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

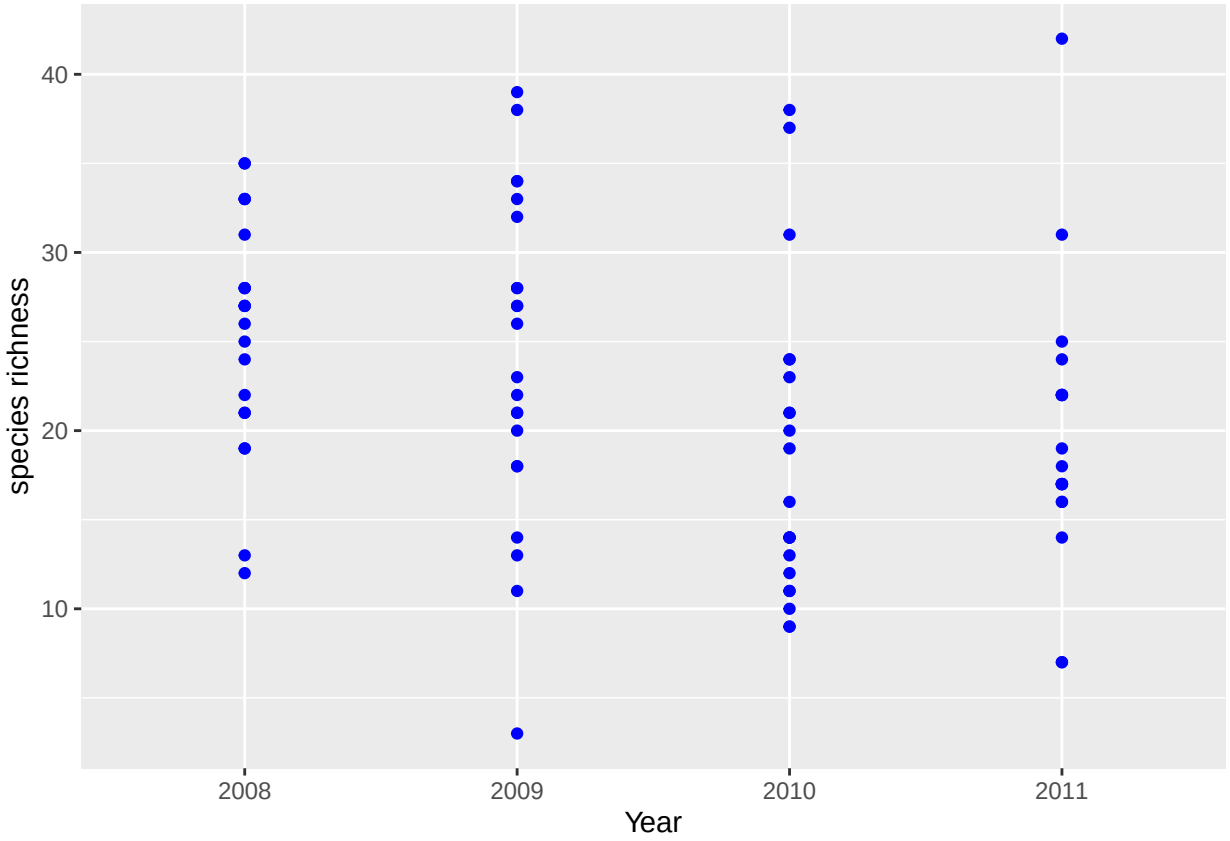
```
rawdata <- read.csv("datos/rawdata_bet.csv")
rawdata$YEAR<-as.factor(rawdata$YEAR)

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

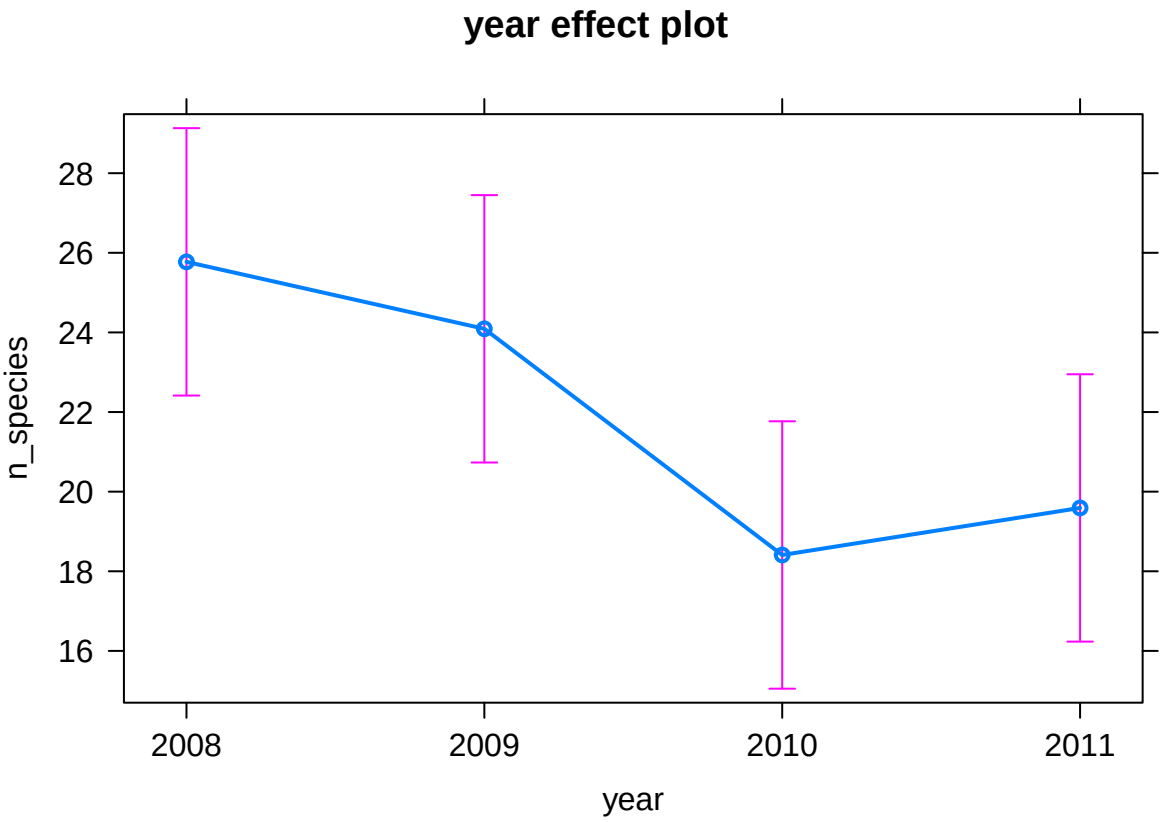
FKN_5	2008	27	103
FKO_4	2008	33	86
FKO_6	2008	25	65
LAO_3	2008	13	20
LAW_18	2008	21	89
LAW_5	2008	22	50

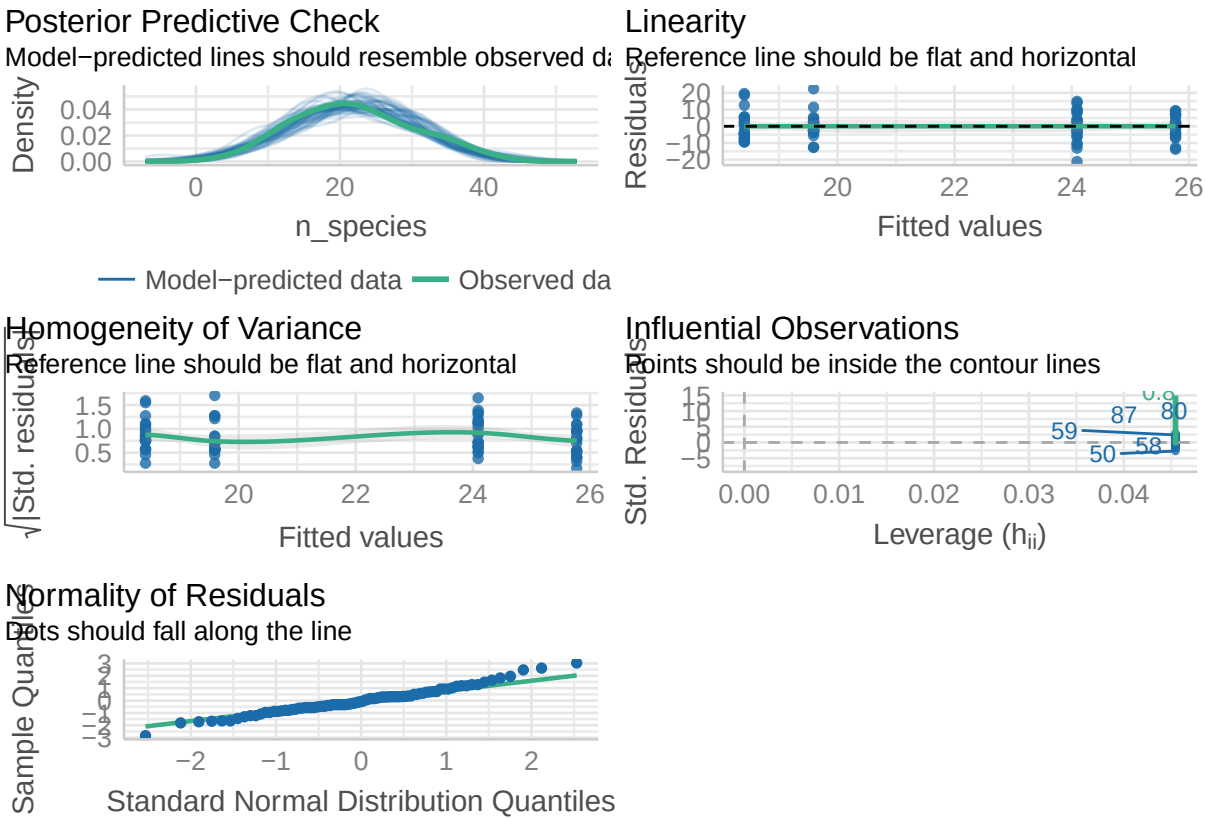
Second, plot that nice data



Is there any differences in species richness by year?

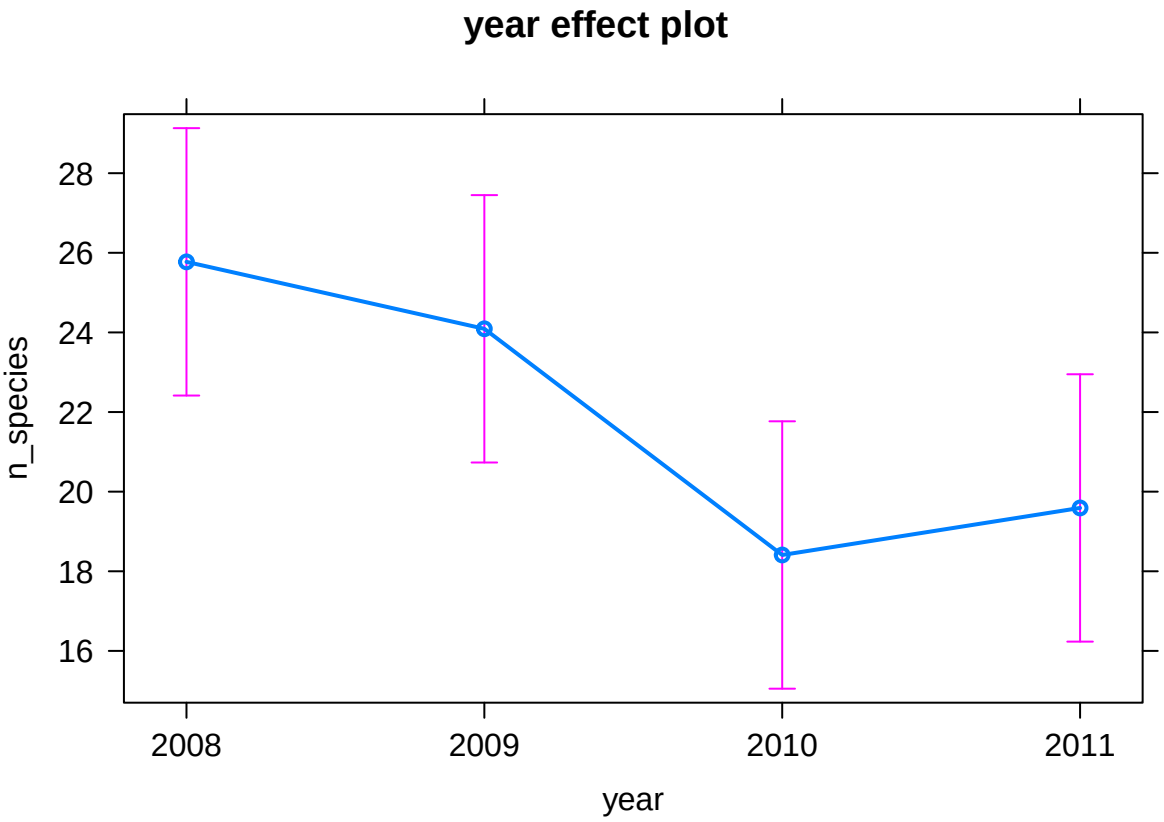
```
##
## Call:
## lm(formula = n_species ~ year, data = bet_sum)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -21.0909  -4.5000  -0.6818   4.0341  22.4091
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   25.773      1.689  15.261  < 2e-16 ***
## 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
```

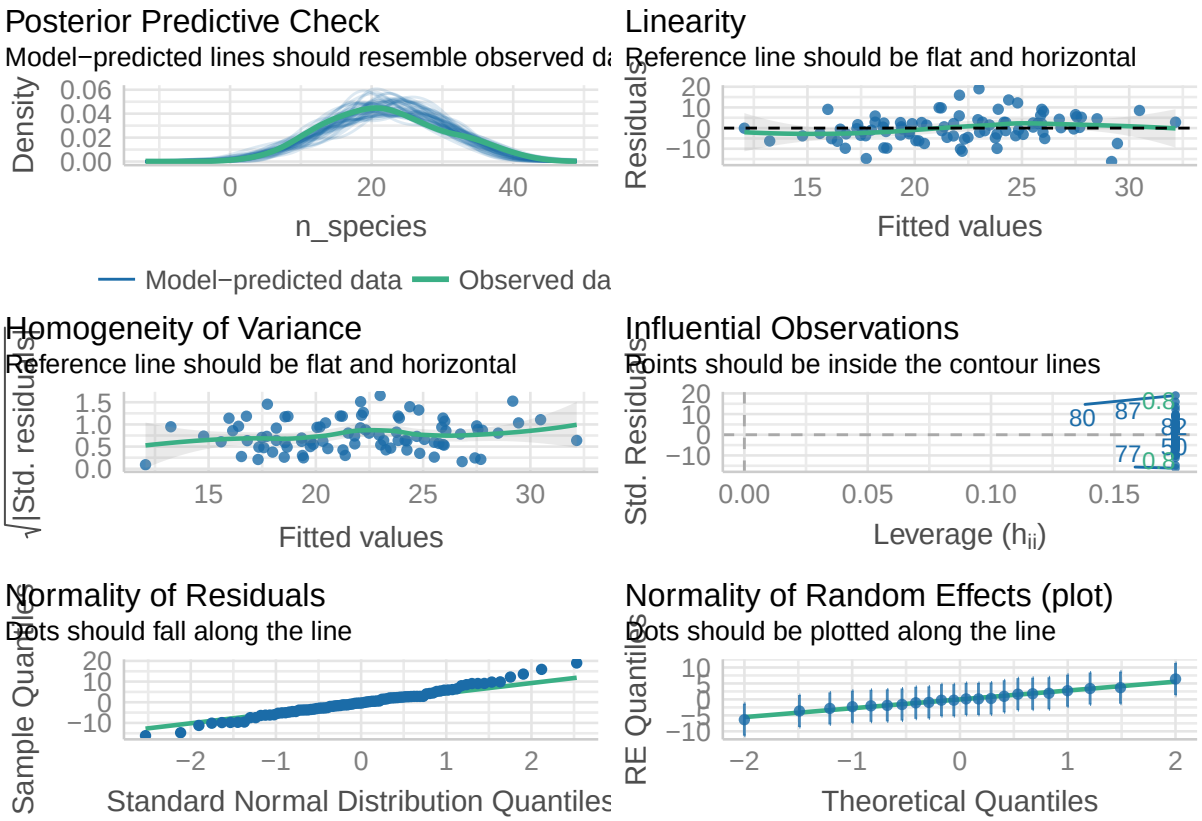

year effect plot
n_species
28
26
24
22
20
18
16
2008
2009
2010
2011
year


Posterior Predictive Check
Model−predicted lines should resemble observed da
Density
0.04
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

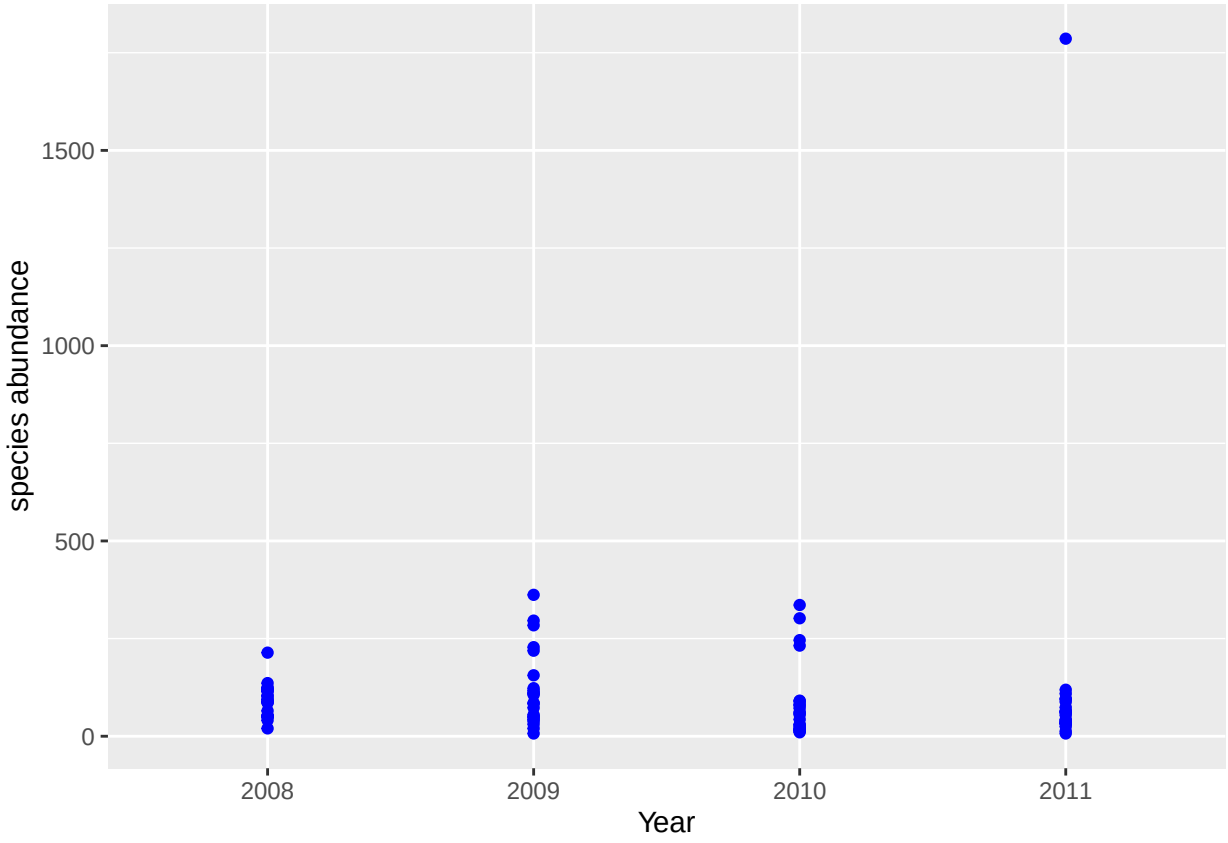
Mixed model with random = plot

```
## 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
```

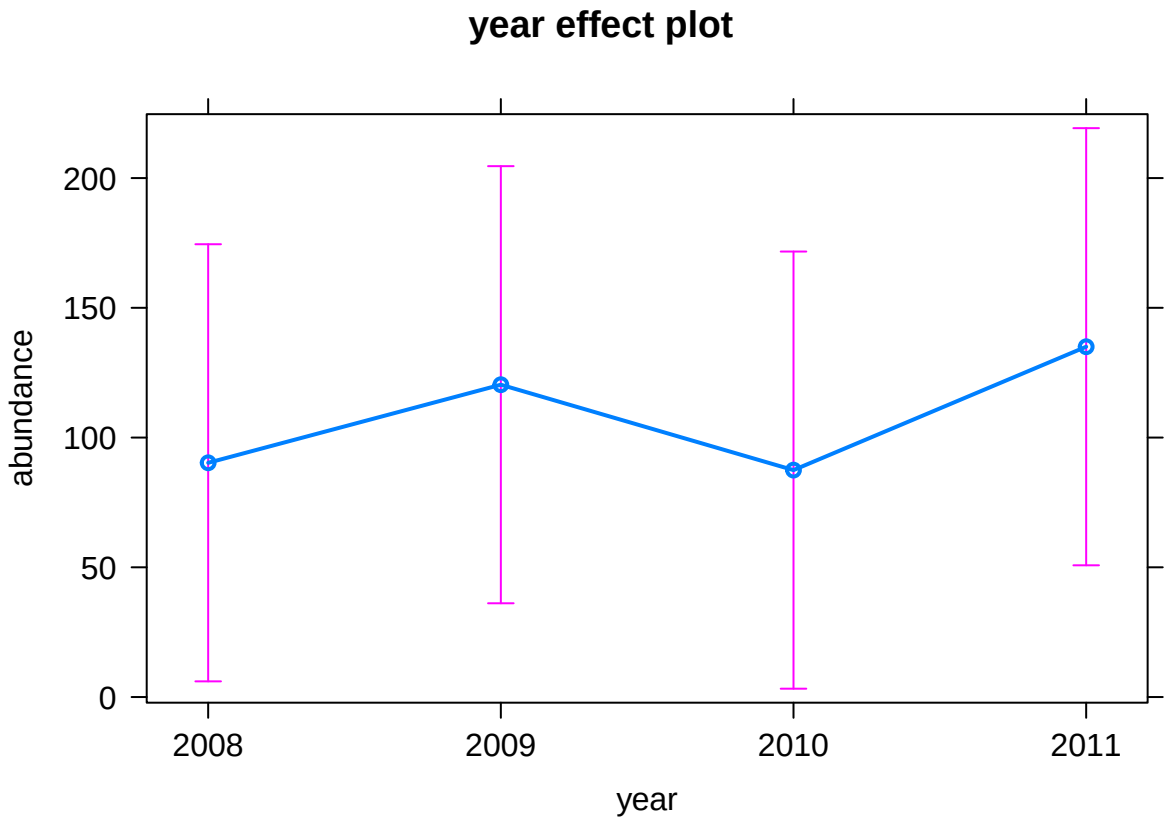

year effect plot
n_species
28
26
24
22
20
18
16
2008
2009
2010
2011
year


Posterior Predictive Check
Model−predicted lines should resemble observed da
Density
0.06
0.04
0.02
0.00
0
20
40
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?

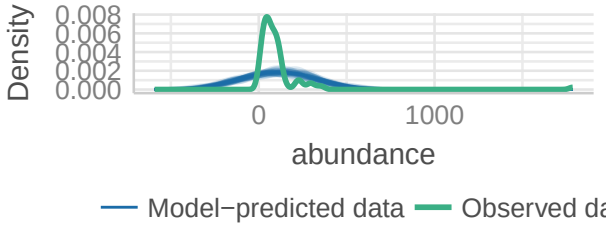



```
##
## Call:
## lm(formula = abundance ~ year, data = bet_sum)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -128.00  -71.34  -37.77    3.59 1651.00
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   90.273     42.355   2.131    0.036 *
## year2009      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

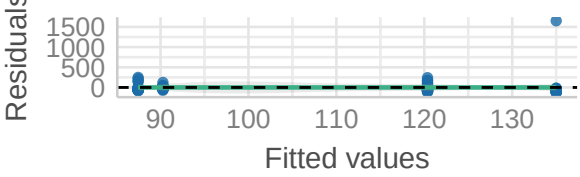
Posterior Predictive Check

Model−predicted lines should resemble observed da



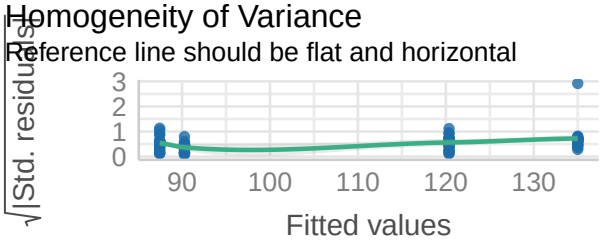
Linearity

Reference line should be flat and horizontal



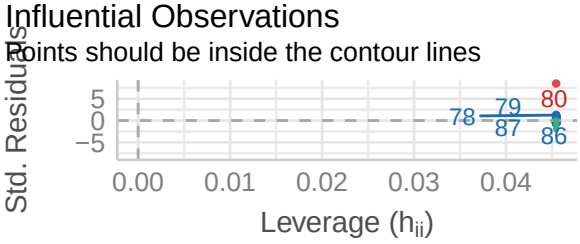
Homogeneity of Variance

Reference line should be flat and horizontal



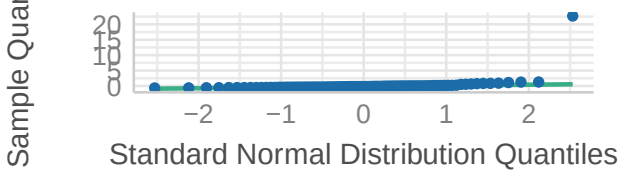
Influential Observations

Points should be inside the contour lines



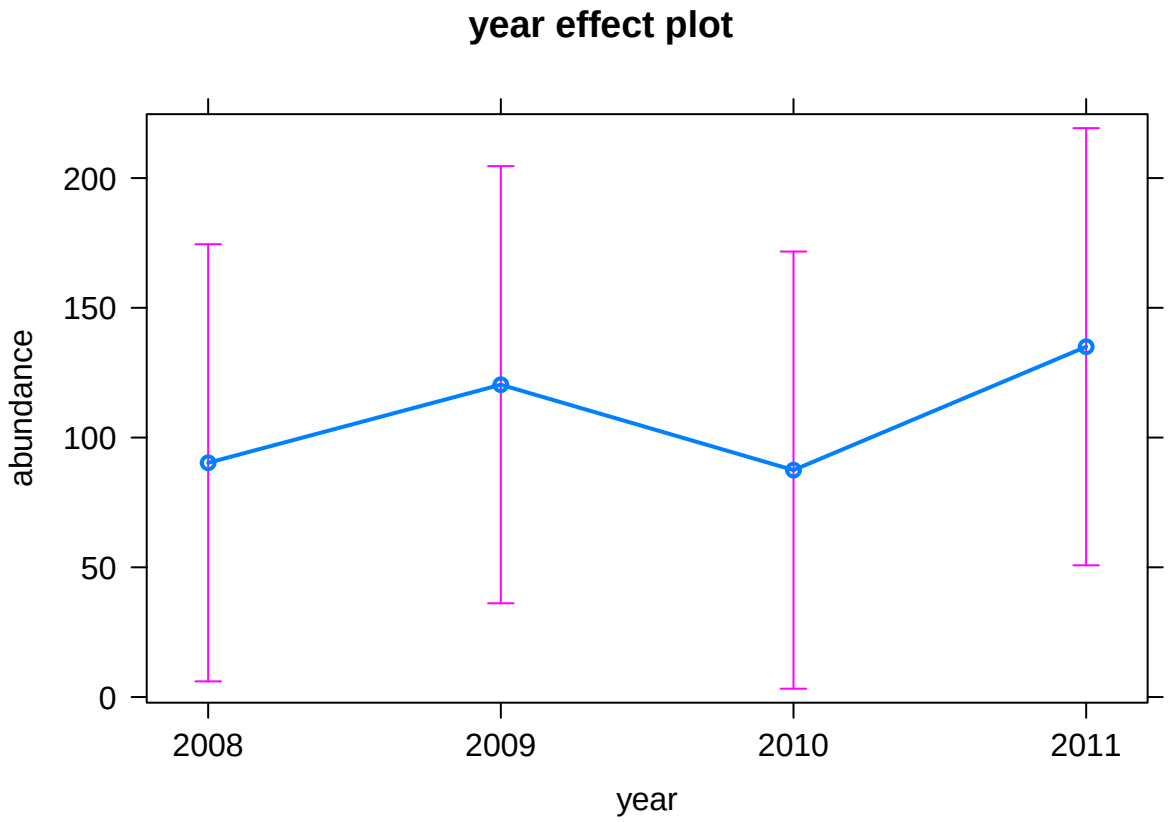
Normality of Residuals

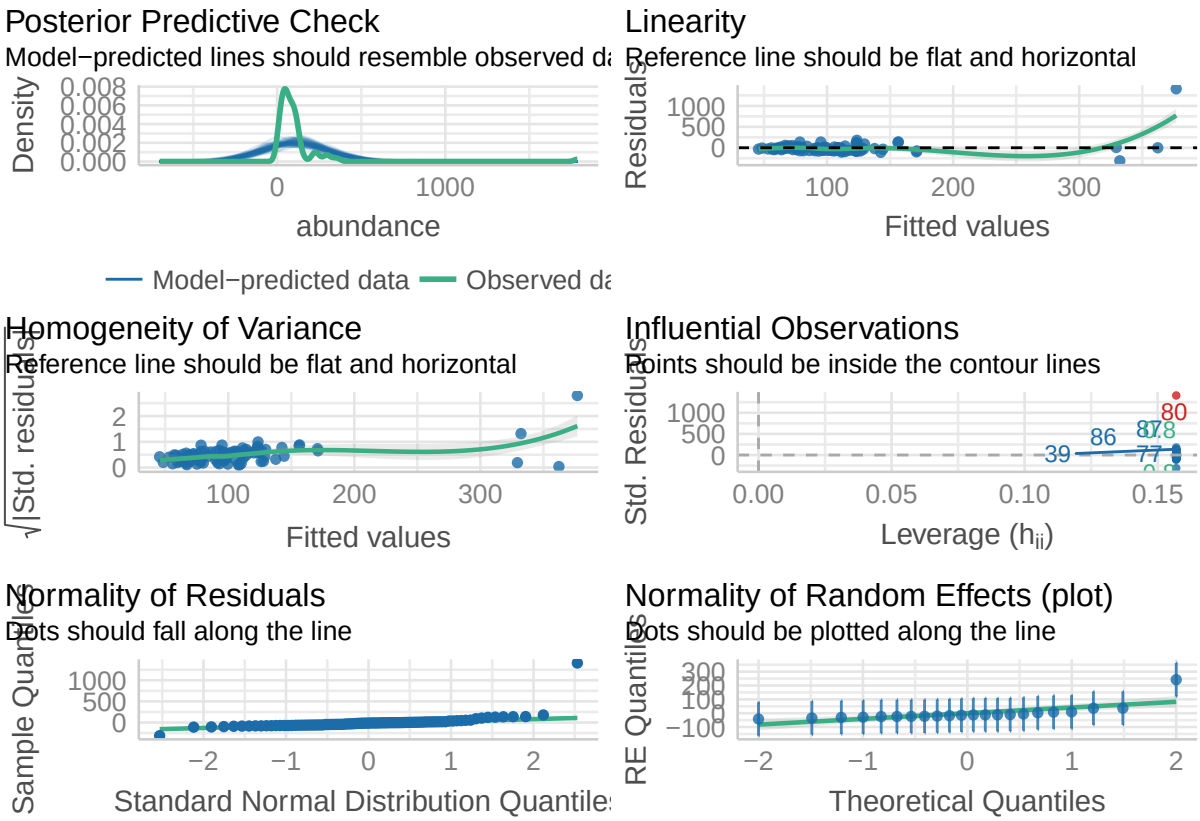
Dots should fall along the line



Mixed model with random = plot

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: abundance ~ year + (1 | plot)
##    Data: bet_sum
##
## REML criterion at convergence: 1136.3
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -1.7353 -0.3326 -0.0765  0.0601  7.8319
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  plot     (Intercept)  7098     84.25
##  Residual             32369    179.91
## Number of obs: 88, groups:  plot, 22
##
## Fixed effects:
##             Estimate Std. Error t value
## (Intercept)   90.273     42.355   2.131
## year2009      30.091     54.246   0.555
## year2010      -2.818     54.246  -0.052
## year2011      44.727     54.246   0.825
##
## Correlation of Fixed Effects:
##          (Intr) yr2009 yr2010
## year2009 -0.640
## year2010 -0.640  0.500
## year2011 -0.640  0.500  0.500
```


year effect plot
abundance
200
150
100
50
0
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
1000
500
0
100
200
300
Fitted values
Homogeneity of Variance
Reference line should be flat and horizontal
√|Std. residuals|
2
1
0
100
200
300
Fitted values
Influential Observations
Points should be inside the contour lines
Std. Residuals
1000
500
0
0.00
0.05
0.10
0.15
Leverage (hii)
80
86
39
77
Normality of Residuals
Dots should fall along the line
Sample Quantiles
1000
500
0
−2
−1
0
1
2
Standard Normal Distribution Quantiles
Normality of Random Effects (plot)
Dots should be plotted along the line
RE Quantiles
300
200
100
0
−100
−2
−1
0
1
2
Theoretical Quantiles