Model−predicted data
Observed da
Linearity
Reference line should be flat and horizontal
Residuals
20
10
0
−10
15
20
25
30
Fitted values
Homogeneity of Variance
Reference line should be flat and horizontal
√|Std. residuals|
1.5
1.0
0.5
0.0
15
20
25
30
Fitted values
Influential Observations
Points should be inside the contour lines
Std. Residuals
20
10
0
−10
0.00
0.05
0.10
0.15
Leverage (hii)
80
87
77
Normality of Residuals
Dots should fall along the line
Sample Quantiles
20
10
0
−10
−2
−1
0
1
2
Standard Normal Distribution Quantiles
Normality of Random Effects (plot)
Dots should be plotted along the line
RE Quantiles
10
5
0
−5
−10
−2
−1
0
1
2
Theoretical Quantiles

Is there any differences in species abundance by year?



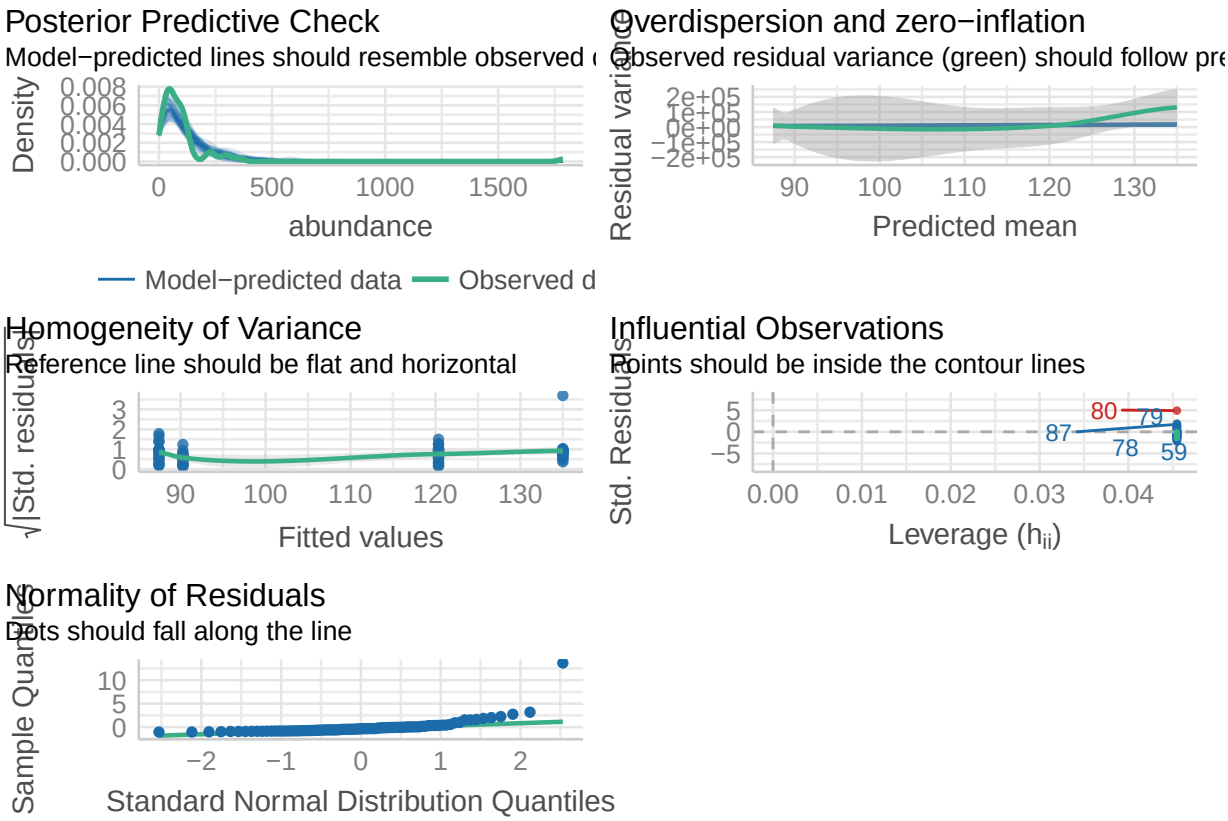

```
##
## Call:
## lm(formula = abundance ~ year, data = bet_sum)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -128.00  -71.34  -37.77    3.59 1651.00
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   90.273     42.355   2.131    0.036 *
## year2009      30.091     59.899   0.502    0.617
## year2010      -2.818     59.899  -0.047    0.963
## year2011      44.727     59.899   0.747    0.457
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 198.7 on 84 degrees of freedom
## Multiple R-squared:  0.01062,    Adjusted R-squared:  -0.02471
## F-statistic: 0.3006 on 3 and 84 DF,  p-value: 0.8249
```


year effect plot
abundance
0
50
100
150
200
2008
2009
2010
2011
year


Posterior Predictive Check
Model−predicted lines should resemble observed da
Density
0.008
0.006
0.004
0.002
0.000
0
1000
abundance
Model−predicted data
Observed da
Linearity
Reference line should be flat and horizontal
Residuals
1500
1000
500
0
90
100
110
120
130
Fitted values
Homogeneity of Variance
Reference line should be flat and horizontal
√|Std. residuals|
3
2
1
0
90
100
110
120
130
Fitted values
Influential Observations
Points should be inside the contour lines
Std. Residuals
5
0
−5
78
79
87
80
86
0.00
0.01
0.02
0.03
0.04
Leverage (hii)
Normality of Residuals
Dots should fall along the line
Sample Quantiles
20
15
10
5
0
−2
−1
0
1
2
Standard Normal Distribution Quantiles

binomial negativa

```
##
## Call:
## glm.nb(formula = abundance ~ year, data = bet_sum, init.theta = 1.202915647,
##     link = log)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -2.1595  -1.0180  -0.4189   0.0438   4.8051
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  4.50284    0.19568  23.011   <2e-16 ***
## year2009     0.28768    0.27651   1.040    0.298
## year2010    -0.03172    0.27676  -0.115    0.909
## year2011     0.40244    0.27643   1.456    0.145
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for Negative Binomial(1.2029) family taken to be 1)
##
##     Null deviance: 102.425  on 87  degrees of freedom
## Residual deviance:  98.821  on 84  degrees of freedom
## AIC: 1006.6
##
## Number of Fisher Scoring iterations: 1
##
##
##               Theta:  1.203
##           Std. Err.:  0.165
##
##  2 x log-likelihood:  -996.569
```


Posterior Predictive Check
Model−predicted lines should resemble observed
Density
0.008
0.006
0.004
0.002
0.000
0
500
1000
1500
abundance
Model−predicted data
Observed d
Overdispersion and zero−inflation
Observed residual variance (green) should follow pre
Residual variance
2e+05
1e+05
0e+00
−1e+05
−2e+05
90
100
110
120
130
Predicted mean
Homogeneity of Variance
Reference line should be flat and horizontal
√|Std. residuals|
3
2
1
0
90
100
110
120
130
Fitted values
Influential Observations
Points should be inside the contour lines
Std. Residuals
5
0
−5
80
79
87
78
59
0.00
0.01
0.02
0.03
0.04
Leverage (hii)
Normality of Residuals
Dots should fall along the line
Sample Quantiles
10
5
0
−2
−1
0
1
2
Standard Normal Distribution Quantiles