warmXtrophic Project: Flowering Duration Phenology Analyses

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Load in packages & data

```
# clear all existing data
rm(list=ls())

#Load packages
library(tidyverse)
library(ggplot2)
library(lme4)
library(lmerTest)
library(emmeans)
library(vegan)
library(car)
library(rstatix)
library(scales)
library(fitdistrplus)
library(moments)# for calculating skewness of data
library(ggpubr)
library(jtools) # summ() function
library(predictmeans)
library(olsrr)
library(car)
library(fitdistrplus)
library(ggpubr)
library(interactions)
library(sjPlot)
library(effects)
library(glmmTMB)
library(GGally) # ggpairs() function
library(bbmle) # AICtab() function

# Set working directory
Sys.getenv("L1DIR")
```

```
## [1] "/Volumes/GoogleDrive/Shared drives/SpaCE_Lab_warmXtrophic/data/L1"
```

```
L0_dir <- Sys.getenv("L0DIR")
L1_dir <- Sys.getenv("L1DIR")
L2_dir <- Sys.getenv("L2DIR")
```

```r
# Set ggplot2 plotting
# This code for ggplot2 sets the theme to mostly black and white
# (Arial font, and large font, base size=24)
theme_set(theme_bw(14))
theme_update(axis.text.x = element_text(size = 12, angle = 90),
             axis.text.y = element_text(size = 12))

# Read in data
flwr_species <- read.csv(file.path(L2_dir, "phenology/final_flwr_species_L2.csv")) # species level data
flwr_plot <- read.csv(file.path(L2_dir, "phenology/final_flwr_plot_L2.csv")) # plot level data
flwr_plot_origin <- read.csv(file.path(L2_dir, "phenology/final_flwr_plot_origin_L2.csv")) # plot level
flwr_plot_growthhabit <- read.csv(file.path(L2_dir, "phenology/final_flwr_plot_growthhabit_L2.csv")) #

# get rid of "X" column that shows up
# flwr_species$X <- NULL
# flwr_plot$X <- NULL
# flwr_plot_origin$X <- NULL
# flwr_plot_growthhabit$X <- NULL

# Order warmed and ambient so that warmed shows up first in plotting (and is default is red = warmed; b
flwr_species$state <- as.factor(flwr_species$state)
levels(flwr_species$state)
```

```
## [1] "ambient" "warmed"
```

```r
# [1] "ambient" "warmed"
flwr_species$state <- factor(flwr_species$state, levels(flwr_species$state)[c(2,1)])
levels(flwr_species$state)
```

```
## [1] "warmed"  "ambient"
```

```r
# [1] "warmed"  "ambient"

# again for plot level data
flwr_plot$state <- as.factor(flwr_plot$state)
levels(flwr_plot$state)
```

```
## [1] "ambient" "warmed"
```

```r
# [1] "ambient" "warmed"
flwr_plot$state <- factor(flwr_plot$state, levels(flwr_plot$state)[c(2,1)])
levels(flwr_plot$state)
```

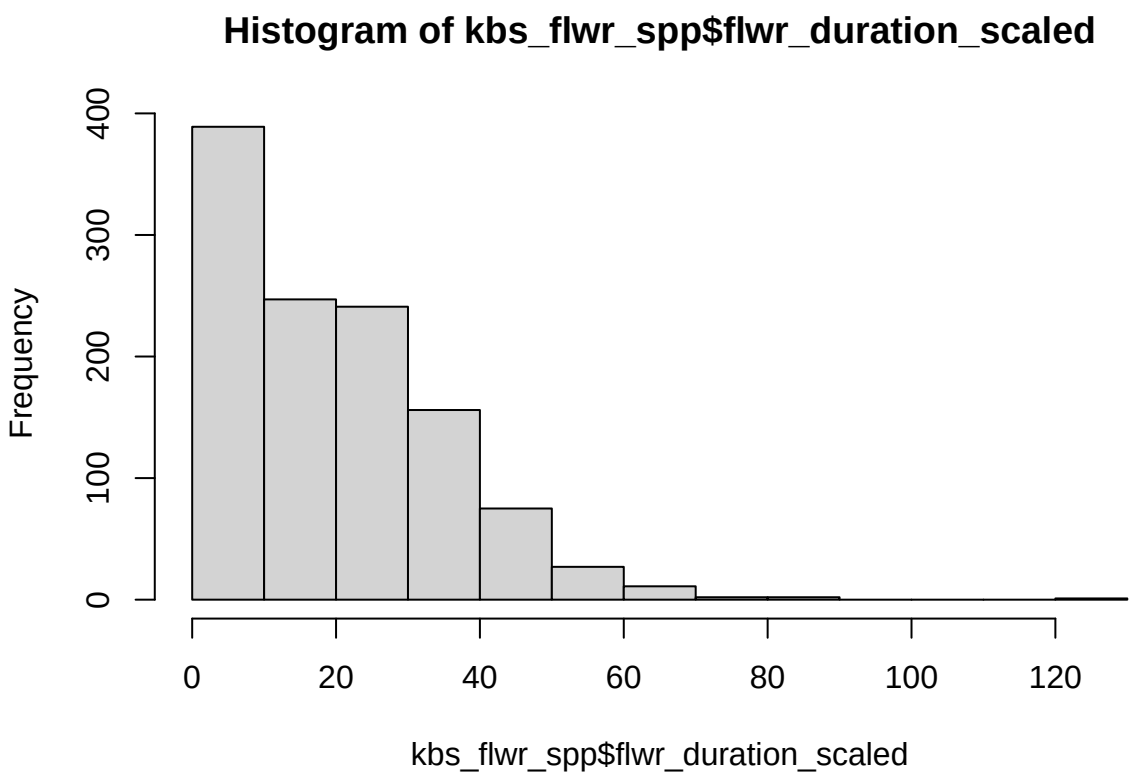
```
## [1] "warmed"  "ambient"
```

```r
# [1] "warmed"  "ambient"

flwr_species$flwr_duration <- as.numeric(as.character(flwr_species$flwr_duration))
flwr_plot$flwr_duration <- as.numeric(as.character(flwr_plot$flwr_duration))
flwr_plot_origin$flwr_duration <- as.numeric(as.character(flwr_plot_origin$flwr_duration))
```

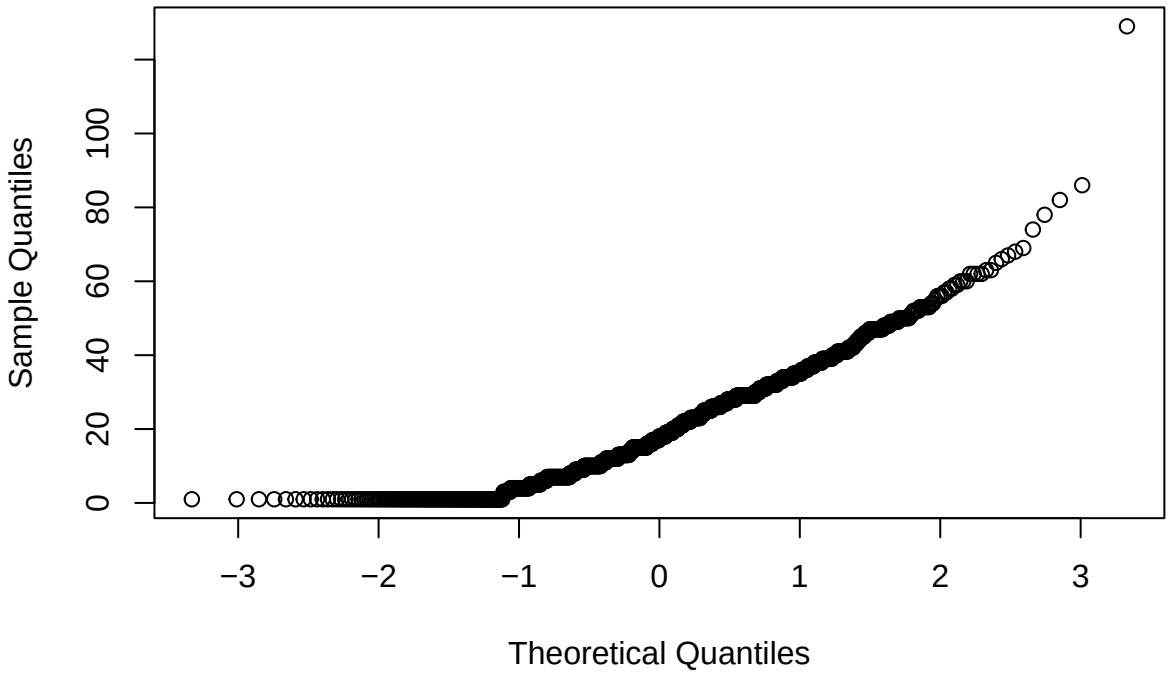
```r
flwr_plot_growthhabit$flwr_duration <- as.numeric(as.character(flwr_plot_growthhabit$flwr_duration))

# Kara's edits:
# adding 1 to each occurrence in the flwr_duration column so everything is scaled up the same & removes
flwr_plot$flwr_duration_scaled <- flwr_plot$flwr_duration+1
flwr_species$flwr_duration_scaled <- flwr_species$flwr_duration+1
flwr_plot_origin$flwr_duration_scaled <- flwr_plot_origin$flwr_duration+1
flwr_plot_growthhabit$flwr_duration_scaled <- flwr_plot_growthhabit$flwr_duration+1

umbs_flwr_plot <- subset(flwr_plot, site == "umbs") # pull out umbs only data at plot level
umbs_flwr_spp <- subset(flwr_species, site == "umbs") # pull out umbs only data at species level
kbs_flwr_plot <- subset(flwr_plot, site == "kbs") # pull out kbs only data at plot level
kbs_flwr_spp <- subset(flwr_species, site == "kbs") # pull out kbs only data at species level
kbs_flwr_plot_origin <- subset(flwr_plot_origin, site == "kbs")
kbs_flwr_plot_growthhabit <- subset(flwr_plot_growthhabit, site == "kbs")
umbs_flwr_plot_origin <- subset(flwr_plot_origin, site == "umbs")
umbs_flwr_plot_growthhabit <- subset(flwr_plot_growthhabit, site == "umbs")
```

KBS SPECIES LEVEL - Looking at DURATION of flowering

```r
### KBS ###
hist(kbs_flwr_spp$flwr_duration_scaled)
```



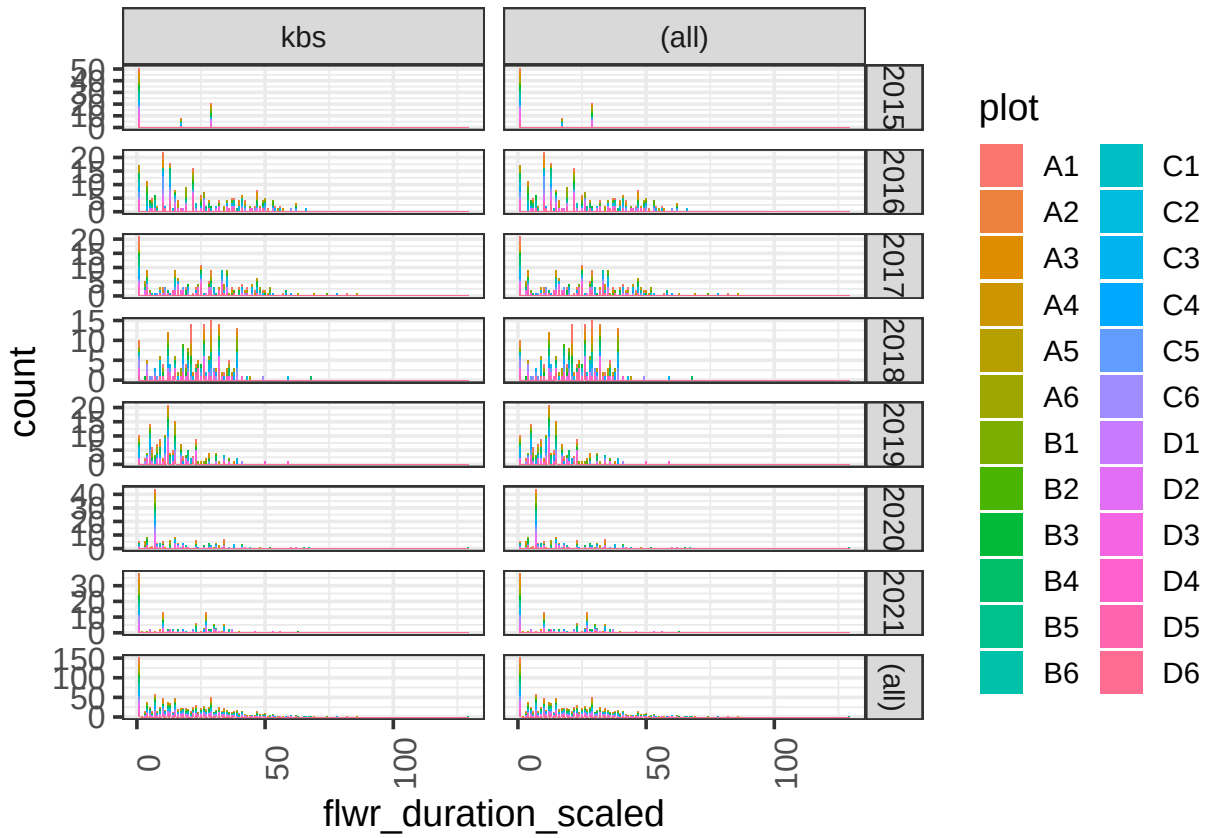

```r
qqnorm(kbs_flwr_spp$flwr_duration_scaled)
```



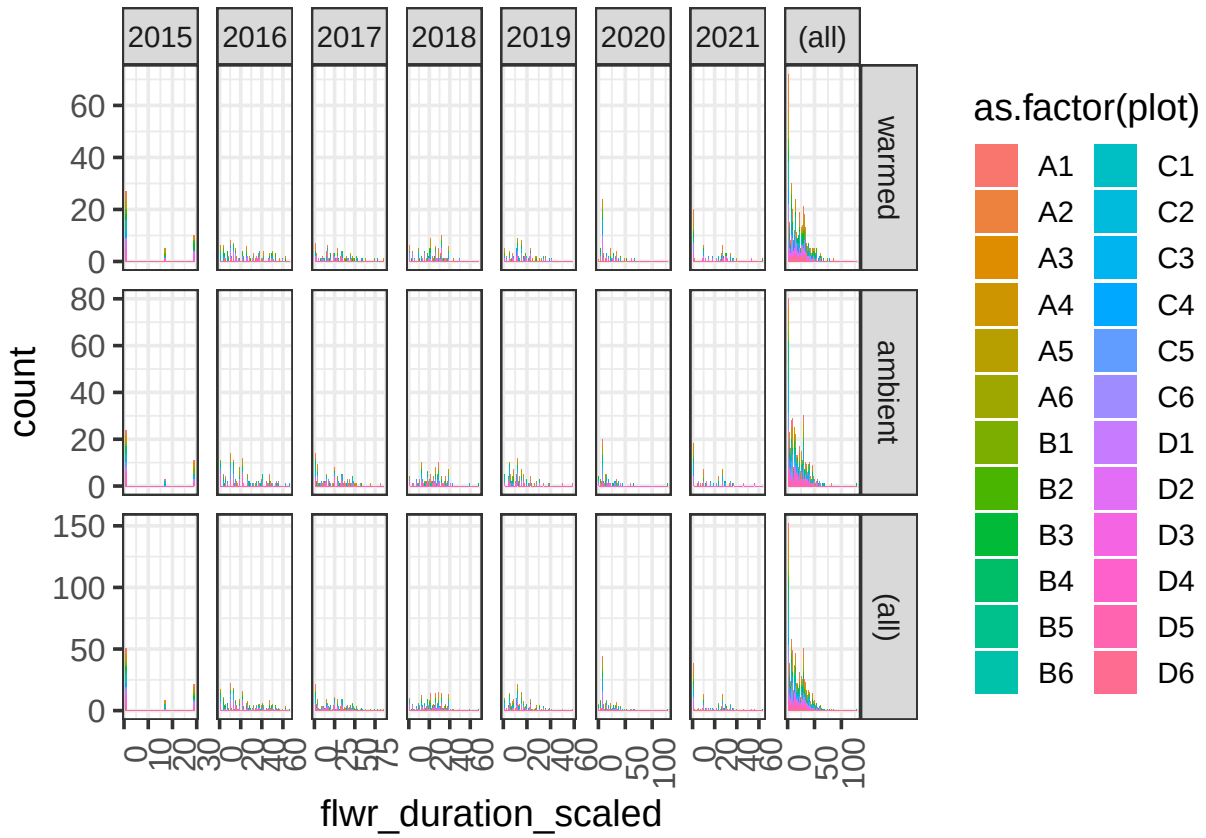

```
shapiro.test(kbs_flwr_spp$flwr_duration_scaled) # pvalue is < 0.05 so we reject the null hypothesis tha
```

```
##
##  Shapiro-Wilk normality test
##
## data:  kbs_flwr_spp$flwr_duration_scaled
## W = 0.92583, p-value < 2.2e-16
```

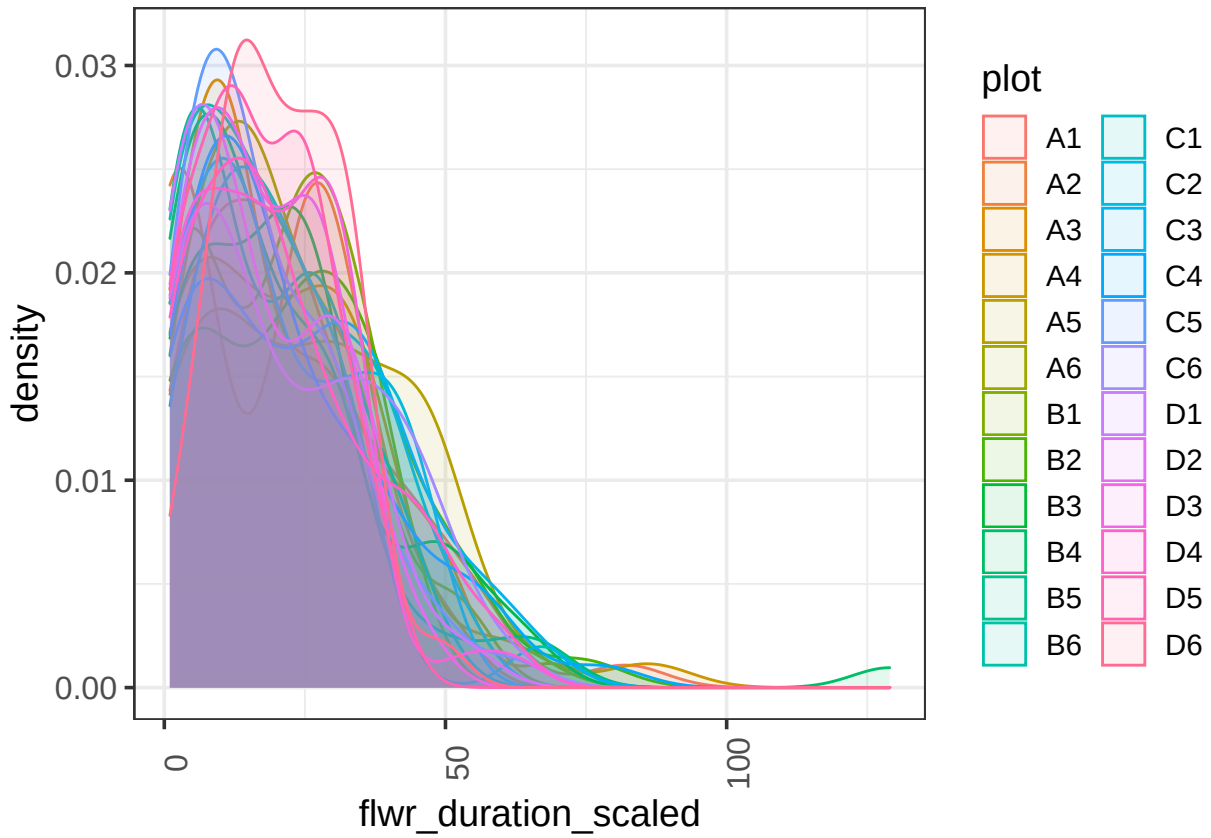
```
# Visualizing median Julian date for umbs at the PLOT LEVEL
ggplot(kbs_flwr_spp, aes(flwr_duration_scaled, fill = plot)) +
        geom_histogram(binwidth = 0.5) +
        facet_grid(year ~ site, margins = TRUE, scales = "free")
```



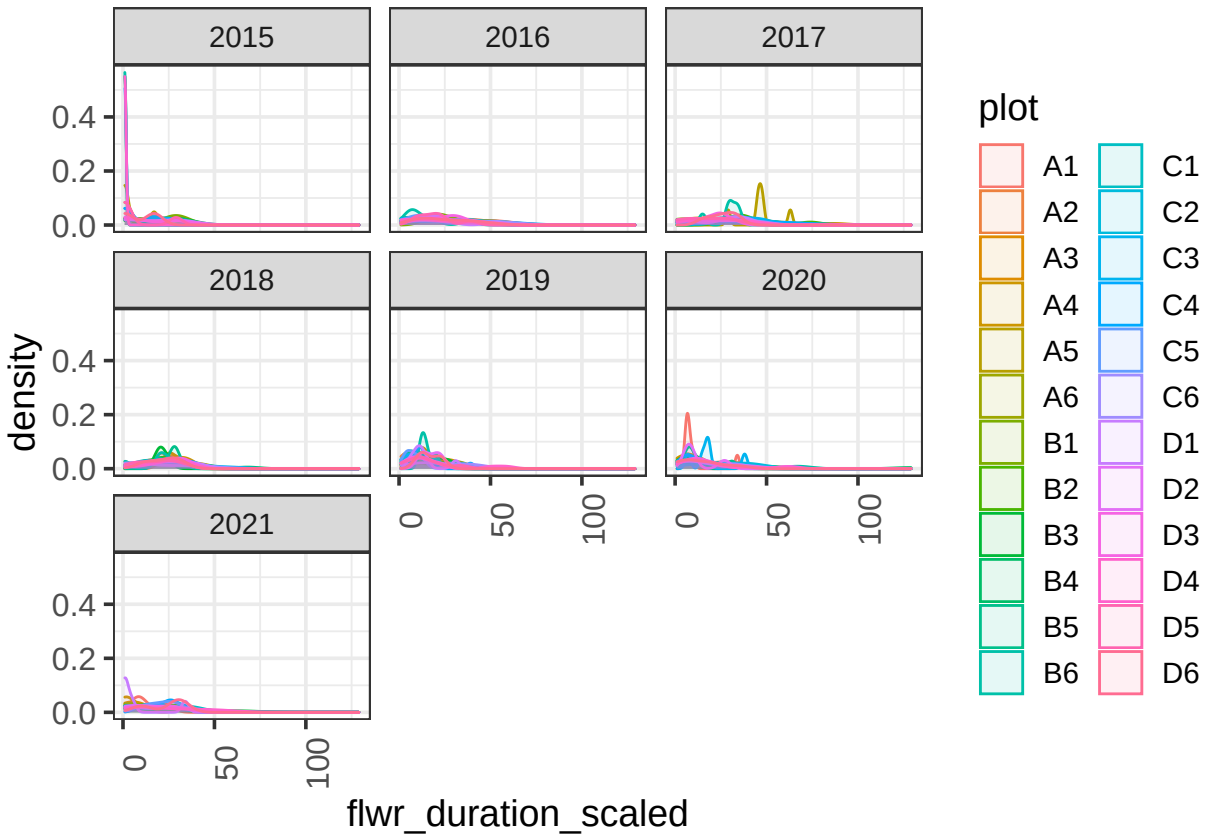

```
ggplot(kbs_flwr_spp, aes(flwr_duration_scaled, fill = as.factor(plot))) + geom_histogram(binwidth = 0.5)
        facet_grid(state~year, margins = TRUE, scales = "free")
```



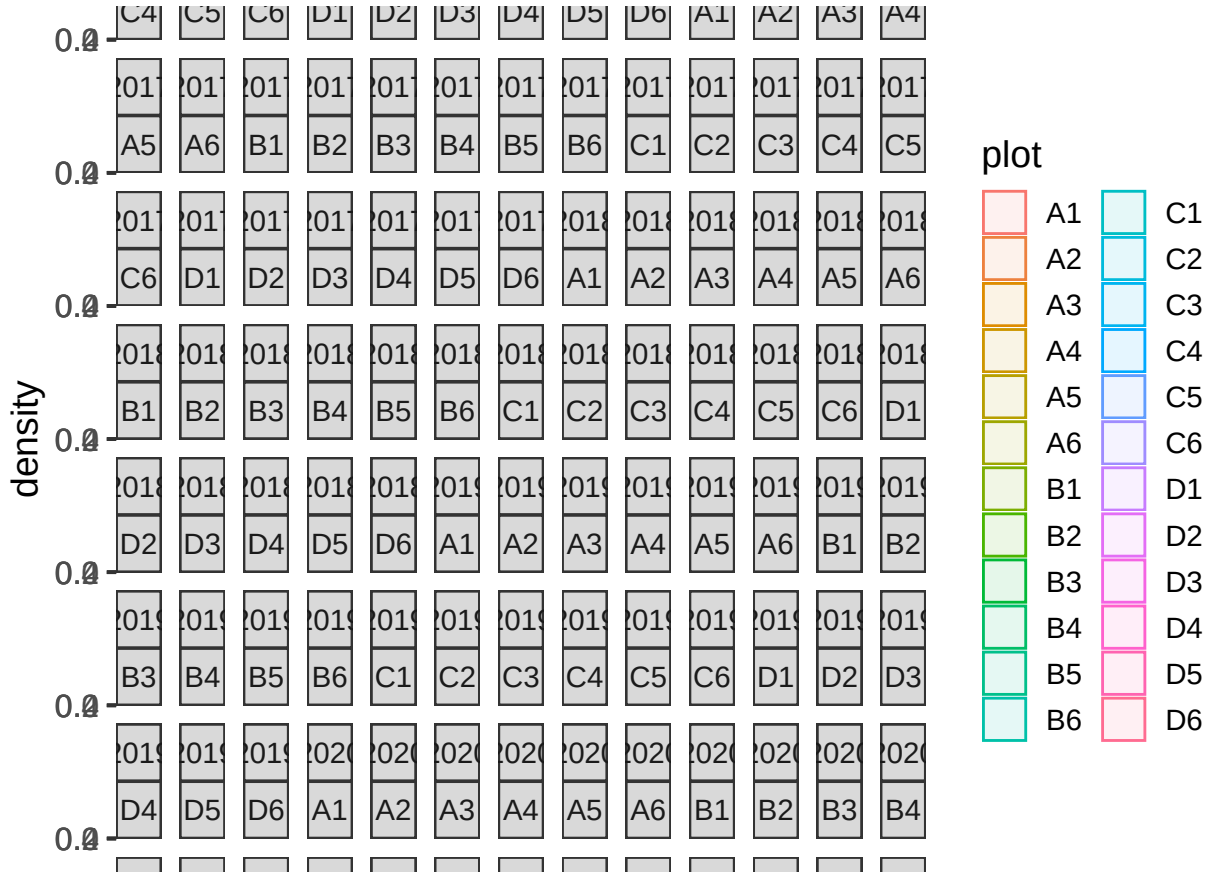

```
ggplot(kbs_flwr_spp, aes(flwr_duration_scaled, fill = plot, color=plot)) +
        geom_density(alpha = 0.1)
```



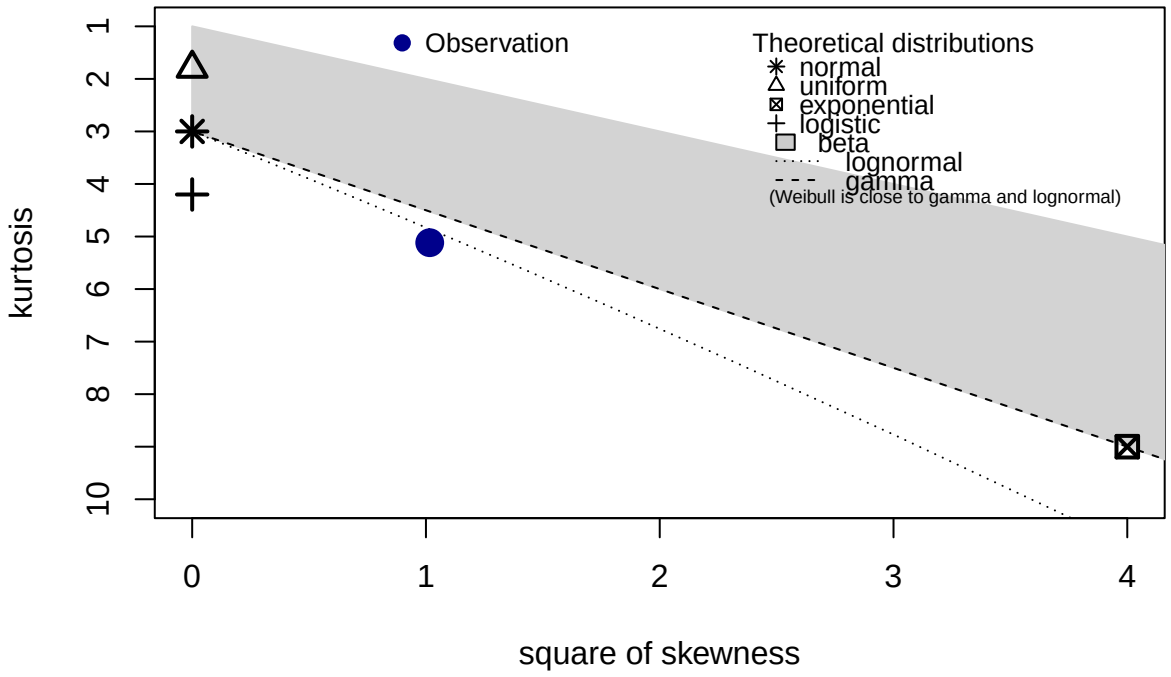

```
ggplot(kbs_flwr_spp, aes(flwr_duration_scaled, fill = plot, color=plot)) +
        geom_density(alpha = 0.1) +
        facet_wrap(~year)
```




```
ggplot(kbs_flwr_spp, aes(flwr_duration_scaled, fill = plot, color=plot)) +
        geom_density(alpha = 0.1) +
        facet_wrap(~year + plot)
```

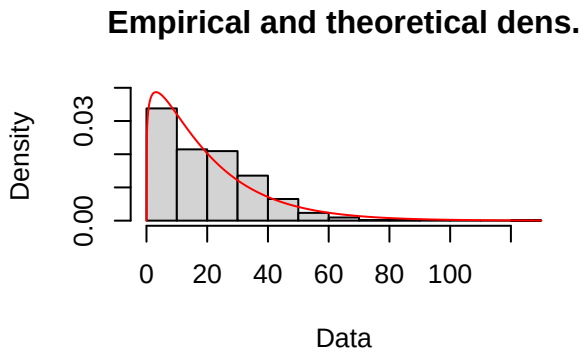


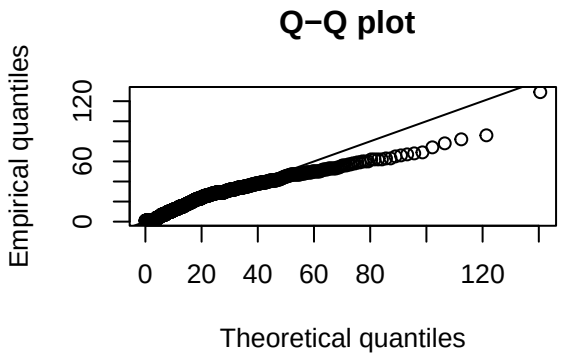

```
# Exploring distributions for these right-skewed data:
descdist(kbs_flwr_spp$flwr_duration_scaled, discrete = FALSE)
```

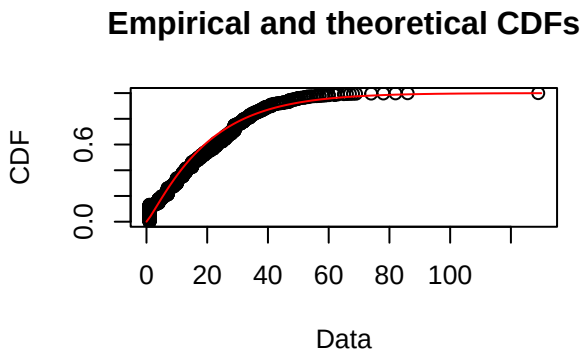


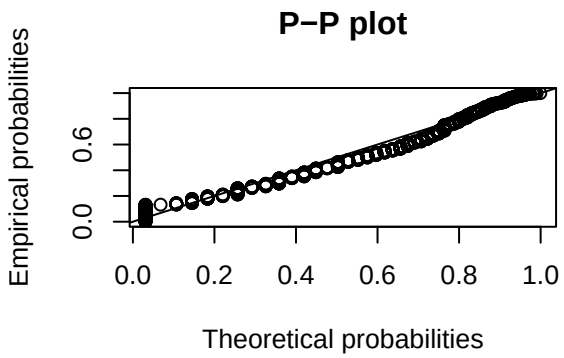

```
## summary statistics
## ------
## min:  1   max:  129
## median:  18
## mean:  20.20938
## estimated sd:  15.62808
## estimated skewness:  1.008056
## estimated kurtosis:  5.117459
```

```
# Gamma distribution
fit.gamma <- fitdist(kbs_flwr_spp$flwr_duration_scaled, "gamma")
plot(fit.gamma)
```

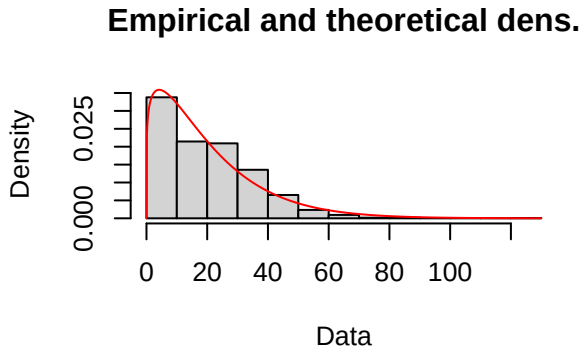


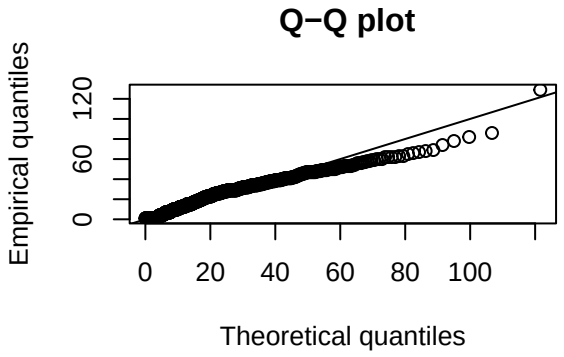


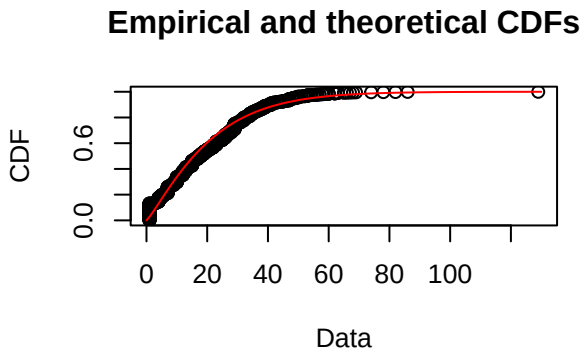


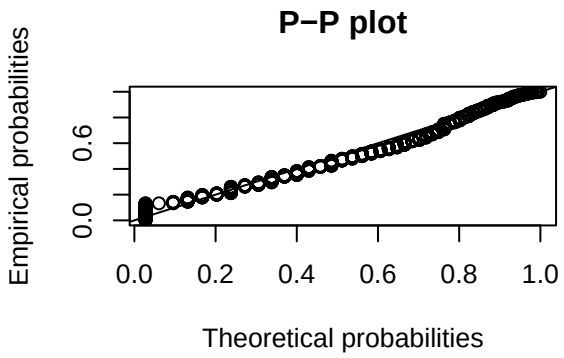



```
# Weibull distribution
fit.weibull  <- fitdist(kbs_flwr_spp$flwr_duration_scaled, "weibull")
plot(fit.weibull)
```

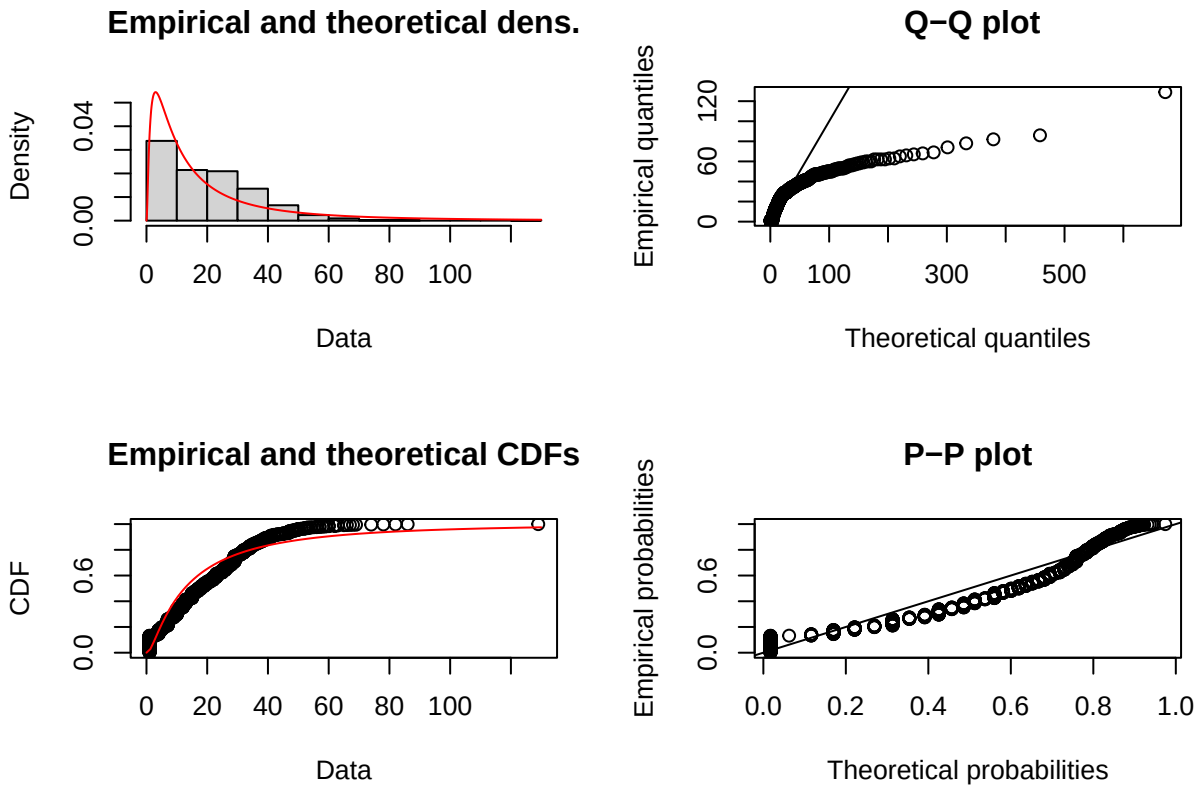




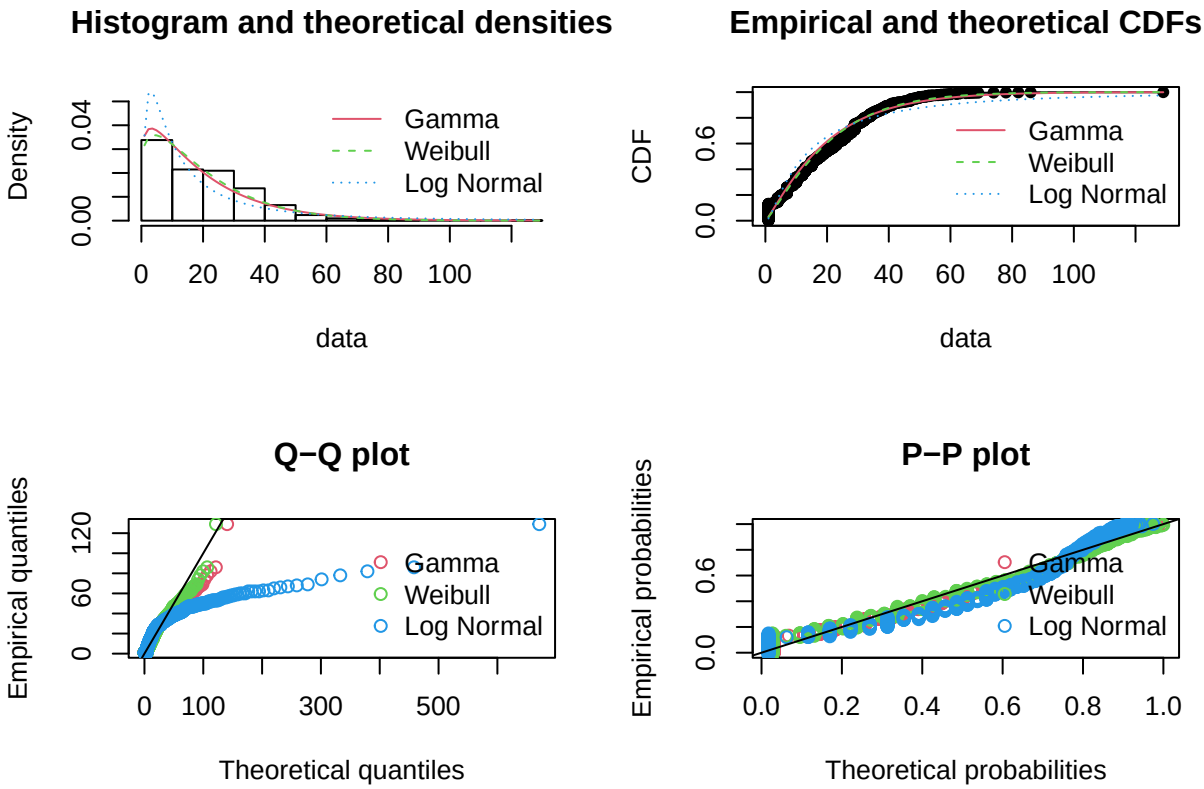




```
# Lognormal distribution
fit.ln <- fitdist(kbs_flwr_spp$flwr_duration_scaled, "lnorm")
plot(fit.ln)
```




```
par(mfrow=c(2,2))
plot.legend <- c("Gamma", "Weibull", "Log Normal")
denscomp(list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
cdfcomp (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
qqcomp  (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
ppcomp  (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
```



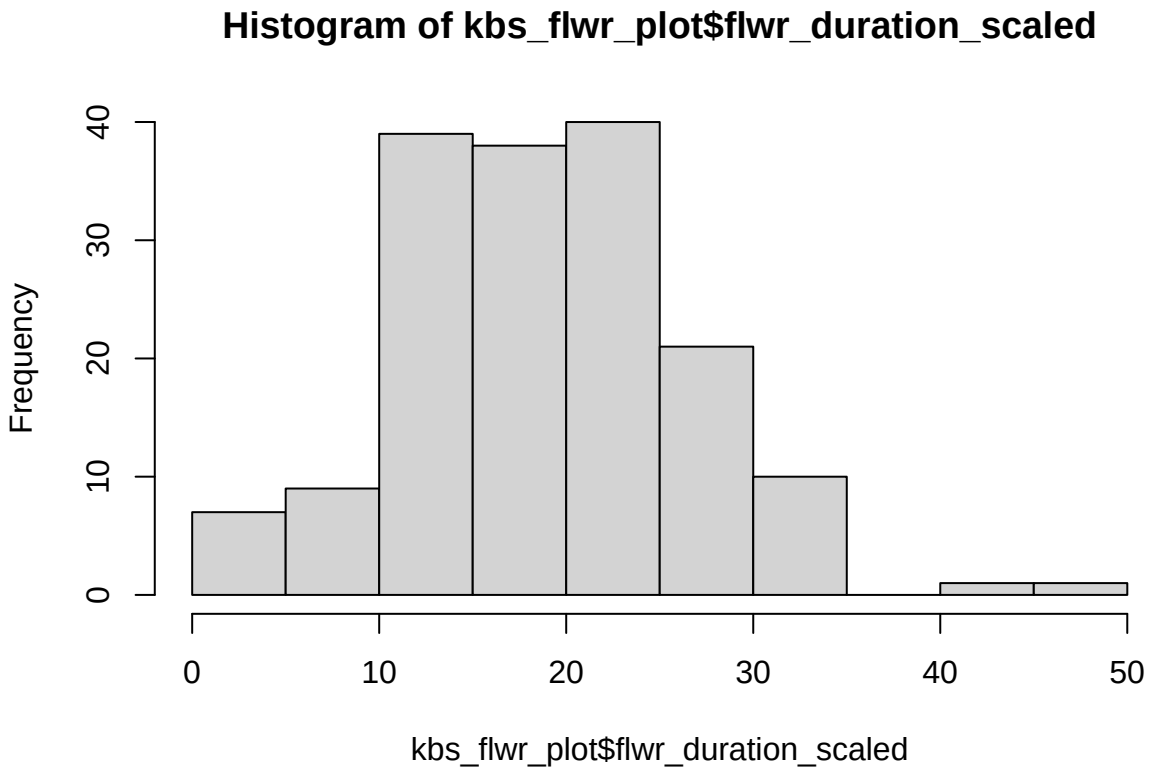

```
# Goodness of fit comparisons across fits (can't include the log normal bc it becomes diff response val
gofstat(list(fit.gamma, fit.weibull, fit.ln), fitnames = c("Gamma", "Weibull", "Log Normal"))
```

```
## Goodness-of-fit statistics
##                                 Gamma    Weibull Log Normal
## Kolmogorov-Smirnov statistic  0.1012177  0.1047727  0.1360167
## Cramer-von Mises statistic    2.5633225  1.9099784  7.3586400
## Anderson-Darling statistic   19.9451679 17.9655150 52.0510035
##
## Goodness-of-fit criteria
##                                 Gamma  Weibull Log Normal
## Akaike's Information Criterion 9206.583 9185.581   9500.254
## Bayesian Information Criterion 9216.680 9195.678   9510.350
```

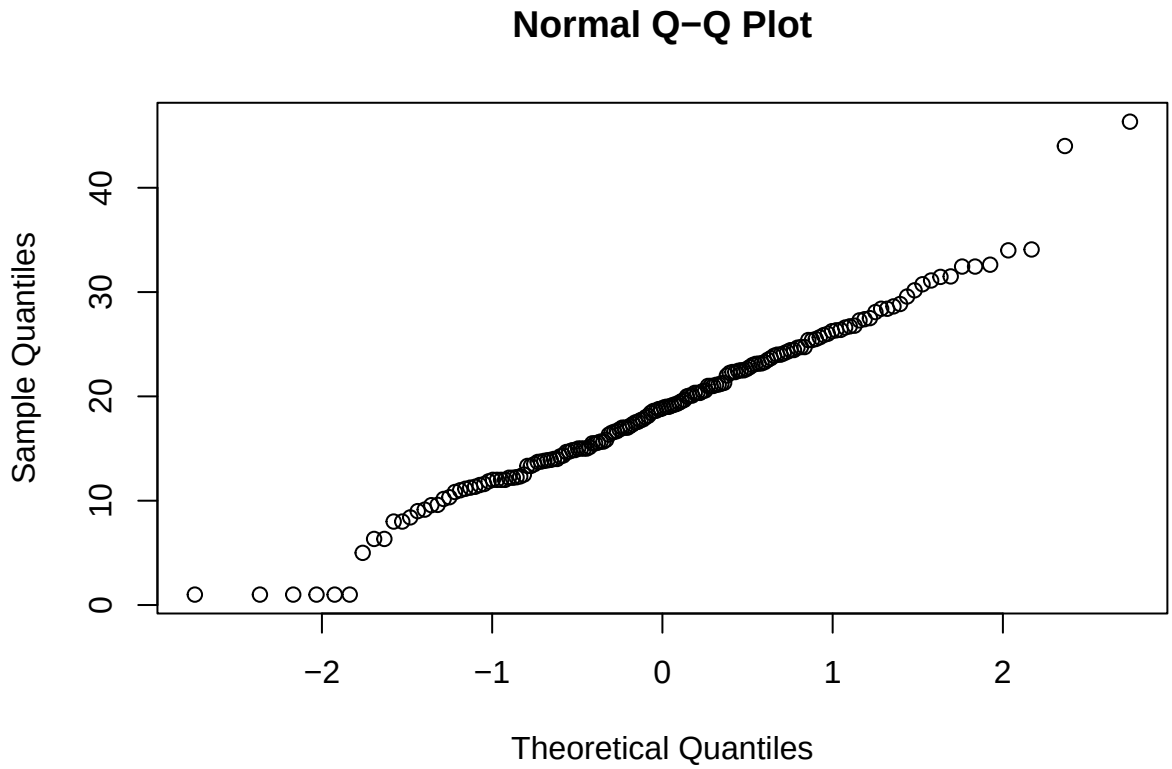
```
# weibull best fit, probably going to go with log transformation
```

KBS PLOT LEVEL - Looking at DURATION of flowering

```
### KBS ###
hist(kbs_flwr_plot$flwr_duration_scaled)
```



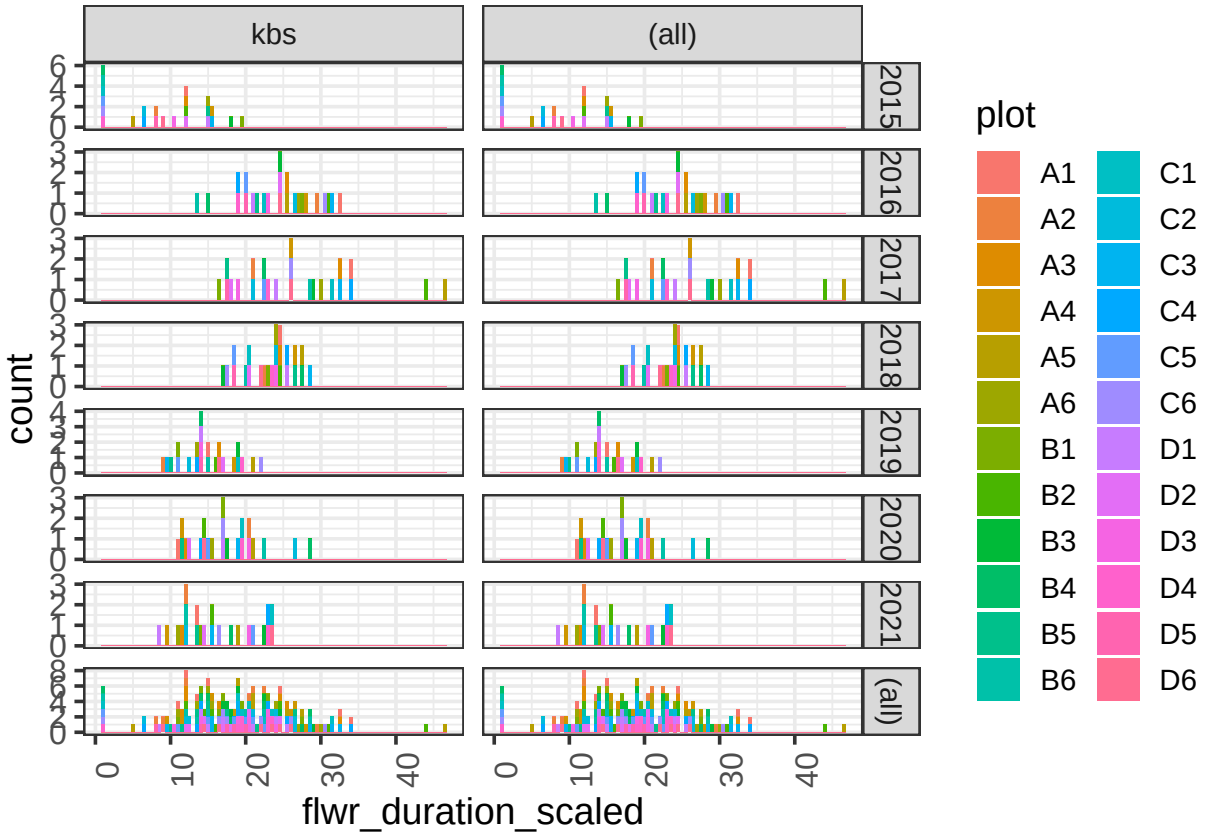

```
qqnorm(kbs_flwr_plot$flwr_duration_scaled)
```



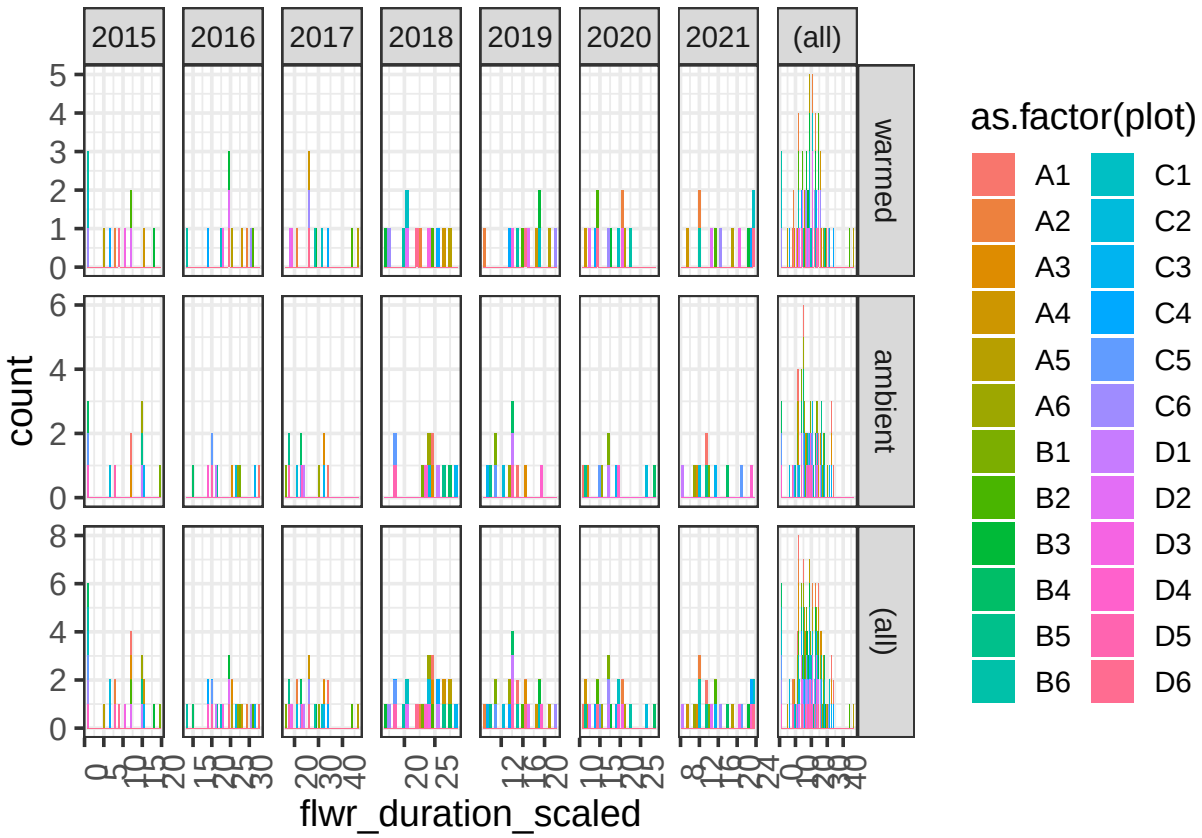
```
shapiro.test(kbs_flwr_plot$flwr_duration_scaled) # pvalue is > 0.05 so we do not reject the null hypoth
```

```
##
##  Shapiro-Wilk normality test
##
## data:  kbs_flwr_plot$flwr_duration_scaled
## W = 0.98388, p-value = 0.05128
```

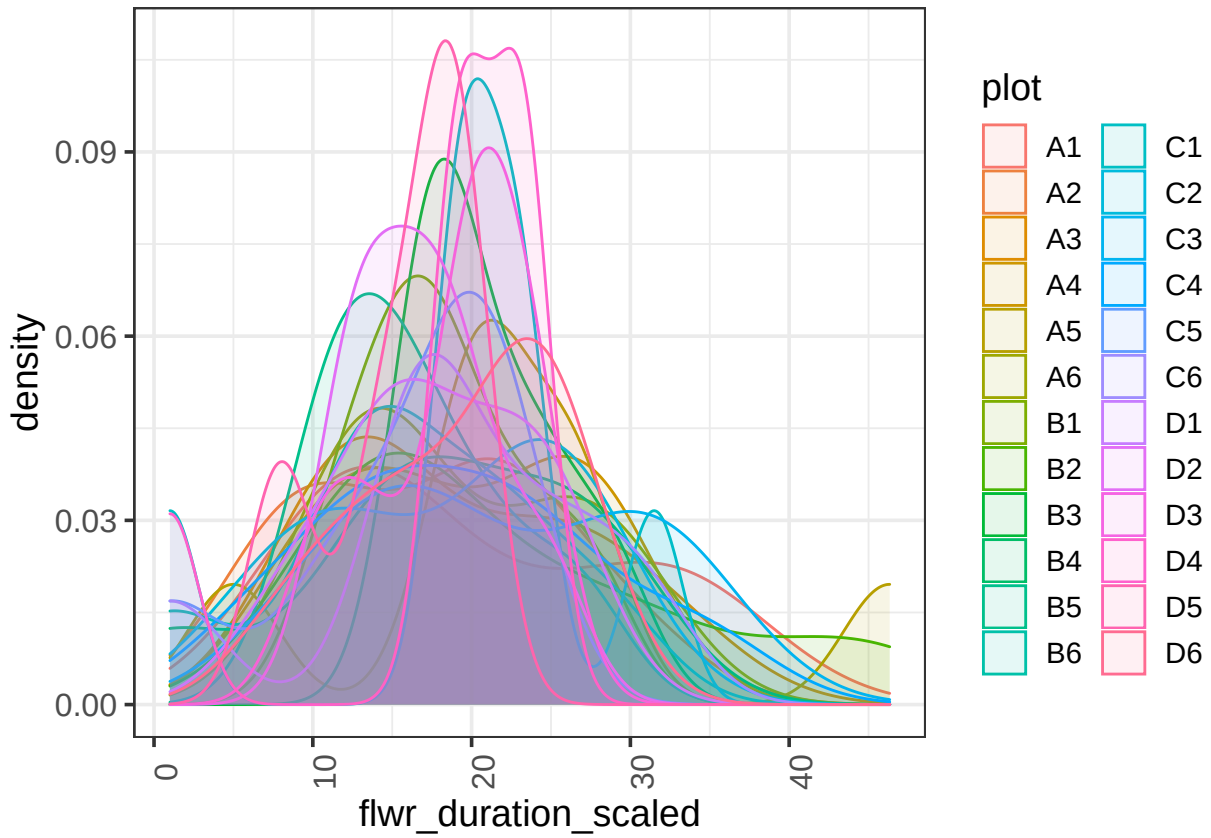
```
# Visualizing median Julian date for umbs at the PLOT LEVEL
ggplot(kbs_flwr_plot, aes(flwr_duration_scaled, fill = plot)) +
        geom_histogram(binwidth = 0.5) +
        facet_grid(year ~ site, margins = TRUE, scales = "free")
```



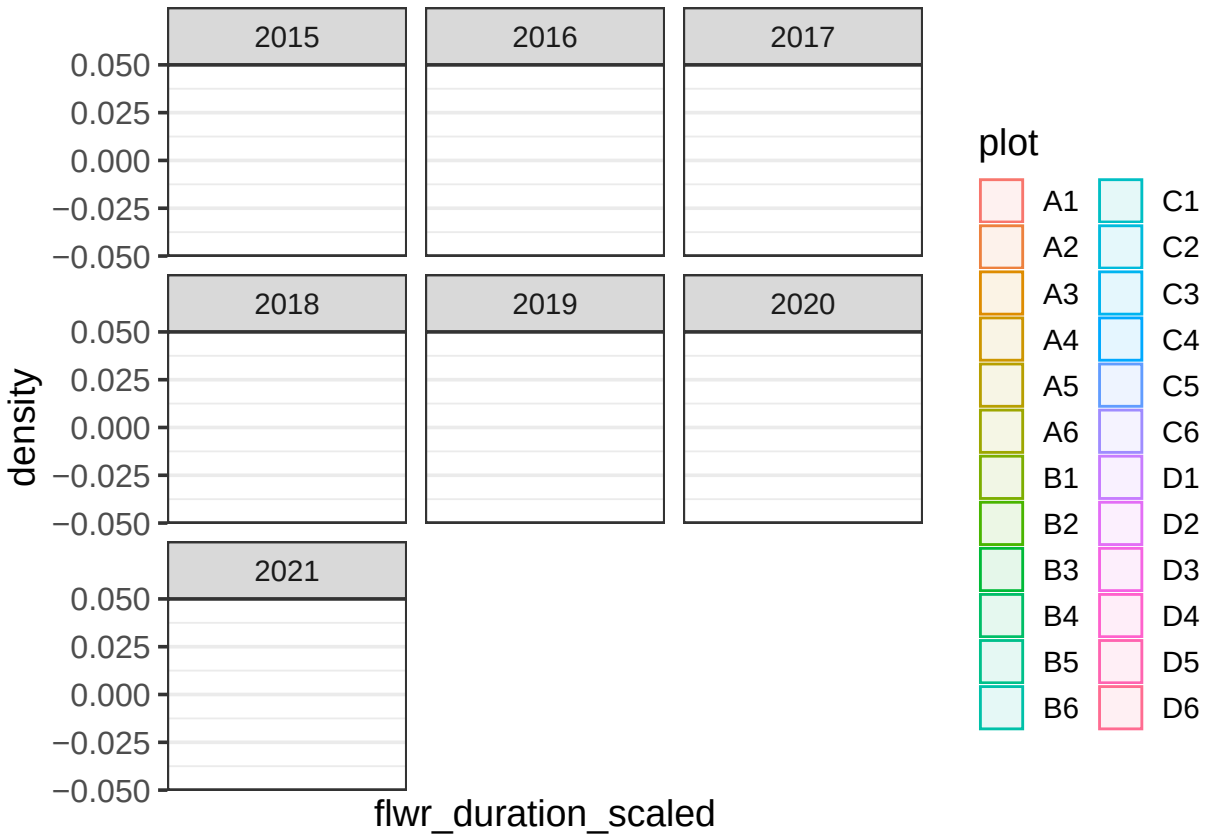

```
ggplot(kbs_flwr_plot, aes(flwr_duration_scaled, fill = as.factor(plot))) + geom_histogram(binwidth = 0.5
        facet_grid(state~year, margins = TRUE, scales = "free")
```



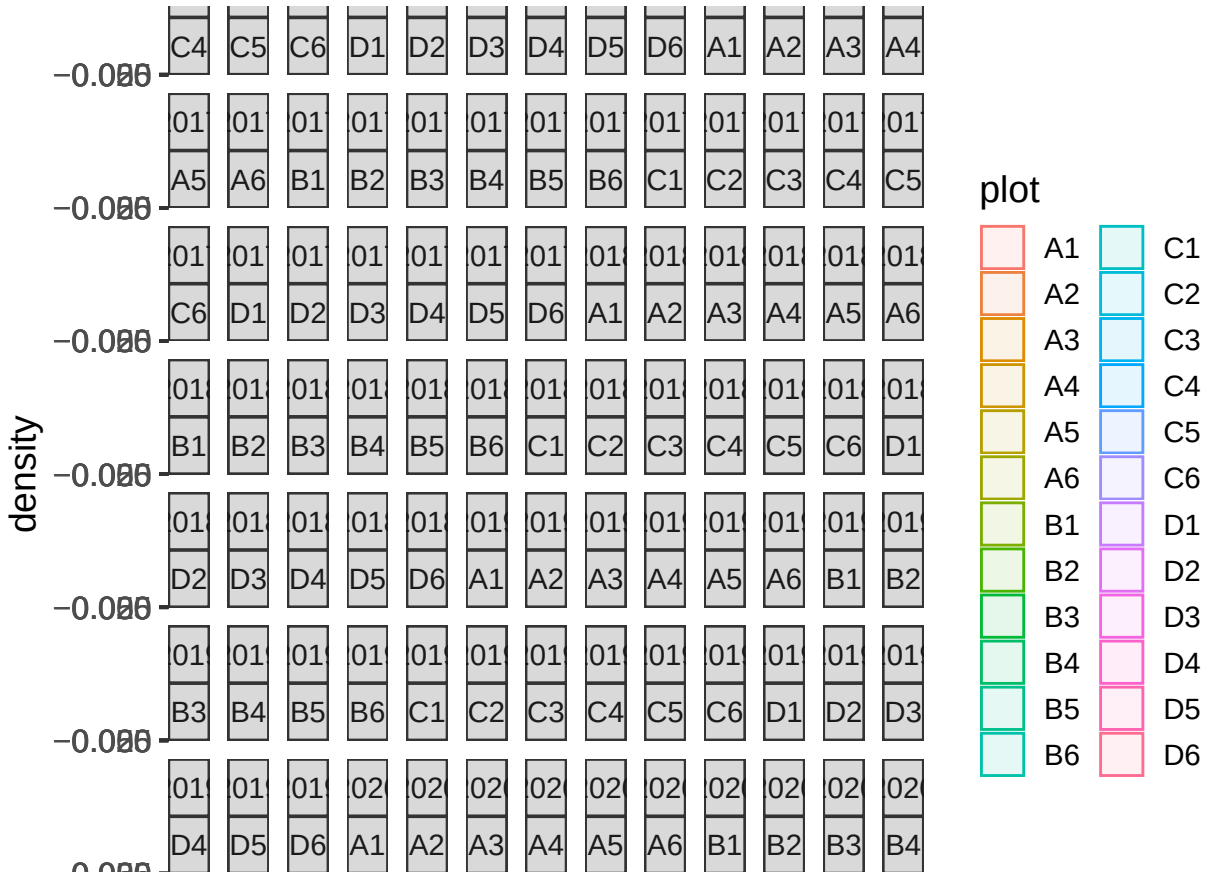

```
ggplot(kbs_flwr_plot, aes(flwr_duration_scaled, fill = plot, color=plot)) +
        geom_density(alpha = 0.1)
```



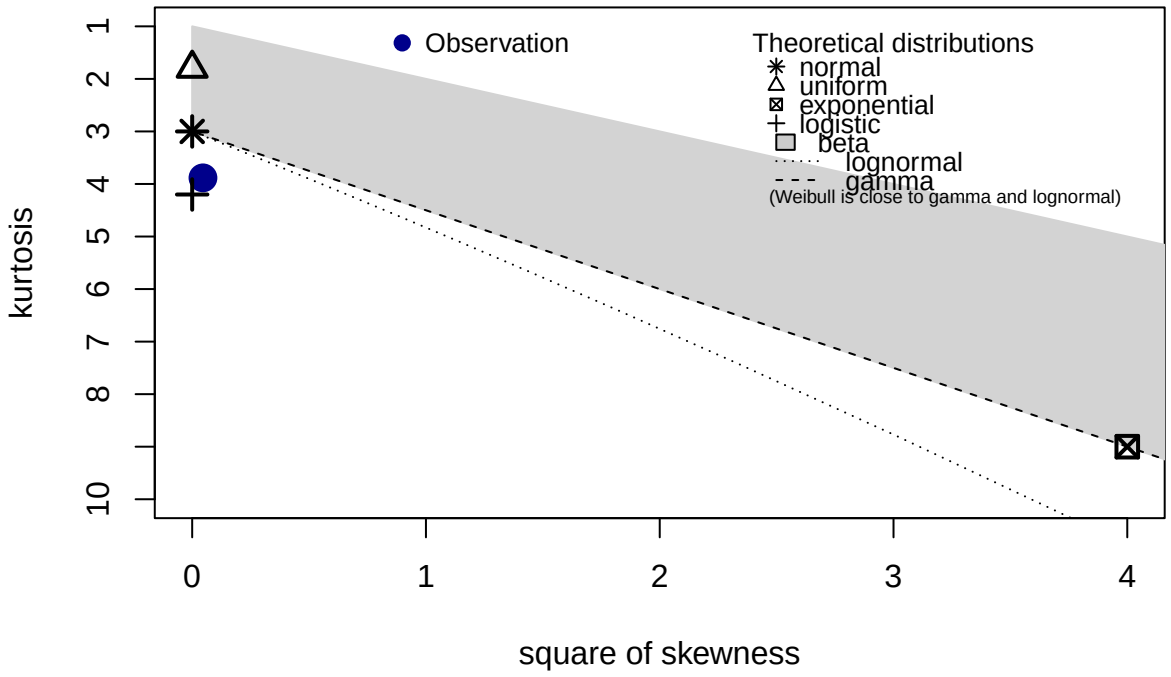

```
ggplot(kbs_flwr_plot, aes(flwr_duration_scaled, fill = plot, color=plot)) +
        geom_density(alpha = 0.1) +
        facet_wrap(~year)
```




```
ggplot(kbs_flwr_plot, aes(flwr_duration_scaled, fill = plot, color=plot)) +
        geom_density(alpha = 0.1) +
        facet_wrap(~year + plot)
```

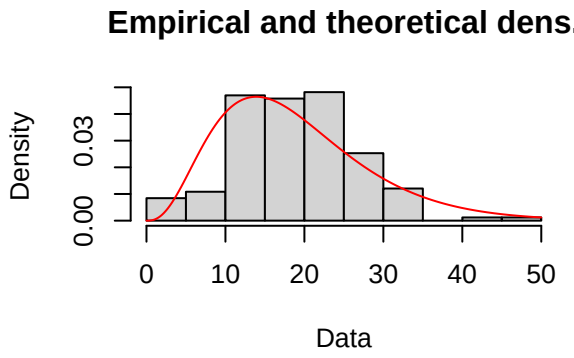


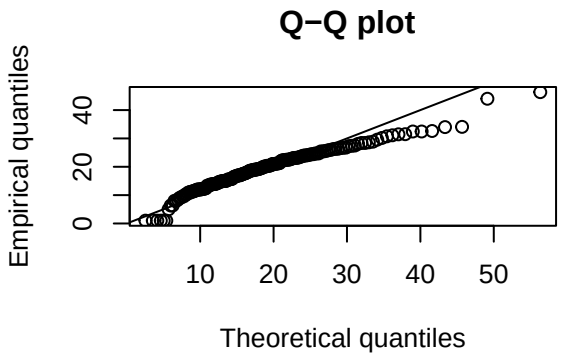

```
# Exploring distributions for these data:
descdist(kbs_flwr_plot$flwr_duration_scaled, discrete = FALSE)
```

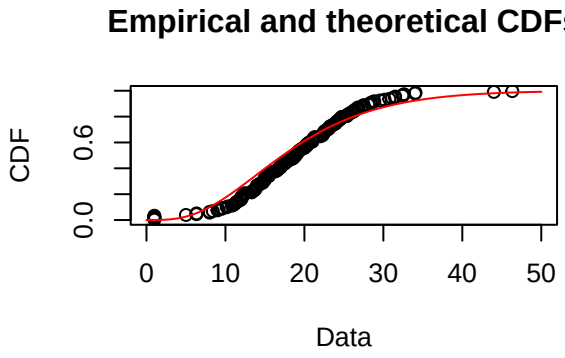


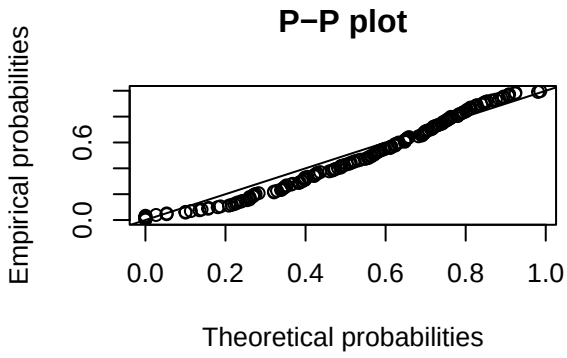

```
## summary statistics
## ------
## min:  1   max:  46.33333
## median:  18.86429
## mean:  18.89765
## estimated sd:  7.73299
## estimated skewness:  0.2148509
## estimated kurtosis:  3.883797
```

```
# Gamma distribution
fit.gamma <- fitdist(kbs_flwr_plot$flwr_duration_scaled, "gamma")
plot(fit.gamma)
```

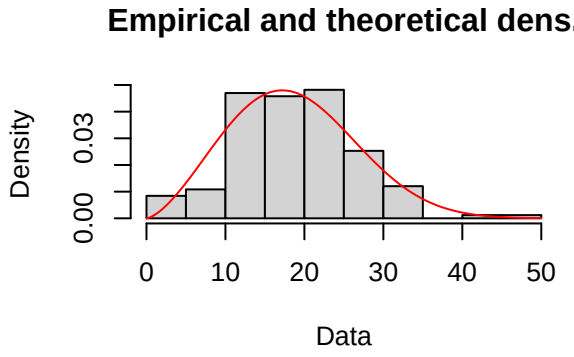


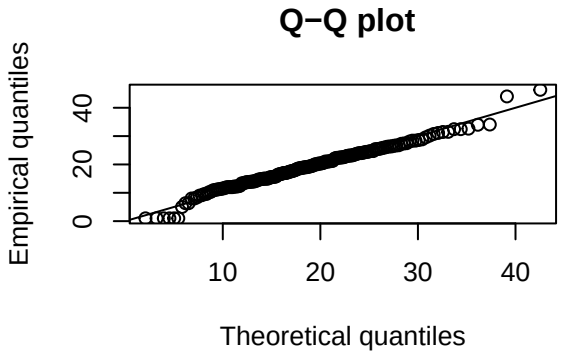


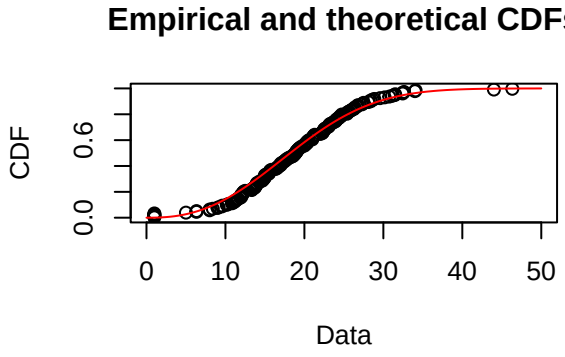


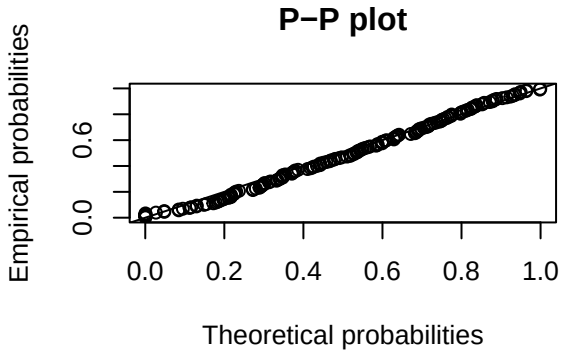



```
# Weibull distribution
fit.weibull  <- fitdist(kbs_flwr_plot$flwr_duration_scaled, "weibull")
plot(fit.weibull)
```

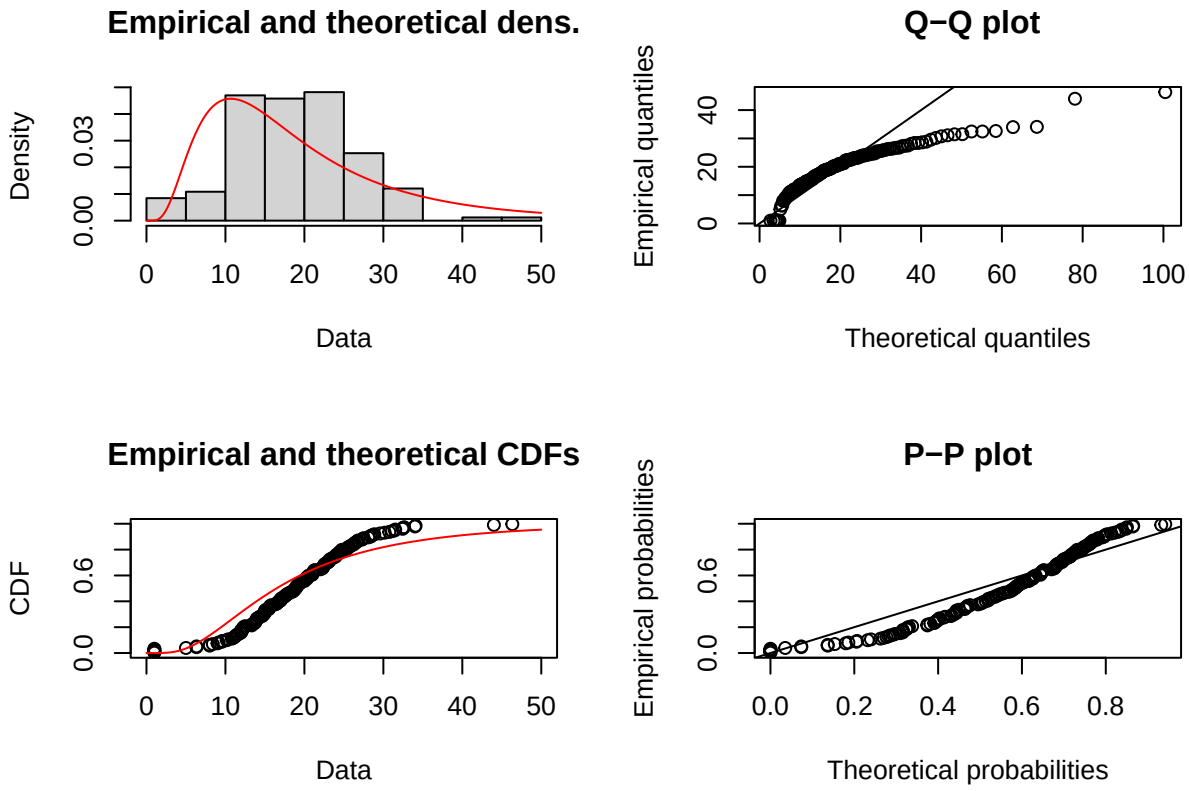




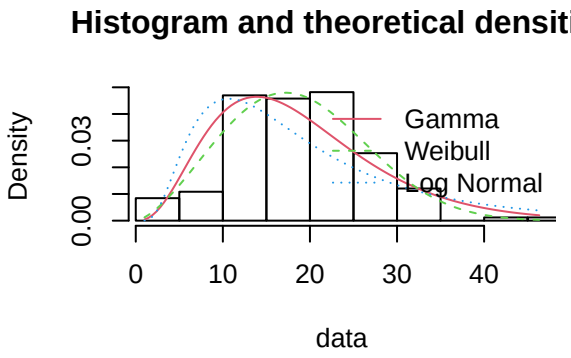


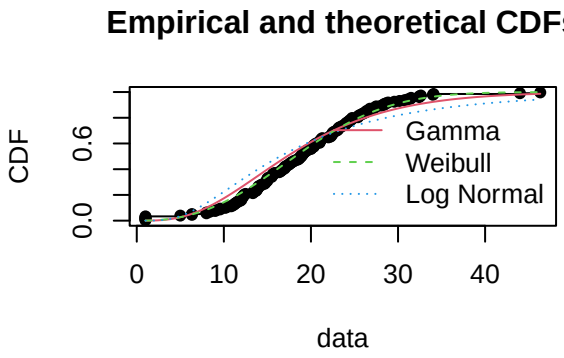


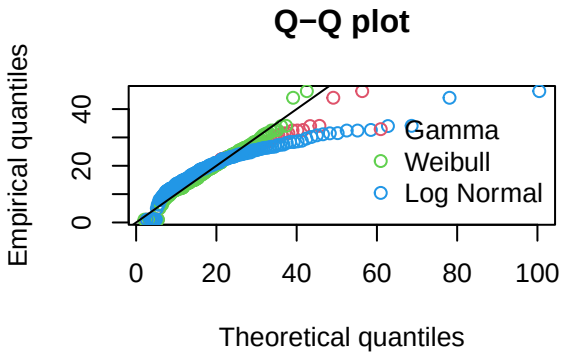
```
# Lognormal distribution
fit.ln <- fitdist(kbs_flwr_plot$flwr_duration_scaled, "lnorm")
plot(fit.ln)
```

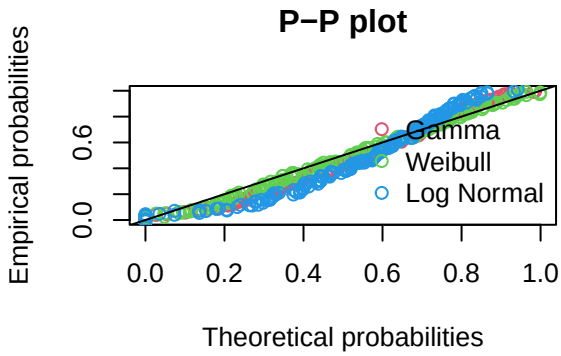



```
par(mfrow=c(2,2))
plot.legend <- c("Gamma", "Weibull", "Log Normal")
denscomp(list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
cdfcomp (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
qqcomp  (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
ppcomp  (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
```









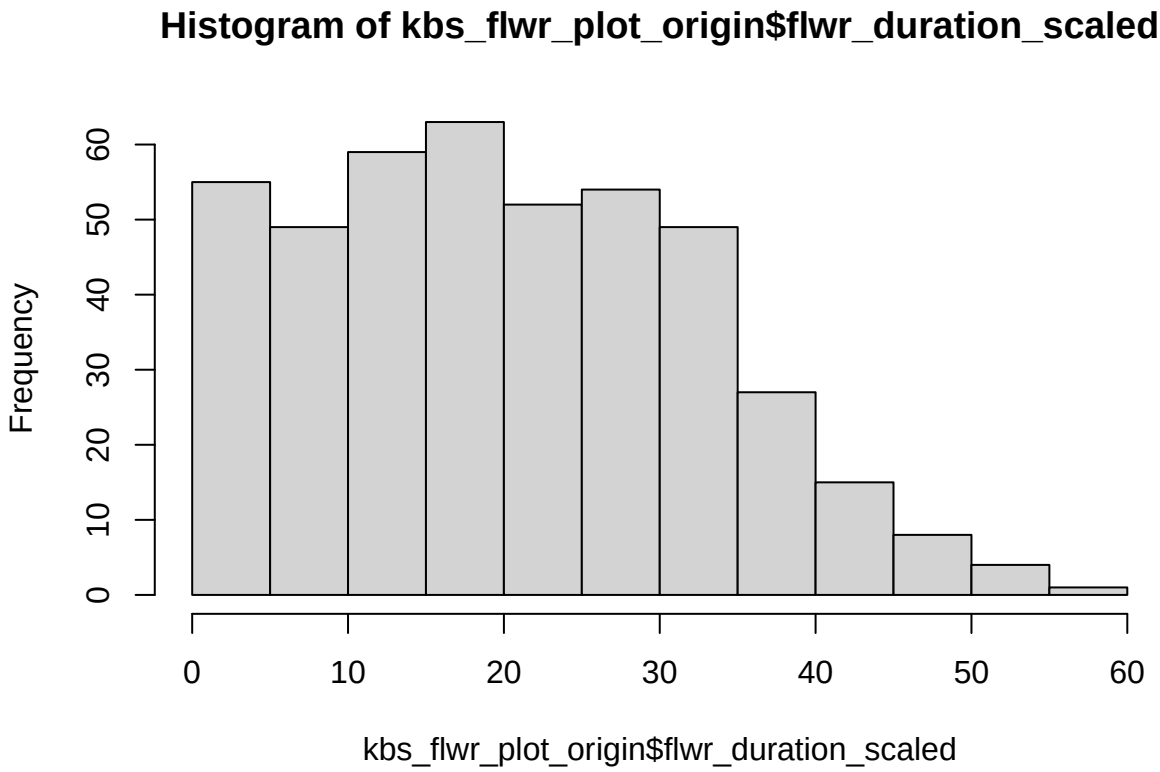

```
# Goodness of fit comparisons across fits (can't include the log normal bc it becomes diff response val
gofstat(list(fit.gamma, fit.weibull, fit.ln), fitnames = c("Gamma", "Weibull", "Log Normal"))
```

```
## Goodness-of-fit statistics
##                                 Gamma    Weibull Log Normal
## Kolmogorov-Smirnov statistic 0.1103947 0.06380716  0.1636293
## Cramer-von Mises statistic   0.6493450 0.14666364  1.5887202
## Anderson-Darling statistic   4.6911012 1.56654597 10.4217087
##
## Goodness-of-fit criteria
##                                  Gamma  Weibull Log Normal
## Akaike's Information Criterion 1198.797 1166.530   1266.349
## Bayesian Information Criterion 1205.021 1172.754   1272.573
```

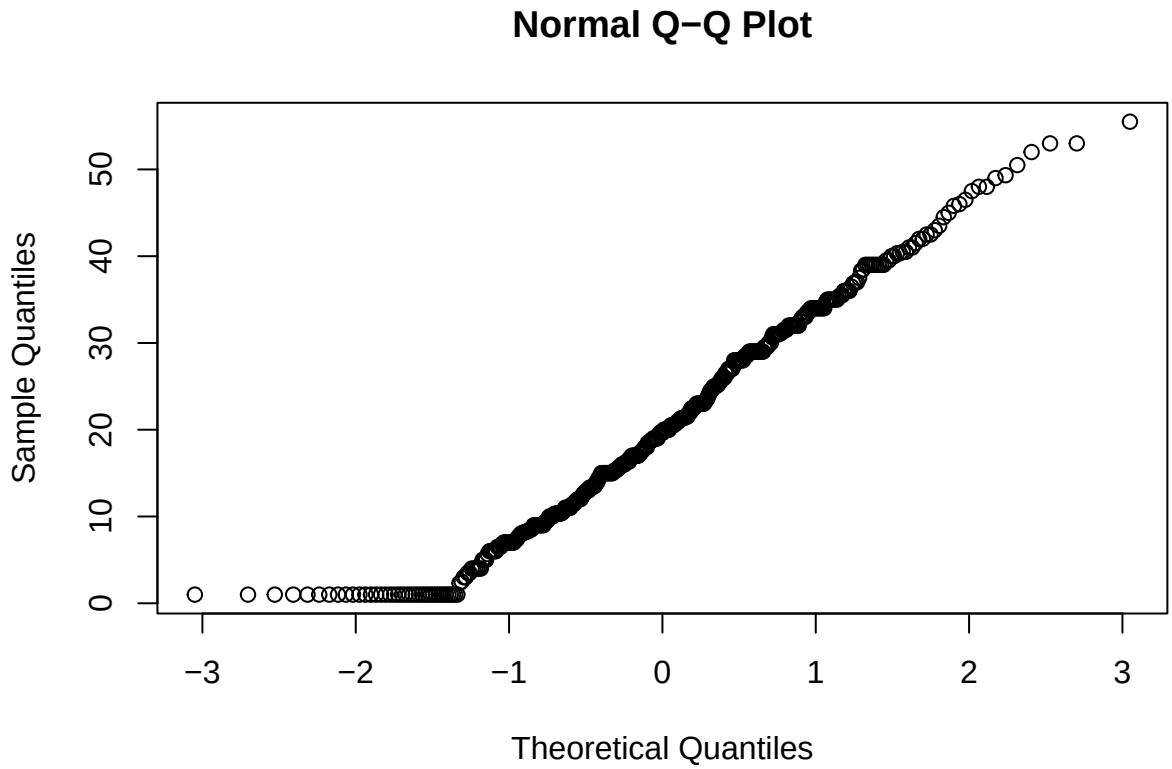
```
# weibull, probably going with log transformation
```

KBS PLOT LEVEL ORIGIN - Looking at DURATION of flowering

```
### KBS ###
hist(kbs_flwr_plot_origin$flwr_duration_scaled)
```



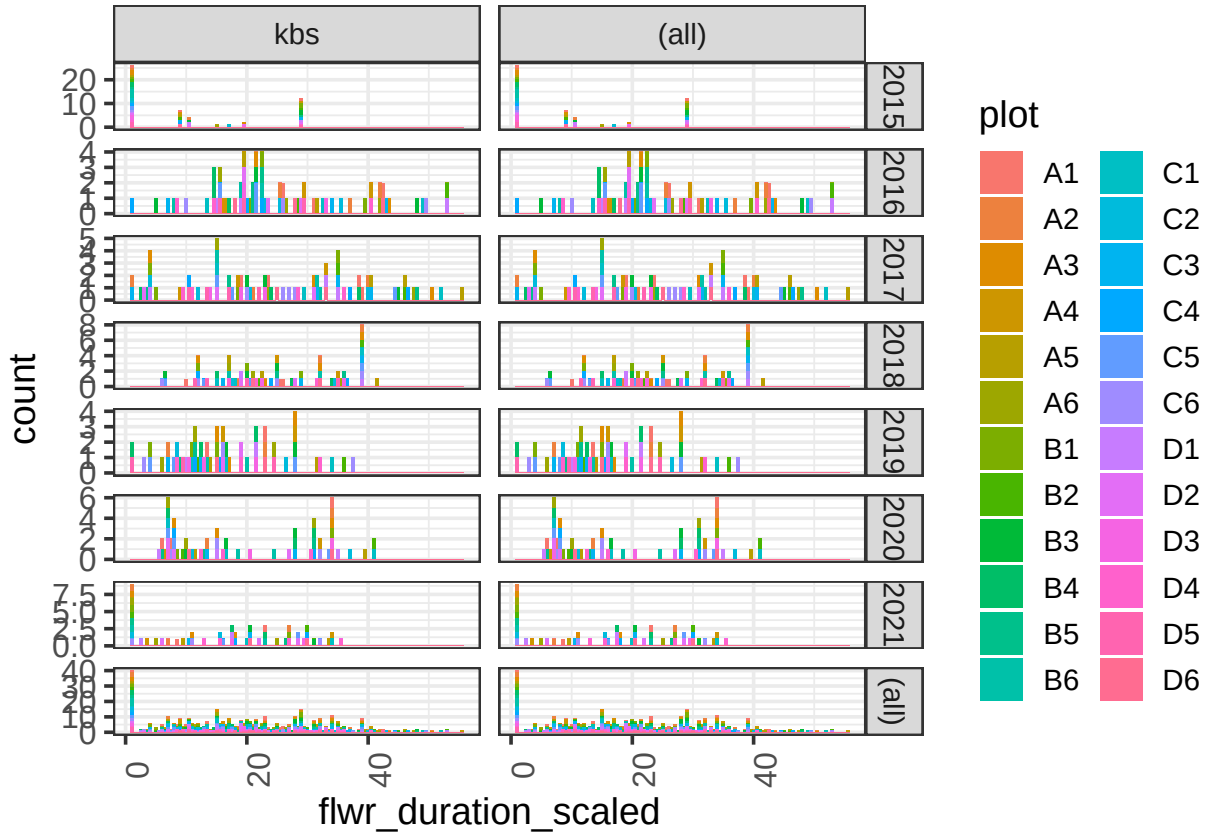

```
qqnorm(kbs_flwr_plot_origin$flwr_duration_scaled)
```



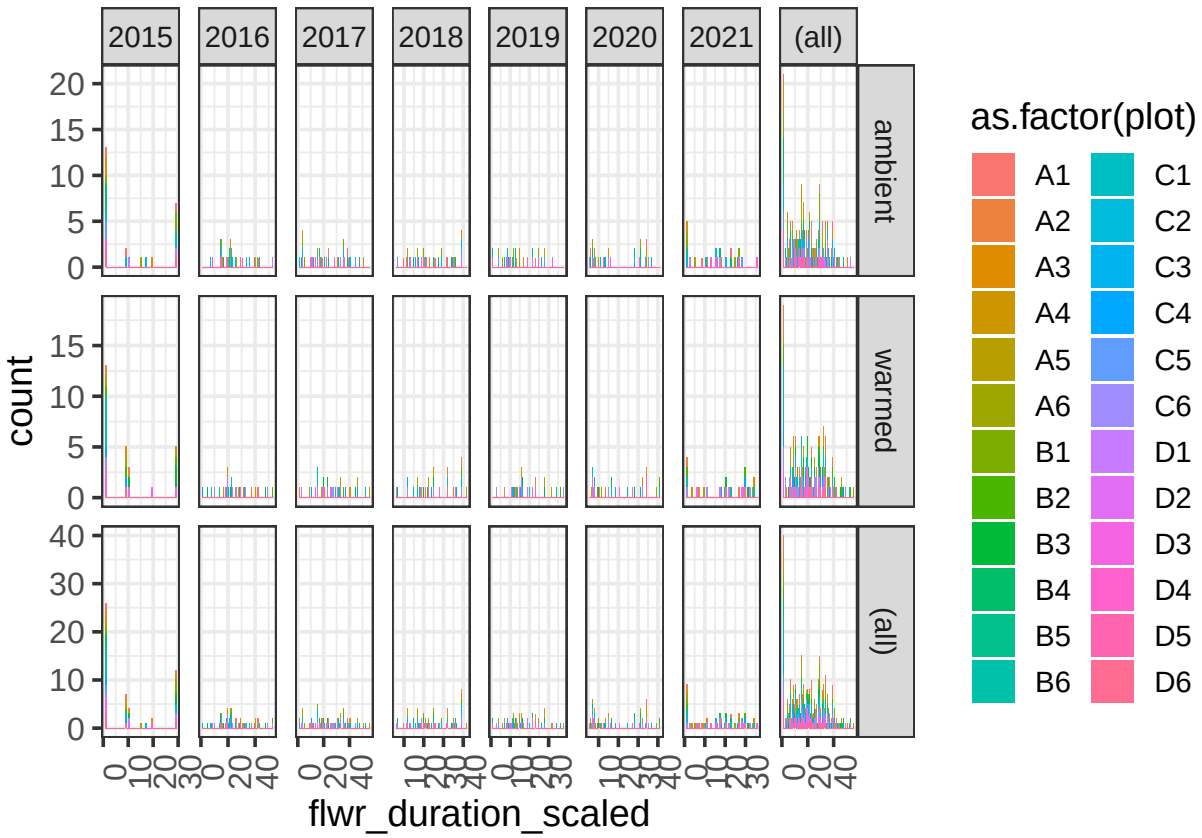
```
shapiro.test(kbs_flwr_plot_origin$flwr_duration_scaled) # pvalue is < 0.05 so we reject the null hypoth
```

```
##
##  Shapiro-Wilk normality test
##
## data:  kbs_flwr_plot_origin$flwr_duration_scaled
## W = 0.97267, p-value = 2.782e-07
```

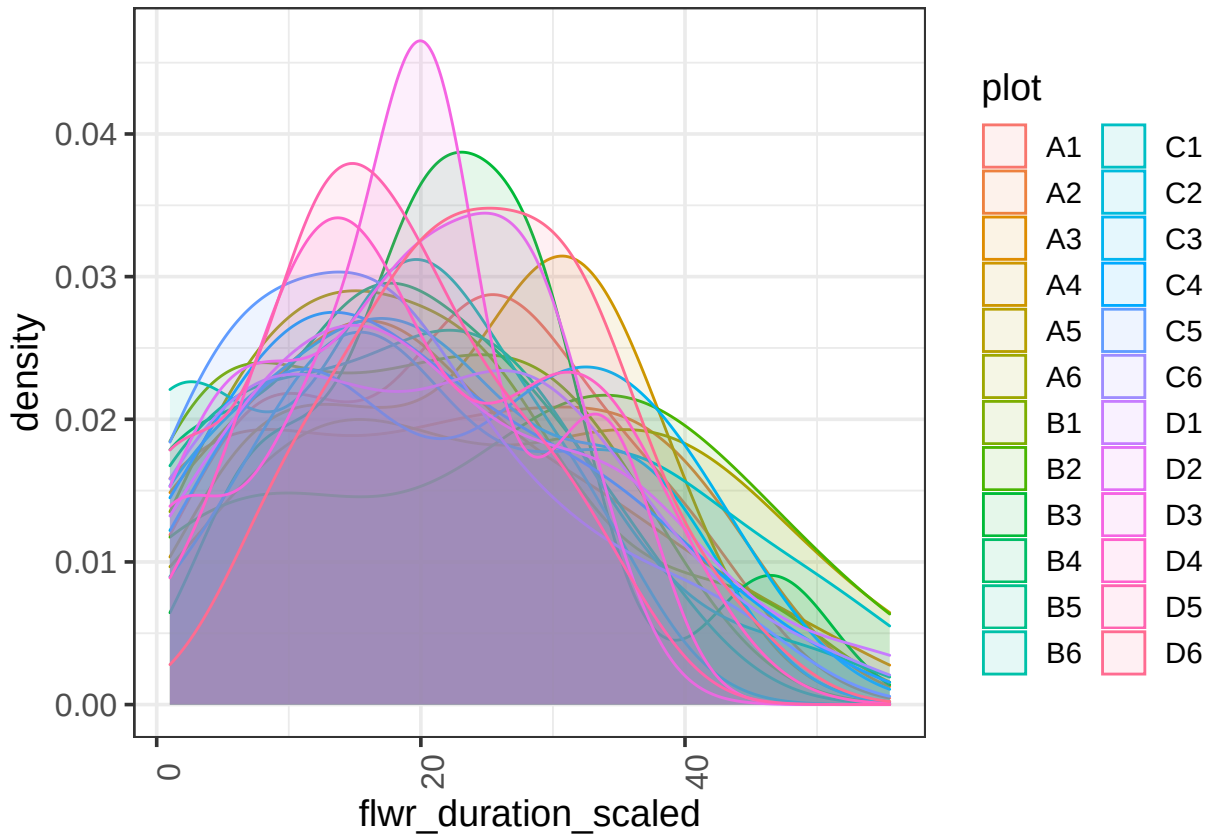
```
# Visualizing median Julian date for umbs at the PLOT LEVEL
ggplot(kbs_flwr_plot_origin, aes(flwr_duration_scaled, fill = plot)) +
        geom_histogram(binwidth = 0.5) +
        facet_grid(year ~ site, margins = TRUE, scales = "free")
```



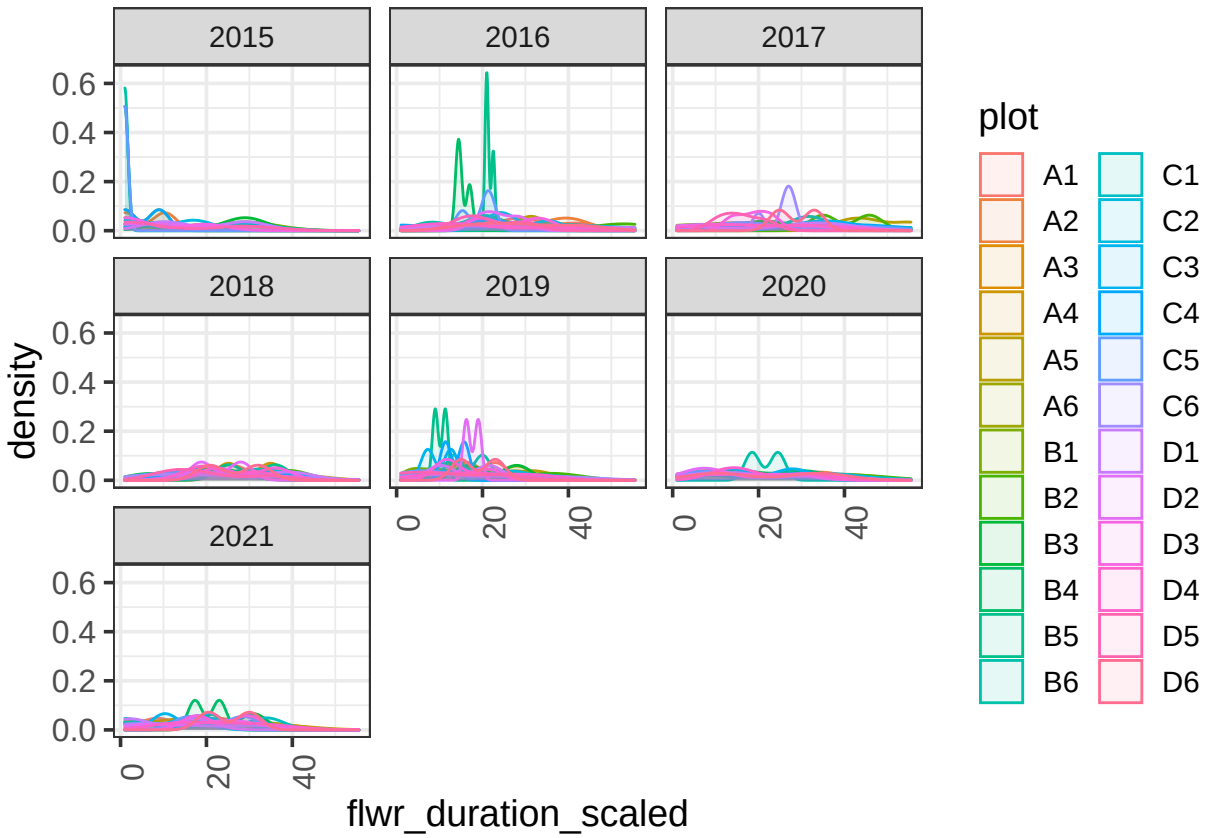

```
ggplot(kbs_flwr_plot_origin, aes(flwr_duration_scaled, fill = as.factor(plot))) + geom_histogram(binwid
        facet_grid(state~year, margins = TRUE, scales = "free")
```



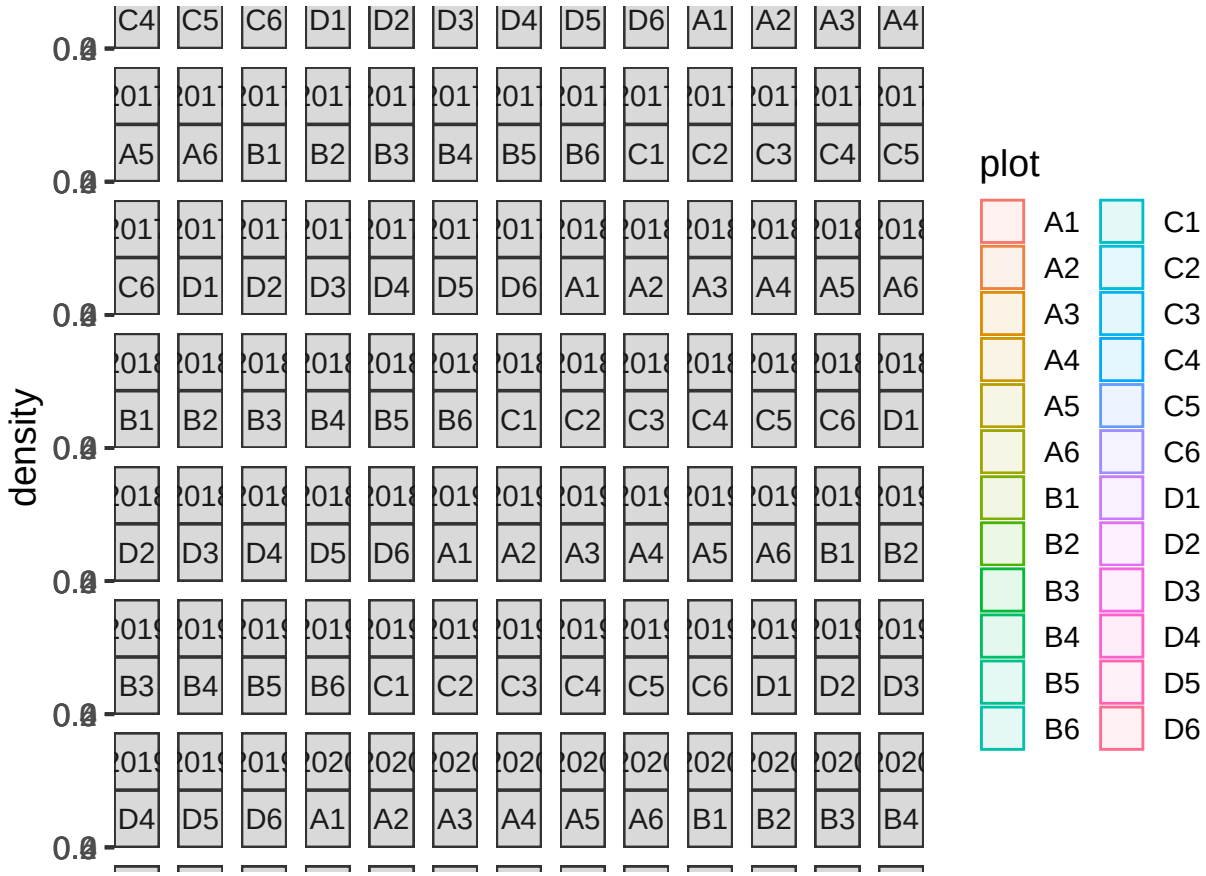

```
ggplot(kbs_flwr_plot_origin, aes(flwr_duration_scaled, fill = plot, color=plot)) +
        geom_density(alpha = 0.1)
```



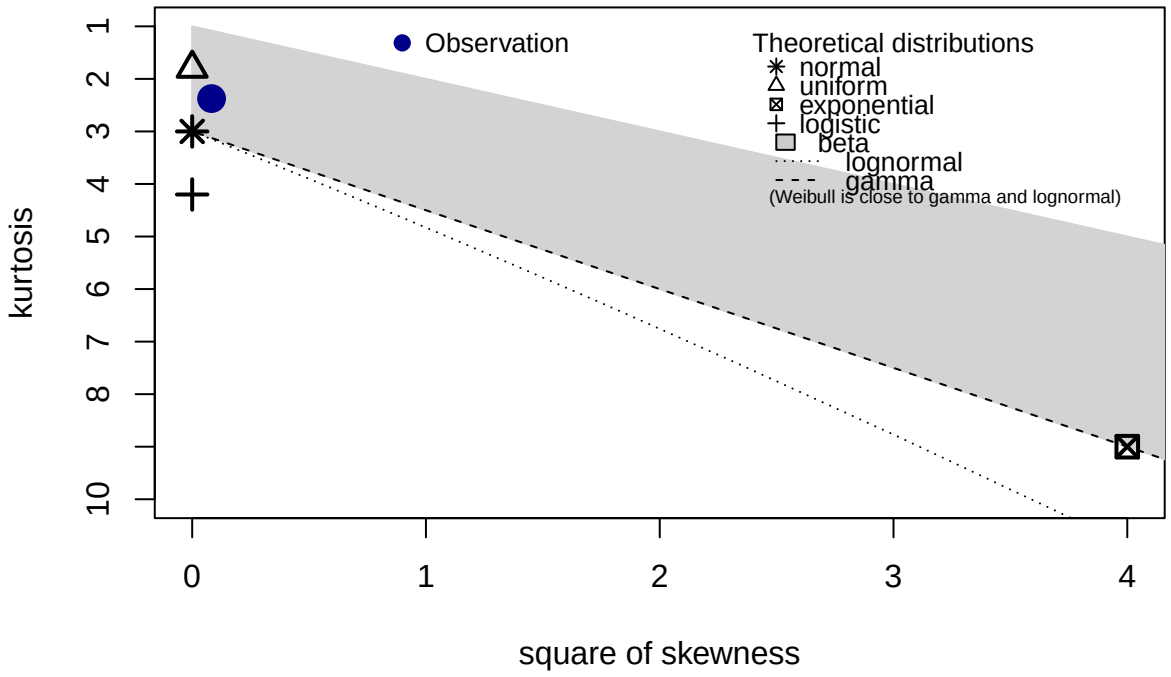

```
ggplot(kbs_flwr_plot_origin, aes(flwr_duration_scaled, fill = plot, color=plot)) +
        geom_density(alpha = 0.1) +
        facet_wrap(~year)
```




```
ggplot(kbs_flwr_plot_origin, aes(flwr_duration_scaled, fill = plot, color=plot)) +
        geom_density(alpha = 0.1) +
        facet_wrap(~year + plot)
```

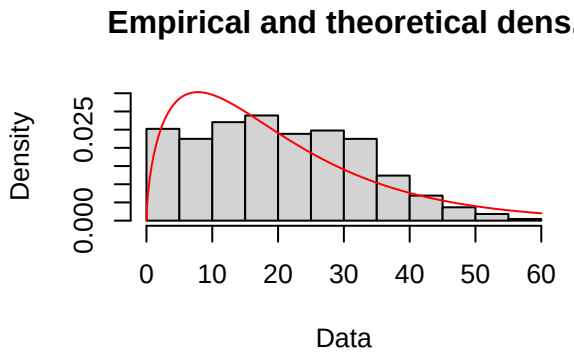


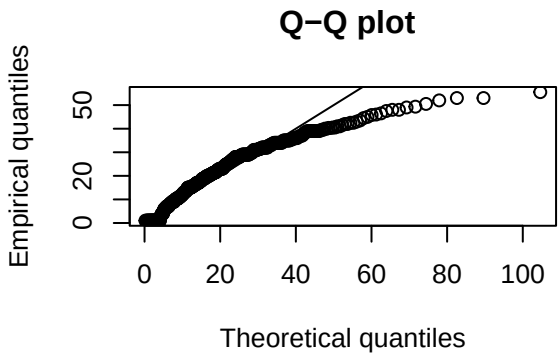

```
# Exploring distributions for these data:
descdist(kbs_flwr_plot_origin$flwr_duration_scaled, discrete = FALSE)
```

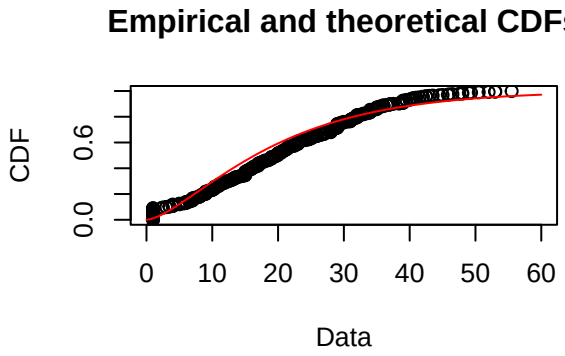


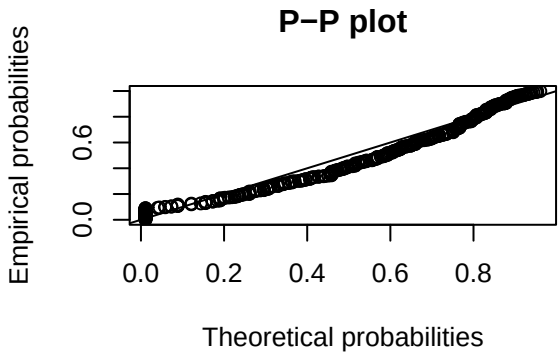

```
## summary statistics
## ------
## min:  1   max:  55.5
## median:  19.66667
## mean:  20.4813
## estimated sd:  12.57484
## estimated skewness:  0.2880935
## estimated kurtosis:  2.374742
```

```
# Gamma distribution
fit.gamma <- fitdist(kbs_flwr_plot_origin$flwr_duration_scaled, "gamma")
plot(fit.gamma)
```

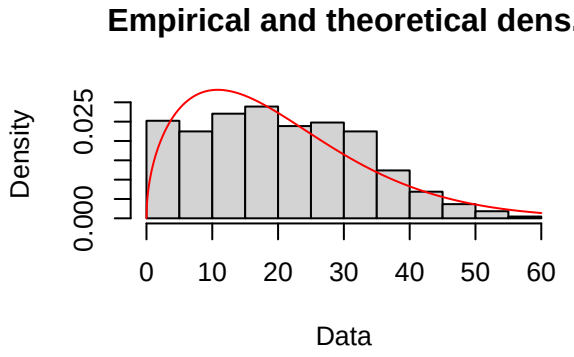


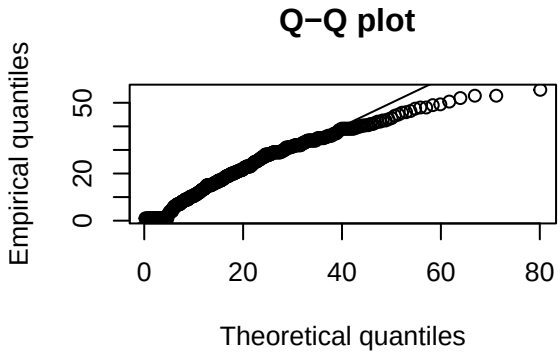


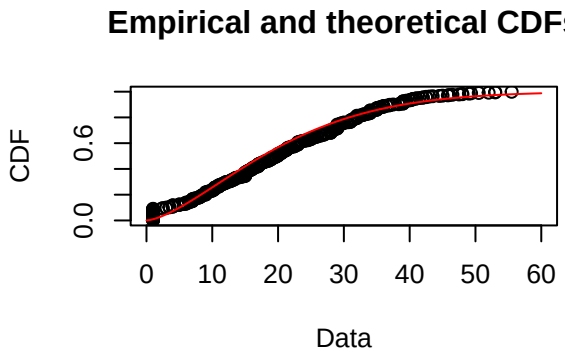


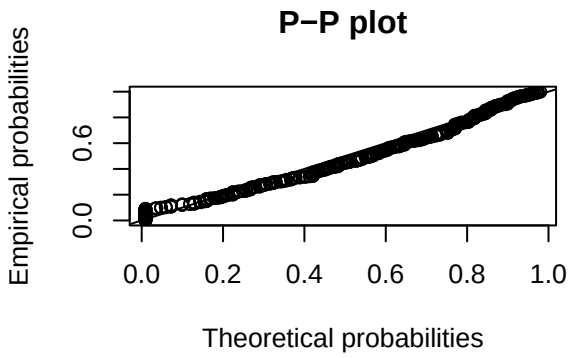



```
# Weibull distribution
fit.weibull  <- fitdist(kbs_flwr_plot_origin$flwr_duration_scaled, "weibull")
plot(fit.weibull)
```

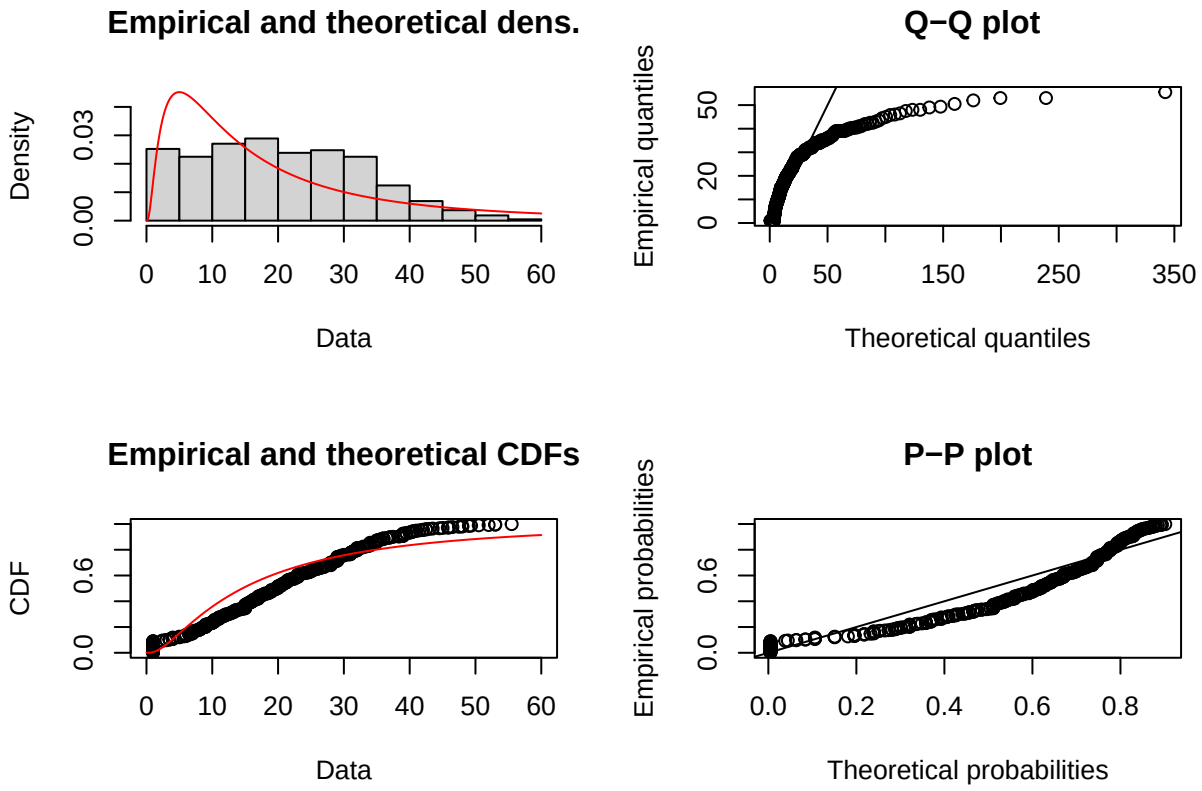




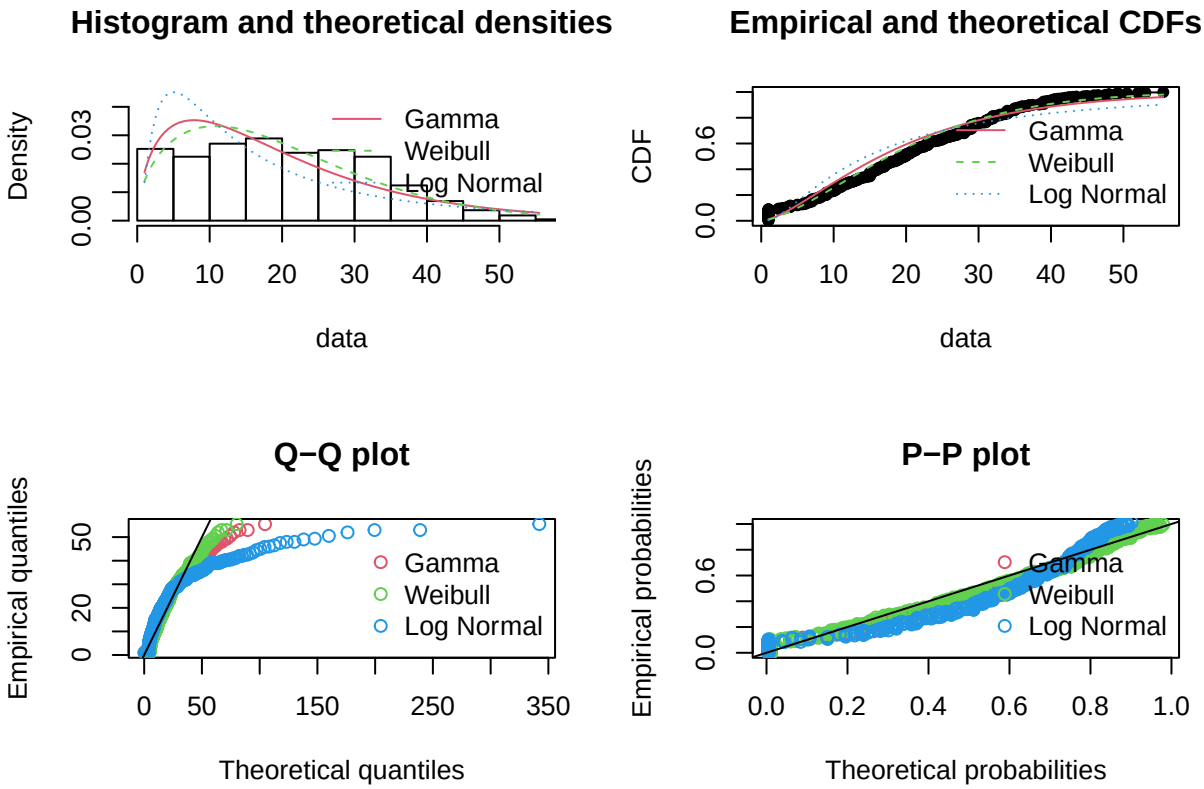




```
# Lognormal distribution
fit.ln <- fitdist(kbs_flwr_plot_origin$flwr_duration_scaled, "lnorm")
plot(fit.ln)
```




```
par(mfrow=c(2,2))
plot.legend <- c("Gamma", "Weibull", "Log Normal")
denscomp(list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
cdfcomp (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
qqcomp  (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
ppcomp  (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
```



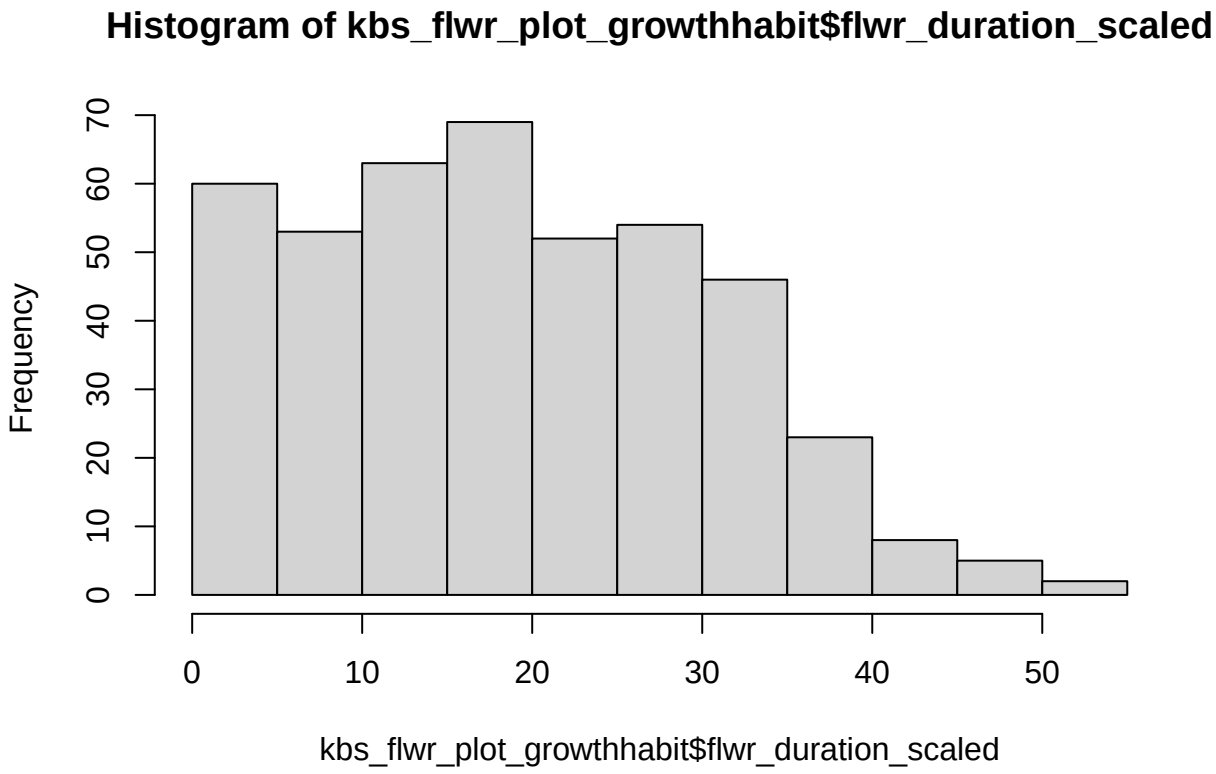

```
# Goodness of fit comparisons across fits (can't include the log normal bc it becomes diff response val
gofstat(list(fit.gamma, fit.weibull, fit.ln), fitnames = c("Gamma", "Weibull", "Log Normal"))
```

```
## Goodness-of-fit statistics
##                                 Gamma    Weibull Log Normal
## Kolmogorov-Smirnov statistic  0.1139634 0.08246571  0.1671529
## Cramer-von Mises statistic    1.5552914 0.76255050  3.7540550
## Anderson-Darling statistic   11.1245128 7.55672816 25.2157916
##
## Goodness-of-fit criteria
##                                 Gamma  Weibull Log Normal
## Akaike's Information Criterion 3456.411 3422.532   3607.446
## Bayesian Information Criterion 3464.566 3430.687   3615.602
```

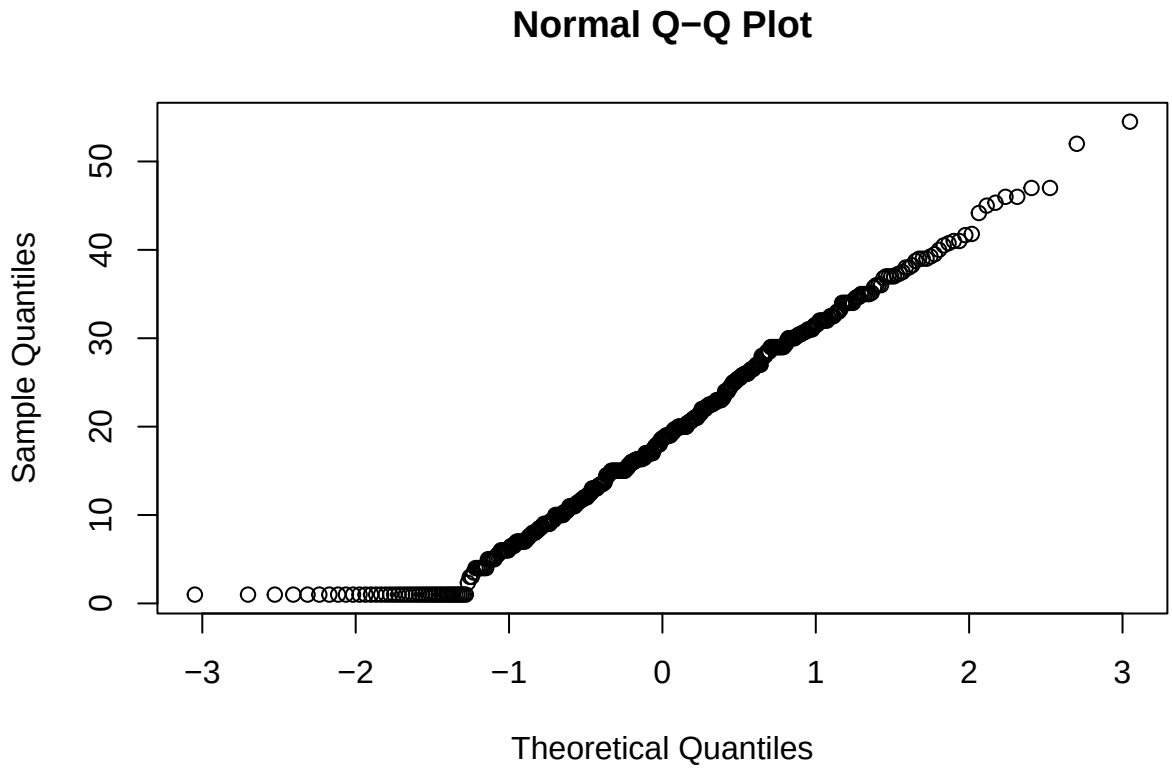
```
# weibull
```

KBS PLOT LEVEL GROWTH HABIT - Looking at DURATION of flowering

```
### KBS ###
hist(kbs_flwr_plot_growthhabit$flwr_duration_scaled)
```



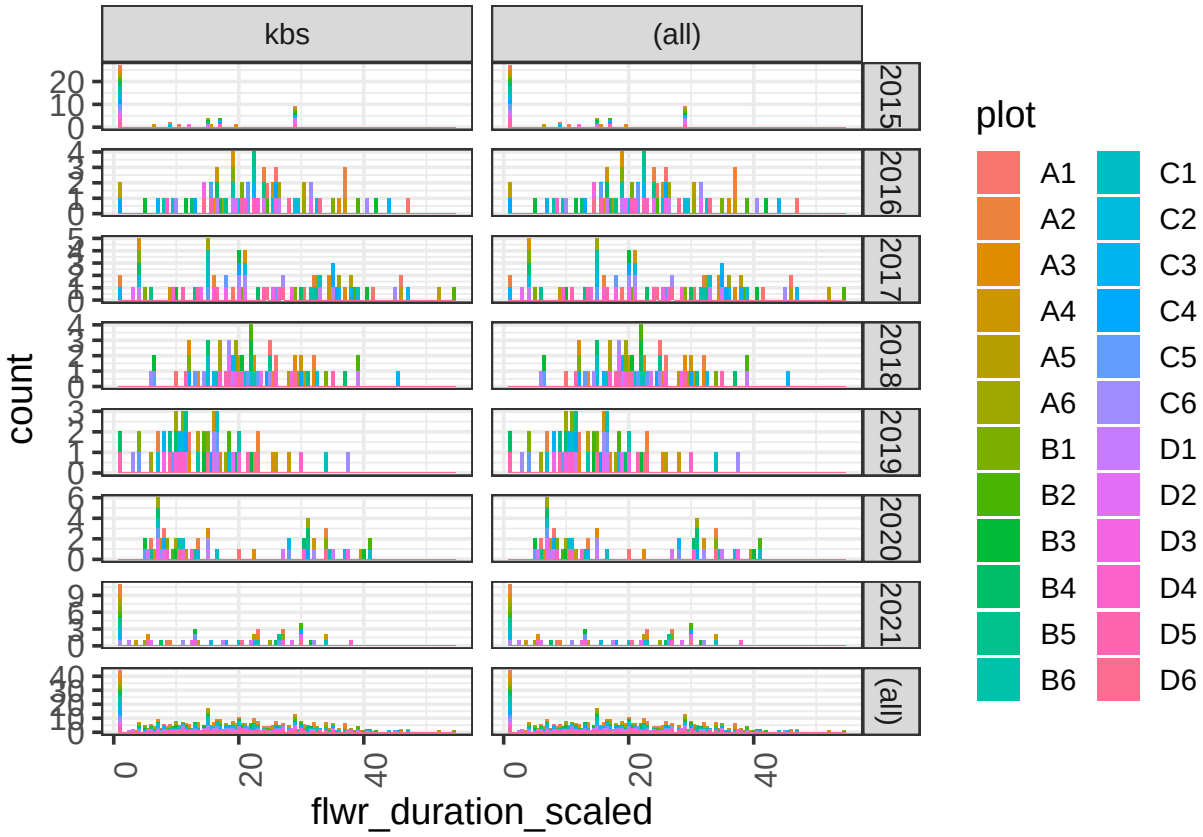

```
qqnorm(kbs_flwr_plot_growthhabit$flwr_duration_scaled)
```



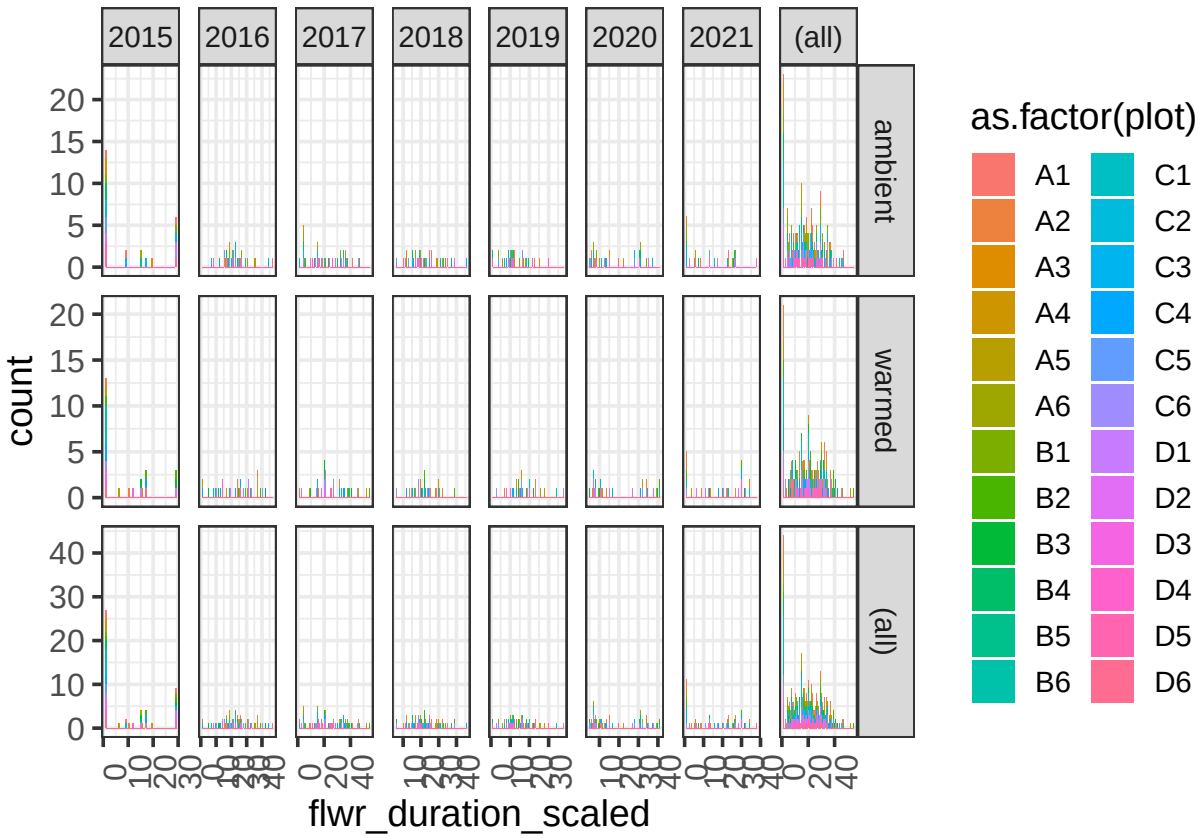
```
shapiro.test(kbs_flwr_plot_growthhabit$flwr_duration_scaled) # pvalue is < 0.05 so we reject the null h
```

```
##
##  Shapiro-Wilk normality test
##
## data:  kbs_flwr_plot_growthhabit$flwr_duration_scaled
## W = 0.97333, p-value = 3.876e-07
```

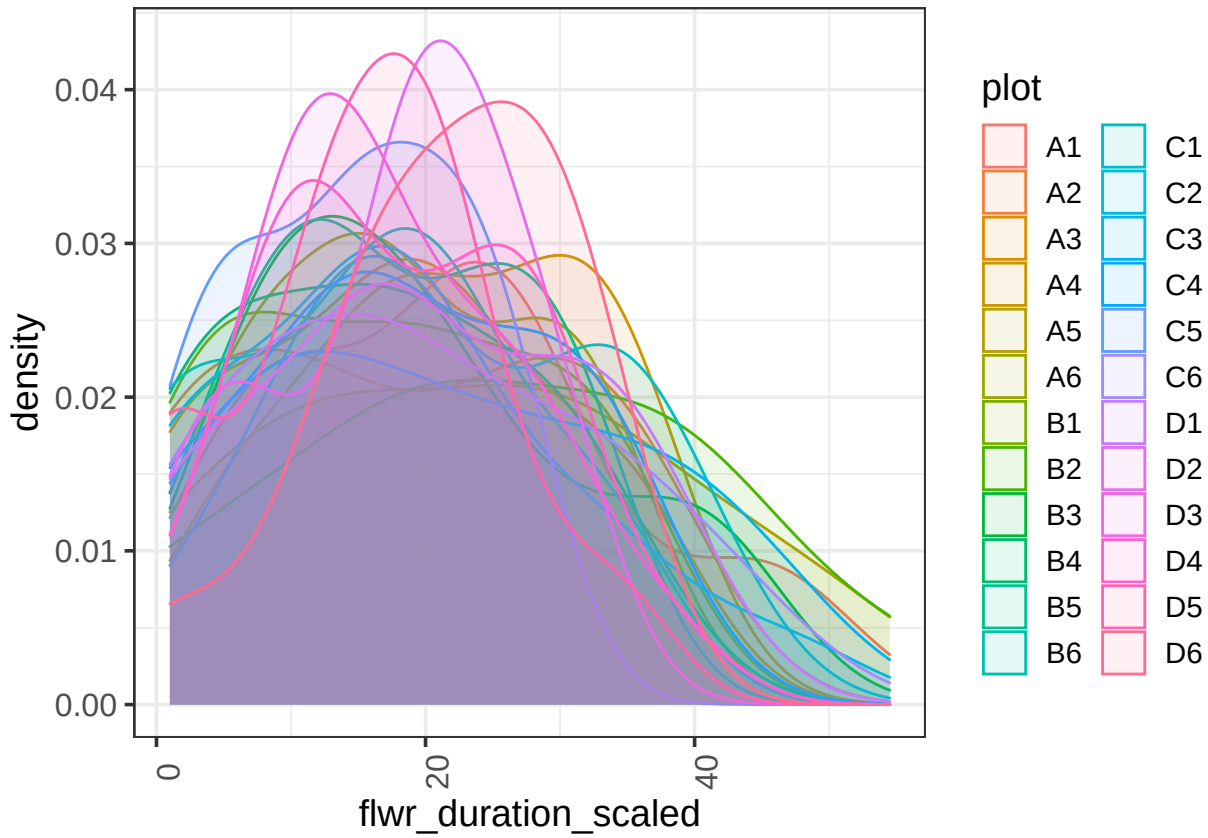
```
# Visualizing median Julian date for umbs at the PLOT LEVEL
ggplot(kbs_flwr_plot_growthhabit, aes(flwr_duration_scaled, fill = plot)) +
        geom_histogram(binwidth = 0.5) +
        facet_grid(year ~ site, margins = TRUE, scales = "free")
```



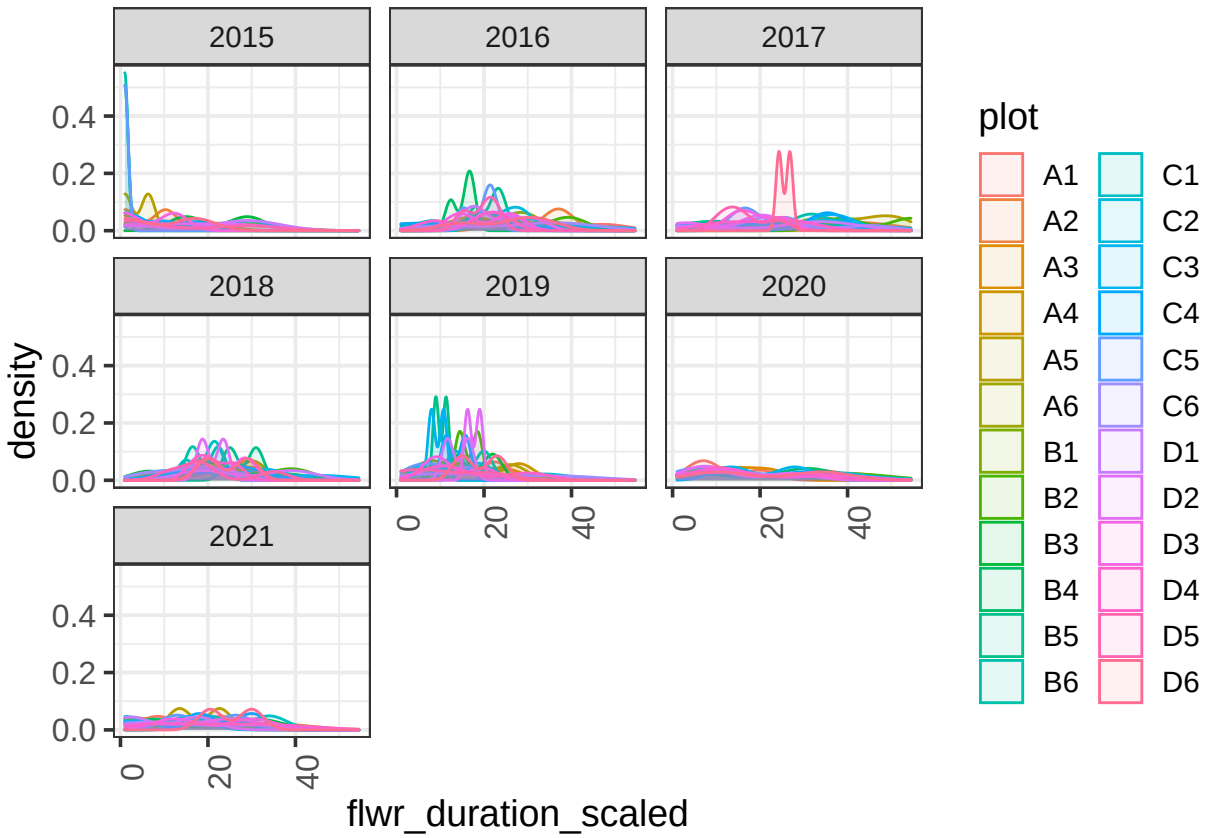

```
ggplot(kbs_flwr_plot_growthhabit, aes(flwr_duration_scaled, fill = as.factor(plot))) + geom_histogram(b
        facet_grid(state~year, margins = TRUE, scales = "free")
```



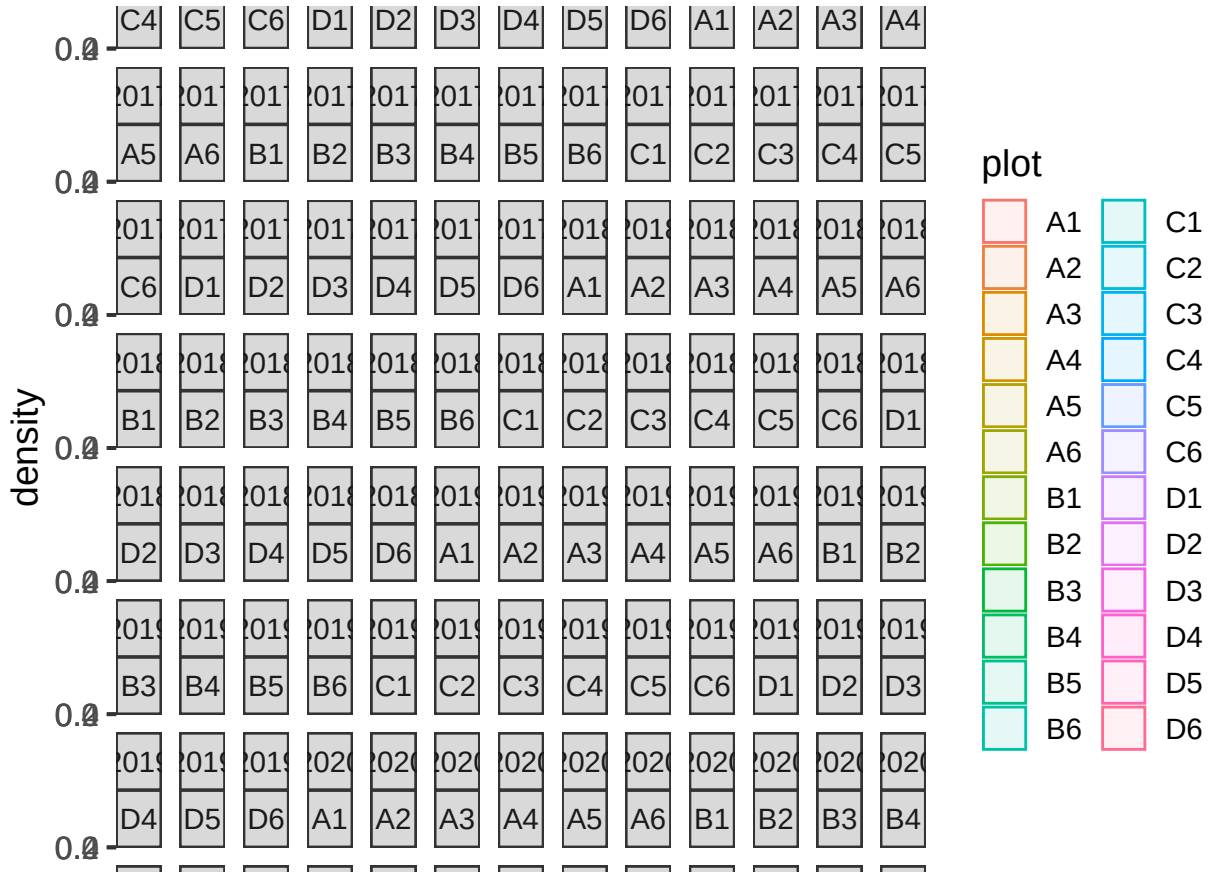

```
ggplot(kbs_flwr_plot_growthhabit, aes(flwr_duration_scaled, fill = plot, color=plot)) +
        geom_density(alpha = 0.1)
```



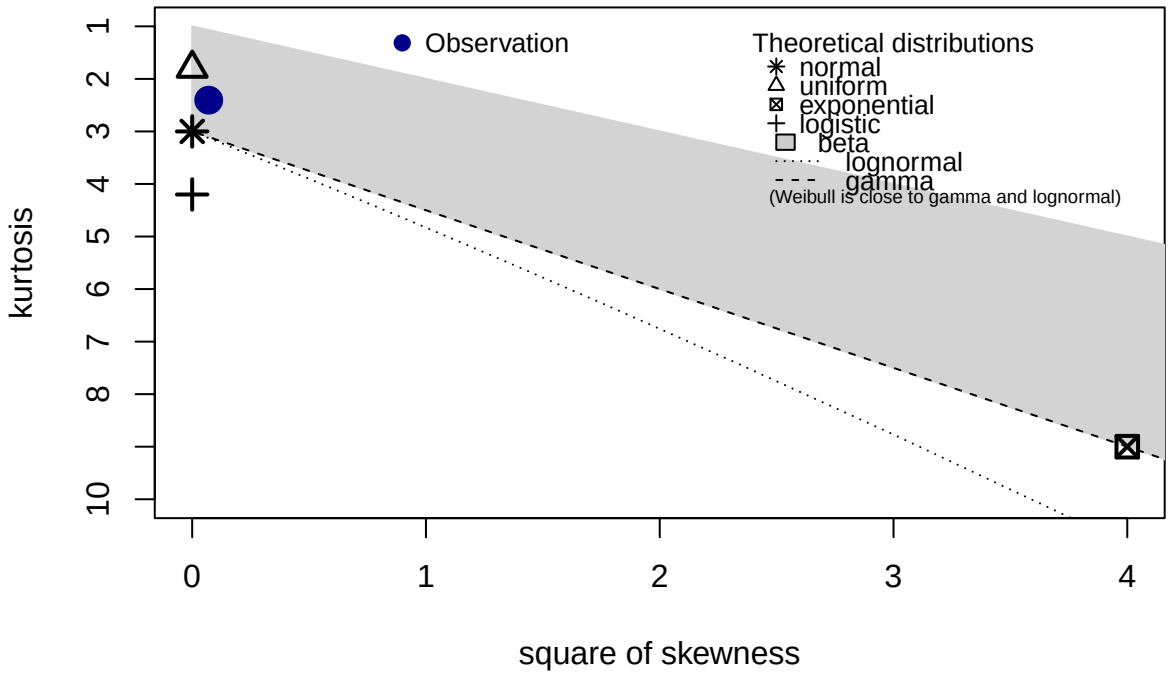

```
ggplot(kbs_flwr_plot_growthhabit, aes(flwr_duration_scaled, fill = plot, color=plot)) +
        geom_density(alpha = 0.1) +
        facet_wrap(~year)
```




```
ggplot(kbs_flwr_plot_growthhabit, aes(flwr_duration_scaled, fill = plot, color=plot)) +
        geom_density(alpha = 0.1) +
        facet_wrap(~year + plot)
```




```
# Exploring distributions for these data:
descdist(kbs_flwr_plot_growthhabit$flwr_duration_scaled, discrete = FALSE)
```



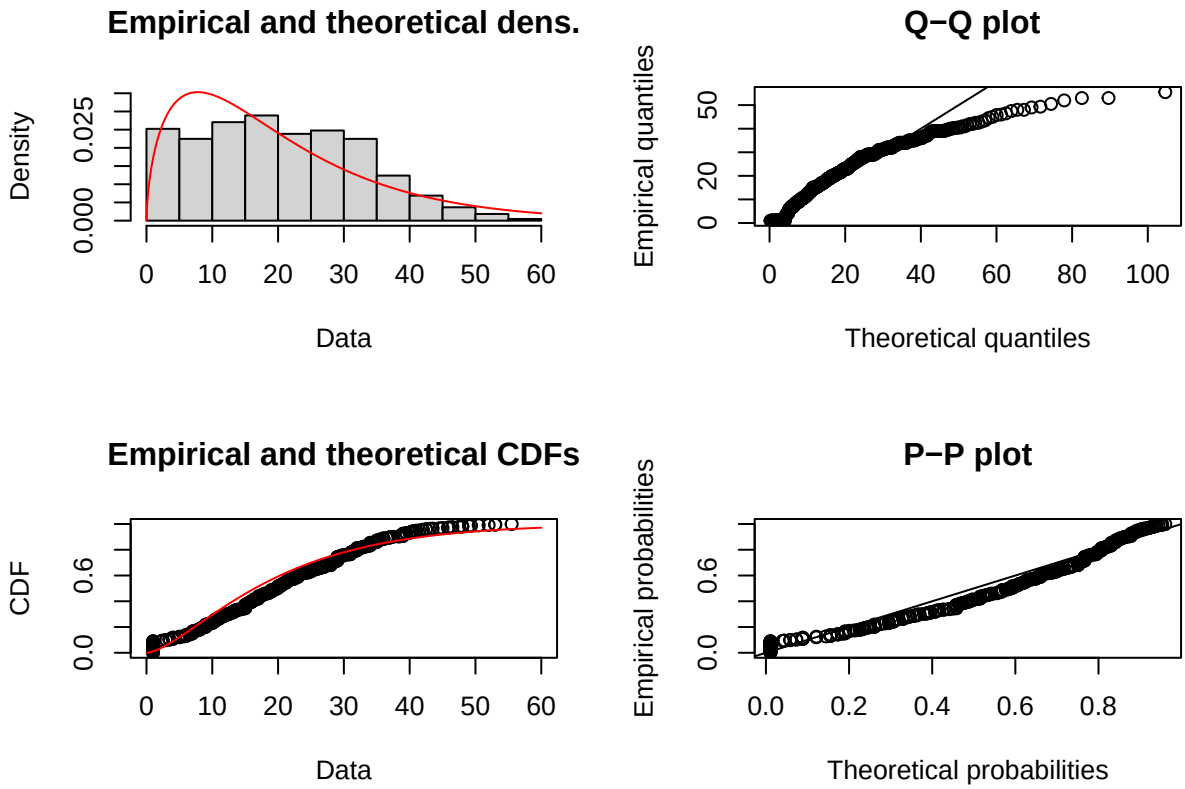

```
## summary statistics
## ------
## min:  1   max:  54.5
## median:  18.66667
## mean:  19.03002
## estimated sd:  11.65004
## estimated skewness:  0.2659687
## estimated kurtosis:  2.404991
```

```
# Gamma distribution
fit.gamma <- fitdist(kbs_flwr_plot_growthhabit$flwr_duration, "gamma")
```

```
## <simpleError in optim(par = vstart, fn = fnobj, fix.arg = fix.arg, obs = data,     gr = gradient, dd
```

```
## Error in fitdist(kbs_flwr_plot_growthhabit$flwr_duration, "gamma"): the function mle failed to estima
##                 with the error code 100
```

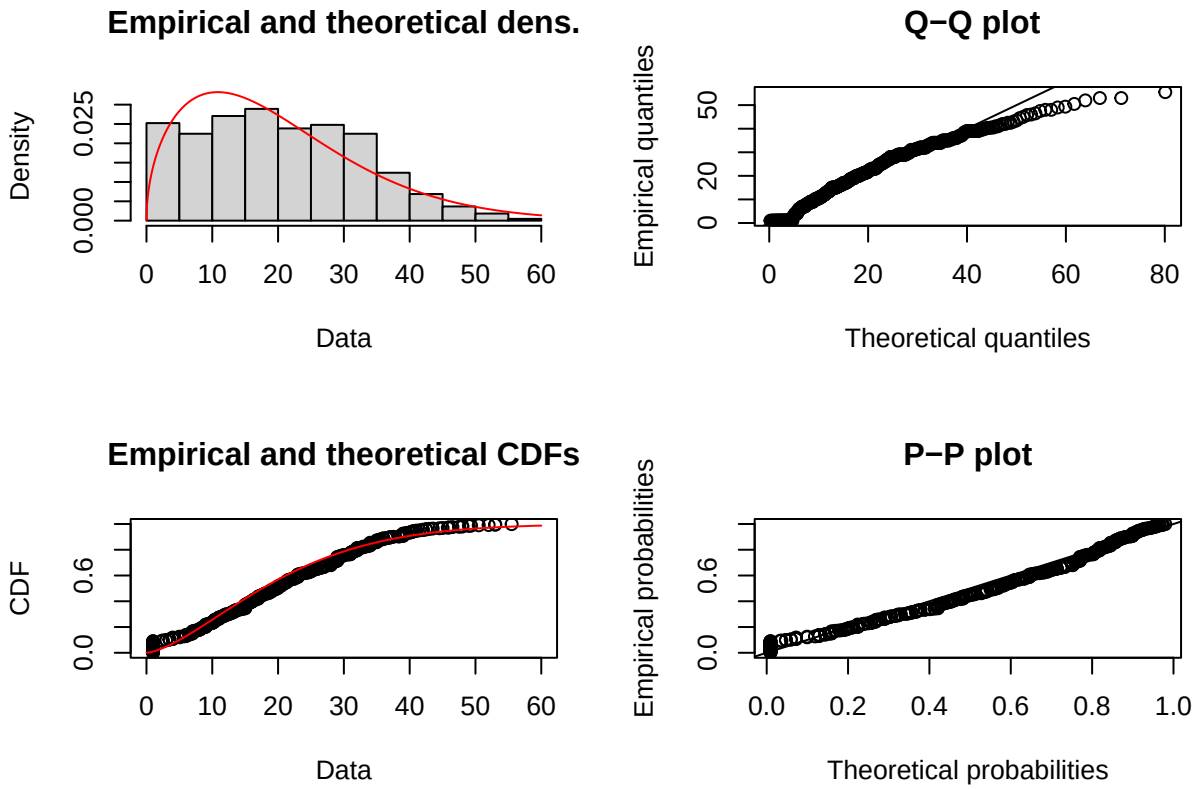
```
plot(fit.gamma)
```




```
# Weibull distribution
fit.weibull  <- fitdist(kbs_flwr_plot_growthhabit$flwr_duration, "weibull")
```

```
## Error in checkparamlist(arg_startfix$start.arg, arg_startfix$fix.arg, : 'start' should not have NA o
```

```
plot(fit.weibull)
```

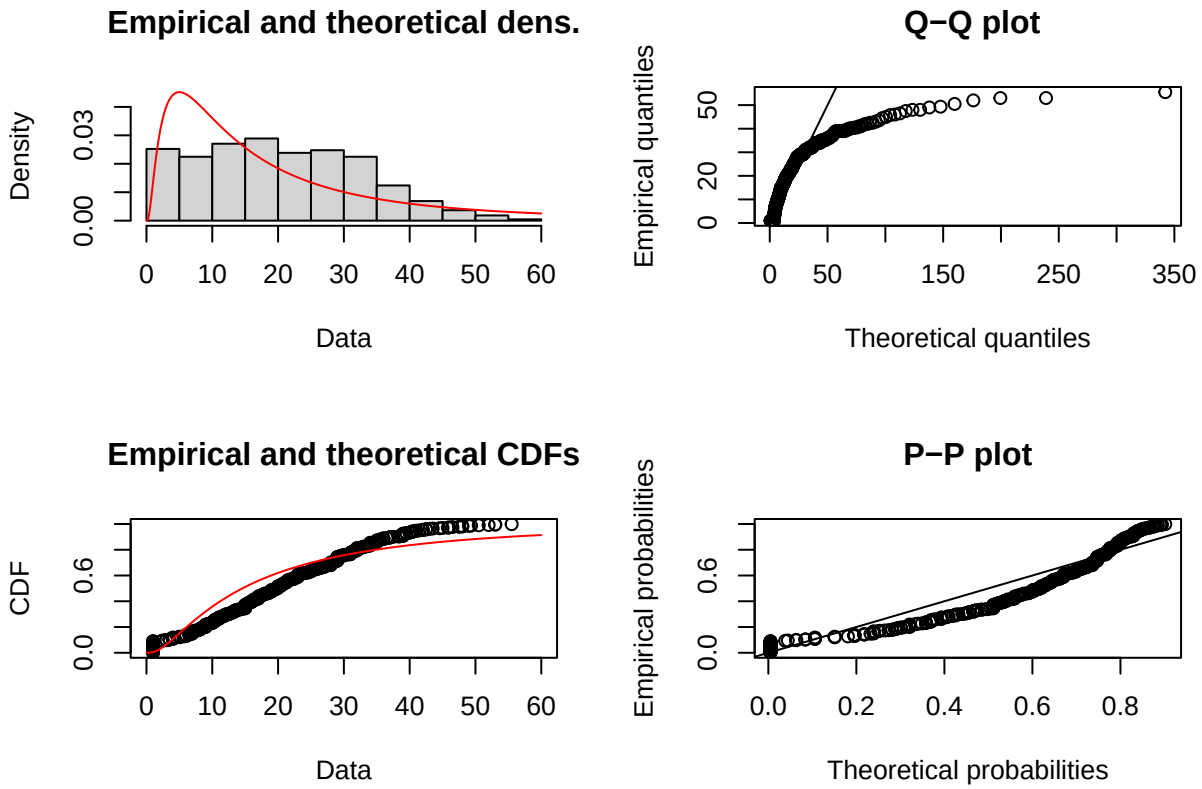



```
# Lognormal distribution
fit.ln <- fitdist(kbs_flwr_plot_growthhabit$flwr_duration, "lnorm")
```

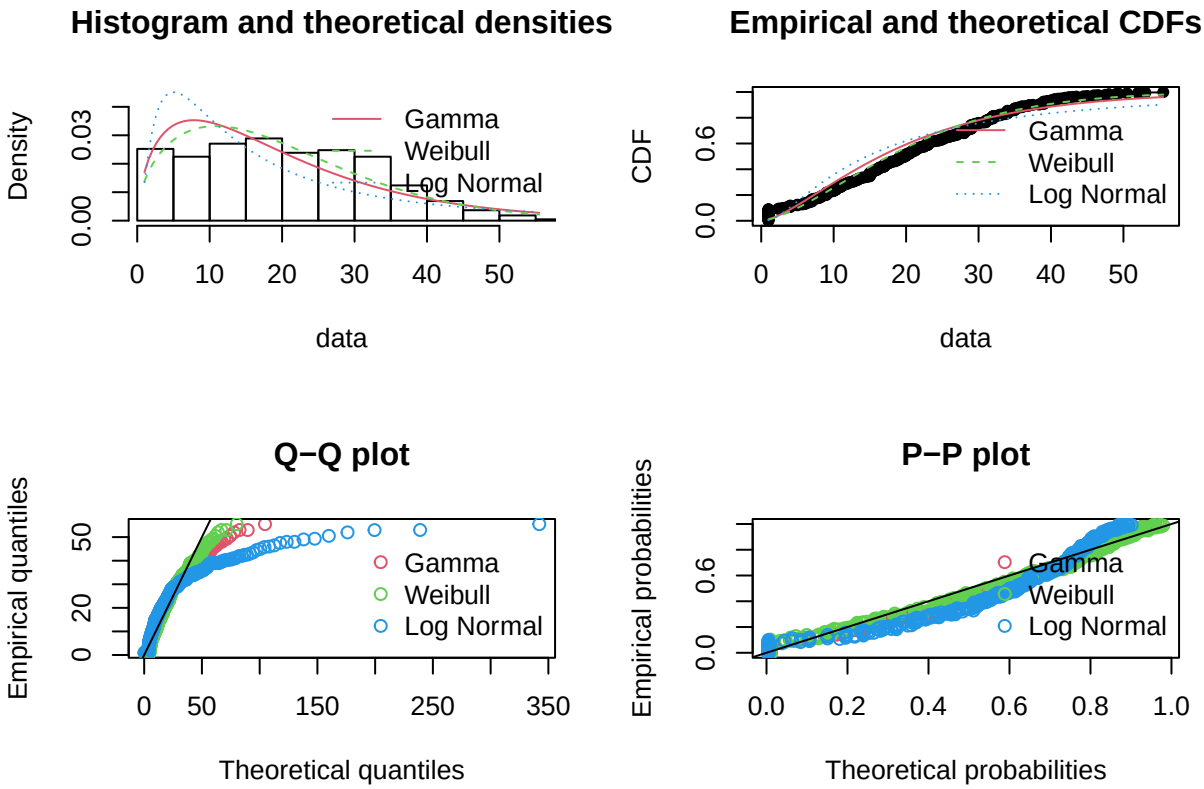
```
## Error in computing default starting values.
```

```
## Error in manageparam(start.arg = start, fix.arg = fix.arg, obs = data, : Error in start.arg.default(
##   values must be positive to fit a lognormal distribution
```

```
plot(fit.ln)
```




```
par(mfrow=c(2,2))
plot.legend <- c("Gamma", "Weibull", "Log Normal")
denscomp(list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
cdfcomp (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
qqcomp  (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
ppcomp  (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
```



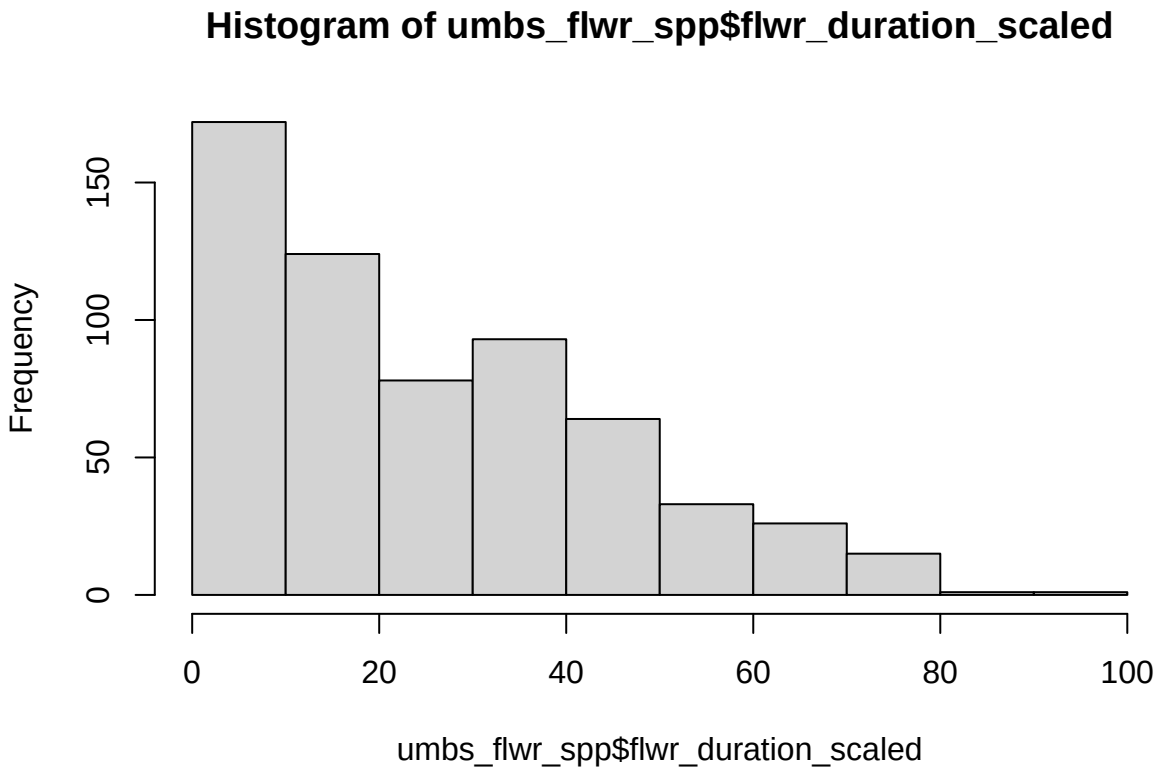

```
# Goodness of fit comparisons across fits (can't include the log normal bc it becomes diff response val
gofstat(list(fit.gamma, fit.weibull, fit.ln), fitnames = c("Gamma", "Weibull", "Log Normal"))
```

```
## Goodness-of-fit statistics
##                                 Gamma    Weibull Log Normal
## Kolmogorov-Smirnov statistic  0.1139634 0.08246571  0.1671529
## Cramer-von Mises statistic    1.5552914 0.76255050  3.7540550
## Anderson-Darling statistic   11.1245128 7.55672816 25.2157916
##
## Goodness-of-fit criteria
##                                 Gamma  Weibull Log Normal
## Akaike's Information Criterion 3456.411 3422.532   3607.446
## Bayesian Information Criterion 3464.566 3430.687   3615.602
```

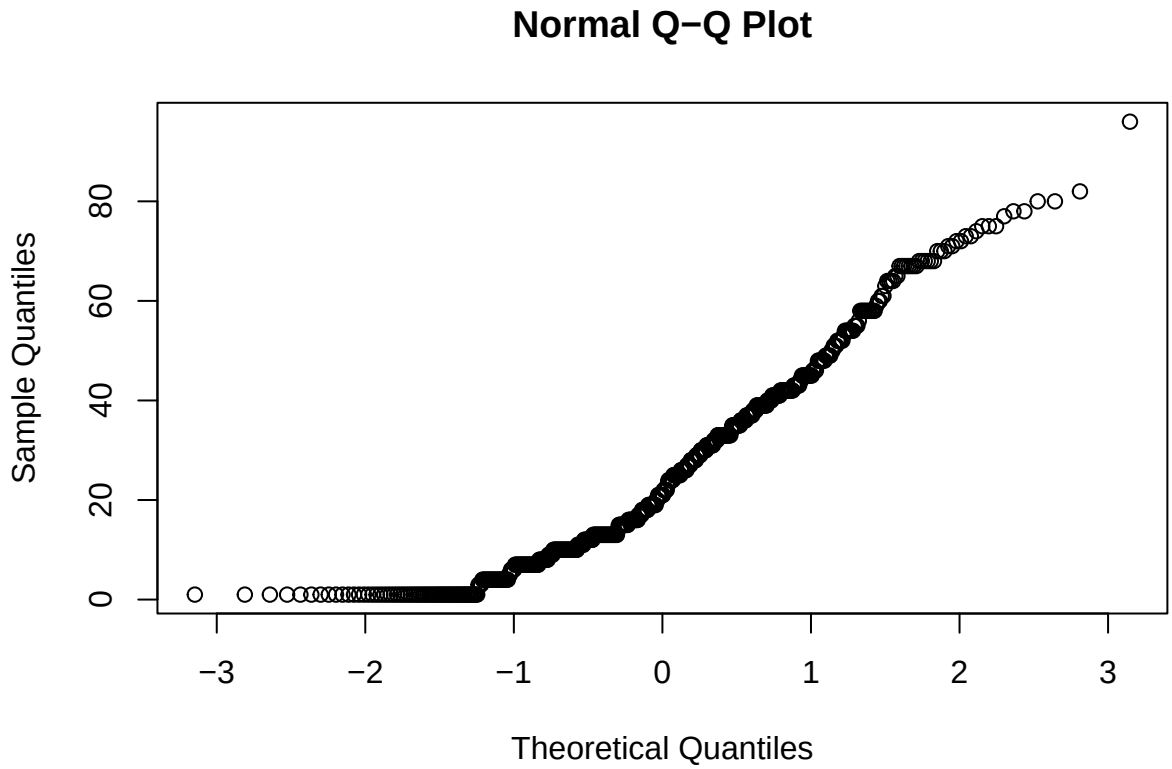
```
# weibull
```

UMBS SPECIES LEVEL - Looking at DURATION of flowering

```
### UMBS ###
hist(umbs_flwr_spp$flwr_duration_scaled)
```



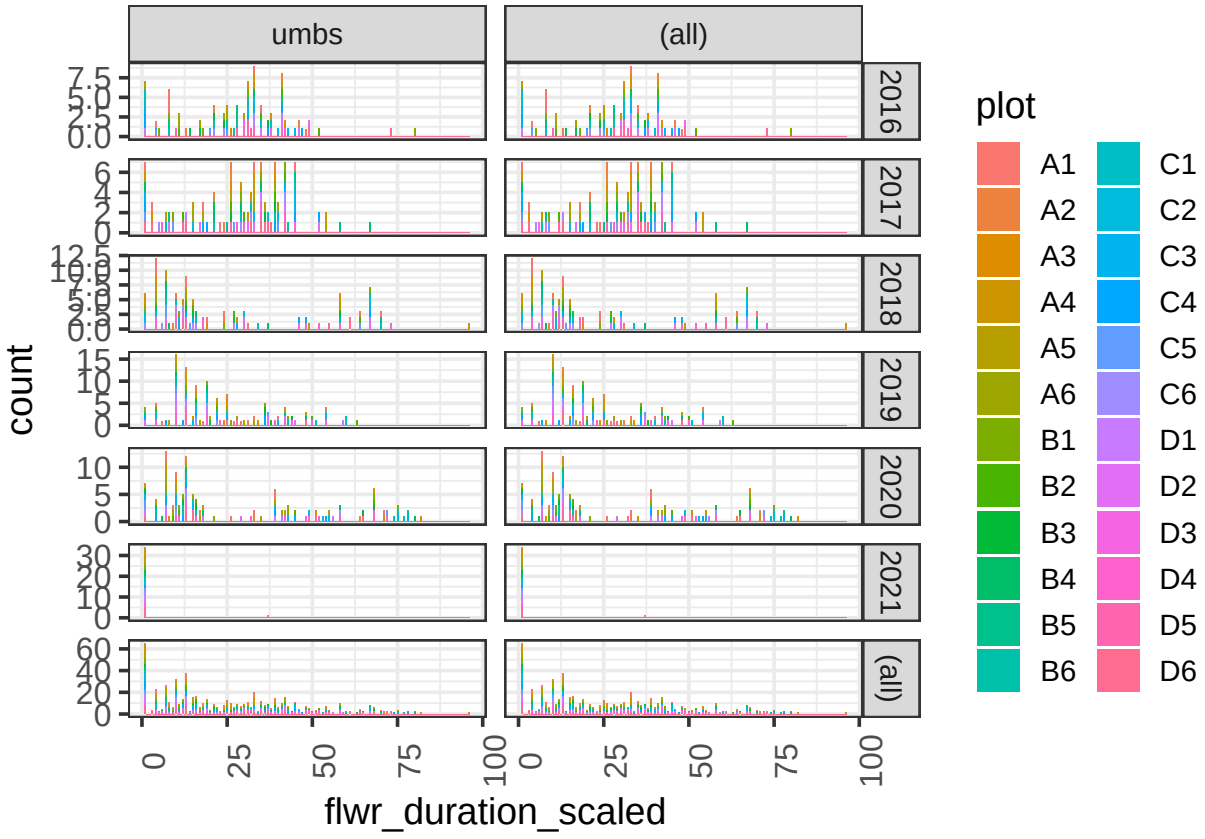

```
qqnorm(umbs_flwr_spp$flwr_duration_scaled)
```



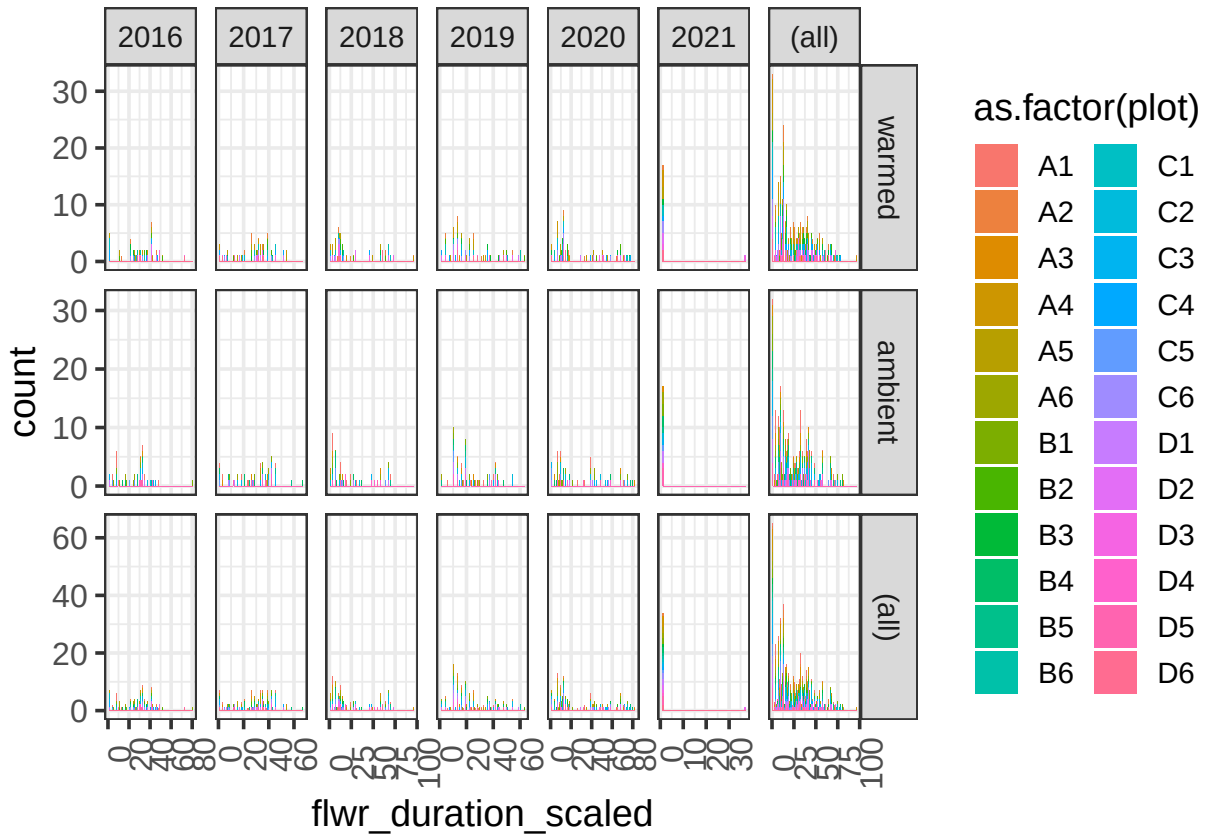
```
shapiro.test(umbs_flwr_spp$flwr_duration_scaled) # pvalue is < 0.05 so we reject the null hypothesis th
```

```
##
##  Shapiro-Wilk normality test
##
## data:  umbs_flwr_spp$flwr_duration_scaled
## W = 0.92953, p-value = 2.739e-16
```

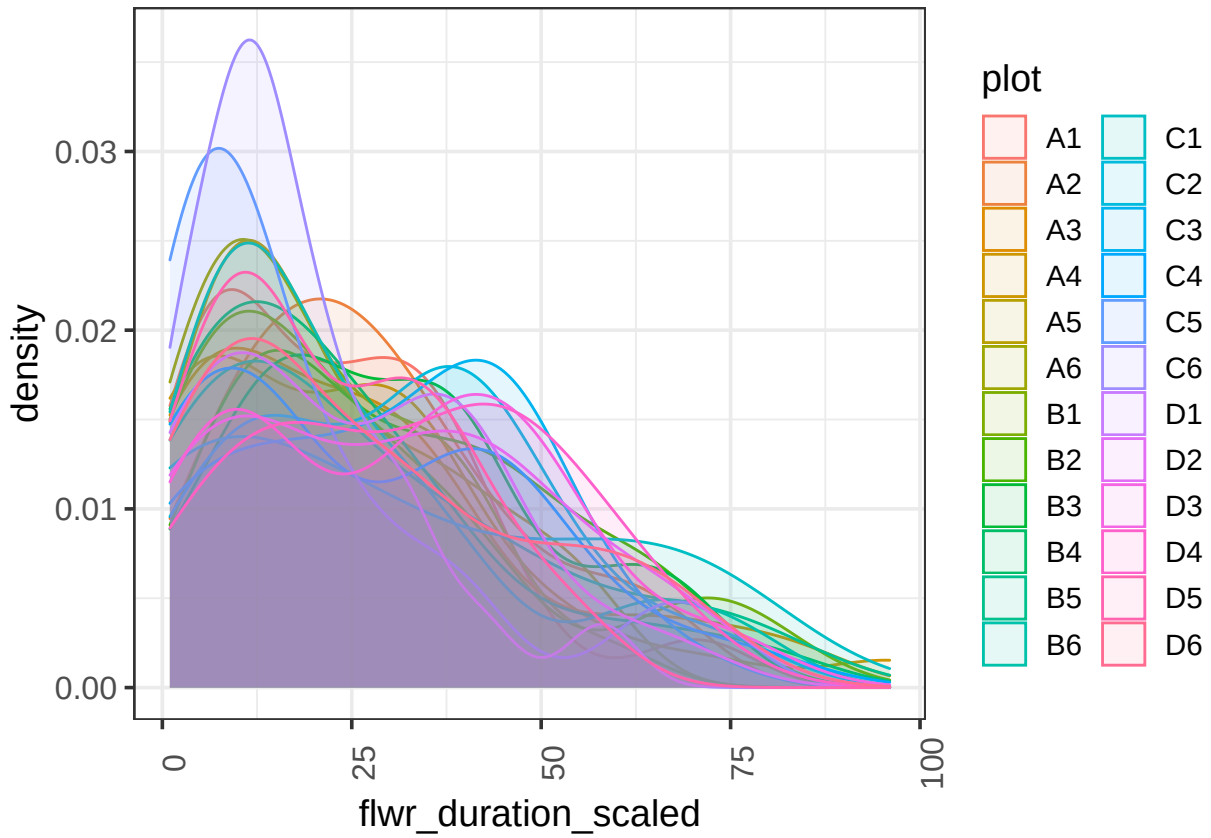
```
# Visualizing median Julian date for umbs at the PLOT LEVEL
ggplot(umbs_flwr_spp, aes(flwr_duration_scaled, fill = plot)) +
        geom_histogram(binwidth = 0.5) +
        facet_grid(year ~ site, margins = TRUE, scales = "free")
```



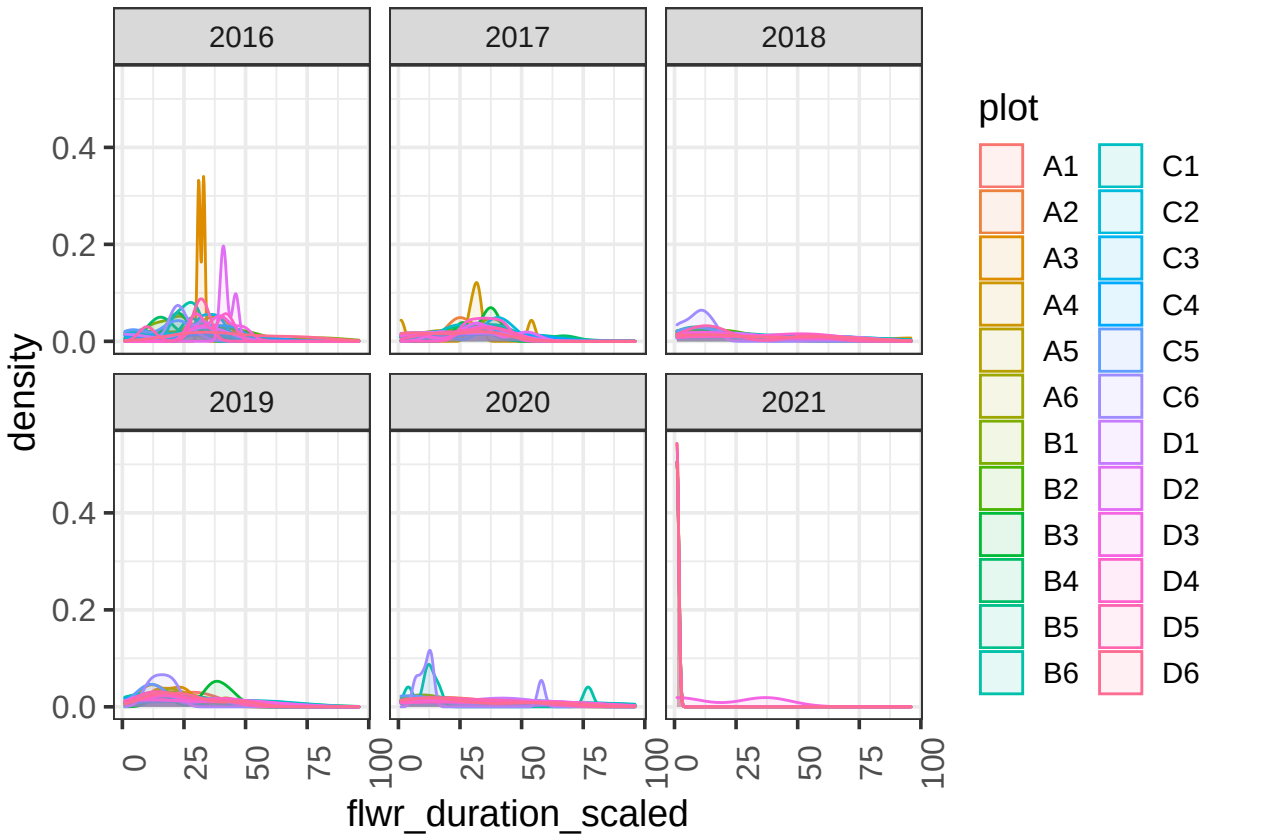

```
ggplot(umbs_flwr_spp, aes(flwr_duration_scaled, fill = as.factor(plot))) + geom_histogram(binwidth = 0.5
        facet_grid(state~year, margins = TRUE, scales = "free")
```



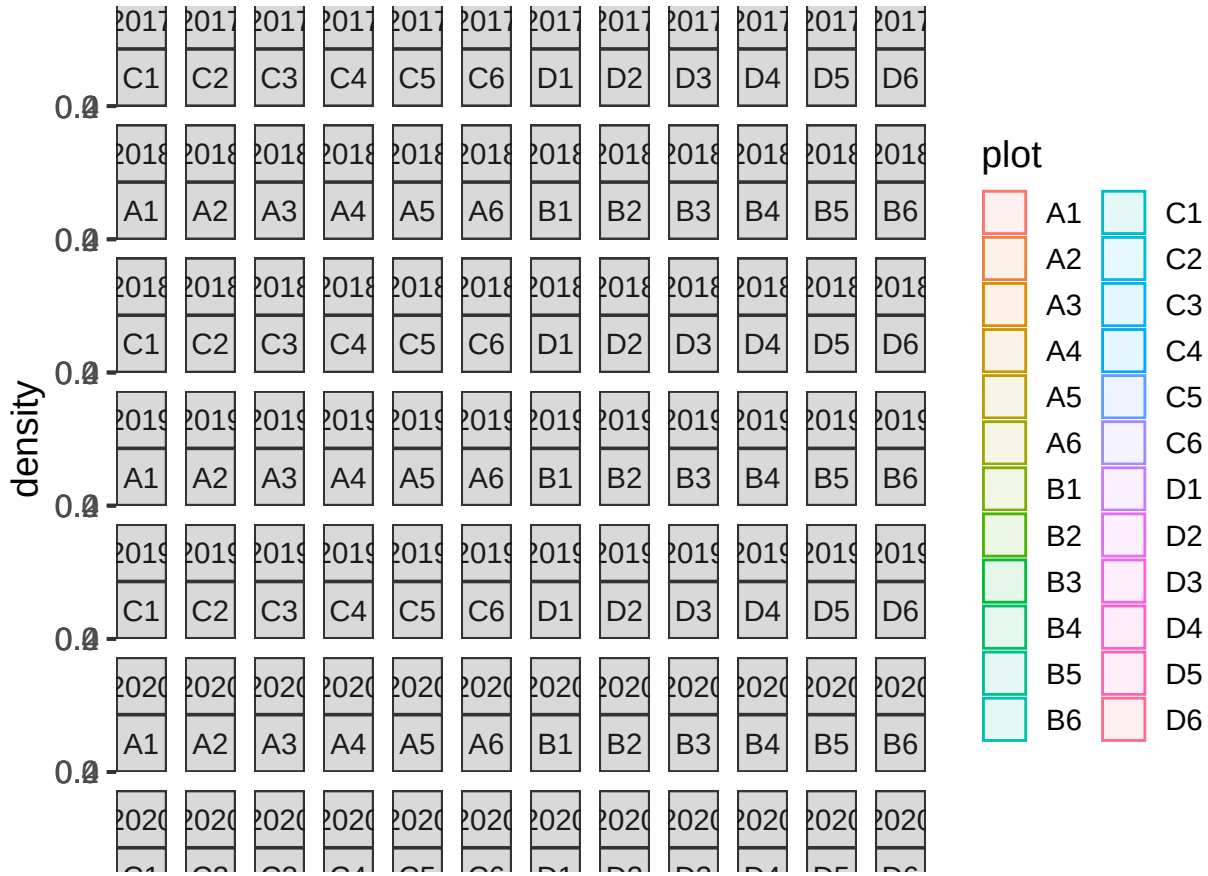

```
ggplot(umbs_flwr_spp, aes(flwr_duration_scaled, fill = plot, color=plot)) +
        geom_density(alpha = 0.1)
```



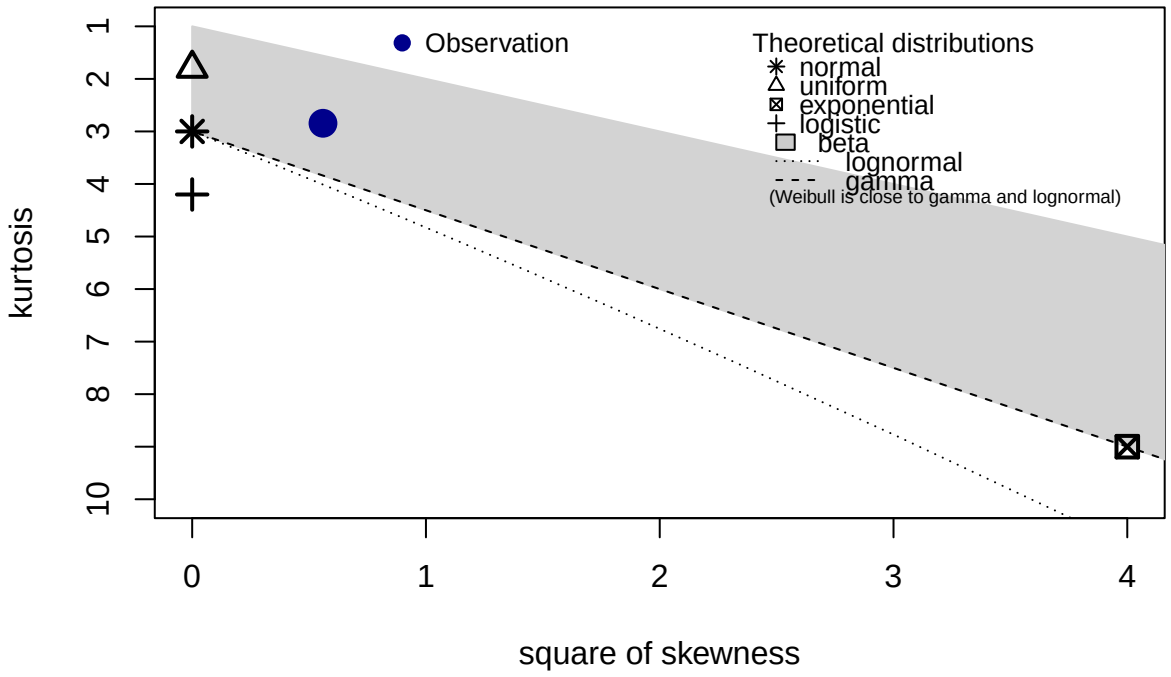

```
ggplot(umbs_flwr_spp, aes(flwr_duration_scaled, fill = plot, color=plot)) +
        geom_density(alpha = 0.1) +
        facet_wrap(~year)
```




```
ggplot(umbs_flwr_spp, aes(flwr_duration_scaled, fill = plot, color=plot)) +
        geom_density(alpha = 0.1) +
        facet_wrap(~year + plot)
```

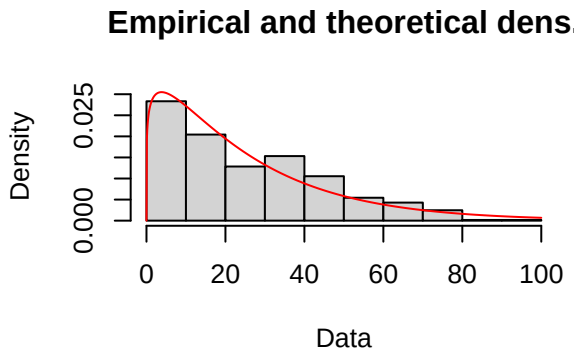


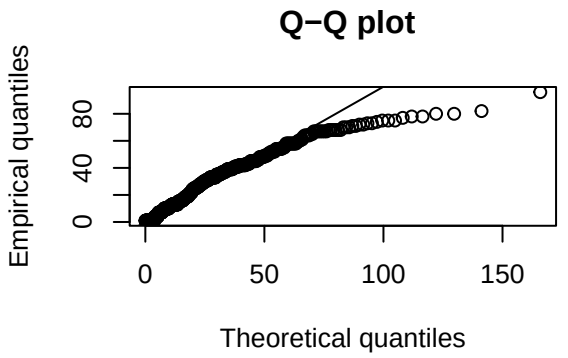

```
# Exploring distributions for these right-skewed data:
descdist(umbs_flwr_spp$flwr_duration_scaled, discrete = FALSE)
```

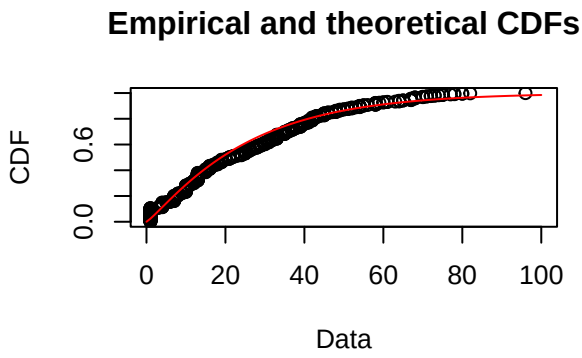


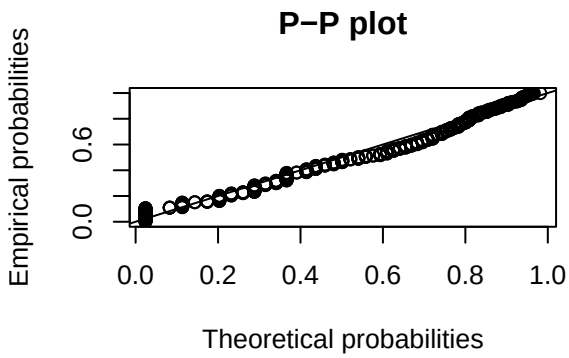

```
## summary statistics
## ------
## min:  1   max:  96
## median:  21
## mean:  25.78089
## estimated sd:  19.96209
## estimated skewness:  0.7480551
## estimated kurtosis:  2.844753
```

```
# Gamma distribution
fit.gamma <- fitdist(umbs_flwr_spp$flwr_duration_scaled, "gamma")
plot(fit.gamma)
```

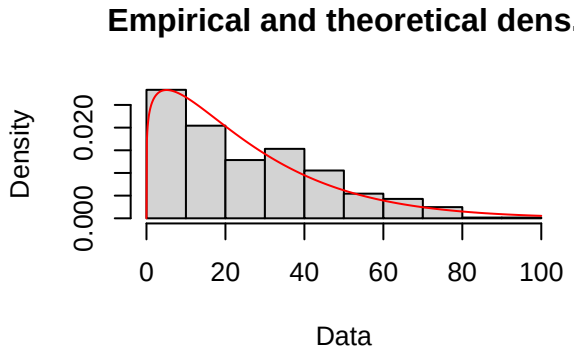


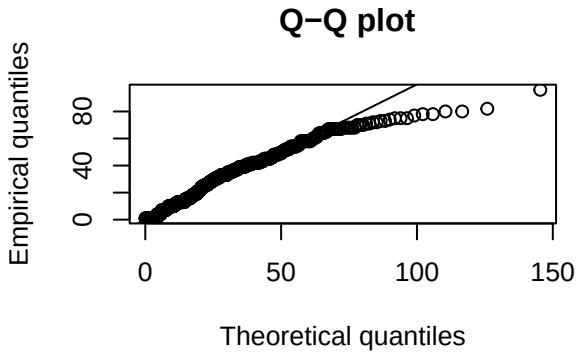


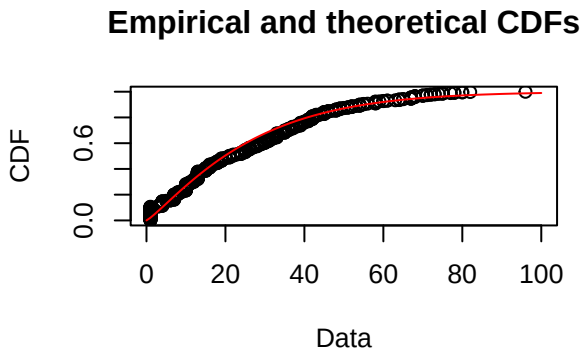


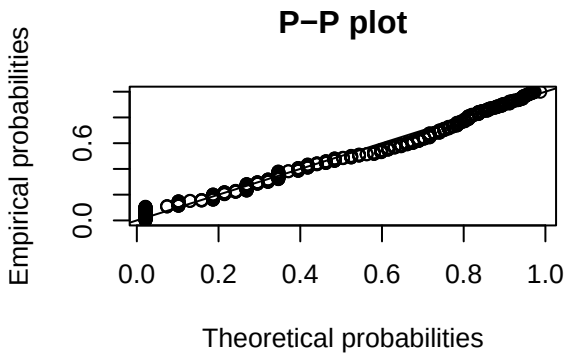



```
# Weibull distribution
fit.weibull  <- fitdist(umbs_flwr_spp$flwr_duration_scaled, "weibull")
plot(fit.weibull)
```

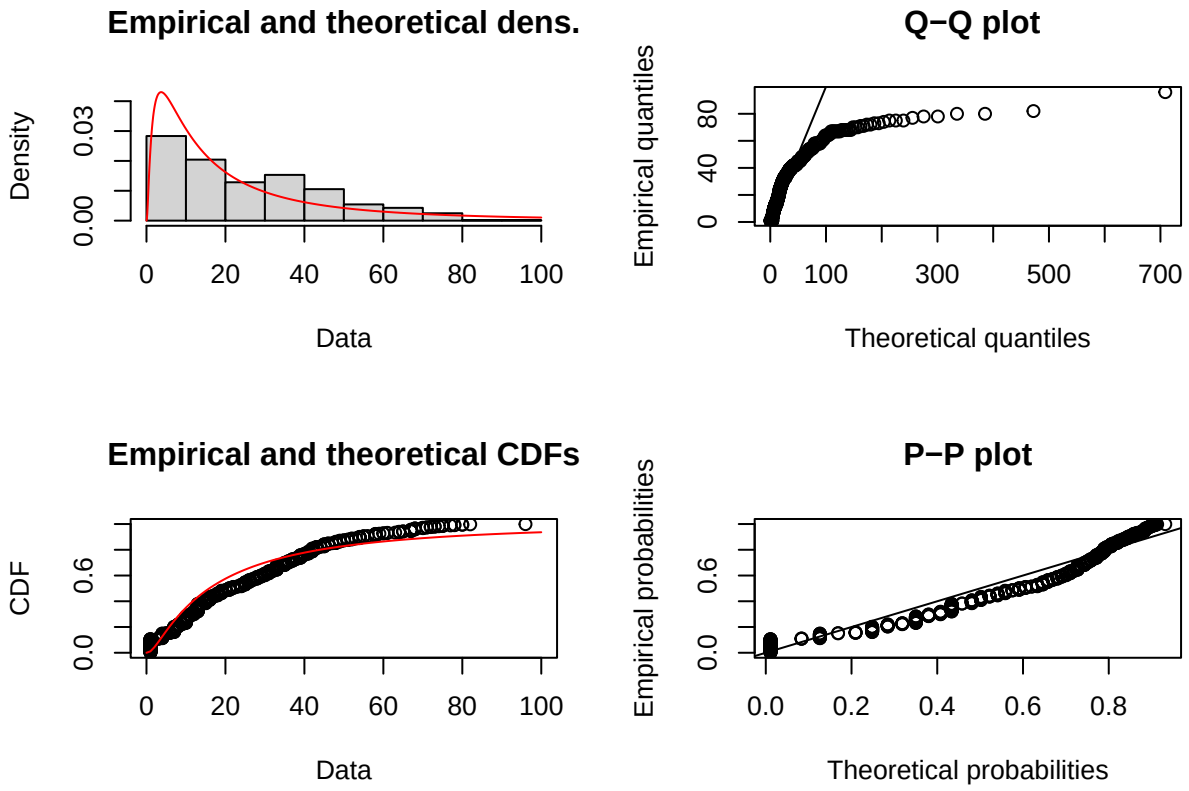




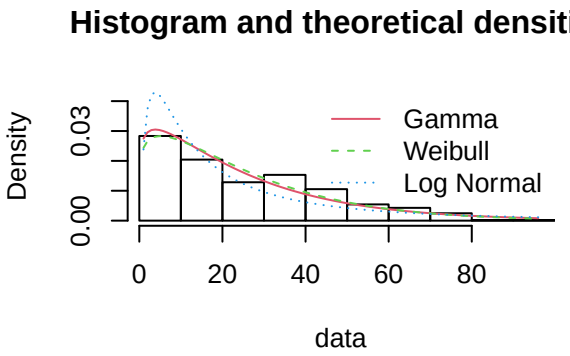


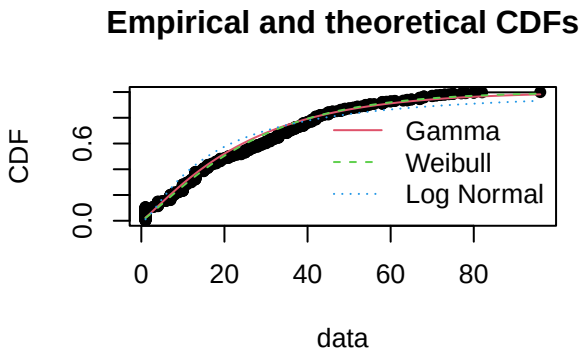


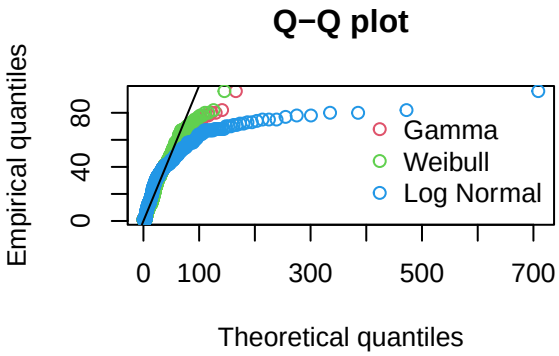
```
# Lognormal distribution
fit.ln <- fitdist(umbs_flwr_spp$flwr_duration_scaled, "lnorm")
plot(fit.ln)
```

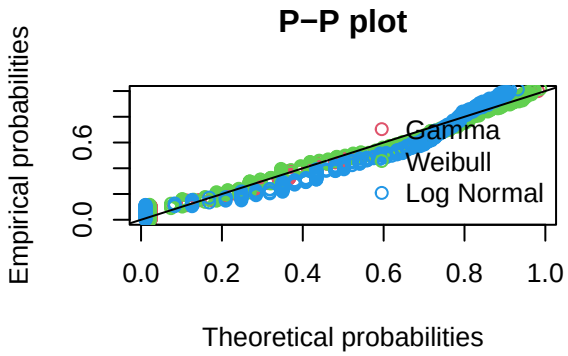



```
par(mfrow=c(2,2))
plot.legend <- c("Gamma", "Weibull", "Log Normal")
denscomp(list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
cdfcomp (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
qqcomp  (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
ppcomp  (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
```









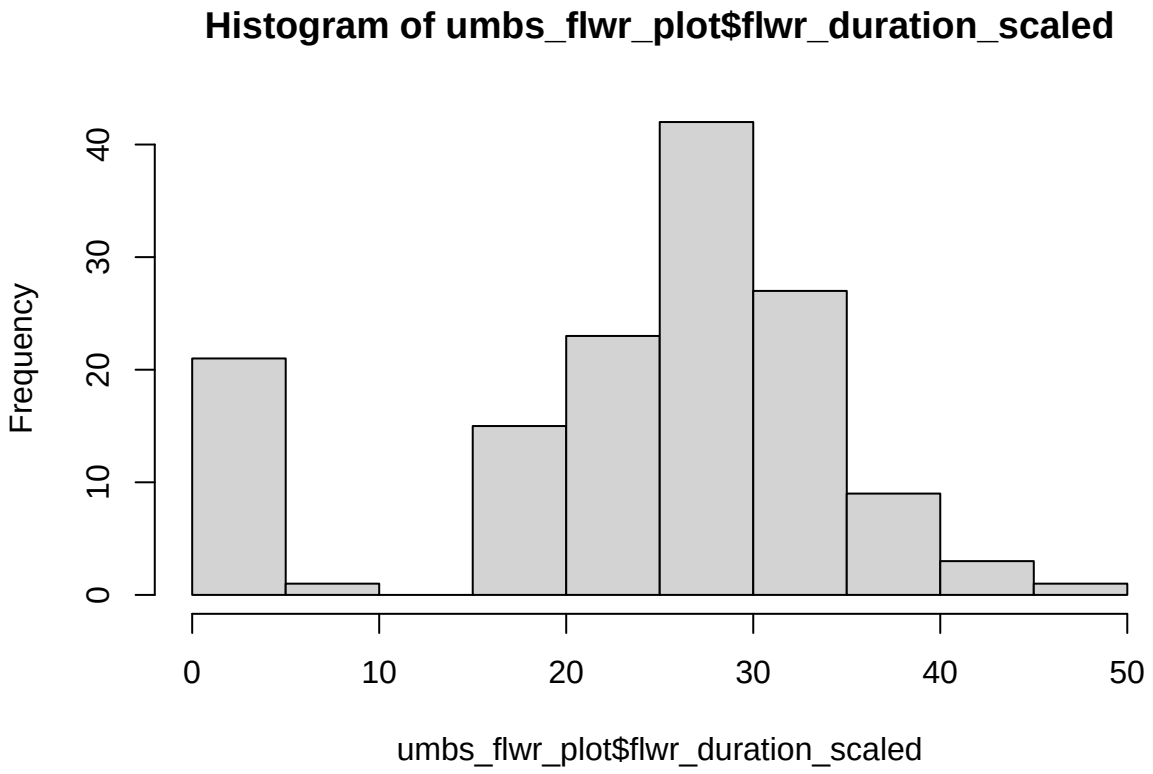

```
# Goodness of fit comparisons across fits (can't include the log normal bc it becomes diff response val
gofstat(list(fit.gamma, fit.weibull, fit.ln), fitnames = c("Gamma", "Weibull", "Log Normal"))
```

```
## Goodness-of-fit statistics
##                                 Gamma    Weibull Log Normal
## Kolmogorov-Smirnov statistic 0.08319317 0.08597213  0.1194855
## Cramer-von Mises statistic   0.93573126 0.71102909  3.1067790
## Anderson-Darling statistic   7.68325283 6.94267550 23.1991121
##
## Goodness-of-fit criteria
##                                 Gamma  Weibull Log Normal
## Akaike's Information Criterion 5153.622 5143.267   5313.315
## Bayesian Information Criterion 5162.439 5152.084   5322.132
```

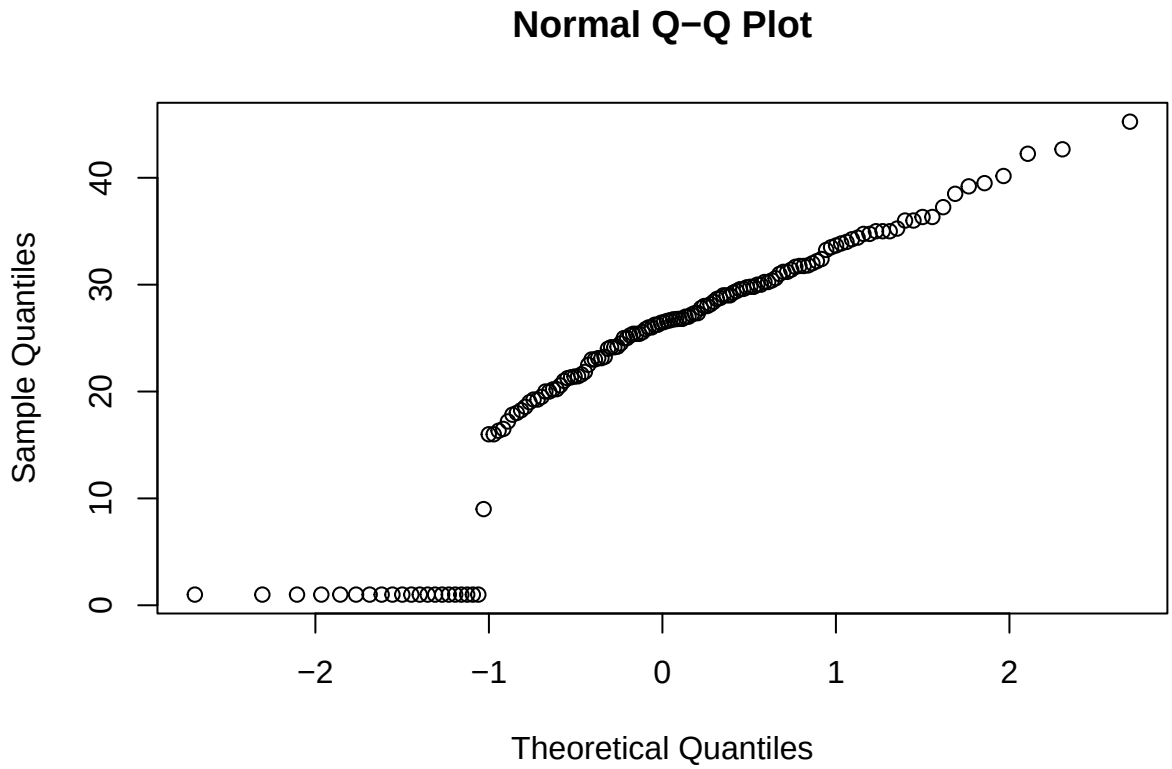
```
# weibull, probably going with log transformation
```

UMBS PLOT LEVEL - Looking at DURATION of flowering

```
### UMBS ###
hist(umbs_flwr_plot$flwr_duration_scaled)
```



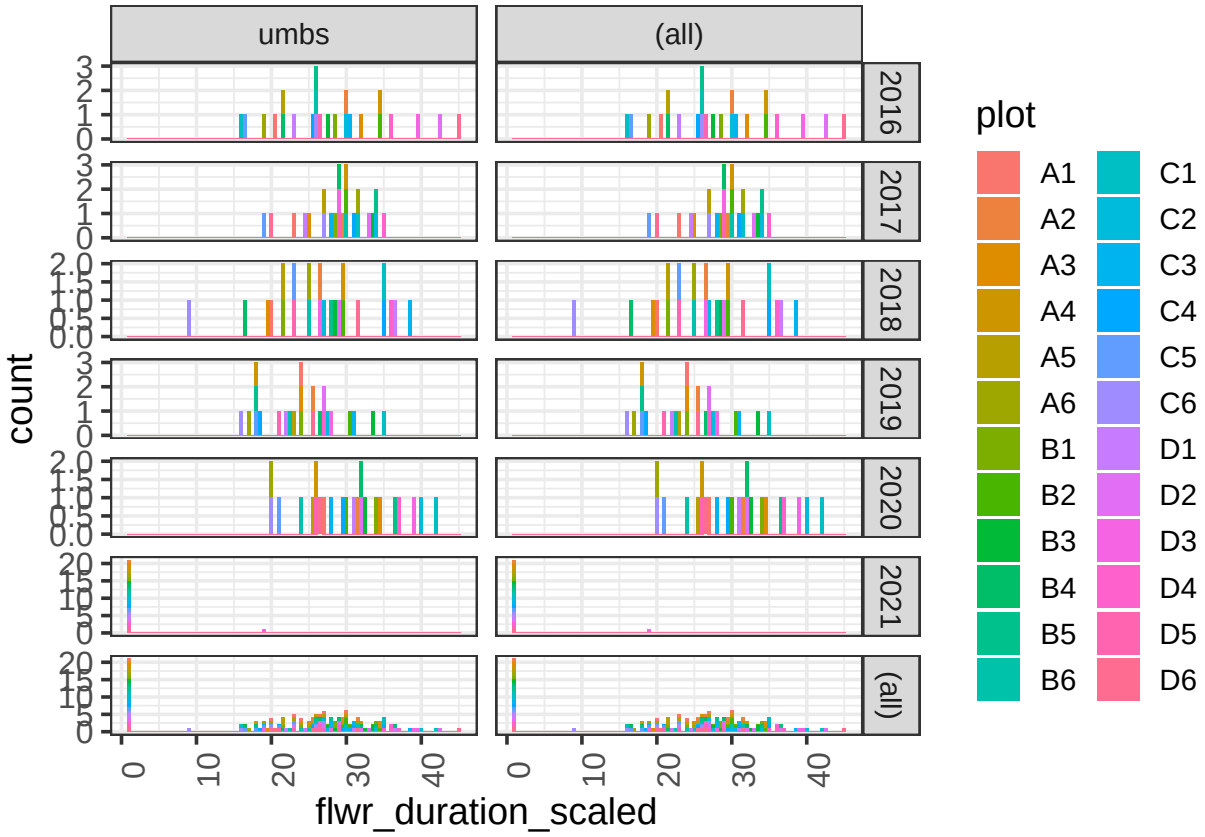

```
qqnorm(umbs_flwr_plot$flwr_duration_scaled)
```



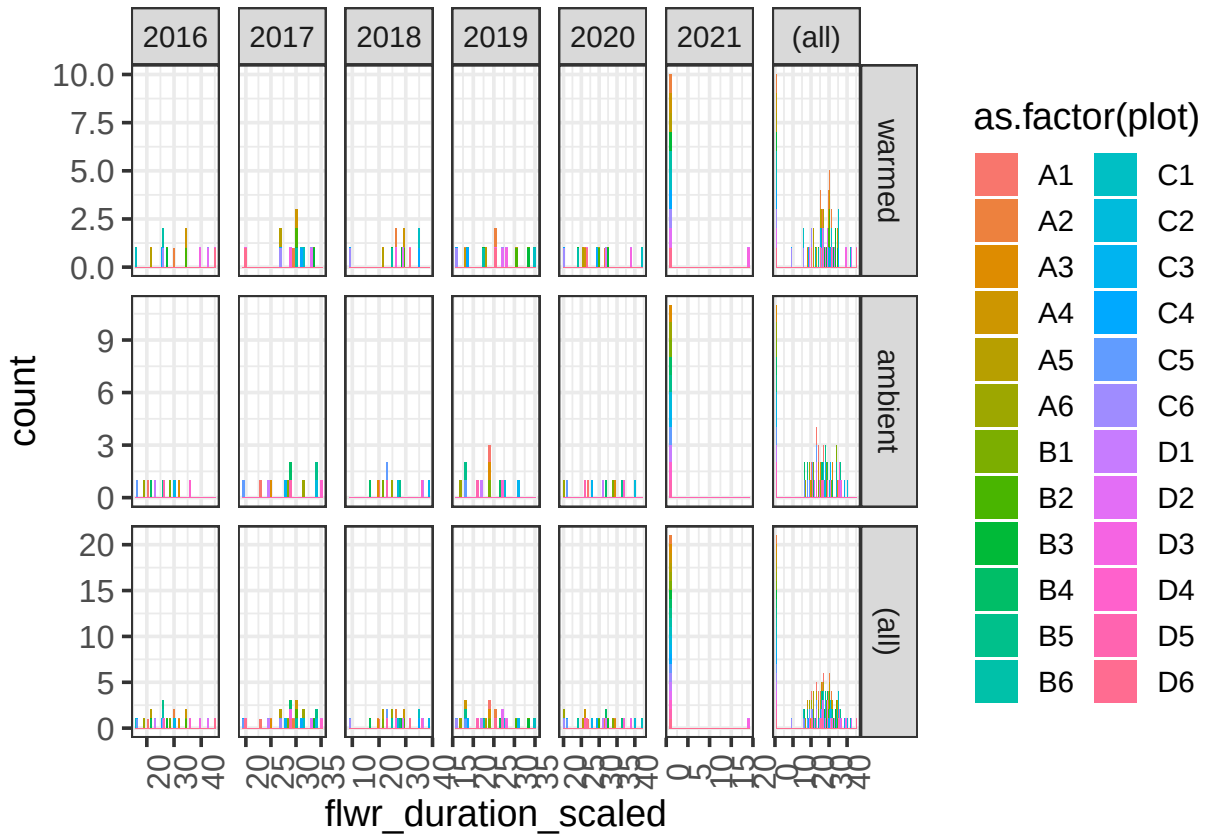
```
shapiro.test(umbs_flwr_plot$flwr_duration_scaled) # pvalue is > 0.05 so we accept the null hypothesis t
```

```
##
##  Shapiro-Wilk normality test
##
## data:  umbs_flwr_plot$flwr_duration_scaled
## W = 0.88056, p-value = 2.562e-09
```

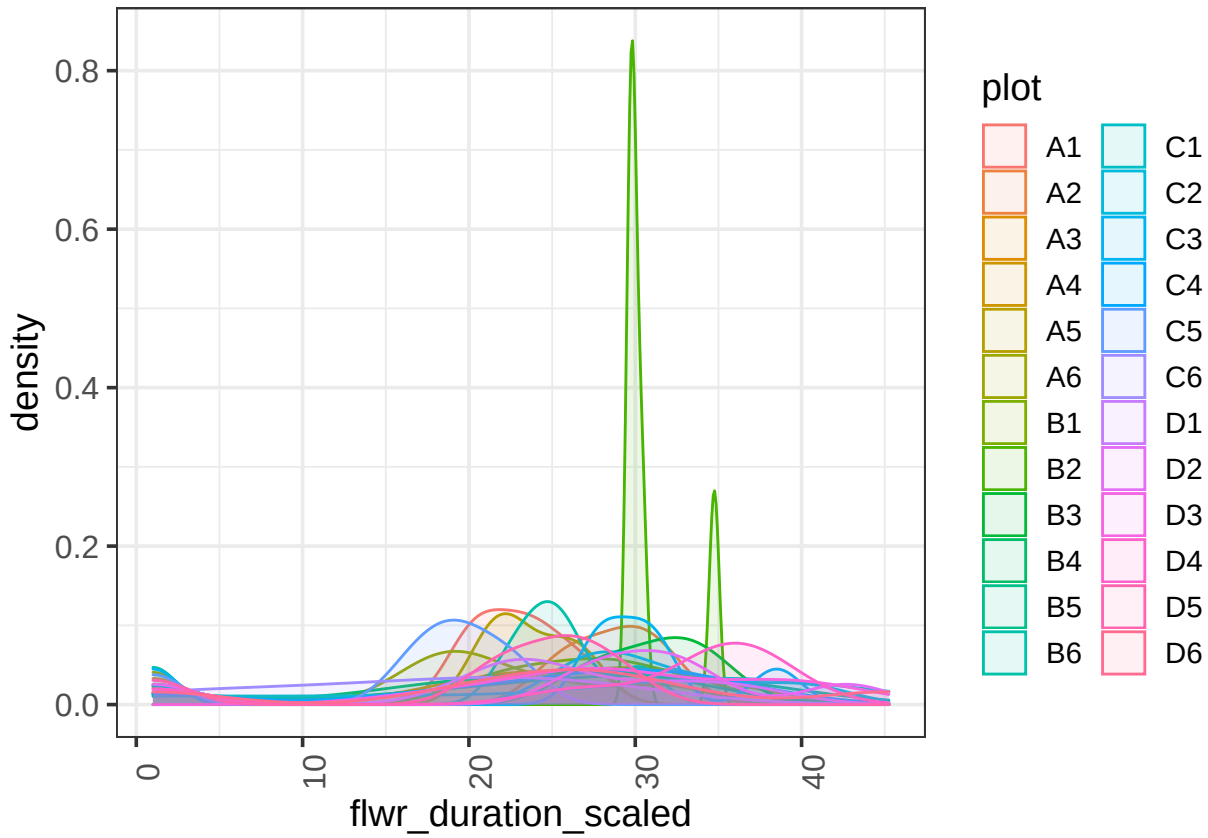
```
# Visualizing median Julian date for umbs at the PLOT LEVEL
ggplot(umbs_flwr_plot, aes(flwr_duration_scaled, fill = plot)) +
        geom_histogram(binwidth = 0.5) +
        facet_grid(year ~ site, margins = TRUE, scales = "free")
```




```
ggplot(umbs_flwr_plot, aes(flwr_duration_scaled, fill = as.factor(plot))) + geom_histogram(binwidth = 0
        facet_grid(state~year, margins = TRUE, scales = "free")
```

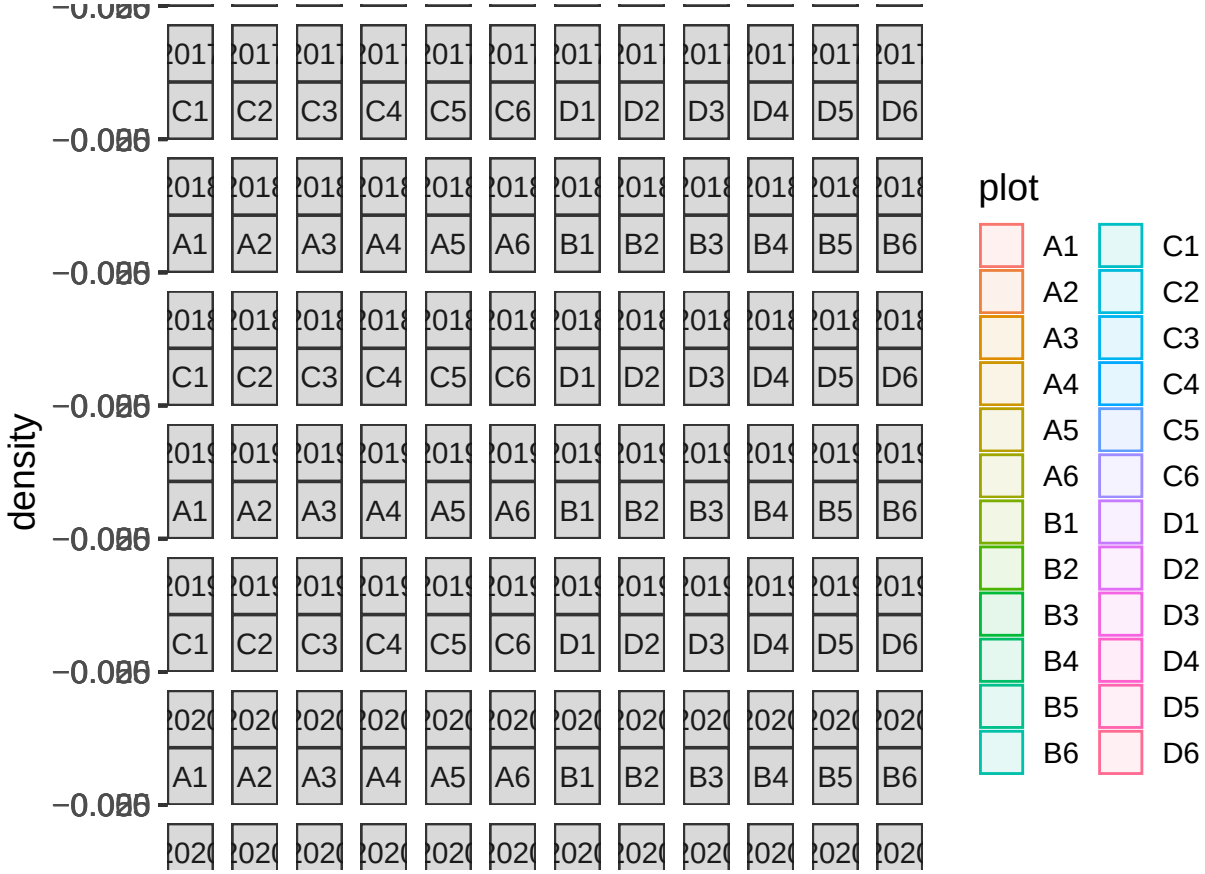



```
ggplot(umbs_flwr_plot, aes(flwr_duration_scaled, fill = plot, color=plot)) +
        geom_density(alpha = 0.1)
```

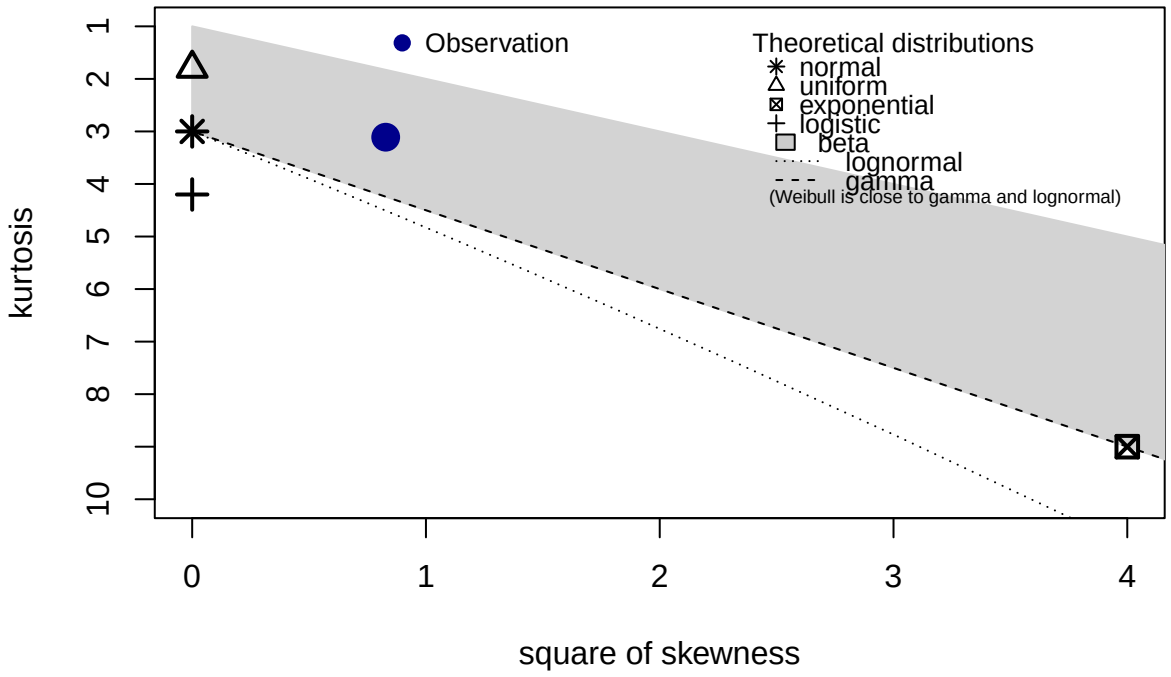



```
ggplot(umbs_flwr_plot, aes(flwr_duration_scaled, fill = plot, color=plot)) +
        geom_density(alpha = 0.1) +
        facet_wrap(~year)
```


```
ggplot(umbs_flwr_plot, aes(flwr_duration_scaled, fill = plot, color=plot)) +
        geom_density(alpha = 0.1) +
        facet_wrap(~year + plot)
```

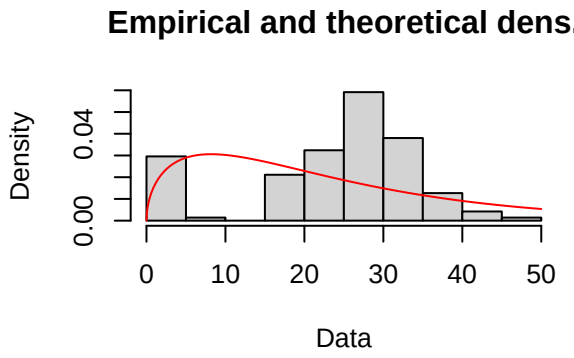


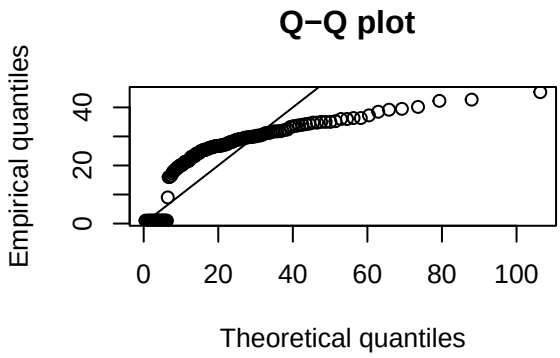

```
# Exploring distributions for these data:
descdist(umbs_flwr_plot$flwr_duration_scaled, discrete = FALSE)
```

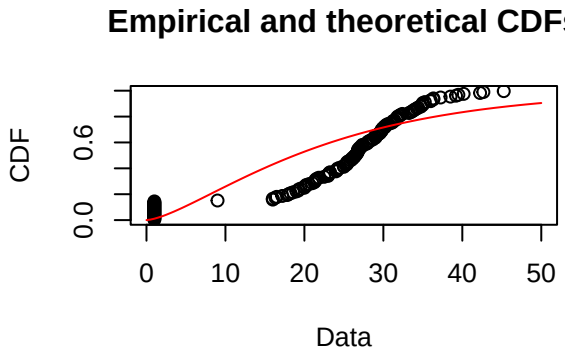


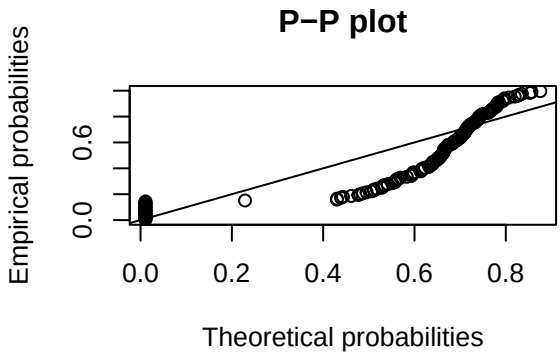

```
## summary statistics
## ------
## min:  1   max:  45.25
## median:  26.46429
## mean:  23.70413
## estimated sd:  11.18981
## estimated skewness:  -0.9098686
## estimated kurtosis:  3.10952
```

```
# Gamma distribution
fit.gamma <- fitdist(umbs_flwr_plot$flwr_duration_scaled, "gamma")
plot(fit.gamma)
```

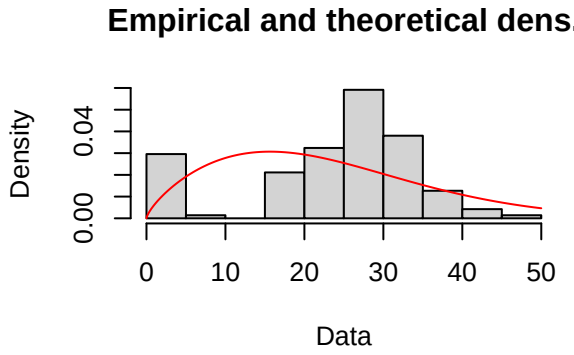


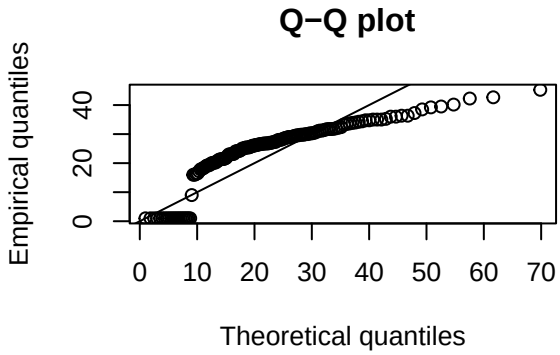


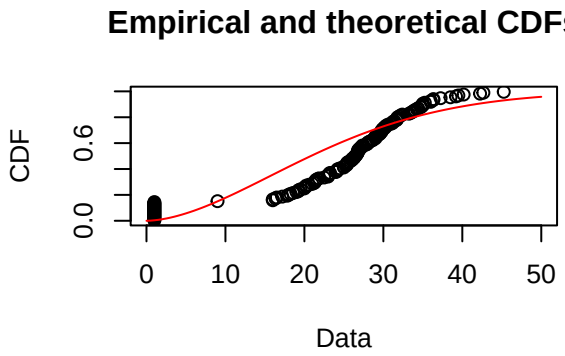


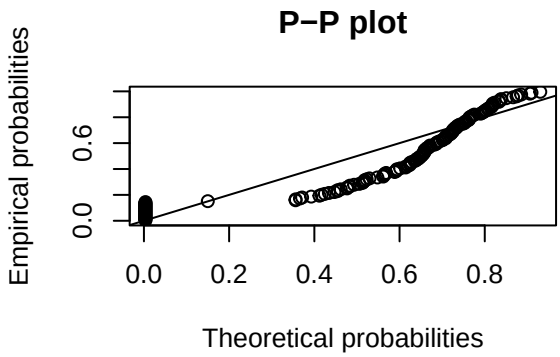



```
# Weibull distribution
fit.weibull  <- fitdist(umbs_flwr_plot$flwr_duration_scaled, "weibull")
plot(fit.weibull)
```

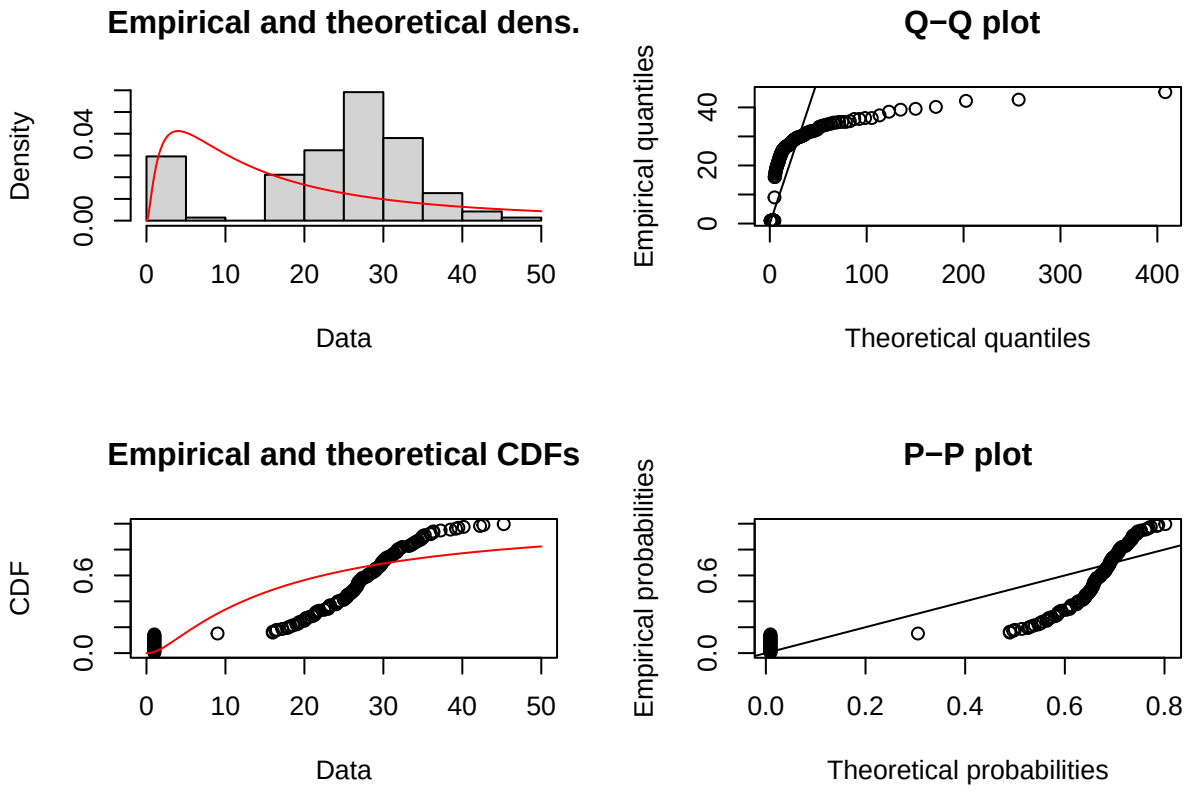




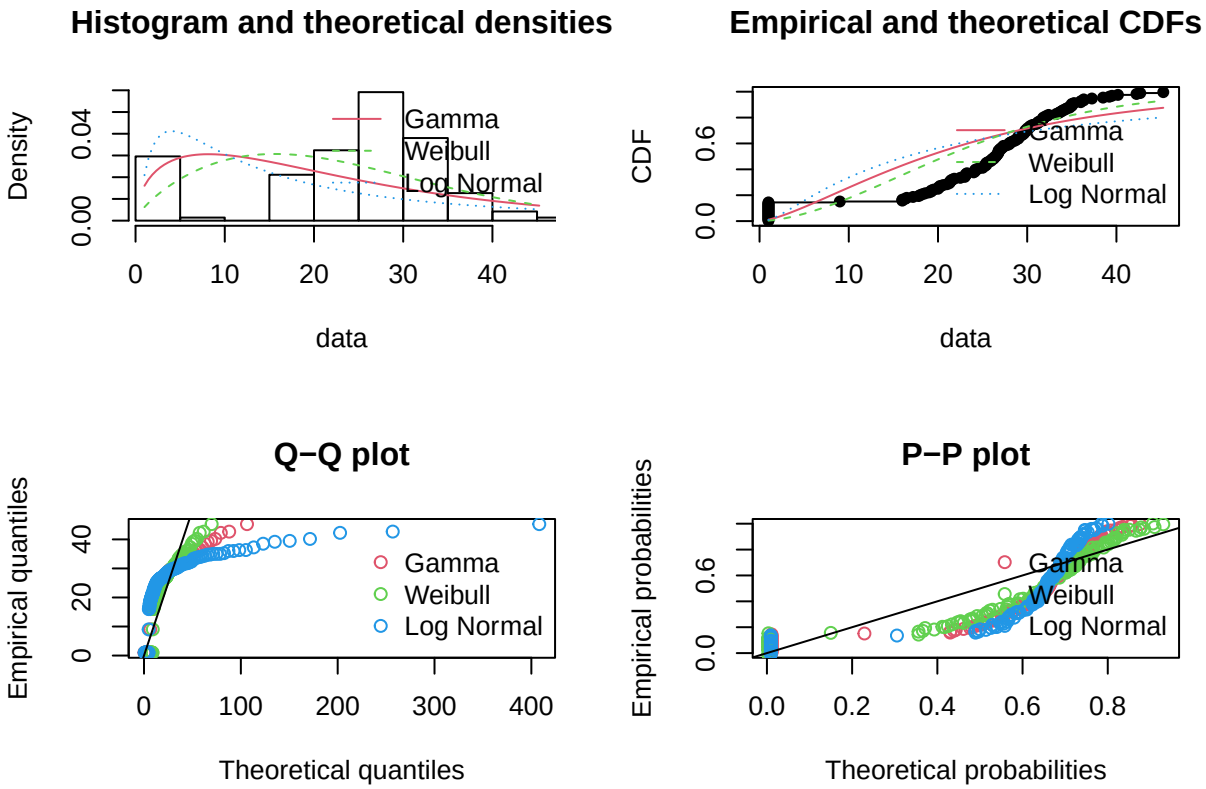




```
# Lognormal distribution
fit.ln <- fitdist(umbs_flwr_plot$flwr_duration_scaled, "lnorm")
plot(fit.ln)
```




```
par(mfrow=c(2,2))
plot.legend <- c("Gamma", "Weibull", "Log Normal")
denscomp(list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
cdfcomp (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
qqcomp  (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
ppcomp  (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
```



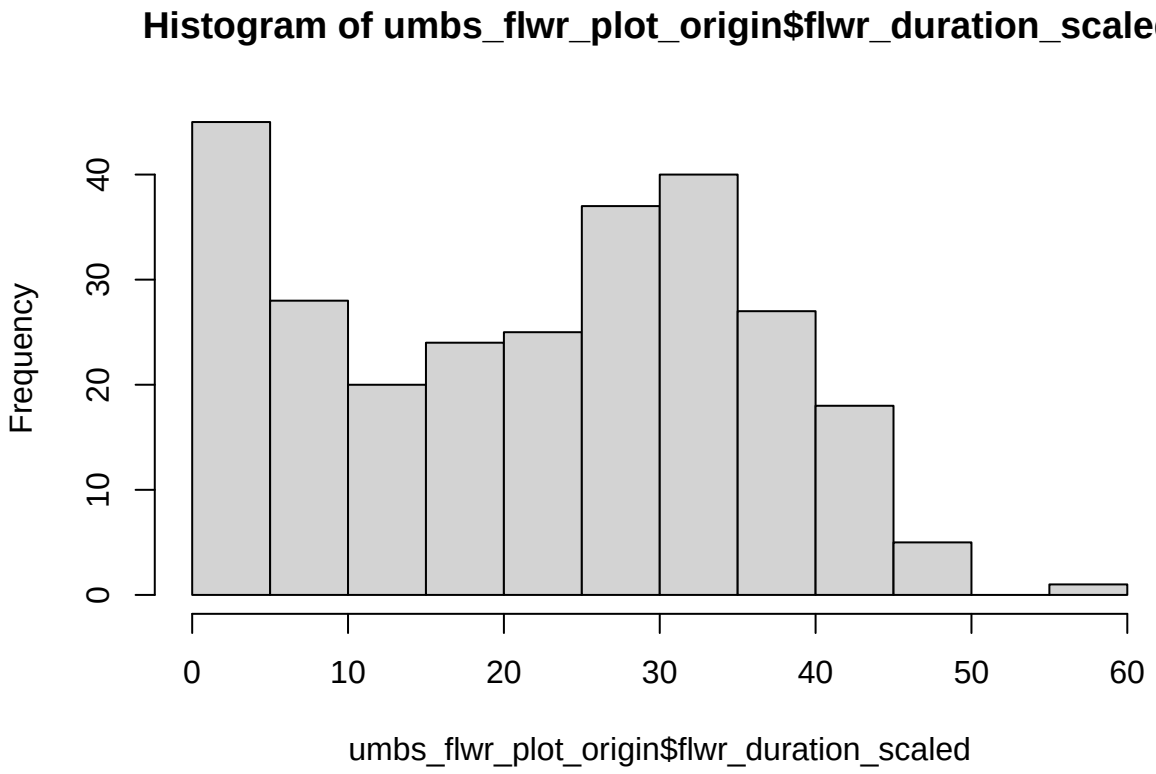

```
# Goodness of fit comparisons across fits (can't include the log normal bc it becomes diff response val
gofstat(list(fit.gamma, fit.weibull, fit.ln), fitnames = c("Gamma", "Weibull", "Log Normal"))
```

```
## Goodness-of-fit statistics
##                                Gamma    Weibull Log Normal
## Kolmogorov-Smirnov statistic  0.2870677  0.2301924  0.3357487
## Cramer-von Mises statistic    3.6271289  2.5535214  4.6646117
## Anderson-Darling statistic   20.3475079 18.3334439 25.6766144
##
## Goodness-of-fit criteria
##                                Gamma  Weibull Log Normal
## Akaike's Information Criterion 1173.375 1146.133   1252.746
## Bayesian Information Criterion 1179.287 1152.045   1258.658
```

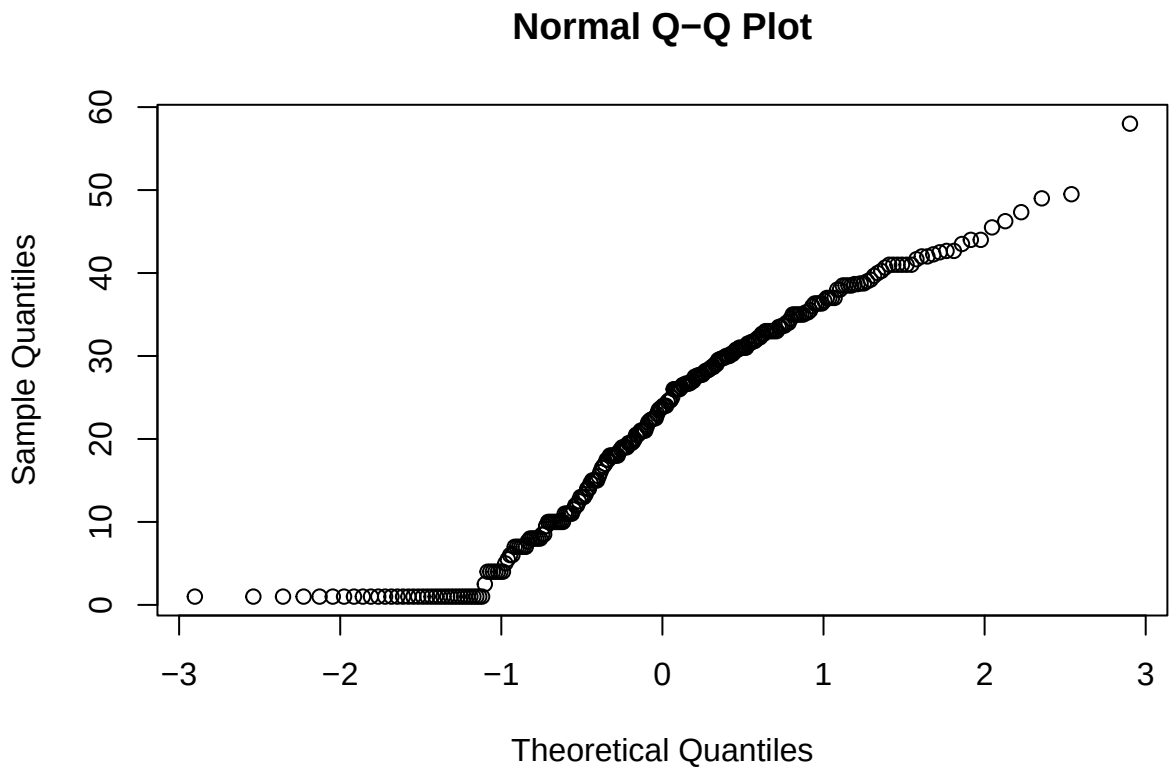
```
# Weibull, probably going with log transformation
```

UMBS PLOT LEVEL ORIGIN - Looking at DURATION of flowering

```
### UMBS ###
hist(umbs_flwr_plot_origin$flwr_duration_scaled)
```



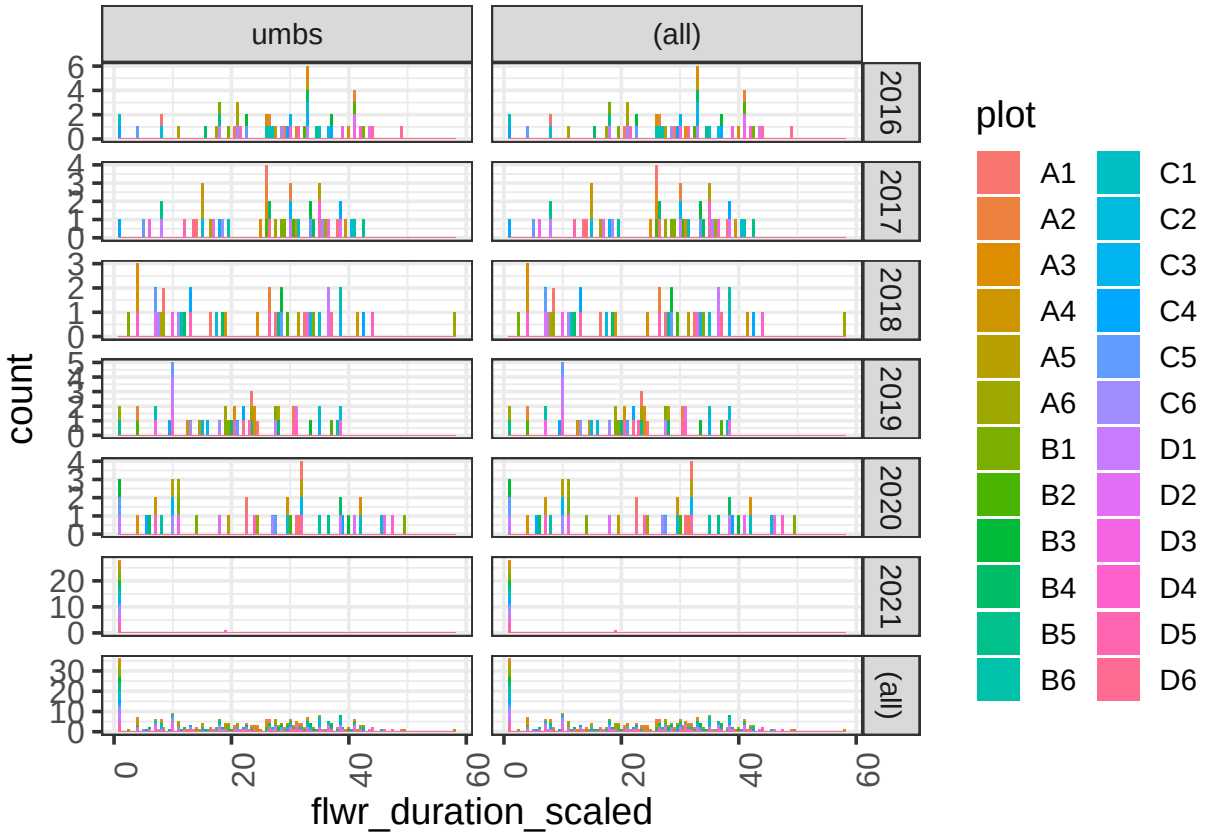

```
qqnorm(umbs_flwr_plot_origin$flwr_duration_scaled)
```



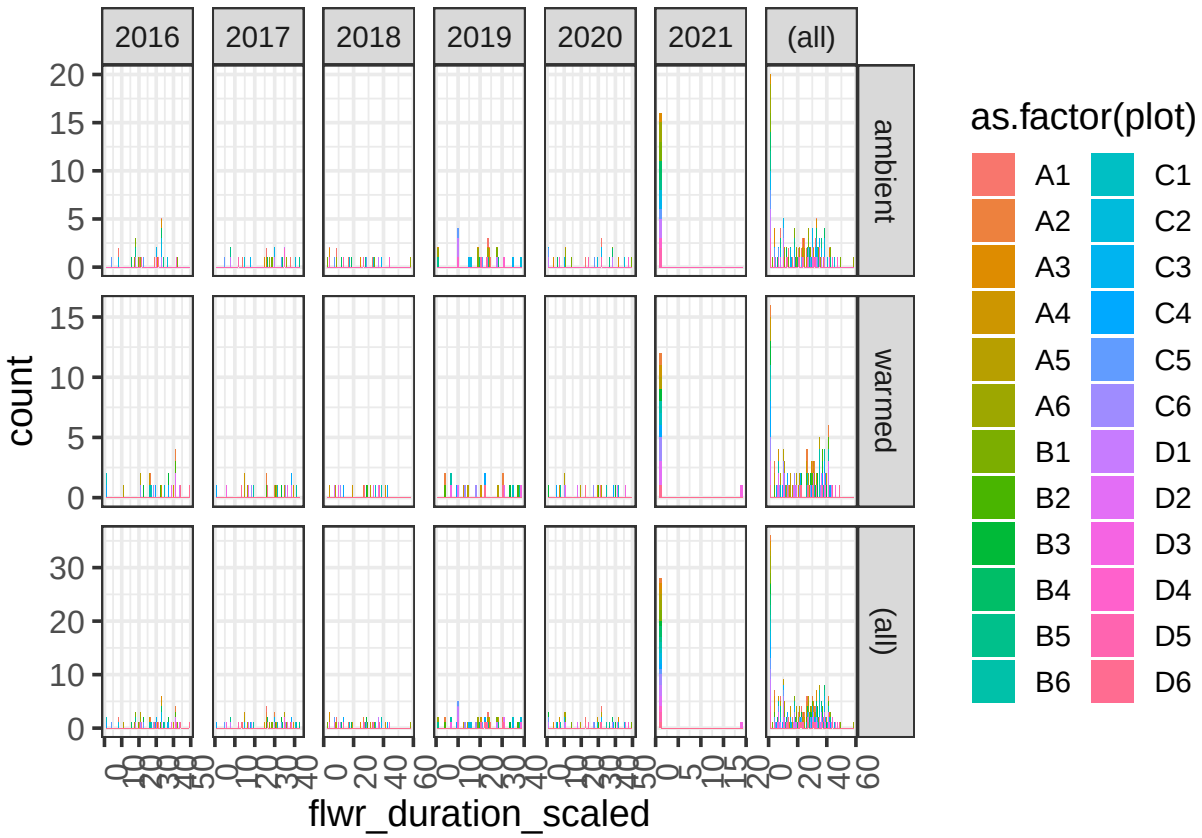
```
shapiro.test(kbs_flwr_plot_origin$flwr_duration_scaled) # pvalue is < 0.05 so we reject the null hypoth
```

```
##
##  Shapiro-Wilk normality test
##
## data:  kbs_flwr_plot_origin$flwr_duration_scaled
## W = 0.97267, p-value = 2.782e-07
```

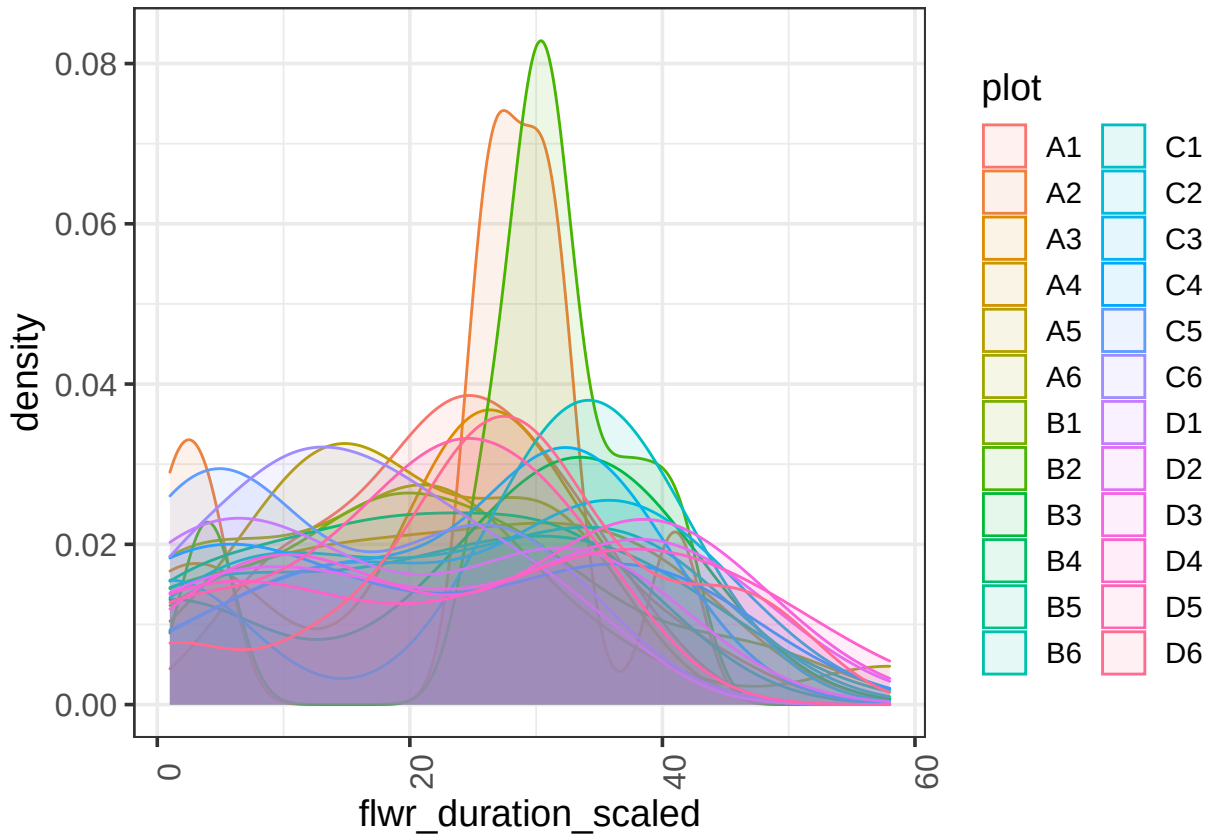
```
# Visualizing median Julian date for umbs at the PLOT LEVEL
ggplot(umbs_flwr_plot_origin, aes(flwr_duration_scaled, fill = plot)) +
        geom_histogram(binwidth = 0.5) +
        facet_grid(year ~ site, margins = TRUE, scales = "free")
```



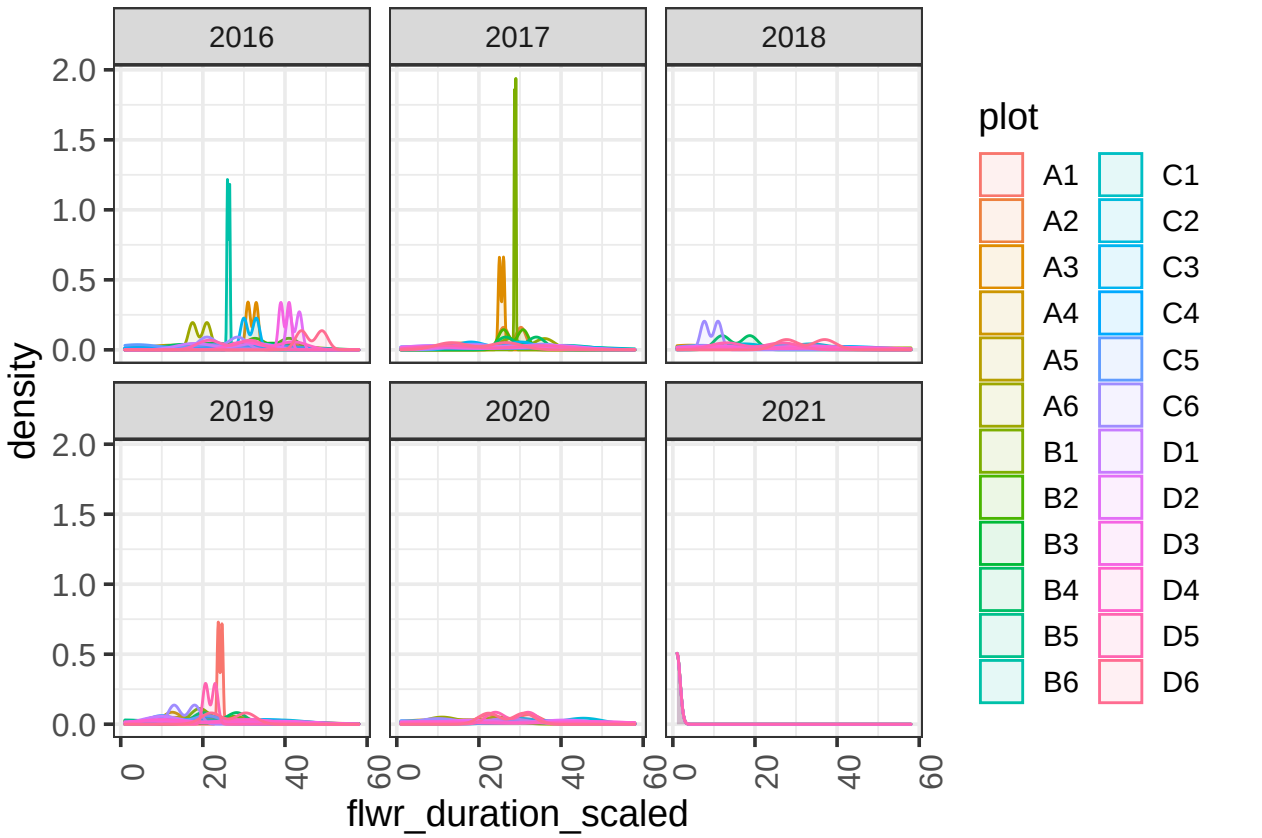

```
ggplot(umbs_flwr_plot_origin, aes(flwr_duration_scaled, fill = as.factor(plot))) + geom_histogram(binwi
        facet_grid(state~year, margins = TRUE, scales = "free")
```



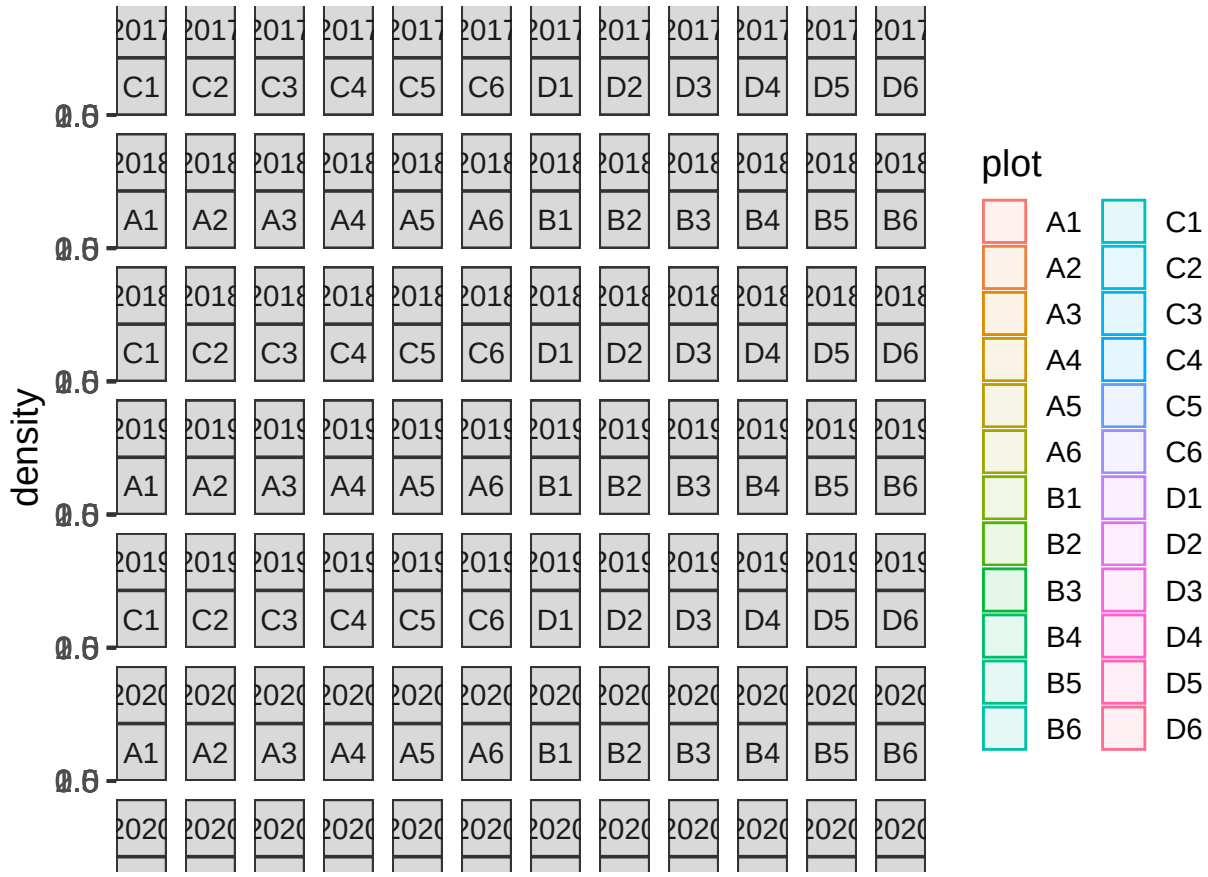

```
ggplot(umbs_flwr_plot_origin, aes(flwr_duration_scaled, fill = plot, color=plot)) +
        geom_density(alpha = 0.1)
```



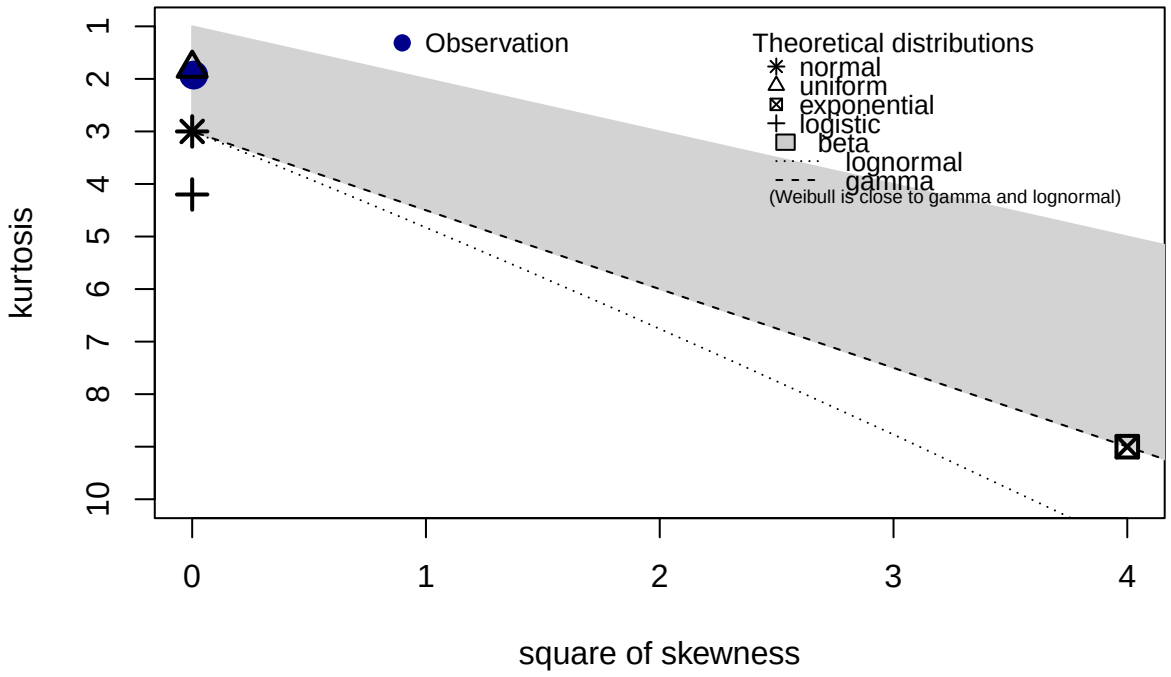

```
ggplot(umbs_flwr_plot_origin, aes(flwr_duration_scaled, fill = plot, color=plot)) +
        geom_density(alpha = 0.1) +
        facet_wrap(~year)
```




```
ggplot(umbs_flwr_plot_origin, aes(flwr_duration_scaled, fill = plot, color=plot)) +
        geom_density(alpha = 0.1) +
        facet_wrap(~year + plot)
```

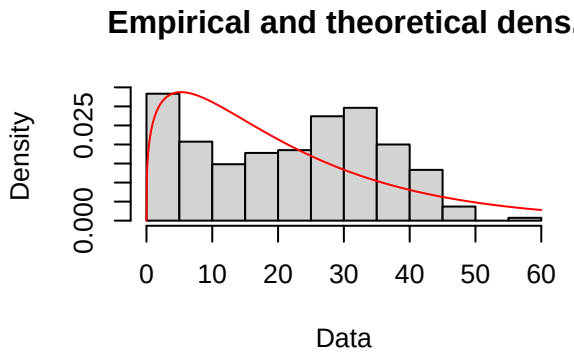


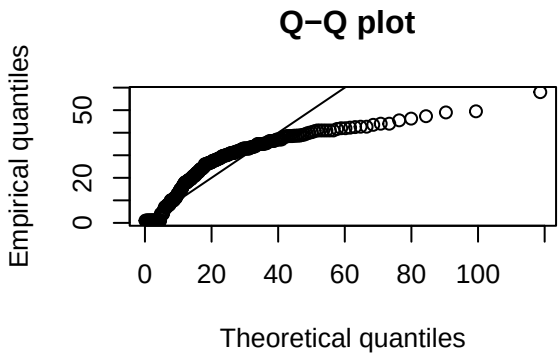

```
# Exploring distributions for these data:
descdist(umbs_flwr_plot_origin$flwr_duration_scaled, discrete = FALSE)
```

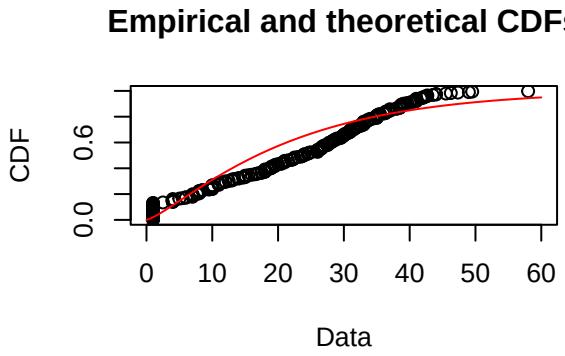


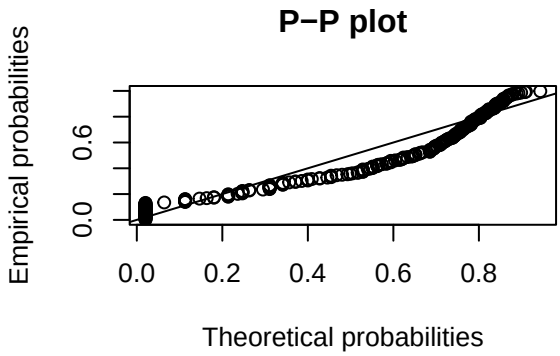

```
## summary statistics
## ------
## min:  1   max:  58
## median:  23.875
## mean:  22.0879
## estimated sd:  13.70896
## estimated skewness:  -0.07971301
## estimated kurtosis:  1.92752
```

```
# Gamma distribution
fit.gamma <- fitdist(umbs_flwr_plot_origin$flwr_duration_scaled, "gamma")
plot(fit.gamma)
```

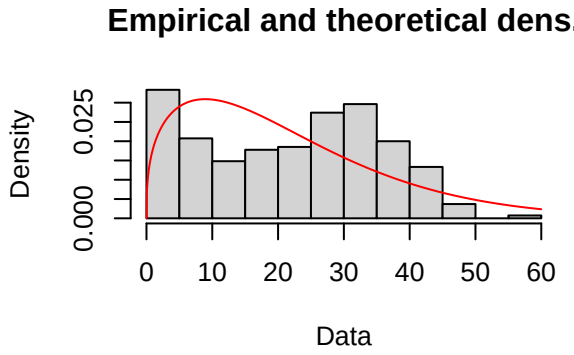


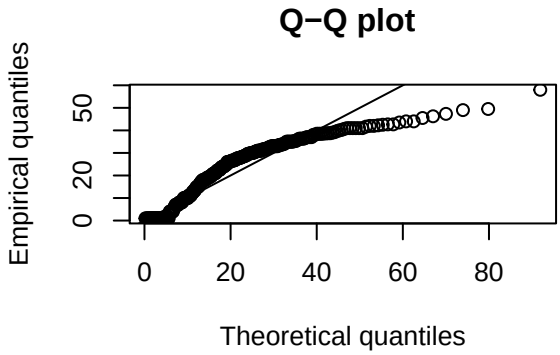


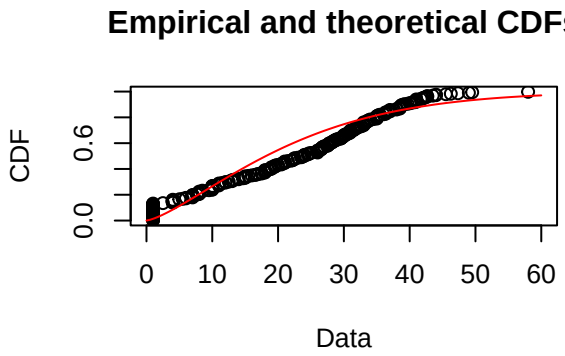


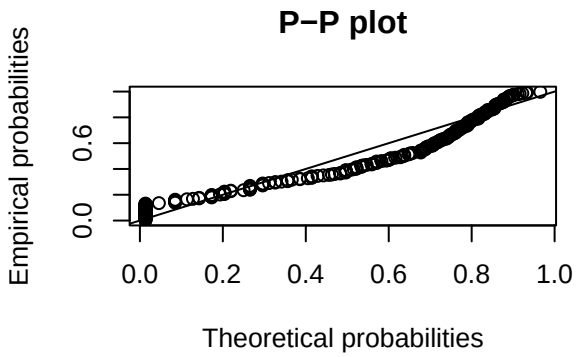



```
# Weibull distribution
fit.weibull  <- fitdist(umbs_flwr_plot_origin$flwr_duration_scaled, "weibull")
plot(fit.weibull)
```

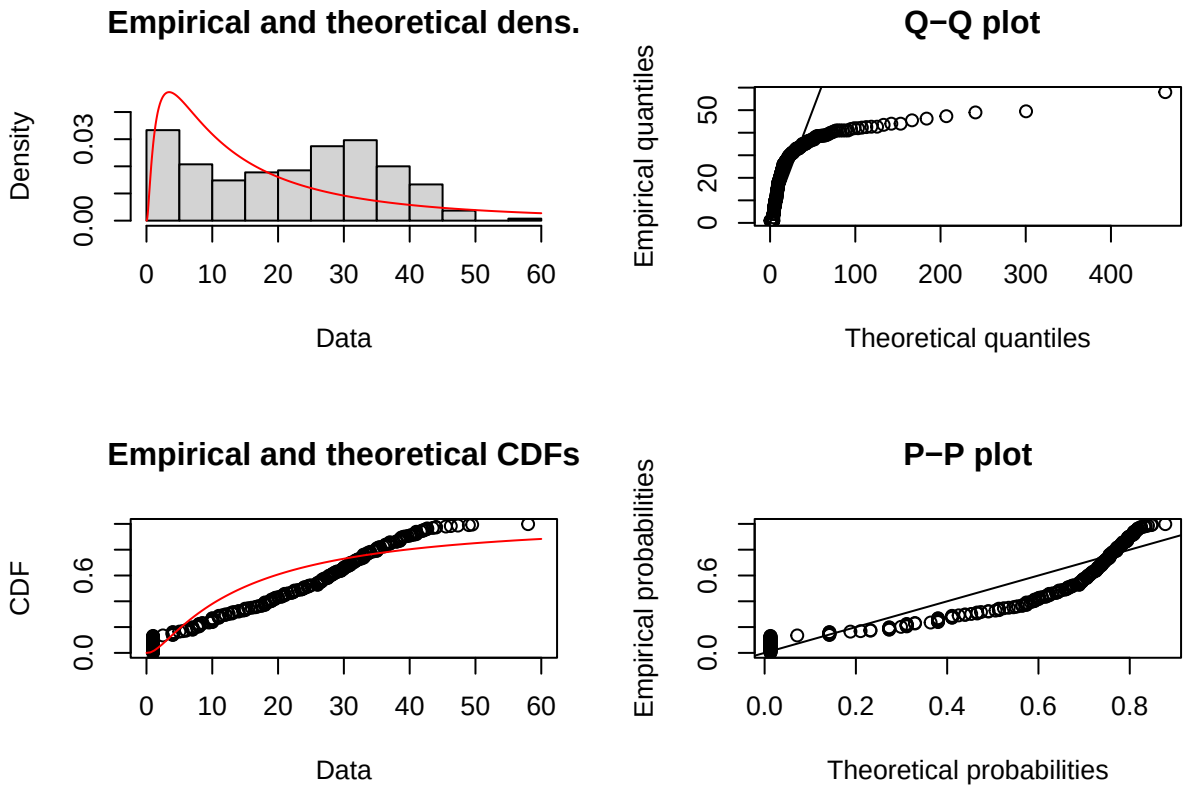




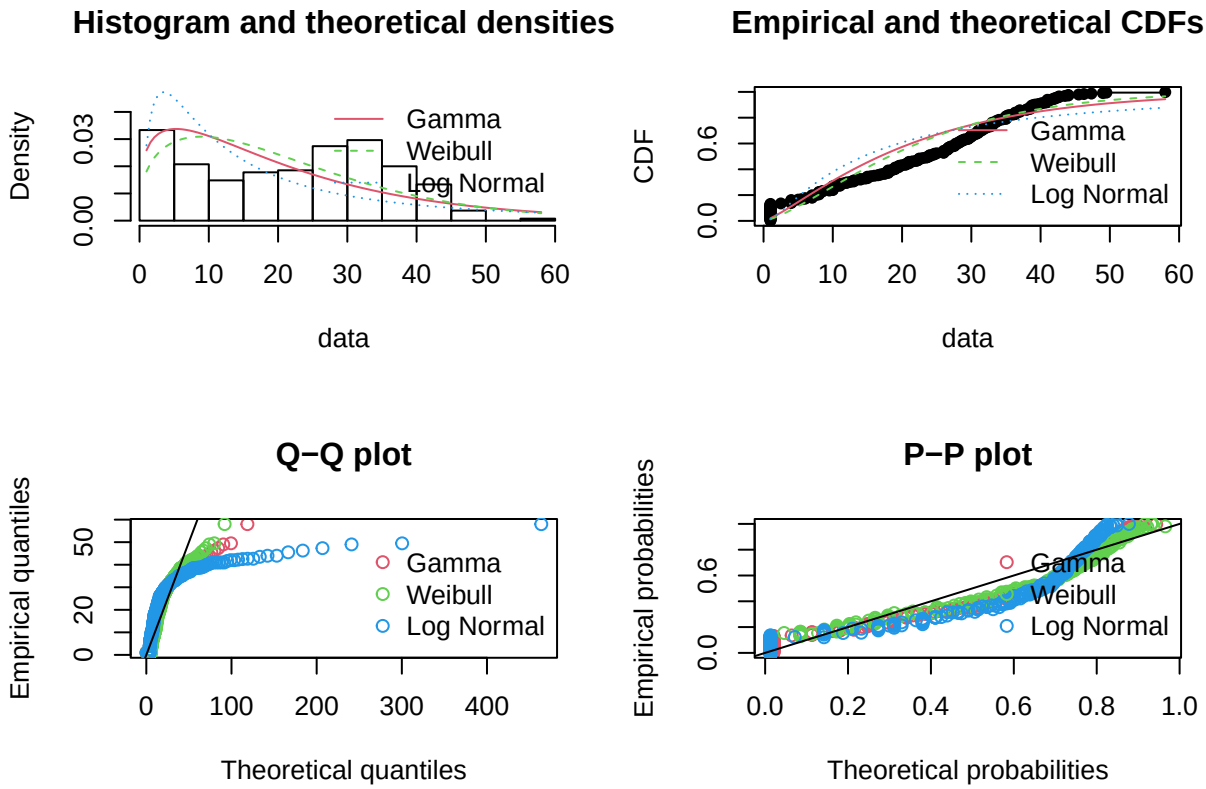




```
# Lognormal distribution
fit.ln <- fitdist(umbs_flwr_plot_origin$flwr_duration_scaled, "lnorm")
plot(fit.ln)
```




```
par(mfrow=c(2,2))
plot.legend <- c("Gamma", "Weibull", "Log Normal")
denscomp(list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
cdfcomp (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
qqcomp  (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
ppcomp  (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
```



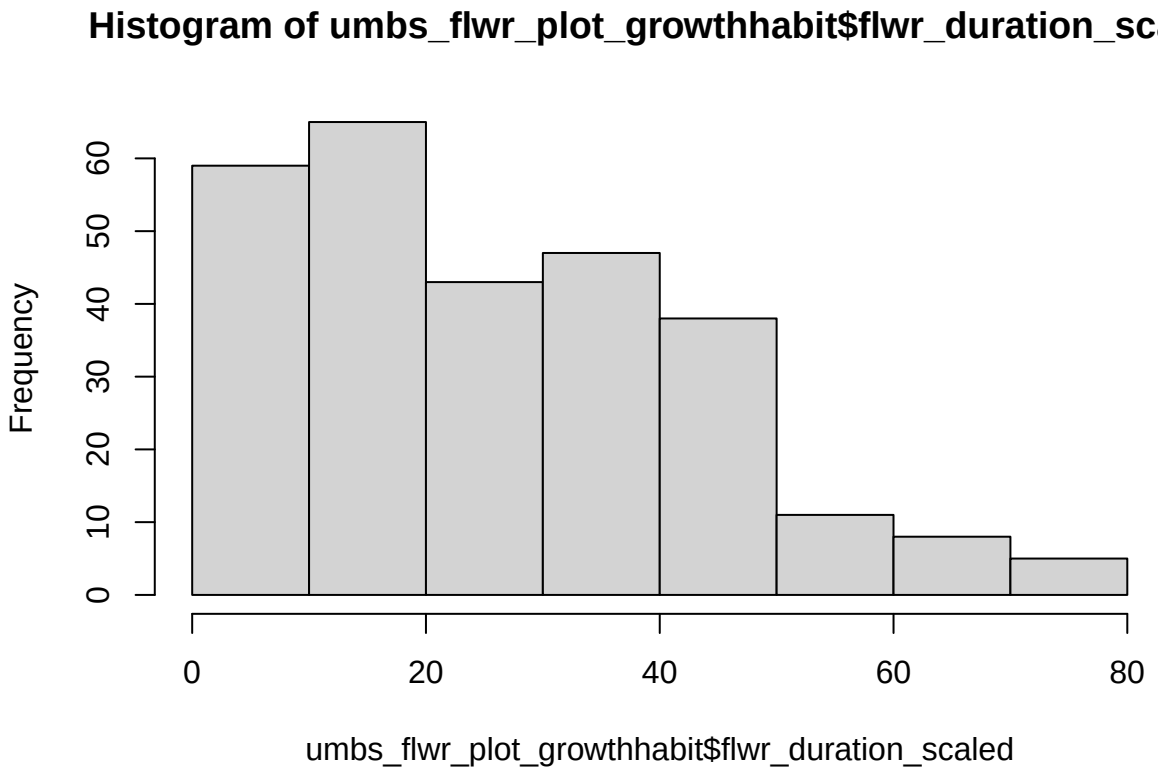

```
# Goodness of fit comparisons across fits (can't include the log normal bc it becomes diff response val
gofstat(list(fit.gamma, fit.weibull, fit.ln), fitnames = c("Gamma", "Weibull", "Log Normal"))
```

```
## Goodness-of-fit statistics
##                                Gamma    Weibull Log Normal
## Kolmogorov-Smirnov statistic  0.1593733  0.1512241  0.2033579
## Cramer-von Mises statistic    2.2091498  1.6856777  3.6195315
## Anderson-Darling statistic   14.0374874 12.9499947 22.7722135
##
## Goodness-of-fit criteria
##                                Gamma  Weibull Log Normal
## Akaike's Information Criterion 2203.875 2185.784   2307.639
## Bayesian Information Criterion 2211.072 2192.980   2314.836
```

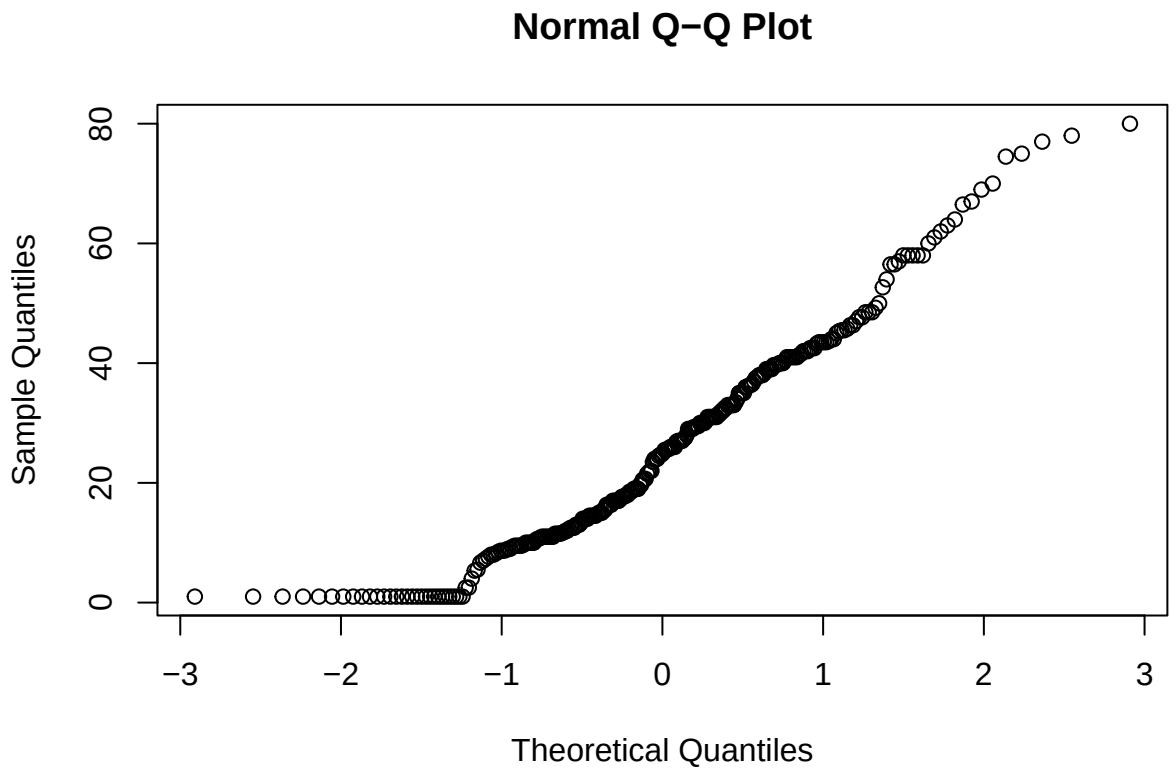
```
# weibull, probably going with log transformation
```

UMBS PLOT LEVEL GROWTH HABIT - Looking at DURATION of flowering

```
### KBS ###
hist(umbs_flwr_plot_growthhabit$flwr_duration_scaled)
```



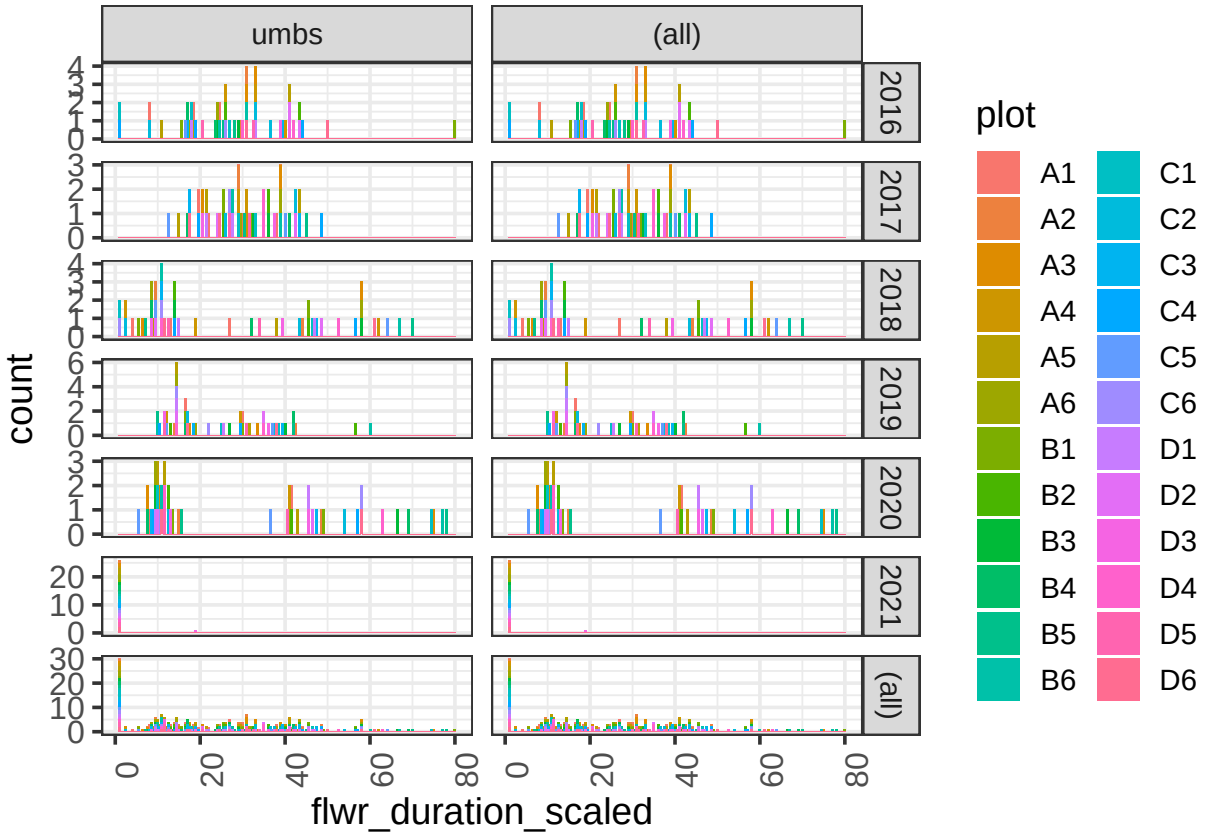

```
qqnorm(umbs_flwr_plot_growthhabit$flwr_duration_scaled)
```



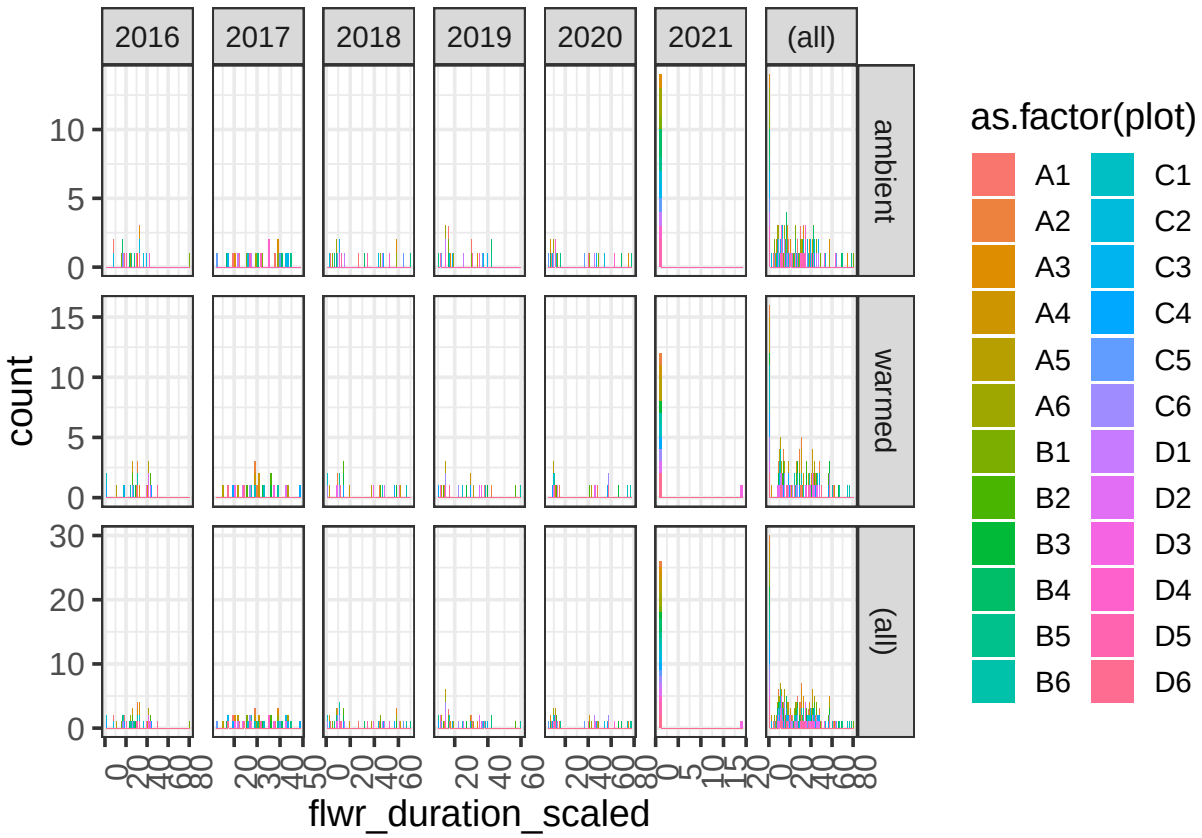
```
shapiro.test(umbs_flwr_plot_growthhabit$flwr_duration_scaled) # pvalue is < 0.05 so we reject the null
```

```
##
##  Shapiro-Wilk normality test
##
## data:  umbs_flwr_plot_growthhabit$flwr_duration_scaled
## W = 0.95137, p-value = 5.992e-08
```

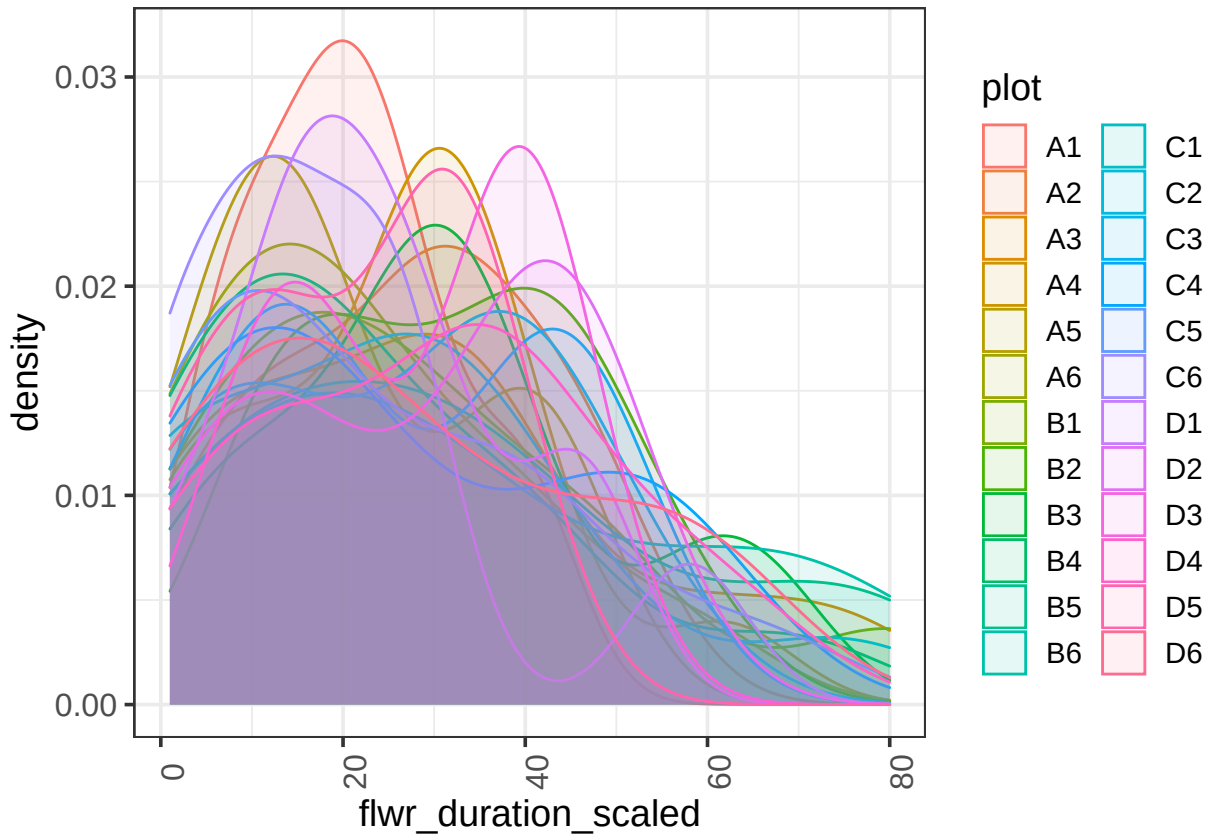
```
# Visualizing median Julian date for umbs at the PLOT LEVEL
ggplot(umbs_flwr_plot_growthhabit, aes(flwr_duration_scaled, fill = plot)) +
        geom_histogram(binwidth = 0.5) +
        facet_grid(year ~ site, margins = TRUE, scales = "free")
```



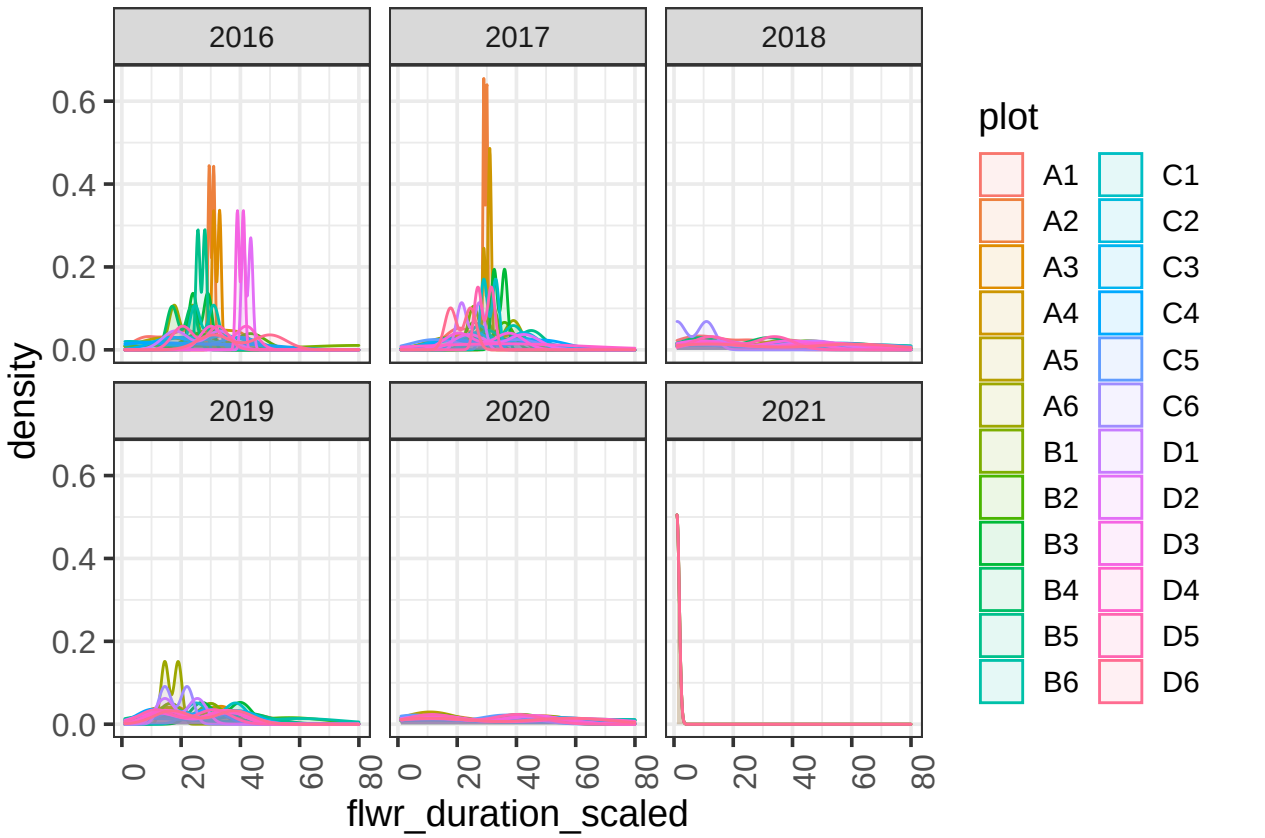

```
ggplot(umbs_flwr_plot_growthhabit, aes(flwr_duration_scaled, fill = as.factor(plot))) + geom_histogram(
```



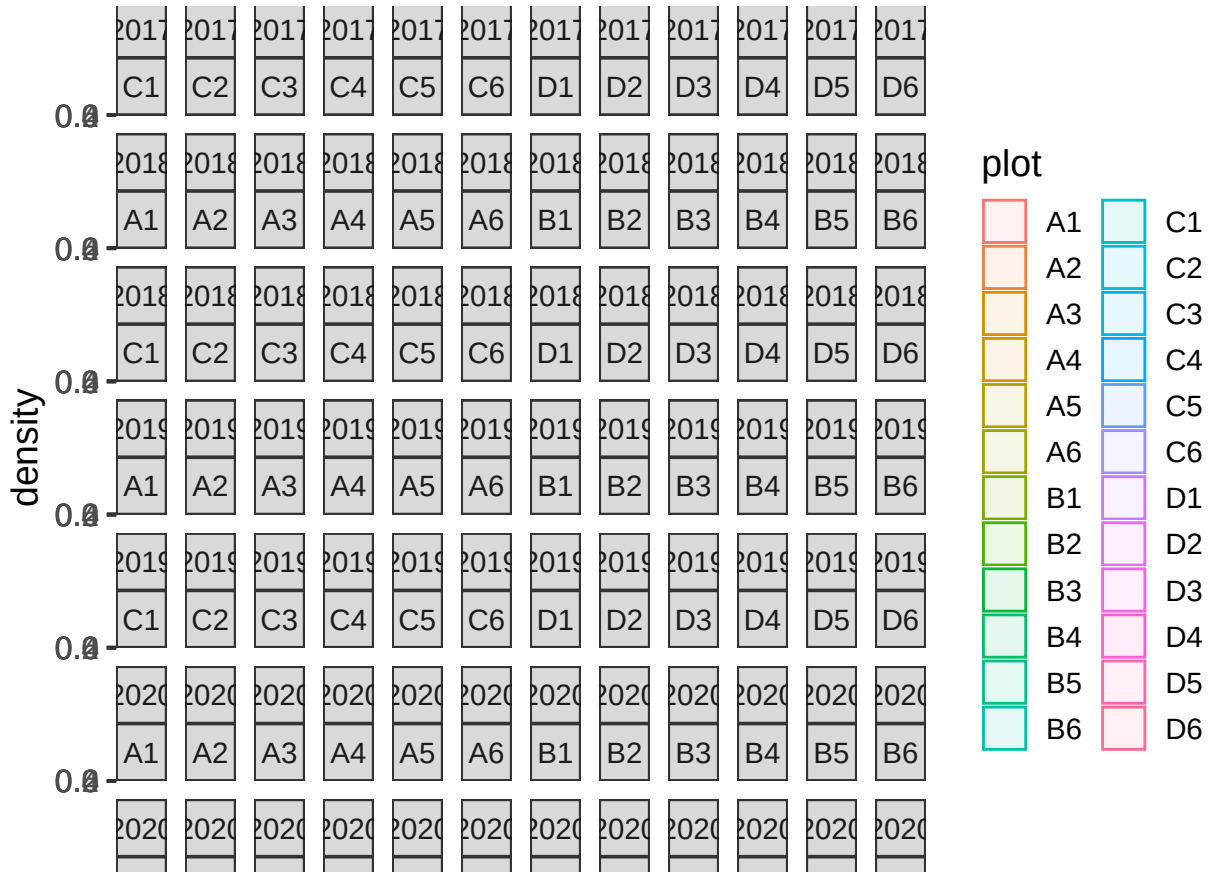

```
ggplot(umbs_flwr_plot_growthhabit, aes(flwr_duration_scaled, fill = plot, color=plot)) +
        geom_density(alpha = 0.1)
```



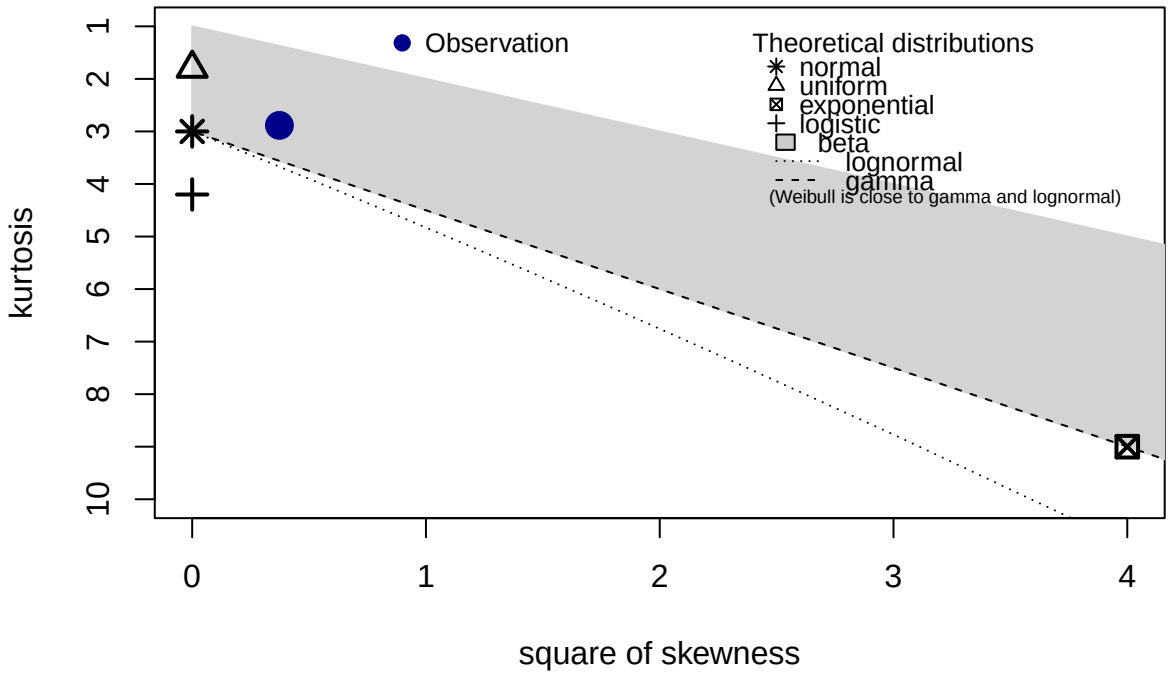

```
ggplot(umbs_flwr_plot_growthhabit, aes(flwr_duration_scaled, fill = plot, color=plot)) +
        geom_density(alpha = 0.1) +
        facet_wrap(~year)
```




```
ggplot(umbs_flwr_plot_growthhabit, aes(flwr_duration_scaled, fill = plot, color=plot)) +
        geom_density(alpha = 0.1) +
        facet_wrap(~year + plot)
```

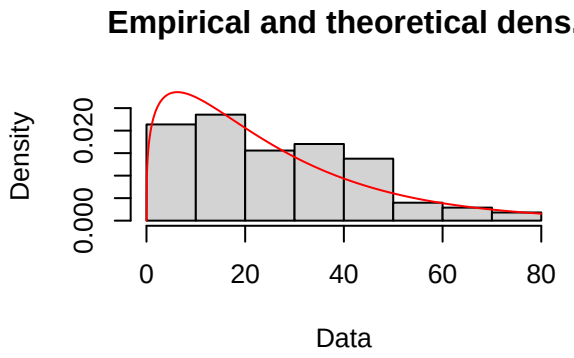


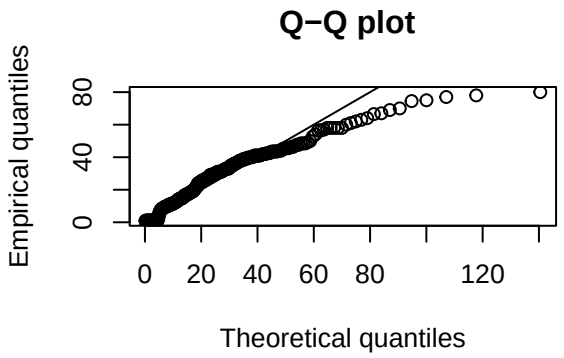

```
# Exploring distributions for these data:
descdist(umbs_flwr_plot_growthhabit$flwr_duration_scaled, discrete = FALSE)
```

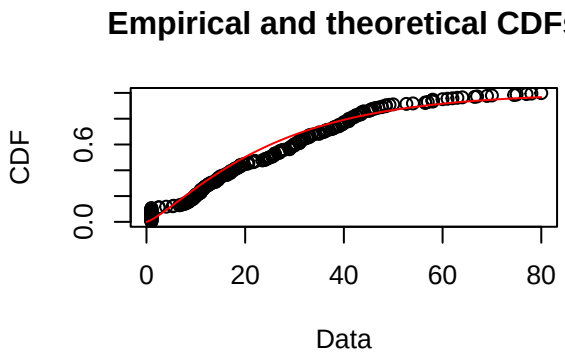


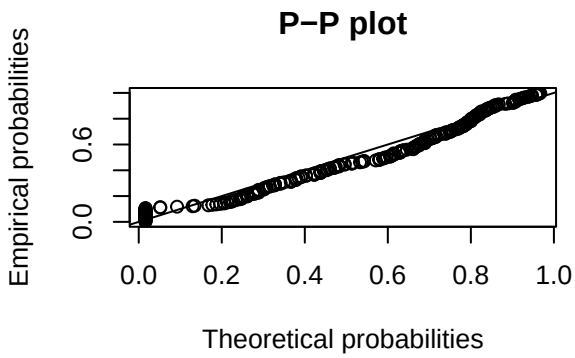

```
## summary statistics
## ------
## min:  1   max:  80
## median:  24.875
## mean:  26.08581
## estimated sd:  18.16827
## estimated skewness:  0.6108626
## estimated kurtosis:  2.884994
```

```
# none of these work below and idk why
# Gamma distribution
fit.gamma <- fitdist(umbs_flwr_plot_growthhabit$flwr_duration_scaled, "gamma")
plot(fit.gamma)
```

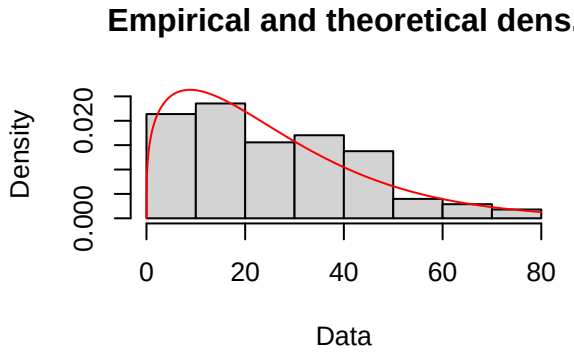


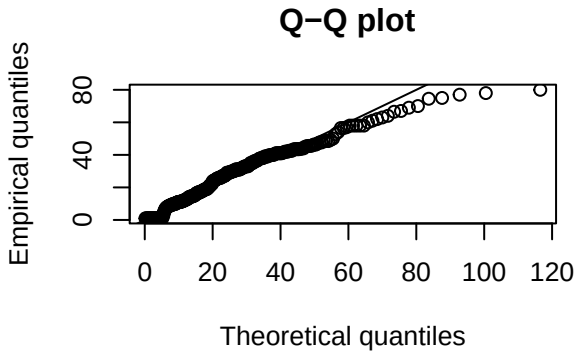


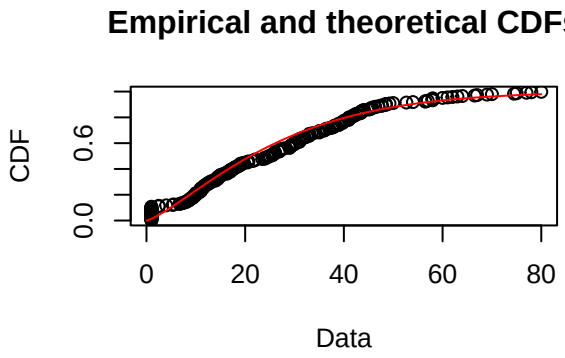


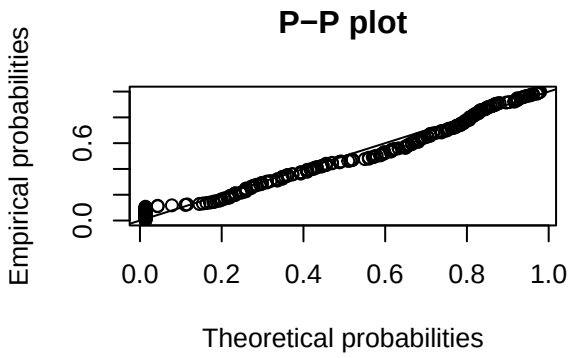



```
# Weibull distribution
fit.weibull  <- fitdist(umbs_flwr_plot_growthhabit$flwr_duration_scaled, "weibull")
plot(fit.weibull)
```

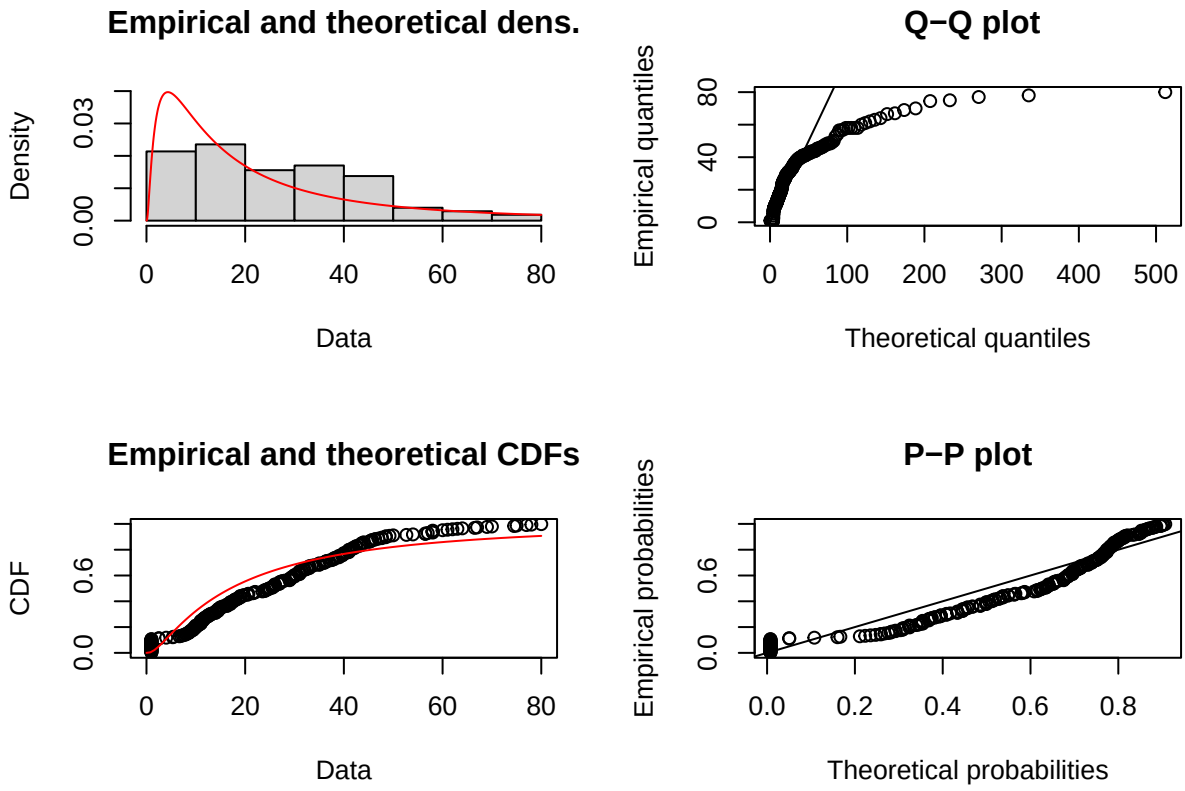




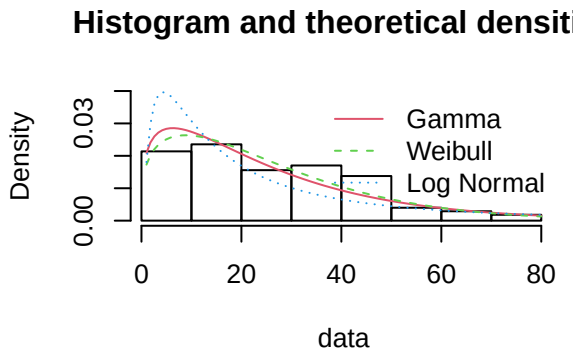


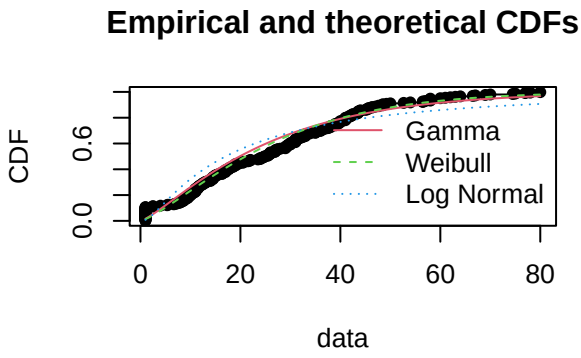


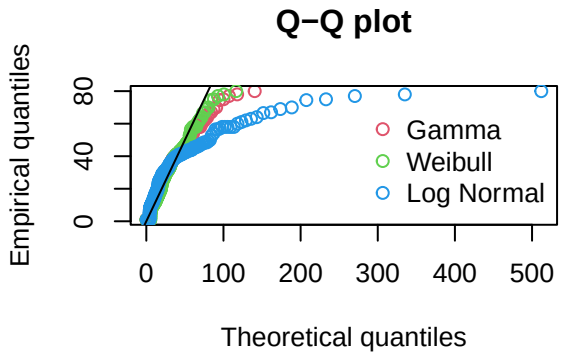
```
# Lognormal distribution
fit.ln <- fitdist(umbs_flwr_plot_growthhabit$flwr_duration_scaled, "lnorm")
plot(fit.ln)
```

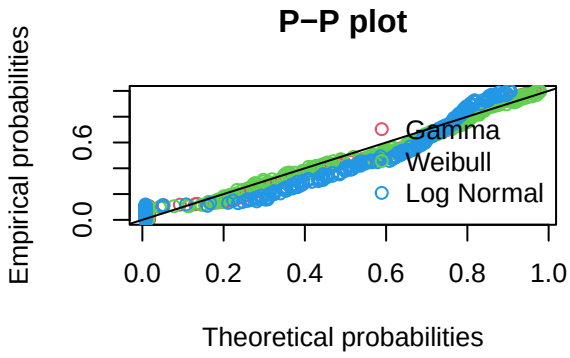



```
par(mfrow=c(2,2))
plot.legend <- c("Gamma", "Weibull", "Log Normal")
denscomp(list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
cdfcomp (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
qqcomp  (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
ppcomp  (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
```










```
# Goodness of fit comparisons across fits (can't include the log normal bc it becomes diff response val
gofstat(list(fit.gamma, fit.weibull, fit.ln), fitnames = c("Gamma", "Weibull", "Log Normal"))
```

```
## Goodness-of-fit statistics
##                                 Gamma    Weibull Log Normal
## Kolmogorov-Smirnov statistic 0.1021444 0.09521307   0.136974
## Cramer-von Mises statistic   0.8087312 0.48533025   2.215026
## Anderson-Darling statistic   6.3074076 5.00594358  15.773896
##
## Goodness-of-fit criteria
##                                   Gamma  Weibull Log Normal
## Akaike's Information Criterion 2344.432 2332.989   2438.882
## Bayesian Information Criterion 2351.673 2340.230   2446.123
```

```
# weibull
```

Leverage plots and detecting Outliers. https://www.statmethods.net/stats/rdiagnostics.html

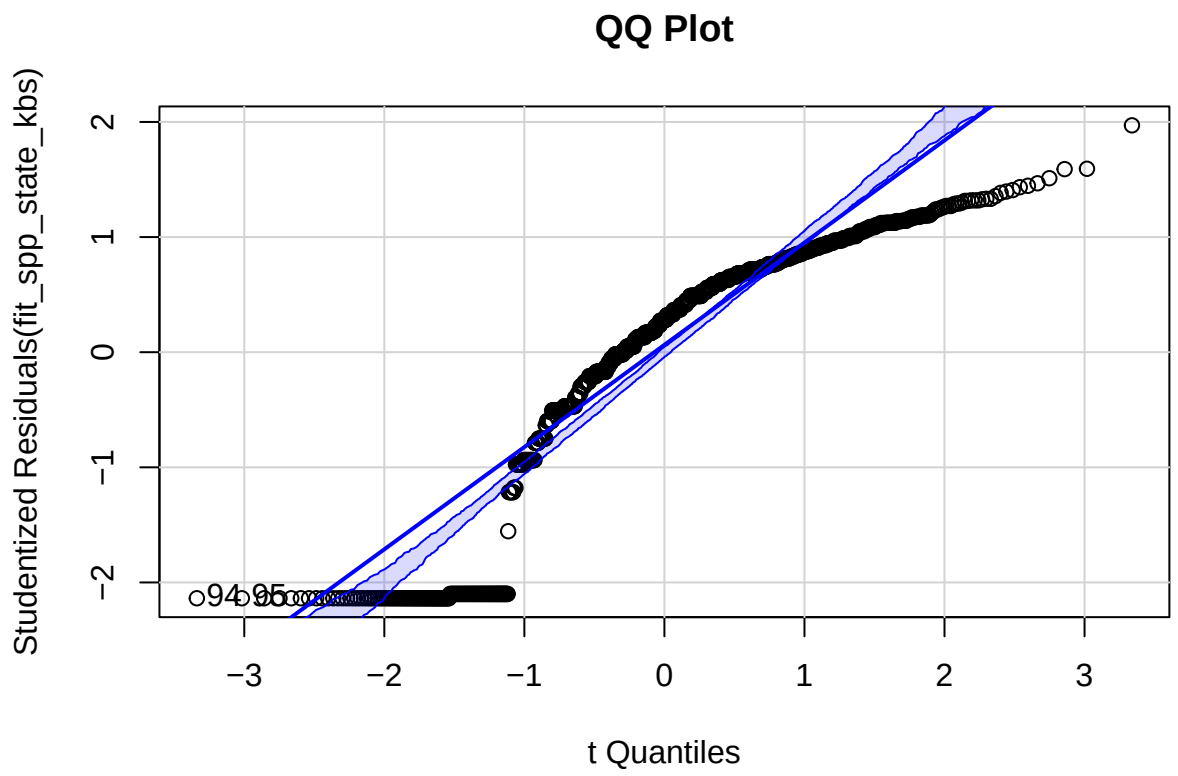
These illustrate whether certain data points have more leverage (more influence), and thus could be outliers. It's a way of detecting outliers. Leverage plots can help identify whether a point has high or low influence, based on its leverage and residual and determining model fit with and without the point in question. Ultimately you decide whether the points are outliers or not, based on the knowledge of the system and how much it changes the model when included vs. excluded from the data used to fit the model. Here is a good overview of the combination of leverage and residual: scroll down to sections beginning at "13.3 Unusual Observations": https://daviddalpiaz.github.io/appliedstats/model-diagnostics.html

KBS

```
# species level data
# KBS State-only model
fit_spp_state_kbs <- lm(log(flwr_duration_scaled) ~ state, data = kbs_flwr_spp)
outlierTest(fit_spp_state_kbs) # no outliers
```

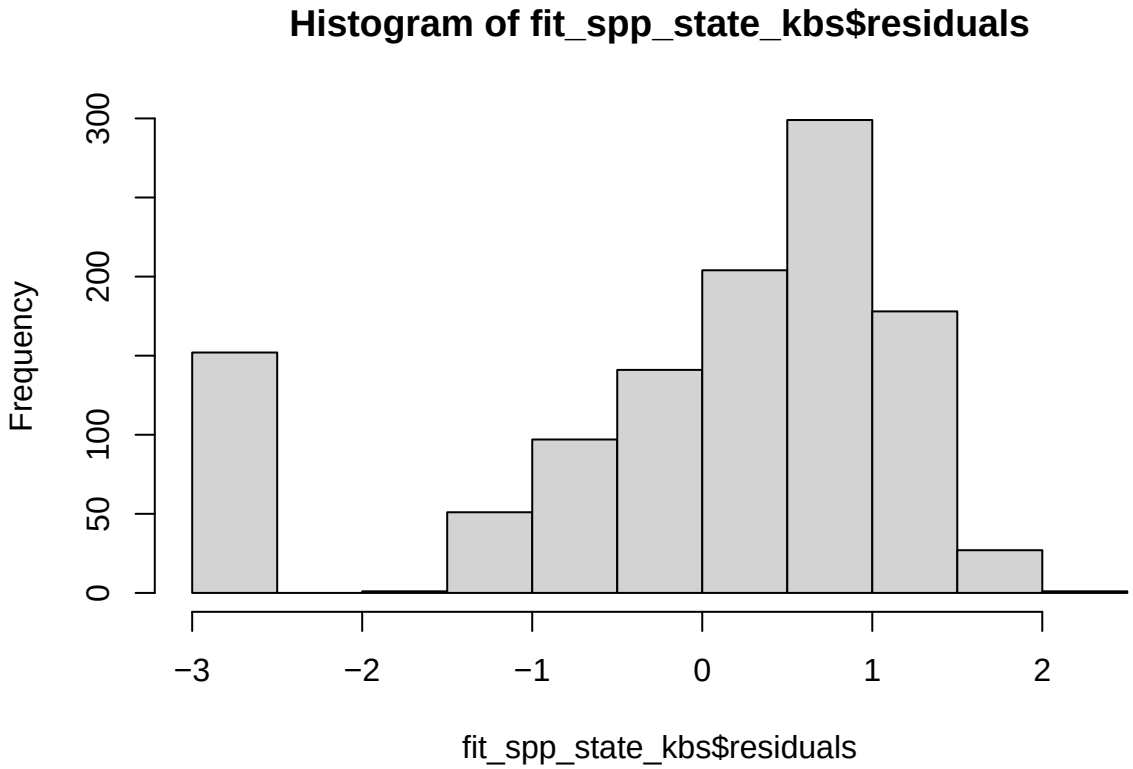
```
## No Studentized residuals with Bonferroni p < 0.05
## Largest |rstudent|:
##    rstudent unadjusted p-value Bonferroni p
## 94 -2.13733           0.032782           NA
```

```
qqPlot(fit_spp_state_kbs, main="QQ Plot")
```

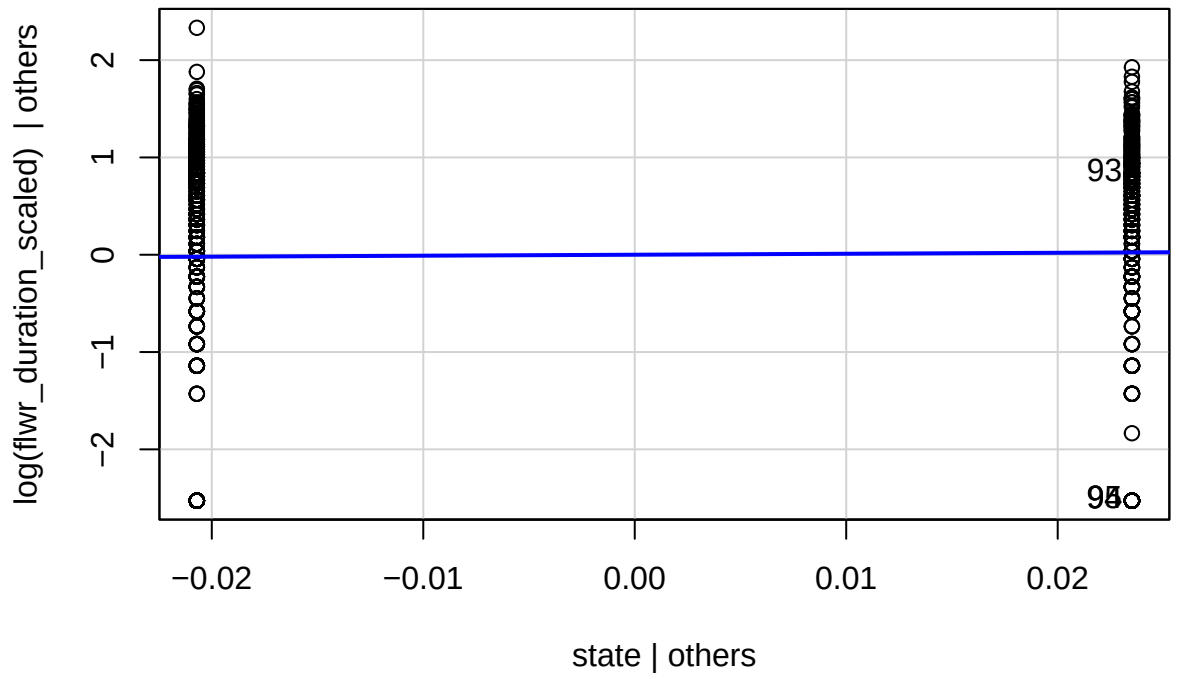



```
## 94 95
## 54 55
```

```
hist(fit_spp_state_kbs$residuals)
```



```
leveragePlots(fit_spp_state_kbs)
```




```
ols_test_normality(fit_spp_state_kbs)
```

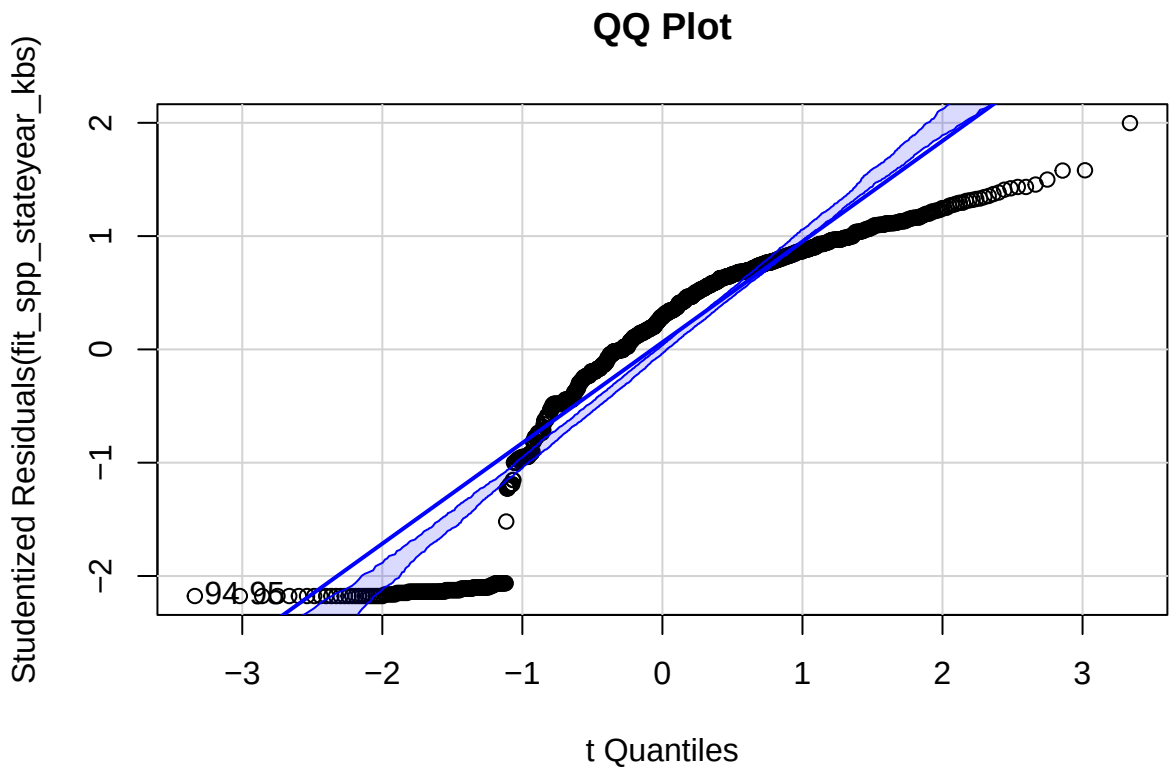
```
## Warning in ks.test.default(y, "pnorm", mean(y), sd(y)): ties should not be
## present for the Kolmogorov-Smirnov test
```

```
## -----------------------------------------------
##        Test             Statistic       pvalue
## -----------------------------------------------
## Shapiro-Wilk              0.868          0.0000
## Kolmogorov-Smirnov        0.1304         0.0000
## Cramer-von Mises         38.2293         0.0000
## Anderson-Darling         51.5221         0.0000
## -----------------------------------------------
```

```
# KBS State and year model
fit_spp_stateyear_kbs <- lm(log(flwr_duration_scaled) ~ state + year_factor, data = kbs_flwr_spp)
outlierTest(fit_spp_stateyear_kbs) # no outliers
```

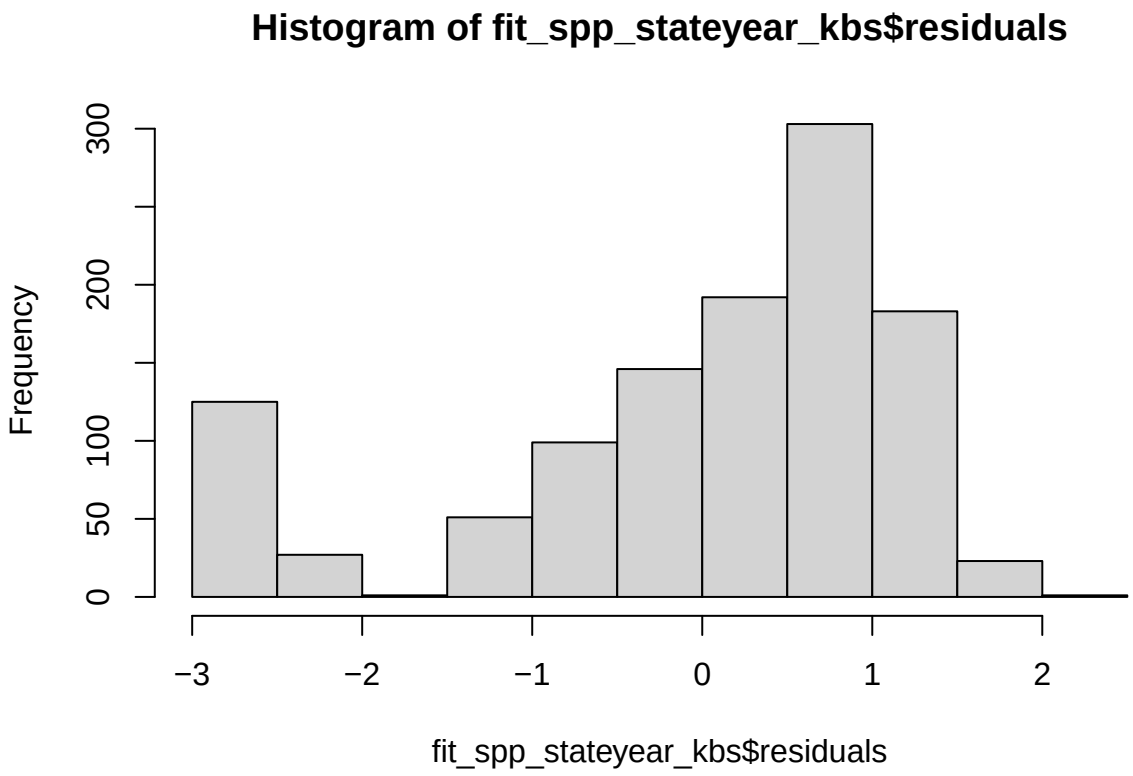
```
## No Studentized residuals with Bonferroni p < 0.05
## Largest |rstudent|:
##     rstudent unadjusted p-value Bonferroni p
## 94 -2.176698           0.029707           NA
```

```
qqPlot(fit_spp_stateyear_kbs, main="QQ Plot")
```

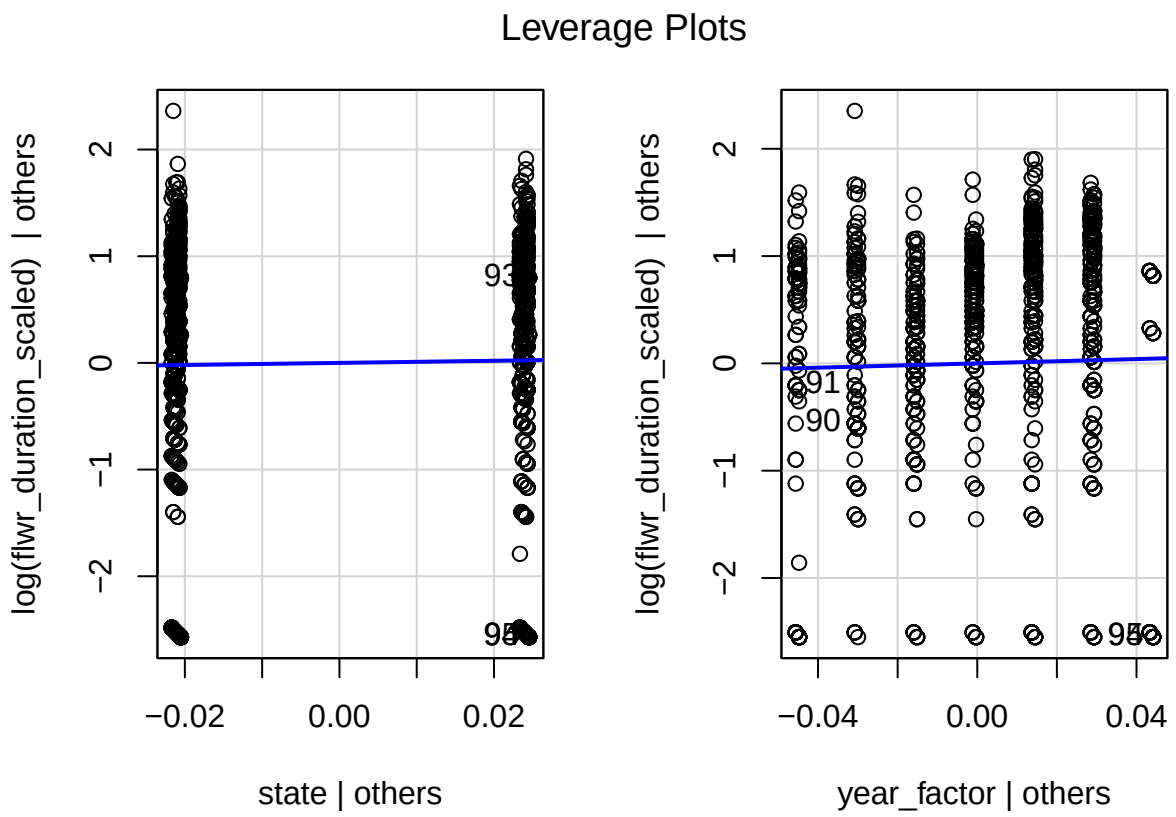



```
## 94 95
## 54 55
```

```
hist(fit_spp_stateyear_kbs$residuals)
```




```
leveragePlots(fit_spp_stateyear_kbs)
```



```
ols_test_normality(fit_spp_stateyear_kbs)
```

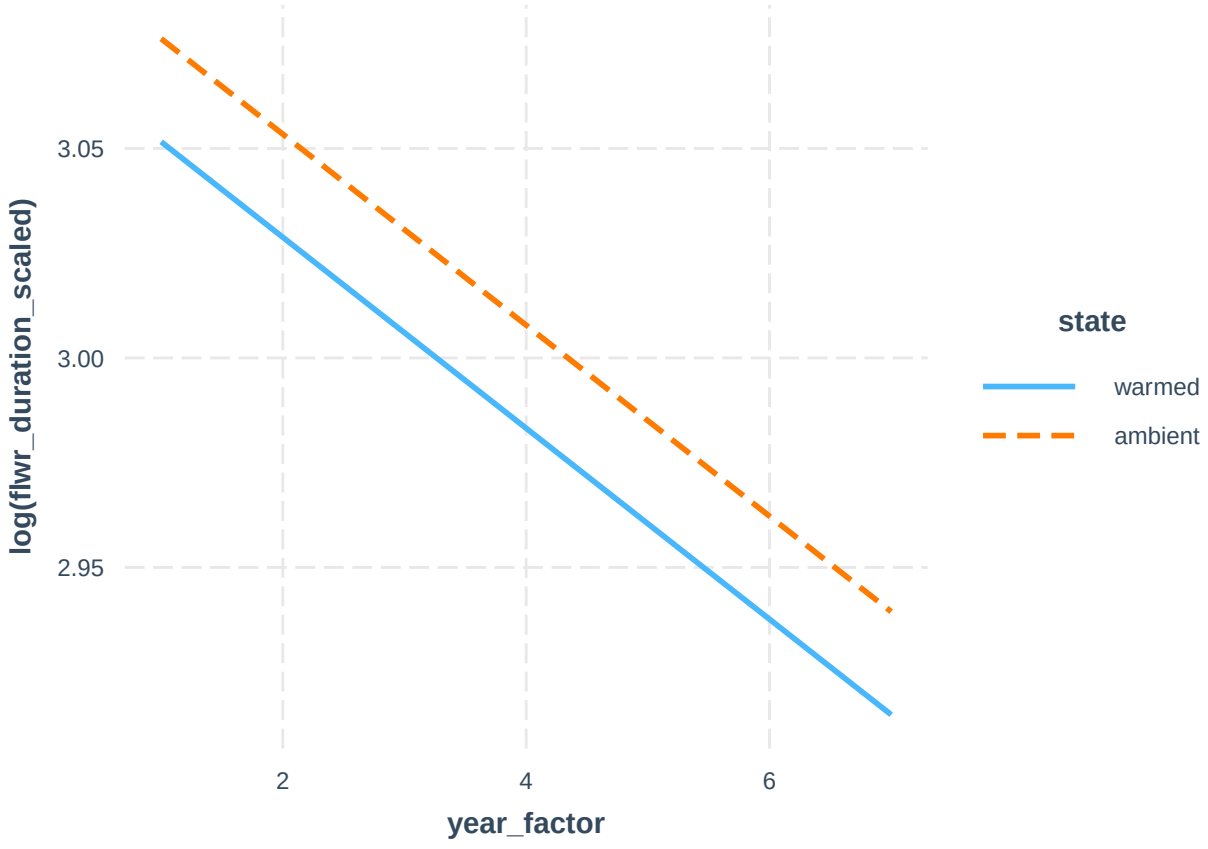
```
## Warning in ks.test.default(y, "pnorm", mean(y), sd(y)): ties should not be
## present for the Kolmogorov-Smirnov test
```

```
## -----------------------------------------------
##        Test             Statistic       pvalue
## -----------------------------------------------
## Shapiro-Wilk              0.8674         0.0000
## Kolmogorov-Smirnov        0.1297         0.0000
## Cramer-von Mises         38.3089         0.0000
## Anderson-Darling         52.0009         0.0000
## -----------------------------------------------
```

```
# Interaction plot (ignore for now the repeated measures with species); see: https://cran.r-project.org
fit3 <- lm(log(flwr_duration_scaled) ~ state + year_factor + species, data = kbs_flwr_spp)
interact_plot(fit3, pred = year_factor, modx = state)
```

```
## Using data kbs_flwr_spp from global environment. This could cause incorrect
## results if kbs_flwr_spp has been altered since the model was fit. You can
## manually provide the data to the "data =" argument.
```

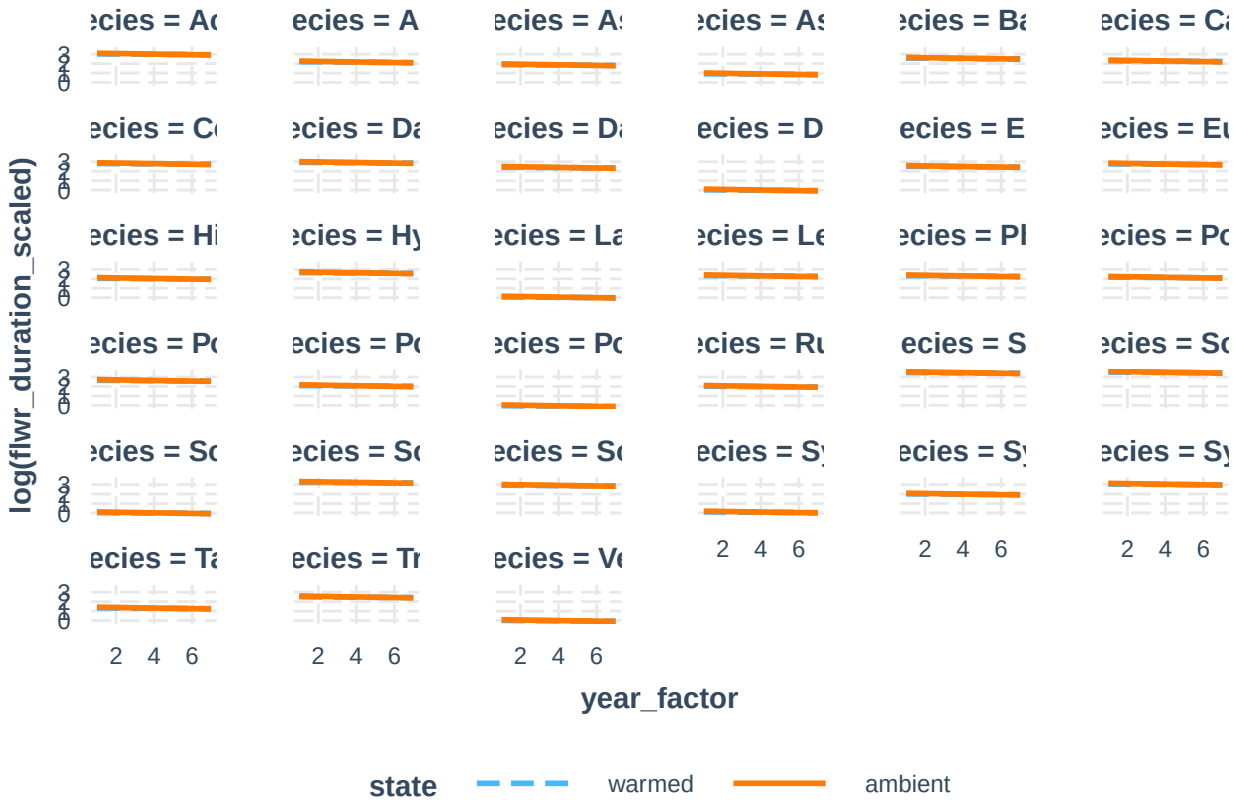
```
## Warning: year_factor and state are not included in an interaction with one another
## in the model.
```



```
fit4 <- lm(log(flwr_duration_scaled) ~ state * year_factor + species, data = kbs_flwr_spp)
interact_plot(fit4, pred = year_factor, modx = state, mod2 = species)
```

```
## Using data kbs_flwr_spp from global environment. This could cause incorrect
## results if kbs_flwr_spp has been altered since the model was fit. You can
## manually provide the data to the "data =" argument.
```

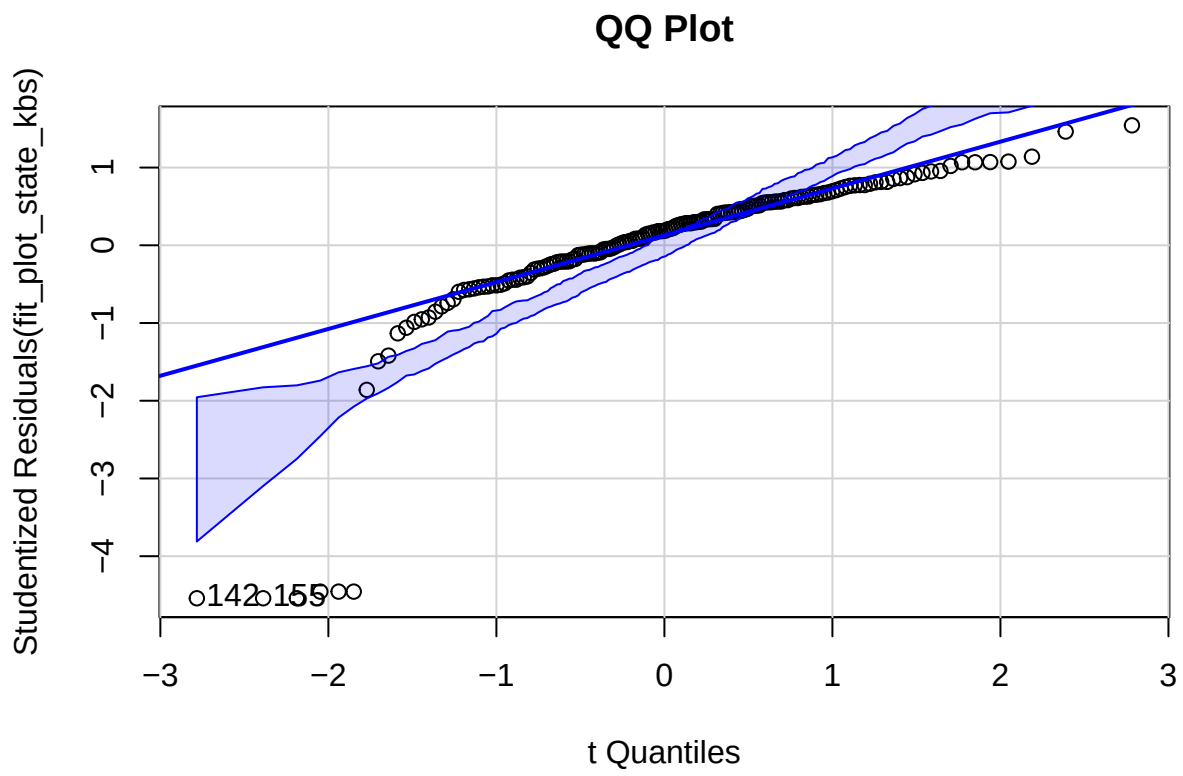
```
## Warning: year_factor and state and species are not included in an interaction with
## one another in the model.
```




```
# Plot level data
# KBS State-only model
fit_plot_state_kbs <- lm(log(flwr_duration_scaled) ~ state, data = kbs_flwr_plot)
outlierTest(fit_plot_state_kbs) # outliers - 142, 155, 220, 116, 207, 272
```

```
##      rstudent unadjusted p-value Bonferroni p
## 142 -4.540917         1.0840e-05    0.0017995
## 155 -4.540917         1.0840e-05    0.0017995
## 220 -4.540917         1.0840e-05    0.0017995
## 116 -4.455768         1.5476e-05    0.0025691
## 207 -4.455768         1.5476e-05    0.0025691
## 272 -4.455768         1.5476e-05    0.0025691
```

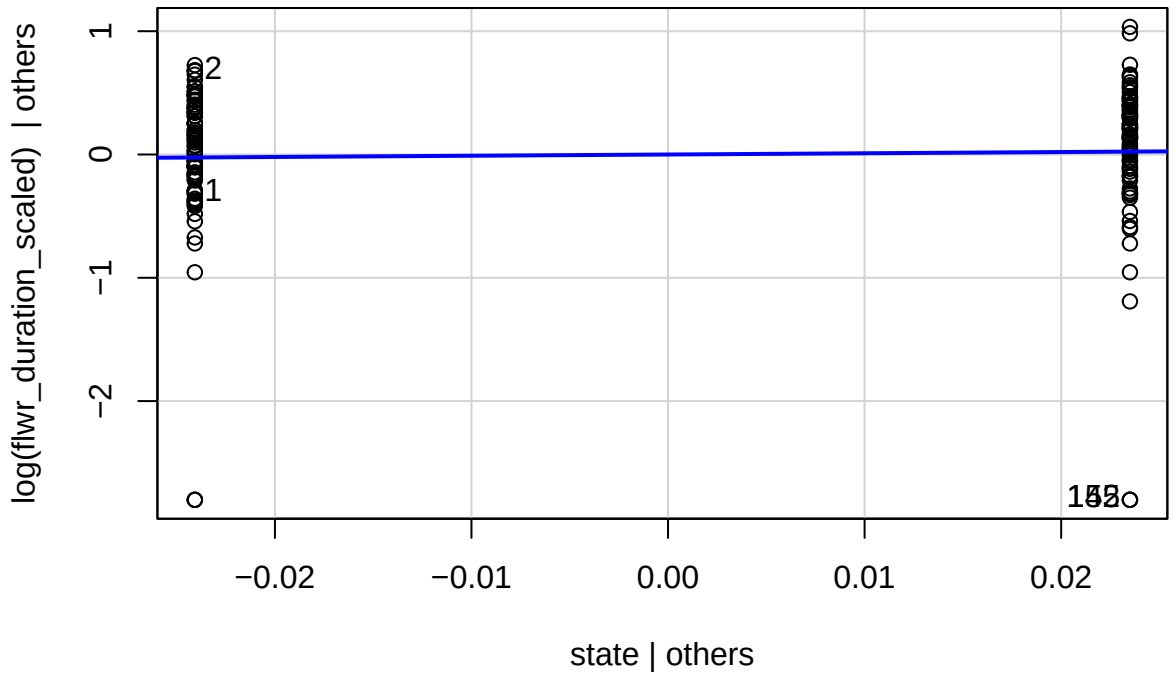
```
qqPlot(fit_plot_state_kbs, main="QQ Plot")
```




```
## 142 155
##  78  85
```

```
hist(fit_plot_state_kbs$residuals)
```

```
leveragePlots(fit_plot_state_kbs)
```




```
ols_test_normality(fit_plot_state_kbs) # looks ok besides Kolmogorov-Smirnov test
```

```
## Warning in ks.test.default(y, "pnorm", mean(y), sd(y)): ties should not be
## present for the Kolmogorov-Smirnov test

## -----------------------------------------------
##        Test             Statistic       pvalue
## -----------------------------------------------
## Shapiro-Wilk              0.7219         0.0000
## Kolmogorov-Smirnov        0.1684          2e-04
## Cramer-von Mises         16.6029         0.0000
## Anderson-Darling         10.5052         0.0000
## -----------------------------------------------
```

```
# KBS State and year model
fit_plot_stateyear_kbs <- lm(log(flwr_duration_scaled) ~ state + year_factor, data = kbs_flwr_plot)
outlierTest(fit_plot_stateyear_kbs) # outliers - 142, 155, 220, 116, 207, 272
```

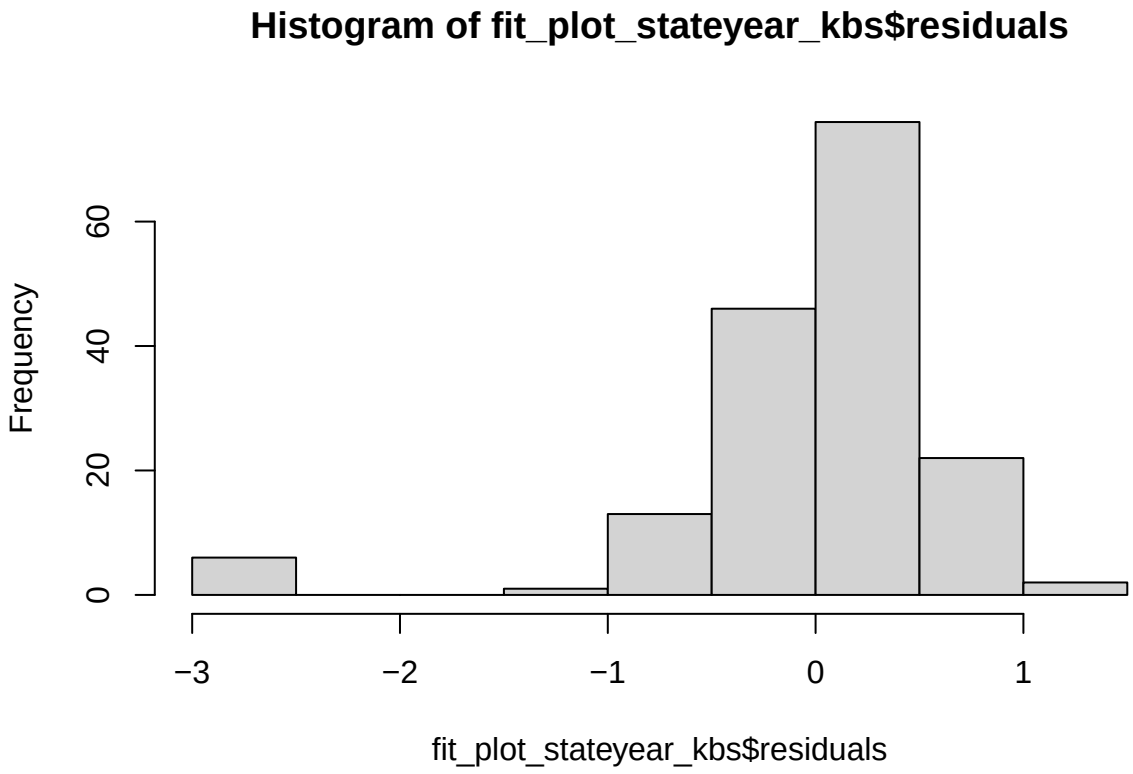
```
##      rstudent unadjusted p-value Bonferroni p
## 142 -4.330288         2.6012e-05    0.0043179
## 155 -4.330288         2.6012e-05    0.0043179
## 220 -4.330288         2.6012e-05    0.0043179
## 116 -4.249572         3.6045e-05    0.0059834
```

```
## 207 -4.249572         3.6045e-05    0.0059834
## 272 -4.249572         3.6045e-05    0.0059834
```

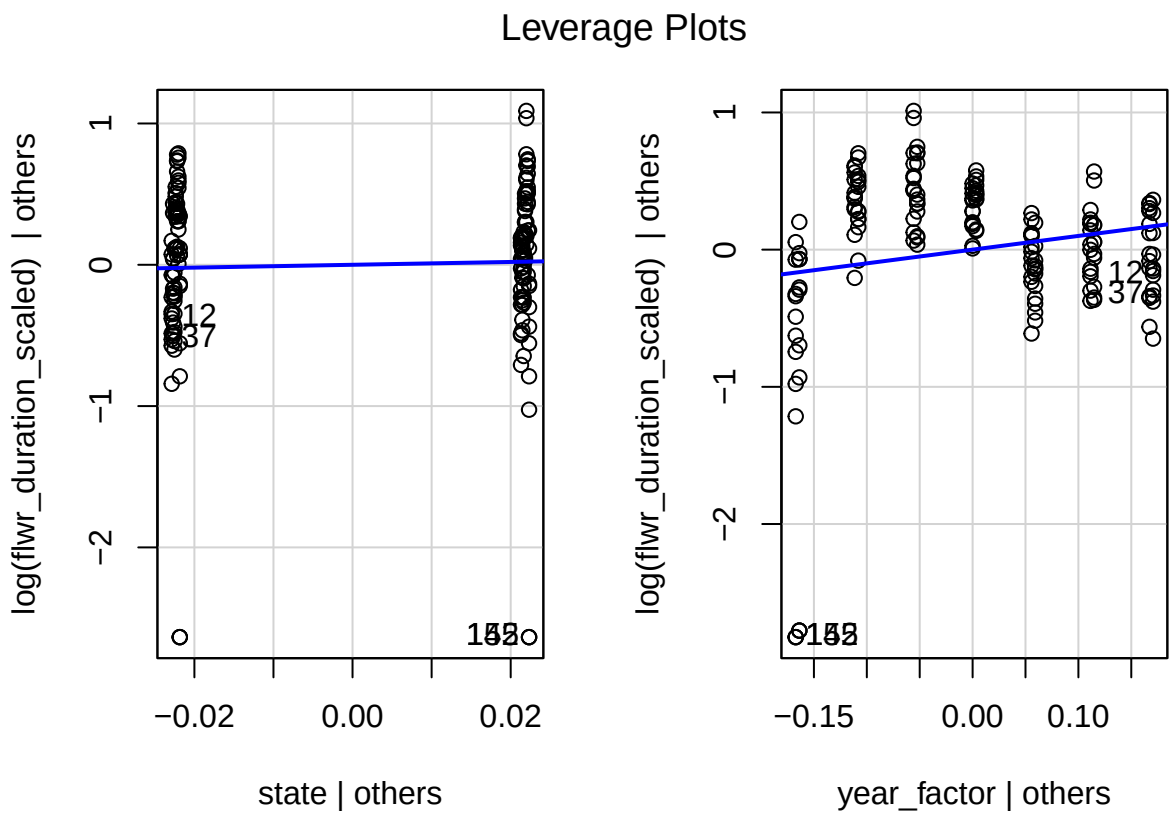
```
qqPlot(fit_plot_stateyear_kbs, main="QQ Plot")
```


```
## 142 155
##  78  85
```

```
hist(fit_plot_stateyear_kbs$residuals)
```




```
leveragePlots(fit_plot_stateyear_kbs)
```



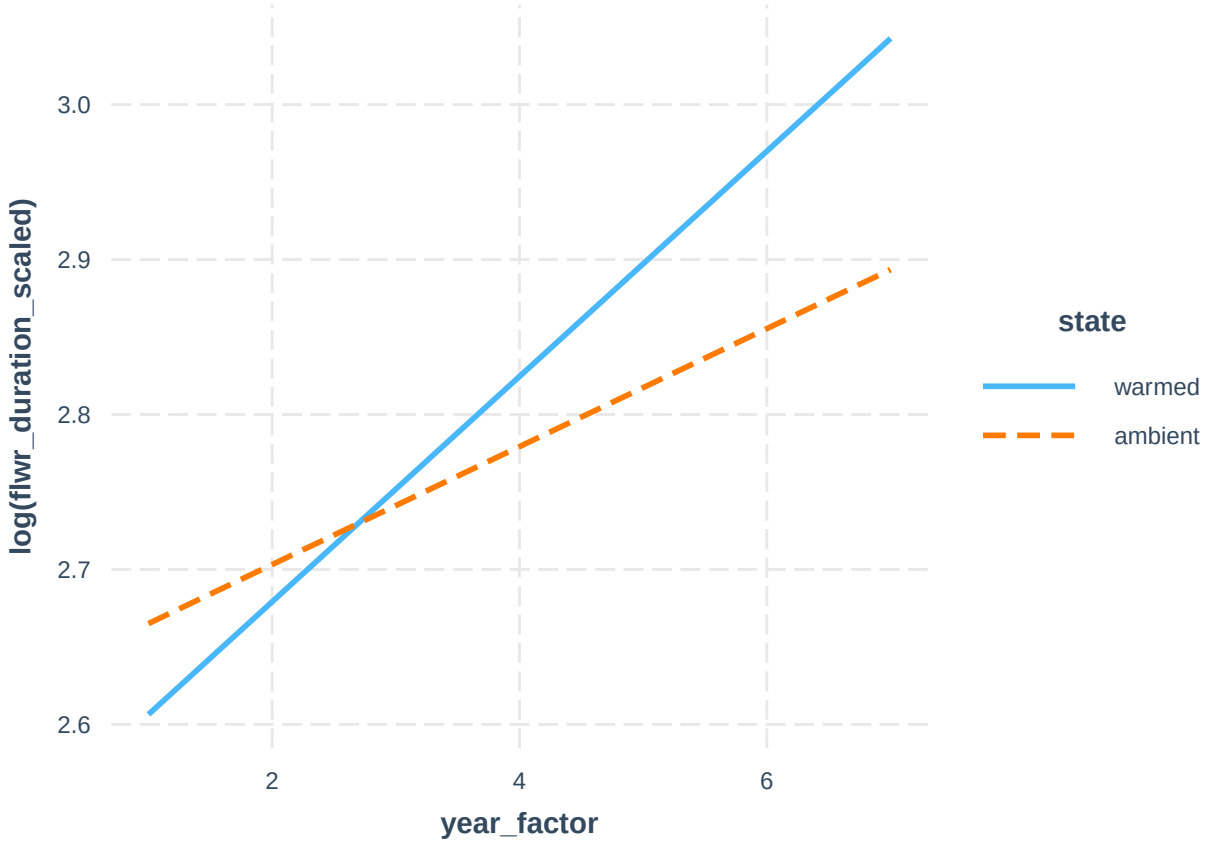
```
ols_test_normality(fit_plot_stateyear_kbs) # a couple tests say not normal
```

```
## Warning in ks.test.default(y, "pnorm", mean(y), sd(y)): ties should not be
## present for the Kolmogorov-Smirnov test
```

```
## -----------------------------------------------
##        Test             Statistic       pvalue
## -----------------------------------------------
## Shapiro-Wilk              0.7854         0.0000
## Kolmogorov-Smirnov        0.1272         0.0093
## Cramer-von Mises         15.8138         0.0000
## Anderson-Darling          7.0546         0.0000
## -----------------------------------------------
```

```
# Interaction plot (ignore for now the repeated measures with species); see: https://cran.r-project.org

fit3 <- lm(log(flwr_duration_scaled) ~ state * year_factor, data = kbs_flwr_plot)
interact_plot(fit3, pred = year_factor, modx = state) # this looks very strange to me
```

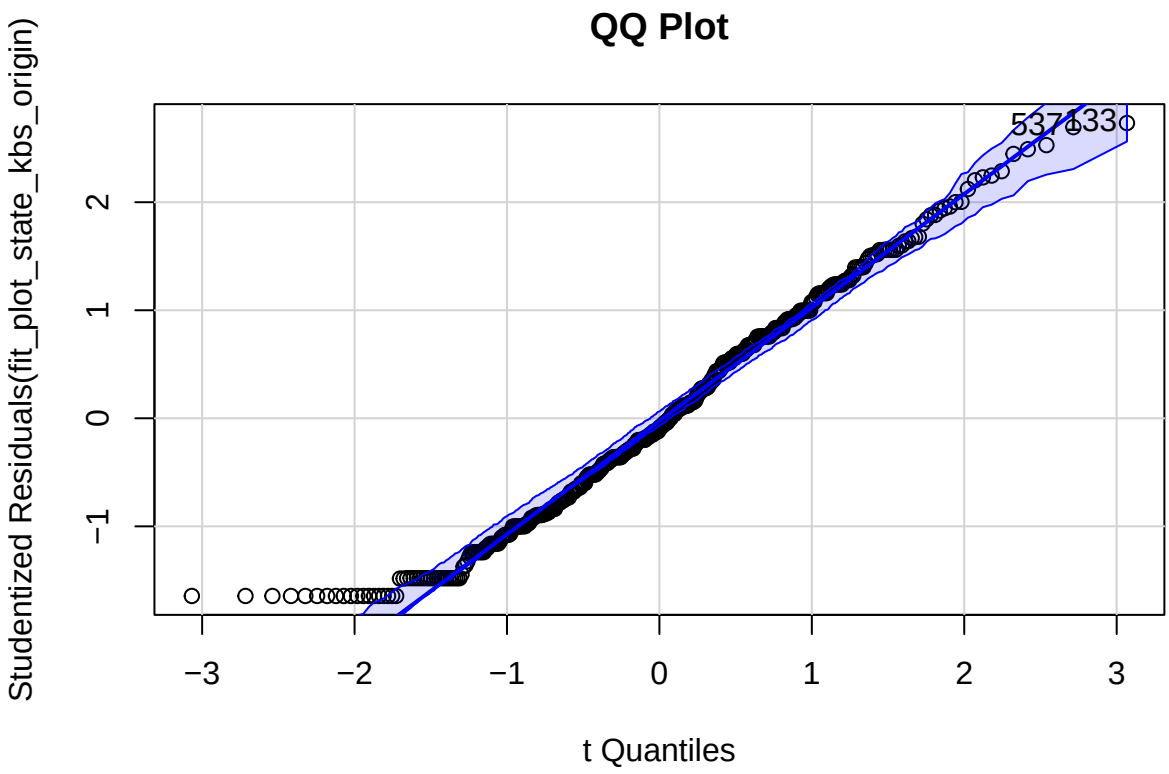
```
## Using data kbs_flwr_plot from global environment. This could cause
## incorrect results if kbs_flwr_plot has been altered since the model was
## fit. You can manually provide the data to the "data =" argument.
```



```
# Plot level ORIGIN data
# KBS State-only model
fit_plot_state_kbs_origin <- lm(flwr_duration_scaled ~ state, data = kbs_flwr_plot_origin)
outlierTest(fit_plot_state_kbs_origin) # no outliers
```

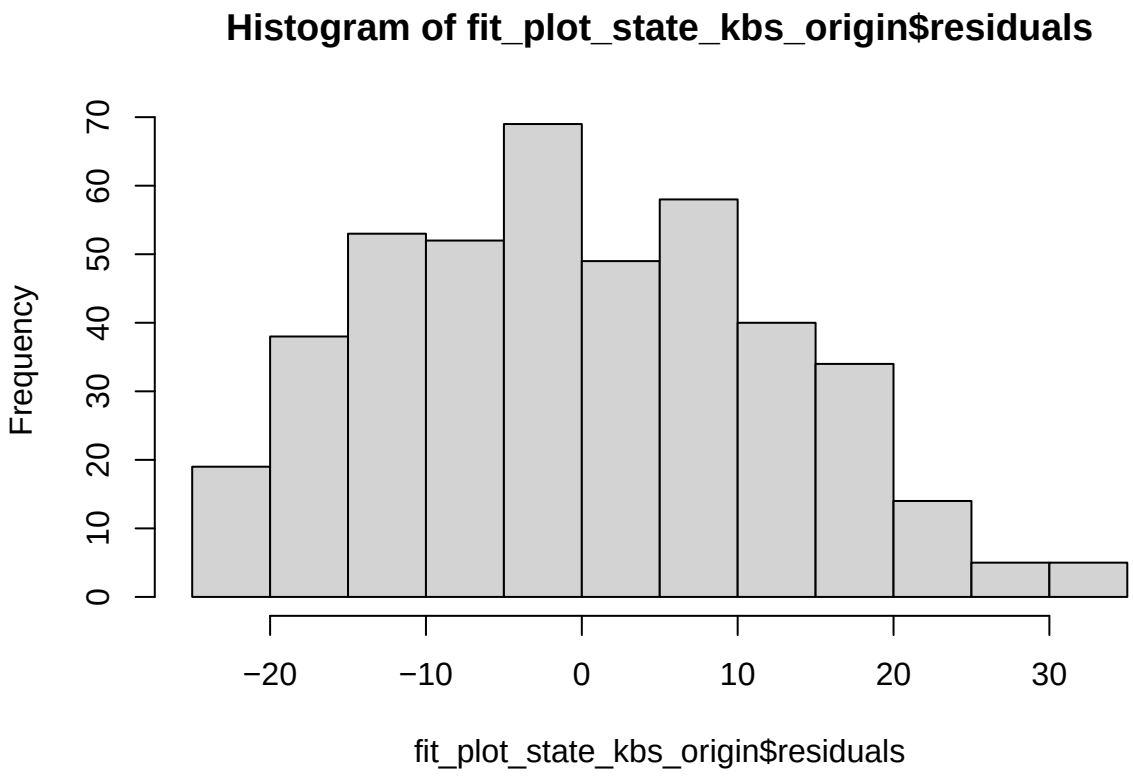
```
## No Studentized residuals with Bonferroni p < 0.05
## Largest |rstudent|:
##     rstudent unadjusted p-value Bonferroni p
## 133  2.73272          0.0065385           NA
```

```
qqPlot(fit_plot_state_kbs_origin, main="QQ Plot")
```

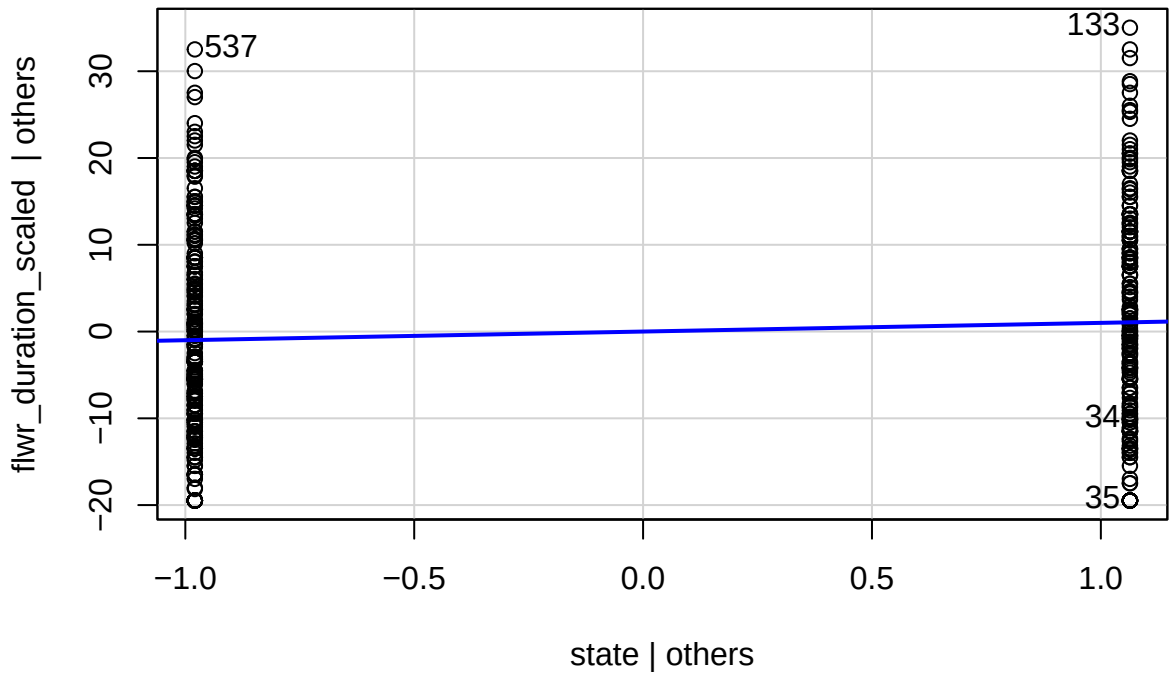



```
## 133 537
##  83 335
```

```
hist(fit_plot_state_kbs_origin$residuals)
```




```
leveragePlots(fit_plot_state_kbs_origin)
```



```
ols_test_normality(fit_plot_state_kbs_origin) # looks ok besides Kolmogorov-Smirnov test
```

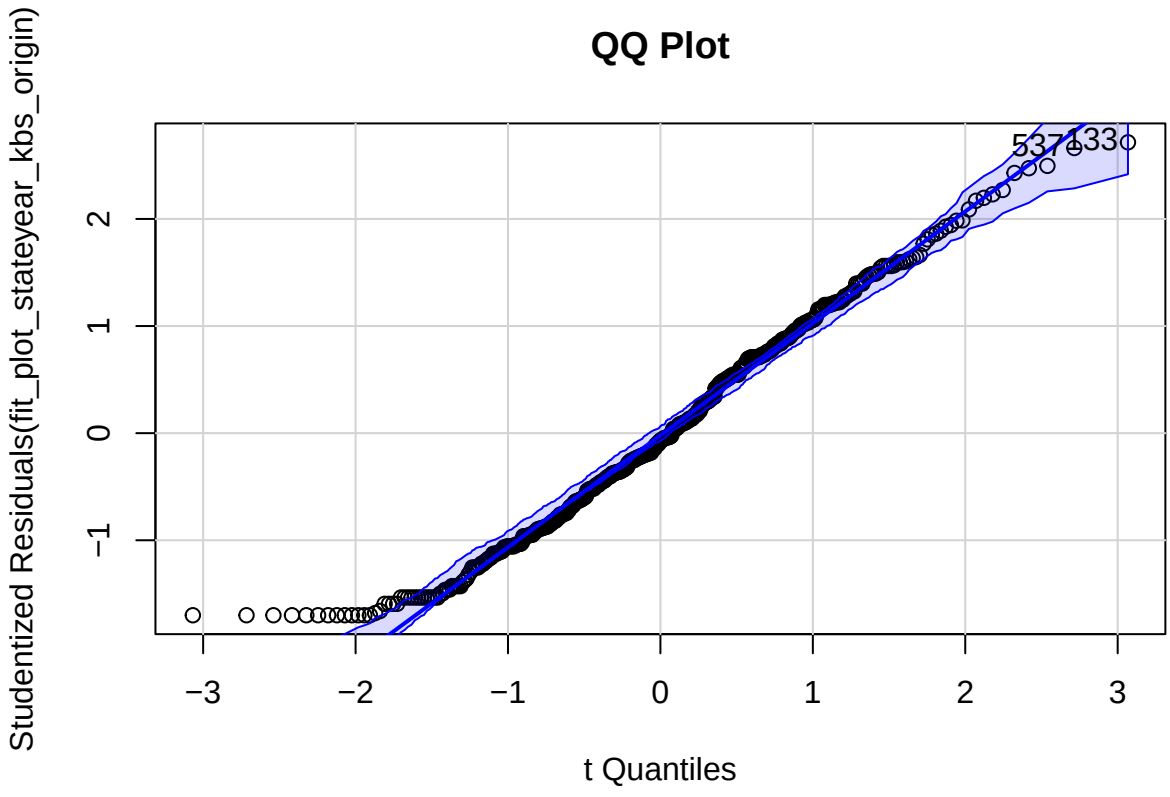
```
## Warning in ks.test.default(y, "pnorm", mean(y), sd(y)): ties should not be
## present for the Kolmogorov-Smirnov test
```

```
## -----------------------------------------------
##        Test             Statistic       pvalue
## -----------------------------------------------
## Shapiro-Wilk              0.977          0.0000
## Kolmogorov-Smirnov        0.0506         0.2145
## Cramer-von Mises          35.657         0.0000
## Anderson-Darling          1.965           1e-04
## -----------------------------------------------
```

```
# KBS State and year model
fit_plot_stateyear_kbs_origin <- lm(flwr_duration_scaled ~ state + year_factor, data = kbs_flwr_plot_ori
outlierTest(fit_plot_stateyear_kbs_origin) # no outliers
```

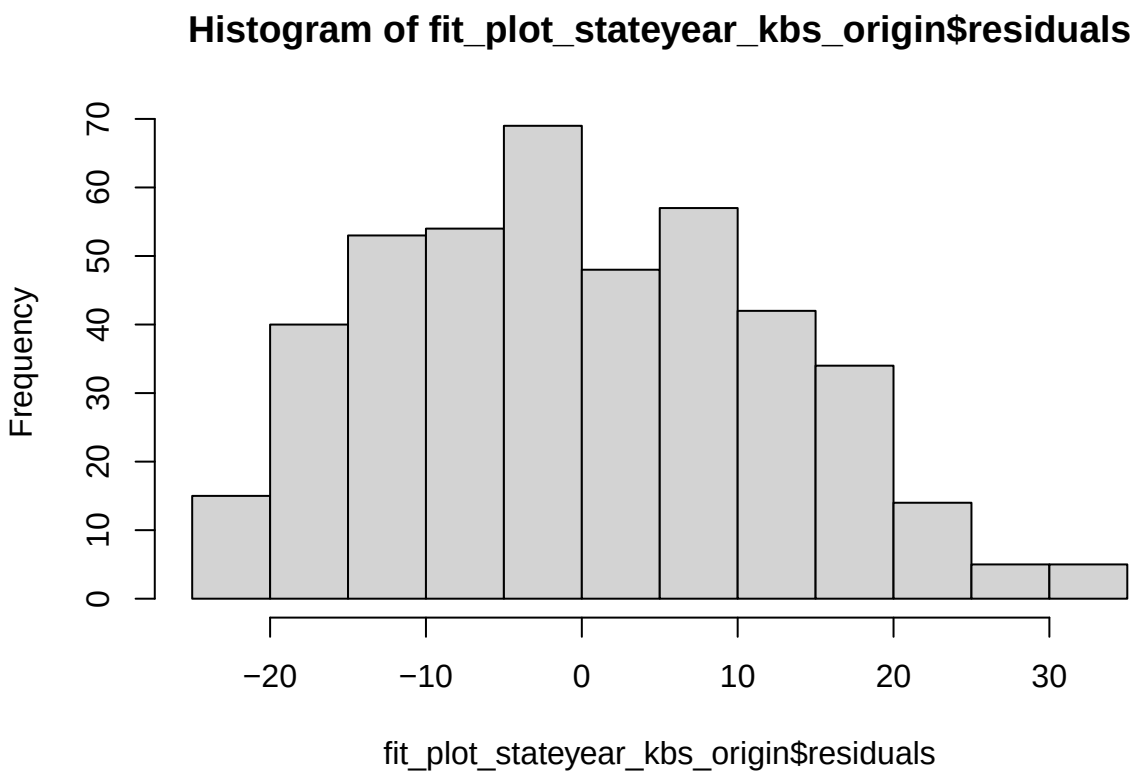
```
## No Studentized residuals with Bonferroni p < 0.05
## Largest |rstudent|:
##     rstudent unadjusted p-value Bonferroni p
## 133 2.715213          0.0068888           NA
```

```
qqPlot(fit_plot_stateyear_kbs_origin, main="QQ Plot")
```

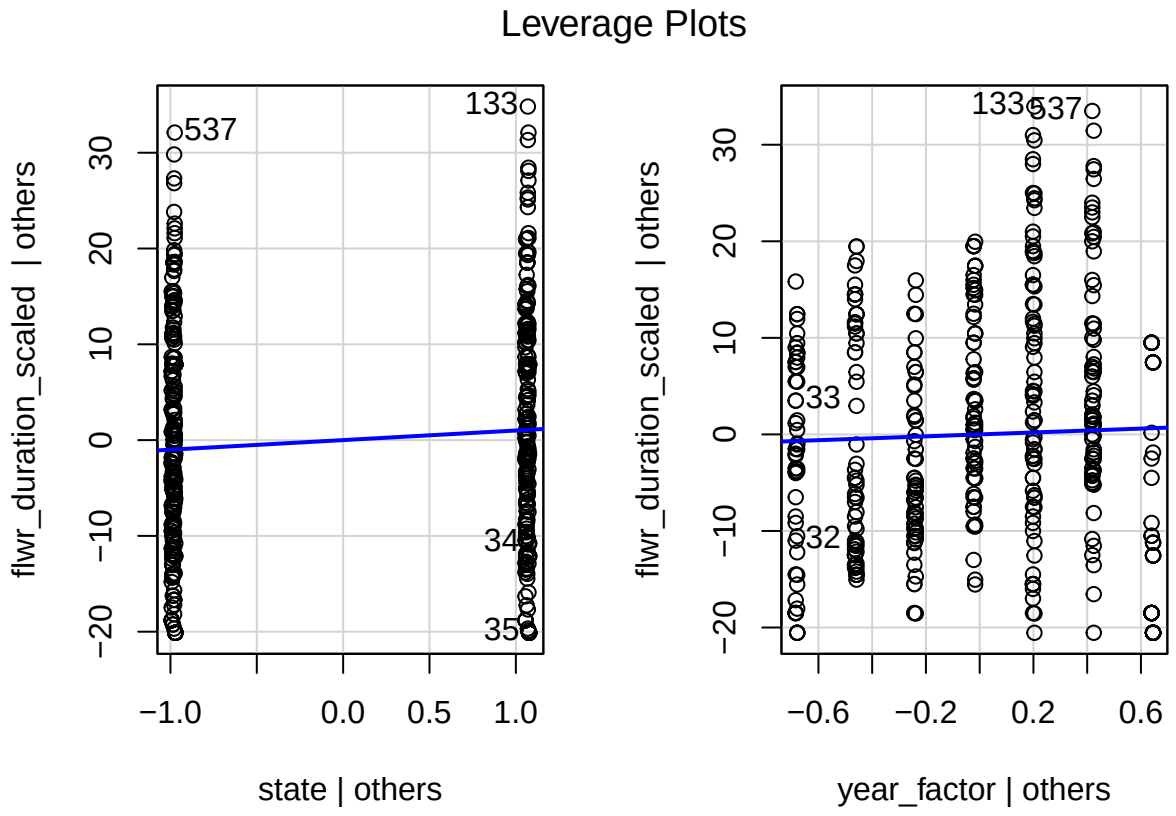



```
## 133 537
##  83 335
```

```
hist(fit_plot_stateyear_kbs_origin$residuals)
```




```
leveragePlots(fit_plot_stateyear_kbs_origin)
```

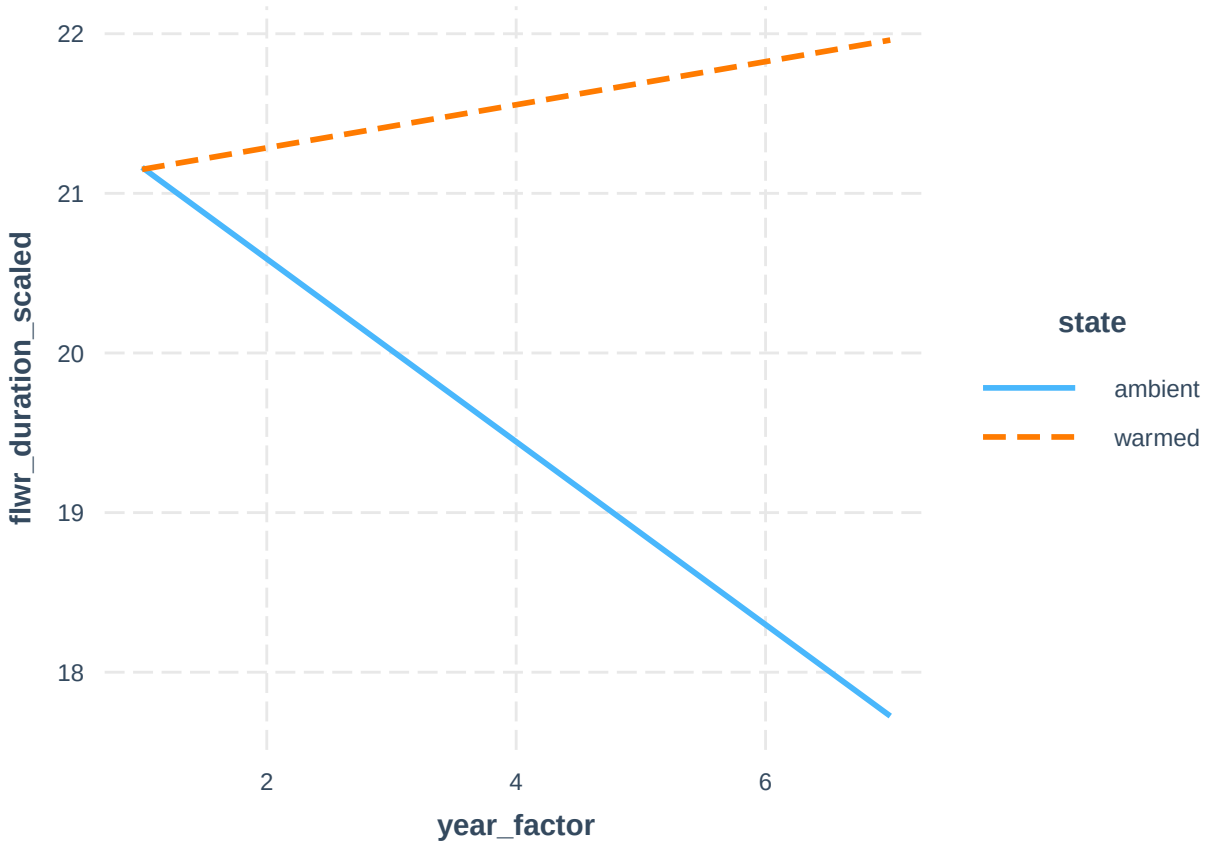



```
ols_test_normality(fit_plot_stateyear_kbs_origin) # a couple tests say not normal
```

```
## Warning in ks.test.default(y, "pnorm", mean(y), sd(y)): ties should not be
## present for the Kolmogorov-Smirnov test
```

```
## ---------------------------------------------------
##        Test             Statistic       pvalue
## ---------------------------------------------------
## Shapiro-Wilk              0.9795         0.0000
## Kolmogorov-Smirnov        0.0486         0.2540
## Cramer-von Mises         35.2889         0.0000
## Anderson-Darling          1.7582          2e-04
## ---------------------------------------------------
```

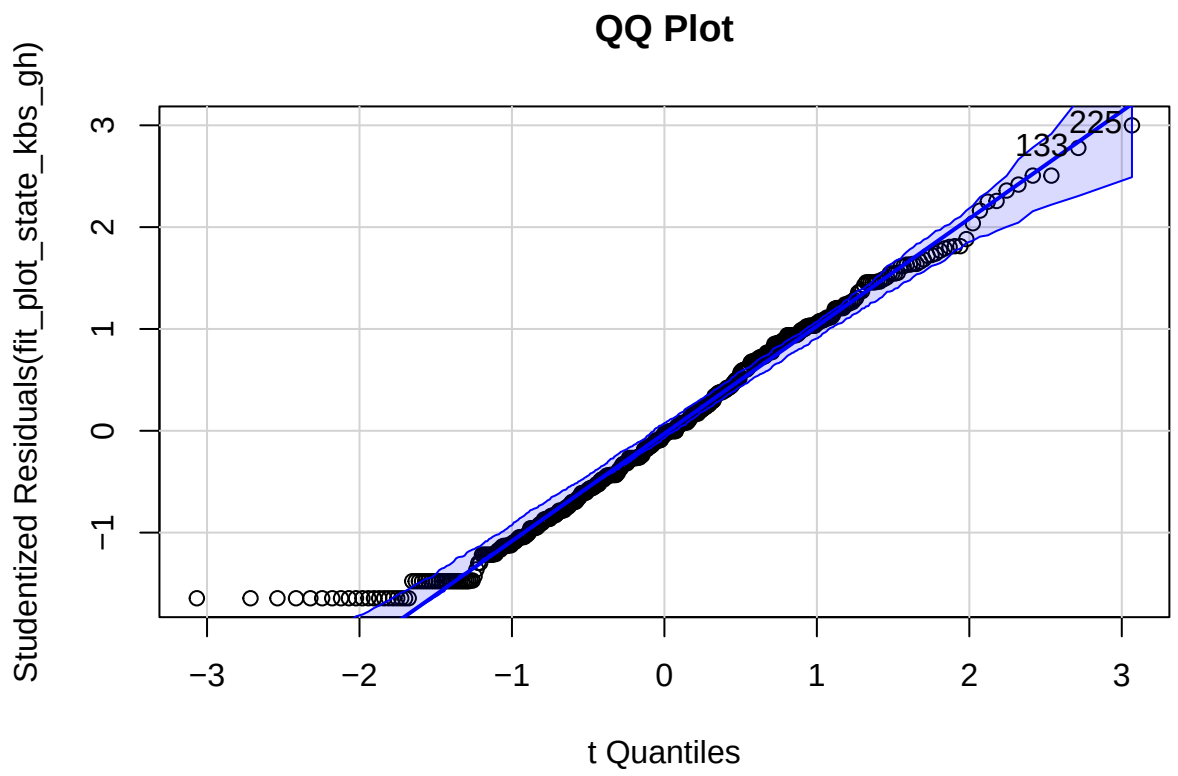
```
# Interaction plot (ignore for now the repeated measures with species); see: https://cran.r-project.org

fit3 <- lm(flwr_duration_scaled ~ state * year_factor, data = kbs_flwr_plot_origin)
interact_plot(fit3, pred = year_factor, modx = state) # this looks very strange to me
```




```
# Plot level GROWTH HABIT data
# KBS State-only model
fit_plot_state_kbs_gh <- lm(flwr_duration_scaled ~ state, data = kbs_flwr_plot_growthhabit)
outlierTest(fit_plot_state_kbs_gh) # no outliers
```

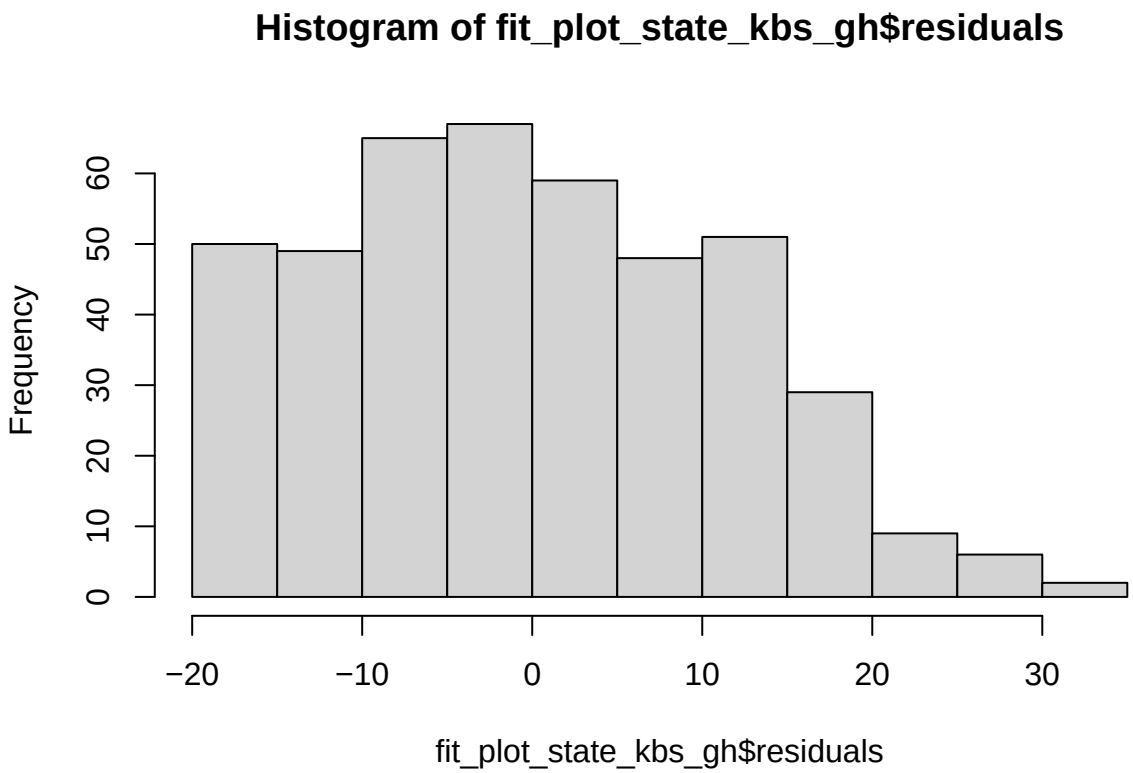
```
## No Studentized residuals with Bonferroni p < 0.05
## Largest |rstudent|:
##     rstudent unadjusted p-value Bonferroni p
## 225 2.999702          0.0028587           NA
```

```
qqPlot(fit_plot_state_kbs_gh, main="QQ Plot")
```

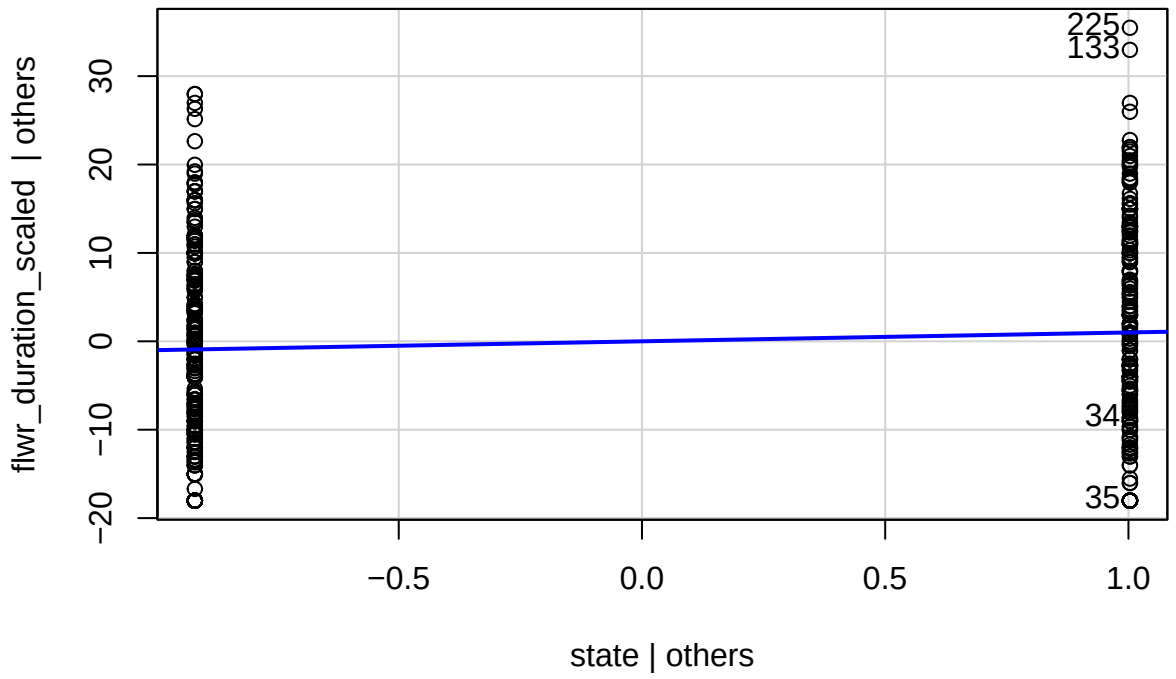



```
## 133 225
##  81 136
```

```
hist(fit_plot_state_kbs_gh$residuals)
```



```
leveragePlots(fit_plot_state_kbs_gh)
```




```
ols_test_normality(fit_plot_state_kbs_gh) # looks ok besides Kolmogorov-Smirnov test
```

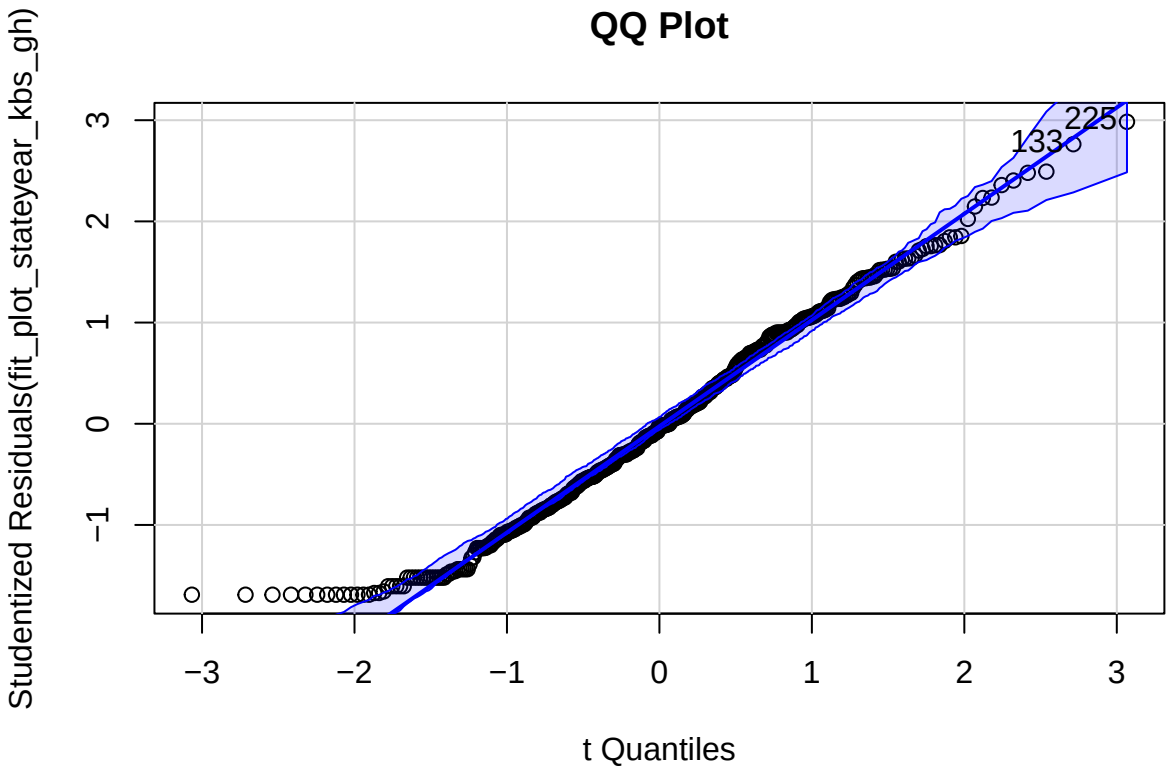
```
## Warning in ks.test.default(y, "pnorm", mean(y), sd(y)): ties should not be
## present for the Kolmogorov-Smirnov test
```

```
## -----------------------------------------------
##        Test             Statistic       pvalue
## -----------------------------------------------
## Shapiro-Wilk              0.9779         0.0000
## Kolmogorov-Smirnov        0.0506         0.2158
## Cramer-von Mises         35.1778         0.0000
## Anderson-Darling          1.815           1e-04
## -----------------------------------------------
```

```
# KBS State and year model
fit_plot_stateyear_kbs_gh <- lm(flwr_duration_scaled ~ state + year_factor, data = kbs_flwr_plot_growthl
outlierTest(fit_plot_stateyear_kbs_gh) # no outliers
```

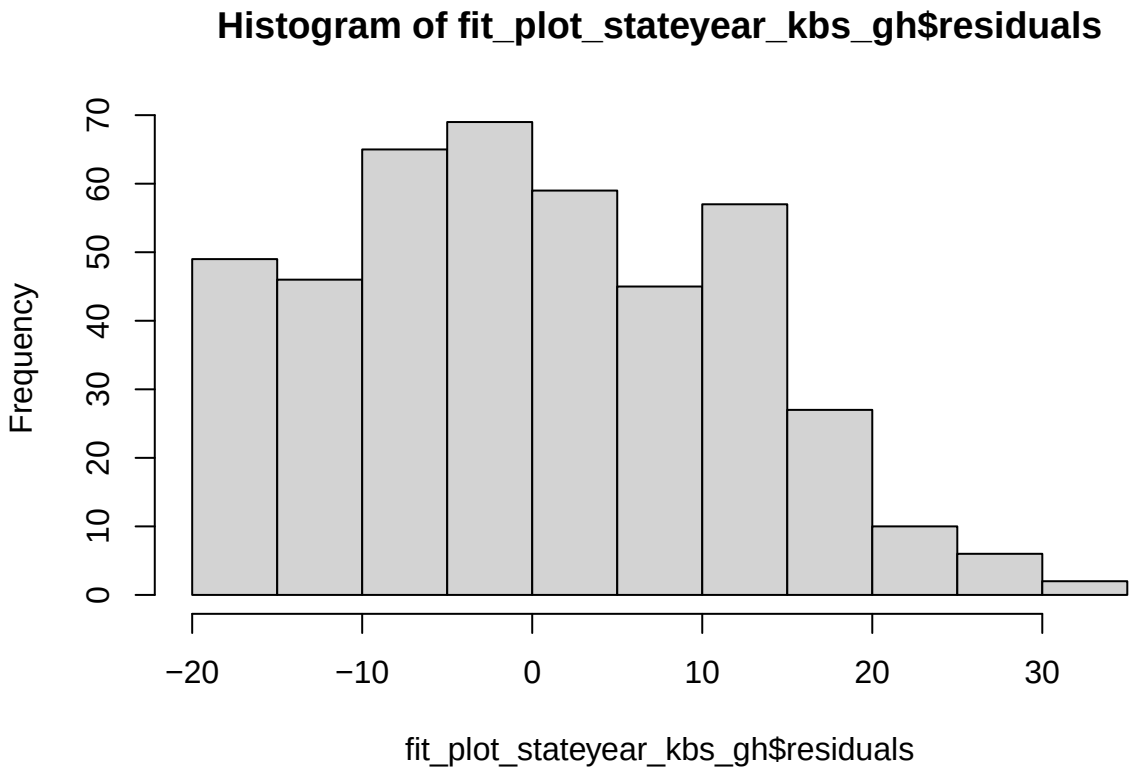
```
## No Studentized residuals with Bonferroni p < 0.05
## Largest |rstudent|:
##     rstudent unadjusted p-value Bonferroni p
## 225 2.984411          0.0030029           NA
```

```
qqPlot(fit_plot_stateyear_kbs_gh, main="QQ Plot")
```

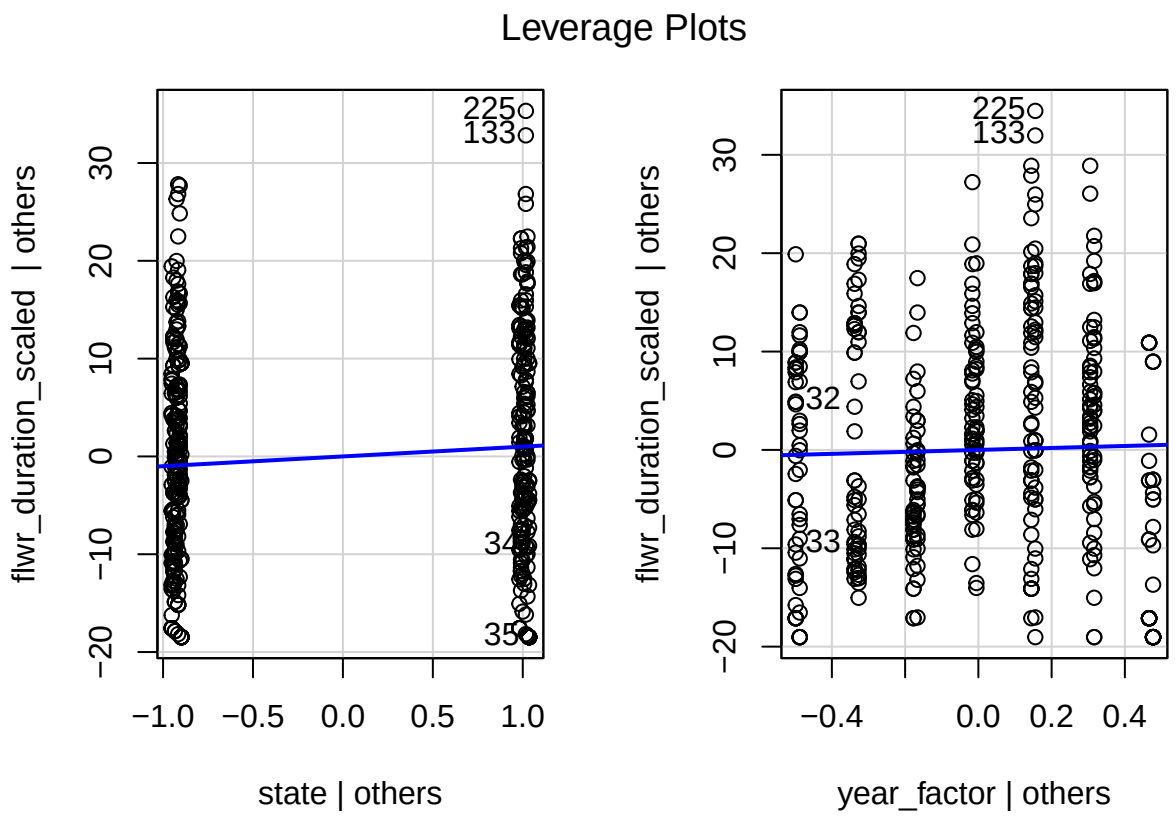



```
## 133 225
##  81 136
```

```
hist(fit_plot_stateyear_kbs_gh$residuals)
```




```
leveragePlots(fit_plot_stateyear_kbs_gh)
```

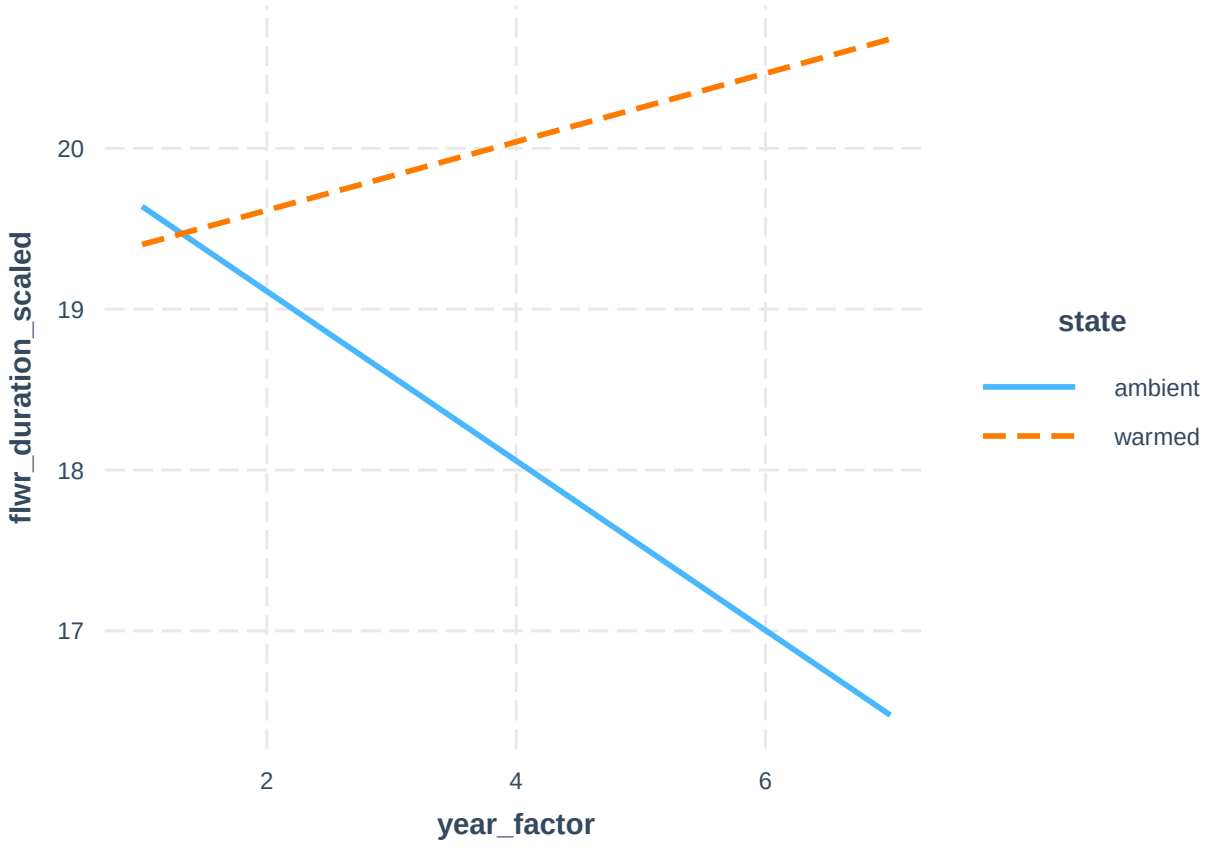


```
ols_test_normality(fit_plot_stateyear_kbs_gh) # a couple tests say not normal
```

```
## Warning in ks.test.default(y, "pnorm", mean(y), sd(y)): ties should not be
## present for the Kolmogorov-Smirnov test
```

```
## -----------------------------------------------
##        Test             Statistic       pvalue
## -----------------------------------------------
## Shapiro-Wilk              0.9801         0.0000
## Kolmogorov-Smirnov        0.0464         0.3067
## Cramer-von Mises         34.3948         0.0000
## Anderson-Darling          1.6239          4e-04
## -----------------------------------------------
```

```
# Interaction plot (ignore for now the repeated measures with species); see: https://cran.r-project.org

fit3 <- lm(flwr_duration_scaled ~ state * year_factor, data = kbs_flwr_plot_growthhabit)
interact_plot(fit3, pred = year_factor, modx = state) # this looks very strange to me
```

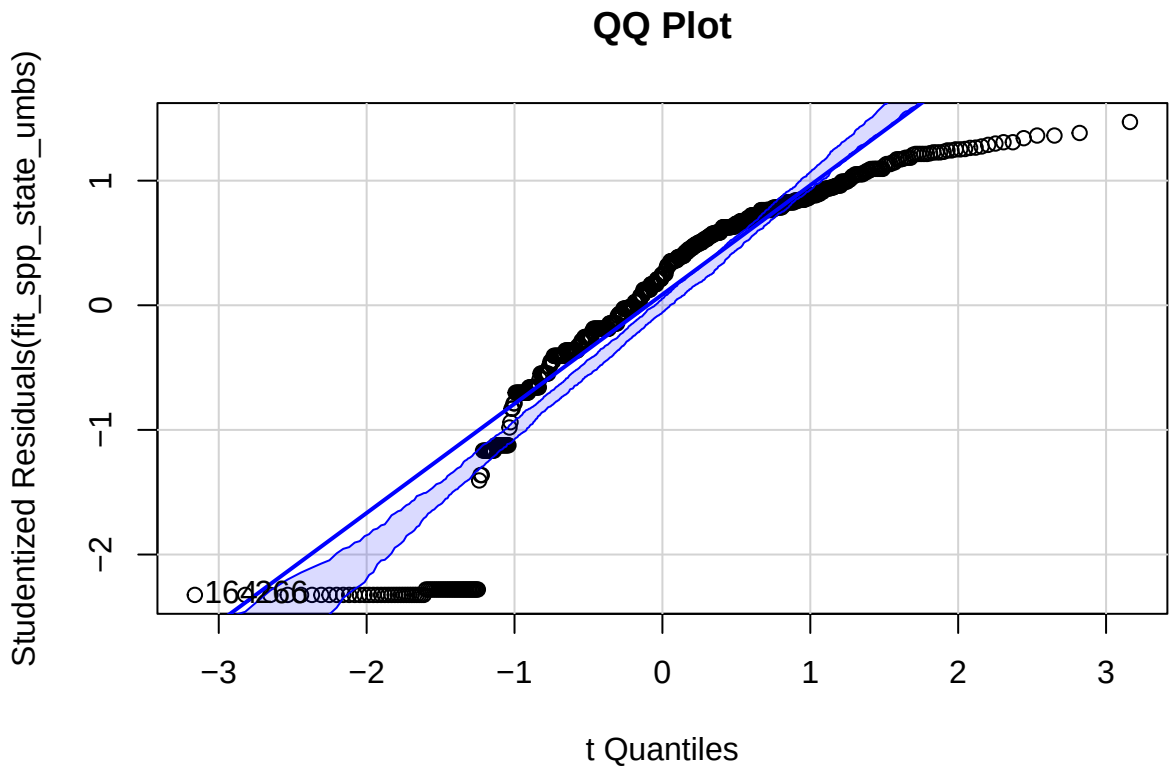


UMBS

```r
# species level data
# UMBS State-only model
fit_spp_state_umbs <- lm(log(flwr_duration_scaled) ~ state, data = umbs_flwr_spp)
outlierTest(fit_spp_state_umbs) # no outliers
```

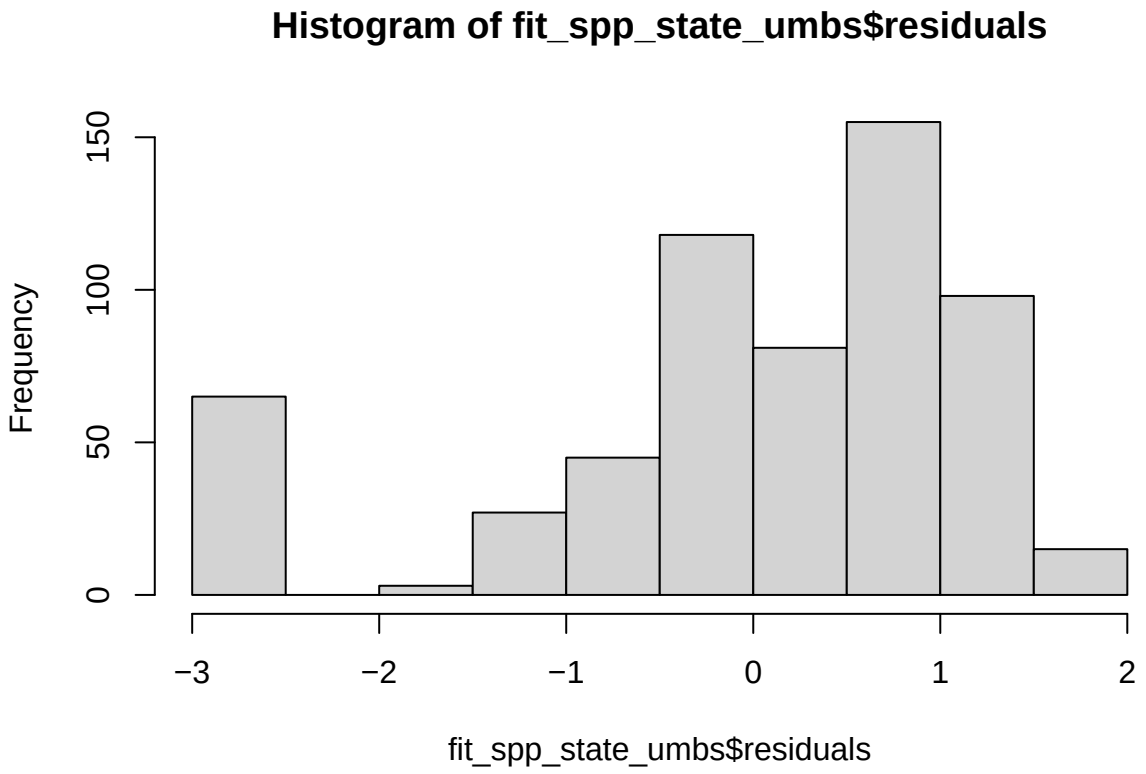
```
## No Studentized residuals with Bonferroni p < 0.05
## Largest |rstudent|:
##     rstudent unadjusted p-value Bonferroni p
## 164 -2.32397           0.020458           NA
```

```r
qqPlot(fit_spp_state_umbs, main="QQ Plot")
```

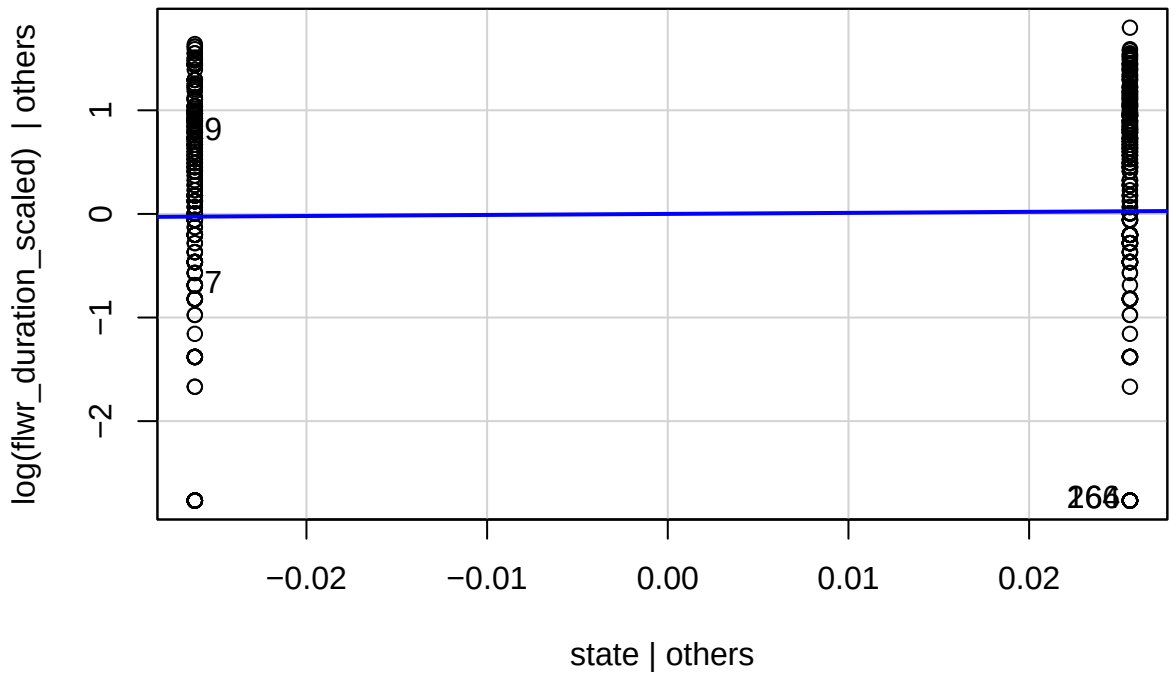



```
## 164 266
##  63  89
```

```r
hist(fit_spp_state_umbs$residuals)
```




```
leveragePlots(fit_spp_state_umbs)
```



```
ols_test_normality(fit_spp_state_umbs) # ok except Kol-Smir test
```

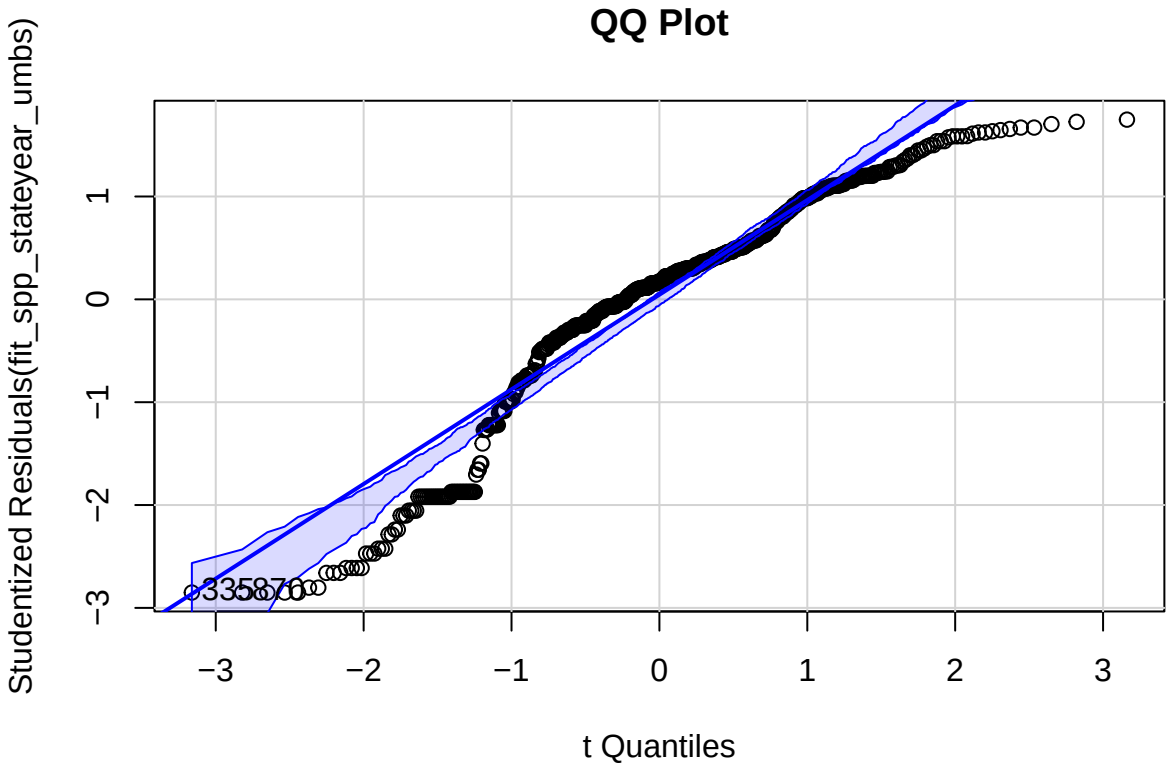
```
## Warning in ks.test.default(y, "pnorm", mean(y), sd(y)): ties should not be
## present for the Kolmogorov-Smirnov test
```

```
## -----------------------------------------------
##        Test             Statistic       pvalue
## -----------------------------------------------
## Shapiro-Wilk              0.8749         0.0000
## Kolmogorov-Smirnov        0.1174         0.0000
## Cramer-von Mises         23.7824         0.0000
## Anderson-Darling         22.9232         0.0000
## -----------------------------------------------
```

```
# UMBS State and year model
fit_spp_stateyear_umbs <- lm(log(flwr_duration_scaled) ~ state + year_factor, data = umbs_flwr_spp)
outlierTest(fit_spp_stateyear_umbs) # no outliers
```

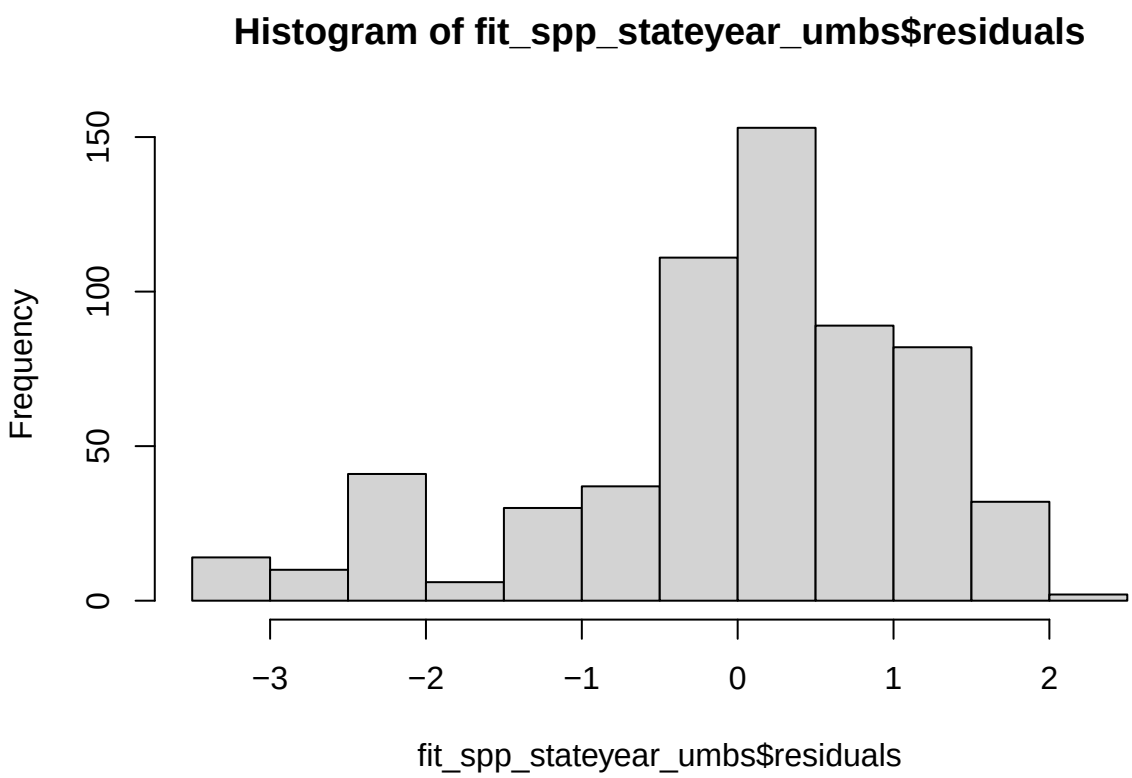
```
## No Studentized residuals with Bonferroni p < 0.05
## Largest |rstudent|:
##      rstudent unadjusted p-value Bonferroni p
## 335 -2.850863          0.0045092           NA
```

```
qqPlot(fit_spp_stateyear_umbs, main="QQ Plot")
```

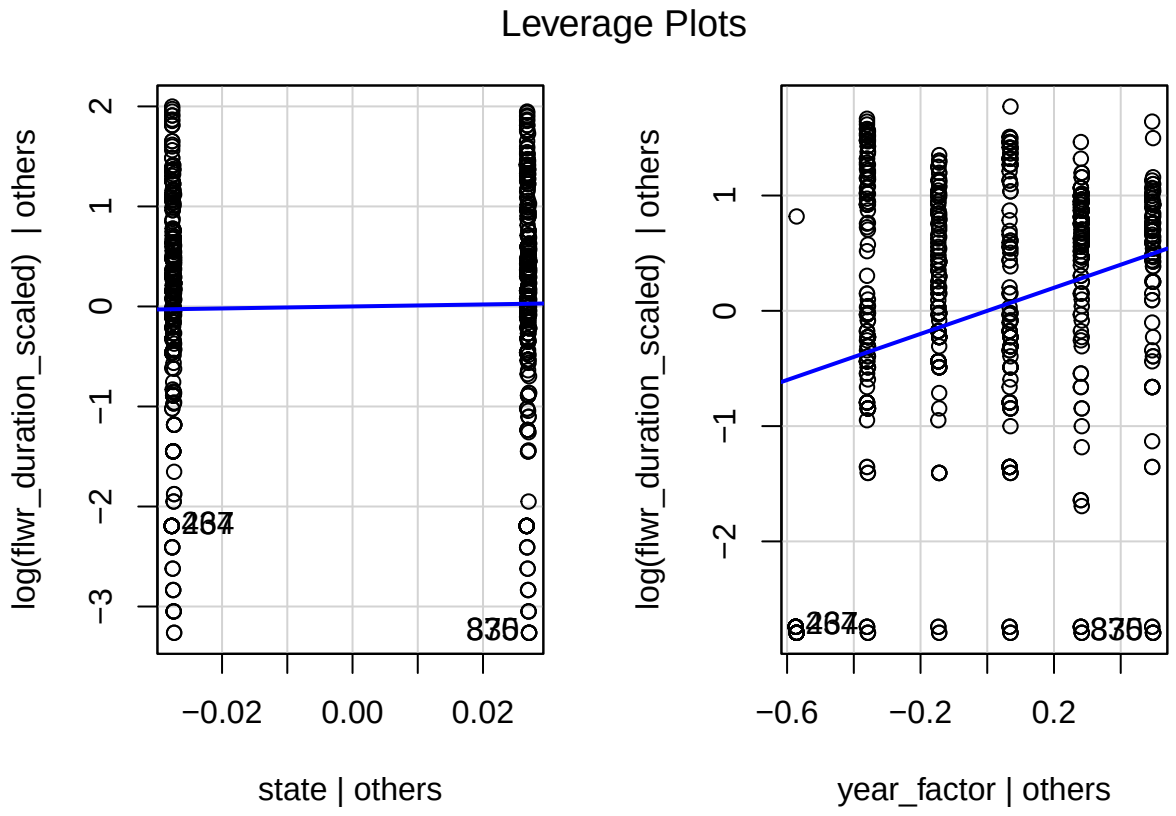



```
## 335 870
## 119 317
```

```
hist(fit_spp_stateyear_umbs$residuals)
```




```
leveragePlots(fit_spp_stateyear_umbs)
```




```
ols_test_normality(fit_spp_stateyear_umbs)
```

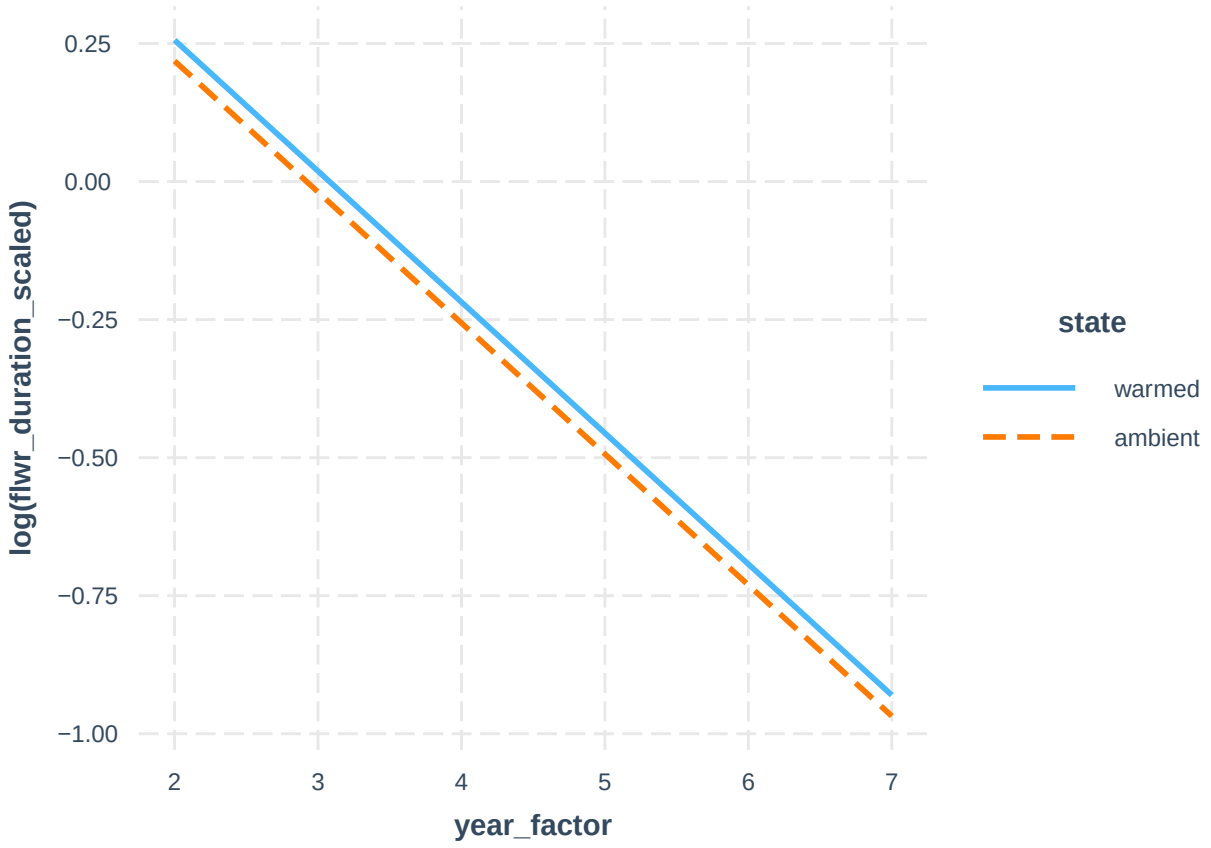
```
## Warning in ks.test.default(y, "pnorm", mean(y), sd(y)): ties should not be
## present for the Kolmogorov-Smirnov test
```

```
## -----------------------------------------------
##        Test             Statistic       pvalue
## -----------------------------------------------
## Shapiro-Wilk              0.9326         0.0000
## Kolmogorov-Smirnov        0.1145         0.0000
## Cramer-von Mises         27.6891         0.0000
## Anderson-Darling         13.2353         0.0000
## -----------------------------------------------
```

```
# Interaction plot (ignore for now the repeated measures with species); see: https://cran.r-project.org
fit3 <- lm(log(flwr_duration_scaled) ~ state + year_factor + species, data = umbs_flwr_spp)
interact_plot(fit3, pred = year_factor, modx = state)
```

```
## Using data umbs_flwr_spp from global environment. This could cause
## incorrect results if umbs_flwr_spp has been altered since the model was
## fit. You can manually provide the data to the "data =" argument.
```

```
## Warning: year_factor and state are not included in an interaction with one another
## in the model.
```




```
fit4 <- lm(log(flwr_duration_scaled) ~ state * year_factor + species, data = umbs_flwr_spp)
interact_plot(fit4, pred = year_factor, modx = state, mod2 = species)
```

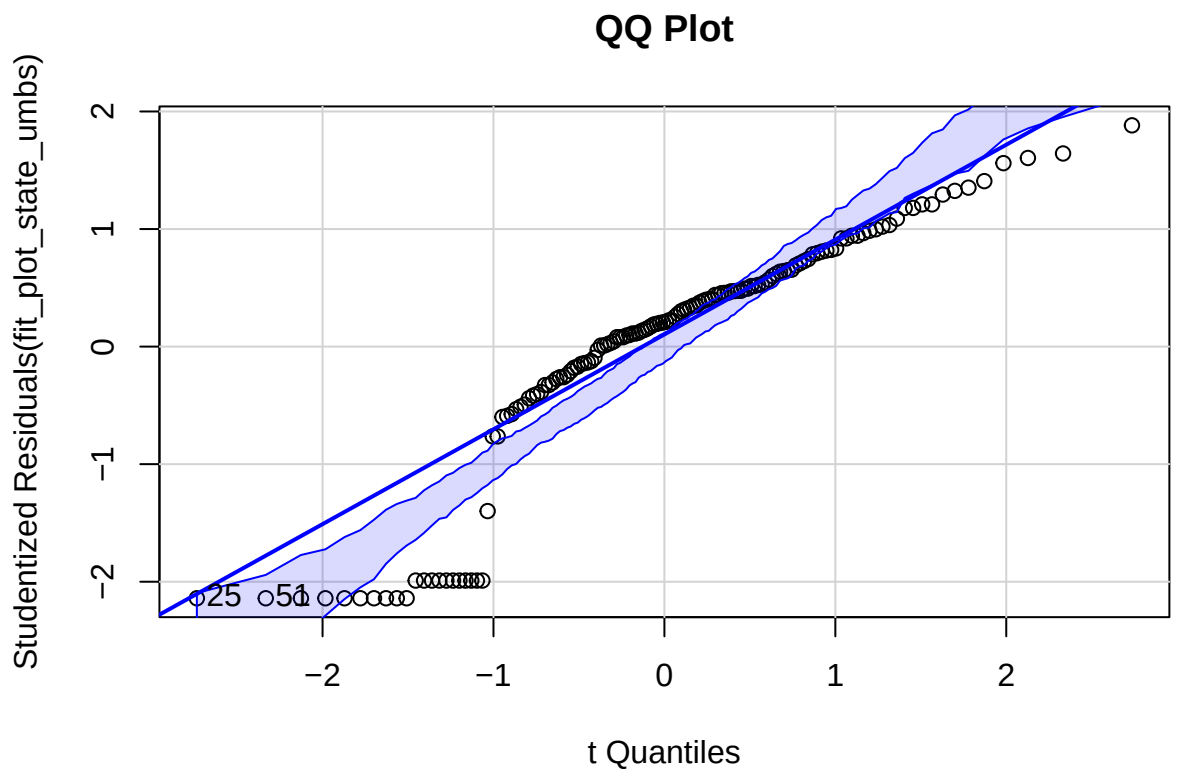
```
## Using data umbs_flwr_spp from global environment. This could cause
## incorrect results if umbs_flwr_spp has been altered since the model was
## fit. You can manually provide the data to the "data =" argument.

## Warning: year_factor and state and species are not included in an interaction with
## one another in the model.
```


```
# Plot level data
# UMBS State-only model
fit_plot_state_umbs <- lm(flwr_duration_scaled ~ state, data = umbs_flwr_plot)
outlierTest(fit_plot_state_umbs) # no outliers
```

```
## No Studentized residuals with Bonferroni p < 0.05
## Largest |rstudent|:
##     rstudent unadjusted p-value Bonferroni p
## 25 -2.140567           0.034054           NA
```

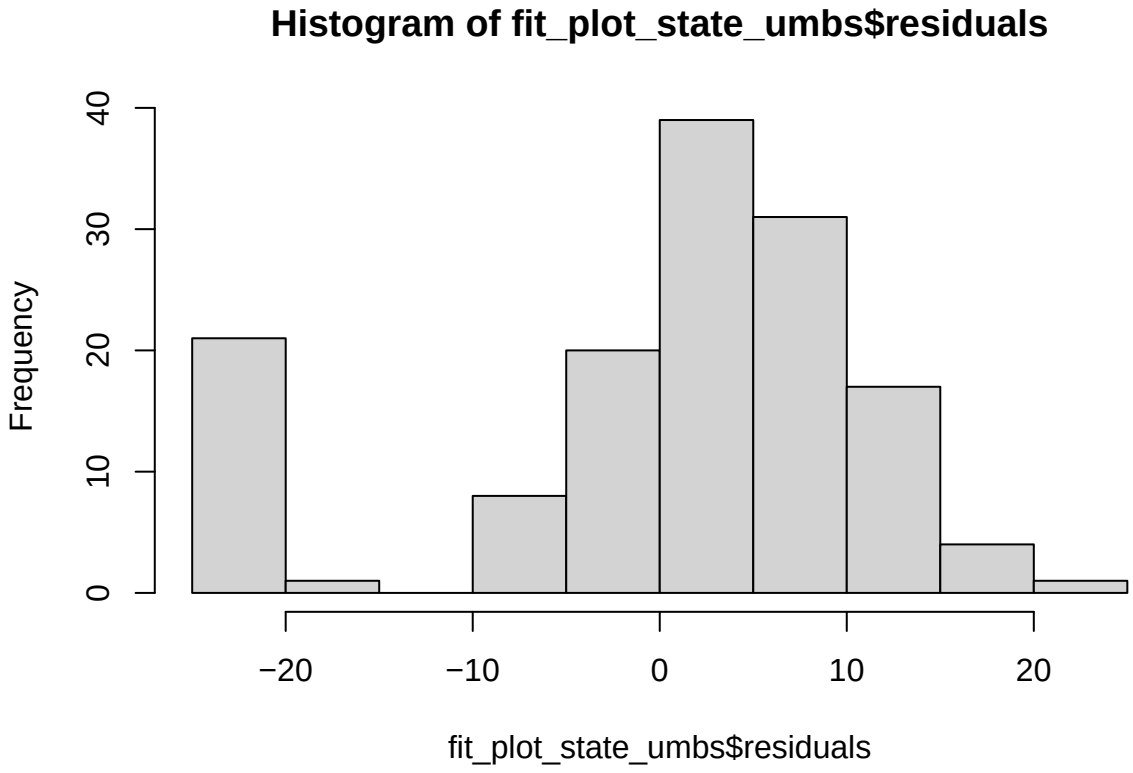
```
qqPlot(fit_plot_state_umbs, main="QQ Plot")
```

```
## Warning in rlm.default(x, y, weights, method = method, wt.method = wt.method, :
## 'rlm' failed to converge in 20 steps
```

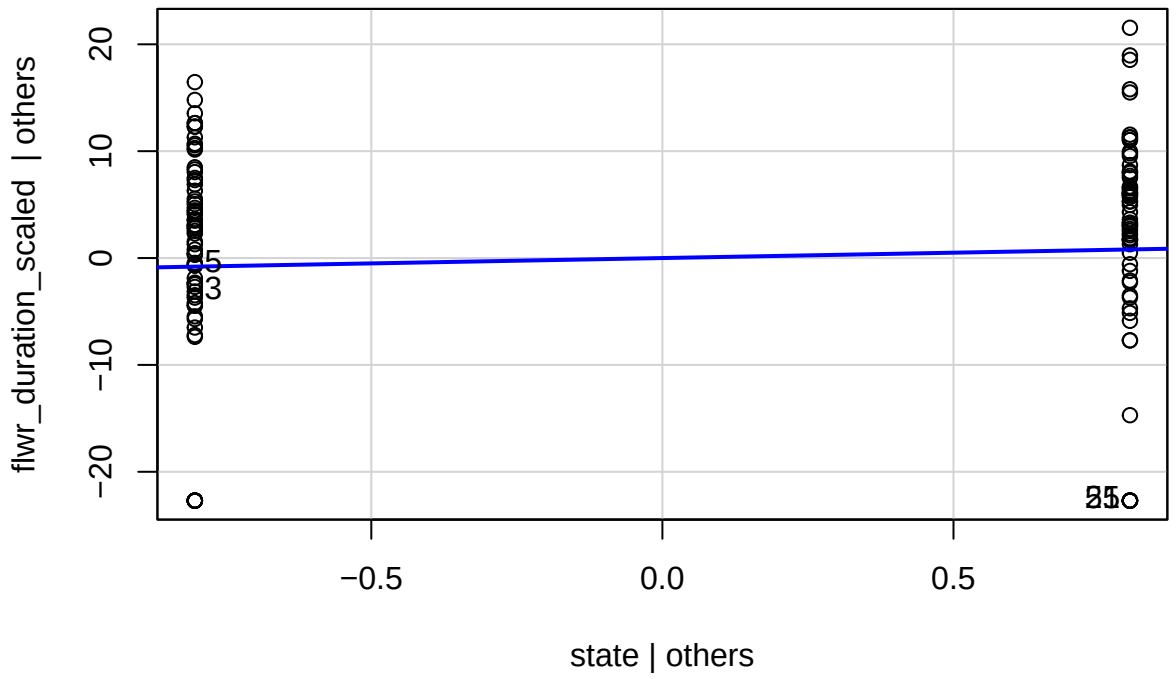



```
## 25 51
## 11 23
```

```
hist(fit_plot_state_umbs$residuals)
```



```
leveragePlots(fit_plot_state_umbs)
```




```
ols_test_normality(fit_plot_state_umbs) # these look good
```

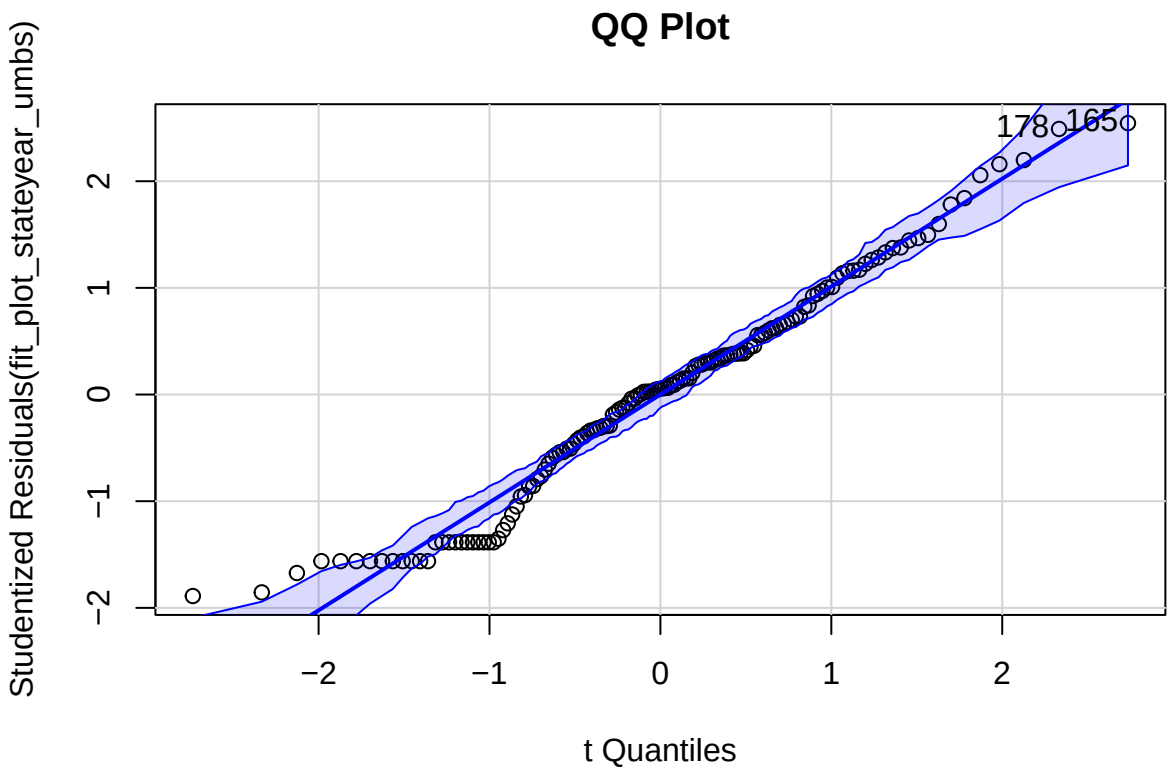
```
## Warning in ks.test.default(y, "pnorm", mean(y), sd(y)): ties should not be
## present for the Kolmogorov-Smirnov test
```

```
## -----------------------------------------------
##        Test             Statistic       pvalue
## -----------------------------------------------
## Shapiro-Wilk              0.8842         0.0000
## Kolmogorov-Smirnov        0.1514         0.0030
## Cramer-von Mises         12.7686         0.0000
## Anderson-Darling          6.0738         0.0000
## -----------------------------------------------
```

```
# UMBS State and year model
fit_plot_stateyear_umbs <- lm(flwr_duration_scaled ~ state + year_factor, data = umbs_flwr_plot)
outlierTest(fit_plot_stateyear_umbs) # no outliers
```

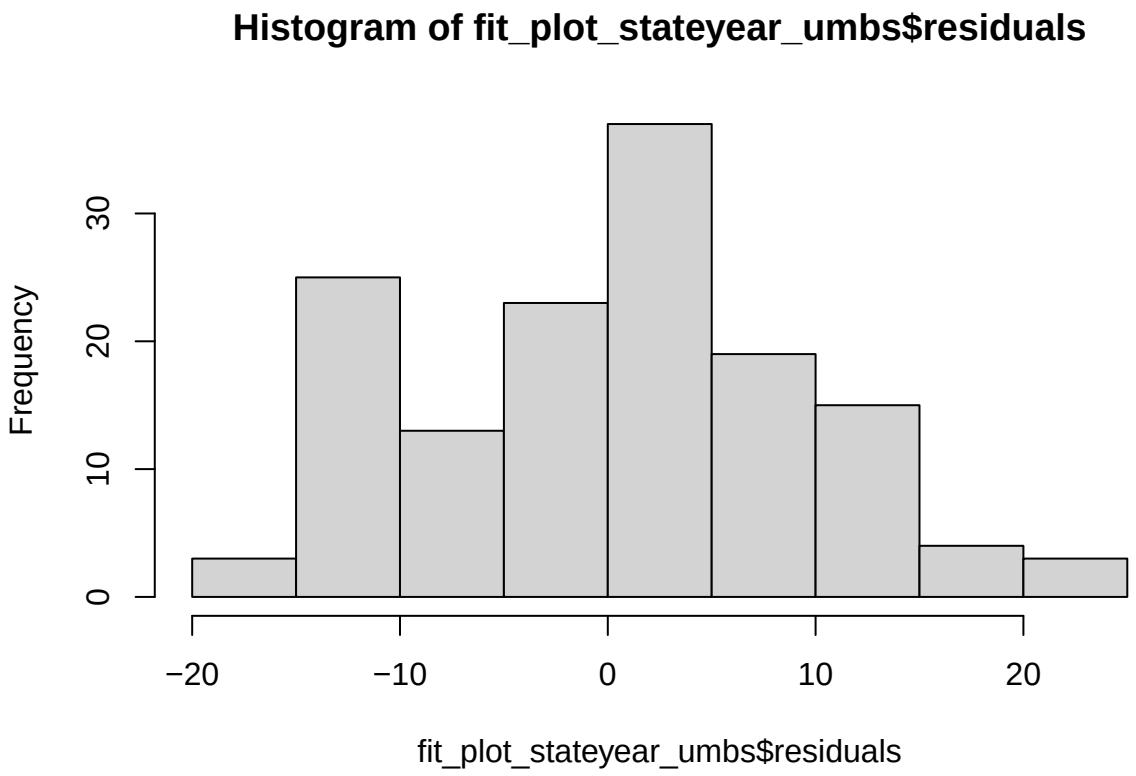
```
## No Studentized residuals with Bonferroni p < 0.05
## Largest |rstudent|:
##     rstudent unadjusted p-value Bonferroni p
## 165 2.544579           0.012041           NA
```

```
qqPlot(fit_plot_stateyear_umbs, main="QQ Plot")
```

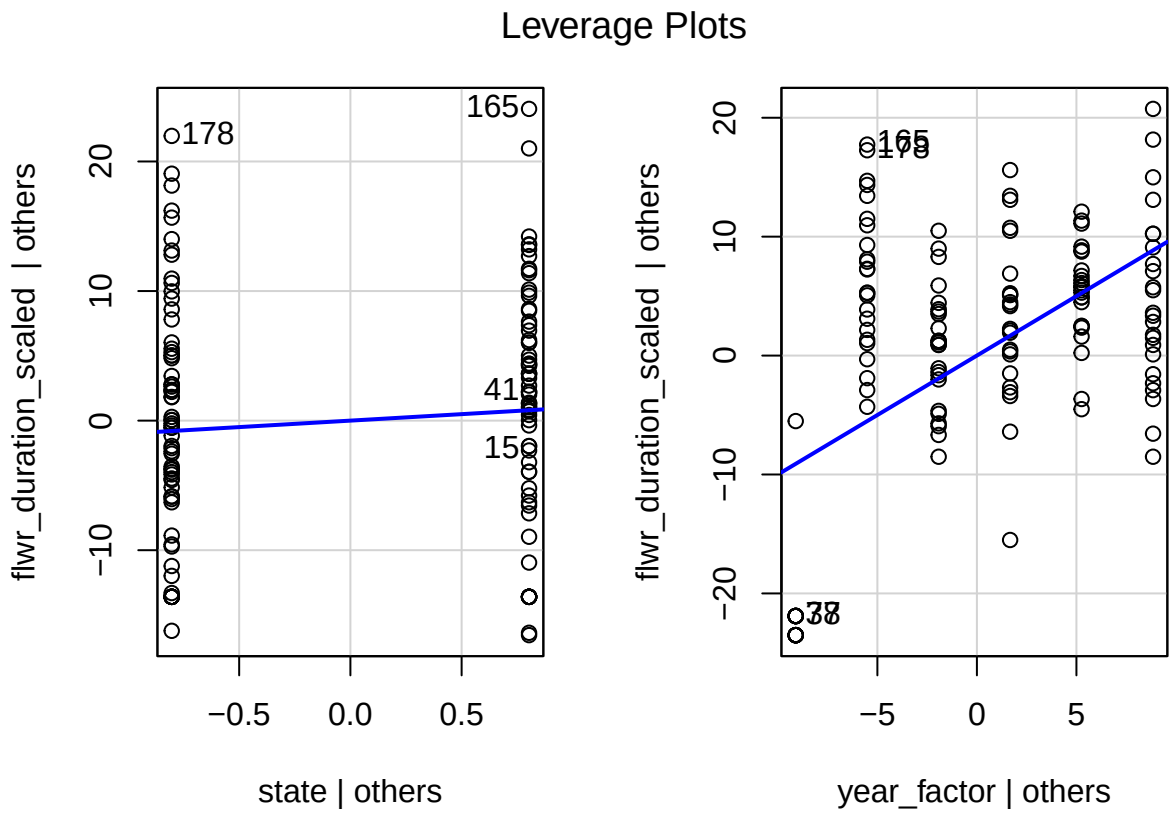



```
## 165 178
##  75  81
```

```
hist(fit_plot_stateyear_umbs$residuals)
```




```
leveragePlots(fit_plot_stateyear_umbs)
```

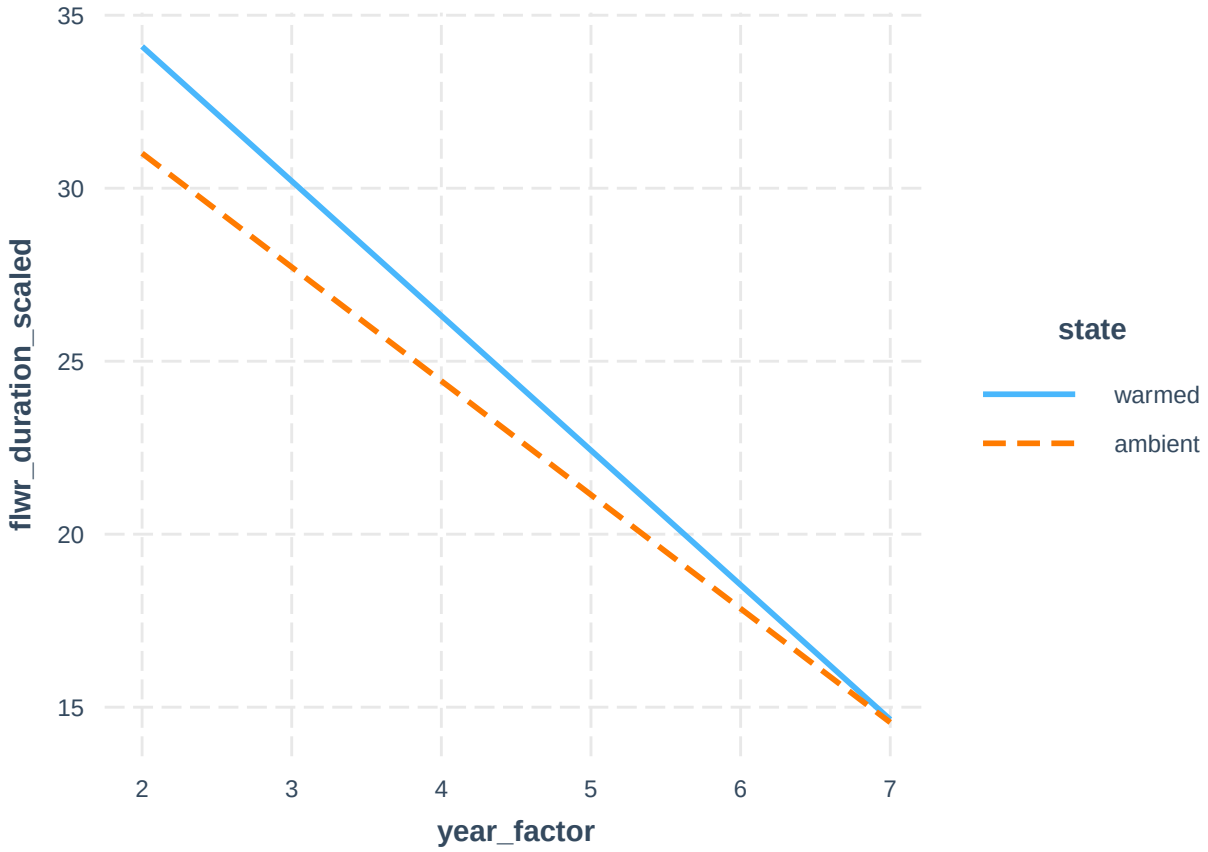


```
ols_test_normality(fit_plot_stateyear_umbs) # these look good except Kolmogorov-Smirnov which is > 0.05
```

```
## Warning in ks.test.default(y, "pnorm", mean(y), sd(y)): ties should not be
## present for the Kolmogorov-Smirnov test
```

```
## -----------------------------------------------
##        Test             Statistic       pvalue
## -----------------------------------------------
## Shapiro-Wilk              0.9744         0.0092
## Kolmogorov-Smirnov        0.0856         0.2493
## Cramer-von Mises          9.6754         0.0000
## Anderson-Darling          0.9279         0.0180
## -----------------------------------------------
```

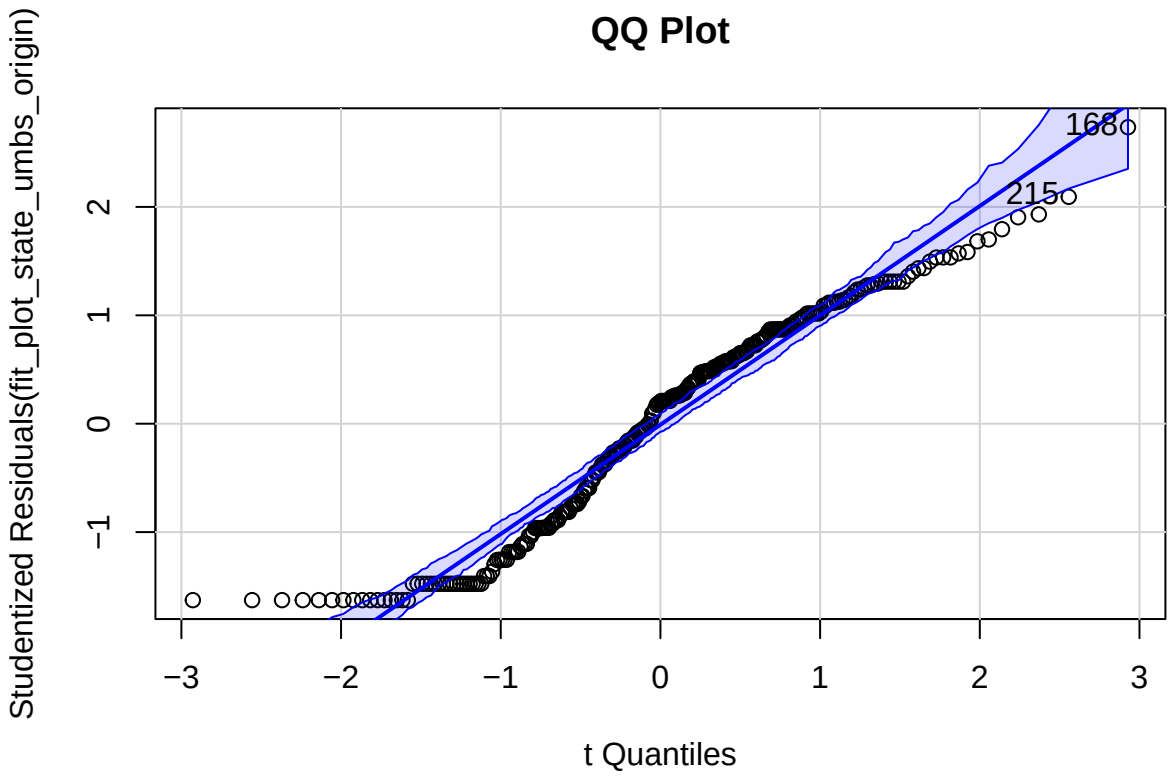
```
# Interaction plot (ignore for now the repeated measures with species); see: https://cran.r-project.org
fit3 <- lm(flwr_duration_scaled ~ state * year_factor, data = umbs_flwr_plot)
interact_plot(fit3, pred = year_factor, modx = state)
```




```
# Plot level ORIGIN data
# UMBS State-only model
fit_plot_state_umbs_origin <- lm(flwr_duration_scaled ~ state, data = umbs_flwr_plot_origin)
outlierTest(fit_plot_state_umbs_origin) # no outliers
```

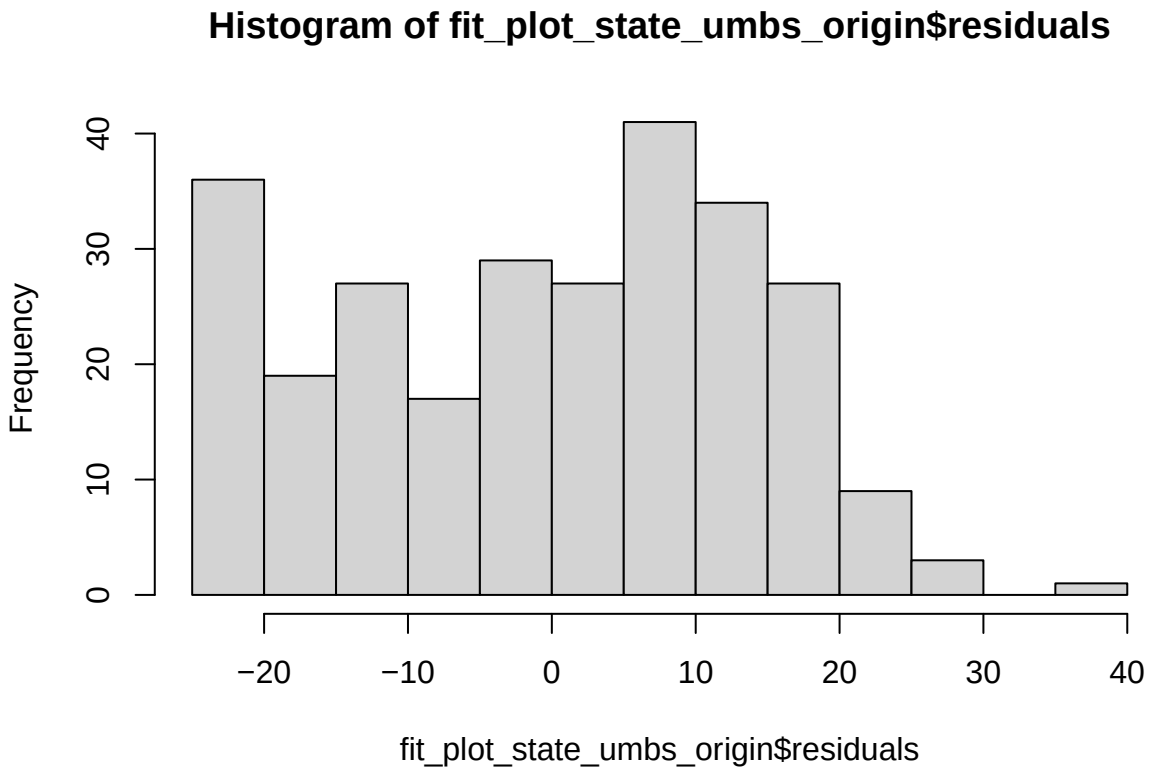
```
## No Studentized residuals with Bonferroni p < 0.05
## Largest |rstudent|:
##     rstudent unadjusted p-value Bonferroni p
## 168 2.735378          0.0066484           NA
```

```
qqPlot(fit_plot_state_umbs_origin, main="QQ Plot")
```

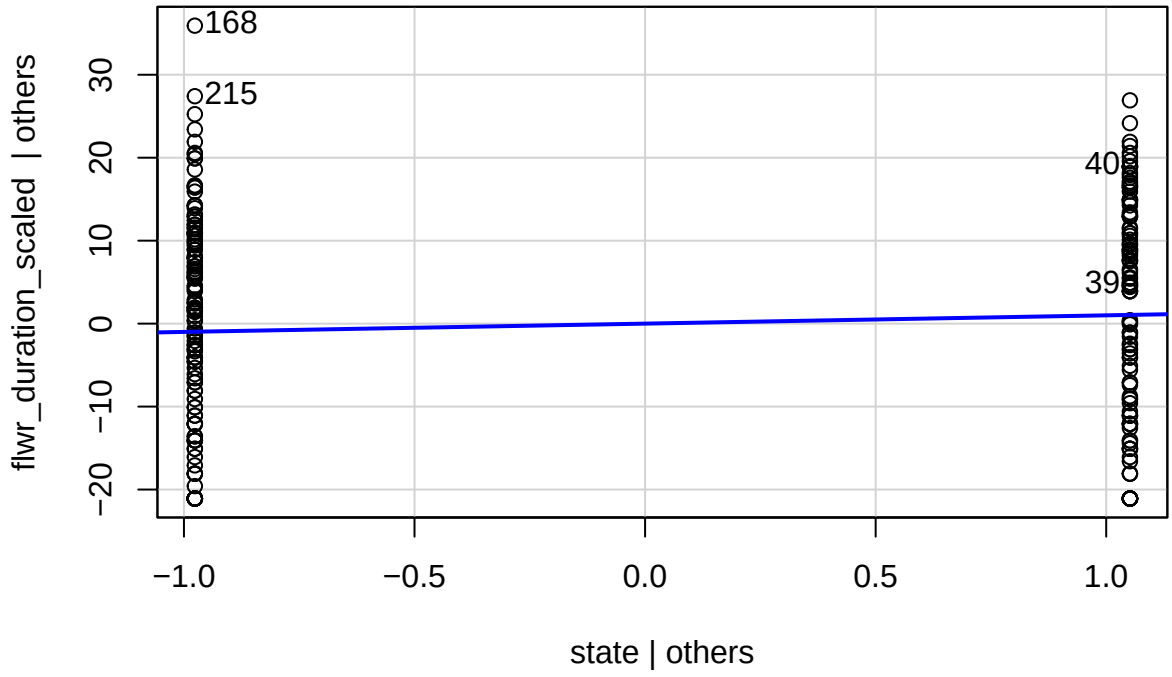



```
## 168 215
##  66  86
```

```
hist(fit_plot_state_umbs_origin$residuals)
```




```
leveragePlots(fit_plot_state_umbs_origin)
```



```
ols_test_normality(fit_plot_state_umbs_origin) # these don't look great...
```

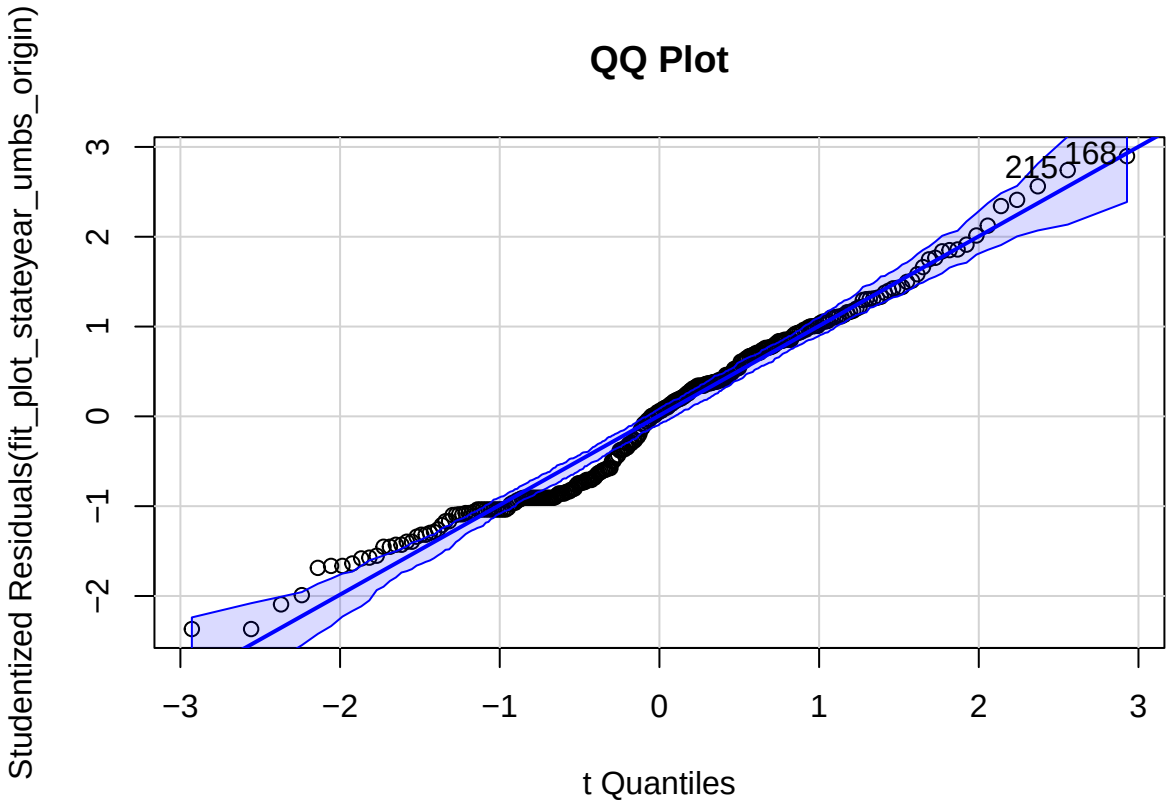
```
## Warning in ks.test.default(y, "pnorm", mean(y), sd(y)): ties should not be
## present for the Kolmogorov-Smirnov test
```

```
## -----------------------------------------------
##        Test             Statistic       pvalue
## -----------------------------------------------
## Shapiro-Wilk              0.9547         0.0000
## Kolmogorov-Smirnov        0.0836         0.0461
## Cramer-von Mises         22.4145         0.0000
## Anderson-Darling          3.7544         0.0000
## -----------------------------------------------
```

```
# UMBS State and year model
fit_plot_stateyear_umbs_origin <- lm(flwr_duration_scaled ~ state + year_factor, data = umbs_flwr_plot_
outlierTest(fit_plot_stateyear_umbs_origin) # no outliers
```

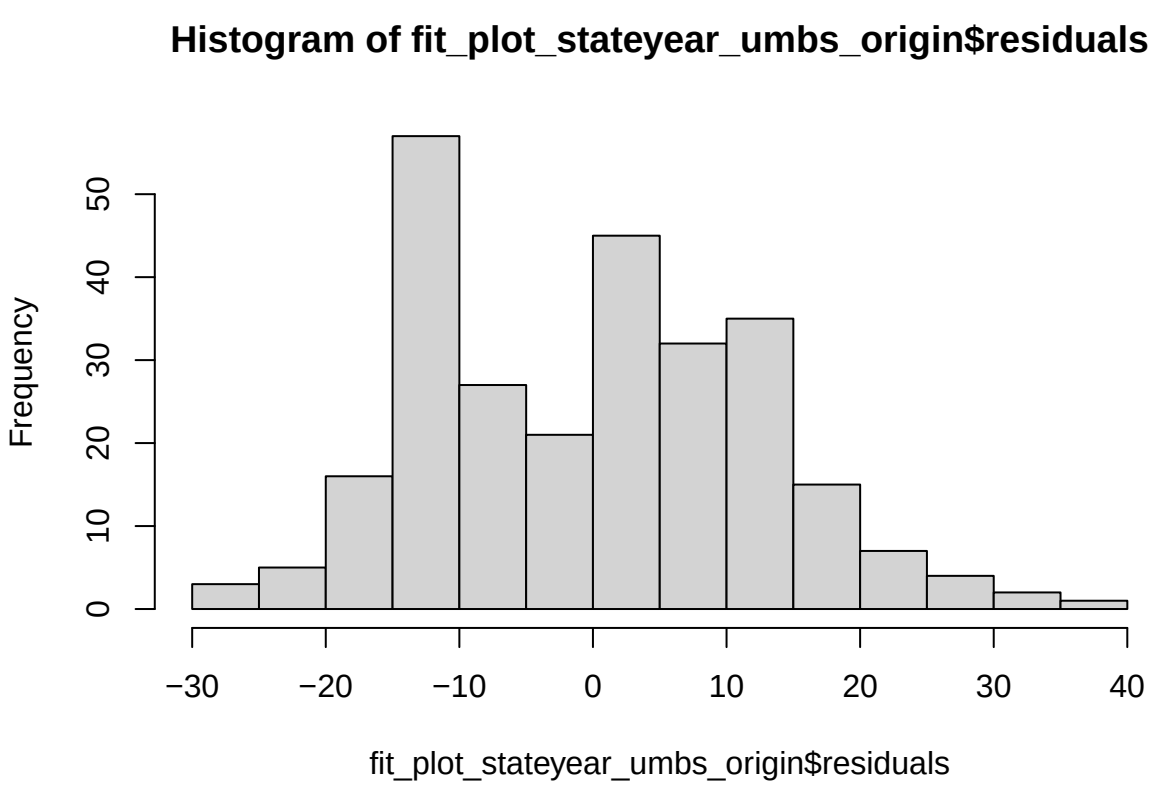
```
## No Studentized residuals with Bonferroni p < 0.05
## Largest |rstudent|:
##     rstudent unadjusted p-value Bonferroni p
## 168 2.897415          0.0040757           NA
```

```
qqPlot(fit_plot_stateyear_umbs_origin, main="QQ Plot")
```

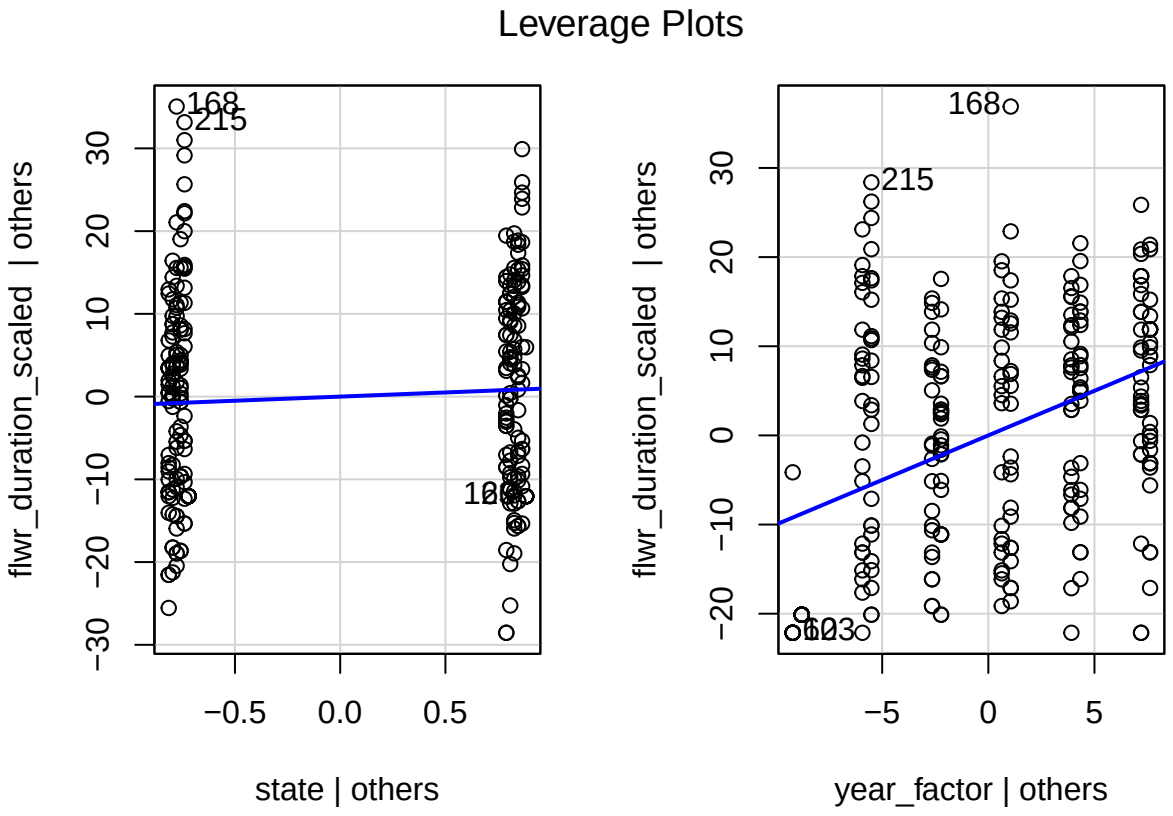


```
## 168 215
##  66  86
```

```
hist(fit_plot_stateyear_umbs_origin$residuals)
```




```
leveragePlots(fit_plot_stateyear_umbs_origin)
```

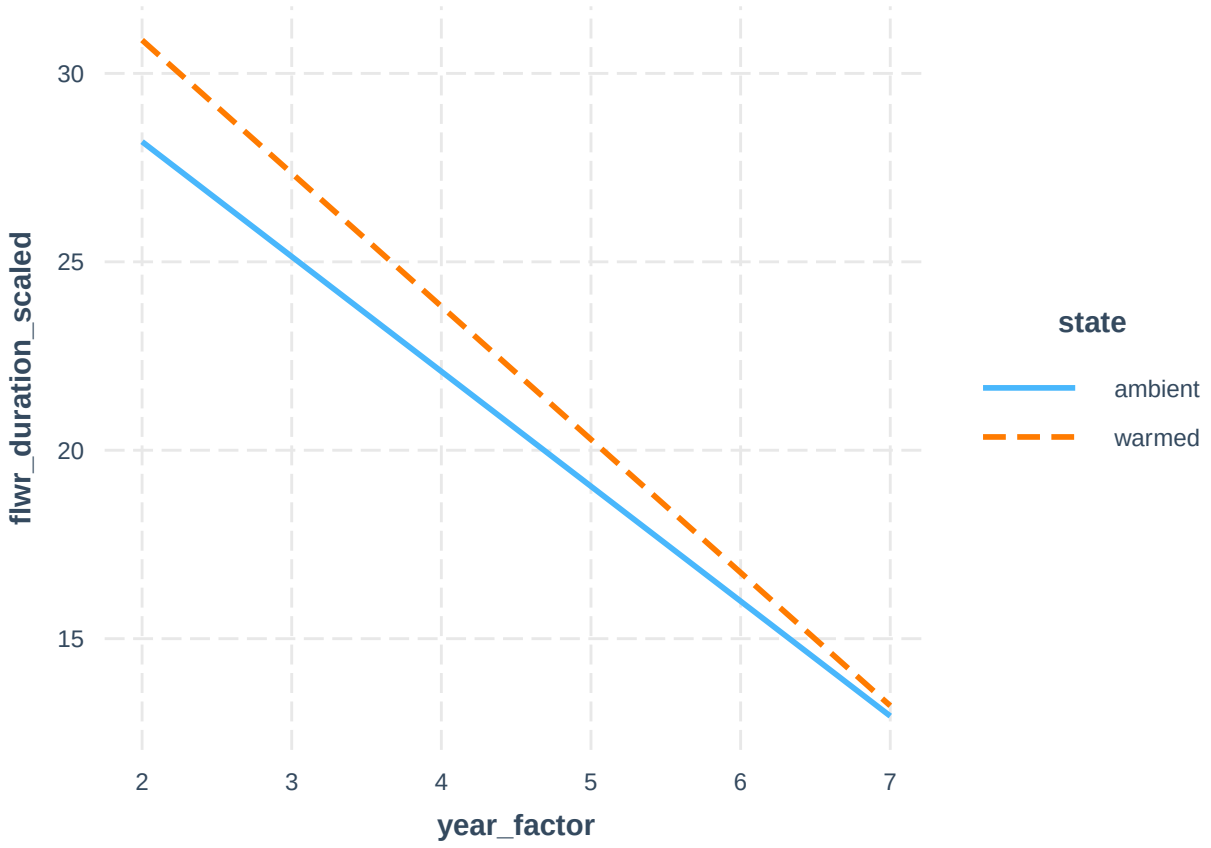



```
ols_test_normality(fit_plot_stateyear_umbs_origin) # these don't look great either
```

```
## Warning in ks.test.default(y, "pnorm", mean(y), sd(y)): ties should not be
## present for the Kolmogorov-Smirnov test
```

```
## -----------------------------------------------
##        Test             Statistic       pvalue
## -----------------------------------------------
## Shapiro-Wilk              0.9786          4e-04
## Kolmogorov-Smirnov        0.0988         0.0103
## Cramer-von Mises         21.3042         0.0000
## Anderson-Darling          2.3921         0.0000
## -----------------------------------------------
```

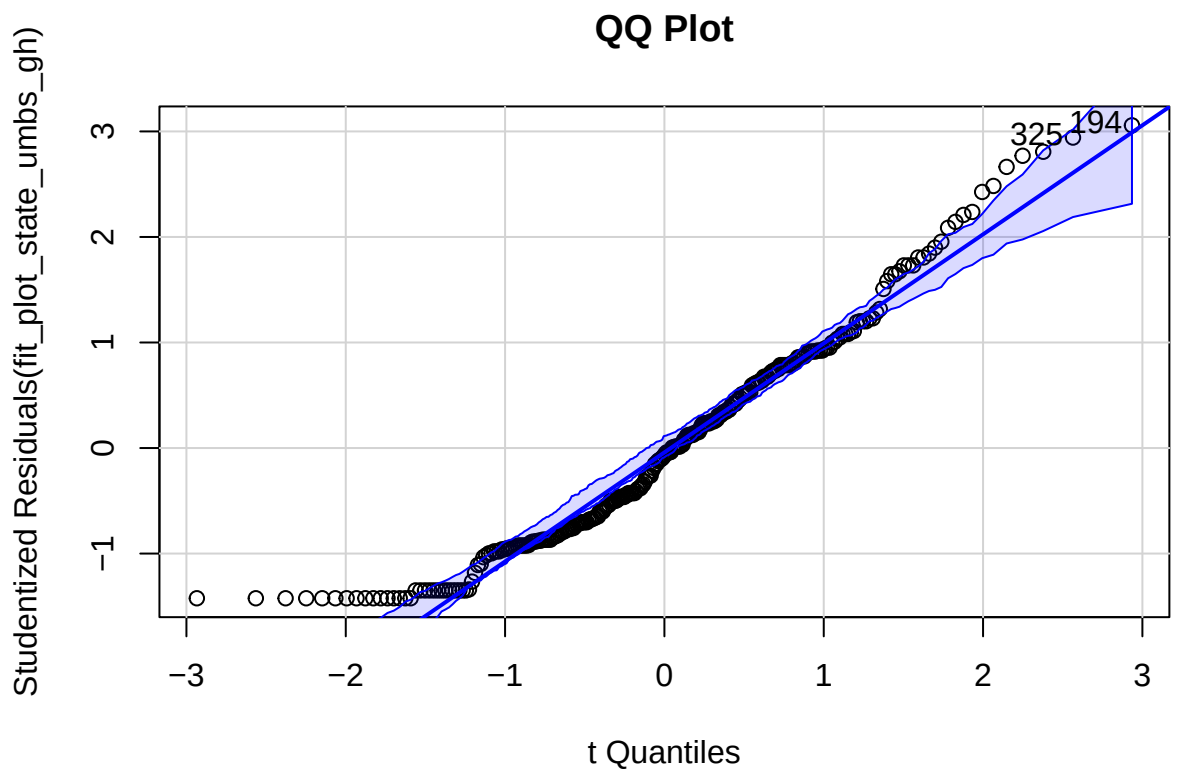
```
# Interaction plot (ignore for now the repeated measures with species); see: https://cran.r-project.org

fit3 <- lm(flwr_duration_scaled ~ state * year_factor, data = umbs_flwr_plot_origin)
interact_plot(fit3, pred = year_factor, modx = state)
```




```
# Plot level GROWTH HABIT data
# UMBS State-only model
fit_plot_state_umbs_gh <- lm(flwr_duration_scaled ~ state, data = umbs_flwr_plot_growthhabit)
outlierTest(fit_plot_state_umbs_gh) # no outliers
```

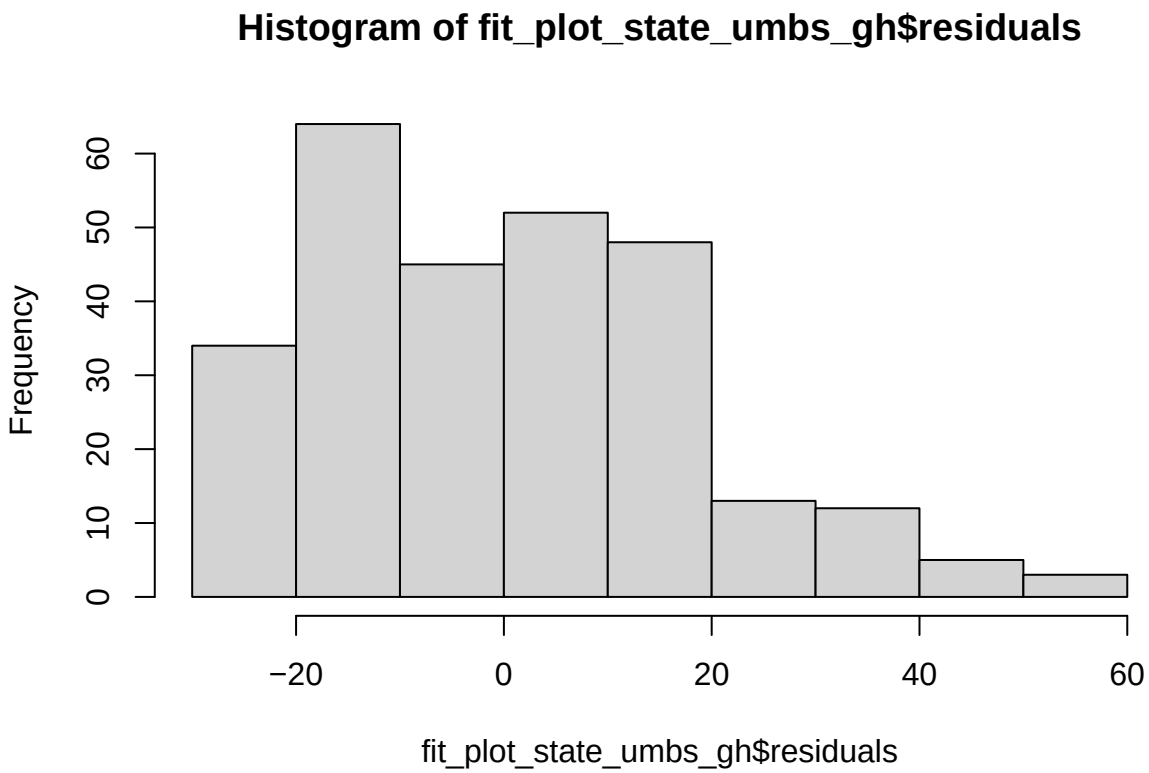
```
## No Studentized residuals with Bonferroni p < 0.05
## Largest |rstudent|:
##     rstudent unadjusted p-value Bonferroni p
## 194 3.057644          0.0024522      0.67682
```

```
qqPlot(fit_plot_state_umbs_gh, main="QQ Plot")
```

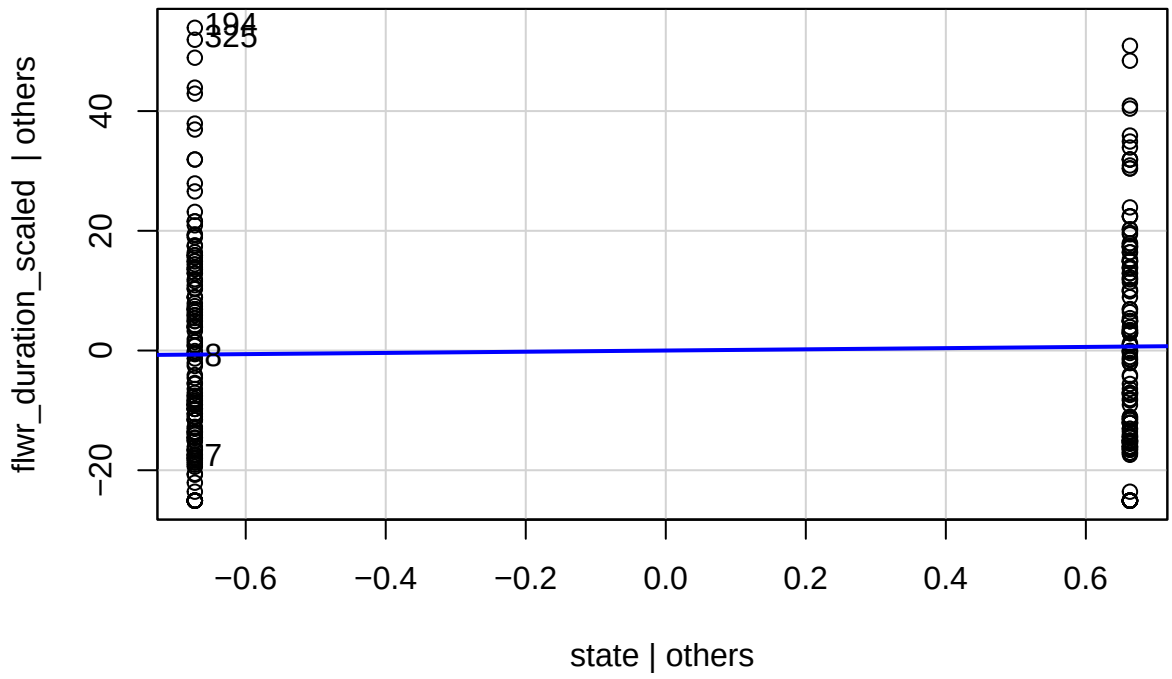



```
## 194 325
##  78 129
```

```
hist(fit_plot_state_umbs_gh$residuals)
```



```
leveragePlots(fit_plot_state_umbs_gh)
```




```
ols_test_normality(fit_plot_state_umbs_gh) # these don't look great...
```

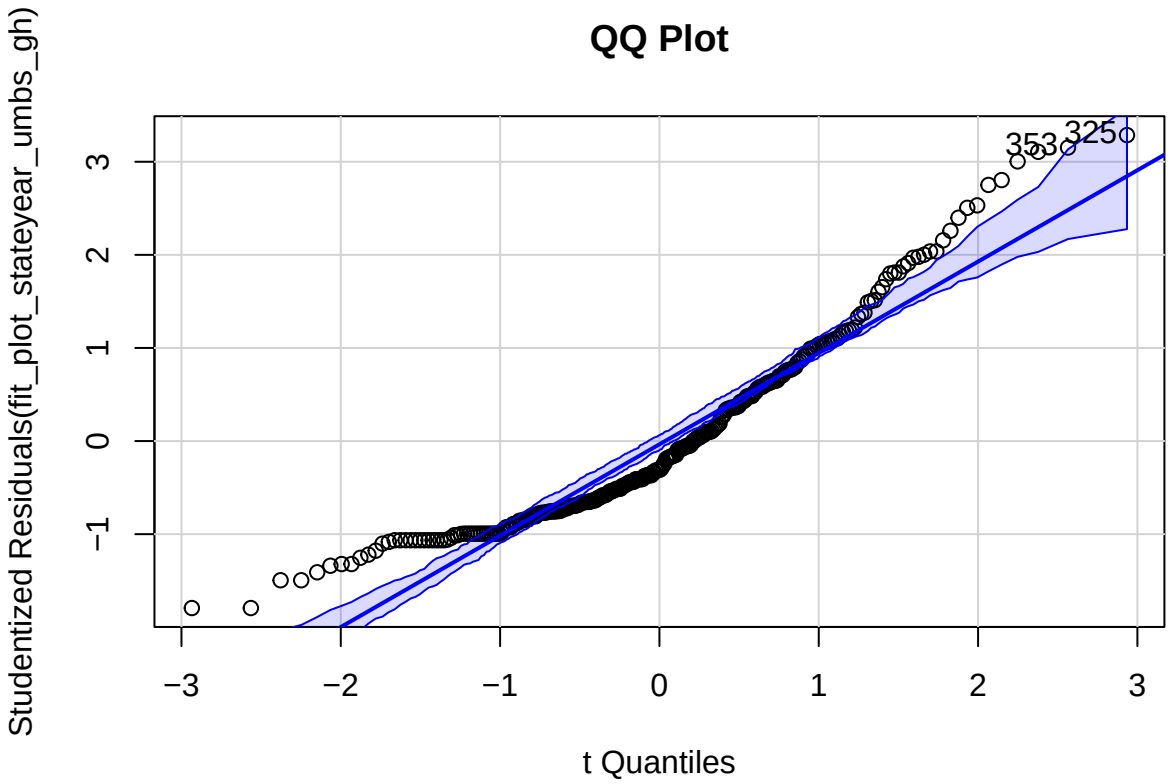
```
## Warning in ks.test.default(y, "pnorm", mean(y), sd(y)): ties should not be
## present for the Kolmogorov-Smirnov test
```

```
## -----------------------------------------------
##        Test             Statistic       pvalue
## -----------------------------------------------
## Shapiro-Wilk              0.954          0.0000
## Kolmogorov-Smirnov        0.0927         0.0174
## Cramer-von Mises         22.0397         0.0000
## Anderson-Darling          2.8599         0.0000
## -----------------------------------------------
```

```
# UMBS State and year model
fit_plot_stateyear_umbs_gh <- lm(flwr_duration_scaled ~ state + year_factor, data = umbs_flwr_plot_grow
outlierTest(fit_plot_stateyear_umbs_gh) # no outliers
```

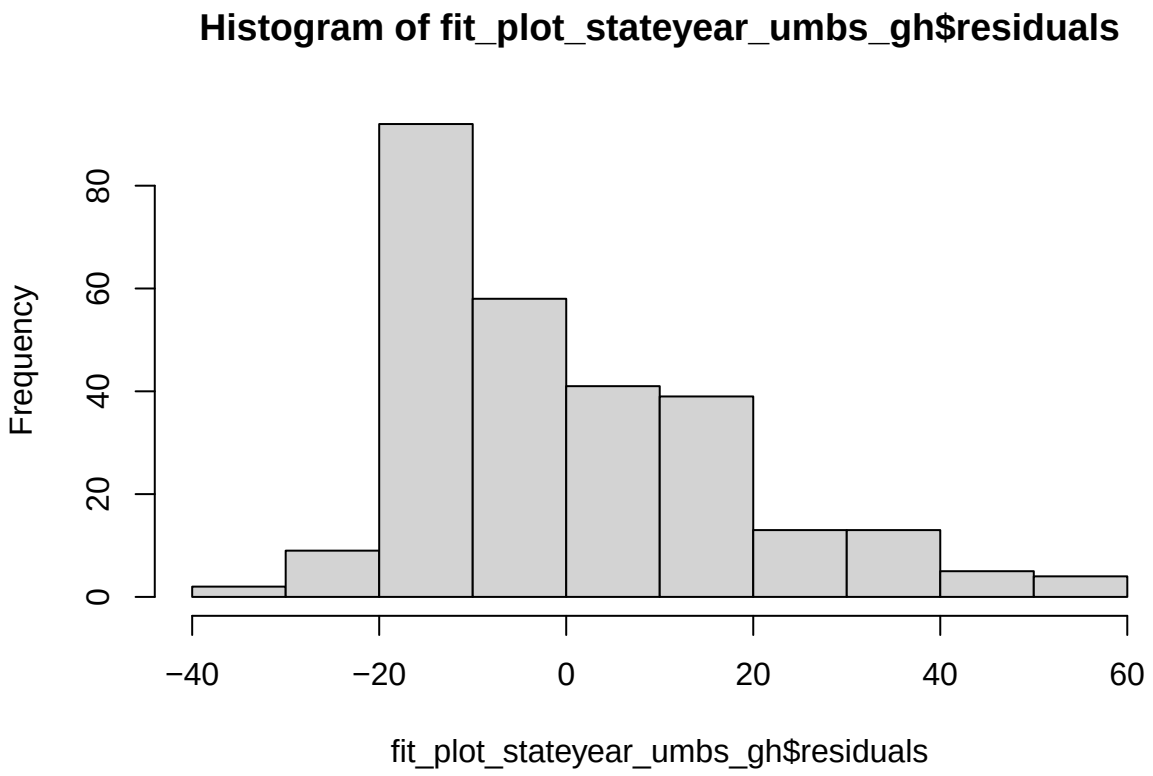
```
## No Studentized residuals with Bonferroni p < 0.05
## Largest |rstudent|:
##     rstudent unadjusted p-value Bonferroni p
## 325 3.286092          0.0011493       0.3172
```

```
qqPlot(fit_plot_stateyear_umbs_gh, main="QQ Plot")
```

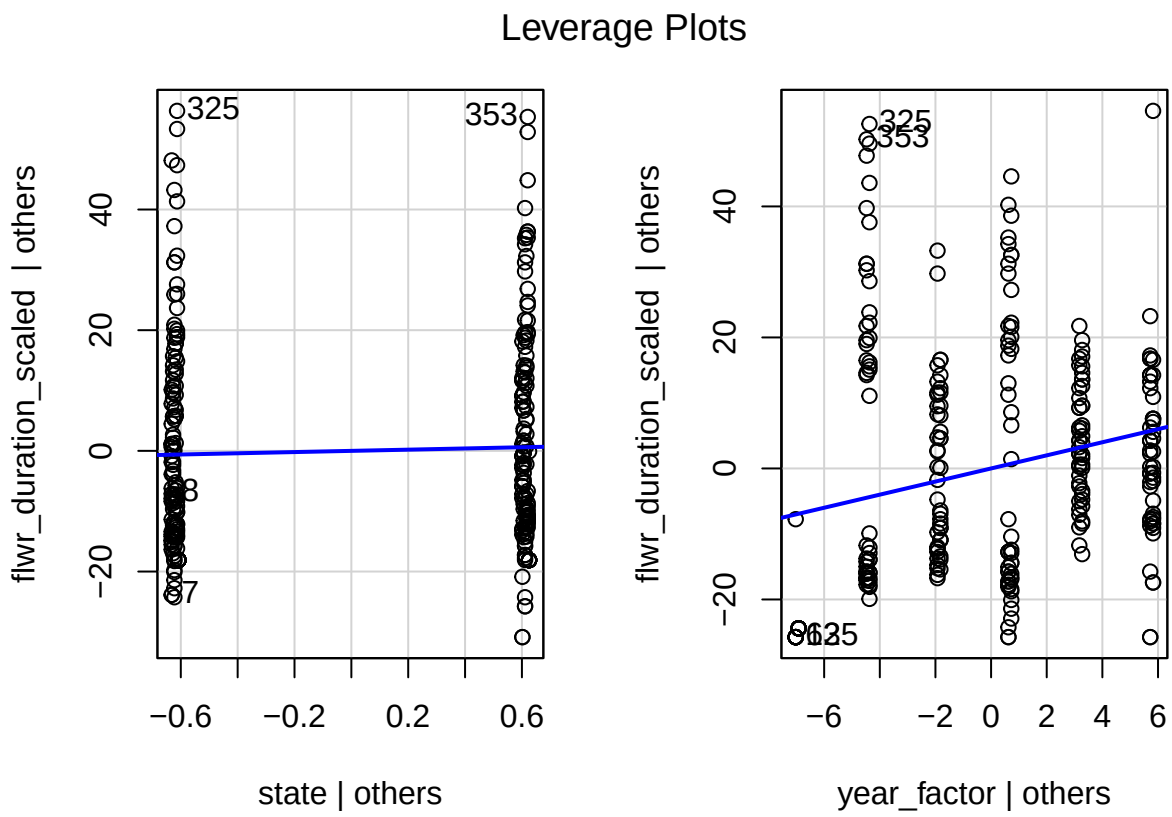



```
## 325 353
## 129 140
```

```
hist(fit_plot_stateyear_umbs_gh$residuals)
```




```
leveragePlots(fit_plot_stateyear_umbs_gh)
```

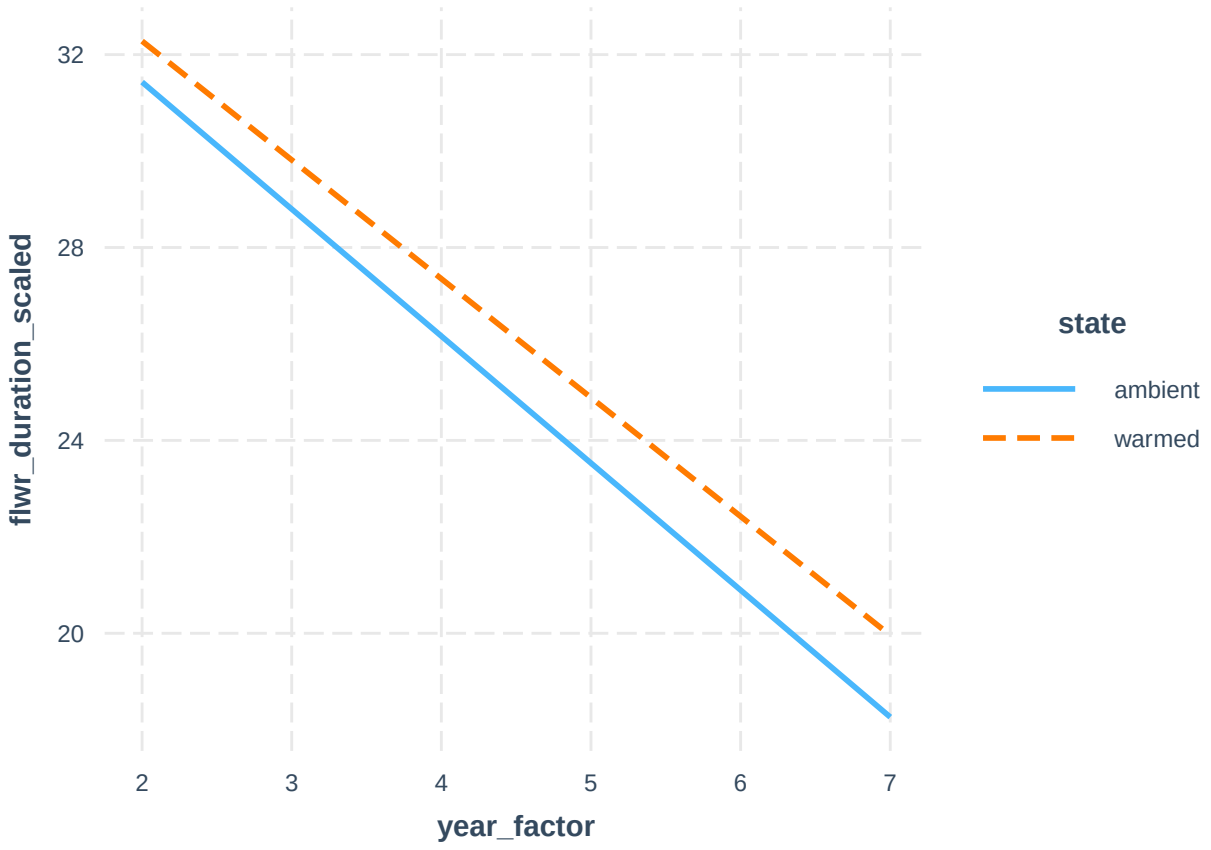


```
ols_test_normality(fit_plot_stateyear_umbs_gh) # these don't look great either
```

```
## Warning in ks.test.default(y, "pnorm", mean(y), sd(y)): ties should not be
## present for the Kolmogorov-Smirnov test
```

```
## -----------------------------------------------
##        Test             Statistic       pvalue
## -----------------------------------------------
## Shapiro-Wilk              0.9247         0.0000
## Kolmogorov-Smirnov        0.1247          4e-04
## Cramer-von Mises          24.527         0.0000
## Anderson-Darling          6.3952         0.0000
## -----------------------------------------------
```

```
# Interaction plot (ignore for now the repeated measures with species); see: https://cran.r-project.org

fit3 <- lm(flwr_duration_scaled ~ state * year_factor, data = umbs_flwr_plot_growthhabit)
interact_plot(fit3, pred = year_factor, modx = state)
```



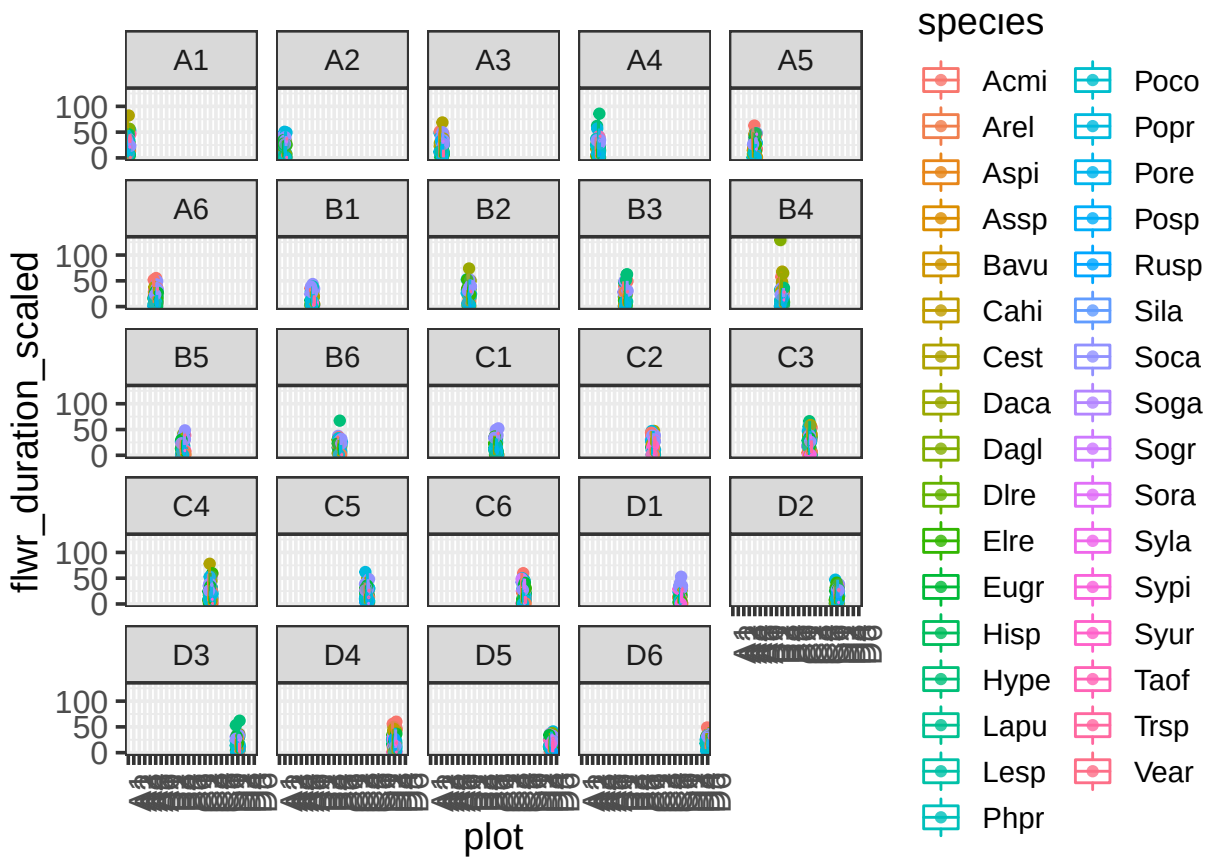
MIXED EFFECT MODELS

KBS

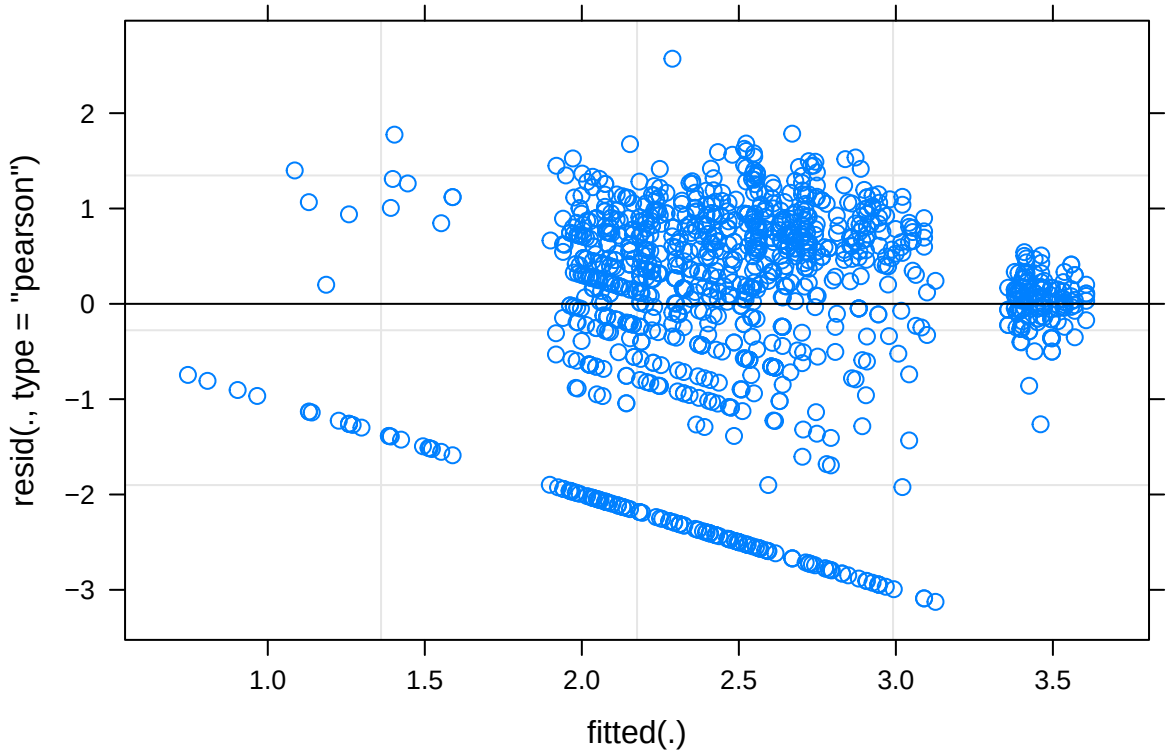
```
# KBS SPECIES LEVEL - Looking at DURATION of flowering
mod1 <- lmer(log(flwr_duration_scaled) ~ state*year_factor + insecticide*year_factor + (1|species) + (1
```

```
## boundary (singular) fit: see help('isSingular')
```

```
ggplot(kbs_flwr_spp,aes(x=plot,y=flwr_duration_scaled,col=species)) + geom_jitter() + geom_boxplot(alpha
```




```
# Check Assumptions:
# (1) Linearity: if covariates are not categorical (year isn't)
# (2) Homogeneity: Need to Check by plotting residuals vs predicted values.
par(mfrow=c(1,2))
plot(mod1) # the ones in the data are making this look weird - idk this doesn't look great
```




```
# Homogeneity of variance looks weird here
# Check for homogeneity of variances (true if p>0.05). If the result is not significant, the assumption
# *****Levene's Test - tests whether or not the variance among two or more groups is equal - If the p-v

leveneTest(residuals(mod1) ~ kbs_flwr_spp$state)
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##         Df F value Pr(>F)
## group    1  0.5122 0.4744
##       1149
```

```
# Assumption not met
leveneTest(residuals(mod1) ~ kbs_flwr_spp$species)
```

```
## Warning in leveneTest.default(y = y, group = group, ...): group coerced to
## factor.
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##         Df F value    Pr(>F)
## group   32  3.5061 3.174e-10 ***
##       1118
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# Assumption met
leveneTest(residuals(mod1) ~ kbs_flwr_spp$insecticide)
```

```
## Warning in leveneTest.default(y = y, group = group, ...): group coerced to
## factor.
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##         Df F value Pr(>F)
## group    1  0.5721 0.4496
##       1149
```

```
# Assumption not met - this seems weird
leveneTest(residuals(mod1) ~ kbs_flwr_spp$plot)
```

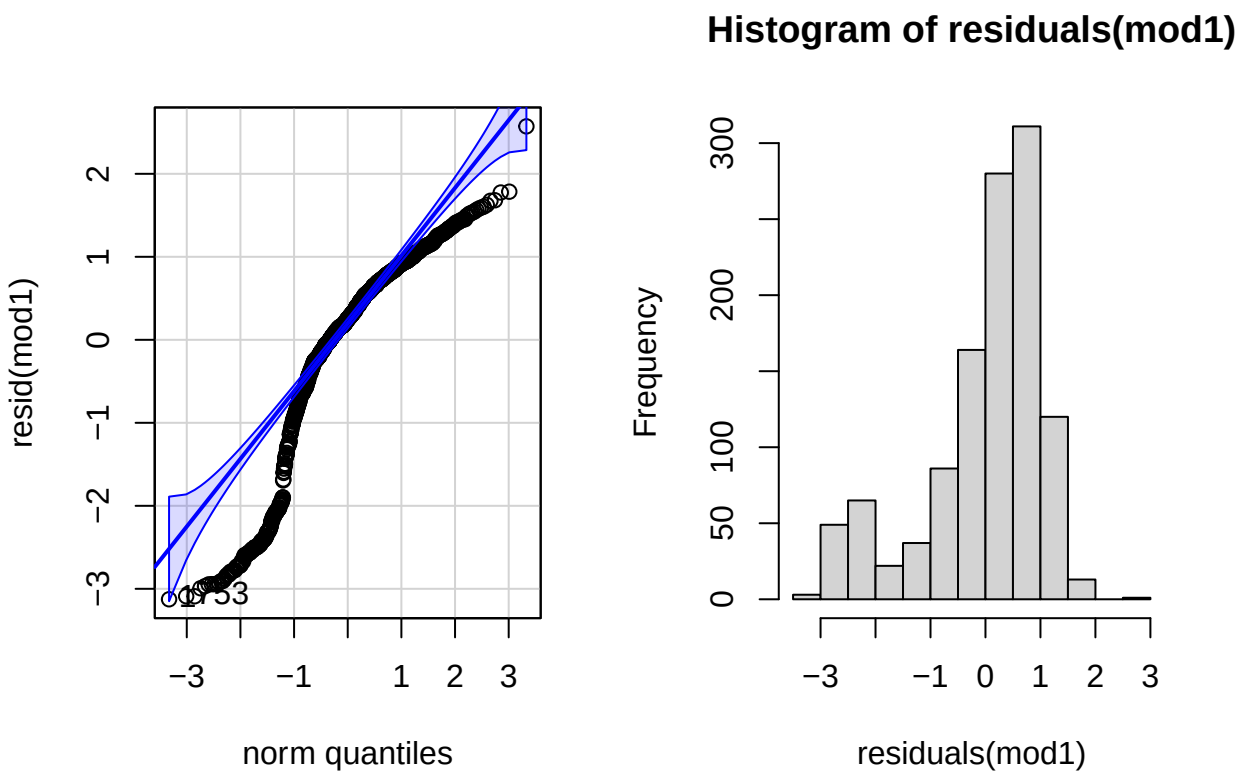
```
## Warning in leveneTest.default(y = y, group = group, ...): group coerced to
## factor.
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##         Df F value Pr(>F)
## group   23   0.901 0.5979
##       1127
```

```
# Assumption not met

# (3) Normality of error term: need to check by histogram, QQplot of residuals, could do Kolmogorov-Smi
# Check for normal residuals
qqPlot(resid(mod1))
```

```
##   1 753
##   1 478
```

```
hist(residuals(mod1))
```



```
shapiro.test(resid(mod1)) # not normally distributed resids bc p<0.05
```

```
##
##  Shapiro-Wilk normality test
##
## data:  resid(mod1)
## W = 0.88491, p-value < 2.2e-16
```

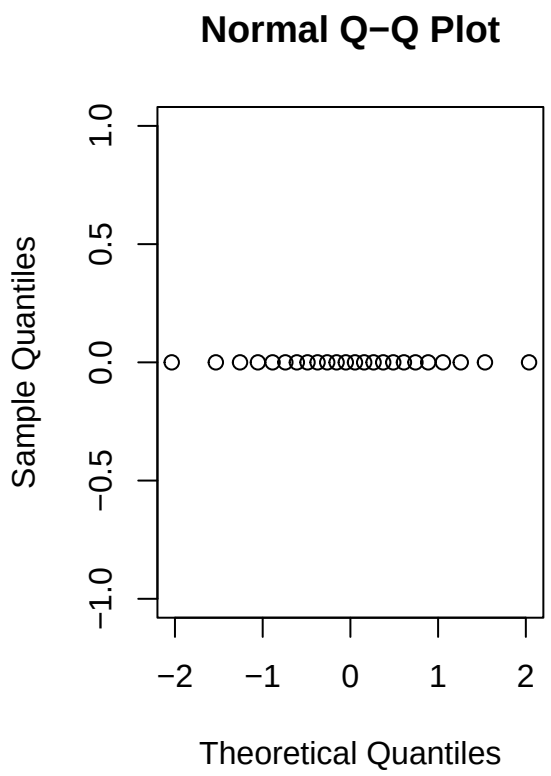
```
outlierTest(mod1) # no outliers
```

```
## No Studentized residuals with Bonferroni p < 0.05
## Largest |rstudent|:
##    rstudent unadjusted p-value Bonferroni p
## 1 -2.927841           0.003481           NA
```

```
# (4) Normality of random effect: Get the estimate of random effect (e.g., random intercepts), and chec
require(lme4)
r_int<- ranef(mod1)$plot$`(Intercept)`
qqnorm(r_int)
# qqline(r_int) doesn't work
shapiro.test(r_int)
```

```
## Error in shapiro.test(r_int): all 'x' values are identical
```

```
# Not normally distributed random effect - p-value = 0.0015
```



```
# Do we need to include plot as a random effect with the KBS models?
mod1 <- lmer(log(flwr_duration_scaled) ~ state*year_factor + insecticide*year_factor + (1|species) + (1
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod2 <- lmer(log(flwr_duration_scaled) ~ state*year_factor + insecticide*year_factor + (1|species), kbs
# Run analysis of variance on each model (see this for more explanation on how anova on a linear mixed
anova(mod1)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##                           Sum Sq Mean Sq NumDF  DenDF F value Pr(>F)
## state                    0.28814 0.28814     1 1115.4  0.2466 0.6195
## year_factor              1.36080 1.36080     1 1147.9  1.1648 0.2807
## insecticide              1.46275 1.46275     1 1112.9  1.2521 0.2634
## state:year_factor        0.20099 0.20099     1 1115.2  0.1720 0.6784
## year_factor:insecticide 0.21197 0.21197     1 1114.0  0.1814 0.6702
```

```
anova(mod2)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##                           Sum Sq Mean Sq NumDF  DenDF F value Pr(>F)
## state                    0.28814 0.28814     1 1115.4  0.2466 0.6195
## year_factor              1.36080 1.36080     1 1147.9  1.1648 0.2807
## insecticide              1.46275 1.46275     1 1112.9  1.2521 0.2634
## state:year_factor        0.20099 0.20099     1 1115.2  0.1720 0.6784
## year_factor:insecticide 0.21197 0.21197     1 1114.0  0.1814 0.6702
```

```
anova(mod1, mod2) # Go with model 2 since pvalue >0.05, aka more complex model does not have something
```

```
## Data: kbs_flwr_spp
## Models:
## mod2: log(flwr_duration_scaled) ~ state * year_factor + insecticide * year_factor + (1 | species)
## mod1: log(flwr_duration_scaled) ~ state * year_factor + insecticide * year_factor + (1 | species) +
##      npar    AIC    BIC  logLik deviance Chisq Df Pr(>Chisq)
## mod2    8 3530.2 3570.6 -1757.1   3514.2
## mod1    9 3532.2 3577.7 -1757.1   3514.2     0  1          1
```

```
summ(mod1)
```

```
## MODEL INFO:
## Observations: 1151
## Dependent Variable: log(flwr_duration_scaled)
## Type: Mixed effects linear regression
##
## MODEL FIT:
## AIC = 3532.23, BIC = 3577.66
## Pseudo-R² (fixed effects) = 0.00
## Pseudo-R² (total) = 0.29
##
## FIXED EFFECTS:
```

```
## ---------------------------------------------------------------------------
##                                          Est.   S.E.   t val.      d.f.      p
## ---------------------------------------- ------- ------ -------- --------- ------
## (Intercept)                               2.15   0.19    11.20     69.97   0.00
## stateambient                              0.08   0.16     0.50   1115.38   0.62
## year_factor                              -0.01   0.03    -0.20   1129.68   0.84
## insecticideno_insects                     0.17   0.16     1.12   1112.89   0.26
## stateambient:year_factor                 -0.01   0.04    -0.41   1115.24   0.68
## year_factor:insecticideno_insects        -0.02   0.04    -0.43   1114.01   0.67
## ---------------------------------------------------------------------------
##
## p values calculated using Satterthwaite d.f.
##
## RANDOM EFFECTS:
## -------------------------------------
##   Group      Parameter    Std. Dev.
## ---------- ------------- -----------
##  species    (Intercept)     0.69
##    plot     (Intercept)     0.00
##  Residual                   1.08
## -------------------------------------
##
## Grouping variables:
## ---------------------------
##   Group    # groups   ICC
## --------- ---------- ------
##  species      33      0.29
##   plot        24      0.00
## ---------------------------
```

```
summ(mod2)
```

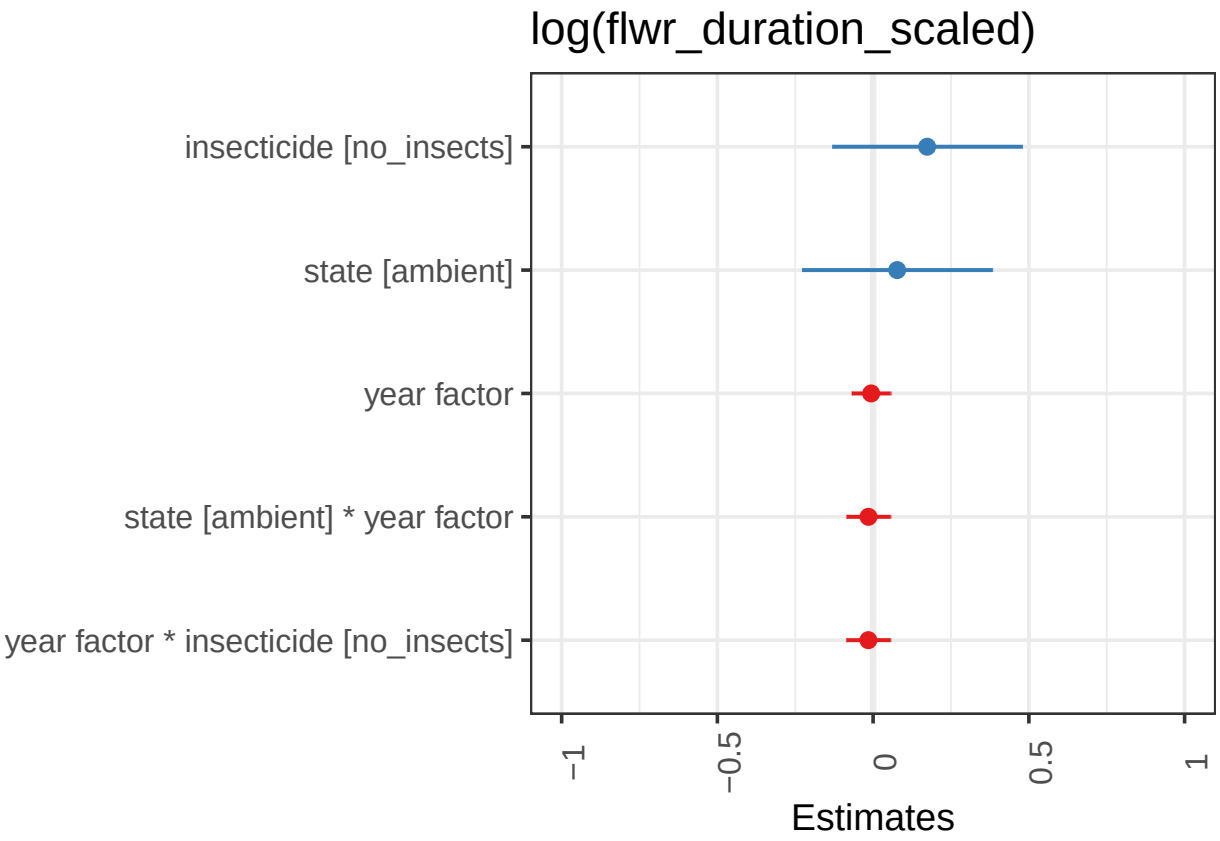
```
## MODEL INFO:
## Observations: 1151
## Dependent Variable: log(flwr_duration_scaled)
## Type: Mixed effects linear regression
##
## MODEL FIT:
## AIC = 3530.23, BIC = 3570.61
## Pseudo-R² (fixed effects) = 0.00
## Pseudo-R² (total) = 0.29
##
## FIXED EFFECTS:
## ---------------------------------------------------------------------------
##                                          Est.   S.E.   t val.      d.f.      p
## ---------------------------------------- ------- ------ -------- --------- ------
## (Intercept)                               2.15   0.19    11.20     69.97   0.00
## stateambient                              0.08   0.16     0.50   1115.38   0.62
## year_factor                              -0.01   0.03    -0.20   1129.68   0.84
## insecticideno_insects                     0.17   0.16     1.12   1112.89   0.26
## stateambient:year_factor                 -0.01   0.04    -0.41   1115.24   0.68
## year_factor:insecticideno_insects        -0.02   0.04    -0.43   1114.01   0.67
## ---------------------------------------------------------------------------
##
```

```
## p values calculated using Satterthwaite d.f.
##
## RANDOM EFFECTS:
## ------------------------------------
##   Group      Parameter    Std. Dev.
## ---------- ------------- -----------
##  species    (Intercept)     0.69
##  Residual                   1.08
## ------------------------------------
##
## Grouping variables:
## ---------------------------
##   Group    # groups   ICC
## --------- ---------- ------
##  species      33      0.29
## ---------------------------
```

```
AICctab(mod1, mod2, weights=T)
```

```
##      dAICc df weight
## mod2 0.0   8  0.73
## mod1 2.0   9  0.27
```

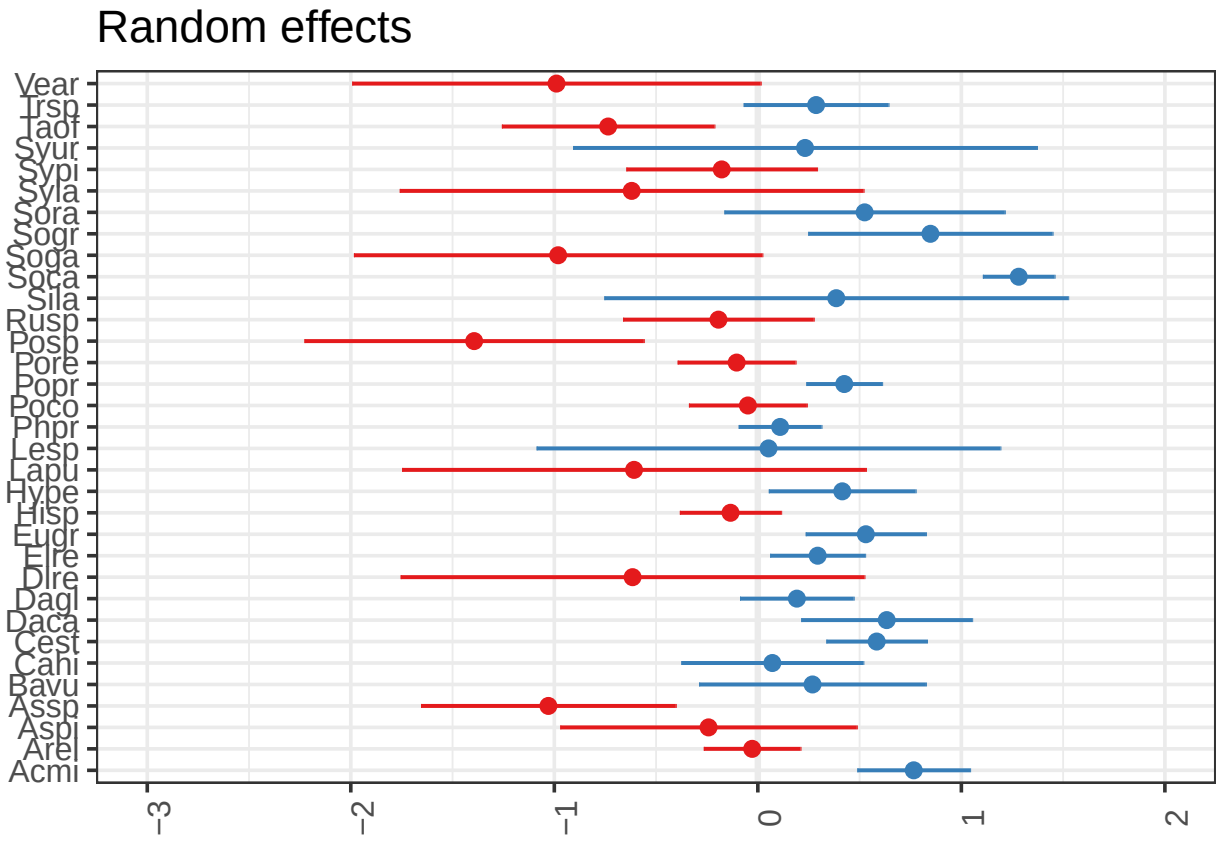
```
# Plot the fixed effects estimates for different models
# these are the fixed effects estimates from summary(mod1)
plot_model(mod2, sort.est = TRUE)
```



```r
# these are the fixed predicted values:
plot_model(mod2, type = "pred", terms = c("year_factor", "state", "insecticide"))
```

```
## Model has log-transformed response. Back-transforming predictions to original response scale. Standa
```


```r
# these are the random effects estimates
plot_model(mod2, type = "re", terms = c("species"))
```




```
# Do we need to include insecticide? (dropping insecticide from the model)
# mod2 <- lmer(log(relabun) ~ state*year_factor + insecticide*year_factor + (1|species), comp_kbs_spp, 
mod3 <- lmer(log(flwr_duration_scaled) ~ state*year_factor + (1|species), kbs_flwr_spp, REML=FALSE)
anova(mod2, mod3)
```

```
## Data: kbs_flwr_spp
## Models:
## mod3: log(flwr_duration_scaled) ~ state * year_factor + (1 | species)
## mod2: log(flwr_duration_scaled) ~ state * year_factor + insecticide * year_factor + (1 | species)
##      npar    AIC    BIC  logLik deviance  Chisq Df Pr(>Chisq)
## mod3    6 3529.5 3559.8 -1758.7   3517.5
## mod2    8 3530.2 3570.6 -1757.1   3514.2 3.2452  2     0.1974
```

```
AICctab(mod2, mod3, weights=T)
```

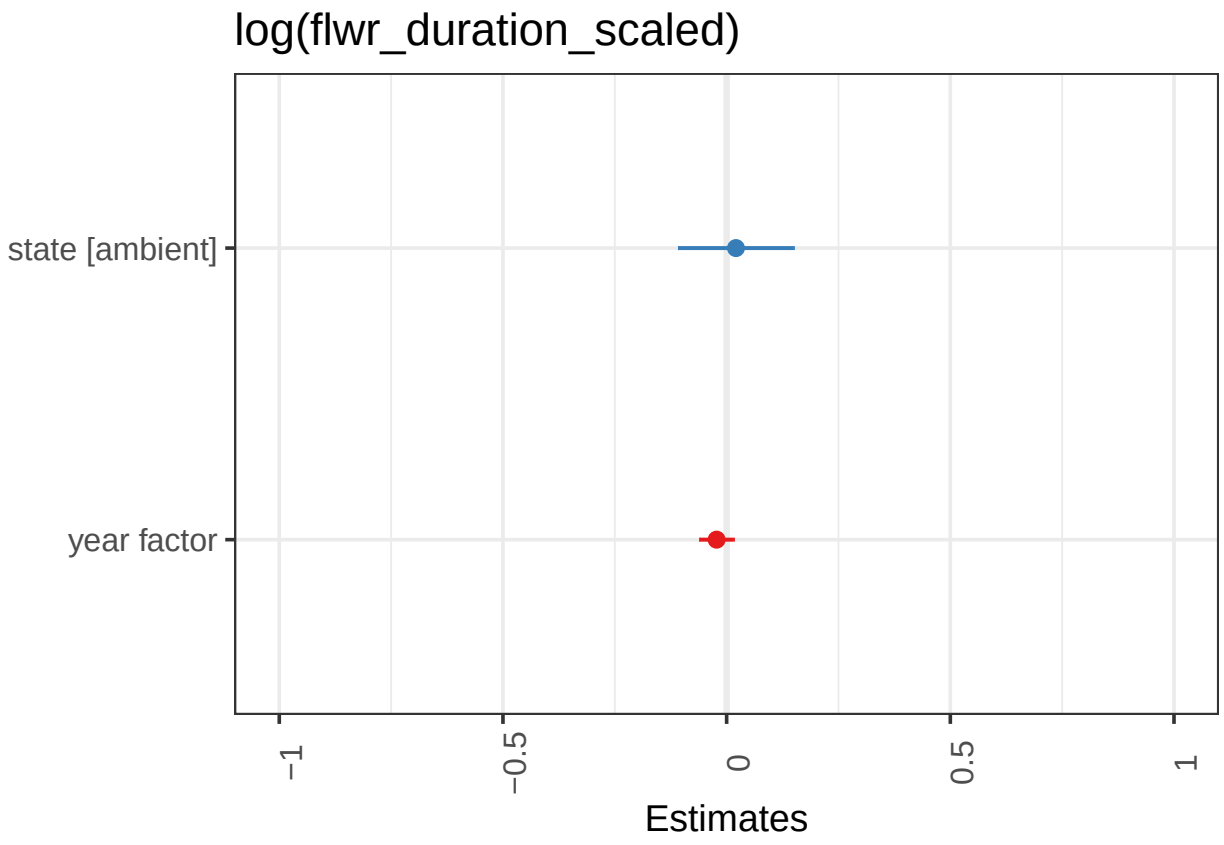
```
##      dAICc df weight
## mod3 0.0   6  0.6
## mod2 0.8   8  0.4
```

```
# Looks like no, pvalue > 0.05, so insecticide does not improve model fit so we will go with mod 3

# Does year need to be interactive with insecticide? - already removed insecticide
# mod4 <- lmer(log(julian_median) ~ state*year_factor + insecticide + (1|species) + (1|plot), umbs_flwr

# Does year need to be interactive with state?
```

```
mod5 <- lmer(log(flwr_duration_scaled) ~ state + year_factor + (1|species), kbs_flwr_spp, REML=FALSE)
anova(mod3, mod5)
```

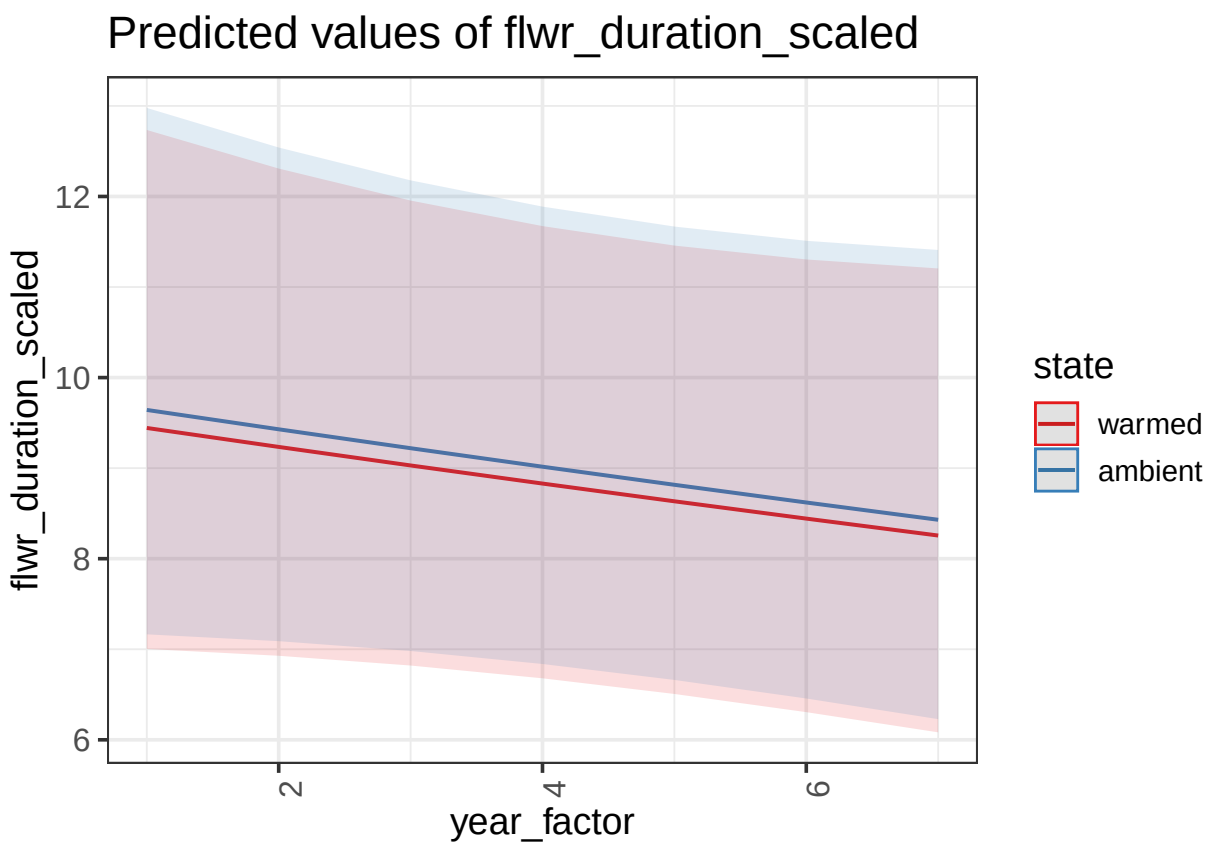
```
## Data: kbs_flwr_spp
## Models:
## mod5: log(flwr_duration_scaled) ~ state + year_factor + (1 | species)
## mod3: log(flwr_duration_scaled) ~ state * year_factor + (1 | species)
##      npar    AIC    BIC  logLik deviance  Chisq Df Pr(>Chisq)
## mod5    5 3527.6 3552.9 -1758.8   3517.6
## mod3    6 3529.5 3559.8 -1758.7   3517.5 0.1538  1     0.6949
```

```
# No, P>0.05 so state*year_factor doesn't strongly improve model fit so we will shift to mod5, but AIC
# Plot the fixed effects estimates for different models
# these are the fixed effects estimates from summary(mod5)
plot_model(mod5, sort.est = TRUE)
```

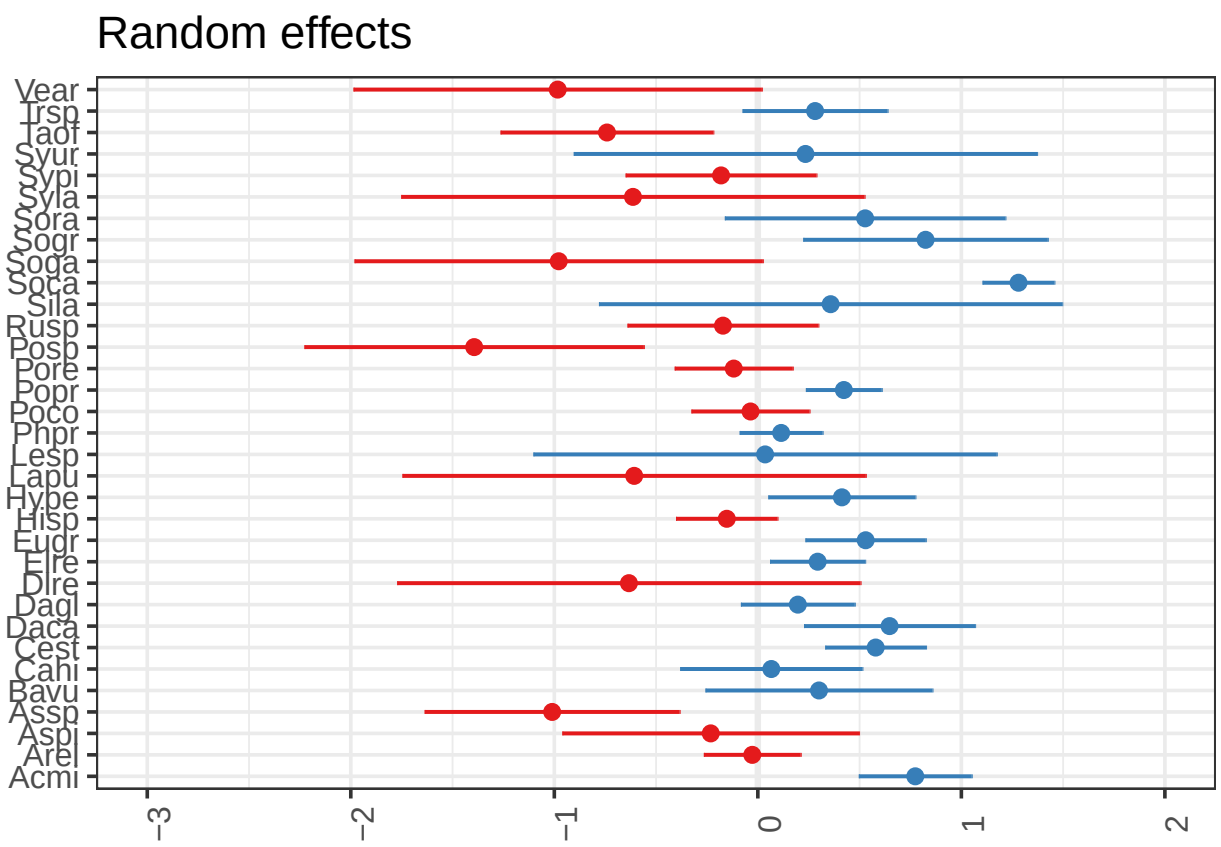



```
# these are the fixed predicted values:
plot_model(mod5, type = "pred", terms = c("year_factor", "state"))
```

```
## Model has log-transformed response. Back-transforming predictions to original response scale. Standa
```




```
# these are the random effects estimates
plot_model(mod5, type = "re", terms = c("species"))
```




```
# If we wanted to include plots nested within year it would look like this:
mod6 <- lmer(log(flwr_duration_scaled) ~ state + year_factor + (1|species) + (1 + year_factor|plot), kbs
```

```
## boundary (singular) fit: see help('isSingular')
```

```
anova(mod5, mod6)
```

```
## Data: kbs_flwr_spp
## Models:
## mod5: log(flwr_duration_scaled) ~ state + year_factor + (1 | species)
## mod6: log(flwr_duration_scaled) ~ state + year_factor + (1 | species) + (1 + year_factor | plot)
##      npar    AIC    BIC  logLik deviance  Chisq Df Pr(>Chisq)
## mod5    5 3527.6 3552.9 -1758.8   3517.6
## mod6    8 3530.6 3571.0 -1757.3   3514.6 3.0431  3      0.385
```

```
AICctab(mod5, mod6, weights=T)
```

```
##      dAICc df weight
## mod5 0.0   5  0.82
## mod6 3.0   8  0.18
```

```
anova(mod5)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
```

```
##              Sum Sq Mean Sq NumDF  DenDF F value Pr(>F)
## state       0.11699 0.11699     1 1128.7  0.0998 0.7521
## year_factor 1.51470 1.51470     1 1147.8  1.2925 0.2558
```

```
# We can consider an alternative model that's simpler to understand and also one that provides more ins
mod7 <- lmer(log(flwr_duration_scaled) ~ state + species + (1+factor(year_factor)|plot), kbs_flwr_spp, l
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod7a <- lmer(log(flwr_duration_scaled)  ~ state + species + factor(year_factor) + (1|plot), kbs_flwr_sp
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod7b <- lmer(log(flwr_duration_scaled)  ~ state * factor(year_factor) + species + (1|plot), kbs_flwr_sp
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod7c <- lmer(log(flwr_duration_scaled)  ~ state + species + factor(year_factor) + insecticide + (1|plo
```

```
## boundary (singular) fit: see help('isSingular')
```

```
anova(mod5, mod7) # model 7 is a better fit to data
```

```
## Data: kbs_flwr_spp
## Models:
## mod5: log(flwr_duration_scaled) ~ state + year_factor + (1 | species)
## mod7: log(flwr_duration_scaled) ~ state + species + (1 + factor(year_factor) | plot)
##      npar    AIC    BIC  logLik deviance  Chisq Df Pr(>Chisq)
## mod5    5 3527.6 3552.9 -1758.8   3517.6
## mod7   63 3290.5 3608.6 -1582.2   3164.5 353.12 58  < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
anova(mod7, mod7a) #mod 7a
```

```
## Data: kbs_flwr_spp
## Models:
## mod7a: log(flwr_duration_scaled) ~ state + species + factor(year_factor) + (1 | plot)
## mod7: log(flwr_duration_scaled) ~ state + species + (1 + factor(year_factor) | plot)
##       npar    AIC    BIC  logLik deviance Chisq Df Pr(>Chisq)
## mod7a   42 3199.6 3411.6 -1557.8   3115.6
## mod7    63 3290.5 3608.6 -1582.2   3164.5     0 21          1
```

```
anova(mod7a, mod7b) #mod 7a - interaction between state and year does not improve model go with simpler
```

```
## Data: kbs_flwr_spp
## Models:
## mod7a: log(flwr_duration_scaled) ~ state + species + factor(year_factor) + (1 | plot)
## mod7b: log(flwr_duration_scaled) ~ state * factor(year_factor) + species + (1 | plot)
##       npar    AIC    BIC  logLik deviance  Chisq Df Pr(>Chisq)
## mod7a   42 3199.6 3411.6 -1557.8   3115.6
## mod7b   48 3209.3 3451.6 -1556.7   3113.3 2.2869  6     0.8915
```

```
anova(mod7a, mod7c) #models are not different than one another, go with simpler model = mod7a
```

```
## Data: kbs_flwr_spp
## Models:
## mod7a: log(flwr_duration_scaled) ~ state + species + factor(year_factor) + (1 | plot)
## mod7c: log(flwr_duration_scaled) ~ state + species + factor(year_factor) + insecticide + (1 | plot)
##       npar    AIC    BIC  logLik deviance  Chisq Df Pr(>Chisq)
## mod7a   42 3199.6 3411.6 -1557.8   3115.6
## mod7c   43 3200.4 3417.5 -1557.2   3114.4 1.2371  1      0.266
```

```
summary(mod7a)
```

```
## Linear mixed model fit by maximum likelihood . t-tests use Satterthwaite's
##   method [lmerModLmerTest]
## Formula: log(flwr_duration_scaled) ~ state + species + factor(year_factor) +
##     (1 | plot)
##    Data: kbs_flwr_spp
##
##      AIC      BIC   logLik deviance df.resid
##   3199.6   3411.6  -1557.8   3115.6     1109
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.6381 -0.3669  0.1663  0.5936  2.8919
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  plot     (Intercept) 0.0000   0.0000
##  Residual             0.8772   0.9366
## Number of obs: 1151, groups:  plot, 24
##
## Fixed effects:
##                       Estimate Std. Error         df t value Pr(>|t|)
## (Intercept)            1.37159    0.16646 1151.00000   8.240 4.65e-16 ***
## stateambient          -0.02860    0.05754 1151.00000  -0.497 0.619258
## speciesArel           -0.92604    0.16877 1151.00000  -5.487 5.03e-08 ***
## speciesAspi           -1.37385    0.40594 1151.00000  -3.384 0.000737 ***
## speciesAssp           -2.39186    0.33958 1151.00000  -7.044 3.22e-12 ***
## speciesBavu           -0.56878    0.30029 1151.00000  -1.894 0.058463 .
## speciesCahi           -1.11291    0.24634 1151.00000  -4.518 6.89e-06 ***
## speciesCest            0.11516    0.16872 1151.00000   0.683 0.495036
## speciesDaca           -0.14226    0.23258 1151.00000  -0.612 0.540895
## speciesDagl           -0.81921    0.17977 1151.00000  -4.557 5.74e-06 ***
## speciesDlre           -3.43605    0.94731 1151.00000  -3.627 0.000299 ***
## speciesElre           -0.58567    0.16696 1151.00000  -3.508 0.000469 ***
## speciesEugr            0.02179    0.18744 1151.00000   0.116 0.907472
## speciesHisp           -1.17902    0.16935 1151.00000  -6.962 5.63e-12 ***
## speciesHype           -0.05845    0.20898 1151.00000  -0.280 0.779767
## speciesLapu           -2.51215    0.95033 1151.00000  -2.643 0.008318 **
## speciesLesp           -1.24721    0.94810 1151.00000  -1.315 0.188611
## speciesPhpr           -0.68003    0.15614 1151.00000  -4.355 1.45e-05 ***
## speciesPoco           -0.91746    0.18682 1151.00000  -4.911 1.04e-06 ***
```

```
## speciesPopr            -0.52308    0.15310 1151.00000  -3.417 0.000656 ***
## speciesPore            -1.02770    0.18212 1151.00000  -5.643 2.10e-08 ***
## speciesPosp            -1.35729    0.49611 1151.00000  -2.736 0.006317 **
## speciesRusp            -1.12566    0.25520 1151.00000  -4.411 1.13e-05 ***
## speciesSila             0.22187    0.94706 1151.00000   0.234 0.814814
## speciesSoca             0.37146    0.15097 1151.00000   2.461 0.014019 *
## speciesSoga            -3.53550    0.67748 1151.00000  -5.219 2.14e-07 ***
## speciesSogr            -0.27801    0.32506 1151.00000  -0.855 0.392575
## speciesSora            -0.50070    0.37997 1151.00000  -1.318 0.187849
## speciesSyla            -2.48355    0.94999 1151.00000  -2.614 0.009058 **
## speciesSypi            -1.08779    0.25955 1151.00000  -4.191 2.99e-05 ***
## speciesSyur             0.46089    0.94999 1151.00000   0.485 0.627662
## speciesTaof            -2.03824    0.28063 1151.00000  -7.263 6.96e-13 ***
## speciesTrsp             0.11860    0.21049 1151.00000   0.563 0.573252
## speciesVear            -3.47862    0.67519 1151.00000  -5.152 3.03e-07 ***
## factor(year_factor)2    1.87227    0.13083 1151.00000  14.311  < 2e-16 ***
## factor(year_factor)3    2.06446    0.13882 1151.00000  14.872  < 2e-16 ***
## factor(year_factor)4    2.17821    0.13884 1151.00000  15.689  < 2e-16 ***
## factor(year_factor)5    1.59855    0.14194 1151.00000  11.262  < 2e-16 ***
## factor(year_factor)6    1.62751    0.14448 1151.00000  11.265  < 2e-16 ***
## factor(year_factor)7    1.14056    0.15036 1151.00000   7.586 6.79e-14 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

##
## Correlation matrix not shown by default, as p = 40 > 12.
## Use print(x, correlation=TRUE)  or
##     vcov(x)        if you need it

## optimizer (nloptwrap) convergence code: 0 (OK)
## boundary (singular) fit: see help('isSingular')
```

```
anova(mod7a) # investigates whether at least one of the levels within each factor is significantly diff
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##                      Sum Sq Mean Sq NumDF DenDF F value Pr(>F)
## state                  0.22   0.217     1  1151   0.247 0.6193
## species              396.26  12.383    32  1151  14.117 <2e-16 ***
## factor(year_factor) 292.34  48.723     6  1151  55.543 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# Yes, at least one of the species is different (they do not all have the same relative abundances).
emmeans(mod7a, list(pairwise ~ state + year_factor), adjust = "tukey")
```

```
## $`emmeans of state, year_factor`
##  state   year_factor emmean    SE  df lower.CL upper.CL
##  warmed            1  0.339 0.146 904   0.0529    0.625
##  ambient           1  0.310 0.147 943   0.0209    0.600
##  warmed            2  2.211 0.109 623   1.9972    2.425
##  ambient           2  2.183 0.108 624   1.9703    2.395
##  warmed            3  2.403 0.109 587   2.1895    2.617
```

```
##  ambient           3  2.375 0.108 609   2.1621    2.588
##  warmed            4  2.517 0.109 600   2.3021    2.732
##  ambient           4  2.489 0.108 589   2.2767    2.700
##  warmed            5  1.937 0.117 651   1.7076    2.167
##  ambient           5  1.909 0.116 658   1.6818    2.136
##  warmed            6  1.966 0.120 712   1.7308    2.202
##  ambient           6  1.938 0.120 719   1.7025    2.173
##  warmed            7  1.480 0.121 681   1.2417    1.717
##  ambient           7  1.451 0.121 693   1.2132    1.689
##
## Results are averaged over the levels of: species
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of state, year_factor`
##  1                                          estimate     SE     df t.ratio
##  warmed year_factor1 - ambient year_factor1   0.028598 0.0602   27.6   0.475
##  warmed year_factor1 - warmed year_factor2   -1.872274 0.1333 1188.9 -14.046
##  warmed year_factor1 - ambient year_factor2  -1.843676 0.1439  554.5 -12.813
##  warmed year_factor1 - warmed year_factor3   -2.064455 0.1414 1188.6 -14.598
##  warmed year_factor1 - ambient year_factor3  -2.035857 0.1516  632.4 -13.425
##  warmed year_factor1 - warmed year_factor4   -2.178206 0.1415 1190.9 -15.395
##  warmed year_factor1 - ambient year_factor4  -2.149608 0.1510  603.8 -14.240
##  warmed year_factor1 - warmed year_factor5   -1.598554 0.1446 1190.2 -11.052
##  warmed year_factor1 - ambient year_factor5  -1.569956 0.1540  640.5 -10.198
##  warmed year_factor1 - warmed year_factor6   -1.627508 0.1473 1191.5 -11.050
##  warmed year_factor1 - ambient year_factor6  -1.598910 0.1574  652.2 -10.158
##  warmed year_factor1 - warmed year_factor7   -1.140558 0.1533 1192.1  -7.441
##  warmed year_factor1 - ambient year_factor7  -1.111960 0.1631  691.5  -6.817
##  ambient year_factor1 - warmed year_factor2  -1.900872 0.1486  629.0 -12.794
##  ambient year_factor1 - ambient year_factor2 -1.872274 0.1333 1188.9 -14.046
##  ambient year_factor1 - warmed year_factor3  -2.093053 0.1557  679.8 -13.441
##  ambient year_factor1 - ambient year_factor3 -2.064455 0.1414 1188.6 -14.598
##  ambient year_factor1 - warmed year_factor4  -2.206804 0.1565  685.6 -14.101
##  ambient year_factor1 - ambient year_factor4 -2.178206 0.1415 1190.9 -15.395
##  ambient year_factor1 - warmed year_factor5  -1.627152 0.1593  703.0 -10.213
##  ambient year_factor1 - ambient year_factor5 -1.598554 0.1446 1190.2 -11.052
##  ambient year_factor1 - warmed year_factor6  -1.656106 0.1608  712.7 -10.300
##  ambient year_factor1 - ambient year_factor6 -1.627508 0.1473 1191.5 -11.050
##  ambient year_factor1 - warmed year_factor7  -1.169156 0.1662  743.5  -7.033
##  ambient year_factor1 - ambient year_factor7 -1.140558 0.1533 1192.1  -7.441
##  warmed year_factor2 - ambient year_factor2   0.028598 0.0602   27.6   0.475
##  warmed year_factor2 - warmed year_factor3   -0.192181 0.0976 1181.6  -1.970
##  warmed year_factor2 - ambient year_factor3  -0.163583 0.1149  330.2  -1.424
##  warmed year_factor2 - warmed year_factor4   -0.305932 0.0958 1180.5  -3.194
##  warmed year_factor2 - ambient year_factor4  -0.277334 0.1124  300.3  -2.468
##  warmed year_factor2 - warmed year_factor5    0.273721 0.1010 1189.6   2.711
##  warmed year_factor2 - ambient year_factor5   0.302319 0.1169  334.3   2.587
##  warmed year_factor2 - warmed year_factor6    0.244766 0.1038 1190.1   2.358
##  warmed year_factor2 - ambient year_factor6   0.273364 0.1206  358.7   2.267
##  warmed year_factor2 - warmed year_factor7    0.731716 0.1129 1192.4   6.479
##  warmed year_factor2 - ambient year_factor7   0.760314 0.1286  420.5   5.911
##  ambient year_factor2 - warmed year_factor3  -0.220779 0.1144  309.8  -1.930
```

```
##  ambient year_factor2 - ambient year_factor3 -0.192181 0.0976 1181.6  -1.970
##  ambient year_factor2 - warmed year_factor4  -0.334530 0.1139  315.3  -2.938
##  ambient year_factor2 - ambient year_factor4 -0.305932 0.0958 1180.5  -3.194
##  ambient year_factor2 - warmed year_factor5   0.245122 0.1182  334.3   2.074
##  ambient year_factor2 - ambient year_factor5  0.273721 0.1010 1189.6   2.711
##  ambient year_factor2 - warmed year_factor6   0.216168 0.1194  349.3   1.811
##  ambient year_factor2 - ambient year_factor6  0.244766 0.1038 1190.1   2.358
##  ambient year_factor2 - warmed year_factor7   0.703118 0.1273  406.0   5.523
##  ambient year_factor2 - ambient year_factor7  0.731716 0.1129 1192.4   6.479
##  warmed year_factor3 - ambient year_factor3   0.028598 0.0602   27.6   0.475
##  warmed year_factor3 - warmed year_factor4   -0.113751 0.0998 1177.8  -1.140
##  warmed year_factor3 - ambient year_factor4  -0.085153 0.1156  322.7  -0.737
##  warmed year_factor3 - warmed year_factor5    0.465902 0.1057 1189.0   4.407
##  warmed year_factor3 - ambient year_factor5   0.494500 0.1208  360.9   4.095
##  warmed year_factor3 - warmed year_factor6    0.436947 0.1089 1192.4   4.011
##  warmed year_factor3 - ambient year_factor6   0.465545 0.1248  377.1   3.730
##  warmed year_factor3 - warmed year_factor7    0.923897 0.1174 1191.7   7.872
##  warmed year_factor3 - ambient year_factor7   0.952495 0.1323  430.2   7.199
##  ambient year_factor3 - warmed year_factor4  -0.142349 0.1175  359.0  -1.211
##  ambient year_factor3 - ambient year_factor4 -0.113751 0.0998 1177.8  -1.140
##  ambient year_factor3 - warmed year_factor5   0.437304 0.1225  381.5   3.569
##  ambient year_factor3 - ambient year_factor5  0.465902 0.1057 1189.0   4.407
##  ambient year_factor3 - warmed year_factor6   0.408349 0.1241  389.2   3.290
##  ambient year_factor3 - ambient year_factor6  0.436947 0.1089 1192.4   4.011
##  ambient year_factor3 - warmed year_factor7   0.895299 0.1315  437.6   6.810
##  ambient year_factor3 - ambient year_factor7  0.923897 0.1174 1191.7   7.872
##  warmed year_factor4 - ambient year_factor4   0.028598 0.0602   27.6   0.475
##  warmed year_factor4 - warmed year_factor5    0.579652 0.1018 1183.6   5.696
##  warmed year_factor4 - ambient year_factor5   0.608250 0.1183  357.3   5.143
##  warmed year_factor4 - warmed year_factor6    0.550698 0.1051 1188.2   5.242
##  warmed year_factor4 - ambient year_factor6   0.579296 0.1224  380.1   4.734
##  warmed year_factor4 - warmed year_factor7    1.037648 0.1138 1191.9   9.117
##  warmed year_factor4 - ambient year_factor7   1.066246 0.1300  438.7   8.199
##  ambient year_factor4 - warmed year_factor5   0.551054 0.1182  341.9   4.663
##  ambient year_factor4 - ambient year_factor5  0.579652 0.1018 1183.6   5.696
##  ambient year_factor4 - warmed year_factor6   0.522100 0.1198  355.8   4.360
##  ambient year_factor4 - ambient year_factor6  0.550698 0.1051 1188.2   5.242
##  ambient year_factor4 - warmed year_factor7   1.009049 0.1274  409.6   7.919
##  ambient year_factor4 - ambient year_factor7  1.037648 0.1138 1191.9   9.117
##  warmed year_factor5 - ambient year_factor5   0.028598 0.0602   27.6   0.475
##  warmed year_factor5 - warmed year_factor6   -0.028955 0.1077 1180.2  -0.269
##  warmed year_factor5 - ambient year_factor6  -0.000356 0.1246  404.9  -0.003
##  warmed year_factor5 - warmed year_factor7    0.457995 0.1155 1181.6   3.966
##  warmed year_factor5 - ambient year_factor7   0.486594 0.1315  469.6   3.702
##  ambient year_factor5 - warmed year_factor6  -0.057553 0.1221  396.9  -0.471
##  ambient year_factor5 - ambient year_factor6 -0.028955 0.1077 1180.2  -0.269
##  ambient year_factor5 - warmed year_factor7   0.429397 0.1289  457.3   3.330
##  ambient year_factor5 - ambient year_factor7  0.457995 0.1155 1181.6   3.966
##  warmed year_factor6 - ambient year_factor6   0.028598 0.0602   27.6   0.475
##  warmed year_factor6 - warmed year_factor7    0.486950 0.1179 1177.2   4.131
##  warmed year_factor6 - ambient year_factor7   0.515548 0.1324  494.2   3.893
##  ambient year_factor6 - warmed year_factor7   0.458352 0.1323  488.0   3.465
##  ambient year_factor6 - ambient year_factor7  0.486950 0.1179 1177.2   4.131
##  warmed year_factor7 - ambient year_factor7   0.028598 0.0602   27.6   0.475
```

```
##  p.value
##   1.0000
##   <.0001
##   <.0001
##   <.0001
##   <.0001
##   <.0001
##   <.0001
##   <.0001
##   <.0001
##   <.0001
##   <.0001
##   <.0001
##   <.0001
##   <.0001
##   <.0001
##   <.0001
##   <.0001
##   <.0001
##   <.0001
##   <.0001
##   <.0001
##   <.0001
##   <.0001
##   <.0001
##   1.0000
##   0.7863
##   0.9786
##   0.0823
##   0.4340
##   0.2737
##   0.3529
##   0.5116
##   0.5805
##   <.0001
##   <.0001
##   0.8083
##   0.7863
##   0.1674
##   0.0823
##   0.7188
##   0.2737
##   0.8699
##   0.5116
##   <.0001
##   <.0001
##   1.0000
##   0.9974
##   1.0000
##   0.0010
##   0.0040
##   0.0050
##   0.0156
```

```
##   <.0001
##   <.0001
##   0.9951
##   0.9974
##   0.0270
##   0.0010
##   0.0645
##   0.0050
##   <.0001
##   <.0001
##   1.0000
##   <.0001
##   <.0001
##   <.0001
##   0.0003
##   <.0001
##   <.0001
##   0.0004
##   <.0001
##   0.0014
##   <.0001
##   <.0001
##   <.0001
##   1.0000
##   1.0000
##   1.0000
##   0.0059
##   0.0169
##   1.0000
##   1.0000
##   0.0568
##   0.0059
##   1.0000
##   0.0031
##   0.0084
##   0.0372
##   0.0031
##   1.0000
##
## Results are averaged over the levels of: species
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## P value adjustment: tukey method for comparing a family of 14 estimates
```

```
emmeans(mod7a, list(pairwise ~ year_factor), adjust = "tukey")
```

```
## $`emmeans of year_factor`
##  year_factor emmean    SE   df lower.CL upper.CL
##            1  0.325 0.144 1100   0.0431    0.606
##            2  2.197 0.104  943   1.9922    2.402
##            3  2.389 0.104  908   2.1843    2.594
##            4  2.503 0.104  903   2.2979    2.708
##            5  1.923 0.112  936   1.7026    2.144
##            6  1.952 0.116  990   1.7243    2.180
```

```
##            7  1.465 0.117  952   1.2350    1.695
##
## Results are averaged over the levels of: state, species
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of year_factor`
##  1                          estimate     SE   df t.ratio p.value
##  year_factor1 - year_factor2   -1.872 0.1333 1189 -14.046  <.0001
##  year_factor1 - year_factor3   -2.064 0.1414 1189 -14.598  <.0001
##  year_factor1 - year_factor4   -2.178 0.1415 1191 -15.395  <.0001
##  year_factor1 - year_factor5   -1.599 0.1446 1190 -11.052  <.0001
##  year_factor1 - year_factor6   -1.628 0.1473 1191 -11.050  <.0001
##  year_factor1 - year_factor7   -1.141 0.1533 1192  -7.441  <.0001
##  year_factor2 - year_factor3   -0.192 0.0976 1182  -1.970  0.4346
##  year_factor2 - year_factor4   -0.306 0.0958 1180  -3.194  0.0242
##  year_factor2 - year_factor5    0.274 0.1010 1190   2.711  0.0963
##  year_factor2 - year_factor6    0.245 0.1038 1190   2.358  0.2175
##  year_factor2 - year_factor7    0.732 0.1129 1192   6.479  <.0001
##  year_factor3 - year_factor4   -0.114 0.0998 1178  -1.140  0.9157
##  year_factor3 - year_factor5    0.466 0.1057 1189   4.407  0.0002
##  year_factor3 - year_factor6    0.437 0.1089 1192   4.011  0.0013
##  year_factor3 - year_factor7    0.924 0.1174 1192   7.872  <.0001
##  year_factor4 - year_factor5    0.580 0.1018 1184   5.696  <.0001
##  year_factor4 - year_factor6    0.551 0.1051 1188   5.242  <.0001
##  year_factor4 - year_factor7    1.038 0.1138 1192   9.117  <.0001
##  year_factor5 - year_factor6   -0.029 0.1077 1180  -0.269  1.0000
##  year_factor5 - year_factor7    0.458 0.1155 1182   3.966  0.0015
##  year_factor6 - year_factor7    0.487 0.1179 1177   4.131  0.0008
##
## Results are averaged over the levels of: state, species
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## P value adjustment: tukey method for comparing a family of 7 estimates
```

```
emmeans(mod7a, list(pairwise ~ species), adjust = "tukey")
```

```
## $`emmeans of species`
##  species emmean     SE   df lower.CL upper.CL
##  Acmi     2.855 0.1300 1082    2.600    3.110
##  Arel     1.929 0.1115 1008    1.710    2.147
##  Aspi     1.481 0.3951 1193    0.706    2.256
##  Assp     0.463 0.3233 1193   -0.171    1.097
##  Bavu     2.286 0.2785 1054    1.739    2.832
##  Cahi     1.742 0.2175 1169    1.315    2.168
##  Cest     2.970 0.1170 1018    2.740    3.199
##  Daca     2.712 0.2009 1154    2.318    3.107
##  Dagl     2.035 0.1309 1041    1.779    2.292
##  Dlre    -0.581 0.9582 1192   -2.461    1.299
##  Elre     2.269 0.1086 1013    2.056    2.482
##  Eugr     2.876 0.1384 1034    2.605    3.148
##  Hisp     1.676 0.1165 1035    1.447    1.904
##  Hype     2.796 0.1700 1005    2.463    3.130
```

```
##  Lapu     0.343 0.9589 1192   -1.539    2.224
##  Lesp     1.607 0.9578 1192   -0.272    3.487
##  Phpr     2.175 0.0934  871    1.991    2.358
##  Poco     1.937 0.1367 1056    1.669    2.205
##  Popr     2.332 0.0867  870    2.161    2.502
##  Pore     1.827 0.1356 1086    1.561    2.093
##  Posp     1.497 0.4896 1192    0.537    2.458
##  Rusp     1.729 0.2275 1054    1.283    2.175
##  Sila     3.077 0.9578 1192    1.197    4.956
##  Soca     3.226 0.0822  816    3.065    3.387
##  Soga    -0.681 0.6785 1192   -2.012    0.650
##  Sogr     2.577 0.3061 1190    1.976    3.177
##  Sora     2.354 0.3675 1193    1.633    3.075
##  Syla     0.371 0.9590 1192   -1.510    2.253
##  Sypi     1.767 0.2295 1181    1.317    2.217
##  Syur     3.316 0.9590 1192    1.434    5.197
##  Taof     0.816 0.2582 1160    0.310    1.323
##  Trsp     2.973 0.1741 1185    2.632    3.315
##  Vear    -0.624 0.6770 1193   -1.952    0.704
##
## Results are averaged over the levels of: state, year_factor
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of species`
##  1           estimate    SE   df t.ratio p.value
##  Acmi - Arel  0.92604 0.172 1192   5.382  <.0001
##  Acmi - Aspi  1.37385 0.414 1188   3.321  0.2113
##  Acmi - Assp  2.39186 0.346 1183   6.916  <.0001
##  Acmi - Bavu  0.56878 0.307 1172   1.854  0.9958
##  Acmi - Cahi  1.11291 0.251 1190   4.433  0.0044
##  Acmi - Cest -0.11516 0.172 1189  -0.670  1.0000
##  Acmi - Daca  0.14226 0.237 1192   0.600  1.0000
##  Acmi - Dagl  0.81921 0.183 1192   4.468  0.0038
##  Acmi - Dlre  3.43605 0.966 1192   3.557  0.1103
##  Acmi - Elre  0.58567 0.170 1192   3.439  0.1545
##  Acmi - Eugr -0.02179 0.191 1192  -0.114  1.0000
##  Acmi - Hisp  1.17902 0.173 1191   6.832  <.0001
##  Acmi - Hype  0.05845 0.214 1172   0.274  1.0000
##  Acmi - Lapu  2.51215 0.969 1192   2.592  0.7578
##  Acmi - Lesp  1.24721 0.967 1192   1.290  1.0000
##  Acmi - Phpr  0.68003 0.159 1191   4.274  0.0086
##  Acmi - Poco  0.91746 0.191 1192   4.815  0.0008
##  Acmi - Popr  0.52308 0.156 1191   3.352  0.1953
##  Acmi - Pore  1.02770 0.186 1192   5.535  <.0001
##  Acmi - Posp  1.35729 0.506 1192   2.683  0.6893
##  Acmi - Rusp  1.12566 0.261 1158   4.311  0.0074
##  Acmi - Sila -0.22187 0.966 1192  -0.230  1.0000
##  Acmi - Soca -0.37146 0.154 1190  -2.414  0.8688
##  Acmi - Soga  3.53550 0.691 1192   5.119  0.0002
##  Acmi - Sogr  0.27802 0.332 1193   0.839  1.0000
##  Acmi - Sora  0.50070 0.387 1189   1.293  1.0000
##  Acmi - Syla  2.48355 0.969 1192   2.564  0.7776
```

```
##  Acmi - Sypi  1.08779 0.265 1192   4.110  0.0165
##  Acmi - Syur -0.46089 0.969 1192  -0.476  1.0000
##  Acmi - Taof  2.03824 0.287 1186   7.114  <.0001
##  Acmi - Trsp -0.11860 0.214 1184  -0.553  1.0000
##  Acmi - Vear  3.47862 0.688 1192   5.053  0.0002
##  Arel - Aspi  0.44780 0.411 1192   1.088  1.0000
##  Arel - Assp  1.46582 0.342 1189   4.280  0.0084
##  Arel - Bavu -0.35726 0.300 1102  -1.193  1.0000
##  Arel - Cahi  0.18686 0.244 1192   0.767  1.0000
##  Arel - Cest -1.04120 0.164 1191  -6.356  <.0001
##  Arel - Daca -0.78379 0.229 1191  -3.417  0.1645
##  Arel - Dagl -0.10684 0.170 1192  -0.629  1.0000
##  Arel - Dlre  2.51000 0.965 1192   2.600  0.7522
##  Arel - Elre -0.34037 0.154 1192  -2.213  0.9485
##  Arel - Eugr -0.94783 0.176 1188  -5.370  <.0001
##  Arel - Hisp  0.25297 0.159 1192   1.586  0.9997
##  Arel - Hype -0.86760 0.204 1172  -4.248  0.0096
##  Arel - Lapu  1.58610 0.965 1192   1.643  0.9995
##  Arel - Lesp  0.32117 0.964 1192   0.333  1.0000
##  Arel - Phpr -0.24601 0.144 1192  -1.703  0.9990
##  Arel - Poco -0.00858 0.174 1191  -0.049  1.0000
##  Arel - Popr -0.40296 0.139 1189  -2.905  0.5059
##  Arel - Pore  0.10166 0.175 1192   0.582  1.0000
##  Arel - Posp  0.43125 0.506 1192   0.853  1.0000
##  Arel - Rusp  0.19961 0.252 1130   0.793  1.0000
##  Arel - Sila -1.14792 0.964 1192  -1.191  1.0000
##  Arel - Soca -1.29750 0.136 1188  -9.548  <.0001
##  Arel - Soga  2.60945 0.687 1192   3.800  0.0509
##  Arel - Sogr -0.64803 0.325 1192  -1.992  0.9872
##  Arel - Sora -0.42534 0.386 1192  -1.103  1.0000
##  Arel - Syla  1.55751 0.965 1192   1.614  0.9997
##  Arel - Sypi  0.16174 0.252 1192   0.641  1.0000
##  Arel - Syur -1.38693 0.965 1192  -1.437  1.0000
##  Arel - Taof  1.11219 0.281 1189   3.961  0.0289
##  Arel - Trsp -1.04464 0.209 1185  -4.993  0.0003
##  Arel - Vear  2.55258 0.686 1192   3.720  0.0663
##  Aspi - Assp  1.01802 0.503 1181   2.023  0.9840
##  Aspi - Bavu -0.80506 0.482 1192  -1.670  0.9993
##  Aspi - Cahi -0.26094 0.451 1190  -0.579  1.0000
##  Aspi - Cest -1.48900 0.412 1192  -3.613  0.0930
##  Aspi - Daca -1.23159 0.441 1189  -2.795  0.5975
##  Aspi - Dagl -0.55464 0.416 1191  -1.334  1.0000
##  Aspi - Dlre  2.06220 1.033 1192   1.996  0.9869
##  Aspi - Elre -0.78818 0.410 1192  -1.921  0.9926
##  Aspi - Eugr -1.39564 0.420 1192  -3.321  0.2113
##  Aspi - Hisp -0.19483 0.410 1191  -0.475  1.0000
##  Aspi - Hype -1.31540 0.430 1190  -3.058  0.3830
##  Aspi - Lapu  1.13830 1.038 1192   1.097  1.0000
##  Aspi - Lesp -0.12663 1.037 1192  -0.122  1.0000
##  Aspi - Phpr -0.69381 0.406 1191  -1.709  0.9990
##  Aspi - Poco -0.45638 0.418 1191  -1.091  1.0000
##  Aspi - Popr -0.85076 0.404 1191  -2.108  0.9720
##  Aspi - Pore -0.34614 0.416 1192  -0.833  1.0000
##  Aspi - Posp -0.01656 0.632 1192  -0.026  1.0000
```

```
##  Aspi - Rusp -0.24819 0.454 1191  -0.547  1.0000
##  Aspi - Sila -1.59572 1.037 1192  -1.539  0.9999
##  Aspi - Soca -1.74531 0.403 1191  -4.333  0.0068
##  Aspi - Soga  2.16165 0.786 1193   2.750  0.6352
##  Aspi - Sogr -1.09583 0.498 1192  -2.199  0.9522
##  Aspi - Sora -0.87314 0.532 1188  -1.641  0.9995
##  Aspi - Syla  1.10970 1.036 1191   1.071  1.0000
##  Aspi - Sypi -0.28606 0.456 1187  -0.627  1.0000
##  Aspi - Syur -1.83474 1.036 1191  -1.771  0.9981
##  Aspi - Taof  0.66439 0.469 1190   1.418  1.0000
##  Aspi - Trsp -1.49244 0.434 1189  -3.440  0.1543
##  Aspi - Vear  2.10478 0.781 1191   2.694  0.6808
##  Assp - Bavu -1.82308 0.425 1189  -4.287  0.0082
##  Assp - Cahi -1.27896 0.388 1184  -3.294  0.2262
##  Assp - Cest -2.50702 0.344 1190  -7.293  <.0001
##  Assp - Daca -2.24961 0.377 1184  -5.965  <.0001
##  Assp - Dagl -1.57266 0.348 1188  -4.522  0.0030
##  Assp - Dlre  1.04418 1.008 1190   1.036  1.0000
##  Assp - Elre -1.80619 0.341 1191  -5.295  0.0001
##  Assp - Eugr -2.41365 0.353 1191  -6.830  <.0001
##  Assp - Hisp -1.21285 0.341 1190  -3.555  0.1109
##  Assp - Hype -2.33342 0.365 1192  -6.389  <.0001
##  Assp - Lapu  0.12029 1.013 1192   0.119  1.0000
##  Assp - Lesp -1.14465 1.012 1192  -1.131  1.0000
##  Assp - Phpr -1.71183 0.336 1188  -5.097  0.0002
##  Assp - Poco -1.47440 0.351 1190  -4.199  0.0116
##  Assp - Popr -1.86878 0.333 1190  -5.604  <.0001
##  Assp - Pore -1.36416 0.348 1188  -3.918  0.0337
##  Assp - Posp -1.03457 0.590 1192  -1.754  0.9984
##  Assp - Rusp -1.26620 0.393 1192  -3.218  0.2715
##  Assp - Sila -2.61374 1.011 1190  -2.585  0.7630
##  Assp - Soca -2.76332 0.333 1190  -8.310  <.0001
##  Assp - Soga  1.14363 0.752 1192   1.520  0.9999
##  Assp - Sogr -2.11385 0.443 1192  -4.767  0.0010
##  Assp - Sora -1.89116 0.482 1187  -3.925  0.0328
##  Assp - Syla  0.09169 1.012 1192   0.091  1.0000
##  Assp - Sypi -1.30408 0.395 1188  -3.300  0.2228
##  Assp - Syur -2.85275 1.012 1192  -2.818  0.5787
##  Assp - Taof -0.35363 0.411 1192  -0.861  1.0000
##  Assp - Trsp -2.51046 0.369 1186  -6.795  <.0001
##  Assp - Vear  1.08676 0.748 1189   1.454  1.0000
##  Bavu - Cahi  0.54412 0.351 1166   1.549  0.9998
##  Bavu - Cest -0.68394 0.303 1111  -2.254  0.9362
##  Bavu - Daca -0.42653 0.343 1161  -1.244  1.0000
##  Bavu - Dagl  0.25042 0.307 1113   0.816  1.0000
##  Bavu - Dlre  2.86726 0.997 1192   2.876  0.5298
##  Bavu - Elre  0.01689 0.297 1129   0.057  1.0000
##  Bavu - Eugr -0.59057 0.310 1138  -1.902  0.9936
##  Bavu - Hisp  0.61023 0.301 1113   2.025  0.9837
##  Bavu - Hype -0.51033 0.327 1131  -1.563  0.9998
##  Bavu - Lapu  1.94337 0.997 1192   1.949  0.9908
##  Bavu - Lesp  0.67843 0.996 1192   0.681  1.0000
##  Bavu - Phpr  0.11125 0.294 1112   0.379  1.0000
##  Bavu - Poco  0.34868 0.309 1114   1.128  1.0000
```

```
##  Bavu - Popr -0.04570 0.290 1118  -0.157  1.0000
##  Bavu - Pore  0.45892 0.310 1113   1.481  0.9999
##  Bavu - Posp  0.78851 0.567 1181   1.391  1.0000
##  Bavu - Rusp  0.55688 0.358 1160   1.553  0.9998
##  Bavu - Sila -0.79065 0.997 1192  -0.793  1.0000
##  Bavu - Soca -0.94024 0.289 1120  -3.253  0.2504
##  Bavu - Soga  2.96671 0.733 1190   4.047  0.0210
##  Bavu - Sogr -0.29077 0.413 1176  -0.705  1.0000
##  Bavu - Sora -0.06808 0.459 1192  -0.148  1.0000
##  Bavu - Syla  1.91477 0.998 1192   1.918  0.9928
##  Bavu - Sypi  0.51901 0.361 1157   1.437  1.0000
##  Bavu - Syur -1.02967 0.998 1192  -1.032  1.0000
##  Bavu - Taof  1.46945 0.379 1147   3.879  0.0388
##  Bavu - Trsp -0.68738 0.331 1127  -2.077  0.9770
##  Bavu - Vear  2.90984 0.732 1189   3.978  0.0271
##  Cahi - Cest -1.22806 0.246 1192  -4.983  0.0003
##  Cahi - Daca -0.97065 0.295 1192  -3.290  0.2288
##  Cahi - Dagl -0.29370 0.251 1192  -1.170  1.0000
##  Cahi - Dlre  2.32314 0.981 1191   2.369  0.8910
##  Cahi - Elre -0.52724 0.241 1192  -2.186  0.9556
##  Cahi - Eugr -1.13470 0.258 1192  -4.391  0.0053
##  Cahi - Hisp  0.06611 0.245 1192   0.270  1.0000
##  Cahi - Hype -1.05446 0.276 1191  -3.815  0.0484
##  Cahi - Lapu  1.39924 0.984 1192   1.422  1.0000
##  Cahi - Lesp  0.13431 0.980 1191   0.137  1.0000
##  Cahi - Phpr -0.43287 0.235 1192  -1.839  0.9963
##  Cahi - Poco -0.19544 0.257 1192  -0.761  1.0000
##  Cahi - Popr -0.58982 0.233 1192  -2.536  0.7968
##  Cahi - Pore -0.08520 0.255 1192  -0.334  1.0000
##  Cahi - Posp  0.24438 0.539 1192   0.454  1.0000
##  Cahi - Rusp  0.01275 0.314 1189   0.041  1.0000
##  Cahi - Sila -1.33478 0.980 1191  -1.362  1.0000
##  Cahi - Soca -1.48437 0.231 1192  -6.424  <.0001
##  Cahi - Soga  2.42259 0.711 1192   3.408  0.1683
##  Cahi - Sogr -0.83489 0.372 1192  -2.244  0.9394
##  Cahi - Sora -0.61220 0.424 1187  -1.443  1.0000
##  Cahi - Syla  1.37064 0.985 1192   1.392  1.0000
##  Cahi - Sypi -0.02512 0.318 1192  -0.079  1.0000
##  Cahi - Syur -1.57379 0.985 1192  -1.598  0.9997
##  Cahi - Taof  0.92533 0.334 1184   2.767  0.6211
##  Cahi - Trsp -1.23150 0.278 1191  -4.424  0.0046
##  Cahi - Vear  2.36572 0.709 1191   3.336  0.2035
##  Cest - Daca  0.25741 0.231 1192   1.113  1.0000
##  Cest - Dagl  0.93437 0.176 1192   5.297  0.0001
##  Cest - Dlre  3.55120 0.965 1192   3.679  0.0758
##  Cest - Elre  0.70083 0.162 1192   4.324  0.0070
##  Cest - Eugr  0.09337 0.182 1181   0.512  1.0000
##  Cest - Hisp  1.29418 0.166 1190   7.819  <.0001
##  Cest - Hype  0.17361 0.205 1160   0.845  1.0000
##  Cest - Lapu  2.62731 0.967 1192   2.716  0.6630
##  Cest - Lesp  1.36237 0.965 1192   1.411  1.0000
##  Cest - Phpr  0.79519 0.149 1190   5.325  0.0001
##  Cest - Poco  1.03262 0.183 1191   5.633  <.0001
##  Cest - Popr  0.63824 0.148 1190   4.320  0.0071
```

```
##  Cest - Pore  1.14286 0.178 1191   6.424  <.0001
##  Cest - Posp  1.47245 0.498 1192   2.954  0.4655
##  Cest - Rusp  1.24082 0.257 1099   4.834  0.0007
##  Cest - Sila -0.10671 0.964 1192  -0.111  1.0000
##  Cest - Soca -0.25630 0.145 1191  -1.763  0.9982
##  Cest - Soga  3.65065 0.689 1192   5.301  0.0001
##  Cest - Sogr  0.39317 0.328 1192   1.199  1.0000
##  Cest - Sora  0.61586 0.386 1192   1.596  0.9997
##  Cest - Syla  2.59871 0.967 1192   2.687  0.6858
##  Cest - Sypi  1.20295 0.259 1192   4.640  0.0018
##  Cest - Syur -0.34573 0.967 1192  -0.358  1.0000
##  Cest - Taof  2.15339 0.283 1176   7.616  <.0001
##  Cest - Trsp -0.00344 0.203 1181  -0.017  1.0000
##  Cest - Vear  3.59378 0.687 1192   5.231  0.0001
##  Daca - Dagl  0.67695 0.239 1192   2.837  0.5627
##  Daca - Dlre  3.29379 0.978 1191   3.368  0.1872
##  Daca - Elre  0.44342 0.229 1191   1.939  0.9914
##  Daca - Eugr -0.16405 0.245 1187  -0.670  1.0000
##  Daca - Hisp  1.03676 0.230 1191   4.500  0.0033
##  Daca - Hype -0.08381 0.263 1181  -0.319  1.0000
##  Daca - Lapu  2.36989 0.981 1192   2.415  0.8684
##  Daca - Lesp  1.10495 0.979 1192   1.129  1.0000
##  Daca - Phpr  0.53778 0.221 1193   2.437  0.8568
##  Daca - Poco  0.77521 0.243 1191   3.185  0.2927
##  Daca - Popr  0.38083 0.218 1192   1.747  0.9985
##  Daca - Pore  0.88545 0.240 1192   3.683  0.0747
##  Daca - Posp  1.21504 0.530 1191   2.293  0.9226
##  Daca - Rusp  0.98340 0.302 1173   3.257  0.2476
##  Daca - Sila -0.36413 0.978 1191  -0.372  1.0000
##  Daca - Soca -0.51372 0.216 1192  -2.373  0.8892
##  Daca - Soga  3.39324 0.708 1192   4.794  0.0009
##  Daca - Sogr  0.13576 0.366 1191   0.371  1.0000
##  Daca - Sora  0.35845 0.416 1190   0.861  1.0000
##  Daca - Syla  2.34130 0.981 1192   2.387  0.8823
##  Daca - Sypi  0.94553 0.304 1192   3.112  0.3431
##  Daca - Syur -0.60314 0.981 1192  -0.615  1.0000
##  Daca - Taof  1.89598 0.325 1184   5.828  <.0001
##  Daca - Trsp -0.26085 0.265 1191  -0.983  1.0000
##  Daca - Vear  3.33637 0.705 1192   4.729  0.0012
##  Dagl - Dlre  2.61684 0.966 1192   2.708  0.6696
##  Dagl - Elre -0.23354 0.168 1192  -1.387  1.0000
##  Dagl - Eugr -0.84100 0.191 1186  -4.412  0.0048
##  Dagl - Hisp  0.35981 0.173 1188   2.084  0.9759
##  Dagl - Hype -0.76076 0.215 1165  -3.535  0.1178
##  Dagl - Lapu  1.69294 0.968 1191   1.749  0.9984
##  Dagl - Lesp  0.42800 0.966 1192   0.443  1.0000
##  Dagl - Phpr -0.13917 0.159 1188  -0.874  1.0000
##  Dagl - Poco  0.09826 0.188 1189   0.523  1.0000
##  Dagl - Popr -0.29613 0.155 1192  -1.913  0.9930
##  Dagl - Pore  0.20850 0.187 1188   1.116  1.0000
##  Dagl - Posp  0.53808 0.510 1192   1.055  1.0000
##  Dagl - Rusp  0.30645 0.261 1153   1.175  1.0000
##  Dagl - Sila -1.04108 0.966 1192  -1.078  1.0000
##  Dagl - Soca -1.19067 0.152 1192  -7.815  <.0001
```

```
##  Dagl - Soga  2.71629 0.690 1192   3.936  0.0317
##  Dagl - Sogr -0.54119 0.331 1192  -1.635  0.9996
##  Dagl - Sora -0.31851 0.389 1192  -0.819  1.0000
##  Dagl - Syla  1.66434 0.969 1192   1.718  0.9989
##  Dagl - Sypi  0.26858 0.264 1190   1.018  1.0000
##  Dagl - Syur -1.28010 0.969 1192  -1.322  1.0000
##  Dagl - Taof  1.21903 0.287 1184   4.240  0.0099
##  Dagl - Trsp -0.93780 0.219 1189  -4.276  0.0085
##  Dagl - Vear  2.65941 0.688 1191   3.863  0.0410
##  Dlre - Elre -2.85038 0.964 1192  -2.957  0.4628
##  Dlre - Eugr -3.45784 0.969 1192  -3.570  0.1062
##  Dlre - Hisp -2.25703 0.964 1192  -2.340  0.9039
##  Dlre - Hype -3.37760 0.973 1192  -3.473  0.1409
##  Dlre - Lapu -0.92390 1.356 1192  -0.681  1.0000
##  Dlre - Lesp -2.18883 1.355 1193  -1.616  0.9996
##  Dlre - Phpr -2.75601 0.962 1192  -2.863  0.5406
##  Dlre - Poco -2.51858 0.968 1193  -2.601  0.7518
##  Dlre - Popr -2.91296 0.962 1192  -3.029  0.4056
##  Dlre - Pore -2.40834 0.967 1192  -2.490  0.8259
##  Dlre - Posp -2.07875 1.078 1192  -1.929  0.9921
##  Dlre - Rusp -2.31039 0.985 1192  -2.346  0.9015
##  Dlre - Sila -3.65792 1.351 1168  -2.707  0.6697
##  Dlre - Soca -3.80751 0.961 1192  -3.961  0.0289
##  Dlre - Soga  0.09945 1.174 1192   0.085  1.0000
##  Dlre - Sogr -3.15803 1.004 1191  -3.145  0.3203
##  Dlre - Sora -2.93534 1.021 1190  -2.876  0.5305
##  Dlre - Syla -0.95249 1.357 1192  -0.702  1.0000
##  Dlre - Sypi -2.34826 0.987 1192  -2.380  0.8860
##  Dlre - Syur -3.89693 1.357 1192  -2.871  0.5340
##  Dlre - Taof -1.39781 0.991 1193  -1.410  1.0000
##  Dlre - Trsp -3.55464 0.975 1192  -3.647  0.0839
##  Dlre - Vear  0.04258 1.169 1180   0.036  1.0000
##  Elre - Eugr -0.60746 0.175 1191  -3.466  0.1437
##  Elre - Hisp  0.59335 0.158 1192   3.747  0.0607
##  Elre - Hype -0.52722 0.202 1157  -2.604  0.7490
##  Elre - Lapu  1.92648 0.964 1192   1.997  0.9867
##  Elre - Lesp  0.66154 0.963 1192   0.687  1.0000
##  Elre - Phpr  0.09436 0.142 1189   0.662  1.0000
##  Elre - Poco  0.33179 0.172 1192   1.927  0.9922
##  Elre - Popr -0.06259 0.137 1185  -0.457  1.0000
##  Elre - Pore  0.44203 0.174 1191   2.542  0.7925
##  Elre - Posp  0.77162 0.505 1192   1.529  0.9999
##  Elre - Rusp  0.53999 0.251 1167   2.147  0.9644
##  Elre - Sila -0.80754 0.964 1192  -0.838  1.0000
##  Elre - Soca -0.95713 0.134 1184  -7.143  <.0001
##  Elre - Soga  2.94983 0.686 1192   4.298  0.0078
##  Elre - Sogr -0.30766 0.323 1191  -0.951  1.0000
##  Elre - Sora -0.08497 0.383 1190  -0.222  1.0000
##  Elre - Syla  1.89788 0.965 1192   1.966  0.9895
##  Elre - Sypi  0.50212 0.253 1192   1.981  0.9882
##  Elre - Syur -1.04656 0.965 1192  -1.084  1.0000
##  Elre - Taof  1.45257 0.280 1187   5.192  0.0001
##  Elre - Trsp -0.70427 0.208 1187  -3.378  0.1826
##  Elre - Vear  2.89295 0.685 1192   4.222  0.0106
```

```
##  Eugr - Hisp  1.20081 0.182 1188   6.611  <.0001
##  Eugr - Hype  0.08024 0.219 1153   0.366  1.0000
##  Eugr - Lapu  2.53394 0.968 1192   2.619  0.7384
##  Eugr - Lesp  1.26900 0.968 1192   1.310  1.0000
##  Eugr - Phpr  0.70182 0.167 1185   4.197  0.0117
##  Eugr - Poco  0.93925 0.194 1180   4.848  0.0007
##  Eugr - Popr  0.54487 0.163 1188   3.340  0.2014
##  Eugr - Pore  1.04949 0.195 1185   5.376  <.0001
##  Eugr - Posp  1.37908 0.509 1192   2.707  0.6700
##  Eugr - Rusp  1.14745 0.266 1176   4.320  0.0071
##  Eugr - Sila -0.20008 0.967 1192  -0.207  1.0000
##  Eugr - Soca -0.34967 0.160 1190  -2.180  0.9570
##  Eugr - Soga  3.55729 0.693 1191   5.131  0.0002
##  Eugr - Sogr  0.29981 0.338 1188   0.888  1.0000
##  Eugr - Sora  0.52249 0.394 1184   1.325  1.0000
##  Eugr - Syla  2.50534 0.968 1192   2.588  0.7611
##  Eugr - Sypi  1.10958 0.268 1190   4.138  0.0148
##  Eugr - Syur -0.43910 0.968 1192  -0.454  1.0000
##  Eugr - Taof  2.06003 0.294 1192   7.005  <.0001
##  Eugr - Trsp -0.09681 0.222 1191  -0.436  1.0000
##  Eugr - Vear  3.50041 0.692 1192   5.058  0.0002
##  Hisp - Hype -1.12057 0.207 1161  -5.422  <.0001
##  Hisp - Lapu  1.33313 0.967 1192   1.379  1.0000
##  Hisp - Lesp  0.06820 0.964 1192   0.071  1.0000
##  Hisp - Phpr -0.49898 0.148 1192  -3.371  0.1860
##  Hisp - Poco -0.26155 0.179 1183  -1.463  1.0000
##  Hisp - Popr -0.65594 0.143 1188  -4.595  0.0022
##  Hisp - Pore -0.15131 0.176 1190  -0.859  1.0000
##  Hisp - Posp  0.17827 0.507 1192   0.352  1.0000
##  Hisp - Rusp -0.05336 0.254 1128  -0.210  1.0000
##  Hisp - Sila -1.40089 0.964 1192  -1.453  1.0000
##  Hisp - Soca -1.55048 0.140 1189 -11.053  <.0001
##  Hisp - Soga  2.35648 0.688 1191   3.427  0.1601
##  Hisp - Sogr -0.90100 0.326 1192  -2.766  0.6220
##  Hisp - Sora -0.67832 0.383 1191  -1.770  0.9981
##  Hisp - Syla  1.30453 0.966 1192   1.350  1.0000
##  Hisp - Sypi -0.09123 0.256 1192  -0.356  1.0000
##  Hisp - Syur -1.63990 0.966 1192  -1.697  0.9991
##  Hisp - Taof  0.85922 0.281 1189   3.061  0.3809
##  Hisp - Trsp -1.29761 0.211 1181  -6.145  <.0001
##  Hisp - Vear  2.29961 0.686 1192   3.352  0.1951
##  Hype - Lapu  2.45370 0.974 1192   2.519  0.8076
##  Hype - Lesp  1.18876 0.973 1190   1.222  1.0000
##  Hype - Phpr  0.62158 0.194 1162   3.203  0.2815
##  Hype - Poco  0.85901 0.219 1148   3.918  0.0338
##  Hype - Popr  0.46463 0.192 1157   2.425  0.8633
##  Hype - Pore  0.96925 0.218 1159   4.450  0.0041
##  Hype - Posp  1.29884 0.516 1192   2.517  0.8089
##  Hype - Rusp  1.06721 0.284 1155   3.757  0.0589
##  Hype - Sila -0.28032 0.972 1192  -0.288  1.0000
##  Hype - Soca -0.42991 0.190 1159  -2.268  0.9316
##  Hype - Soga  3.47705 0.700 1192   4.968  0.0004
##  Hype - Sogr  0.21957 0.351 1192   0.626  1.0000
##  Hype - Sora  0.44225 0.404 1192   1.093  1.0000
```

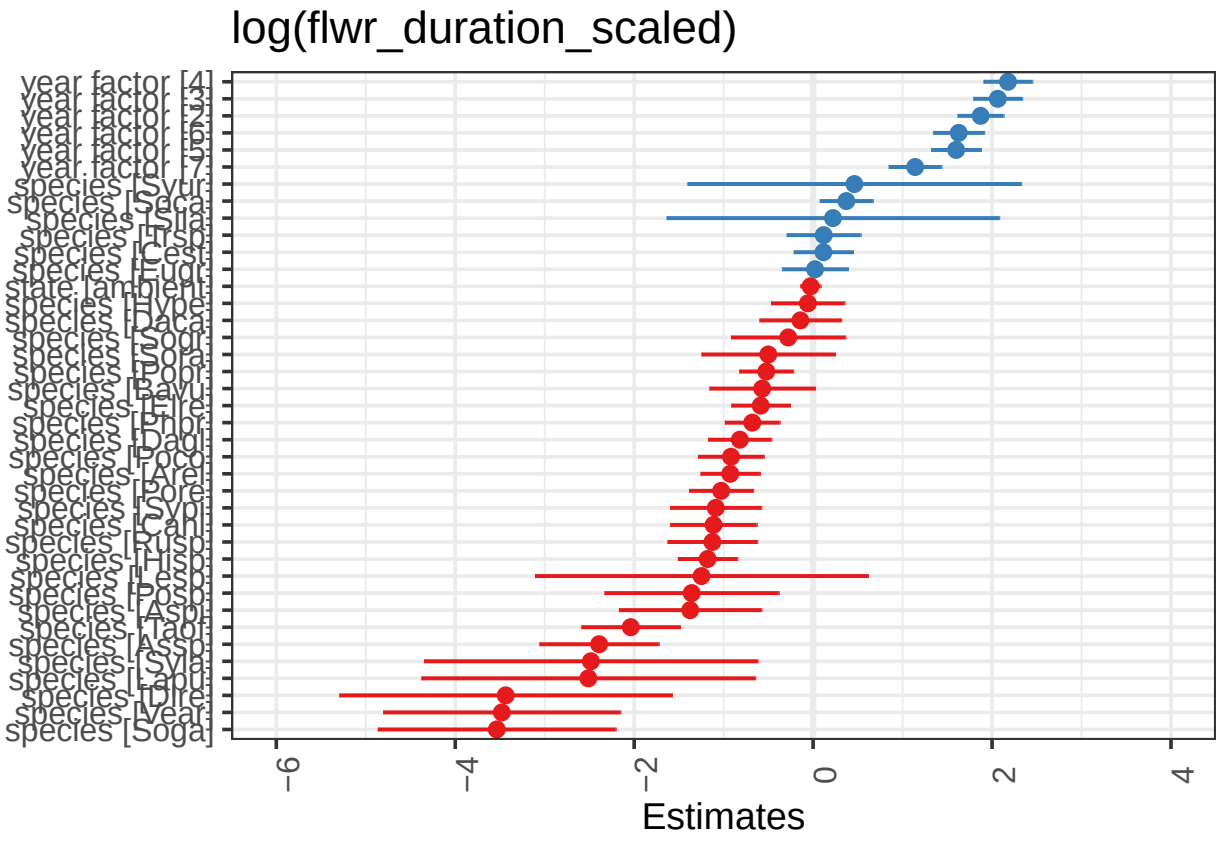
```
##  Hype - Syla  2.42510 0.974 1192   2.489  0.8263
##  Hype - Sypi  1.02934 0.287 1175   3.588  0.1005
##  Hype - Syur -0.51934 0.974 1192  -0.533  1.0000
##  Hype - Taof  1.97979 0.310 1168   6.395  <.0001
##  Hype - Trsp -0.17705 0.242 1187  -0.732  1.0000
##  Hype - Vear  3.42017 0.698 1192   4.899  0.0005
##  Lapu - Lesp -1.26494 1.356 1192  -0.933  1.0000
##  Lapu - Phpr -1.83212 0.964 1192  -1.901  0.9937
##  Lapu - Poco -1.59468 0.967 1192  -1.648  0.9995
##  Lapu - Popr -1.98907 0.963 1192  -2.066  0.9785
##  Lapu - Pore -1.48445 0.969 1192  -1.531  0.9999
##  Lapu - Posp -1.15486 1.079 1192  -1.070  1.0000
##  Lapu - Rusp -1.38649 0.986 1193  -1.406  1.0000
##  Lapu - Sila -2.73402 1.356 1193  -2.017  0.9847
##  Lapu - Soca -2.88361 0.962 1192  -2.998  0.4304
##  Lapu - Soga  1.02335 1.175 1192   0.871  1.0000
##  Lapu - Sogr -2.23413 1.007 1191  -2.218  0.9470
##  Lapu - Sora -2.01145 1.028 1192  -1.957  0.9902
##  Lapu - Syla -0.02860 1.352 1192  -0.021  1.0000
##  Lapu - Sypi -1.42436 0.987 1192  -1.444  1.0000
##  Lapu - Syur -2.97304 1.352 1192  -2.199  0.9521
##  Lapu - Taof -0.47391 0.994 1190  -0.477  1.0000
##  Lapu - Trsp -2.63075 0.976 1192  -2.694  0.6802
##  Lapu - Vear  0.96647 1.175 1192   0.823  1.0000
##  Lesp - Phpr -0.56718 0.962 1192  -0.590  1.0000
##  Lesp - Poco -0.32975 0.967 1192  -0.341  1.0000
##  Lesp - Popr -0.72413 0.961 1192  -0.753  1.0000
##  Lesp - Pore -0.21951 0.967 1192  -0.227  1.0000
##  Lesp - Posp  0.11008 1.078 1192   0.102  1.0000
##  Lesp - Rusp -0.12155 0.985 1192  -0.123  1.0000
##  Lesp - Sila -1.46908 1.354 1193  -1.085  1.0000
##  Lesp - Soca -1.61867 0.961 1192  -1.685  0.9992
##  Lesp - Soga  2.28829 1.170 1192   1.956  0.9903
##  Lesp - Sogr -0.96920 1.003 1192  -0.967  1.0000
##  Lesp - Sora -0.74651 1.026 1192  -0.727  1.0000
##  Lesp - Syla  1.23634 1.357 1192   0.911  1.0000
##  Lesp - Sypi -0.15942 0.985 1192  -0.162  1.0000
##  Lesp - Syur -1.70810 1.357 1192  -1.259  1.0000
##  Lesp - Taof  0.79102 0.991 1192   0.798  1.0000
##  Lesp - Trsp -1.36581 0.975 1192  -1.401  1.0000
##  Lesp - Vear  2.23141 1.171 1192   1.905  0.9935
##  Phpr - Poco  0.23743 0.165 1189   1.439  1.0000
##  Phpr - Popr -0.15695 0.126 1189  -1.242  1.0000
##  Phpr - Pore  0.34767 0.163 1187   2.127  0.9685
##  Phpr - Posp  0.67726 0.499 1192   1.356  1.0000
##  Phpr - Rusp  0.44563 0.245 1146   1.817  0.9970
##  Phpr - Sila -0.90190 0.962 1192  -0.938  1.0000
##  Phpr - Soca -1.05149 0.123 1187  -8.517  <.0001
##  Phpr - Soga  2.85547 0.685 1192   4.171  0.0130
##  Phpr - Sogr -0.40202 0.319 1192  -1.259  1.0000
##  Phpr - Sora -0.17933 0.379 1191  -0.473  1.0000
##  Phpr - Syla  1.80352 0.964 1192   1.871  0.9951
##  Phpr - Sypi  0.40775 0.247 1192   1.649  0.9995
##  Phpr - Syur -1.14092 0.964 1192  -1.183  1.0000
```

```
##  Phpr - Taof  1.35820 0.274 1180   4.961  0.0004
##  Phpr - Trsp -0.79863 0.198 1181  -4.043  0.0214
##  Phpr - Vear  2.79859 0.683 1192   4.098  0.0173
##  Poco - Popr -0.39438 0.160 1191  -2.472  0.8368
##  Poco - Pore  0.11024 0.192 1192   0.574  1.0000
##  Poco - Posp  0.43983 0.512 1192   0.858  1.0000
##  Poco - Rusp  0.20819 0.264 1184   0.789  1.0000
##  Poco - Sila -1.13933 0.968 1193  -1.177  1.0000
##  Poco - Soca -1.28893 0.157 1192  -8.208  <.0001
##  Poco - Soga  2.61803 0.691 1192   3.789  0.0528
##  Poco - Sogr -0.63945 0.334 1192  -1.915  0.9929
##  Poco - Sora -0.41676 0.393 1192  -1.060  1.0000
##  Poco - Syla  1.56609 0.968 1192   1.618  0.9996
##  Poco - Sypi  0.17032 0.264 1191   0.645  1.0000
##  Poco - Syur -1.37835 0.968 1192  -1.424  1.0000
##  Poco - Taof  1.12077 0.292 1187   3.833  0.0454
##  Poco - Trsp -1.03606 0.227 1190  -4.571  0.0024
##  Poco - Vear  2.56116 0.690 1193   3.710  0.0686
##  Popr - Pore  0.50462 0.160 1192   3.159  0.3102
##  Popr - Posp  0.83421 0.501 1192   1.665  0.9994
##  Popr - Rusp  0.60258 0.242 1130   2.489  0.8268
##  Popr - Sila -0.74495 0.961 1192  -0.775  1.0000
##  Popr - Soca -0.89454 0.116 1170  -7.684  <.0001
##  Popr - Soga  3.01241 0.683 1192   4.409  0.0049
##  Popr - Sogr -0.24507 0.317 1192  -0.774  1.0000
##  Popr - Sora -0.02238 0.377 1191  -0.059  1.0000
##  Popr - Syla  1.96047 0.963 1192   2.036  0.9825
##  Popr - Sypi  0.56471 0.244 1192   2.317  0.9134
##  Popr - Syur -0.98397 0.963 1192  -1.022  1.0000
##  Popr - Taof  1.51515 0.271 1184   5.589  <.0001
##  Popr - Trsp -0.64168 0.198 1180  -3.243  0.2562
##  Popr - Vear  2.95554 0.682 1192   4.335  0.0067
##  Pore - Posp  0.32959 0.509 1192   0.647  1.0000
##  Pore - Rusp  0.09796 0.264 1140   0.372  1.0000
##  Pore - Sila -1.24957 0.967 1192  -1.292  1.0000
##  Pore - Soca -1.39916 0.158 1192  -8.876  <.0001
##  Pore - Soga  2.50779 0.691 1192   3.629  0.0887
##  Pore - Sogr -0.74969 0.333 1192  -2.252  0.9367
##  Pore - Sora -0.52700 0.390 1192  -1.351  1.0000
##  Pore - Syla  1.45585 0.969 1192   1.502  0.9999
##  Pore - Sypi  0.06008 0.265 1188   0.227  1.0000
##  Pore - Syur -1.48859 0.969 1192  -1.536  0.9999
##  Pore - Taof  1.01053 0.289 1186   3.492  0.1332
##  Pore - Trsp -1.14630 0.221 1187  -5.193  0.0001
##  Pore - Vear  2.45092 0.689 1191   3.556  0.1107
##  Posp - Rusp -0.23163 0.543 1192  -0.427  1.0000
##  Posp - Sila -1.57916 1.077 1193  -1.466  1.0000
##  Posp - Soca -1.72875 0.500 1192  -3.456  0.1477
##  Posp - Soga  2.17821 0.838 1188   2.598  0.7534
##  Posp - Sogr -1.07928 0.581 1192  -1.858  0.9956
##  Posp - Sora -0.85659 0.615 1192  -1.392  1.0000
##  Posp - Syla  1.12626 1.079 1192   1.044  1.0000
##  Posp - Sypi -0.26950 0.545 1192  -0.495  1.0000
##  Posp - Syur -1.81818 1.079 1192  -1.685  0.9992
```

```
##  Posp - Taof  0.68095 0.556 1192   1.224  1.0000
##  Posp - Trsp -1.47589 0.511 1192  -2.887  0.5211
##  Posp - Vear  2.12133 0.838 1192   2.532  0.7996
##  Rusp - Sila -1.34753 0.984 1192  -1.369  1.0000
##  Rusp - Soca -1.49712 0.241 1136  -6.224  <.0001
##  Rusp - Soga  2.40984 0.715 1192   3.370  0.1864
##  Rusp - Sogr -0.84764 0.381 1190  -2.226  0.9447
##  Rusp - Sora -0.62496 0.431 1192  -1.450  1.0000
##  Rusp - Syla  1.35789 0.986 1192   1.378  1.0000
##  Rusp - Sypi -0.03787 0.321 1172  -0.118  1.0000
##  Rusp - Syur -1.58655 0.986 1192  -1.610  0.9997
##  Rusp - Taof  0.91258 0.342 1192   2.670  0.6993
##  Rusp - Trsp -1.24426 0.288 1170  -4.327  0.0069
##  Rusp - Vear  2.35296 0.714 1191   3.295  0.2259
##  Sila - Soca -0.14959 0.961 1192  -0.156  1.0000
##  Sila - Soga  3.75737 1.174 1192   3.200  0.2829
##  Sila - Sogr  0.49989 1.005 1191   0.497  1.0000
##  Sila - Sora  0.72257 1.025 1190   0.705  1.0000
##  Sila - Syla  2.70542 1.357 1192   1.994  0.9870
##  Sila - Sypi  1.30966 0.986 1192   1.328  1.0000
##  Sila - Syur -0.23902 1.357 1192  -0.176  1.0000
##  Sila - Taof  2.26011 0.991 1192   2.281  0.9271
##  Sila - Trsp  0.10328 0.972 1192   0.106  1.0000
##  Sila - Vear  3.70049 1.171 1180   3.160  0.3099
##  Soca - Soga  3.90696 0.683 1192   5.721  <.0001
##  Soca - Sogr  0.64948 0.316 1192   2.057  0.9799
##  Soca - Sora  0.87216 0.376 1191   2.322  0.9117
##  Soca - Syla  2.85501 0.962 1192   2.967  0.4547
##  Soca - Sypi  1.45925 0.242 1192   6.023  <.0001
##  Soca - Syur -0.08943 0.962 1192  -0.093  1.0000
##  Soca - Taof  2.40970 0.270 1186   8.928  <.0001
##  Soca - Trsp  0.25286 0.196 1179   1.290  1.0000
##  Soca - Vear  3.85008 0.681 1192   5.650  <.0001
##  Soga - Sogr -3.25748 0.740 1187  -4.404  0.0050
##  Soga - Sora -3.03480 0.772 1191  -3.932  0.0321
##  Soga - Syla -1.05195 1.176 1192  -0.895  1.0000
##  Soga - Sypi -2.44771 0.715 1192  -3.422  0.1623
##  Soga - Syur -3.99639 1.176 1192  -3.399  0.1724
##  Soga - Taof -1.49726 0.724 1187  -2.068  0.9782
##  Soga - Trsp -3.65409 0.702 1191  -5.206  0.0001
##  Soga - Vear -0.05688 0.956 1192  -0.059  1.0000
##  Sogr - Sora  0.22269 0.475 1182   0.469  1.0000
##  Sogr - Syla  2.20554 1.008 1192   2.189  0.9549
##  Sogr - Sypi  0.80977 0.382 1192   2.122  0.9694
##  Sogr - Syur -0.73890 1.008 1192  -0.733  1.0000
##  Sogr - Taof  1.76022 0.397 1185   4.435  0.0044
##  Sogr - Trsp -0.39661 0.355 1189  -1.118  1.0000
##  Sogr - Vear  3.20061 0.740 1192   4.325  0.0070
##  Sora - Syla  1.98285 1.028 1192   1.928  0.9922
##  Sora - Sypi  0.58709 0.435 1191   1.350  1.0000
##  Sora - Syur -0.96159 1.028 1192  -0.935  1.0000
##  Sora - Taof  1.53754 0.445 1190   3.452  0.1494
##  Sora - Trsp -0.61930 0.409 1188  -1.514  0.9999
##  Sora - Vear  2.97792 0.767 1191   3.882  0.0383
```

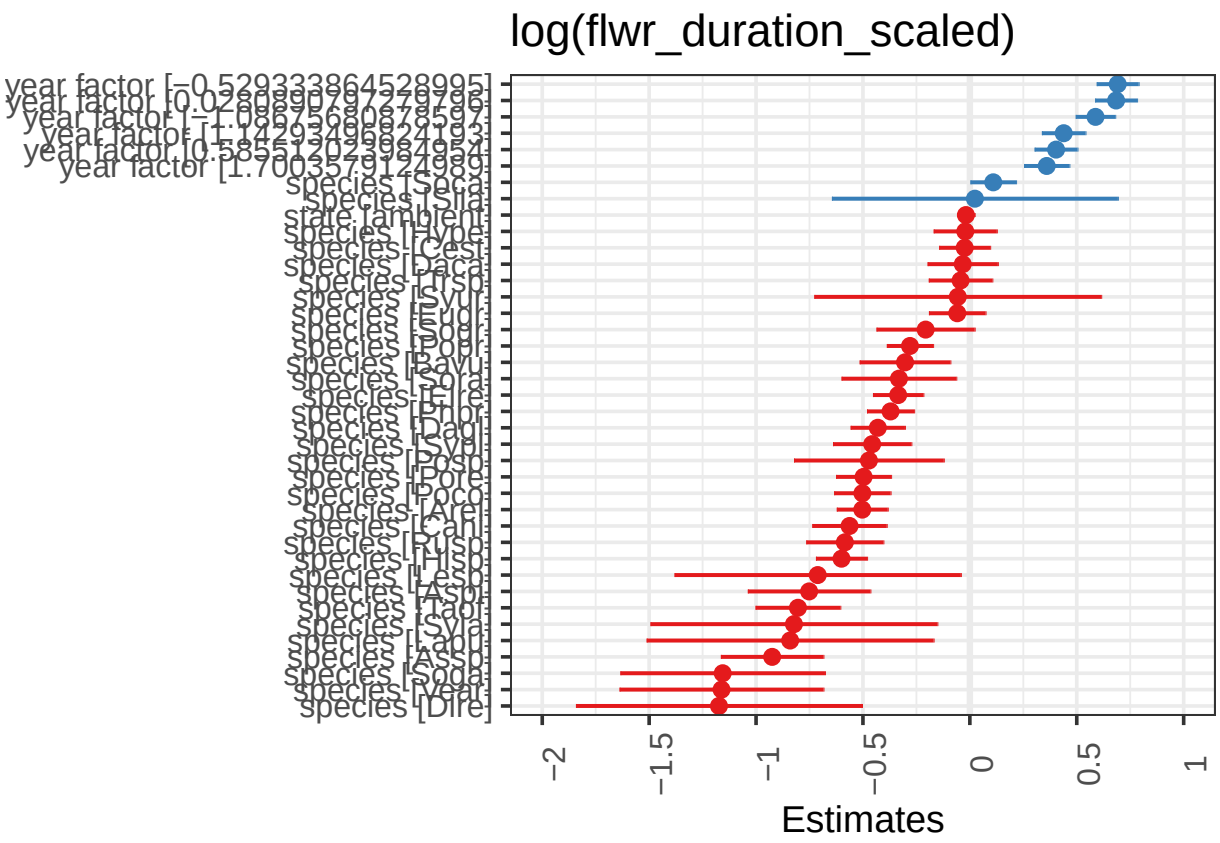
```
##  Syla - Sypi -1.39576 0.985 1191  -1.417  1.0000
##  Syla - Syur -2.94444 1.348 1167  -2.185  0.9557
##  Syla - Taof -0.44531 0.994 1192  -0.448  1.0000
##  Syla - Trsp -2.60215 0.976 1192  -2.666  0.7026
##  Syla - Vear  0.99507 1.175 1192   0.847  1.0000
##  Sypi - Syur -1.54868 0.985 1191  -1.573  0.9998
##  Sypi - Taof  0.95045 0.345 1192   2.753  0.6327
##  Sypi - Trsp -1.20638 0.292 1190  -4.138  0.0148
##  Sypi - Vear  2.39083 0.715 1192   3.345  0.1989
##  Syur - Taof  2.49912 0.994 1192   2.515  0.8101
##  Syur - Trsp  0.34229 0.976 1192   0.351  1.0000
##  Syur - Vear  3.93951 1.175 1192   3.353  0.1947
##  Taof - Trsp -2.15683 0.311 1192  -6.929  <.0001
##  Taof - Vear  1.44039 0.723 1192   1.992  0.9872
##  Trsp - Vear  3.59722 0.700 1191   5.137  0.0002
##
## Results are averaged over the levels of: state, year_factor
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## P value adjustment: tukey method for comparing a family of 33 estimates
```

```
# Take a look at the estimates for each fixed effect. These are the estimates from summary(mod7a). You'
plot_model(mod7a, sort.est = TRUE)
```



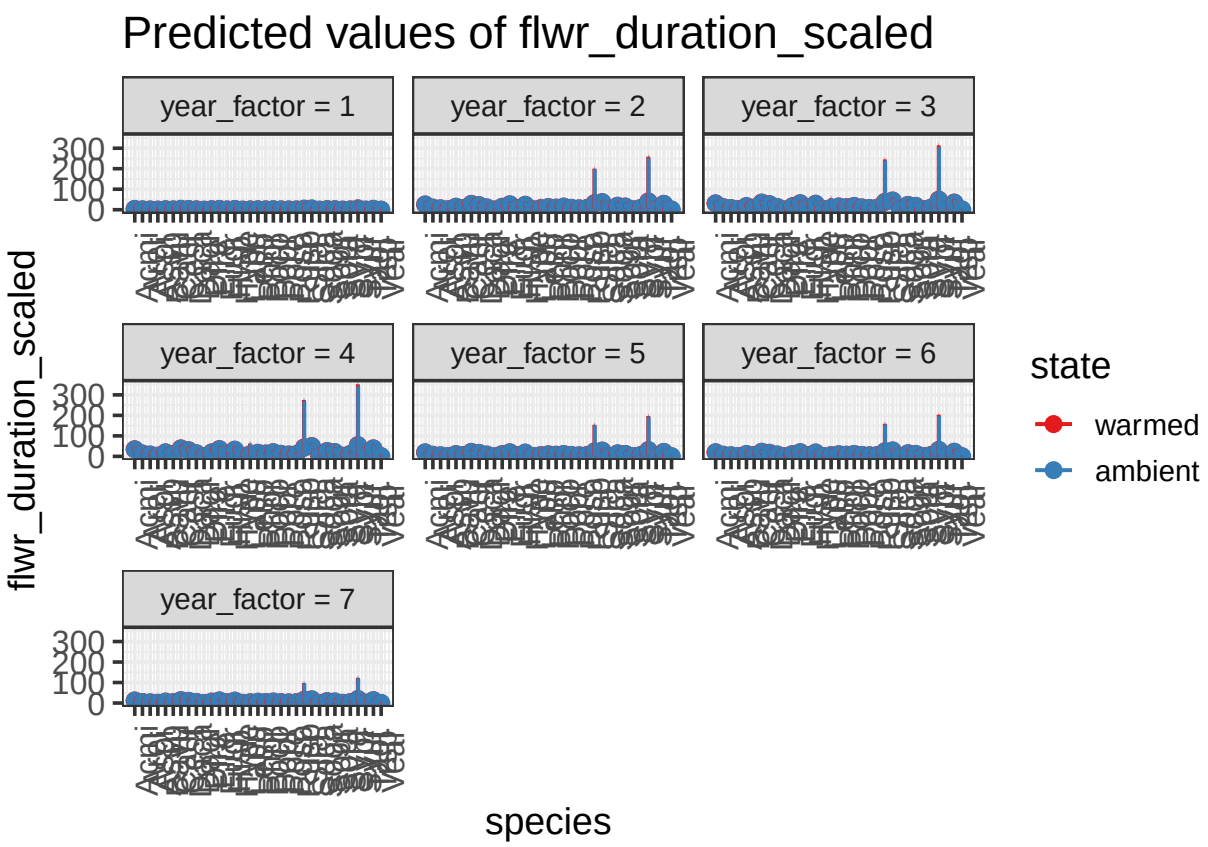

```
# if you want to standardize the estimates:
plot_model(mod7a, sort.est = TRUE, type="std")
```

```
## Formula contains log- or sqrt-terms. See help("standardize") for how
##   such terms are standardized.
```

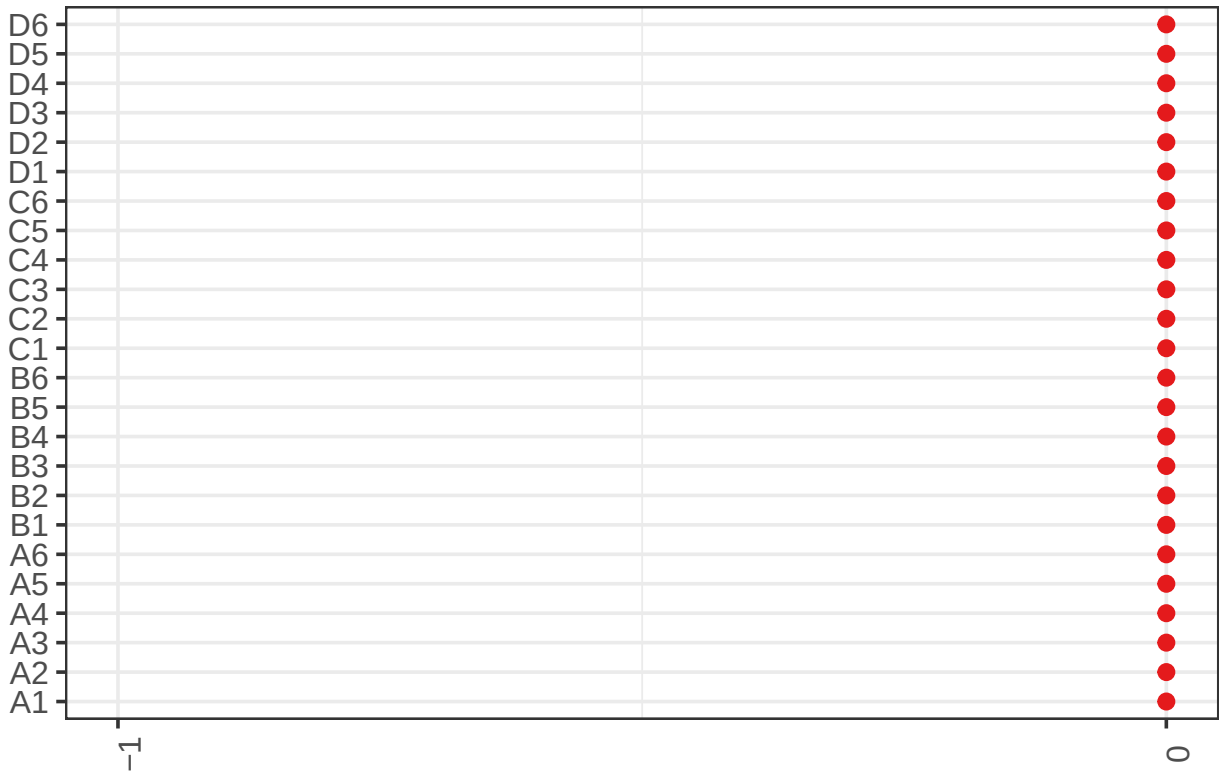



```
# these are the fixed predicted values: - note this is a new plot
plot_model(mod7a, type = "pred", terms = c("species", "state", "year_factor"))
```

```
## Model has log-transformed response. Back-transforming predictions to original response scale. Standa
```




```
# these are the random effects estimates
plot_model(mod7a, type = "re")
```




```
# including native vs. exotic
kbs_flwr_spp <- within(kbs_flwr_spp, origin <- relevel(factor(origin), ref = "Native")) # releveling so
mod8 <- lmer(log(flwr_duration_scaled) ~ state * origin + (1+factor(year_factor)|plot), kbs_flwr_spp, RE
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod9 <- lmer(log(flwr_duration_scaled) ~ state + origin + (1+factor(year_factor)|plot), kbs_flwr_spp, RE
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod9a <- lmer(log(flwr_duration_scaled) ~ state + origin + factor(year_factor) + (1|plot), kbs_flwr_spp
```

```
## boundary (singular) fit: see help('isSingular')
```

```
anova(mod8, mod9) # model 9 is a better fit to data
```

```
## Data: kbs_flwr_spp
## Models:
## mod9: log(flwr_duration_scaled) ~ state + origin + (1 + factor(year_factor) | plot)
## mod8: log(flwr_duration_scaled) ~ state * origin + (1 + factor(year_factor) | plot)
##      npar    AIC    BIC  logLik deviance  Chisq Df Pr(>Chisq)
## mod9   34 3392.8 3563.6 -1662.4   3324.8
## mod8   37 3398.0 3584.0 -1662.0   3324.0 0.7217  3     0.8681
```

```
anova(mod9, mod9a) # mod 9a
```

```
## Data: kbs_flwr_spp
## Models:
## mod9a: log(flwr_duration_scaled) ~ state + origin + factor(year_factor) + (1 | plot)
## mod9: log(flwr_duration_scaled) ~ state + origin + (1 + factor(year_factor) | plot)
##       npar    AIC    BIC  logLik deviance Chisq Df Pr(>Chisq)
## mod9a   13 3305.0 3370.4 -1639.5   3279.0
## mod9    34 3392.8 3563.6 -1662.4   3324.8     0 21          1
```

```
summary(mod9a)
```

```
## Linear mixed model fit by maximum likelihood . t-tests use Satterthwaite's
##   method [lmerModLmerTest]
## Formula: log(flwr_duration_scaled) ~ state + origin + factor(year_factor) +
##     (1 | plot)
##    Data: kbs_flwr_spp
##
##      AIC      BIC   logLik deviance df.resid
##   3305.0   3370.4  -1639.5   3279.0     1112
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.4025 -0.3879  0.1925  0.5738  2.4878
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  plot     (Intercept) 0.00     0.000
##  Residual             1.08     1.039
## Number of obs: 1125, groups:  plot, 24
##
## Fixed effects:
##                         Estimate Std. Error         df t value Pr(>|t|)
## (Intercept)              1.94928    0.13671 1125.00000  14.259  < 2e-16 ***
## stateambient            -0.07433    0.06240 1125.00000  -1.191  0.23383
## origin                  -1.91211    0.53645 1125.00000  -3.564  0.00038 ***
## originBoth              -1.08630    0.11221 1125.00000  -9.681  < 2e-16 ***
## originExotic            -0.76838    0.07475 1125.00000 -10.279  < 2e-16 ***
## factor(year_factor)2     1.52687    0.13767 1125.00000  11.091  < 2e-16 ***
## factor(year_factor)3     1.58408    0.14217 1125.00000  11.142  < 2e-16 ***
## factor(year_factor)4     1.66077    0.14113 1125.00000  11.767  < 2e-16 ***
## factor(year_factor)5     1.10392    0.14407 1125.00000   7.662 3.92e-14 ***
## factor(year_factor)6     1.16807    0.14646 1125.00000   7.975 3.72e-15 ***
## factor(year_factor)7     0.66663    0.15292 1125.00000   4.359 1.42e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) sttmbn origin orgnBt orgnEx fc(_)2 fc(_)3 fc(_)4 fc(_)5
## stateambint -0.216
## origin      -0.242 -0.003
## originBoth  -0.308 -0.054  0.082
```

```
## originExotc -0.424  0.023  0.107  0.488
## fctr(yr_f)2 -0.758 -0.031  0.195  0.018  0.021
## fctr(yr_f)3 -0.734 -0.033  0.189  0.028  0.017  0.728
## fctr(yr_f)4 -0.733 -0.040  0.189  0.061 -0.013  0.733  0.711
## fctr(yr_f)5 -0.733 -0.045  0.189  0.076  0.028  0.719  0.697  0.705
## fctr(yr_f)6 -0.722 -0.014  0.185  0.063  0.018  0.706  0.684  0.692  0.679
## fctr(yr_f)7 -0.714 -0.007  0.182  0.104  0.058  0.677  0.657  0.664  0.653
##             fc(_)6
## stateambint
## origin
## originBoth
## originExotc
## fctr(yr_f)2
## fctr(yr_f)3
## fctr(yr_f)4
## fctr(yr_f)5
## fctr(yr_f)6
## fctr(yr_f)7  0.641
## optimizer (nloptwrap) convergence code: 0 (OK)
## boundary (singular) fit: see help('isSingular')
```

```
anova(mod9a)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##                       Sum Sq Mean Sq NumDF DenDF F value Pr(>F)
## state                  1.532   1.532     1  1125  1.4189 0.2338
## origin               150.676  50.225     3  1125 46.5116 <2e-16 ***
## factor(year_factor) 234.217  39.036     6  1125 36.1497 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
emmeans(mod9a, list(pairwise ~ state + origin + year_factor), adjust = "tukey")
```

```
## boundary (singular) fit: see help('isSingular')
```

```
## $`emmeans of state, origin, year_factor`
##  state   origin year_factor  emmean     SE   df  lower.CL upper.CL
##  warmed  Native           1  1.9493 0.1376  752  1.679182    2.219
##  ambient Native           1  1.8749 0.1383  799  1.603556    2.146
##  warmed                   1  0.0372 0.5239 1135 -0.990690    1.065
##  ambient                  1 -0.0372 0.5240 1134 -1.065228    0.991
##  warmed  Both             1  0.8630 0.1487  846  0.571169    1.155
##  ambient Both             1  0.7886 0.1468  852  0.500598    1.077
##  warmed  Exotic           1  1.1809 0.1257  655  0.933998    1.428
##  ambient Exotic           1  1.1066 0.1274  696  0.856483    1.357
##  warmed  Native           2  3.4761 0.0959  373  3.287528    3.665
##  ambient Native           2  3.4018 0.0942  352  3.216486    3.587
##  warmed                   2  1.5640 0.5422 1134  0.500134    2.628
##  ambient                  2  1.4897 0.5419 1132  0.426520    2.553
##  warmed  Both             2  2.3898 0.1139  549  2.166205    2.613
##  ambient Both             2  2.3155 0.1090  472  2.101250    2.530
##  warmed  Exotic           2  2.7078 0.0808  217  2.548545    2.867
```

```
##  ambient Exotic          2  2.6334 0.0802  199  2.475271    2.792
##  warmed  Native          3  3.5334 0.1024  430  3.332005    3.735
##  ambient Native          3  3.4590 0.1005  411  3.261405    3.657
##  warmed                  3  1.6212 0.5434 1135  0.555066    2.687
##  ambient                 3  1.5469 0.5430 1133  0.481571    2.612
##  warmed  Both            3  2.4471 0.1208  611  2.209790    2.684
##  ambient Both            3  2.3727 0.1160  541  2.144846    2.601
##  warmed  Exotic          3  2.7650 0.0881  273  2.591631    2.938
##  ambient Exotic          3  2.6907 0.0871  252  2.519030    2.862
##  warmed  Native          4  3.6100 0.1023  437  3.409010    3.811
##  ambient Native          4  3.5357 0.0998  403  3.339507    3.732
##  warmed                  4  1.6979 0.5432 1135  0.632178    2.764
##  ambient                 4  1.6236 0.5427 1133  0.558888    2.688
##  warmed  Both            4  2.5237 0.1249  647  2.278405    2.769
##  ambient Both            4  2.4494 0.1198  566  2.214059    2.685
##  warmed  Exotic          4  2.8417 0.0841  248  2.675984    3.007
##  ambient Exotic          4  2.7673 0.0825  215  2.604757    2.930
##  warmed  Native          5  3.0532 0.1035  445  2.849748    3.257
##  ambient Native          5  2.9789 0.1005  416  2.781327    3.176
##  warmed                  5  1.1411 0.5440 1135  0.073727    2.208
##  ambient                 5  1.0668 0.5434 1133  0.000645    2.133
##  warmed  Both            5  1.9669 0.1281  687  1.715478    2.218
##  ambient Both            5  1.8926 0.1226  617  1.651819    2.133
##  warmed  Exotic          5  2.2848 0.0906  302  2.106590    2.463
##  ambient Exotic          5  2.2105 0.0884  270  2.036452    2.385
##  warmed  Native          6  3.1174 0.1065  483  2.908073    3.327
##  ambient Native          6  3.0430 0.1064  466  2.834038    3.252
##  warmed                  6  1.2052 0.5445 1134  0.136990    2.273
##  ambient                 6  1.1309 0.5444 1132  0.062855    2.199
##  warmed  Both            6  2.0310 0.1289  703  1.777897    2.284
##  ambient Both            6  1.9567 0.1259  636  1.709572    2.204
##  warmed  Exotic          6  2.3490 0.0929  332  2.166161    2.532
##  ambient Exotic          6  2.2746 0.0940  314  2.089747    2.460
##  warmed  Native          7  2.6159 0.1113  516  2.397225    2.835
##  ambient Native          7  2.5416 0.1116  515  2.322246    2.761
##  warmed                  7  0.7038 0.5461 1135 -0.367725    1.775
##  ambient                 7  0.6295 0.5461 1133 -0.442053    1.701
##  warmed  Both            7  1.5296 0.1385  756  1.257720    1.801
##  ambient Both            7  1.4553 0.1360  711  1.188209    1.722
##  warmed  Exotic          7  1.8475 0.1030  425  1.645001    2.050
##  ambient Exotic          7  1.7732 0.1045  419  1.567802    1.979
##
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of state, origin, year_factor`
##  1                                                                 estimate     SE
##  warmed Native year_factor1 - ambient Native year_factor1   0.07433 0.0629
##  warmed Native year_factor1 - warmed  year_factor1          1.91211 0.5401
##  warmed Native year_factor1 - ambient  year_factor1         1.98644 0.5437
##  warmed Native year_factor1 - warmed Both year_factor1      1.08630 0.1129
##  warmed Native year_factor1 - ambient Both year_factor1     1.16063 0.1263
##  warmed Native year_factor1 - warmed Exotic year_factor1    0.76838 0.0752
```

```
##  warmed Native year_factor1 - ambient Exotic year_factor1   0.84271 0.0993
##  warmed Native year_factor1 - warmed Native year_factor2   -1.52687 0.1385
##  warmed Native year_factor1 - ambient Native year_factor2  -1.45254 0.1504
##  warmed Native year_factor1 - warmed  year_factor2          0.38525 0.5833
##  warmed Native year_factor1 - ambient  year_factor2         0.45958 0.5861
##  warmed Native year_factor1 - warmed Both year_factor2     -0.44056 0.1803
##  warmed Native year_factor1 - ambient Both year_factor2    -0.36623 0.1877
##  warmed Native year_factor1 - warmed Exotic year_factor2   -0.75849 0.1590
##  warmed Native year_factor1 - ambient Exotic year_factor2  -0.68416 0.1702
##  warmed Native year_factor1 - warmed Native year_factor3   -1.58408 0.1430
##  warmed Native year_factor1 - ambient Native year_factor3  -1.50975 0.1544
##  warmed Native year_factor1 - warmed  year_factor3          0.32803 0.5843
##  warmed Native year_factor1 - ambient  year_factor3         0.40236 0.5872
##  warmed Native year_factor1 - warmed Both year_factor3     -0.49778 0.1847
##  warmed Native year_factor1 - ambient Both year_factor3    -0.42345 0.1917
##  warmed Native year_factor1 - warmed Exotic year_factor3   -0.81570 0.1628
##  warmed Native year_factor1 - ambient Exotic year_factor3  -0.74137 0.1735
##  warmed Native year_factor1 - warmed Native year_factor4   -1.66077 0.1420
##  warmed Native year_factor1 - ambient Native year_factor4  -1.58644 0.1531
##  warmed Native year_factor1 - warmed  year_factor4          0.25135 0.5839
##  warmed Native year_factor1 - ambient  year_factor4         0.32567 0.5866
##  warmed Native year_factor1 - warmed Both year_factor4     -0.57446 0.1868
##  warmed Native year_factor1 - ambient Both year_factor4    -0.50013 0.1934
##  warmed Native year_factor1 - warmed Exotic year_factor4   -0.89239 0.1599
##  warmed Native year_factor1 - ambient Exotic year_factor4  -0.81806 0.1705
##  warmed Native year_factor1 - warmed Native year_factor5   -1.10392 0.1449
##  warmed Native year_factor1 - ambient Native year_factor5  -1.02959 0.1554
##  warmed Native year_factor1 - warmed  year_factor5          0.80819 0.5852
##  warmed Native year_factor1 - ambient  year_factor5         0.88252 0.5878
##  warmed Native year_factor1 - warmed Both year_factor5     -0.01762 0.1904
##  warmed Native year_factor1 - ambient Both year_factor5     0.05671 0.1966
##  warmed Native year_factor1 - warmed Exotic year_factor5   -0.33554 0.1651
##  warmed Native year_factor1 - ambient Exotic year_factor5  -0.26122 0.1751
##  warmed Native year_factor1 - warmed Native year_factor6   -1.16807 0.1474
##  warmed Native year_factor1 - ambient Native year_factor6  -1.09375 0.1595
##  warmed Native year_factor1 - warmed  year_factor6          0.74404 0.5857
##  warmed Native year_factor1 - ambient  year_factor6         0.81837 0.5888
##  warmed Native year_factor1 - warmed Both year_factor6     -0.08177 0.1912
##  warmed Native year_factor1 - ambient Both year_factor6    -0.00744 0.1989
##  warmed Native year_factor1 - warmed Exotic year_factor6   -0.39970 0.1667
##  warmed Native year_factor1 - ambient Exotic year_factor6  -0.32537 0.1782
##  warmed Native year_factor1 - warmed Native year_factor7   -0.66663 0.1538
##  warmed Native year_factor1 - ambient Native year_factor7  -0.59230 0.1659
##  warmed Native year_factor1 - warmed  year_factor7          1.24548 0.5880
##  warmed Native year_factor1 - ambient  year_factor7         1.31981 0.5912
##  warmed Native year_factor1 - warmed Both year_factor7      0.41968 0.2001
##  warmed Native year_factor1 - ambient Both year_factor7     0.49400 0.2077
##  warmed Native year_factor1 - warmed Exotic year_factor7    0.10175 0.1751
##  warmed Native year_factor1 - ambient Exotic year_factor7   0.17608 0.1864
##  ambient Native year_factor1 - warmed  year_factor1         1.83778 0.5438
##  ambient Native year_factor1 - ambient  year_factor1        1.91211 0.5401
##  ambient Native year_factor1 - warmed Both year_factor1     1.01197 0.1321
##  ambient Native year_factor1 - ambient Both year_factor1    1.08630 0.1129
##  ambient Native year_factor1 - warmed Exotic year_factor1   0.69405 0.0969
```

```
##  ambient Native year_factor1 - ambient Exotic year_factor1  0.76838 0.0752
##  ambient Native year_factor1 - warmed Native year_factor2  -1.60119 0.1538
##  ambient Native year_factor1 - ambient Native year_factor2 -1.52687 0.1385
##  ambient Native year_factor1 - warmed  year_factor2         0.31092 0.5871
##  ambient Native year_factor1 - ambient  year_factor2        0.38525 0.5833
##  ambient Native year_factor1 - warmed Both year_factor2    -0.51489 0.1942
##  ambient Native year_factor1 - ambient Both year_factor2   -0.44056 0.1803
##  ambient Native year_factor1 - warmed Exotic year_factor2  -0.83282 0.1718
##  ambient Native year_factor1 - ambient Exotic year_factor2 -0.75849 0.1590
##  ambient Native year_factor1 - warmed Native year_factor3  -1.65841 0.1581
##  ambient Native year_factor1 - ambient Native year_factor3 -1.58408 0.1430
##  ambient Native year_factor1 - warmed  year_factor3         0.25370 0.5883
##  ambient Native year_factor1 - ambient  year_factor3        0.32803 0.5843
##  ambient Native year_factor1 - warmed Both year_factor3    -0.57210 0.1985
##  ambient Native year_factor1 - ambient Both year_factor3   -0.49778 0.1847
##  ambient Native year_factor1 - warmed Exotic year_factor3  -0.89003 0.1755
##  ambient Native year_factor1 - ambient Exotic year_factor3 -0.81570 0.1628
##  ambient Native year_factor1 - warmed Native year_factor4  -1.73510 0.1575
##  ambient Native year_factor1 - ambient Native year_factor4 -1.66077 0.1420
##  ambient Native year_factor1 - warmed  year_factor4         0.17702 0.5879
##  ambient Native year_factor1 - ambient  year_factor4        0.25135 0.5839
##  ambient Native year_factor1 - warmed Both year_factor4    -0.64879 0.2007
##  ambient Native year_factor1 - ambient Both year_factor4   -0.57446 0.1868
##  ambient Native year_factor1 - warmed Exotic year_factor4  -0.96672 0.1731
##  ambient Native year_factor1 - ambient Exotic year_factor4 -0.89239 0.1599
##  ambient Native year_factor1 - warmed Native year_factor5  -1.17825 0.1605
##  ambient Native year_factor1 - ambient Native year_factor5 -1.10392 0.1449
##  ambient Native year_factor1 - warmed  year_factor5         0.73386 0.5893
##  ambient Native year_factor1 - ambient  year_factor5        0.80819 0.5852
##  ambient Native year_factor1 - warmed Both year_factor5    -0.09195 0.2044
##  ambient Native year_factor1 - ambient Both year_factor5   -0.01762 0.1904
##  ambient Native year_factor1 - warmed Exotic year_factor5  -0.40987 0.1783
##  ambient Native year_factor1 - ambient Exotic year_factor5 -0.33554 0.1651
##  ambient Native year_factor1 - warmed Native year_factor6  -1.24240 0.1609
##  ambient Native year_factor1 - ambient Native year_factor6 -1.16807 0.1474
##  ambient Native year_factor1 - warmed  year_factor6         0.66971 0.5893
##  ambient Native year_factor1 - ambient  year_factor6        0.74404 0.5857
##  ambient Native year_factor1 - warmed Both year_factor6    -0.15610 0.2037
##  ambient Native year_factor1 - ambient Both year_factor6   -0.08177 0.1912
##  ambient Native year_factor1 - warmed Exotic year_factor6  -0.47403 0.1782
##  ambient Native year_factor1 - ambient Exotic year_factor6 -0.39970 0.1667
##  ambient Native year_factor1 - warmed Native year_factor7  -0.74096 0.1665
##  ambient Native year_factor1 - ambient Native year_factor7 -0.66663 0.1538
##  ambient Native year_factor1 - warmed  year_factor7         1.17116 0.5915
##  ambient Native year_factor1 - ambient  year_factor7        1.24548 0.5880
##  ambient Native year_factor1 - warmed Both year_factor7     0.34535 0.2118
##  ambient Native year_factor1 - ambient Both year_factor7    0.41968 0.2001
##  ambient Native year_factor1 - warmed Exotic year_factor7   0.02742 0.1858
##  ambient Native year_factor1 - ambient Exotic year_factor7  0.10175 0.1751
##  warmed  year_factor1 - ambient  year_factor1                0.07433 0.0629
##  warmed  year_factor1 - warmed Both year_factor1           -0.82581 0.5427
##  warmed  year_factor1 - ambient Both year_factor1          -0.75148 0.5457
##  warmed  year_factor1 - warmed Exotic year_factor1         -1.14374 0.5372
##  warmed  year_factor1 - ambient Exotic year_factor1        -1.06941 0.5412
```

```
##  warmed  year_factor1 - warmed Native year_factor2        -3.43898 0.5306
##  warmed  year_factor1 - ambient Native year_factor2       -3.36465 0.5339
##  warmed  year_factor1 - warmed  year_factor2              -1.52687 0.1385
##  warmed  year_factor1 - ambient  year_factor2             -1.45254 0.1504
##  warmed  year_factor1 - warmed Both year_factor2          -2.35268 0.5338
##  warmed  year_factor1 - ambient Both year_factor2         -2.27835 0.5364
##  warmed  year_factor1 - warmed Exotic year_factor2        -2.67060 0.5281
##  warmed  year_factor1 - ambient Exotic year_factor2       -2.59627 0.5317
##  warmed  year_factor1 - warmed Native year_factor3        -3.49619 0.5319
##  warmed  year_factor1 - ambient Native year_factor3       -3.42186 0.5351
##  warmed  year_factor1 - warmed  year_factor3              -1.58408 0.1430
##  warmed  year_factor1 - ambient  year_factor3             -1.50975 0.1544
##  warmed  year_factor1 - warmed Both year_factor3          -2.40989 0.5354
##  warmed  year_factor1 - ambient Both year_factor3         -2.33556 0.5379
##  warmed  year_factor1 - warmed Exotic year_factor3        -2.72782 0.5293
##  warmed  year_factor1 - ambient Exotic year_factor3       -2.65349 0.5328
##  warmed  year_factor1 - warmed Native year_factor4        -3.57288 0.5318
##  warmed  year_factor1 - ambient Native year_factor4       -3.49855 0.5349
##  warmed  year_factor1 - warmed  year_factor4              -1.66077 0.1420
##  warmed  year_factor1 - ambient  year_factor4             -1.58644 0.1531
##  warmed  year_factor1 - warmed Both year_factor4          -2.48658 0.5363
##  warmed  year_factor1 - ambient Both year_factor4         -2.41225 0.5387
##  warmed  year_factor1 - warmed Exotic year_factor4        -2.80450 0.5286
##  warmed  year_factor1 - ambient Exotic year_factor4       -2.73018 0.5320
##  warmed  year_factor1 - warmed Native year_factor5        -3.01603 0.5320
##  warmed  year_factor1 - ambient Native year_factor5       -2.94170 0.5350
##  warmed  year_factor1 - warmed  year_factor5              -1.10392 0.1449
##  warmed  year_factor1 - ambient  year_factor5             -1.02959 0.1554
##  warmed  year_factor1 - warmed Both year_factor5          -1.92973 0.5369
##  warmed  year_factor1 - ambient Both year_factor5         -1.85540 0.5392
##  warmed  year_factor1 - warmed Exotic year_factor5        -2.24766 0.5296
##  warmed  year_factor1 - ambient Exotic year_factor5       -2.17333 0.5329
##  warmed  year_factor1 - warmed Native year_factor6        -3.08019 0.5328
##  warmed  year_factor1 - ambient Native year_factor6       -3.00586 0.5363
##  warmed  year_factor1 - warmed  year_factor6              -1.16807 0.1474
##  warmed  year_factor1 - ambient  year_factor6             -1.09375 0.1595
##  warmed  year_factor1 - warmed Both year_factor6          -1.99388 0.5374
##  warmed  year_factor1 - ambient Both year_factor6         -1.91955 0.5402
##  warmed  year_factor1 - warmed Exotic year_factor6        -2.31181 0.5302
##  warmed  year_factor1 - ambient Exotic year_factor6       -2.23748 0.5340
##  warmed  year_factor1 - warmed Native year_factor7        -2.57874 0.5339
##  warmed  year_factor1 - ambient Native year_factor7       -2.50441 0.5375
##  warmed  year_factor1 - warmed  year_factor7              -0.66663 0.1538
##  warmed  year_factor1 - ambient  year_factor7             -0.59230 0.1659
##  warmed  year_factor1 - warmed Both year_factor7          -1.49244 0.5399
##  warmed  year_factor1 - ambient Both year_factor7         -1.41811 0.5428
##  warmed  year_factor1 - warmed Exotic year_factor7        -1.81036 0.5322
##  warmed  year_factor1 - ambient Exotic year_factor7       -1.73603 0.5361
##  ambient  year_factor1 - warmed Both year_factor1         -0.90014 0.5469
##  ambient  year_factor1 - ambient Both year_factor1        -0.82581 0.5427
##  ambient  year_factor1 - warmed Exotic year_factor1       -1.21806 0.5406
##  ambient  year_factor1 - ambient Exotic year_factor1      -1.14374 0.5372
##  ambient  year_factor1 - warmed Native year_factor2       -3.51331 0.5348
##  ambient  year_factor1 - ambient Native year_factor2      -3.43898 0.5306
```

```
##  ambient  year_factor1 - warmed  year_factor2             -1.60119 0.1538
##  ambient  year_factor1 - ambient  year_factor2             -1.52687 0.1385
##  ambient  year_factor1 - warmed Both year_factor2         -2.42700 0.5386
##  ambient  year_factor1 - ambient Both year_factor2         -2.35268 0.5338
##  ambient  year_factor1 - warmed Exotic year_factor2        -2.74493 0.5321
##  ambient  year_factor1 - ambient Exotic year_factor2       -2.67060 0.5281
##  ambient  year_factor1 - warmed Native year_factor3        -3.57052 0.5360
##  ambient  year_factor1 - ambient Native year_factor3       -3.49619 0.5319
##  ambient  year_factor1 - warmed  year_factor3              -1.65841 0.1581
##  ambient  year_factor1 - ambient  year_factor3             -1.58408 0.1430
##  ambient  year_factor1 - warmed Both year_factor3         -2.48422 0.5402
##  ambient  year_factor1 - ambient Both year_factor3         -2.40989 0.5354
##  ambient  year_factor1 - warmed Exotic year_factor3        -2.80214 0.5333
##  ambient  year_factor1 - ambient Exotic year_factor3       -2.72782 0.5293
##  ambient  year_factor1 - warmed Native year_factor4        -3.64721 0.5361
##  ambient  year_factor1 - ambient Native year_factor4       -3.57288 0.5318
##  ambient  year_factor1 - warmed  year_factor4              -1.73510 0.1575
##  ambient  year_factor1 - ambient  year_factor4             -1.66077 0.1420
##  ambient  year_factor1 - warmed Both year_factor4         -2.56091 0.5412
##  ambient  year_factor1 - ambient Both year_factor4         -2.48658 0.5363
##  ambient  year_factor1 - warmed Exotic year_factor4        -2.87883 0.5327
##  ambient  year_factor1 - ambient Exotic year_factor4       -2.80450 0.5286
##  ambient  year_factor1 - warmed Native year_factor5        -3.09036 0.5363
##  ambient  year_factor1 - ambient Native year_factor5       -3.01603 0.5320
##  ambient  year_factor1 - warmed  year_factor5              -1.17825 0.1605
##  ambient  year_factor1 - ambient  year_factor5             -1.10392 0.1449
##  ambient  year_factor1 - warmed Both year_factor5         -2.00406 0.5420
##  ambient  year_factor1 - ambient Both year_factor5         -1.92973 0.5369
##  ambient  year_factor1 - warmed Exotic year_factor5        -2.32199 0.5338
##  ambient  year_factor1 - ambient Exotic year_factor5       -2.24766 0.5296
##  ambient  year_factor1 - warmed Native year_factor6        -3.15452 0.5366
##  ambient  year_factor1 - ambient Native year_factor6       -3.08019 0.5328
##  ambient  year_factor1 - warmed  year_factor6              -1.24240 0.1609
##  ambient  year_factor1 - ambient  year_factor6             -1.16807 0.1474
##  ambient  year_factor1 - warmed Both year_factor6         -2.06821 0.5419
##  ambient  year_factor1 - ambient Both year_factor6         -1.99388 0.5374
##  ambient  year_factor1 - warmed Exotic year_factor6        -2.38614 0.5339
##  ambient  year_factor1 - ambient Exotic year_factor6       -2.31181 0.5302
##  ambient  year_factor1 - warmed Native year_factor7        -2.65307 0.5376
##  ambient  year_factor1 - ambient Native year_factor7       -2.57874 0.5339
##  ambient  year_factor1 - warmed  year_factor7              -0.74096 0.1665
##  ambient  year_factor1 - ambient  year_factor7             -0.66663 0.1538
##  ambient  year_factor1 - warmed Both year_factor7         -1.56677 0.5442
##  ambient  year_factor1 - ambient Both year_factor7         -1.49244 0.5399
##  ambient  year_factor1 - warmed Exotic year_factor7        -1.88469 0.5358
##  ambient  year_factor1 - ambient Exotic year_factor7       -1.81036 0.5322
##  warmed Both year_factor1 - ambient Both year_factor1       0.07433 0.0629
##  warmed Both year_factor1 - warmed Exotic year_factor1     -0.31793 0.1006
##  warmed Both year_factor1 - ambient Exotic year_factor1    -0.24360 0.1227
##  warmed Both year_factor1 - warmed Native year_factor2     -2.61317 0.1770
##  warmed Both year_factor1 - ambient Native year_factor2    -2.53884 0.1885
##  warmed Both year_factor1 - warmed  year_factor2           -0.70106 0.5852
##  warmed Both year_factor1 - ambient  year_factor2          -0.62673 0.5887
##  warmed Both year_factor1 - warmed Both year_factor2       -1.52687 0.1385
```

```
##  warmed Both year_factor1 - ambient Both year_factor2      -1.45254 0.1504
##  warmed Both year_factor1 - warmed Exotic year_factor2     -1.84479 0.1708
##  warmed Both year_factor1 - ambient Exotic year_factor2    -1.77046 0.1833
##  warmed Both year_factor1 - warmed Native year_factor3     -2.67038 0.1796
##  warmed Both year_factor1 - ambient Native year_factor3    -2.59605 0.1908
##  warmed Both year_factor1 - warmed  year_factor3           -0.75827 0.5859
##  warmed Both year_factor1 - ambient  year_factor3          -0.68394 0.5894
##  warmed Both year_factor1 - warmed Both year_factor3       -1.58408 0.1430
##  warmed Both year_factor1 - ambient Both year_factor3      -1.50975 0.1544
##  warmed Both year_factor1 - warmed Exotic year_factor3     -1.90201 0.1733
##  warmed Both year_factor1 - ambient Exotic year_factor3    -1.82768 0.1855
##  warmed Both year_factor1 - warmed Native year_factor4     -2.74707 0.1759
##  warmed Both year_factor1 - ambient Native year_factor4    -2.67274 0.1870
##  warmed Both year_factor1 - warmed  year_factor4           -0.83496 0.5846
##  warmed Both year_factor1 - ambient  year_factor4          -0.76063 0.5880
##  warmed Both year_factor1 - warmed Both year_factor4       -1.66077 0.1420
##  warmed Both year_factor1 - ambient Both year_factor4      -1.58644 0.1531
##  warmed Both year_factor1 - warmed Exotic year_factor4     -1.97869 0.1675
##  warmed Both year_factor1 - ambient Exotic year_factor4    -1.90437 0.1797
##  warmed Both year_factor1 - warmed Native year_factor5     -2.19022 0.1767
##  warmed Both year_factor1 - ambient Native year_factor5    -2.11590 0.1875
##  warmed Both year_factor1 - warmed  year_factor5           -0.27811 0.5854
##  warmed Both year_factor1 - ambient  year_factor5          -0.20378 0.5887
##  warmed Both year_factor1 - warmed Both year_factor5       -1.10392 0.1449
##  warmed Both year_factor1 - ambient Both year_factor5      -1.02959 0.1554
##  warmed Both year_factor1 - warmed Exotic year_factor5     -1.42185 0.1709
##  warmed Both year_factor1 - ambient Exotic year_factor5    -1.34752 0.1826
##  warmed Both year_factor1 - warmed Native year_factor6     -2.25438 0.1799
##  warmed Both year_factor1 - ambient Native year_factor6    -2.18005 0.1919
##  warmed Both year_factor1 - warmed  year_factor6           -0.34226 0.5863
##  warmed Both year_factor1 - ambient  year_factor6          -0.26794 0.5900
##  warmed Both year_factor1 - warmed Both year_factor6       -1.16807 0.1474
##  warmed Both year_factor1 - ambient Both year_factor6      -1.09375 0.1595
##  warmed Both year_factor1 - warmed Exotic year_factor6     -1.48600 0.1736
##  warmed Both year_factor1 - ambient Exotic year_factor6    -1.41167 0.1867
##  warmed Both year_factor1 - warmed Native year_factor7     -1.75293 0.1811
##  warmed Both year_factor1 - ambient Native year_factor7    -1.67860 0.1934
##  warmed Both year_factor1 - warmed  year_factor7            0.15918 0.5873
##  warmed Both year_factor1 - ambient  year_factor7           0.23351 0.5911
##  warmed Both year_factor1 - warmed Both year_factor7       -0.66663 0.1538
##  warmed Both year_factor1 - ambient Both year_factor7      -0.59230 0.1659
##  warmed Both year_factor1 - warmed Exotic year_factor7     -0.98455 0.1775
##  warmed Both year_factor1 - ambient Exotic year_factor7    -0.91023 0.1906
##  ambient Both year_factor1 - warmed Exotic year_factor1    -0.39226 0.1145
##  ambient Both year_factor1 - ambient Exotic year_factor1   -0.31793 0.1006
##  ambient Both year_factor1 - warmed Native year_factor2    -2.68750 0.1872
##  ambient Both year_factor1 - ambient Native year_factor2   -2.61317 0.1770
##  ambient Both year_factor1 - warmed  year_factor2          -0.77539 0.5884
##  ambient Both year_factor1 - ambient  year_factor2         -0.70106 0.5852
##  ambient Both year_factor1 - warmed Both year_factor2      -1.60119 0.1538
##  ambient Both year_factor1 - ambient Both year_factor2     -1.52687 0.1385
##  ambient Both year_factor1 - warmed Exotic year_factor2    -1.91912 0.1807
##  ambient Both year_factor1 - ambient Exotic year_factor2   -1.84479 0.1708
##  ambient Both year_factor1 - warmed Native year_factor3    -2.74471 0.1899
```

```
##  ambient Both year_factor1 - ambient Native year_factor3   -2.67038 0.1796
##  ambient Both year_factor1 - warmed  year_factor3          -0.83260 0.5892
##  ambient Both year_factor1 - ambient  year_factor3         -0.75827 0.5859
##  ambient Both year_factor1 - warmed Both year_factor3      -1.65841 0.1581
##  ambient Both year_factor1 - ambient Both year_factor3     -1.58408 0.1430
##  ambient Both year_factor1 - warmed Exotic year_factor3    -1.97634 0.1833
##  ambient Both year_factor1 - ambient Exotic year_factor3   -1.90201 0.1733
##  ambient Both year_factor1 - warmed Native year_factor4    -2.82140 0.1866
##  ambient Both year_factor1 - ambient Native year_factor4   -2.74707 0.1759
##  ambient Both year_factor1 - warmed  year_factor4          -0.90929 0.5880
##  ambient Both year_factor1 - ambient  year_factor4         -0.83496 0.5846
##  ambient Both year_factor1 - warmed Both year_factor4      -1.73510 0.1575
##  ambient Both year_factor1 - ambient Both year_factor4     -1.66077 0.1420
##  ambient Both year_factor1 - warmed Exotic year_factor4    -2.05302 0.1781
##  ambient Both year_factor1 - ambient Exotic year_factor4   -1.97869 0.1675
##  ambient Both year_factor1 - warmed Native year_factor5    -2.26455 0.1877
##  ambient Both year_factor1 - ambient Native year_factor5   -2.19022 0.1767
##  ambient Both year_factor1 - warmed  year_factor5          -0.35244 0.5889
##  ambient Both year_factor1 - ambient  year_factor5         -0.27811 0.5854
##  ambient Both year_factor1 - warmed Both year_factor5      -1.17825 0.1605
##  ambient Both year_factor1 - ambient Both year_factor5     -1.10392 0.1449
##  ambient Both year_factor1 - warmed Exotic year_factor5    -1.49618 0.1817
##  ambient Both year_factor1 - ambient Exotic year_factor5   -1.42185 0.1709
##  ambient Both year_factor1 - warmed Native year_factor6    -2.32871 0.1892
##  ambient Both year_factor1 - ambient Native year_factor6   -2.25438 0.1799
##  ambient Both year_factor1 - warmed  year_factor6          -0.41659 0.5892
##  ambient Both year_factor1 - ambient  year_factor6         -0.34226 0.5863
##  ambient Both year_factor1 - warmed Both year_factor6      -1.24240 0.1609
##  ambient Both year_factor1 - ambient Both year_factor6     -1.16807 0.1474
##  ambient Both year_factor1 - warmed Exotic year_factor6    -1.56033 0.1826
##  ambient Both year_factor1 - ambient Exotic year_factor6   -1.48600 0.1736
##  ambient Both year_factor1 - warmed Native year_factor7    -1.82726 0.1900
##  ambient Both year_factor1 - ambient Native year_factor7   -1.75293 0.1811
##  ambient Both year_factor1 - warmed  year_factor7           0.08485 0.5902
##  ambient Both year_factor1 - ambient  year_factor7          0.15918 0.5873
##  ambient Both year_factor1 - warmed Both year_factor7      -0.74096 0.1665
##  ambient Both year_factor1 - ambient Both year_factor7     -0.66663 0.1538
##  ambient Both year_factor1 - warmed Exotic year_factor7    -1.05888 0.1860
##  ambient Both year_factor1 - ambient Exotic year_factor7   -0.98455 0.1775
##  warmed Exotic year_factor1 - ambient Exotic year_factor1   0.07433 0.0629
##  warmed Exotic year_factor1 - warmed Native year_factor2   -2.29524 0.1562
##  warmed Exotic year_factor1 - ambient Native year_factor2  -2.22091 0.1662
##  warmed Exotic year_factor1 - warmed  year_factor2         -0.38313 0.5802
##  warmed Exotic year_factor1 - ambient  year_factor2        -0.30880 0.5829
##  warmed Exotic year_factor1 - warmed Both year_factor2     -1.20894 0.1716
##  warmed Exotic year_factor1 - ambient Both year_factor2    -1.13461 0.1787
##  warmed Exotic year_factor1 - warmed Exotic year_factor2   -1.52687 0.1385
##  warmed Exotic year_factor1 - ambient Exotic year_factor2  -1.45254 0.1504
##  warmed Exotic year_factor1 - warmed Native year_factor3   -2.35246 0.1604
##  warmed Exotic year_factor1 - ambient Native year_factor3  -2.27813 0.1700
##  warmed Exotic year_factor1 - warmed  year_factor3         -0.44034 0.5814
##  warmed Exotic year_factor1 - ambient  year_factor3        -0.36601 0.5840
##  warmed Exotic year_factor1 - warmed Both year_factor3     -1.26615 0.1764
##  warmed Exotic year_factor1 - ambient Both year_factor3    -1.19182 0.1831
```

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##  warmed Exotic year_factor1 - warmed Exotic year_factor3   -1.58408 0.1430
##  warmed Exotic year_factor1 - ambient Exotic year_factor3  -1.50975 0.1544
##  warmed Exotic year_factor1 - warmed Native year_factor4   -2.42914 0.1615
##  warmed Exotic year_factor1 - ambient Native year_factor4  -2.35481 0.1707
##  warmed Exotic year_factor1 - warmed  year_factor4         -0.51703 0.5815
##  warmed Exotic year_factor1 - ambient  year_factor4        -0.44270 0.5840
##  warmed Exotic year_factor1 - warmed Both year_factor4     -1.34284 0.1804
##  warmed Exotic year_factor1 - ambient Both year_factor4    -1.26851 0.1866
##  warmed Exotic year_factor1 - warmed Exotic year_factor4   -1.66077 0.1420
##  warmed Exotic year_factor1 - ambient Exotic year_factor4  -1.58644 0.1531
##  warmed Exotic year_factor1 - warmed Native year_factor5   -1.87230 0.1614
##  warmed Exotic year_factor1 - ambient Native year_factor5  -1.79797 0.1702
##  warmed Exotic year_factor1 - warmed  year_factor5          0.03982 0.5820
##  warmed Exotic year_factor1 - ambient  year_factor5         0.11414 0.5844
##  warmed Exotic year_factor1 - warmed Both year_factor5     -0.78599 0.1817
##  warmed Exotic year_factor1 - ambient Both year_factor5    -0.71166 0.1876
##  warmed Exotic year_factor1 - warmed Exotic year_factor5   -1.10392 0.1449
##  warmed Exotic year_factor1 - ambient Exotic year_factor5  -1.02959 0.1554
##  warmed Exotic year_factor1 - warmed Native year_factor6   -1.93645 0.1642
##  warmed Exotic year_factor1 - ambient Native year_factor6  -1.86212 0.1746
##  warmed Exotic year_factor1 - warmed  year_factor6         -0.02434 0.5827
##  warmed Exotic year_factor1 - ambient  year_factor6         0.04999 0.5856
##  warmed Exotic year_factor1 - warmed Both year_factor6     -0.85015 0.1831
##  warmed Exotic year_factor1 - ambient Both year_factor6    -0.77582 0.1905
##  warmed Exotic year_factor1 - warmed Exotic year_factor6   -1.16807 0.1474
##  warmed Exotic year_factor1 - ambient Exotic year_factor6  -1.09375 0.1595
##  warmed Exotic year_factor1 - warmed Native year_factor7   -1.43500 0.1673
##  warmed Exotic year_factor1 - ambient Native year_factor7  -1.36068 0.1778
##  warmed Exotic year_factor1 - warmed  year_factor7          0.47711 0.5842
##  warmed Exotic year_factor1 - ambient  year_factor7         0.55144 0.5872
##  warmed Exotic year_factor1 - warmed Both year_factor7     -0.34870 0.1899
##  warmed Exotic year_factor1 - ambient Both year_factor7    -0.27437 0.1973
##  warmed Exotic year_factor1 - warmed Exotic year_factor7   -0.66663 0.1538
##  warmed Exotic year_factor1 - ambient Exotic year_factor7  -0.59230 0.1659
##  ambient Exotic year_factor1 - warmed Native year_factor2  -2.36957 0.1706
##  ambient Exotic year_factor1 - ambient Native year_factor2 -2.29524 0.1562
##  ambient Exotic year_factor1 - warmed  year_factor2        -0.45746 0.5843
##  ambient Exotic year_factor1 - ambient  year_factor2       -0.38313 0.5802
##  ambient Exotic year_factor1 - warmed Both year_factor2    -1.28327 0.1868
##  ambient Exotic year_factor1 - ambient Both year_factor2   -1.20894 0.1716
##  ambient Exotic year_factor1 - warmed Exotic year_factor2  -1.60119 0.1538
##  ambient Exotic year_factor1 - ambient Exotic year_factor2 -1.52687 0.1385
##  ambient Exotic year_factor1 - warmed Native year_factor3  -2.42679 0.1746
##  ambient Exotic year_factor1 - ambient Native year_factor3 -2.35246 0.1604
##  ambient Exotic year_factor1 - warmed  year_factor3        -0.51467 0.5855
##  ambient Exotic year_factor1 - ambient  year_factor3       -0.44034 0.5814
##  ambient Exotic year_factor1 - warmed Both year_factor3    -1.34048 0.1914
##  ambient Exotic year_factor1 - ambient Both year_factor3   -1.26615 0.1764
##  ambient Exotic year_factor1 - warmed Exotic year_factor3  -1.65841 0.1581
##  ambient Exotic year_factor1 - ambient Exotic year_factor3 -1.58408 0.1430
##  ambient Exotic year_factor1 - warmed Native year_factor4  -2.50347 0.1760
##  ambient Exotic year_factor1 - ambient Native year_factor4 -2.42914 0.1615
##  ambient Exotic year_factor1 - warmed  year_factor4        -0.59136 0.5857
##  ambient Exotic year_factor1 - ambient  year_factor4       -0.51703 0.5815
```

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##  ambient Exotic year_factor1 - warmed Both year_factor4    -1.41717 0.1953
##  ambient Exotic year_factor1 - ambient Both year_factor4   -1.34284 0.1804
##  ambient Exotic year_factor1 - warmed Exotic year_factor4  -1.73510 0.1575
##  ambient Exotic year_factor1 - ambient Exotic year_factor4 -1.66077 0.1420
##  ambient Exotic year_factor1 - warmed Native year_factor5  -1.94663 0.1762
##  ambient Exotic year_factor1 - ambient Native year_factor5 -1.87230 0.1614
##  ambient Exotic year_factor1 - warmed  year_factor5        -0.03451 0.5863
##  ambient Exotic year_factor1 - ambient  year_factor5        0.03982 0.5820
##  ambient Exotic year_factor1 - warmed Both year_factor5    -0.86032 0.1969
##  ambient Exotic year_factor1 - ambient Both year_factor5   -0.78599 0.1817
##  ambient Exotic year_factor1 - warmed Exotic year_factor5  -1.17825 0.1605
##  ambient Exotic year_factor1 - ambient Exotic year_factor5 -1.10392 0.1449
##  ambient Exotic year_factor1 - warmed Native year_factor6  -2.01078 0.1771
##  ambient Exotic year_factor1 - ambient Native year_factor6 -1.93645 0.1642
##  ambient Exotic year_factor1 - warmed  year_factor6        -0.09867 0.5865
##  ambient Exotic year_factor1 - ambient  year_factor6       -0.02434 0.5827
##  ambient Exotic year_factor1 - warmed Both year_factor6    -0.92448 0.1967
##  ambient Exotic year_factor1 - ambient Both year_factor6   -0.85015 0.1831
##  ambient Exotic year_factor1 - warmed Exotic year_factor6  -1.24240 0.1609
##  ambient Exotic year_factor1 - ambient Exotic year_factor6 -1.16807 0.1474
##  ambient Exotic year_factor1 - warmed Native year_factor7  -1.50933 0.1797
##  ambient Exotic year_factor1 - ambient Native year_factor7 -1.43500 0.1673
##  ambient Exotic year_factor1 - warmed  year_factor7         0.40278 0.5879
##  ambient Exotic year_factor1 - ambient  year_factor7        0.47711 0.5842
##  ambient Exotic year_factor1 - warmed Both year_factor7    -0.42303 0.2028
##  ambient Exotic year_factor1 - ambient Both year_factor7   -0.34870 0.1899
##  ambient Exotic year_factor1 - warmed Exotic year_factor7  -0.74096 0.1665
##  ambient Exotic year_factor1 - ambient Exotic year_factor7 -0.66663 0.1538
##  warmed Native year_factor2 - ambient Native year_factor2   0.07433 0.0629
##  warmed Native year_factor2 - warmed  year_factor2          1.91211 0.5401
##  warmed Native year_factor2 - ambient  year_factor2         1.98644 0.5437
##  warmed Native year_factor2 - warmed Both year_factor2      1.08630 0.1129
##  warmed Native year_factor2 - ambient Both year_factor2     1.16063 0.1263
##  warmed Native year_factor2 - warmed Exotic year_factor2    0.76838 0.0752
##  warmed Native year_factor2 - ambient Exotic year_factor2   0.84271 0.0993
##  warmed Native year_factor2 - warmed Native year_factor3   -0.05721 0.1039
##  warmed Native year_factor2 - ambient Native year_factor3   0.01712 0.1212
##  warmed Native year_factor2 - warmed  year_factor3          1.85490 0.5500
##  warmed Native year_factor2 - ambient  year_factor3         1.92923 0.5534
##  warmed Native year_factor2 - warmed Both year_factor3      1.02909 0.1546
##  warmed Native year_factor2 - ambient Both year_factor3     1.10342 0.1644
##  warmed Native year_factor2 - warmed Exotic year_factor3    0.71116 0.1281
##  warmed Native year_factor2 - ambient Exotic year_factor3   0.78549 0.1433
##  warmed Native year_factor2 - warmed Native year_factor4   -0.13390 0.1025
##  warmed Native year_factor2 - ambient Native year_factor4  -0.05957 0.1195
##  warmed Native year_factor2 - warmed  year_factor4          1.77821 0.5495
##  warmed Native year_factor2 - ambient  year_factor4         1.85254 0.5529
##  warmed Native year_factor2 - warmed Both year_factor4      0.95240 0.1570
##  warmed Native year_factor2 - ambient Both year_factor4     1.02673 0.1663
##  warmed Native year_factor2 - warmed Exotic year_factor4    0.63448 0.1243
##  warmed Native year_factor2 - ambient Exotic year_factor4   0.70881 0.1395
##  warmed Native year_factor2 - warmed Native year_factor5    0.42295 0.1064
##  warmed Native year_factor2 - ambient Native year_factor5   0.49727 0.1224
##  warmed Native year_factor2 - warmed  year_factor5          2.33506 0.5508
```

```
##  warmed Native year_factor2 - ambient  year_factor5         2.40939 0.5541
##  warmed Native year_factor2 - warmed Both year_factor5      1.50925 0.1612
##  warmed Native year_factor2 - ambient Both year_factor5     1.58358 0.1700
##  warmed Native year_factor2 - warmed Exotic year_factor5    1.19132 0.1309
##  warmed Native year_factor2 - ambient Exotic year_factor5   1.26565 0.1450
##  warmed Native year_factor2 - warmed Native year_factor6    0.35879 0.1099
##  warmed Native year_factor2 - ambient Native year_factor6   0.43312 0.1278
##  warmed Native year_factor2 - warmed  year_factor6          2.27090 0.5514
##  warmed Native year_factor2 - ambient  year_factor6         2.34523 0.5552
##  warmed Native year_factor2 - warmed Both year_factor6      1.44510 0.1623
##  warmed Native year_factor2 - ambient Both year_factor6     1.51942 0.1727
##  warmed Native year_factor2 - warmed Exotic year_factor6    1.12717 0.1331
##  warmed Native year_factor2 - ambient Exotic year_factor6   1.20150 0.1489
##  warmed Native year_factor2 - warmed Native year_factor7    0.86024 0.1183
##  warmed Native year_factor2 - ambient Native year_factor7   0.93457 0.1355
##  warmed Native year_factor2 - warmed  year_factor7          2.77235 0.5538
##  warmed Native year_factor2 - ambient  year_factor7         2.84668 0.5577
##  warmed Native year_factor2 - warmed Both year_factor7      1.94654 0.1726
##  warmed Native year_factor2 - ambient Both year_factor7     2.02087 0.1827
##  warmed Native year_factor2 - warmed Exotic year_factor7    1.62861 0.1434
##  warmed Native year_factor2 - ambient Exotic year_factor7   1.70294 0.1586
##  ambient Native year_factor2 - warmed  year_factor2         1.83778 0.5438
##  ambient Native year_factor2 - ambient  year_factor2        1.91211 0.5401
##  ambient Native year_factor2 - warmed Both year_factor2     1.01197 0.1321
##  ambient Native year_factor2 - ambient Both year_factor2    1.08630 0.1129
##  ambient Native year_factor2 - warmed Exotic year_factor2   0.69405 0.0969
##  ambient Native year_factor2 - ambient Exotic year_factor2  0.76838 0.0752
##  ambient Native year_factor2 - warmed Native year_factor3  -0.13154 0.1218
##  ambient Native year_factor2 - ambient Native year_factor3 -0.05721 0.1039
##  ambient Native year_factor2 - warmed  year_factor3         1.78057 0.5537
##  ambient Native year_factor2 - ambient  year_factor3        1.85490 0.5500
##  ambient Native year_factor2 - warmed Both year_factor3     0.95476 0.1693
##  ambient Native year_factor2 - ambient Both year_factor3    1.02909 0.1546
##  ambient Native year_factor2 - warmed Exotic year_factor3   0.63683 0.1421
##  ambient Native year_factor2 - ambient Exotic year_factor3  0.71116 0.1281
##  ambient Native year_factor2 - warmed Native year_factor4  -0.20823 0.1210
##  ambient Native year_factor2 - ambient Native year_factor4 -0.13390 0.1025
##  ambient Native year_factor2 - warmed  year_factor4         1.70388 0.5533
##  ambient Native year_factor2 - ambient  year_factor4        1.77821 0.5495
##  ambient Native year_factor2 - warmed Both year_factor4     0.87807 0.1718
##  ambient Native year_factor2 - ambient Both year_factor4    0.95240 0.1570
##  ambient Native year_factor2 - warmed Exotic year_factor4   0.56015 0.1392
##  ambient Native year_factor2 - ambient Exotic year_factor4  0.63448 0.1243
##  ambient Native year_factor2 - warmed Native year_factor5   0.34862 0.1248
##  ambient Native year_factor2 - ambient Native year_factor5  0.42295 0.1064
##  ambient Native year_factor2 - warmed  year_factor5         2.26073 0.5548
##  ambient Native year_factor2 - ambient  year_factor5        2.33506 0.5508
##  ambient Native year_factor2 - warmed Both year_factor5     1.43492 0.1761
##  ambient Native year_factor2 - ambient Both year_factor5    1.50925 0.1612
##  ambient Native year_factor2 - warmed Exotic year_factor5   1.11699 0.1455
##  ambient Native year_factor2 - ambient Exotic year_factor5  1.19132 0.1309
##  ambient Native year_factor2 - warmed Native year_factor6   0.28446 0.1255
##  ambient Native year_factor2 - ambient Native year_factor6  0.35879 0.1099
##  ambient Native year_factor2 - warmed  year_factor6         2.19658 0.5548
```

```
##  ambient Native year_factor2 - ambient  year_factor6        2.27090 0.5514
##  ambient Native year_factor2 - warmed Both year_factor6     1.37077 0.1754
##  ambient Native year_factor2 - ambient Both year_factor6    1.44510 0.1623
##  ambient Native year_factor2 - warmed Exotic year_factor6   1.05284 0.1454
##  ambient Native year_factor2 - ambient Exotic year_factor6  1.12717 0.1331
##  ambient Native year_factor2 - warmed Native year_factor7   0.78591 0.1326
##  ambient Native year_factor2 - ambient Native year_factor7  0.86024 0.1183
##  ambient Native year_factor2 - warmed  year_factor7         2.69802 0.5571
##  ambient Native year_factor2 - ambient  year_factor7        2.77235 0.5538
##  ambient Native year_factor2 - warmed Both year_factor7     1.87221 0.1847
##  ambient Native year_factor2 - ambient Both year_factor7    1.94654 0.1726
##  ambient Native year_factor2 - warmed Exotic year_factor7   1.55429 0.1546
##  ambient Native year_factor2 - ambient Exotic year_factor7  1.62861 0.1434
##  warmed  year_factor2 - ambient  year_factor2               0.07433 0.0629
##  warmed  year_factor2 - warmed Both year_factor2           -0.82581 0.5427
##  warmed  year_factor2 - ambient Both year_factor2          -0.75148 0.5457
##  warmed  year_factor2 - warmed Exotic year_factor2         -1.14374 0.5372
##  warmed  year_factor2 - ambient Exotic year_factor2        -1.06941 0.5412
##  warmed  year_factor2 - warmed Native year_factor3         -1.96933 0.5500
##  warmed  year_factor2 - ambient Native year_factor3        -1.89500 0.5536
##  warmed  year_factor2 - warmed  year_factor3               -0.05721 0.1039
##  warmed  year_factor2 - ambient  year_factor3               0.01712 0.1212
##  warmed  year_factor2 - warmed Both year_factor3           -0.88302 0.5529
##  warmed  year_factor2 - ambient Both year_factor3          -0.80869 0.5558
##  warmed  year_factor2 - warmed Exotic year_factor3         -1.20095 0.5472
##  warmed  year_factor2 - ambient Exotic year_factor3        -1.12662 0.5510
##  warmed  year_factor2 - warmed Native year_factor4         -2.04601 0.5499
##  warmed  year_factor2 - ambient Native year_factor4        -1.97168 0.5534
##  warmed  year_factor2 - warmed  year_factor4               -0.13390 0.1025
##  warmed  year_factor2 - ambient  year_factor4              -0.05957 0.1195
##  warmed  year_factor2 - warmed Both year_factor4           -0.95971 0.5537
##  warmed  year_factor2 - ambient Both year_factor4          -0.88538 0.5565
##  warmed  year_factor2 - warmed Exotic year_factor4         -1.27764 0.5465
##  warmed  year_factor2 - ambient Exotic year_factor4        -1.20331 0.5502
##  warmed  year_factor2 - warmed Native year_factor5         -1.48917 0.5501
##  warmed  year_factor2 - ambient Native year_factor5        -1.41484 0.5535
##  warmed  year_factor2 - warmed  year_factor5                0.42295 0.1064
##  warmed  year_factor2 - ambient  year_factor5               0.49727 0.1224
##  warmed  year_factor2 - warmed Both year_factor5           -0.40286 0.5544
##  warmed  year_factor2 - ambient Both year_factor5          -0.32854 0.5571
##  warmed  year_factor2 - warmed Exotic year_factor5         -0.72079 0.5474
##  warmed  year_factor2 - ambient Exotic year_factor5        -0.64646 0.5511
##  warmed  year_factor2 - warmed Native year_factor6         -1.55332 0.5509
##  warmed  year_factor2 - ambient Native year_factor6        -1.47899 0.5548
##  warmed  year_factor2 - warmed  year_factor6                0.35879 0.1099
##  warmed  year_factor2 - ambient  year_factor6               0.43312 0.1278
##  warmed  year_factor2 - warmed Both year_factor6           -0.46702 0.5548
##  warmed  year_factor2 - ambient Both year_factor6          -0.39269 0.5580
##  warmed  year_factor2 - warmed Exotic year_factor6         -0.78495 0.5481
##  warmed  year_factor2 - ambient Exotic year_factor6        -0.71062 0.5522
##  warmed  year_factor2 - warmed Native year_factor7         -1.05187 0.5520
##  warmed  year_factor2 - ambient Native year_factor7        -0.97754 0.5560
##  warmed  year_factor2 - warmed  year_factor7                0.86024 0.1183
##  warmed  year_factor2 - ambient  year_factor7               0.93457 0.1355
```

```
##  warmed  year_factor2 - warmed Both year_factor7           0.03443 0.5572
##  warmed  year_factor2 - ambient Both year_factor7           0.10876 0.5605
##  warmed  year_factor2 - warmed Exotic year_factor7         -0.28350 0.5500
##  warmed  year_factor2 - ambient Exotic year_factor7        -0.20917 0.5542
##  ambient  year_factor2 - warmed Both year_factor2          -0.90014 0.5469
##  ambient  year_factor2 - ambient Both year_factor2         -0.82581 0.5427
##  ambient  year_factor2 - warmed Exotic year_factor2        -1.21806 0.5406
##  ambient  year_factor2 - ambient Exotic year_factor2       -1.14374 0.5372
##  ambient  year_factor2 - warmed Native year_factor3        -2.04366 0.5536
##  ambient  year_factor2 - ambient Native year_factor3       -1.96933 0.5500
##  ambient  year_factor2 - warmed  year_factor3              -0.13154 0.1218
##  ambient  year_factor2 - ambient  year_factor3             -0.05721 0.1039
##  ambient  year_factor2 - warmed Both year_factor3          -0.95735 0.5571
##  ambient  year_factor2 - ambient Both year_factor3         -0.88302 0.5529
##  ambient  year_factor2 - warmed Exotic year_factor3        -1.27528 0.5505
##  ambient  year_factor2 - ambient Exotic year_factor3       -1.20095 0.5472
##  ambient  year_factor2 - warmed Native year_factor4        -2.12034 0.5536
##  ambient  year_factor2 - ambient Native year_factor4       -2.04601 0.5499
##  ambient  year_factor2 - warmed  year_factor4              -0.20823 0.1210
##  ambient  year_factor2 - ambient  year_factor4             -0.13390 0.1025
##  ambient  year_factor2 - warmed Both year_factor4          -1.03404 0.5581
##  ambient  year_factor2 - ambient Both year_factor4         -0.95971 0.5537
##  ambient  year_factor2 - warmed Exotic year_factor4        -1.35197 0.5500
##  ambient  year_factor2 - ambient Exotic year_factor4       -1.27764 0.5465
##  ambient  year_factor2 - warmed Native year_factor5        -1.56350 0.5539
##  ambient  year_factor2 - ambient Native year_factor5       -1.48917 0.5501
##  ambient  year_factor2 - warmed  year_factor5               0.34862 0.1248
##  ambient  year_factor2 - ambient  year_factor5              0.42295 0.1064
##  ambient  year_factor2 - warmed Both year_factor5          -0.47719 0.5588
##  ambient  year_factor2 - ambient Both year_factor5         -0.40286 0.5544
##  ambient  year_factor2 - warmed Exotic year_factor5        -0.79512 0.5510
##  ambient  year_factor2 - ambient Exotic year_factor5       -0.72079 0.5474
##  ambient  year_factor2 - warmed Native year_factor6        -1.62765 0.5542
##  ambient  year_factor2 - ambient Native year_factor6       -1.55332 0.5509
##  ambient  year_factor2 - warmed  year_factor6               0.28446 0.1255
##  ambient  year_factor2 - ambient  year_factor6              0.35879 0.1099
##  ambient  year_factor2 - warmed Both year_factor6          -0.54135 0.5587
##  ambient  year_factor2 - ambient Both year_factor6         -0.46702 0.5548
##  ambient  year_factor2 - warmed Exotic year_factor6        -0.85927 0.5511
##  ambient  year_factor2 - ambient Exotic year_factor6       -0.78495 0.5481
##  ambient  year_factor2 - warmed Native year_factor7        -1.12620 0.5551
##  ambient  year_factor2 - ambient Native year_factor7       -1.05187 0.5520
##  ambient  year_factor2 - warmed  year_factor7               0.78591 0.1326
##  ambient  year_factor2 - ambient  year_factor7              0.86024 0.1183
##  ambient  year_factor2 - warmed Both year_factor7          -0.03990 0.5610
##  ambient  year_factor2 - ambient Both year_factor7           0.03443 0.5572
##  ambient  year_factor2 - warmed Exotic year_factor7        -0.35783 0.5529
##  ambient  year_factor2 - ambient Exotic year_factor7       -0.28350 0.5500
##  warmed Both year_factor2 - ambient Both year_factor2       0.07433 0.0629
##  warmed Both year_factor2 - warmed Exotic year_factor2     -0.31793 0.1006
##  warmed Both year_factor2 - ambient Exotic year_factor2    -0.24360 0.1227
##  warmed Both year_factor2 - warmed Native year_factor3     -1.14352 0.1523
##  warmed Both year_factor2 - ambient Native year_factor3    -1.06919 0.1669
##  warmed Both year_factor2 - warmed  year_factor3            0.76860 0.5522
```

```
##  warmed Both year_factor2 - ambient  year_factor3          0.84293 0.5563
##  warmed Both year_factor2 - warmed Both year_factor3      -0.05721 0.1039
##  warmed Both year_factor2 - ambient Both year_factor3      0.01712 0.1212
##  warmed Both year_factor2 - warmed Exotic year_factor3    -0.37514 0.1433
##  warmed Both year_factor2 - ambient Exotic year_factor3   -0.30081 0.1594
##  warmed Both year_factor2 - warmed Native year_factor4    -1.22020 0.1479
##  warmed Both year_factor2 - ambient Native year_factor4   -1.14587 0.1625
##  warmed Both year_factor2 - warmed  year_factor4           0.69191 0.5508
##  warmed Both year_factor2 - ambient  year_factor4          0.76624 0.5548
##  warmed Both year_factor2 - warmed Both year_factor4      -0.13390 0.1025
##  warmed Both year_factor2 - ambient Both year_factor4     -0.05957 0.1195
##  warmed Both year_factor2 - warmed Exotic year_factor4    -0.45183 0.1362
##  warmed Both year_factor2 - ambient Exotic year_factor4   -0.37750 0.1526
##  warmed Both year_factor2 - warmed Native year_factor5    -0.66336 0.1488
##  warmed Both year_factor2 - ambient Native year_factor5   -0.58903 0.1630
##  warmed Both year_factor2 - warmed  year_factor5           1.24876 0.5516
##  warmed Both year_factor2 - ambient  year_factor5          1.32308 0.5556
##  warmed Both year_factor2 - warmed Both year_factor5       0.42295 0.1064
##  warmed Both year_factor2 - ambient Both year_factor5      0.49727 0.1224
##  warmed Both year_factor2 - warmed Exotic year_factor5     0.10502 0.1403
##  warmed Both year_factor2 - ambient Exotic year_factor5    0.17935 0.1560
##  warmed Both year_factor2 - warmed Native year_factor6    -0.72751 0.1527
##  warmed Both year_factor2 - ambient Native year_factor6   -0.65318 0.1682
##  warmed Both year_factor2 - warmed  year_factor6           1.18460 0.5526
##  warmed Both year_factor2 - ambient  year_factor6          1.25893 0.5570
##  warmed Both year_factor2 - warmed Both year_factor6       0.35879 0.1099
##  warmed Both year_factor2 - ambient Both year_factor6      0.43312 0.1278
##  warmed Both year_factor2 - warmed Exotic year_factor6     0.04086 0.1437
##  warmed Both year_factor2 - ambient Exotic year_factor6    0.11519 0.1609
##  warmed Both year_factor2 - warmed Native year_factor7    -0.22606 0.1540
##  warmed Both year_factor2 - ambient Native year_factor7   -0.15174 0.1698
##  warmed Both year_factor2 - warmed  year_factor7           1.68605 0.5536
##  warmed Both year_factor2 - ambient  year_factor7          1.76038 0.5582
##  warmed Both year_factor2 - warmed Both year_factor7       0.86024 0.1183
##  warmed Both year_factor2 - ambient Both year_factor7      0.93457 0.1355
##  warmed Both year_factor2 - warmed Exotic year_factor7     0.54231 0.1483
##  warmed Both year_factor2 - ambient Exotic year_factor7    0.61664 0.1653
##  ambient Both year_factor2 - warmed Exotic year_factor2   -0.39226 0.1145
##  ambient Both year_factor2 - ambient Exotic year_factor2  -0.31793 0.1006
##  ambient Both year_factor2 - warmed Native year_factor3   -1.21785 0.1627
##  ambient Both year_factor2 - ambient Native year_factor3  -1.14352 0.1523
##  ambient Both year_factor2 - warmed  year_factor3          0.69427 0.5552
##  ambient Both year_factor2 - ambient  year_factor3         0.76860 0.5522
##  ambient Both year_factor2 - warmed Both year_factor3     -0.13154 0.1218
##  ambient Both year_factor2 - ambient Both year_factor3    -0.05721 0.1039
##  ambient Both year_factor2 - warmed Exotic year_factor3   -0.44947 0.1535
##  ambient Both year_factor2 - ambient Exotic year_factor3  -0.37514 0.1433
##  ambient Both year_factor2 - warmed Native year_factor4   -1.29453 0.1589
##  ambient Both year_factor2 - ambient Native year_factor4  -1.22020 0.1479
##  ambient Both year_factor2 - warmed  year_factor4          0.61758 0.5539
##  ambient Both year_factor2 - ambient  year_factor4         0.69191 0.5508
##  ambient Both year_factor2 - warmed Both year_factor4     -0.20823 0.1210
##  ambient Both year_factor2 - ambient Both year_factor4    -0.13390 0.1025
##  ambient Both year_factor2 - warmed Exotic year_factor4   -0.52616 0.1473
```

```
##  ambient Both year_factor2 - ambient Exotic year_factor4   -0.45183 0.1362
##  ambient Both year_factor2 - warmed Native year_factor5    -0.73769 0.1602
##  ambient Both year_factor2 - ambient Native year_factor5   -0.66336 0.1488
##  ambient Both year_factor2 - warmed  year_factor5           1.17443 0.5549
##  ambient Both year_factor2 - ambient  year_factor5          1.24876 0.5516
##  ambient Both year_factor2 - warmed Both year_factor5       0.34862 0.1248
##  ambient Both year_factor2 - ambient Both year_factor5      0.42295 0.1064
##  ambient Both year_factor2 - warmed Exotic year_factor5     0.03069 0.1516
##  ambient Both year_factor2 - ambient Exotic year_factor5    0.10502 0.1403
##  ambient Both year_factor2 - warmed Native year_factor6    -0.80184 0.1619
##  ambient Both year_factor2 - ambient Native year_factor6   -0.72751 0.1527
##  ambient Both year_factor2 - warmed  year_factor6           1.11027 0.5553
##  ambient Both year_factor2 - ambient  year_factor6          1.18460 0.5526
##  ambient Both year_factor2 - warmed Both year_factor6       0.28446 0.1255
##  ambient Both year_factor2 - ambient Both year_factor6      0.35879 0.1099
##  ambient Both year_factor2 - warmed Exotic year_factor6    -0.03346 0.1528
##  ambient Both year_factor2 - ambient Exotic year_factor6    0.04086 0.1437
##  ambient Both year_factor2 - warmed Native year_factor7    -0.30039 0.1629
##  ambient Both year_factor2 - ambient Native year_factor7   -0.22606 0.1540
##  ambient Both year_factor2 - warmed  year_factor7           1.61172 0.5562
##  ambient Both year_factor2 - ambient  year_factor7          1.68605 0.5536
##  ambient Both year_factor2 - warmed Both year_factor7       0.78591 0.1326
##  ambient Both year_factor2 - ambient Both year_factor7      0.86024 0.1183
##  ambient Both year_factor2 - warmed Exotic year_factor7     0.46798 0.1568
##  ambient Both year_factor2 - ambient Exotic year_factor7    0.54231 0.1483
##  warmed Exotic year_factor2 - ambient Exotic year_factor2   0.07433 0.0629
##  warmed Exotic year_factor2 - warmed Native year_factor3   -0.82559 0.1286
##  warmed Exotic year_factor2 - ambient Native year_factor3  -0.75126 0.1421
##  warmed Exotic year_factor2 - warmed  year_factor3          1.08652 0.5472
##  warmed Exotic year_factor2 - ambient  year_factor3         1.16085 0.5505
##  warmed Exotic year_factor2 - warmed Both year_factor3      0.26071 0.1461
##  warmed Exotic year_factor2 - ambient Both year_factor3     0.33504 0.1557
##  warmed Exotic year_factor2 - warmed Exotic year_factor3   -0.05721 0.1039
##  warmed Exotic year_factor2 - ambient Exotic year_factor3   0.01712 0.1212
##  warmed Exotic year_factor2 - warmed Native year_factor4   -0.90228 0.1299
##  warmed Exotic year_factor2 - ambient Native year_factor4  -0.82795 0.1429
##  warmed Exotic year_factor2 - warmed  year_factor4          1.00984 0.5474
##  warmed Exotic year_factor2 - ambient  year_factor4         1.08417 0.5505
##  warmed Exotic year_factor2 - warmed Both year_factor4      0.18403 0.1508
##  warmed Exotic year_factor2 - ambient Both year_factor4     0.25836 0.1598
##  warmed Exotic year_factor2 - warmed Exotic year_factor4   -0.13390 0.1025
##  warmed Exotic year_factor2 - ambient Exotic year_factor4  -0.05957 0.1195
##  warmed Exotic year_factor2 - warmed Native year_factor5   -0.34543 0.1297
##  warmed Exotic year_factor2 - ambient Native year_factor5  -0.27110 0.1423
##  warmed Exotic year_factor2 - warmed  year_factor5          1.56668 0.5479
##  warmed Exotic year_factor2 - ambient  year_factor5         1.64101 0.5509
##  warmed Exotic year_factor2 - warmed Both year_factor5      0.74087 0.1523
##  warmed Exotic year_factor2 - ambient Both year_factor5     0.81520 0.1609
##  warmed Exotic year_factor2 - warmed Exotic year_factor5    0.42295 0.1064
##  warmed Exotic year_factor2 - ambient Exotic year_factor5   0.49727 0.1224
##  warmed Exotic year_factor2 - warmed Native year_factor6   -0.40958 0.1333
##  warmed Exotic year_factor2 - ambient Native year_factor6  -0.33526 0.1476
##  warmed Exotic year_factor2 - warmed  year_factor6          1.50253 0.5486
##  warmed Exotic year_factor2 - ambient  year_factor6         1.57686 0.5522
```

```
##  warmed Exotic year_factor2 - warmed Both year_factor6      0.67672 0.1541
##  warmed Exotic year_factor2 - ambient Both year_factor6     0.75105 0.1644
##  warmed Exotic year_factor2 - warmed Exotic year_factor6    0.35879 0.1099
##  warmed Exotic year_factor2 - ambient Exotic year_factor6   0.43312 0.1278
##  warmed Exotic year_factor2 - warmed Native year_factor7    0.09186 0.1370
##  warmed Exotic year_factor2 - ambient Native year_factor7   0.16619 0.1513
##  warmed Exotic year_factor2 - warmed  year_factor7          2.00398 0.5502
##  warmed Exotic year_factor2 - ambient  year_factor7         2.07830 0.5539
##  warmed Exotic year_factor2 - warmed Both year_factor7      1.17816 0.1621
##  warmed Exotic year_factor2 - ambient Both year_factor7     1.25249 0.1722
##  warmed Exotic year_factor2 - warmed Exotic year_factor7    0.86024 0.1183
##  warmed Exotic year_factor2 - ambient Exotic year_factor7   0.93457 0.1355
##  ambient Exotic year_factor2 - warmed Native year_factor3  -0.89992 0.1442
##  ambient Exotic year_factor2 - ambient Native year_factor3 -0.82559 0.1286
##  ambient Exotic year_factor2 - warmed  year_factor3         1.01219 0.5512
##  ambient Exotic year_factor2 - ambient  year_factor3        1.08652 0.5472
##  ambient Exotic year_factor2 - warmed Both year_factor3     0.18638 0.1623
##  ambient Exotic year_factor2 - ambient Both year_factor3    0.26071 0.1461
##  ambient Exotic year_factor2 - warmed Exotic year_factor3  -0.13154 0.1218
##  ambient Exotic year_factor2 - ambient Exotic year_factor3 -0.05721 0.1039
##  ambient Exotic year_factor2 - warmed Native year_factor4  -0.97661 0.1458
##  ambient Exotic year_factor2 - ambient Native year_factor4 -0.90228 0.1299
##  ambient Exotic year_factor2 - warmed  year_factor4         0.93551 0.5514
##  ambient Exotic year_factor2 - ambient  year_factor4        1.00984 0.5474
##  ambient Exotic year_factor2 - warmed Both year_factor4     0.10970 0.1669
##  ambient Exotic year_factor2 - ambient Both year_factor4    0.18403 0.1508
##  ambient Exotic year_factor2 - warmed Exotic year_factor4  -0.20823 0.1210
##  ambient Exotic year_factor2 - ambient Exotic year_factor4 -0.13390 0.1025
##  ambient Exotic year_factor2 - warmed Native year_factor5  -0.41976 0.1460
##  ambient Exotic year_factor2 - ambient Native year_factor5 -0.34543 0.1297
##  ambient Exotic year_factor2 - warmed  year_factor5         1.49235 0.5520
##  ambient Exotic year_factor2 - ambient  year_factor5        1.56668 0.5479
##  ambient Exotic year_factor2 - warmed Both year_factor5     0.66654 0.1687
##  ambient Exotic year_factor2 - ambient Both year_factor5    0.74087 0.1523
##  ambient Exotic year_factor2 - warmed Exotic year_factor5   0.34862 0.1248
##  ambient Exotic year_factor2 - ambient Exotic year_factor5  0.42295 0.1064
##  ambient Exotic year_factor2 - warmed Native year_factor6  -0.48391 0.1472
##  ambient Exotic year_factor2 - ambient Native year_factor6 -0.40958 0.1333
##  ambient Exotic year_factor2 - warmed  year_factor6         1.42820 0.5522
##  ambient Exotic year_factor2 - ambient  year_factor6        1.50253 0.5486
##  ambient Exotic year_factor2 - warmed Both year_factor6     0.60239 0.1686
##  ambient Exotic year_factor2 - ambient Both year_factor6    0.67672 0.1541
##  ambient Exotic year_factor2 - warmed Exotic year_factor6   0.28446 0.1255
##  ambient Exotic year_factor2 - ambient Exotic year_factor6  0.35879 0.1099
##  ambient Exotic year_factor2 - warmed Native year_factor7   0.01753 0.1502
##  ambient Exotic year_factor2 - ambient Native year_factor7  0.09186 0.1370
##  ambient Exotic year_factor2 - warmed  year_factor7         1.92965 0.5537
##  ambient Exotic year_factor2 - ambient  year_factor7        2.00398 0.5502
##  ambient Exotic year_factor2 - warmed Both year_factor7     1.10384 0.1755
##  ambient Exotic year_factor2 - ambient Both year_factor7    1.17816 0.1621
##  ambient Exotic year_factor2 - warmed Exotic year_factor7   0.78591 0.1326
##  ambient Exotic year_factor2 - ambient Exotic year_factor7  0.86024 0.1183
##  warmed Native year_factor3 - ambient Native year_factor3   0.07433 0.0629
##  warmed Native year_factor3 - warmed  year_factor3          1.91211 0.5401
```

```
##  warmed Native year_factor3 - ambient  year_factor3         1.98644 0.5437
##  warmed Native year_factor3 - warmed Both year_factor3      1.08630 0.1129
##  warmed Native year_factor3 - ambient Both year_factor3     1.16063 0.1263
##  warmed Native year_factor3 - warmed Exotic year_factor3    0.76838 0.0752
##  warmed Native year_factor3 - ambient Exotic year_factor3   0.84271 0.0993
##  warmed Native year_factor3 - warmed Native year_factor4   -0.07669 0.1083
##  warmed Native year_factor3 - ambient Native year_factor4  -0.00236 0.1248
##  warmed Native year_factor3 - warmed  year_factor4          1.83543 0.5507
##  warmed Native year_factor3 - ambient  year_factor4         1.90975 0.5541
##  warmed Native year_factor3 - warmed Both year_factor4      1.00962 0.1598
##  warmed Native year_factor3 - ambient Both year_factor4     1.08394 0.1692
##  warmed Native year_factor3 - warmed Exotic year_factor4    0.69169 0.1294
##  warmed Native year_factor3 - ambient Exotic year_factor4   0.76602 0.1443
##  warmed Native year_factor3 - warmed Native year_factor5    0.48016 0.1120
##  warmed Native year_factor3 - ambient Native year_factor5   0.55449 0.1276
##  warmed Native year_factor3 - warmed  year_factor5          2.39227 0.5520
##  warmed Native year_factor3 - ambient  year_factor5         2.46660 0.5553
##  warmed Native year_factor3 - warmed Both year_factor5      1.56646 0.1639
##  warmed Native year_factor3 - ambient Both year_factor5     1.64079 0.1728
##  warmed Native year_factor3 - warmed Exotic year_factor5    1.24853 0.1358
##  warmed Native year_factor3 - ambient Exotic year_factor5   1.32286 0.1497
##  warmed Native year_factor3 - warmed Native year_factor6    0.41601 0.1154
##  warmed Native year_factor3 - ambient Native year_factor6   0.49033 0.1328
##  warmed Native year_factor3 - warmed  year_factor6          2.32812 0.5526
##  warmed Native year_factor3 - ambient  year_factor6         2.40245 0.5564
##  warmed Native year_factor3 - warmed Both year_factor6      1.50231 0.1651
##  warmed Native year_factor3 - ambient Both year_factor6     1.57664 0.1755
##  warmed Native year_factor3 - warmed Exotic year_factor6    1.18438 0.1379
##  warmed Native year_factor3 - ambient Exotic year_factor6   1.25871 0.1535
##  warmed Native year_factor3 - warmed Native year_factor7    0.91745 0.1235
##  warmed Native year_factor3 - ambient Native year_factor7   0.99178 0.1403
##  warmed Native year_factor3 - warmed  year_factor7          2.82956 0.5550
##  warmed Native year_factor3 - ambient  year_factor7         2.90389 0.5589
##  warmed Native year_factor3 - warmed Both year_factor7      2.00375 0.1752
##  warmed Native year_factor3 - ambient Both year_factor7     2.07808 0.1853
##  warmed Native year_factor3 - warmed Exotic year_factor7    1.68583 0.1479
##  warmed Native year_factor3 - ambient Exotic year_factor7   1.76016 0.1629
##  ambient Native year_factor3 - warmed  year_factor3         1.83778 0.5438
##  ambient Native year_factor3 - ambient  year_factor3        1.91211 0.5401
##  ambient Native year_factor3 - warmed Both year_factor3     1.01197 0.1321
##  ambient Native year_factor3 - ambient Both year_factor3    1.08630 0.1129
##  ambient Native year_factor3 - warmed Exotic year_factor3   0.69405 0.0969
##  ambient Native year_factor3 - ambient Exotic year_factor3  0.76838 0.0752
##  ambient Native year_factor3 - warmed Native year_factor4  -0.15102 0.1257
##  ambient Native year_factor3 - ambient Native year_factor4 -0.07669 0.1083
##  ambient Native year_factor3 - warmed  year_factor4         1.76110 0.5544
##  ambient Native year_factor3 - ambient  year_factor4        1.83543 0.5507
##  ambient Native year_factor3 - warmed Both year_factor4     0.93529 0.1742
##  ambient Native year_factor3 - ambient Both year_factor4    1.00962 0.1598
##  ambient Native year_factor3 - warmed Exotic year_factor4   0.61736 0.1435
##  ambient Native year_factor3 - ambient Exotic year_factor4  0.69169 0.1294
##  ambient Native year_factor3 - warmed Native year_factor5   0.40583 0.1294
##  ambient Native year_factor3 - ambient Native year_factor5  0.48016 0.1120
##  ambient Native year_factor3 - warmed  year_factor5         2.31794 0.5558
```

```
##  ambient Native year_factor3 - ambient  year_factor5        2.39227 0.5520
##  ambient Native year_factor3 - warmed Both year_factor5     1.49213 0.1784
##  ambient Native year_factor3 - ambient Both year_factor5    1.56646 0.1639
##  ambient Native year_factor3 - warmed Exotic year_factor5   1.17421 0.1497
##  ambient Native year_factor3 - ambient Exotic year_factor5  1.24853 0.1358
##  ambient Native year_factor3 - warmed Native year_factor6   0.34168 0.1301
##  ambient Native year_factor3 - ambient Native year_factor6  0.41601 0.1154
##  ambient Native year_factor3 - warmed  year_factor6         2.25379 0.5559
##  ambient Native year_factor3 - ambient  year_factor6        2.32812 0.5526
##  ambient Native year_factor3 - warmed Both year_factor6     1.42798 0.1778
##  ambient Native year_factor3 - ambient Both year_factor6    1.50231 0.1651
##  ambient Native year_factor3 - warmed Exotic year_factor6   1.11005 0.1497
##  ambient Native year_factor3 - ambient Exotic year_factor6  1.18438 0.1379
##  ambient Native year_factor3 - warmed Native year_factor7   0.84312 0.1369
##  ambient Native year_factor3 - ambient Native year_factor7  0.91745 0.1235
##  ambient Native year_factor3 - warmed  year_factor7         2.75523 0.5582
##  ambient Native year_factor3 - ambient  year_factor7        2.82956 0.5550
##  ambient Native year_factor3 - warmed Both year_factor7     1.92943 0.1869
##  ambient Native year_factor3 - ambient Both year_factor7    2.00375 0.1752
##  ambient Native year_factor3 - warmed Exotic year_factor7   1.61150 0.1586
##  ambient Native year_factor3 - ambient Exotic year_factor7  1.68583 0.1479
##  warmed  year_factor3 - ambient  year_factor3               0.07433 0.0629
##  warmed  year_factor3 - warmed Both year_factor3           -0.82581 0.5427
##  warmed  year_factor3 - ambient Both year_factor3          -0.75148 0.5457
##  warmed  year_factor3 - warmed Exotic year_factor3         -1.14374 0.5372
##  warmed  year_factor3 - ambient Exotic year_factor3        -1.06941 0.5412
##  warmed  year_factor3 - warmed Native year_factor4         -1.98880 0.5510
##  warmed  year_factor3 - ambient Native year_factor4        -1.91447 0.5546
##  warmed  year_factor3 - warmed  year_factor4               -0.07669 0.1083
##  warmed  year_factor3 - ambient  year_factor4              -0.00236 0.1248
##  warmed  year_factor3 - warmed Both year_factor4           -0.90250 0.5545
##  warmed  year_factor3 - ambient Both year_factor4          -0.82817 0.5574
##  warmed  year_factor3 - warmed Exotic year_factor4         -1.22042 0.5476
##  warmed  year_factor3 - ambient Exotic year_factor4        -1.14610 0.5514
##  warmed  year_factor3 - warmed Native year_factor5         -1.43195 0.5512
##  warmed  year_factor3 - ambient Native year_factor5        -1.35763 0.5546
##  warmed  year_factor3 - warmed  year_factor5                0.48016 0.1120
##  warmed  year_factor3 - ambient  year_factor5               0.55449 0.1276
##  warmed  year_factor3 - warmed Both year_factor5           -0.34565 0.5552
##  warmed  year_factor3 - ambient Both year_factor5          -0.27132 0.5579
##  warmed  year_factor3 - warmed Exotic year_factor5         -0.66358 0.5486
##  warmed  year_factor3 - ambient Exotic year_factor5        -0.58925 0.5523
##  warmed  year_factor3 - warmed Native year_factor6         -1.49611 0.5520
##  warmed  year_factor3 - ambient Native year_factor6        -1.42178 0.5560
##  warmed  year_factor3 - warmed  year_factor6                0.41601 0.1154
##  warmed  year_factor3 - ambient  year_factor6               0.49033 0.1328
##  warmed  year_factor3 - warmed Both year_factor6           -0.40980 0.5556
##  warmed  year_factor3 - ambient Both year_factor6          -0.33548 0.5589
##  warmed  year_factor3 - warmed Exotic year_factor6         -0.72773 0.5492
##  warmed  year_factor3 - ambient Exotic year_factor6        -0.65340 0.5534
##  warmed  year_factor3 - warmed Native year_factor7         -0.99466 0.5531
##  warmed  year_factor3 - ambient Native year_factor7        -0.92033 0.5571
##  warmed  year_factor3 - warmed  year_factor7                0.91745 0.1235
##  warmed  year_factor3 - ambient  year_factor7               0.99178 0.1403
```

```
##  warmed  year_factor3 - warmed Both year_factor7           0.09164 0.5580
##  warmed  year_factor3 - ambient Both year_factor7           0.16597 0.5614
##  warmed  year_factor3 - warmed Exotic year_factor7         -0.22628 0.5511
##  warmed  year_factor3 - ambient Exotic year_factor7        -0.15196 0.5554
##  ambient  year_factor3 - warmed Both year_factor3          -0.90014 0.5469
##  ambient  year_factor3 - ambient Both year_factor3         -0.82581 0.5427
##  ambient  year_factor3 - warmed Exotic year_factor3        -1.21806 0.5406
##  ambient  year_factor3 - ambient Exotic year_factor3       -1.14374 0.5372
##  ambient  year_factor3 - warmed Native year_factor4        -2.06313 0.5546
##  ambient  year_factor3 - ambient Native year_factor4       -1.98880 0.5510
##  ambient  year_factor3 - warmed  year_factor4              -0.15102 0.1257
##  ambient  year_factor3 - ambient  year_factor4             -0.07669 0.1083
##  ambient  year_factor3 - warmed Both year_factor4          -0.97683 0.5588
##  ambient  year_factor3 - ambient Both year_factor4         -0.90250 0.5545
##  ambient  year_factor3 - warmed Exotic year_factor4        -1.29475 0.5511
##  ambient  year_factor3 - ambient Exotic year_factor4       -1.22042 0.5476
##  ambient  year_factor3 - warmed Native year_factor5        -1.50628 0.5549
##  ambient  year_factor3 - ambient Native year_factor5       -1.43195 0.5512
##  ambient  year_factor3 - warmed  year_factor5               0.40583 0.1294
##  ambient  year_factor3 - ambient  year_factor5              0.48016 0.1120
##  ambient  year_factor3 - warmed Both year_factor5          -0.41998 0.5595
##  ambient  year_factor3 - ambient Both year_factor5         -0.34565 0.5552
##  ambient  year_factor3 - warmed Exotic year_factor5        -0.73791 0.5521
##  ambient  year_factor3 - ambient Exotic year_factor5       -0.66358 0.5486
##  ambient  year_factor3 - warmed Native year_factor6        -1.57044 0.5552
##  ambient  year_factor3 - ambient Native year_factor6       -1.49611 0.5520
##  ambient  year_factor3 - warmed  year_factor6               0.34168 0.1301
##  ambient  year_factor3 - ambient  year_factor6              0.41601 0.1154
##  ambient  year_factor3 - warmed Both year_factor6          -0.48413 0.5595
##  ambient  year_factor3 - ambient Both year_factor6         -0.40980 0.5556
##  ambient  year_factor3 - warmed Exotic year_factor6        -0.80206 0.5522
##  ambient  year_factor3 - ambient Exotic year_factor6       -0.72773 0.5492
##  ambient  year_factor3 - warmed Native year_factor7        -1.06899 0.5562
##  ambient  year_factor3 - ambient Native year_factor7       -0.99466 0.5531
##  ambient  year_factor3 - warmed  year_factor7               0.84312 0.1369
##  ambient  year_factor3 - ambient  year_factor7              0.91745 0.1235
##  ambient  year_factor3 - warmed Both year_factor7           0.01731 0.5617
##  ambient  year_factor3 - ambient Both year_factor7          0.09164 0.5580
##  ambient  year_factor3 - warmed Exotic year_factor7        -0.30061 0.5540
##  ambient  year_factor3 - ambient Exotic year_factor7       -0.22628 0.5511
##  warmed Both year_factor3 - ambient Both year_factor3       0.07433 0.0629
##  warmed Both year_factor3 - warmed Exotic year_factor3     -0.31793 0.1006
##  warmed Both year_factor3 - ambient Exotic year_factor3    -0.24360 0.1227
##  warmed Both year_factor3 - warmed Native year_factor4     -1.16299 0.1531
##  warmed Both year_factor3 - ambient Native year_factor4    -1.08866 0.1674
##  warmed Both year_factor3 - warmed  year_factor4            0.74912 0.5523
##  warmed Both year_factor3 - ambient  year_factor4           0.82345 0.5563
##  warmed Both year_factor3 - warmed Both year_factor4       -0.07669 0.1083
##  warmed Both year_factor3 - ambient Both year_factor4      -0.00236 0.1248
##  warmed Both year_factor3 - warmed Exotic year_factor4     -0.39461 0.1420
##  warmed Both year_factor3 - ambient Exotic year_factor4    -0.32028 0.1581
##  warmed Both year_factor3 - warmed Native year_factor5     -0.60615 0.1540
##  warmed Both year_factor3 - ambient Native year_factor5    -0.53182 0.1679
##  warmed Both year_factor3 - warmed  year_factor5            1.30597 0.5531
```

```
##  warmed Both year_factor3 - ambient  year_factor5          1.38030 0.5571
##  warmed Both year_factor3 - warmed Both year_factor5       0.48016 0.1120
##  warmed Both year_factor3 - ambient Both year_factor5      0.55449 0.1276
##  warmed Both year_factor3 - warmed Exotic year_factor5     0.16223 0.1461
##  warmed Both year_factor3 - ambient Exotic year_factor5    0.23656 0.1614
##  warmed Both year_factor3 - warmed Native year_factor6    -0.67030 0.1578
##  warmed Both year_factor3 - ambient Native year_factor6   -0.59597 0.1731
##  warmed Both year_factor3 - warmed  year_factor6           1.24181 0.5540
##  warmed Both year_factor3 - ambient  year_factor6          1.31614 0.5585
##  warmed Both year_factor3 - warmed Both year_factor6       0.41601 0.1154
##  warmed Both year_factor3 - ambient Both year_factor6      0.49033 0.1328
##  warmed Both year_factor3 - warmed Exotic year_factor6     0.09808 0.1494
##  warmed Both year_factor3 - ambient Exotic year_factor6    0.17241 0.1661
##  warmed Both year_factor3 - warmed Native year_factor7    -0.16885 0.1591
##  warmed Both year_factor3 - ambient Native year_factor7   -0.09452 0.1746
##  warmed Both year_factor3 - warmed  year_factor7           1.74326 0.5551
##  warmed Both year_factor3 - ambient  year_factor7          1.81759 0.5597
##  warmed Both year_factor3 - warmed Both year_factor7       0.91745 0.1235
##  warmed Both year_factor3 - ambient Both year_factor7      0.99178 0.1403
##  warmed Both year_factor3 - warmed Exotic year_factor7     0.59952 0.1538
##  warmed Both year_factor3 - ambient Exotic year_factor7    0.67385 0.1705
##  ambient Both year_factor3 - warmed Exotic year_factor3   -0.39226 0.1145
##  ambient Both year_factor3 - ambient Exotic year_factor3  -0.31793 0.1006
##  ambient Both year_factor3 - warmed Native year_factor4   -1.23732 0.1636
##  ambient Both year_factor3 - ambient Native year_factor4  -1.16299 0.1531
##  ambient Both year_factor3 - warmed  year_factor4          0.67479 0.5553
##  ambient Both year_factor3 - ambient  year_factor4         0.74912 0.5523
##  ambient Both year_factor3 - warmed Both year_factor4     -0.15102 0.1257
##  ambient Both year_factor3 - ambient Both year_factor4    -0.07669 0.1083
##  ambient Both year_factor3 - warmed Exotic year_factor4   -0.46894 0.1525
##  ambient Both year_factor3 - ambient Exotic year_factor4  -0.39461 0.1420
##  ambient Both year_factor3 - warmed Native year_factor5   -0.68047 0.1648
##  ambient Both year_factor3 - ambient Native year_factor5  -0.60615 0.1540
##  ambient Both year_factor3 - warmed  year_factor5          1.23164 0.5563
##  ambient Both year_factor3 - ambient  year_factor5         1.30597 0.5531
##  ambient Both year_factor3 - warmed Both year_factor5      0.40583 0.1294
##  ambient Both year_factor3 - ambient Both year_factor5     0.48016 0.1120
##  ambient Both year_factor3 - warmed Exotic year_factor5    0.08790 0.1567
##  ambient Both year_factor3 - ambient Exotic year_factor5   0.16223 0.1461
##  ambient Both year_factor3 - warmed Native year_factor6   -0.74463 0.1666
##  ambient Both year_factor3 - ambient Native year_factor6  -0.67030 0.1578
##  ambient Both year_factor3 - warmed  year_factor6          1.16749 0.5567
##  ambient Both year_factor3 - ambient  year_factor6         1.24181 0.5540
##  ambient Both year_factor3 - warmed Both year_factor6      0.34168 0.1301
##  ambient Both year_factor3 - ambient Both year_factor6     0.41601 0.1154
##  ambient Both year_factor3 - warmed Exotic year_factor6    0.02375 0.1579
##  ambient Both year_factor3 - ambient Exotic year_factor6   0.09808 0.1494
##  ambient Both year_factor3 - warmed Native year_factor7   -0.24318 0.1675
##  ambient Both year_factor3 - ambient Native year_factor7  -0.16885 0.1591
##  ambient Both year_factor3 - warmed  year_factor7          1.66893 0.5576
##  ambient Both year_factor3 - ambient  year_factor7         1.74326 0.5551
##  ambient Both year_factor3 - warmed Both year_factor7      0.84312 0.1369
##  ambient Both year_factor3 - ambient Both year_factor7     0.91745 0.1235
##  ambient Both year_factor3 - warmed Exotic year_factor7    0.52520 0.1618
```

```
##  ambient Both year_factor3 - ambient Exotic year_factor7    0.59952 0.1538
##  warmed Exotic year_factor3 - ambient Exotic year_factor3   0.07433 0.0629
##  warmed Exotic year_factor3 - warmed Native year_factor4   -0.84506 0.1343
##  warmed Exotic year_factor3 - ambient Native year_factor4  -0.77073 0.1472
##  warmed Exotic year_factor3 - warmed  year_factor4          1.06705 0.5484
##  warmed Exotic year_factor3 - ambient  year_factor4         1.14138 0.5517
##  warmed Exotic year_factor3 - warmed Both year_factor4      0.24124 0.1534
##  warmed Exotic year_factor3 - ambient Both year_factor4     0.31557 0.1625
##  warmed Exotic year_factor3 - warmed Exotic year_factor4   -0.07669 0.1083
##  warmed Exotic year_factor3 - ambient Exotic year_factor4  -0.00236 0.1248
##  warmed Exotic year_factor3 - warmed Native year_factor5   -0.28822 0.1341
##  warmed Exotic year_factor3 - ambient Native year_factor5  -0.21389 0.1466
##  warmed Exotic year_factor3 - warmed  year_factor5          1.62390 0.5490
##  warmed Exotic year_factor3 - ambient  year_factor5         1.69822 0.5521
##  warmed Exotic year_factor3 - warmed Both year_factor5      0.79809 0.1550
##  warmed Exotic year_factor3 - ambient Both year_factor5     0.87241 0.1637
##  warmed Exotic year_factor3 - warmed Exotic year_factor5    0.48016 0.1120
##  warmed Exotic year_factor3 - ambient Exotic year_factor5   0.55449 0.1276
##  warmed Exotic year_factor3 - warmed Native year_factor6   -0.35237 0.1377
##  warmed Exotic year_factor3 - ambient Native year_factor6  -0.27804 0.1518
##  warmed Exotic year_factor3 - warmed  year_factor6          1.55974 0.5497
##  warmed Exotic year_factor3 - ambient  year_factor6         1.63407 0.5534
##  warmed Exotic year_factor3 - warmed Both year_factor6      0.73393 0.1568
##  warmed Exotic year_factor3 - ambient Both year_factor6     0.80826 0.1671
##  warmed Exotic year_factor3 - warmed Exotic year_factor6    0.41601 0.1154
##  warmed Exotic year_factor3 - ambient Exotic year_factor6   0.49033 0.1328
##  warmed Exotic year_factor3 - warmed Native year_factor7    0.14908 0.1412
##  warmed Exotic year_factor3 - ambient Native year_factor7   0.22340 0.1554
##  warmed Exotic year_factor3 - warmed  year_factor7          2.06119 0.5513
##  warmed Exotic year_factor3 - ambient  year_factor7         2.13552 0.5551
##  warmed Exotic year_factor3 - warmed Both year_factor7      1.23538 0.1646
##  warmed Exotic year_factor3 - ambient Both year_factor7     1.30971 0.1748
##  warmed Exotic year_factor3 - warmed Exotic year_factor7    0.91745 0.1235
##  warmed Exotic year_factor3 - ambient Exotic year_factor7   0.99178 0.1403
##  ambient Exotic year_factor3 - warmed Native year_factor4  -0.91939 0.1495
##  ambient Exotic year_factor3 - ambient Native year_factor4 -0.84506 0.1343
##  ambient Exotic year_factor3 - warmed  year_factor4         0.99272 0.5524
##  ambient Exotic year_factor3 - ambient  year_factor4        1.06705 0.5484
##  ambient Exotic year_factor3 - warmed Both year_factor4     0.16691 0.1691
##  ambient Exotic year_factor3 - ambient Both year_factor4    0.24124 0.1534
##  ambient Exotic year_factor3 - warmed Exotic year_factor4  -0.15102 0.1257
##  ambient Exotic year_factor3 - ambient Exotic year_factor4 -0.07669 0.1083
##  ambient Exotic year_factor3 - warmed Native year_factor5  -0.36255 0.1497
##  ambient Exotic year_factor3 - ambient Native year_factor5 -0.28822 0.1341
##  ambient Exotic year_factor3 - warmed  year_factor5         1.54957 0.5531
##  ambient Exotic year_factor3 - ambient  year_factor5        1.62390 0.5490
##  ambient Exotic year_factor3 - warmed Both year_factor5     0.72376 0.1709
##  ambient Exotic year_factor3 - ambient Both year_factor5    0.79809 0.1550
##  ambient Exotic year_factor3 - warmed Exotic year_factor5   0.40583 0.1294
##  ambient Exotic year_factor3 - ambient Exotic year_factor5  0.48016 0.1120
##  ambient Exotic year_factor3 - warmed Native year_factor6  -0.42670 0.1510
##  ambient Exotic year_factor3 - ambient Native year_factor6 -0.35237 0.1377
##  ambient Exotic year_factor3 - warmed  year_factor6         1.48541 0.5533
##  ambient Exotic year_factor3 - ambient  year_factor6        1.55974 0.5497
```

```
##  ambient Exotic year_factor3 - warmed Both year_factor6     0.65960 0.1708
##  ambient Exotic year_factor3 - ambient Both year_factor6    0.73393 0.1568
##  ambient Exotic year_factor3 - warmed Exotic year_factor6   0.34168 0.1301
##  ambient Exotic year_factor3 - ambient Exotic year_factor6  0.41601 0.1154
##  ambient Exotic year_factor3 - warmed Native year_factor7   0.07475 0.1539
##  ambient Exotic year_factor3 - ambient Native year_factor7  0.14908 0.1412
##  ambient Exotic year_factor3 - warmed  year_factor7         1.98686 0.5548
##  ambient Exotic year_factor3 - ambient  year_factor7        2.06119 0.5513
##  ambient Exotic year_factor3 - warmed Both year_factor7     1.16105 0.1777
##  ambient Exotic year_factor3 - ambient Both year_factor7    1.23538 0.1646
##  ambient Exotic year_factor3 - warmed Exotic year_factor7   0.84312 0.1369
##  ambient Exotic year_factor3 - ambient Exotic year_factor7  0.91745 0.1235
##  warmed Native year_factor4 - ambient Native year_factor4   0.07433 0.0629
##  warmed Native year_factor4 - warmed  year_factor4          1.91211 0.5401
##  warmed Native year_factor4 - ambient  year_factor4         1.98644 0.5437
##  warmed Native year_factor4 - warmed Both year_factor4      1.08630 0.1129
##  warmed Native year_factor4 - ambient Both year_factor4     1.16063 0.1263
##  warmed Native year_factor4 - warmed Exotic year_factor4    0.76838 0.0752
##  warmed Native year_factor4 - ambient Exotic year_factor4   0.84271 0.0993
##  warmed Native year_factor4 - warmed Native year_factor5    0.55685 0.1101
##  warmed Native year_factor4 - ambient Native year_factor5   0.63118 0.1264
##  warmed Native year_factor4 - warmed  year_factor5          2.46896 0.5518
##  warmed Native year_factor4 - ambient  year_factor5         2.54329 0.5552
##  warmed Native year_factor4 - warmed Both year_factor5      1.64315 0.1594
##  warmed Native year_factor4 - ambient Both year_factor5     1.71748 0.1688
##  warmed Native year_factor4 - warmed Exotic year_factor5    1.32522 0.1366
##  warmed Native year_factor4 - ambient Exotic year_factor5   1.39955 0.1508
##  warmed Native year_factor4 - warmed Native year_factor6    0.49269 0.1136
##  warmed Native year_factor4 - ambient Native year_factor6   0.56702 0.1317
##  warmed Native year_factor4 - warmed  year_factor6          2.40481 0.5524
##  warmed Native year_factor4 - ambient  year_factor6         2.47913 0.5563
##  warmed Native year_factor4 - warmed Both year_factor6      1.57900 0.1606
##  warmed Native year_factor4 - ambient Both year_factor6     1.65332 0.1716
##  warmed Native year_factor4 - warmed Exotic year_factor6    1.26107 0.1387
##  warmed Native year_factor4 - ambient Exotic year_factor6   1.33540 0.1546
##  warmed Native year_factor4 - warmed Native year_factor7    0.99414 0.1217
##  warmed Native year_factor4 - ambient Native year_factor7   1.06847 0.1391
##  warmed Native year_factor4 - warmed  year_factor7          2.90625 0.5548
##  warmed Native year_factor4 - ambient  year_factor7         2.98058 0.5588
##  warmed Native year_factor4 - warmed Both year_factor7      2.08044 0.1709
##  warmed Native year_factor4 - ambient Both year_factor7     2.15477 0.1816
##  warmed Native year_factor4 - warmed Exotic year_factor7    1.76252 0.1486
##  warmed Native year_factor4 - ambient Exotic year_factor7   1.83684 0.1639
##  ambient Native year_factor4 - warmed  year_factor4         1.83778 0.5438
##  ambient Native year_factor4 - ambient  year_factor4        1.91211 0.5401
##  ambient Native year_factor4 - warmed Both year_factor4     1.01197 0.1321
##  ambient Native year_factor4 - ambient Both year_factor4    1.08630 0.1129
##  ambient Native year_factor4 - warmed Exotic year_factor4   0.69405 0.0969
##  ambient Native year_factor4 - ambient Exotic year_factor4  0.76838 0.0752
##  ambient Native year_factor4 - warmed Native year_factor5   0.48252 0.1273
##  ambient Native year_factor4 - ambient Native year_factor5  0.55685 0.1101
##  ambient Native year_factor4 - warmed  year_factor5         2.39463 0.5555
##  ambient Native year_factor4 - ambient  year_factor5        2.46896 0.5518
##  ambient Native year_factor4 - warmed Both year_factor5     1.56882 0.1739
```

```
##  ambient Native year_factor4 - ambient Both year_factor5    1.64315 0.1594
##  ambient Native year_factor4 - warmed Exotic year_factor5   1.25089 0.1500
##  ambient Native year_factor4 - ambient Exotic year_factor5  1.32522 0.1366
##  ambient Native year_factor4 - warmed Native year_factor6   0.41836 0.1281
##  ambient Native year_factor4 - ambient Native year_factor6  0.49269 0.1136
##  ambient Native year_factor4 - warmed  year_factor6         2.33048 0.5556
##  ambient Native year_factor4 - ambient  year_factor6        2.40481 0.5524
##  ambient Native year_factor4 - warmed Both year_factor6     1.50467 0.1733
##  ambient Native year_factor4 - ambient Both year_factor6    1.57900 0.1606
##  ambient Native year_factor4 - warmed Exotic year_factor6   1.18674 0.1500
##  ambient Native year_factor4 - ambient Exotic year_factor6  1.26107 0.1387
##  ambient Native year_factor4 - warmed Native year_factor7   0.91981 0.1349
##  ambient Native year_factor4 - ambient Native year_factor7  0.99414 0.1217
##  ambient Native year_factor4 - warmed  year_factor7         2.83192 0.5579
##  ambient Native year_factor4 - ambient  year_factor7        2.90625 0.5548
##  ambient Native year_factor4 - warmed Both year_factor7     2.00611 0.1826
##  ambient Native year_factor4 - ambient Both year_factor7    2.08044 0.1709
##  ambient Native year_factor4 - warmed Exotic year_factor7   1.68819 0.1589
##  ambient Native year_factor4 - ambient Exotic year_factor7  1.76252 0.1486
##  warmed  year_factor4 - ambient  year_factor4                0.07433 0.0629
##  warmed  year_factor4 - warmed Both year_factor4           -0.82581 0.5427
##  warmed  year_factor4 - ambient Both year_factor4          -0.75148 0.5457
##  warmed  year_factor4 - warmed Exotic year_factor4         -1.14374 0.5372
##  warmed  year_factor4 - ambient Exotic year_factor4        -1.06941 0.5412
##  warmed  year_factor4 - warmed Native year_factor5         -1.35527 0.5506
##  warmed  year_factor4 - ambient Native year_factor5        -1.28094 0.5542
##  warmed  year_factor4 - warmed  year_factor5                 0.55685 0.1101
##  warmed  year_factor4 - ambient  year_factor5                0.63118 0.1264
##  warmed  year_factor4 - warmed Both year_factor5           -0.26896 0.5537
##  warmed  year_factor4 - ambient Both year_factor5          -0.19463 0.5565
##  warmed  year_factor4 - warmed Exotic year_factor5         -0.58689 0.5486
##  warmed  year_factor4 - ambient Exotic year_factor5        -0.51256 0.5524
##  warmed  year_factor4 - warmed Native year_factor6         -1.41942 0.5515
##  warmed  year_factor4 - ambient Native year_factor6        -1.34509 0.5555
##  warmed  year_factor4 - warmed  year_factor6                 0.49269 0.1136
##  warmed  year_factor4 - ambient  year_factor6                0.56702 0.1317
##  warmed  year_factor4 - warmed Both year_factor6           -0.33312 0.5541
##  warmed  year_factor4 - ambient Both year_factor6          -0.25879 0.5575
##  warmed  year_factor4 - warmed Exotic year_factor6         -0.65104 0.5493
##  warmed  year_factor4 - ambient Exotic year_factor6        -0.57671 0.5536
##  warmed  year_factor4 - warmed Native year_factor7         -0.91797 0.5525
##  warmed  year_factor4 - ambient Native year_factor7        -0.84364 0.5566
##  warmed  year_factor4 - warmed  year_factor7                 0.99414 0.1217
##  warmed  year_factor4 - ambient  year_factor7                1.06847 0.1391
##  warmed  year_factor4 - warmed Both year_factor7            0.16833 0.5565
##  warmed  year_factor4 - ambient Both year_factor7           0.24266 0.5600
##  warmed  year_factor4 - warmed Exotic year_factor7         -0.14960 0.5512
##  warmed  year_factor4 - ambient Exotic year_factor7        -0.07527 0.5555
##  ambient  year_factor4 - warmed Both year_factor4          -0.90014 0.5469
##  ambient  year_factor4 - ambient Both year_factor4         -0.82581 0.5427
##  ambient  year_factor4 - warmed Exotic year_factor4        -1.21806 0.5406
##  ambient  year_factor4 - ambient Exotic year_factor4       -1.14374 0.5372
##  ambient  year_factor4 - warmed Native year_factor5        -1.42960 0.5543
##  ambient  year_factor4 - ambient Native year_factor5       -1.35527 0.5506
```

```
##  ambient  year_factor4 - warmed  year_factor5              0.48252 0.1273
##  ambient  year_factor4 - ambient  year_factor5              0.55685 0.1101
##  ambient  year_factor4 - warmed Both year_factor5          -0.34329 0.5579
##  ambient  year_factor4 - ambient Both year_factor5         -0.26896 0.5537
##  ambient  year_factor4 - warmed Exotic year_factor5        -0.66122 0.5520
##  ambient  year_factor4 - ambient Exotic year_factor5       -0.58689 0.5486
##  ambient  year_factor4 - warmed Native year_factor6        -1.49375 0.5545
##  ambient  year_factor4 - ambient Native year_factor6       -1.41942 0.5515
##  ambient  year_factor4 - warmed  year_factor6               0.41836 0.1281
##  ambient  year_factor4 - ambient  year_factor6              0.49269 0.1136
##  ambient  year_factor4 - warmed Both year_factor6          -0.40745 0.5579
##  ambient  year_factor4 - ambient Both year_factor6         -0.33312 0.5541
##  ambient  year_factor4 - warmed Exotic year_factor6        -0.72537 0.5522
##  ambient  year_factor4 - ambient Exotic year_factor6       -0.65104 0.5493
##  ambient  year_factor4 - warmed Native year_factor7        -0.99230 0.5555
##  ambient  year_factor4 - ambient Native year_factor7       -0.91797 0.5525
##  ambient  year_factor4 - warmed  year_factor7               0.91981 0.1349
##  ambient  year_factor4 - ambient  year_factor7              0.99414 0.1217
##  ambient  year_factor4 - warmed Both year_factor7           0.09400 0.5601
##  ambient  year_factor4 - ambient Both year_factor7          0.16833 0.5565
##  ambient  year_factor4 - warmed Exotic year_factor7        -0.22393 0.5539
##  ambient  year_factor4 - ambient Exotic year_factor7       -0.14960 0.5512
##  warmed Both year_factor4 - ambient Both year_factor4       0.07433 0.0629
##  warmed Both year_factor4 - warmed Exotic year_factor4     -0.31793 0.1006
##  warmed Both year_factor4 - ambient Exotic year_factor4    -0.24360 0.1227
##  warmed Both year_factor4 - warmed Native year_factor5     -0.52946 0.1560
##  warmed Both year_factor4 - ambient Native year_factor5    -0.45513 0.1701
##  warmed Both year_factor4 - warmed  year_factor5            1.38266 0.5538
##  warmed Both year_factor4 - ambient  year_factor5           1.45698 0.5579
##  warmed Both year_factor4 - warmed Both year_factor5        0.55685 0.1101
##  warmed Both year_factor4 - ambient Both year_factor5       0.63118 0.1264
##  warmed Both year_factor4 - warmed Exotic year_factor5      0.23892 0.1503
##  warmed Both year_factor4 - ambient Exotic year_factor5     0.31325 0.1656
##  warmed Both year_factor4 - warmed Native year_factor6     -0.59361 0.1597
##  warmed Both year_factor4 - ambient Native year_factor6    -0.51928 0.1752
##  warmed Both year_factor4 - warmed  year_factor6            1.31850 0.5548
##  warmed Both year_factor4 - ambient  year_factor6           1.39283 0.5594
##  warmed Both year_factor4 - warmed Both year_factor6        0.49269 0.1136
##  warmed Both year_factor4 - ambient Both year_factor6       0.56702 0.1317
##  warmed Both year_factor4 - warmed Exotic year_factor6      0.17477 0.1536
##  warmed Both year_factor4 - ambient Exotic year_factor6     0.24909 0.1703
##  warmed Both year_factor4 - warmed Native year_factor7     -0.09216 0.1610
##  warmed Both year_factor4 - ambient Native year_factor7    -0.01784 0.1767
##  warmed Both year_factor4 - warmed  year_factor7            1.81995 0.5558
##  warmed Both year_factor4 - ambient  year_factor7           1.89428 0.5605
##  warmed Both year_factor4 - warmed Both year_factor7        0.99414 0.1217
##  warmed Both year_factor4 - ambient Both year_factor7       1.06847 0.1391
##  warmed Both year_factor4 - warmed Exotic year_factor7      0.67621 0.1578
##  warmed Both year_factor4 - ambient Exotic year_factor7     0.75054 0.1744
##  ambient Both year_factor4 - warmed Exotic year_factor4    -0.39226 0.1145
##  ambient Both year_factor4 - ambient Exotic year_factor4   -0.31793 0.1006
##  ambient Both year_factor4 - warmed Native year_factor5    -0.60379 0.1663
##  ambient Both year_factor4 - ambient Native year_factor5   -0.52946 0.1560
##  ambient Both year_factor4 - warmed  year_factor5           1.30833 0.5569
```

```
##  ambient Both year_factor4 - ambient  year_factor5          1.38266 0.5538
##  ambient Both year_factor4 - warmed Both year_factor5       0.48252 0.1273
##  ambient Both year_factor4 - ambient Both year_factor5      0.55685 0.1101
##  ambient Both year_factor4 - warmed Exotic year_factor5     0.16459 0.1603
##  ambient Both year_factor4 - ambient Exotic year_factor5    0.23892 0.1503
##  ambient Both year_factor4 - warmed Native year_factor6    -0.66794 0.1681
##  ambient Both year_factor4 - ambient Native year_factor6   -0.59361 0.1597
##  ambient Both year_factor4 - warmed  year_factor6           1.24417 0.5573
##  ambient Both year_factor4 - ambient  year_factor6          1.31850 0.5548
##  ambient Both year_factor4 - warmed Both year_factor6       0.41836 0.1281
##  ambient Both year_factor4 - ambient Both year_factor6      0.49269 0.1136
##  ambient Both year_factor4 - warmed Exotic year_factor6     0.10044 0.1615
##  ambient Both year_factor4 - ambient Exotic year_factor6    0.17477 0.1536
##  ambient Both year_factor4 - warmed Native year_factor7    -0.16649 0.1690
##  ambient Both year_factor4 - ambient Native year_factor7   -0.09216 0.1610
##  ambient Both year_factor4 - warmed  year_factor7           1.74562 0.5583
##  ambient Both year_factor4 - ambient  year_factor7          1.81995 0.5558
##  ambient Both year_factor4 - warmed Both year_factor7       0.91981 0.1349
##  ambient Both year_factor4 - ambient Both year_factor7      0.99414 0.1217
##  ambient Both year_factor4 - warmed Exotic year_factor7     0.60188 0.1653
##  ambient Both year_factor4 - ambient Exotic year_factor7    0.67621 0.1578
##  warmed Exotic year_factor4 - ambient Exotic year_factor4   0.07433 0.0629
##  warmed Exotic year_factor4 - warmed Native year_factor5   -0.21153 0.1301
##  warmed Exotic year_factor4 - ambient Native year_factor5  -0.13720 0.1433
##  warmed Exotic year_factor4 - warmed  year_factor5          1.70058 0.5482
##  warmed Exotic year_factor4 - ambient  year_factor5         1.77491 0.5514
##  warmed Exotic year_factor4 - warmed Both year_factor5      0.87477 0.1480
##  warmed Exotic year_factor4 - ambient Both year_factor5     0.94910 0.1574
##  warmed Exotic year_factor4 - warmed Exotic year_factor5    0.55685 0.1101
##  warmed Exotic year_factor4 - ambient Exotic year_factor5   0.63118 0.1264
##  warmed Exotic year_factor4 - warmed Native year_factor6   -0.27568 0.1338
##  warmed Exotic year_factor4 - ambient Native year_factor6  -0.20136 0.1486
##  warmed Exotic year_factor4 - warmed  year_factor6          1.63643 0.5489
##  warmed Exotic year_factor4 - ambient  year_factor6         1.71076 0.5527
##  warmed Exotic year_factor4 - warmed Both year_factor6      0.81062 0.1500
##  warmed Exotic year_factor4 - ambient Both year_factor6     0.88495 0.1610
##  warmed Exotic year_factor4 - warmed Exotic year_factor6    0.49269 0.1136
##  warmed Exotic year_factor4 - ambient Exotic year_factor6   0.56702 0.1317
##  warmed Exotic year_factor4 - warmed Native year_factor7    0.22576 0.1374
##  warmed Exotic year_factor4 - ambient Native year_factor7   0.30009 0.1522
##  warmed Exotic year_factor4 - warmed  year_factor7          2.13788 0.5505
##  warmed Exotic year_factor4 - ambient  year_factor7         2.21220 0.5544
##  warmed Exotic year_factor4 - warmed Both year_factor7      1.31207 0.1580
##  warmed Exotic year_factor4 - ambient Both year_factor7     1.38640 0.1689
##  warmed Exotic year_factor4 - warmed Exotic year_factor7    0.99414 0.1217
##  warmed Exotic year_factor4 - ambient Exotic year_factor7   1.06847 0.1391
##  ambient Exotic year_factor4 - warmed Native year_factor5  -0.28586 0.1457
##  ambient Exotic year_factor4 - ambient Native year_factor5 -0.21153 0.1301
##  ambient Exotic year_factor4 - warmed  year_factor5         1.62625 0.5522
##  ambient Exotic year_factor4 - ambient  year_factor5        1.70058 0.5482
##  ambient Exotic year_factor4 - warmed Both year_factor5     0.80044 0.1642
##  ambient Exotic year_factor4 - ambient Both year_factor5    0.87477 0.1480
##  ambient Exotic year_factor4 - warmed Exotic year_factor5   0.48252 0.1273
##  ambient Exotic year_factor4 - ambient Exotic year_factor5  0.55685 0.1101
```

```
##  ambient Exotic year_factor4 - warmed Native year_factor6  -0.35001 0.1470
##  ambient Exotic year_factor4 - ambient Native year_factor6 -0.27568 0.1338
##  ambient Exotic year_factor4 - warmed  year_factor6         1.56210 0.5524
##  ambient Exotic year_factor4 - ambient  year_factor6        1.63643 0.5489
##  ambient Exotic year_factor4 - warmed Both year_factor6     0.73629 0.1642
##  ambient Exotic year_factor4 - ambient Both year_factor6    0.81062 0.1500
##  ambient Exotic year_factor4 - warmed Exotic year_factor6   0.41836 0.1281
##  ambient Exotic year_factor4 - ambient Exotic year_factor6  0.49269 0.1136
##  ambient Exotic year_factor4 - warmed Native year_factor7   0.15143 0.1499
##  ambient Exotic year_factor4 - ambient Native year_factor7  0.22576 0.1374
##  ambient Exotic year_factor4 - warmed  year_factor7         2.06355 0.5539
##  ambient Exotic year_factor4 - ambient  year_factor7        2.13788 0.5505
##  ambient Exotic year_factor4 - warmed Both year_factor7     1.23774 0.1713
##  ambient Exotic year_factor4 - ambient Both year_factor7    1.31207 0.1580
##  ambient Exotic year_factor4 - warmed Exotic year_factor7   0.91981 0.1349
##  ambient Exotic year_factor4 - ambient Exotic year_factor7  0.99414 0.1217
##  warmed Native year_factor5 - ambient Native year_factor5   0.07433 0.0629
##  warmed Native year_factor5 - warmed  year_factor5          1.91211 0.5401
##  warmed Native year_factor5 - ambient  year_factor5         1.98644 0.5437
##  warmed Native year_factor5 - warmed Both year_factor5      1.08630 0.1129
##  warmed Native year_factor5 - ambient Both year_factor5     1.16063 0.1263
##  warmed Native year_factor5 - warmed Exotic year_factor5    0.76838 0.0752
##  warmed Native year_factor5 - ambient Exotic year_factor5   0.84271 0.0993
##  warmed Native year_factor5 - warmed Native year_factor6   -0.06415 0.1171
##  warmed Native year_factor5 - ambient Native year_factor6   0.01018 0.1351
##  warmed Native year_factor5 - warmed  year_factor6          1.84796 0.5525
##  warmed Native year_factor5 - ambient  year_factor6         1.92229 0.5566
##  warmed Native year_factor5 - warmed Both year_factor6      1.02215 0.1614
##  warmed Native year_factor5 - ambient Both year_factor6     1.09648 0.1728
##  warmed Native year_factor5 - warmed Exotic year_factor6    0.70422 0.1385
##  warmed Native year_factor5 - ambient Exotic year_factor6   0.77855 0.1548
##  warmed Native year_factor5 - warmed Native year_factor7    0.43729 0.1247
##  warmed Native year_factor5 - ambient Native year_factor7   0.51162 0.1421
##  warmed Native year_factor5 - warmed  year_factor7          2.34941 0.5549
##  warmed Native year_factor5 - ambient  year_factor7         2.42374 0.5590
##  warmed Native year_factor5 - warmed Both year_factor7      1.52360 0.1715
##  warmed Native year_factor5 - ambient Both year_factor7     1.59793 0.1825
##  warmed Native year_factor5 - warmed Exotic year_factor7    1.20567 0.1482
##  warmed Native year_factor5 - ambient Exotic year_factor7   1.28000 0.1638
##  ambient Native year_factor5 - warmed  year_factor5         1.83778 0.5438
##  ambient Native year_factor5 - ambient  year_factor5        1.91211 0.5401
##  ambient Native year_factor5 - warmed Both year_factor5     1.01197 0.1321
##  ambient Native year_factor5 - ambient Both year_factor5    1.08630 0.1129
##  ambient Native year_factor5 - warmed Exotic year_factor5   0.69405 0.0969
##  ambient Native year_factor5 - ambient Exotic year_factor5  0.76838 0.0752
##  ambient Native year_factor5 - warmed Native year_factor6  -0.13848 0.1307
##  ambient Native year_factor5 - ambient Native year_factor6 -0.06415 0.1171
##  ambient Native year_factor5 - warmed  year_factor6         1.77363 0.5556
##  ambient Native year_factor5 - ambient  year_factor6        1.84796 0.5525
##  ambient Native year_factor5 - warmed Both year_factor6     0.94782 0.1738
##  ambient Native year_factor5 - ambient Both year_factor6    1.02215 0.1614
##  ambient Native year_factor5 - warmed Exotic year_factor6   0.62989 0.1494
##  ambient Native year_factor5 - ambient Exotic year_factor6  0.70422 0.1385
##  ambient Native year_factor5 - warmed Native year_factor7   0.36296 0.1372
```

```
##  ambient Native year_factor5 - ambient Native year_factor7  0.43729 0.1247
##  ambient Native year_factor5 - warmed  year_factor7         2.27508 0.5579
##  ambient Native year_factor5 - ambient  year_factor7        2.34941 0.5549
##  ambient Native year_factor5 - warmed Both year_factor7     1.44927 0.1828
##  ambient Native year_factor5 - ambient Both year_factor7    1.52360 0.1715
##  ambient Native year_factor5 - warmed Exotic year_factor7   1.13134 0.1581
##  ambient Native year_factor5 - ambient Exotic year_factor7  1.20567 0.1482
##  warmed  year_factor5 - ambient  year_factor5               0.07433 0.0629
##  warmed  year_factor5 - warmed Both year_factor5           -0.82581 0.5427
##  warmed  year_factor5 - ambient Both year_factor5          -0.75148 0.5457
##  warmed  year_factor5 - warmed Exotic year_factor5         -1.14374 0.5372
##  warmed  year_factor5 - ambient Exotic year_factor5        -1.06941 0.5412
##  warmed  year_factor5 - warmed Native year_factor6         -1.97627 0.5528
##  warmed  year_factor5 - ambient Native year_factor6        -1.90194 0.5569
##  warmed  year_factor5 - warmed  year_factor6               -0.06415 0.1171
##  warmed  year_factor5 - ambient  year_factor6               0.01018 0.1351
##  warmed  year_factor5 - warmed Both year_factor6           -0.88996 0.5549
##  warmed  year_factor5 - ambient Both year_factor6          -0.81563 0.5584
##  warmed  year_factor5 - warmed Exotic year_factor6         -1.20789 0.5498
##  warmed  year_factor5 - ambient Exotic year_factor6        -1.13356 0.5542
##  warmed  year_factor5 - warmed Native year_factor7         -1.47482 0.5537
##  warmed  year_factor5 - ambient Native year_factor7        -1.40049 0.5580
##  warmed  year_factor5 - warmed  year_factor7                0.43729 0.1247
##  warmed  year_factor5 - ambient  year_factor7               0.51162 0.1421
##  warmed  year_factor5 - warmed Both year_factor7           -0.38852 0.5573
##  warmed  year_factor5 - ambient Both year_factor7          -0.31419 0.5608
##  warmed  year_factor5 - warmed Exotic year_factor7         -0.70644 0.5516
##  warmed  year_factor5 - ambient Exotic year_factor7        -0.63211 0.5561
##  ambient  year_factor5 - warmed Both year_factor5          -0.90014 0.5469
##  ambient  year_factor5 - ambient Both year_factor5         -0.82581 0.5427
##  ambient  year_factor5 - warmed Exotic year_factor5        -1.21806 0.5406
##  ambient  year_factor5 - ambient Exotic year_factor5       -1.14374 0.5372
##  ambient  year_factor5 - warmed Native year_factor6        -2.05059 0.5557
##  ambient  year_factor5 - ambient Native year_factor6       -1.97627 0.5528
##  ambient  year_factor5 - warmed  year_factor6              -0.13848 0.1307
##  ambient  year_factor5 - ambient  year_factor6              -0.06415 0.1171
##  ambient  year_factor5 - warmed Both year_factor6          -0.96429 0.5586
##  ambient  year_factor5 - ambient Both year_factor6         -0.88996 0.5549
##  ambient  year_factor5 - warmed Exotic year_factor6        -1.28222 0.5526
##  ambient  year_factor5 - ambient Exotic year_factor6       -1.20789 0.5498
##  ambient  year_factor5 - warmed Native year_factor7        -1.54915 0.5566
##  ambient  year_factor5 - ambient Native year_factor7       -1.47482 0.5537
##  ambient  year_factor5 - warmed  year_factor7               0.36296 0.1372
##  ambient  year_factor5 - ambient  year_factor7               0.43729 0.1247
##  ambient  year_factor5 - warmed Both year_factor7          -0.46285 0.5608
##  ambient  year_factor5 - ambient Both year_factor7         -0.38852 0.5573
##  ambient  year_factor5 - warmed Exotic year_factor7        -0.78077 0.5543
##  ambient  year_factor5 - ambient Exotic year_factor7       -0.70644 0.5516
##  warmed Both year_factor5 - ambient Both year_factor5       0.07433 0.0629
##  warmed Both year_factor5 - warmed Exotic year_factor5     -0.31793 0.1006
##  warmed Both year_factor5 - ambient Exotic year_factor5    -0.24360 0.1227
##  warmed Both year_factor5 - warmed Native year_factor6     -1.15046 0.1639
##  warmed Both year_factor5 - ambient Native year_factor6    -1.07613 0.1793
##  warmed Both year_factor5 - warmed  year_factor6            0.76166 0.5554
```

```
##  warmed Both year_factor5 - ambient  year_factor6          0.83598 0.5601
##  warmed Both year_factor5 - warmed Both year_factor6      -0.06415 0.1171
##  warmed Both year_factor5 - ambient Both year_factor6      0.01018 0.1351
##  warmed Both year_factor5 - warmed Exotic year_factor6    -0.38208 0.1551
##  warmed Both year_factor5 - ambient Exotic year_factor6   -0.30775 0.1720
##  warmed Both year_factor5 - warmed Native year_factor7    -0.64901 0.1649
##  warmed Both year_factor5 - ambient Native year_factor7   -0.57468 0.1805
##  warmed Both year_factor5 - warmed  year_factor7           1.26310 0.5564
##  warmed Both year_factor5 - ambient  year_factor7          1.33743 0.5612
##  warmed Both year_factor5 - warmed Both year_factor7       0.43729 0.1247
##  warmed Both year_factor5 - ambient Both year_factor7      0.51162 0.1421
##  warmed Both year_factor5 - warmed Exotic year_factor7     0.11937 0.1591
##  warmed Both year_factor5 - ambient Exotic year_factor7    0.19370 0.1759
##  ambient Both year_factor5 - warmed Exotic year_factor5   -0.39226 0.1145
##  ambient Both year_factor5 - ambient Exotic year_factor5  -0.31793 0.1006
##  ambient Both year_factor5 - warmed Native year_factor6   -1.22479 0.1717
##  ambient Both year_factor5 - ambient Native year_factor6  -1.15046 0.1639
##  ambient Both year_factor5 - warmed  year_factor6          0.68733 0.5578
##  ambient Both year_factor5 - ambient  year_factor6         0.76166 0.5554
##  ambient Both year_factor5 - warmed Both year_factor6     -0.13848 0.1307
##  ambient Both year_factor5 - ambient Both year_factor6    -0.06415 0.1171
##  ambient Both year_factor5 - warmed Exotic year_factor6   -0.45641 0.1626
##  ambient Both year_factor5 - ambient Exotic year_factor6  -0.38208 0.1551
##  ambient Both year_factor5 - warmed Native year_factor7   -0.72334 0.1723
##  ambient Both year_factor5 - ambient Native year_factor7  -0.64901 0.1649
##  ambient Both year_factor5 - warmed  year_factor7          1.18877 0.5587
##  ambient Both year_factor5 - ambient  year_factor7         1.26310 0.5564
##  ambient Both year_factor5 - warmed Both year_factor7      0.36296 0.1372
##  ambient Both year_factor5 - ambient Both year_factor7     0.43729 0.1247
##  ambient Both year_factor5 - warmed Exotic year_factor7    0.04504 0.1661
##  ambient Both year_factor5 - ambient Exotic year_factor7   0.11937 0.1591
##  warmed Exotic year_factor5 - ambient Exotic year_factor5  0.07433 0.0629
##  warmed Exotic year_factor5 - warmed Native year_factor6  -0.83253 0.1399
##  warmed Exotic year_factor5 - ambient Native year_factor6 -0.75820 0.1546
##  warmed Exotic year_factor5 - warmed  year_factor6         1.07958 0.5499
##  warmed Exotic year_factor5 - ambient  year_factor6        1.15391 0.5537
##  warmed Exotic year_factor5 - warmed Both year_factor6     0.25377 0.1537
##  warmed Exotic year_factor5 - ambient Both year_factor6    0.32810 0.1649
##  warmed Exotic year_factor5 - warmed Exotic year_factor6  -0.06415 0.1171
##  warmed Exotic year_factor5 - ambient Exotic year_factor6  0.01018 0.1351
##  warmed Exotic year_factor5 - warmed Native year_factor7  -0.33108 0.1431
##  warmed Exotic year_factor5 - ambient Native year_factor7 -0.25675 0.1578
##  warmed Exotic year_factor5 - warmed  year_factor7         1.58103 0.5514
##  warmed Exotic year_factor5 - ambient  year_factor7        1.65536 0.5553
##  warmed Exotic year_factor5 - warmed Both year_factor7     0.75522 0.1614
##  warmed Exotic year_factor5 - ambient Both year_factor7    0.82955 0.1724
##  warmed Exotic year_factor5 - warmed Exotic year_factor7   0.43729 0.1247
##  warmed Exotic year_factor5 - ambient Exotic year_factor7  0.51162 0.1421
##  ambient Exotic year_factor5 - warmed Native year_factor6 -0.90686 0.1522
##  ambient Exotic year_factor5 - ambient Native year_factor6 -0.83253 0.1399
##  ambient Exotic year_factor5 - warmed  year_factor6        1.00525 0.5532
##  ambient Exotic year_factor5 - ambient  year_factor6       1.07958 0.5499
##  ambient Exotic year_factor5 - warmed Both year_factor6    0.17944 0.1673
##  ambient Exotic year_factor5 - ambient Both year_factor6   0.25377 0.1537
```

```
##  ambient Exotic year_factor5 - warmed Exotic year_factor6  -0.13848 0.1307
##  ambient Exotic year_factor5 - ambient Exotic year_factor6 -0.06415 0.1171
##  ambient Exotic year_factor5 - warmed Native year_factor7  -0.40541 0.1548
##  ambient Exotic year_factor5 - ambient Native year_factor7 -0.33108 0.1431
##  ambient Exotic year_factor5 - warmed  year_factor7         1.50670 0.5546
##  ambient Exotic year_factor5 - ambient  year_factor7        1.58103 0.5514
##  ambient Exotic year_factor5 - warmed Both year_factor7     0.68089 0.1741
##  ambient Exotic year_factor5 - ambient Both year_factor7    0.75522 0.1614
##  ambient Exotic year_factor5 - warmed Exotic year_factor7   0.36296 0.1372
##  ambient Exotic year_factor5 - ambient Exotic year_factor7  0.43729 0.1247
##  warmed Native year_factor6 - ambient Native year_factor6   0.07433 0.0629
##  warmed Native year_factor6 - warmed  year_factor6          1.91211 0.5401
##  warmed Native year_factor6 - ambient  year_factor6         1.98644 0.5437
##  warmed Native year_factor6 - warmed Both year_factor6      1.08630 0.1129
##  warmed Native year_factor6 - ambient Both year_factor6     1.16063 0.1263
##  warmed Native year_factor6 - warmed Exotic year_factor6    0.76838 0.0752
##  warmed Native year_factor6 - ambient Exotic year_factor6   0.84271 0.0993
##  warmed Native year_factor6 - warmed Native year_factor7    0.50145 0.1277
##  warmed Native year_factor6 - ambient Native year_factor7   0.57578 0.1427
##  warmed Native year_factor6 - warmed  year_factor7          2.41356 0.5557
##  warmed Native year_factor6 - ambient  year_factor7         2.48789 0.5593
##  warmed Native year_factor6 - warmed Both year_factor7      1.58775 0.1748
##  warmed Native year_factor6 - ambient Both year_factor7     1.66208 0.1841
##  warmed Native year_factor6 - warmed Exotic year_factor7    1.26982 0.1513
##  warmed Native year_factor6 - ambient Exotic year_factor7   1.34415 0.1649
##  ambient Native year_factor6 - warmed  year_factor6         1.83778 0.5438
##  ambient Native year_factor6 - ambient  year_factor6        1.91211 0.5401
##  ambient Native year_factor6 - warmed Both year_factor6     1.01197 0.1321
##  ambient Native year_factor6 - ambient Both year_factor6    1.08630 0.1129
##  ambient Native year_factor6 - warmed Exotic year_factor6   0.69405 0.0969
##  ambient Native year_factor6 - ambient Exotic year_factor6  0.76838 0.0752
##  ambient Native year_factor6 - warmed Native year_factor7   0.42712 0.1420
##  ambient Native year_factor6 - ambient Native year_factor7  0.50145 0.1277
##  ambient Native year_factor6 - warmed  year_factor7         2.33923 0.5592
##  ambient Native year_factor6 - ambient  year_factor7        2.41356 0.5557
##  ambient Native year_factor6 - warmed Both year_factor7     1.51342 0.1875
##  ambient Native year_factor6 - ambient Both year_factor7    1.58775 0.1748
##  ambient Native year_factor6 - warmed Exotic year_factor7   1.19549 0.1629
##  ambient Native year_factor6 - ambient Exotic year_factor7  1.26982 0.1513
##  warmed  year_factor6 - ambient  year_factor6                0.07433 0.0629
##  warmed  year_factor6 - warmed Both year_factor6           -0.82581 0.5427
##  warmed  year_factor6 - ambient Both year_factor6          -0.75148 0.5457
##  warmed  year_factor6 - warmed Exotic year_factor6         -1.14374 0.5372
##  warmed  year_factor6 - ambient Exotic year_factor6        -1.06941 0.5412
##  warmed  year_factor6 - warmed Native year_factor7         -1.41067 0.5543
##  warmed  year_factor6 - ambient Native year_factor7        -1.33634 0.5580
##  warmed  year_factor6 - warmed  year_factor7                0.50145 0.1277
##  warmed  year_factor6 - ambient  year_factor7               0.57578 0.1427
##  warmed  year_factor6 - warmed Both year_factor7           -0.32436 0.5582
##  warmed  year_factor6 - ambient Both year_factor7          -0.25003 0.5612
##  warmed  year_factor6 - warmed Exotic year_factor7         -0.64229 0.5523
##  warmed  year_factor6 - ambient Exotic year_factor7        -0.56796 0.5563
##  ambient  year_factor6 - warmed Both year_factor6          -0.90014 0.5469
##  ambient  year_factor6 - ambient Both year_factor6         -0.82581 0.5427
```

```
##  ambient  year_factor6 - warmed Exotic year_factor6        -1.21806 0.5406
##  ambient  year_factor6 - ambient Exotic year_factor6       -1.14374 0.5372
##  ambient  year_factor6 - warmed Native year_factor7        -1.48500 0.5577
##  ambient  year_factor6 - ambient Native year_factor7       -1.41067 0.5543
##  ambient  year_factor6 - warmed  year_factor7                0.42712 0.1420
##  ambient  year_factor6 - ambient  year_factor7               0.50145 0.1277
##  ambient  year_factor6 - warmed Both year_factor7          -0.39869 0.5622
##  ambient  year_factor6 - ambient Both year_factor7         -0.32436 0.5582
##  ambient  year_factor6 - warmed Exotic year_factor7        -0.71662 0.5555
##  ambient  year_factor6 - ambient Exotic year_factor7       -0.64229 0.5523
##  warmed Both year_factor6 - ambient Both year_factor6       0.07433 0.0629
##  warmed Both year_factor6 - warmed Exotic year_factor6     -0.31793 0.1006
##  warmed Both year_factor6 - ambient Exotic year_factor6    -0.24360 0.1227
##  warmed Both year_factor6 - warmed Native year_factor7     -0.58486 0.1660
##  warmed Both year_factor6 - ambient Native year_factor7    -0.51053 0.1799
##  warmed Both year_factor6 - warmed  year_factor7            1.32726 0.5568
##  warmed Both year_factor6 - ambient  year_factor7           1.40159 0.5611
##  warmed Both year_factor6 - warmed Both year_factor7        0.50145 0.1277
##  warmed Both year_factor6 - ambient Both year_factor7       0.57578 0.1427
##  warmed Both year_factor6 - warmed Exotic year_factor7      0.18352 0.1608
##  warmed Both year_factor6 - ambient Exotic year_factor7     0.25785 0.1758
##  ambient Both year_factor6 - warmed Exotic year_factor6    -0.39226 0.1145
##  ambient Both year_factor6 - ambient Exotic year_factor6   -0.31793 0.1006
##  ambient Both year_factor6 - warmed Native year_factor7    -0.65919 0.1750
##  ambient Both year_factor6 - ambient Native year_factor7   -0.58486 0.1660
##  ambient Both year_factor6 - warmed  year_factor7           1.25293 0.5597
##  ambient Both year_factor6 - ambient  year_factor7          1.32726 0.5568
##  ambient Both year_factor6 - warmed Both year_factor7       0.42712 0.1420
##  ambient Both year_factor6 - ambient Both year_factor7      0.50145 0.1277
##  ambient Both year_factor6 - warmed Exotic year_factor7     0.10919 0.1695
##  ambient Both year_factor6 - ambient Exotic year_factor7    0.18352 0.1608
##  warmed Exotic year_factor6 - ambient Exotic year_factor6   0.07433 0.0629
##  warmed Exotic year_factor6 - warmed Native year_factor7   -0.26693 0.1450
##  warmed Exotic year_factor6 - ambient Native year_factor7  -0.19260 0.1577
##  warmed Exotic year_factor6 - warmed  year_factor7          1.64518 0.5520
##  warmed Exotic year_factor6 - ambient  year_factor7         1.71951 0.5554
##  warmed Exotic year_factor6 - warmed Both year_factor7      0.81937 0.1643
##  warmed Exotic year_factor6 - ambient Both year_factor7     0.89370 0.1735
##  warmed Exotic year_factor6 - warmed Exotic year_factor7    0.50145 0.1277
##  warmed Exotic year_factor6 - ambient Exotic year_factor7   0.57578 0.1427
##  ambient Exotic year_factor6 - warmed Native year_factor7  -0.34126 0.1585
##  ambient Exotic year_factor6 - ambient Native year_factor7 -0.26693 0.1450
##  ambient Exotic year_factor6 - warmed  year_factor7         1.57085 0.5558
##  ambient Exotic year_factor6 - ambient  year_factor7        1.64518 0.5520
##  ambient Exotic year_factor6 - warmed Both year_factor7     0.74504 0.1784
##  ambient Exotic year_factor6 - ambient Both year_factor7    0.81937 0.1643
##  ambient Exotic year_factor6 - warmed Exotic year_factor7   0.42712 0.1420
##  ambient Exotic year_factor6 - ambient Exotic year_factor7  0.50145 0.1277
##  warmed Native year_factor7 - ambient Native year_factor7   0.07433 0.0629
##  warmed Native year_factor7 - warmed  year_factor7          1.91211 0.5401
##  warmed Native year_factor7 - ambient  year_factor7         1.98644 0.5437
##  warmed Native year_factor7 - warmed Both year_factor7      1.08630 0.1129
##  warmed Native year_factor7 - ambient Both year_factor7     1.16063 0.1263
##  warmed Native year_factor7 - warmed Exotic year_factor7    0.76838 0.0752
```

```
##  warmed Native year_factor7 - ambient Exotic year_factor7   0.84271 0.0993
##  ambient Native year_factor7 - warmed  year_factor7         1.83778 0.5438
##  ambient Native year_factor7 - ambient  year_factor7        1.91211 0.5401
##  ambient Native year_factor7 - warmed Both year_factor7     1.01197 0.1321
##  ambient Native year_factor7 - ambient Both year_factor7    1.08630 0.1129
##  ambient Native year_factor7 - warmed Exotic year_factor7   0.69405 0.0969
##  ambient Native year_factor7 - ambient Exotic year_factor7  0.76838 0.0752
##  warmed  year_factor7 - ambient  year_factor7               0.07433 0.0629
##  warmed  year_factor7 - warmed Both year_factor7           -0.82581 0.5427
##  warmed  year_factor7 - ambient Both year_factor7          -0.75148 0.5457
##  warmed  year_factor7 - warmed Exotic year_factor7         -1.14374 0.5372
##  warmed  year_factor7 - ambient Exotic year_factor7        -1.06941 0.5412
##  ambient  year_factor7 - warmed Both year_factor7          -0.90014 0.5469
##  ambient  year_factor7 - ambient Both year_factor7         -0.82581 0.5427
##  ambient  year_factor7 - warmed Exotic year_factor7        -1.21806 0.5406
##  ambient  year_factor7 - ambient Exotic year_factor7       -1.14374 0.5372
##  warmed Both year_factor7 - ambient Both year_factor7       0.07433 0.0629
##  warmed Both year_factor7 - warmed Exotic year_factor7     -0.31793 0.1006
##  warmed Both year_factor7 - ambient Exotic year_factor7    -0.24360 0.1227
##  ambient Both year_factor7 - warmed Exotic year_factor7    -0.39226 0.1145
##  ambient Both year_factor7 - ambient Exotic year_factor7   -0.31793 0.1006
##  warmed Exotic year_factor7 - ambient Exotic year_factor7   0.07433 0.0629
##      df t.ratio p.value
##    21.8   1.181  1.0000
##  1136.1   3.540  0.2449
##  1120.1   3.654  0.1809
##  1135.0   9.622  <.0001
##   272.6   9.188  <.0001
##  1136.1  10.211  <.0001
##   119.7   8.491  <.0001
##  1132.2 -11.025  <.0001
##   444.2  -9.655  <.0001
##  1136.0   0.661  1.0000
##  1121.6   0.784  1.0000
##  1135.5  -2.443  0.9745
##   672.5  -1.952  0.9998
##  1134.7  -4.770  0.0027
##   569.0  -4.020  0.0592
##  1132.5 -11.076  <.0001
##   475.7  -9.778  <.0001
##  1136.1   0.561  1.0000
##  1123.1   0.685  1.0000
##  1135.3  -2.694  0.8944
##   701.7  -2.208  0.9961
##  1135.0  -5.011  0.0009
##   592.4  -4.273  0.0235
##  1133.5 -11.696  <.0001
##   457.3 -10.363  <.0001
##  1136.0   0.430  1.0000
##  1122.5   0.555  1.0000
##  1135.9  -3.076  0.6196
##   697.5  -2.586  0.9378
##  1135.0  -5.582  <.0001
##   566.5  -4.799  0.0026
```

```
##  1129.3  -7.619  <.0001
##   493.5  -6.625  <.0001
##  1136.1   1.381  1.0000
##  1123.9   1.501  1.0000
##  1134.0  -0.093  1.0000
##   741.1   0.288  1.0000
##  1133.2  -2.032  0.9994
##   614.1  -1.492  1.0000
##  1133.0  -7.927  <.0001
##   503.5  -6.855  <.0001
##  1135.9   1.270  1.0000
##  1121.2   1.390  1.0000
##  1135.1  -0.428  1.0000
##   736.2  -0.037  1.0000
##  1134.9  -2.398  0.9815
##   615.3  -1.826  1.0000
##  1131.7  -4.334  0.0175
##   560.2  -3.571  0.2298
##  1136.1   2.118  0.9985
##  1124.6   2.233  0.9953
##  1134.9   2.098  0.9988
##   788.0   2.379  0.9836
##  1133.9   0.581  1.0000
##   679.8   0.945  1.0000
##  1129.0   3.379  0.3584
##  1136.1   3.540  0.2449
##   332.1   7.659  <.0001
##  1135.0   9.622  <.0001
##   116.6   7.161  <.0001
##  1136.1  10.211  <.0001
##   517.6 -10.413  <.0001
##  1132.2 -11.025  <.0001
##  1130.2   0.530  1.0000
##  1136.0   0.661  1.0000
##   776.8  -2.651  0.9134
##  1135.5  -2.443  0.9745
##   647.4  -4.847  0.0020
##  1134.7  -4.770  0.0027
##   546.8 -10.491  <.0001
##  1132.5 -11.076  <.0001
##  1131.0   0.431  1.0000
##  1136.1   0.561  1.0000
##   799.1  -2.882  0.7785
##  1135.3  -2.694  0.8944
##   667.2  -5.071  0.0007
##  1135.0  -5.011  0.0009
##   544.0 -11.016  <.0001
##  1133.5 -11.696  <.0001
##  1130.9   0.301  1.0000
##  1136.0   0.430  1.0000
##   805.3  -3.233  0.4811
##  1135.9  -3.076  0.6196
##   656.9  -5.584  0.0001
##  1135.0  -5.582  <.0001
```

```
##   573.9  -7.342  <.0001
##  1129.3  -7.619  <.0001
##  1131.5   1.245  1.0000
##  1136.1   1.381  1.0000
##   836.8  -0.450  1.0000
##  1134.0  -0.093  1.0000
##   695.2  -2.299  0.9912
##  1133.2  -2.032  0.9994
##   575.8  -7.721  <.0001
##  1133.0  -7.927  <.0001
##  1130.1   1.136  1.0000
##  1135.9   1.270  1.0000
##   833.7  -0.766  1.0000
##  1135.1  -0.428  1.0000
##   693.4  -2.661  0.9088
##  1134.9  -2.398  0.9815
##   616.2  -4.449  0.0116
##  1131.7  -4.334  0.0175
##  1132.0   1.980  0.9997
##  1136.1   2.118  0.9985
##   865.6   1.631  1.0000
##  1134.9   2.098  0.9988
##   741.3   0.148  1.0000
##  1133.9   0.581  1.0000
##    21.8   1.181  1.0000
##  1136.1  -1.522  1.0000
##  1128.5  -1.377  1.0000
##  1136.1  -2.129  0.9983
##  1130.2  -1.976  0.9997
##  1135.9  -6.481  <.0001
##  1130.7  -6.302  <.0001
##  1132.2 -11.025  <.0001
##   444.2  -9.655  <.0001
##  1136.0  -4.407  0.0130
##  1129.8  -4.247  0.0246
##  1135.5  -5.057  0.0007
##  1131.7  -4.883  0.0016
##  1136.1  -6.574  <.0001
##  1129.8  -6.395  <.0001
##  1132.5 -11.076  <.0001
##   475.7  -9.778  <.0001
##  1136.1  -4.501  0.0088
##  1129.0  -4.342  0.0170
##  1135.8  -5.154  0.0004
##  1130.8  -4.980  0.0010
##  1136.0  -6.719  <.0001
##  1129.6  -6.540  <.0001
##  1133.5 -11.696  <.0001
##   457.3 -10.363  <.0001
##  1136.1  -4.637  0.0049
##  1128.7  -4.478  0.0097
##  1135.8  -5.305  0.0002
##  1130.8  -5.132  0.0005
##  1136.1  -5.670  <.0001
```

```
##  1129.7  -5.499  0.0001
##  1129.3  -7.619  <.0001
##   493.5  -6.625  <.0001
##  1136.1  -3.594  0.2129
##  1129.1  -3.441  0.3121
##  1135.8  -4.244  0.0249
##  1130.8  -4.078  0.0463
##  1135.9  -5.782  <.0001
##  1130.9  -5.604  <.0001
##  1133.0  -7.927  <.0001
##   503.5  -6.855  <.0001
##  1136.0  -3.711  0.1538
##  1130.3  -3.553  0.2368
##  1135.5  -4.360  0.0158
##  1131.9  -4.190  0.0307
##  1136.1  -4.830  0.0020
##  1129.0  -4.659  0.0044
##  1131.7  -4.334  0.0175
##   560.2  -3.571  0.2298
##  1136.1  -2.765  0.8569
##  1128.4  -2.613  0.9294
##  1136.0  -3.401  0.3414
##  1130.3  -3.238  0.4757
##  1120.8  -1.646  1.0000
##  1136.1  -1.522  1.0000
##  1122.6  -2.253  0.9943
##  1136.1  -2.129  0.9983
##  1124.4  -6.570  <.0001
##  1135.9  -6.481  <.0001
##   517.6 -10.413  <.0001
##  1132.2 -11.025  <.0001
##  1124.3  -4.506  0.0086
##  1136.0  -4.407  0.0130
##  1126.5  -5.159  0.0004
##  1135.5  -5.057  0.0007
##  1123.0  -6.661  <.0001
##  1136.1  -6.574  <.0001
##   546.8 -10.491  <.0001
##  1132.5 -11.076  <.0001
##  1123.0  -4.599  0.0058
##  1136.1  -4.501  0.0088
##  1125.1  -5.254  0.0003
##  1135.8  -5.154  0.0004
##  1123.2  -6.804  <.0001
##  1136.0  -6.719  <.0001
##   544.0 -11.016  <.0001
##  1133.5 -11.696  <.0001
##  1123.2  -4.732  0.0032
##  1136.1  -4.637  0.0049
##  1125.4  -5.404  0.0001
##  1135.8  -5.305  0.0002
##  1122.8  -5.762  <.0001
##  1136.1  -5.670  <.0001
##   573.9  -7.342  <.0001
```

```
##  1129.3  -7.619  <.0001
##  1123.2  -3.698  0.1596
##  1136.1  -3.594  0.2129
##  1125.0  -4.350  0.0164
##  1135.8  -4.244  0.0249
##  1125.2  -5.879  <.0001
##  1135.9  -5.782  <.0001
##   575.8  -7.721  <.0001
##  1133.0  -7.927  <.0001
##  1125.5  -3.817  0.1116
##  1136.0  -3.711  0.1538
##  1127.2  -4.469  0.0101
##  1135.5  -4.360  0.0158
##  1122.1  -4.935  0.0012
##  1136.1  -4.830  0.0020
##   616.2  -4.449  0.0116
##  1131.7  -4.334  0.0175
##  1122.5  -2.879  0.7813
##  1136.1  -2.765  0.8569
##  1124.5  -3.518  0.2593
##  1136.0  -3.401  0.3414
##    21.8   1.181  1.0000
##  1136.1  -3.159  0.5454
##   254.3  -1.985  0.9995
##  1129.9 -14.762  <.0001
##   731.9 -13.467  <.0001
##  1136.0  -1.198  1.0000
##  1122.6  -1.065  1.0000
##  1132.2 -11.025  <.0001
##   444.2  -9.655  <.0001
##  1132.3 -10.803  <.0001
##   680.3  -9.659  <.0001
##  1130.8 -14.865  <.0001
##   744.3 -13.605  <.0001
##  1136.1  -1.294  1.0000
##  1123.9  -1.160  1.0000
##  1132.5 -11.076  <.0001
##   475.7  -9.778  <.0001
##  1133.3 -10.976  <.0001
##   691.5  -9.855  <.0001
##  1130.0 -15.619  <.0001
##   719.7 -14.295  <.0001
##  1136.1  -1.428  1.0000
##  1123.5  -1.294  1.0000
##  1133.5 -11.696  <.0001
##   457.3 -10.363  <.0001
##  1131.8 -11.815  <.0001
##   656.8 -10.596  <.0001
##  1128.8 -12.393  <.0001
##   732.9 -11.287  <.0001
##  1136.1  -0.475  1.0000
##  1124.4  -0.346  1.0000
##  1129.3  -7.619  <.0001
##   493.5  -6.625  <.0001
```

```
##  1131.6  -8.318  <.0001
##   682.9  -7.378  <.0001
##  1131.8 -12.534  <.0001
##   738.1 -11.357  <.0001
##  1135.9  -0.584  1.0000
##  1121.9  -0.454  1.0000
##  1133.0  -7.927  <.0001
##   503.5  -6.855  <.0001
##  1133.9  -8.559  <.0001
##   687.6  -7.560  <.0001
##  1129.7  -9.680  <.0001
##   760.4  -8.681  <.0001
##  1136.1   0.271  1.0000
##  1125.2   0.395  1.0000
##  1131.7  -4.334  0.0175
##   560.2  -3.571  0.2298
##  1131.9  -5.546  0.0001
##   726.9  -4.774  0.0028
##   199.5  -3.426  0.3359
##  1136.1  -3.159  0.5454
##   748.2 -14.354  <.0001
##  1129.9 -14.762  <.0001
##  1130.2  -1.318  1.0000
##  1136.0  -1.198  1.0000
##   517.6 -10.413  <.0001
##  1132.2 -11.025  <.0001
##   706.9 -10.621  <.0001
##  1132.3 -10.803  <.0001
##   757.6 -14.455  <.0001
##  1130.8 -14.865  <.0001
##  1130.9  -1.413  1.0000
##  1136.1  -1.294  1.0000
##   546.8 -10.491  <.0001
##  1132.5 -11.076  <.0001
##   715.1 -10.784  <.0001
##  1133.3 -10.976  <.0001
##   746.8 -15.118  <.0001
##  1130.0 -15.619  <.0001
##  1130.9  -1.546  1.0000
##  1136.1  -1.428  1.0000
##   544.0 -11.016  <.0001
##  1133.5 -11.696  <.0001
##   695.0 -11.528  <.0001
##  1131.8 -11.815  <.0001
##   751.5 -12.062  <.0001
##  1128.8 -12.393  <.0001
##  1131.3  -0.598  1.0000
##  1136.1  -0.475  1.0000
##   573.9  -7.342  <.0001
##  1129.3  -7.619  <.0001
##   712.6  -8.236  <.0001
##  1131.6  -8.318  <.0001
##   757.6 -12.311  <.0001
##  1131.8 -12.534  <.0001
```

```
##  1129.9  -0.707  1.0000
##  1135.9  -0.584  1.0000
##   575.8  -7.721  <.0001
##  1133.0  -7.927  <.0001
##   716.6  -8.545  <.0001
##  1133.9  -8.559  <.0001
##   766.4  -9.615  <.0001
##  1129.7  -9.680  <.0001
##  1131.8   0.144  1.0000
##  1136.1   0.271  1.0000
##   616.2  -4.449  0.0116
##  1131.7  -4.334  0.0175
##   742.6  -5.692  <.0001
##  1131.9  -5.546  0.0001
##    21.8   1.181  1.0000
##  1132.8 -14.695  <.0001
##   568.4 -13.363  <.0001
##  1136.1  -0.660  1.0000
##  1123.7  -0.530  1.0000
##  1135.8  -7.045  <.0001
##   622.1  -6.350  <.0001
##  1132.2 -11.025  <.0001
##   444.2  -9.655  <.0001
##  1132.6 -14.663  <.0001
##   598.9 -13.401  <.0001
##  1136.1  -0.757  1.0000
##  1125.2  -0.627  1.0000
##  1135.4  -7.176  <.0001
##   657.3  -6.508  <.0001
##  1132.5 -11.076  <.0001
##   475.7  -9.778  <.0001
##  1134.2 -15.039  <.0001
##   590.8 -13.796  <.0001
##  1136.1  -0.889  1.0000
##  1124.6  -0.758  1.0000
##  1136.1  -7.445  <.0001
##   661.0  -6.798  <.0001
##  1133.5 -11.696  <.0001
##   457.3 -10.363  <.0001
##  1130.5 -11.600  <.0001
##   610.2 -10.562  <.0001
##  1136.1   0.068  1.0000
##  1125.9   0.195  1.0000
##  1134.1  -4.325  0.0181
##   696.3  -3.793  0.1220
##  1129.3  -7.619  <.0001
##   493.5  -6.625  <.0001
##  1133.3 -11.792  <.0001
##   618.6 -10.666  <.0001
##  1136.1  -0.042  1.0000
##  1123.4   0.085  1.0000
##  1135.3  -4.642  0.0048
##   694.9  -4.072  0.0487
##  1133.0  -7.927  <.0001
```

```
##   503.5  -6.855  <.0001
##  1132.5  -8.579  <.0001
##   649.5  -7.654  <.0001
##  1136.0   0.817  1.0000
##  1126.4   0.939  1.0000
##  1135.2  -1.836  1.0000
##   739.0  -1.391  1.0000
##  1131.7  -4.334  0.0175
##   560.2  -3.571  0.2298
##   629.4 -13.893  <.0001
##  1132.8 -14.695  <.0001
##  1131.2  -0.783  1.0000
##  1136.1  -0.660  1.0000
##   724.3  -6.870  <.0001
##  1135.8  -7.045  <.0001
##   517.6 -10.413  <.0001
##  1132.2 -11.025  <.0001
##   655.6 -13.895  <.0001
##  1132.6 -14.663  <.0001
##  1132.0  -0.879  1.0000
##  1136.1  -0.757  1.0000
##   752.5  -7.002  <.0001
##  1135.4  -7.176  <.0001
##   546.8 -10.491  <.0001
##  1132.5 -11.076  <.0001
##   661.7 -14.226  <.0001
##  1134.2 -15.039  <.0001
##  1131.9  -1.010  1.0000
##  1136.1  -0.889  1.0000
##   765.4  -7.255  <.0001
##  1136.1  -7.445  <.0001
##   544.0 -11.016  <.0001
##  1133.5 -11.696  <.0001
##   673.5 -11.049  <.0001
##  1130.5 -11.600  <.0001
##  1132.4  -0.059  1.0000
##  1136.1   0.068  1.0000
##   791.0  -4.370  0.0156
##  1134.1  -4.325  0.0181
##   573.9  -7.342  <.0001
##  1129.3  -7.619  <.0001
##   678.1 -11.352  <.0001
##  1133.3 -11.792  <.0001
##  1131.2  -0.168  1.0000
##  1136.1  -0.042  1.0000
##   789.6  -4.700  0.0039
##  1135.3  -4.642  0.0048
##   575.8  -7.721  <.0001
##  1133.0  -7.927  <.0001
##   692.7  -8.401  <.0001
##  1132.5  -8.579  <.0001
##  1132.8   0.685  1.0000
##  1136.0   0.817  1.0000
##   814.8  -2.086  0.9989
```

```
##  1135.2  -1.836  1.0000
##   616.2  -4.449  0.0116
##  1131.7  -4.334  0.0175
##    21.8   1.181  1.0000
##  1136.1   3.540  0.2449
##  1120.1   3.654  0.1809
##  1135.0   9.622  <.0001
##   272.6   9.188  <.0001
##  1136.1  10.211  <.0001
##   119.7   8.491  <.0001
##  1126.2  -0.550  1.0000
##   259.4   0.141  1.0000
##  1136.1   3.373  0.3636
##  1123.6   3.486  0.2805
##  1131.2   6.658  <.0001
##   567.4   6.711  <.0001
##  1132.6   5.553  0.0001
##   404.9   5.483  0.0001
##  1123.8  -1.306  1.0000
##   245.7  -0.498  1.0000
##  1136.1   3.236  0.4777
##  1123.2   3.351  0.3811
##  1132.5   6.067  <.0001
##   571.2   6.172  <.0001
##  1129.7   5.103  0.0005
##   377.8   5.080  0.0008
##  1129.7   3.975  0.0666
##   265.2   4.062  0.0562
##  1136.1   4.239  0.0254
##  1124.0   4.348  0.0165
##  1131.9   9.362  <.0001
##   606.4   9.315  <.0001
##  1133.5   9.098  <.0001
##   416.6   8.726  <.0001
##  1131.2   3.265  0.4528
##   293.1   3.390  0.3579
##  1136.1   4.118  0.0400
##  1121.4   4.224  0.0269
##  1132.1   8.903  <.0001
##   614.3   8.796  <.0001
##  1134.0   8.471  <.0001
##   435.0   8.067  <.0001
##  1133.8   7.269  <.0001
##   349.1   6.897  <.0001
##  1136.0   5.006  0.0009
##  1124.8   5.104  0.0005
##  1134.1  11.280  <.0001
##   676.3  11.060  <.0001
##  1134.8  11.356  <.0001
##   508.7  10.738  <.0001
##  1129.0   3.379  0.3584
##  1136.1   3.540  0.2449
##   332.1   7.659  <.0001
##  1135.0   9.622  <.0001
```

```
##   116.6   7.161  <.0001
##  1136.1  10.211  <.0001
##   259.3  -1.080  1.0000
##  1126.2  -0.550  1.0000
##  1130.9   3.216  0.4953
##  1136.1   3.373  0.3636
##   621.3   5.639  <.0001
##  1131.2   6.658  <.0001
##   409.0   4.481  0.0109
##  1132.6   5.553  0.0001
##   259.6  -1.720  1.0000
##  1123.8  -1.306  1.0000
##  1130.9   3.079  0.6166
##  1136.1   3.236  0.4777
##   639.3   5.110  0.0006
##  1132.5   6.067  <.0001
##   397.3   4.025  0.0603
##  1129.7   5.103  0.0005
##   276.2   2.793  0.8338
##  1129.7   3.975  0.0666
##  1131.1   4.075  0.0468
##  1136.1   4.239  0.0254
##   664.1   8.150  <.0001
##  1131.9   9.362  <.0001
##   431.0   7.676  <.0001
##  1133.5   9.098  <.0001
##   287.3   2.267  0.9922
##  1131.2   3.265  0.4528
##  1129.8   3.959  0.0702
##  1136.1   4.118  0.0400
##   669.1   7.815  <.0001
##  1132.1   8.903  <.0001
##   438.7   7.239  <.0001
##  1134.0   8.471  <.0001
##   328.7   5.929  <.0001
##  1133.8   7.269  <.0001
##  1131.7   4.843  0.0019
##  1136.0   5.006  0.0009
##   712.3  10.139  <.0001
##  1134.1  11.280  <.0001
##   498.9  10.053  <.0001
##  1134.8  11.356  <.0001
##    21.8   1.181  1.0000
##  1136.1  -1.522  1.0000
##  1128.5  -1.377  1.0000
##  1136.1  -2.129  0.9983
##  1130.2  -1.976  0.9997
##  1136.1  -3.580  0.2207
##  1129.1  -3.423  0.3253
##  1126.2  -0.550  1.0000
##   259.4   0.141  1.0000
##  1136.0  -1.597  1.0000
##  1128.7  -1.455  1.0000
##  1136.1  -2.195  0.9967
```

```
##  1130.2  -2.045  0.9994
##  1136.1  -3.720  0.1494
##  1129.1  -3.563  0.2313
##  1123.8  -1.306  1.0000
##   245.7  -0.498  1.0000
##  1136.0  -1.733  1.0000
##  1128.7  -1.591  1.0000
##  1136.1  -2.338  0.9883
##  1130.3  -2.187  0.9969
##  1136.0  -2.707  0.8882
##  1128.6  -2.556  0.9483
##  1129.7   3.975  0.0666
##   265.2   4.062  0.0562
##  1136.0  -0.727  1.0000
##  1128.5  -0.590  1.0000
##  1136.1  -1.317  1.0000
##  1129.8  -1.173  1.0000
##  1136.1  -2.820  0.8227
##  1130.1  -2.666  0.9078
##  1131.2   3.265  0.4528
##   293.1   3.390  0.3579
##  1136.1  -0.842  1.0000
##  1129.9  -0.704  1.0000
##  1136.0  -1.432  1.0000
##  1131.2  -1.287  1.0000
##  1135.9  -1.906  0.9999
##  1127.9  -1.758  1.0000
##  1133.8   7.269  <.0001
##   349.1   6.897  <.0001
##  1135.9   0.062  1.0000
##  1127.7   0.194  1.0000
##  1136.1  -0.515  1.0000
##  1129.3  -0.377  1.0000
##  1120.8  -1.646  1.0000
##  1136.1  -1.522  1.0000
##  1122.6  -2.253  0.9943
##  1136.1  -2.129  0.9983
##  1120.5  -3.691  0.1625
##  1136.1  -3.580  0.2207
##   259.3  -1.080  1.0000
##  1126.2  -0.550  1.0000
##  1121.2  -1.718  1.0000
##  1136.0  -1.597  1.0000
##  1122.8  -2.316  0.9902
##  1136.1  -2.195  0.9967
##  1121.0  -3.830  0.1071
##  1136.1  -3.720  0.1494
##   259.6  -1.720  1.0000
##  1123.8  -1.306  1.0000
##  1121.6  -1.853  1.0000
##  1136.0  -1.733  1.0000
##  1123.3  -2.458  0.9718
##  1136.1  -2.338  0.9883
##  1119.8  -2.823  0.8205
```

```
##  1136.0  -2.707  0.8882
##   276.2   2.793  0.8338
##  1129.7   3.975  0.0666
##  1120.9  -0.854  1.0000
##  1136.0  -0.727  1.0000
##  1122.2  -1.443  1.0000
##  1136.1  -1.317  1.0000
##  1122.6  -2.937  0.7368
##  1136.1  -2.820  0.8227
##   287.3   2.267  0.9922
##  1131.2   3.265  0.4528
##  1123.5  -0.969  1.0000
##  1136.1  -0.842  1.0000
##  1124.8  -1.559  1.0000
##  1136.0  -1.432  1.0000
##  1119.0  -2.029  0.9995
##  1135.9  -1.906  0.9999
##   328.7   5.929  <.0001
##  1133.8   7.269  <.0001
##  1120.1  -0.071  1.0000
##  1135.9   0.062  1.0000
##  1121.6  -0.647  1.0000
##  1136.1  -0.515  1.0000
##    21.8   1.181  1.0000
##  1136.1  -3.159  0.5454
##   254.3  -1.985  0.9995
##  1132.7  -7.506  <.0001
##   603.4  -6.406  <.0001
##  1136.1   1.392  1.0000
##  1123.9   1.515  1.0000
##  1126.2  -0.550  1.0000
##   259.4   0.141  1.0000
##  1134.5  -2.619  0.9272
##   530.8  -1.888  0.9999
##  1129.9  -8.252  <.0001
##   575.4  -7.053  <.0001
##  1136.1   1.256  1.0000
##  1123.7   1.381  1.0000
##  1123.8  -1.306  1.0000
##   245.7  -0.498  1.0000
##  1130.7  -3.319  0.4073
##   488.0  -2.473  0.9672
##  1134.1  -4.457  0.0106
##   570.0  -3.614  0.2052
##  1136.1   2.264  0.9937
##  1124.1   2.382  0.9836
##  1129.7   3.975  0.0666
##   265.2   4.062  0.0562
##  1135.4   0.748  1.0000
##   501.6   1.150  1.0000
##  1134.6  -4.766  0.0027
##   594.4  -3.883  0.0931
##  1136.1   2.144  0.9980
##  1121.5   2.260  0.9939
```

```
##  1131.2   3.265  0.4528
##   293.1   3.390  0.3579
##  1135.7   0.284  1.0000
##   525.2   0.716  1.0000
##  1134.7  -1.468  1.0000
##   610.2  -0.894  1.0000
##  1136.0   3.045  0.6463
##  1124.9   3.154  0.5503
##  1133.8   7.269  <.0001
##   349.1   6.897  <.0001
##  1135.5   3.656  0.1797
##   563.9   3.729  0.1488
##   199.5  -3.426  0.3359
##  1136.1  -3.159  0.5454
##   544.2  -7.483  <.0001
##  1132.7  -7.506  <.0001
##  1130.4   1.250  1.0000
##  1136.1   1.392  1.0000
##   259.3  -1.080  1.0000
##  1126.2  -0.550  1.0000
##   477.3  -2.928  0.7425
##  1134.5  -2.619  0.9272
##   530.3  -8.146  <.0001
##  1129.9  -8.252  <.0001
##  1130.5   1.115  1.0000
##  1136.1   1.256  1.0000
##   259.6  -1.720  1.0000
##  1123.8  -1.306  1.0000
##   447.8  -3.572  0.2308
##  1130.7  -3.319  0.4073
##   518.3  -4.606  0.0062
##  1134.1  -4.457  0.0106
##  1130.5   2.117  0.9985
##  1136.1   2.264  0.9937
##   276.2   2.793  0.8338
##  1129.7   3.975  0.0666
##   456.5   0.202  1.0000
##  1135.4   0.748  1.0000
##   538.4  -4.951  0.0013
##  1134.6  -4.766  0.0027
##  1129.1   2.000  0.9996
##  1136.1   2.144  0.9980
##   287.3   2.267  0.9922
##  1131.2   3.265  0.4528
##   473.0  -0.219  1.0000
##  1135.7   0.284  1.0000
##   538.7  -1.844  1.0000
##  1134.7  -1.468  1.0000
##  1131.1   2.897  0.7674
##  1136.0   3.045  0.6463
##   328.7   5.929  <.0001
##  1133.8   7.269  <.0001
##   497.9   2.984  0.6971
##  1135.5   3.656  0.1797
```

```
##    21.8   1.181  1.0000
##  1131.3  -6.421  <.0001
##   417.0  -5.286  0.0003
##  1135.9   1.986  0.9997
##  1125.8   2.109  0.9987
##  1132.3   1.785  1.0000
##   507.8   2.151  0.9976
##  1126.2  -0.550  1.0000
##   259.4   0.141  1.0000
##  1132.2  -6.944  <.0001
##   416.4  -5.792  <.0001
##  1135.9   1.845  1.0000
##  1125.4   1.969  0.9998
##  1134.4   1.221  1.0000
##   524.1   1.617  1.0000
##  1123.8  -1.306  1.0000
##   245.7  -0.498  1.0000
##  1133.2  -2.663  0.9089
##   414.9  -1.905  0.9999
##  1135.8   2.860  0.7952
##  1126.1   2.979  0.7031
##  1133.2   4.863  0.0017
##   544.6   5.066  0.0008
##  1129.7   3.975  0.0666
##   265.2   4.062  0.0562
##  1133.9  -3.072  0.6227
##   443.3  -2.271  0.9926
##  1136.1   2.739  0.8716
##  1123.7   2.856  0.7980
##  1133.5   4.390  0.0139
##   558.5   4.569  0.0072
##  1131.2   3.265  0.4528
##   293.1   3.390  0.3579
##  1135.2   0.671  1.0000
##   470.3   1.098  1.0000
##  1135.7   3.642  0.1868
##  1126.7   3.752  0.1360
##  1135.2   7.270  <.0001
##   608.0   7.276  <.0001
##  1133.8   7.269  <.0001
##   349.1   6.897  <.0001
##   410.1  -6.242  <.0001
##  1131.3  -6.421  <.0001
##  1132.0   1.836  1.0000
##  1135.9   1.986  0.9997
##   556.4   1.148  1.0000
##  1132.3   1.785  1.0000
##   259.3  -1.080  1.0000
##  1126.2  -0.550  1.0000
##   425.2  -6.699  <.0001
##  1132.2  -6.944  <.0001
##  1131.9   1.697  1.0000
##  1135.9   1.845  1.0000
##   585.9   0.657  1.0000
```

```
##  1134.4   1.221  1.0000
##   259.6  -1.720  1.0000
##  1123.8  -1.306  1.0000
##   418.0  -2.876  0.7809
##  1133.2  -2.663  0.9089
##  1132.1   2.703  0.8900
##  1135.8   2.860  0.7952
##   598.0   3.952  0.0742
##  1133.2   4.863  0.0017
##   276.2   2.793  0.8338
##  1129.7   3.975  0.0666
##   434.8  -3.287  0.4369
##  1133.9  -3.072  0.6227
##  1131.0   2.586  0.9388
##  1136.1   2.739  0.8716
##   606.3   3.574  0.2275
##  1133.5   4.390  0.0139
##   287.3   2.267  0.9922
##  1131.2   3.265  0.4528
##   445.3   0.117  1.0000
##  1135.2   0.671  1.0000
##  1132.5   3.485  0.2812
##  1135.7   3.642  0.1868
##   637.0   6.289  <.0001
##  1135.2   7.270  <.0001
##   328.7   5.929  <.0001
##  1133.8   7.269  <.0001
##    21.8   1.181  1.0000
##  1136.1   3.540  0.2449
##  1120.1   3.654  0.1809
##  1135.0   9.622  <.0001
##   272.6   9.188  <.0001
##  1136.1  10.211  <.0001
##   119.7   8.491  <.0001
##  1120.3  -0.708  1.0000
##   283.4  -0.019  1.0000
##  1136.1   3.333  0.3953
##  1122.0   3.447  0.3079
##  1132.0   6.320  <.0001
##   590.9   6.408  <.0001
##  1126.6   5.345  0.0002
##   417.4   5.309  0.0003
##  1129.6   4.285  0.0212
##   300.2   4.345  0.0199
##  1136.1   4.334  0.0175
##  1122.7   4.442  0.0113
##  1132.4   9.555  <.0001
##   621.1   9.495  <.0001
##  1132.8   9.193  <.0001
##   451.6   8.838  <.0001
##  1134.5   3.604  0.2075
##   320.8   3.692  0.1709
##  1136.0   4.213  0.0281
##  1119.6   4.318  0.0187
```

```
##  1134.2   9.100  <.0001
##   620.5   8.982  <.0001
##  1135.2   8.587  <.0001
##   461.0   8.199  <.0001
##  1136.0   7.430  <.0001
##   372.2   7.072  <.0001
##  1136.1   5.098  0.0006
##  1123.1   5.196  0.0003
##  1135.6  11.439  <.0001
##   677.1  11.212  <.0001
##  1135.9  11.397  <.0001
##   528.2  10.807  <.0001
##  1129.0   3.379  0.3584
##  1136.1   3.540  0.2449
##   332.1   7.659  <.0001
##  1135.0   9.622  <.0001
##   116.6   7.161  <.0001
##  1136.1  10.211  <.0001
##   298.2  -1.201  1.0000
##  1120.3  -0.708  1.0000
##  1130.2   3.176  0.5301
##  1136.1   3.333  0.3953
##   660.0   5.369  0.0002
##  1132.0   6.320  <.0001
##   439.8   4.302  0.0218
##  1126.6   5.345  0.0002
##   311.3   3.136  0.5673
##  1129.6   4.285  0.0212
##  1130.4   4.170  0.0330
##  1136.1   4.334  0.0175
##   679.9   8.365  <.0001
##  1132.4   9.555  <.0001
##   467.9   7.844  <.0001
##  1132.8   9.193  <.0001
##   316.2   2.626  0.9198
##  1134.5   3.604  0.2075
##  1128.7   4.054  0.0504
##  1136.0   4.213  0.0281
##   676.6   8.032  <.0001
##  1134.2   9.100  <.0001
##   467.7   7.417  <.0001
##  1135.2   8.587  <.0001
##   353.4   6.158  <.0001
##  1136.0   7.430  <.0001
##  1130.7   4.936  0.0012
##  1136.1   5.098  0.0006
##   714.9  10.323  <.0001
##  1135.6  11.439  <.0001
##   521.5  10.162  <.0001
##  1135.9  11.397  <.0001
##    21.8   1.181  1.0000
##  1136.1  -1.522  1.0000
##  1128.5  -1.377  1.0000
##  1136.1  -2.129  0.9983
```

```
##  1130.2  -1.976  0.9997
##  1136.1  -3.609  0.2044
##  1130.2  -3.452  0.3040
##  1120.3  -0.708  1.0000
##   283.4  -0.019  1.0000
##  1136.1  -1.628  1.0000
##  1129.7  -1.486  1.0000
##  1136.0  -2.229  0.9955
##  1131.4  -2.078  0.9990
##  1136.1  -2.598  0.9348
##  1129.7  -2.448  0.9737
##  1129.6   4.285  0.0212
##   300.2   4.345  0.0199
##  1136.1  -0.623  1.0000
##  1129.5  -0.486  1.0000
##  1136.1  -1.210  1.0000
##  1130.9  -1.067  1.0000
##  1136.1  -2.710  0.8866
##  1130.8  -2.557  0.9479
##  1134.5   3.604  0.2075
##   320.8   3.692  0.1709
##  1136.1  -0.738  1.0000
##  1130.6  -0.600  1.0000
##  1135.9  -1.325  1.0000
##  1131.9  -1.181  1.0000
##  1136.0  -1.798  1.0000
##  1128.7  -1.652  1.0000
##  1136.0   7.430  <.0001
##   372.2   7.072  <.0001
##  1136.0   0.164  1.0000
##  1128.4   0.296  1.0000
##  1136.1  -0.411  1.0000
##  1130.0  -0.274  1.0000
##  1120.8  -1.646  1.0000
##  1136.1  -1.522  1.0000
##  1122.6  -2.253  0.9943
##  1136.1  -2.129  0.9983
##  1122.9  -3.720  0.1497
##  1136.1  -3.609  0.2044
##   298.2  -1.201  1.0000
##  1120.3  -0.708  1.0000
##  1123.3  -1.748  1.0000
##  1136.1  -1.628  1.0000
##  1125.1  -2.350  0.9872
##  1136.0  -2.229  0.9955
##  1121.6  -2.714  0.8844
##  1136.1  -2.598  0.9348
##   311.3   3.136  0.5673
##  1129.6   4.285  0.0212
##  1122.5  -0.751  1.0000
##  1136.1  -0.623  1.0000
##  1124.0  -1.336  1.0000
##  1136.1  -1.210  1.0000
##  1124.0  -2.829  0.8166
```

```
##  1136.1  -2.710  0.8866
##   316.2   2.626  0.9198
##  1134.5   3.604  0.2075
##  1124.7  -0.865  1.0000
##  1136.1  -0.738  1.0000
##  1126.1  -1.452  1.0000
##  1135.9  -1.325  1.0000
##  1120.4  -1.922  0.9999
##  1136.0  -1.798  1.0000
##   353.4   6.158  <.0001
##  1136.0   7.430  <.0001
##  1121.3   0.031  1.0000
##  1136.0   0.164  1.0000
##  1122.9  -0.543  1.0000
##  1136.1  -0.411  1.0000
##    21.8   1.181  1.0000
##  1136.1  -3.159  0.5454
##   254.3  -1.985  0.9995
##  1127.3  -7.598  <.0001
##   616.7  -6.503  <.0001
##  1136.1   1.356  1.0000
##  1122.7   1.480  1.0000
##  1120.3  -0.708  1.0000
##   283.4  -0.019  1.0000
##  1127.0  -2.779  0.8484
##   536.3  -2.026  0.9994
##  1133.3  -3.936  0.0760
##   606.9  -3.167  0.5395
##  1136.1   2.361  0.9860
##  1123.0   2.478  0.9679
##  1129.6   4.285  0.0212
##   300.2   4.345  0.0199
##  1134.4   1.111  1.0000
##   544.3   1.466  1.0000
##  1135.2  -4.248  0.0245
##   620.8  -3.443  0.3129
##  1136.0   2.241  0.9949
##  1119.9   2.356  0.9865
##  1134.5   3.604  0.2075
##   320.8   3.692  0.1709
##  1135.8   0.657  1.0000
##   557.8   1.038  1.0000
##  1135.7  -1.061  1.0000
##   632.2  -0.541  1.0000
##  1136.1   3.140  0.5622
##  1123.3   3.248  0.4676
##  1136.0   7.430  <.0001
##   372.2   7.072  <.0001
##  1136.0   3.898  0.0860
##   590.9   3.953  0.0740
##   199.5  -3.426  0.3359
##  1136.1  -3.159  0.5454
##   575.3  -7.565  <.0001
##  1127.3  -7.598  <.0001
```

```
##  1130.0   1.215  1.0000
##  1136.1   1.356  1.0000
##   298.2  -1.201  1.0000
##  1120.3  -0.708  1.0000
##   499.9  -3.075  0.6204
##  1127.0  -2.779  0.8484
##   558.4  -4.129  0.0404
##  1133.3  -3.936  0.0760
##  1129.8   2.214  0.9960
##  1136.1   2.361  0.9860
##   311.3   3.136  0.5673
##  1129.6   4.285  0.0212
##   502.4   0.561  1.0000
##  1134.4   1.111  1.0000
##   569.8  -4.470  0.0108
##  1135.2  -4.248  0.0245
##  1128.1   2.097  0.9988
##  1136.0   2.241  0.9949
##   316.2   2.626  0.9198
##  1134.5   3.604  0.2075
##   510.8   0.150  1.0000
##  1135.8   0.657  1.0000
##   566.2  -1.452  1.0000
##  1135.7  -1.061  1.0000
##  1130.2   2.993  0.6912
##  1136.1   3.140  0.5622
##   353.4   6.158  <.0001
##  1136.0   7.430  <.0001
##   530.5   3.246  0.4705
##  1136.0   3.898  0.0860
##    21.8   1.181  1.0000
##  1131.0  -6.293  <.0001
##   449.5  -5.238  0.0003
##  1136.0   1.946  0.9998
##  1124.2   2.069  0.9991
##  1134.3   1.572  1.0000
##   542.1   1.942  0.9998
##  1120.3  -0.708  1.0000
##   283.4  -0.019  1.0000
##  1133.4  -2.149  0.9979
##   444.4  -1.459  1.0000
##  1136.0   2.958  0.7199
##  1124.8   3.076  0.6194
##  1133.9   5.148  0.0004
##   558.5   5.331  0.0002
##  1129.6   4.285  0.0212
##   300.2   4.345  0.0199
##  1135.6  -2.559  0.9473
##   463.5  -1.832  1.0000
##  1136.1   2.837  0.8107
##  1122.0   2.953  0.7241
##  1135.4   4.679  0.0040
##   563.7   4.836  0.0022
##  1134.5   3.604  0.2075
```

```
##   320.8   3.692  0.1709
##  1136.1   1.056  1.0000
##   485.8   1.438  1.0000
##  1136.0   3.739  0.1416
##  1125.0   3.847  0.1013
##  1136.1   7.505  <.0001
##   608.0   7.495  <.0001
##  1136.0   7.430  <.0001
##   372.2   7.072  <.0001
##   459.0  -6.152  <.0001
##  1131.0  -6.293  <.0001
##  1131.3   1.797  1.0000
##  1136.0   1.946  0.9998
##   604.8   0.987  1.0000
##  1134.3   1.572  1.0000
##   298.2  -1.201  1.0000
##  1120.3  -0.708  1.0000
##   447.8  -2.422  0.9765
##  1133.4  -2.149  0.9979
##  1131.4   2.802  0.8341
##  1136.0   2.958  0.7199
##   612.6   4.235  0.0270
##  1133.9   5.148  0.0004
##   311.3   3.136  0.5673
##  1129.6   4.285  0.0212
##   456.7  -2.826  0.8153
##  1135.6  -2.559  0.9473
##  1129.9   2.685  0.8991
##  1136.1   2.837  0.8107
##   612.5   3.861  0.0995
##  1135.4   4.679  0.0040
##   316.2   2.626  0.9198
##  1134.5   3.604  0.2075
##   463.0   0.486  1.0000
##  1136.1   1.056  1.0000
##  1131.6   3.581  0.2201
##  1136.0   3.739  0.1416
##   638.7   6.534  <.0001
##  1136.1   7.505  <.0001
##   353.4   6.158  <.0001
##  1136.0   7.430  <.0001
##    21.8   1.181  1.0000
##  1136.1   3.540  0.2449
##  1120.1   3.654  0.1809
##  1135.0   9.622  <.0001
##   272.6   9.188  <.0001
##  1136.1  10.211  <.0001
##   119.7   8.491  <.0001
##  1127.2   5.057  0.0007
##   297.9   4.995  0.0013
##  1136.1   4.475  0.0098
##  1123.2   4.581  0.0062
##  1129.6  10.309  <.0001
##   608.7  10.174  <.0001
```

```
##  1133.2   9.701  <.0001
##   463.9   9.282  <.0001
##  1132.6   4.337  0.0173
##   320.8   4.307  0.0227
##  1136.0   4.354  0.0162
##  1120.2   4.457  0.0106
##  1131.8   9.833  <.0001
##   610.7   9.632  <.0001
##  1135.0   9.090  <.0001
##   475.1   8.637  <.0001
##  1135.3   8.167  <.0001
##   373.0   7.681  <.0001
##  1136.1   5.238  0.0003
##  1123.7   5.334  0.0002
##  1134.4  12.173  <.0001
##   670.0  11.863  <.0001
##  1135.8  11.858  <.0001
##   541.8  11.209  <.0001
##  1129.0   3.379  0.3584
##  1136.1   3.540  0.2449
##   332.1   7.659  <.0001
##  1135.0   9.622  <.0001
##   116.6   7.161  <.0001
##  1136.1  10.211  <.0001
##   294.4   3.791  0.1299
##  1127.2   5.057  0.0007
##  1130.4   4.311  0.0192
##  1136.1   4.475  0.0098
##   654.9   9.023  <.0001
##  1129.6  10.309  <.0001
##   464.3   8.338  <.0001
##  1133.2   9.701  <.0001
##   301.3   3.267  0.4556
##  1132.6   4.337  0.0173
##  1128.8   4.195  0.0301
##  1136.0   4.354  0.0162
##   653.6   8.683  <.0001
##  1131.8   9.833  <.0001
##   466.4   7.910  <.0001
##  1135.0   9.090  <.0001
##   338.8   6.818  <.0001
##  1135.3   8.167  <.0001
##  1130.8   5.076  0.0006
##  1136.1   5.238  0.0003
##   695.1  10.986  <.0001
##  1134.4  12.173  <.0001
##   519.9  10.624  <.0001
##  1135.8  11.858  <.0001
##    21.8   1.181  1.0000
##  1136.1  -1.522  1.0000
##  1128.5  -1.377  1.0000
##  1136.1  -2.129  0.9983
##  1130.2  -1.976  0.9997
##  1136.1  -2.461  0.9712
```

```
##  1129.8  -2.311  0.9906
##  1127.2   5.057  0.0007
##   297.9   4.995  0.0013
##  1136.1  -0.486  1.0000
##  1129.6  -0.350  1.0000
##  1136.1  -1.070  1.0000
##  1130.9  -0.928  1.0000
##  1136.1  -2.574  0.9428
##  1130.9  -2.421  0.9781
##  1132.6   4.337  0.0173
##   320.8   4.307  0.0227
##  1136.1  -0.601  1.0000
##  1130.8  -0.464  1.0000
##  1135.9  -1.185  1.0000
##  1131.9  -1.042  1.0000
##  1136.0  -1.662  1.0000
##  1128.8  -1.516  1.0000
##  1135.3   8.167  <.0001
##   373.0   7.681  <.0001
##  1136.0   0.302  1.0000
##  1128.7   0.433  1.0000
##  1136.1  -0.271  1.0000
##  1130.1  -0.135  1.0000
##  1120.8  -1.646  1.0000
##  1136.1  -1.522  1.0000
##  1122.6  -2.253  0.9943
##  1136.1  -2.129  0.9983
##  1121.3  -2.579  0.9410
##  1136.1  -2.461  0.9712
##   294.4   3.791  0.1299
##  1127.2   5.057  0.0007
##  1122.2  -0.615  1.0000
##  1136.1  -0.486  1.0000
##  1123.5  -1.198  1.0000
##  1136.1  -1.070  1.0000
##  1123.7  -2.694  0.8948
##  1136.1  -2.574  0.9428
##   301.3   3.267  0.4556
##  1132.6   4.337  0.0173
##  1124.5  -0.730  1.0000
##  1136.1  -0.601  1.0000
##  1125.8  -1.314  1.0000
##  1135.9  -1.185  1.0000
##  1120.1  -1.786  1.0000
##  1136.0  -1.662  1.0000
##   338.8   6.818  <.0001
##  1135.3   8.167  <.0001
##  1121.1   0.168  1.0000
##  1136.0   0.302  1.0000
##  1122.6  -0.404  1.0000
##  1136.1  -0.271  1.0000
##    21.8   1.181  1.0000
##  1136.1  -3.159  0.5454
##   254.3  -1.985  0.9995
```

```
##  1134.1  -3.394  0.3472
##   623.5  -2.676  0.9017
##  1136.1   2.496  0.9639
##  1123.3   2.612  0.9298
##  1127.2   5.057  0.0007
##   297.9   4.995  0.0013
##  1135.5   1.590  1.0000
##   572.2   1.892  0.9999
##  1135.4  -3.716  0.1514
##   638.6  -2.964  0.7144
##  1136.0   2.377  0.9842
##  1120.4   2.490  0.9653
##  1132.6   4.337  0.0173
##   320.8   4.307  0.0227
##  1136.1   1.138  1.0000
##   586.3   1.463  1.0000
##  1135.8  -0.572  1.0000
##   649.8  -0.101  1.0000
##  1136.1   3.274  0.4446
##  1123.8   3.380  0.3582
##  1135.3   8.167  <.0001
##   373.0   7.681  <.0001
##  1136.1   4.284  0.0213
##   618.0   4.303  0.0209
##   199.5  -3.426  0.3359
##  1136.1  -3.159  0.5454
##   560.4  -3.630  0.1965
##  1134.1  -3.394  0.3472
##  1129.8   2.349  0.9872
##  1136.1   2.496  0.9639
##   294.4   3.791  0.1299
##  1127.2   5.057  0.0007
##   516.4   1.027  1.0000
##  1135.5   1.590  1.0000
##   573.8  -3.973  0.0693
##  1135.4  -3.716  0.1514
##  1128.1   2.232  0.9953
##  1136.0   2.377  0.9842
##   301.3   3.267  0.4556
##  1132.6   4.337  0.0173
##   526.6   0.622  1.0000
##  1136.1   1.138  1.0000
##   570.1  -0.985  1.0000
##  1135.8  -0.572  1.0000
##  1130.2   3.127  0.5743
##  1136.1   3.274  0.4446
##   338.8   6.818  <.0001
##  1135.3   8.167  <.0001
##   545.4   3.641  0.1908
##  1136.1   4.284  0.0213
##    21.8   1.181  1.0000
##  1130.8  -1.626  1.0000
##   431.0  -0.958  1.0000
##  1136.0   3.102  0.5962
```

```
##  1125.3   3.219  0.4926
##  1130.0   5.909  <.0001
##   531.9   6.030  <.0001
##  1127.2   5.057  0.0007
##   297.9   4.995  0.0013
##  1133.9  -2.061  0.9992
##   453.4  -1.355  1.0000
##  1136.1   2.981  0.7011
##  1122.6   3.095  0.6023
##  1132.5   5.406  0.0001
##   540.6   5.495  0.0001
##  1132.6   4.337  0.0173
##   320.8   4.307  0.0227
##  1135.7   1.644  1.0000
##   476.5   1.971  0.9997
##  1135.9   3.883  0.0903
##  1125.6   3.991  0.0631
##  1135.2   8.302  <.0001
##   588.5   8.208  <.0001
##  1135.3   8.167  <.0001
##   373.0   7.681  <.0001
##   419.2  -1.962  0.9997
##  1130.8  -1.626  1.0000
##  1131.5   2.945  0.7303
##  1136.0   3.102  0.5962
##   574.1   4.874  0.0018
##  1130.0   5.909  <.0001
##   294.4   3.791  0.1299
##  1127.2   5.057  0.0007
##   430.5  -2.381  0.9823
##  1133.9  -2.061  0.9992
##  1130.1   2.828  0.8171
##  1136.1   2.981  0.7011
##   576.3   4.484  0.0102
##  1132.5   5.406  0.0001
##   301.3   3.267  0.4556
##  1132.6   4.337  0.0173
##   437.7   1.010  1.0000
##  1135.7   1.644  1.0000
##  1131.8   3.726  0.1471
##  1135.9   3.883  0.0903
##   606.0   7.226  <.0001
##  1135.2   8.302  <.0001
##   338.8   6.818  <.0001
##  1135.3   8.167  <.0001
##    21.8   1.181  1.0000
##  1136.1   3.540  0.2449
##  1120.1   3.654  0.1809
##  1135.0   9.622  <.0001
##   272.6   9.188  <.0001
##  1136.1  10.211  <.0001
##   119.7   8.491  <.0001
##  1126.1  -0.548  1.0000
##   350.5   0.075  1.0000
```

```
##  1136.0   3.345  0.3860
##  1119.8   3.454  0.3027
##  1131.1   6.332  <.0001
##   614.8   6.346  <.0001
##  1131.1   5.085  0.0006
##   484.3   5.030  0.0009
##  1127.3   3.507  0.2664
##   408.4   3.600  0.2157
##  1136.1   4.234  0.0259
##  1123.5   4.336  0.0174
##  1132.5   8.885  <.0001
##   680.2   8.756  <.0001
##  1131.0   8.138  <.0001
##   558.0   7.814  <.0001
##  1129.0   3.379  0.3584
##  1136.1   3.540  0.2449
##   332.1   7.659  <.0001
##  1135.0   9.622  <.0001
##   116.6   7.161  <.0001
##  1136.1  10.211  <.0001
##   335.6  -1.059  1.0000
##  1126.1  -0.548  1.0000
##  1128.9   3.192  0.5163
##  1136.0   3.345  0.3860
##   665.9   5.455  0.0001
##  1131.1   6.332  <.0001
##   482.8   4.215  0.0300
##  1131.1   5.085  0.0006
##   378.9   2.646  0.9126
##  1127.3   3.507  0.2664
##  1131.0   4.078  0.0463
##  1136.1   4.234  0.0259
##   713.6   7.927  <.0001
##  1132.5   8.885  <.0001
##   544.0   7.156  <.0001
##  1131.0   8.138  <.0001
##    21.8   1.181  1.0000
##  1136.1  -1.522  1.0000
##  1128.5  -1.377  1.0000
##  1136.1  -2.129  0.9983
##  1130.2  -1.976  0.9997
##  1136.0  -3.575  0.2237
##  1131.5  -3.415  0.3311
##  1126.1  -0.548  1.0000
##   350.5   0.075  1.0000
##  1136.0  -1.604  1.0000
##  1131.2  -1.461  1.0000
##  1135.7  -2.197  0.9966
##  1132.5  -2.045  0.9993
##  1136.1  -2.663  0.9088
##  1129.7  -2.510  0.9607
##  1127.3   3.507  0.2664
##   408.4   3.600  0.2157
##  1136.1  -0.697  1.0000
```

```
##  1129.3  -0.560  1.0000
##  1136.1  -1.281  1.0000
##  1130.9  -1.137  1.0000
##  1120.8  -1.646  1.0000
##  1136.1  -1.522  1.0000
##  1122.6  -2.253  0.9943
##  1136.1  -2.129  0.9983
##  1125.1  -3.690  0.1633
##  1136.0  -3.575  0.2237
##   335.6  -1.059  1.0000
##  1126.1  -0.548  1.0000
##  1125.5  -1.726  1.0000
##  1136.0  -1.604  1.0000
##  1127.0  -2.320  0.9898
##  1135.7  -2.197  0.9966
##  1122.0  -2.783  0.8457
##  1136.1  -2.663  0.9088
##   378.9   2.646  0.9126
##  1127.3   3.507  0.2664
##  1122.5  -0.825  1.0000
##  1136.1  -0.697  1.0000
##  1124.3  -1.409  1.0000
##  1136.1  -1.281  1.0000
##    21.8   1.181  1.0000
##  1136.1  -3.159  0.5454
##   254.3  -1.985  0.9995
##  1131.7  -7.020  <.0001
##   679.8  -6.001  <.0001
##  1136.0   1.371  1.0000
##  1120.4   1.493  1.0000
##  1126.1  -0.548  1.0000
##   350.5   0.075  1.0000
##  1133.0  -2.464  0.9707
##   615.2  -1.790  1.0000
##  1130.6  -3.936  0.0758
##   697.6  -3.184  0.5245
##  1136.1   2.270  0.9934
##  1124.0   2.383  0.9834
##  1127.3   3.507  0.2664
##   408.4   3.600  0.2157
##  1131.7   0.750  1.0000
##   653.4   1.101  1.0000
##   199.5  -3.426  0.3359
##  1136.1  -3.159  0.5454
##   625.8  -7.133  <.0001
##  1131.7  -7.020  <.0001
##  1128.4   1.232  1.0000
##  1136.0   1.371  1.0000
##   335.6  -1.059  1.0000
##  1126.1  -0.548  1.0000
##   564.5  -2.807  0.8291
##  1133.0  -2.464  0.9707
##   628.6  -4.197  0.0311
##  1130.6  -3.936  0.0758
```

```
##  1130.6   2.128  0.9983
##  1136.1   2.270  0.9934
##   378.9   2.646  0.9126
##  1127.3   3.507  0.2664
##   589.8   0.271  1.0000
##  1131.7   0.750  1.0000
##    21.8   1.181  1.0000
##  1131.4  -5.951  <.0001
##   500.5  -4.906  0.0016
##  1136.1   1.963  0.9998
##  1122.2   2.084  0.9990
##  1132.7   1.651  1.0000
##   562.0   1.989  0.9996
##  1126.1  -0.548  1.0000
##   350.5   0.075  1.0000
##  1132.0  -2.314  0.9904
##   529.2  -1.627  1.0000
##  1135.9   2.867  0.7897
##  1125.5   2.981  0.7013
##  1134.0   4.679  0.0040
##   614.5   4.812  0.0024
##  1127.3   3.507  0.2664
##   408.4   3.600  0.2157
##   484.5  -5.957  <.0001
##  1131.4  -5.951  <.0001
##  1130.1   1.817  1.0000
##  1136.1   1.963  0.9998
##   604.6   1.073  1.0000
##  1132.7   1.651  1.0000
##   335.6  -1.059  1.0000
##  1126.1  -0.548  1.0000
##   496.8  -2.619  0.9249
##  1132.0  -2.314  0.9904
##  1131.9   2.717  0.8834
##  1135.9   2.867  0.7897
##   639.4   3.912  0.0843
##  1134.0   4.679  0.0040
##   378.9   2.646  0.9126
##  1127.3   3.507  0.2664
##    21.8   1.181  1.0000
##  1136.1   3.540  0.2449
##  1120.1   3.654  0.1809
##  1135.0   9.622  <.0001
##   272.6   9.188  <.0001
##  1136.1  10.211  <.0001
##   119.7   8.491  <.0001
##  1123.2   3.927  0.0782
##   430.1   4.034  0.0579
##  1135.9   4.343  0.0169
##  1126.2   4.449  0.0110
##  1131.2   9.082  <.0001
##   705.9   9.030  <.0001
##  1128.8   8.391  <.0001
##   583.5   8.151  <.0001
```

```
##  1129.0   3.379  0.3584
##  1136.1   3.540  0.2449
##   332.1   7.659  <.0001
##  1135.0   9.622  <.0001
##   116.6   7.161  <.0001
##  1136.1  10.211  <.0001
##   412.9   3.008  0.6769
##  1123.2   3.927  0.0782
##  1132.3   4.183  0.0315
##  1135.9   4.343  0.0169
##   738.2   8.071  <.0001
##  1131.2   9.082  <.0001
##   576.1   7.340  <.0001
##  1128.8   8.391  <.0001
##    21.8   1.181  1.0000
##  1136.1  -1.522  1.0000
##  1128.5  -1.377  1.0000
##  1136.1  -2.129  0.9983
##  1130.2  -1.976  0.9997
##  1136.0  -2.545  0.9515
##  1128.5  -2.395  0.9819
##  1123.2   3.927  0.0782
##   430.1   4.034  0.0579
##  1135.9  -0.581  1.0000
##  1128.1  -0.446  1.0000
##  1136.1  -1.163  1.0000
##  1129.9  -1.021  1.0000
##  1120.8  -1.646  1.0000
##  1136.1  -1.522  1.0000
##  1122.6  -2.253  0.9943
##  1136.1  -2.129  0.9983
##  1119.6  -2.663  0.9091
##  1136.0  -2.545  0.9515
##   412.9   3.008  0.6769
##  1123.2   3.927  0.0782
##  1120.2  -0.709  1.0000
##  1135.9  -0.581  1.0000
##  1122.1  -1.290  1.0000
##  1136.1  -1.163  1.0000
##    21.8   1.181  1.0000
##  1136.1  -3.159  0.5454
##   254.3  -1.985  0.9995
##  1128.2  -3.524  0.2551
##   712.3  -2.838  0.8092
##  1135.9   2.384  0.9834
##  1126.6   2.498  0.9635
##  1123.2   3.927  0.0782
##   430.1   4.034  0.0579
##  1129.5   1.141  1.0000
##   671.2   1.467  1.0000
##   199.5  -3.426  0.3359
##  1136.1  -3.159  0.5454
##   645.2  -3.766  0.1330
##  1128.2  -3.524  0.2551
```

```
##  1132.0   2.239  0.9950
##  1135.9   2.384  0.9834
##   412.9   3.008  0.6769
##  1123.2   3.927  0.0782
##   611.5   0.644  1.0000
##  1129.5   1.141  1.0000
##    21.8   1.181  1.0000
##  1129.4  -1.841  1.0000
##   547.2  -1.221  1.0000
##  1135.5   2.980  0.7018
##  1128.0   3.096  0.6020
##  1132.7   4.986  0.0010
##   638.9   5.152  0.0005
##  1123.2   3.927  0.0782
##   430.1   4.034  0.0579
##   521.7  -2.153  0.9976
##  1129.4  -1.841  1.0000
##  1133.1   2.826  0.8181
##  1135.5   2.980  0.7018
##   665.1   4.175  0.0336
##  1132.7   4.986  0.0010
##   412.9   3.008  0.6769
##  1123.2   3.927  0.0782
##    21.8   1.181  1.0000
##  1136.1   3.540  0.2449
##  1120.1   3.654  0.1809
##  1135.0   9.622  <.0001
##   272.6   9.188  <.0001
##  1136.1  10.211  <.0001
##   119.7   8.491  <.0001
##  1129.0   3.379  0.3584
##  1136.1   3.540  0.2449
##   332.1   7.659  <.0001
##  1135.0   9.622  <.0001
##   116.6   7.161  <.0001
##  1136.1  10.211  <.0001
##    21.8   1.181  1.0000
##  1136.1  -1.522  1.0000
##  1128.5  -1.377  1.0000
##  1136.1  -2.129  0.9983
##  1130.2  -1.976  0.9997
##  1120.8  -1.646  1.0000
##  1136.1  -1.522  1.0000
##  1122.6  -2.253  0.9943
##  1136.1  -2.129  0.9983
##    21.8   1.181  1.0000
##  1136.1  -3.159  0.5454
##   254.3  -1.985  0.9995
##   199.5  -3.426  0.3359
##  1136.1  -3.159  0.5454
##    21.8   1.181  1.0000
##
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
```

```
## P value adjustment: tukey method for comparing a family of 56 estimates
```

```
emmeans(mod9a, list(pairwise ~ origin), adjust = "tukey")
```

```
## boundary (singular) fit: see help('isSingular')
```

```
## $`emmeans of origin`
##  origin emmean     SE     df lower.CL upper.CL
##  Native   3.01 0.0651  322.6    2.886     3.14
##           1.10 0.5339 1135.6    0.054     2.15
##  Both     1.93 0.0933  689.5    1.744     2.11
##  Exotic   2.25 0.0406   56.8    2.164     2.33
##
## Results are averaged over the levels of: state, year_factor
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of origin`
##  1               estimate     SE   df t.ratio p.value
##  Native -           1.912 0.5401 1136   3.540  0.0023
##  Native - Both      1.086 0.1129 1135   9.622  <.0001
##  Native - Exotic    0.768 0.0752 1136  10.211  <.0001
##   - Both           -0.826 0.5427 1136  -1.522  0.4247
##   - Exotic         -1.144 0.5372 1136  -2.129  0.1445
##  Both - Exotic     -0.318 0.1006 1136  -3.159  0.0088
##
## Results are averaged over the levels of: state, year_factor
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## P value adjustment: tukey method for comparing a family of 4 estimates
```

```
emmeans(mod9a, list(pairwise ~ year_factor), adjust = "tukey")
```

```
## boundary (singular) fit: see help('isSingular')
```

```
## $`emmeans of year_factor`
##  year_factor emmean    SE   df lower.CL upper.CL
##            1   0.97 0.159 1090    0.658     1.28
##            2   2.50 0.152 1047    2.200     2.79
##            3   2.55 0.156 1062    2.249     2.86
##            4   2.63 0.156 1062    2.325     2.94
##            5   2.07 0.158 1072    1.764     2.38
##            6   2.14 0.160 1060    1.824     2.45
##            7   1.64 0.166 1082    1.311     1.96
##
## Results are averaged over the levels of: state, origin
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of year_factor`
```

```
##  1                           estimate    SE   df t.ratio p.value
##  year_factor1 - year_factor2  -1.5269 0.138 1132 -11.025  <.0001
##  year_factor1 - year_factor3  -1.5841 0.143 1133 -11.076  <.0001
##  year_factor1 - year_factor4  -1.6608 0.142 1134 -11.696  <.0001
##  year_factor1 - year_factor5  -1.1039 0.145 1129  -7.619  <.0001
##  year_factor1 - year_factor6  -1.1681 0.147 1133  -7.927  <.0001
##  year_factor1 - year_factor7  -0.6666 0.154 1132  -4.334  0.0003
##  year_factor2 - year_factor3  -0.0572 0.104 1126  -0.550  0.9980
##  year_factor2 - year_factor4  -0.1339 0.103 1124  -1.306  0.8492
##  year_factor2 - year_factor5   0.4229 0.106 1130   3.975  0.0015
##  year_factor2 - year_factor6   0.3588 0.110 1131   3.265  0.0193
##  year_factor2 - year_factor7   0.8602 0.118 1134   7.269  <.0001
##  year_factor3 - year_factor4  -0.0767 0.108 1120  -0.708  0.9921
##  year_factor3 - year_factor5   0.4802 0.112 1130   4.285  0.0004
##  year_factor3 - year_factor6   0.4160 0.115 1135   3.604  0.0060
##  year_factor3 - year_factor7   0.9175 0.123 1136   7.430  <.0001
##  year_factor4 - year_factor5   0.5568 0.110 1127   5.057  <.0001
##  year_factor4 - year_factor6   0.4927 0.114 1133   4.337  0.0003
##  year_factor4 - year_factor7   0.9941 0.122 1135   8.167  <.0001
##  year_factor5 - year_factor6  -0.0642 0.117 1126  -0.548  0.9981
##  year_factor5 - year_factor7   0.4373 0.125 1127   3.507  0.0085
##  year_factor6 - year_factor7   0.5014 0.128 1123   3.927  0.0018
##
## Results are averaged over the levels of: state, origin
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## P value adjustment: tukey method for comparing a family of 7 estimates
```

```
# including growth form - first with interaction term
kbs_flwr_spp <- within(kbs_flwr_spp, growth_habit <- relevel(factor(growth_habit), ref = "Forb")) # rel
mod10 <- lmer(log(flwr_duration_scaled) ~ state * growth_habit + (1+factor(year_factor)|plot), kbs_flwr
```

```
## fixed-effect model matrix is rank deficient so dropping 1 column / coefficient
## boundary (singular) fit: see help('isSingular')
```

```
mod11 <- lmer(log(flwr_duration_scaled) ~ state + growth_habit + (1+factor(year_factor)|plot), kbs_flwr
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod11a <- lmer(log(flwr_duration_scaled) ~ state + growth_habit + factor(year_factor) + (1|plot), kbs_fl
```

```
## boundary (singular) fit: see help('isSingular')
```

```
anova(mod10, mod11) # model 11 is a better fit to data
```

```
## Data: kbs_flwr_spp
## Models:
## mod11: log(flwr_duration_scaled) ~ state + growth_habit + (1 + factor(year_factor) | plot)
## mod10: log(flwr_duration_scaled) ~ state * growth_habit + (1 + factor(year_factor) | plot)
##       npar    AIC    BIC  logLik deviance  Chisq Df Pr(>Chisq)
## mod11   34 3460.0 3630.9 -1696.0   3392.0
## mod10   36 3462.3 3643.2 -1695.1   3390.3 1.7175  2     0.4237
```

```
anova(mod11, mod11a) # model 11a is still a better fit to data
```

```
## Data: kbs_flwr_spp
## Models:
## mod11a: log(flwr_duration_scaled) ~ state + growth_habit + factor(year_factor) + (1 | plot)
## mod11: log(flwr_duration_scaled) ~ state + growth_habit + (1 + factor(year_factor) | plot)
##        npar  AIC    BIC logLik deviance Chisq Df Pr(>Chisq)
## mod11a   13 3368 3433.3  -1671     3342
## mod11    34 3460 3630.9  -1696     3392     0 21          1
```

```
summary(mod11a)
```

```
## Linear mixed model fit by maximum likelihood . t-tests use Satterthwaite's
##   method [lmerModLmerTest]
## Formula:
## log(flwr_duration_scaled) ~ state + growth_habit + factor(year_factor) +
##     (1 | plot)
##    Data: kbs_flwr_spp
##
##      AIC      BIC   logLik deviance df.resid
##   3368.0   3433.3  -1671.0   3342.0     1112
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.0791 -0.4005  0.2601  0.6315  2.4887
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  plot     (Intercept) 0.000    0.000
##  Residual             1.142    1.069
## Number of obs: 1125, groups:  plot, 24
##
## Fixed effects:
##                          Estimate Std. Error         df t value Pr(>|t|)
## (Intercept)               1.44014    0.12652 1125.00000  11.383  < 2e-16 ***
## stateambient             -0.10780    0.06432 1125.00000  -1.676    0.094 .
## growth_habit             -0.62455    0.10854 1125.00000  -5.754 1.12e-08 ***
## growth_habitForb/herb    -2.41091    1.07424 1125.00000  -2.244    0.025 *
## growth_habitGraminoid    -0.49957    0.06900 1125.00000  -7.240 8.28e-13 ***
## factor(year_factor)2      1.69267    0.13918 1125.00000  12.162  < 2e-16 ***
## factor(year_factor)3      1.71160    0.14384 1125.00000  11.899  < 2e-16 ***
## factor(year_factor)4      1.85033    0.14355 1125.00000  12.890  < 2e-16 ***
## factor(year_factor)5      1.34643    0.14663 1125.00000   9.183  < 2e-16 ***
## factor(year_factor)6      1.43330    0.14968 1125.00000   9.575  < 2e-16 ***
## factor(year_factor)7      0.97077    0.15558 1125.00000   6.240 6.19e-10 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) sttmbn grwth_ grw_F/ grwt_G fc(_)2 fc(_)3 fc(_)4 fc(_)5
## stateambint -0.245
## growth_habt -0.176 -0.040
```

```
## grwth_hbtF/ -0.014  0.031  0.013
## grwth_hbtGr -0.185  0.075  0.293  0.036
## fctr(yr_f)2 -0.791 -0.036 -0.018 -0.003 -0.068
## fctr(yr_f)3 -0.774 -0.038  0.029 -0.002 -0.046  0.717
## fctr(yr_f)4 -0.764 -0.048  0.034 -0.005 -0.123  0.724  0.701
## fctr(yr_f)5 -0.747 -0.054  0.038 -0.005 -0.120  0.709  0.687  0.700
## fctr(yr_f)6 -0.732 -0.024  0.012 -0.005 -0.148  0.696  0.673  0.687  0.673
## fctr(yr_f)7 -0.717 -0.016  0.050 -0.060 -0.100  0.666  0.646  0.658  0.644
##             fc(_)6
## stateambint
## growth_habt
## grwth_hbtF/
## grwth_hbtGr
## fctr(yr_f)2
## fctr(yr_f)3
## fctr(yr_f)4
## fctr(yr_f)5
## fctr(yr_f)6
## fctr(yr_f)7  0.633
## optimizer (nloptwrap) convergence code: 0 (OK)
## boundary (singular) fit: see help('isSingular')
```

```
anova(mod11a)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##                      Sum Sq Mean Sq NumDF DenDF F value    Pr(>F)
## state                 3.208   3.208     1  1125  2.8093   0.09399 .
## growth_habit         80.775  26.925     3  1125 23.5773 8.396e-15 ***
## factor(year_factor) 252.838  42.140     6  1125 36.9005 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
emmeans(mod11a, list(pairwise ~ factor(year_factor)), adjust = "tukey")
```

```
## boundary (singular) fit: see help('isSingular')
```

```
## $`emmeans of year_factor`
##  year_factor emmean    SE   df lower.CL upper.CL
##            1  0.502 0.296 1130  -0.0787     1.08
##            2  2.195 0.279 1129   1.6469     2.74
##            3  2.214 0.282 1123   1.6603     2.77
##            4  2.353 0.282 1127   1.8003     2.91
##            5  1.849 0.283 1128   1.2933     2.40
##            6  1.936 0.285 1130   1.3774     2.49
##            7  1.473 0.280 1126   0.9242     2.02
##
## Results are averaged over the levels of: state, growth_habit
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of year_factor`
```

```
##  1                           estimate    SE   df t.ratio p.value
##  year_factor1 - year_factor2  -1.6927 0.140 1130 -12.092  <.0001
##  year_factor1 - year_factor3  -1.7116 0.145 1132 -11.830  <.0001
##  year_factor1 - year_factor4  -1.8503 0.144 1133 -12.813  <.0001
##  year_factor1 - year_factor5  -1.3464 0.147 1129  -9.130  <.0001
##  year_factor1 - year_factor6  -1.4333 0.151 1132  -9.518  <.0001
##  year_factor1 - year_factor7  -0.9708 0.157 1133  -6.203  <.0001
##  year_factor2 - year_factor3  -0.0189 0.107 1126  -0.177  1.0000
##  year_factor2 - year_factor4  -0.1577 0.106 1124  -1.492  0.7496
##  year_factor2 - year_factor5   0.3462 0.110 1130   3.152  0.0277
##  year_factor2 - year_factor6   0.2594 0.114 1132   2.280  0.2546
##  year_factor2 - year_factor7   0.7219 0.122 1134   5.914  <.0001
##  year_factor3 - year_factor4  -0.1387 0.112 1121  -1.243  0.8773
##  year_factor3 - year_factor5   0.3652 0.116 1131   3.158  0.0271
##  year_factor3 - year_factor6   0.2783 0.120 1135   2.326  0.2323
##  year_factor3 - year_factor7   0.7408 0.127 1136   5.823  <.0001
##  year_factor4 - year_factor5   0.5039 0.113 1127   4.456  0.0002
##  year_factor4 - year_factor6   0.4170 0.117 1133   3.570  0.0068
##  year_factor4 - year_factor7   0.8796 0.125 1135   7.035  <.0001
##  year_factor5 - year_factor6  -0.0869 0.121 1126  -0.721  0.9914
##  year_factor5 - year_factor7   0.3757 0.128 1127   2.925  0.0542
##  year_factor6 - year_factor7   0.4625 0.132 1122   3.514  0.0083
##
## Results are averaged over the levels of: state, growth_habit
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## P value adjustment: tukey method for comparing a family of 7 estimates
```

```
emmeans(mod11a, list(pairwise ~ growth_habit), adjust = "tukey")
```

```
## boundary (singular) fit: see help('isSingular')

## $`emmeans of growth_habit`
##  growth_habit emmean     SE   df lower.CL upper.CL
##  Forb          2.673 0.0493  105     2.57     2.77
##                2.048 0.0992  732     1.85     2.24
##  Forb/herb     0.262 1.0800 1136    -1.86     2.38
##  Graminoid     2.173 0.0504  118     2.07     2.27
##
## Results are averaged over the levels of: state, year_factor
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of growth_habit`
##  1                       estimate     SE   df t.ratio p.value
##  Forb -                     0.625 0.1092 1135   5.719  <.0001
##  Forb - (Forb/herb)         2.411 1.0815 1136   2.229  0.1160
##  Forb - Graminoid           0.500 0.0695 1134   7.188  <.0001
##   - (Forb/herb)             1.786 1.0855 1136   1.646  0.3534
##   - Graminoid              -0.125 0.1110 1135  -1.126  0.6734
##  (Forb/herb) - Graminoid   -1.911 1.0811 1136  -1.768  0.2894
##
```

```
## Results are averaged over the levels of: state, year_factor
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## P value adjustment: tukey method for comparing a family of 4 estimates

# New version of our model incorporating interaction term and species within year so that there is a se
# updated mod4
mod12 <- lmer(log(flwr_duration_scaled) ~ state * factor(year_factor) + (1+factor(year_factor)|species)


## boundary (singular) fit: see help('isSingular')

# So another version of this model would include the interaction but not include the nesting (and thus
# updated mod5
mod13 <- lmer(log(flwr_duration_scaled) ~ state * factor(year_factor) + (1|species), kbs_flwr_spp)

# All the models ran:
mod1 <- lmer(log(flwr_duration_scaled) ~ state*year_factor + insecticide*year_factor + (1|species) + (1


## boundary (singular) fit: see help('isSingular')

mod2 <- lmer(log(flwr_duration_scaled) ~ state*year_factor + insecticide*year_factor + (1|species), kbs
mod3 <- lmer(log(flwr_duration_scaled) ~ state*year_factor + (1|species), kbs_flwr_spp, REML=FALSE)
mod4 <- lmer(log(flwr_duration_scaled) ~ state*year_factor + insecticide + (1|species) + (1|plot), kbs_


## boundary (singular) fit: see help('isSingular')

mod5 <- lmer(log(flwr_duration_scaled) ~ state + year_factor + (1|species), kbs_flwr_spp, REML=FALSE)
mod6 <- lmer(log(flwr_duration_scaled) ~ state + year_factor + (1|species) + (1 + year|plot), kbs_flwr_


## boundary (singular) fit: see help('isSingular')

mod7 <- lmer(log(flwr_duration_scaled) ~ state + species + (1+factor(year_factor)|plot), kbs_flwr_spp, R


## boundary (singular) fit: see help('isSingular')

mod7a <- lmer(log(flwr_duration_scaled) ~ state + species + factor(year_factor) + (1|plot), kbs_flwr_sp


## boundary (singular) fit: see help('isSingular')

mod7b <- lmer(log(flwr_duration_scaled) ~ state * factor(year_factor) + species + (1|plot), kbs_flwr_sp


## boundary (singular) fit: see help('isSingular')

mod7c <- lmer(log(flwr_duration_scaled) ~ state + species + factor(year_factor) + insecticide + (1|plot


## boundary (singular) fit: see help('isSingular')
```

```
mod8 <- lmer(log(flwr_duration_scaled) ~ state * origin + (1+factor(year_factor)|plot), kbs_flwr_spp, RE
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod9 <- lmer(log(flwr_duration_scaled) ~ state + origin + (1+factor(year_factor)|plot), kbs_flwr_spp, RE
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod9a <- lmer(log(flwr_duration_scaled) ~ state + origin + factor(year_factor) + (1|plot), kbs_flwr_spp
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod10 <- lmer(log(flwr_duration_scaled) ~ state * growth_habit + (1+factor(year_factor)|plot), kbs_flwr
```

```
## fixed-effect model matrix is rank deficient so dropping 1 column / coefficient
## boundary (singular) fit: see help('isSingular')
```

```
mod11 <- lmer(log(flwr_duration_scaled) ~ state + growth_habit + (1+factor(year_factor)|plot), kbs_flwr
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod11a <- lmer(log(flwr_duration_scaled) ~ state + growth_habit + factor(year_factor) + (1|plot), kbs_fl
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod12 <- lmer(log(flwr_duration_scaled) ~ state * factor(year_factor) + (1+factor(year_factor)|species)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.00608627 (tol = 0.002, component 1)
```

```
# mod13 <- lmer(log(flwr_duration_scaled) ~ state * factor(year_factor) + (1|species), kbs_flwr_spp, RE
AICctab(mod1, mod2, mod3, mod5, mod7, mod7a, mod7b, mod7c, mod8, mod9, mod9a, mod10, mod11, mod11a, mod
```

```
## Error in ICtab(..., mnames = mnames, type = "AICc"): nobs different: must have identical data for al
```

```
# not sure why the above code wont work - all the data looks identical to me despite what error says??
AICctab(mod9a, mod11a, weights=T)
```

```
##        dAICc df weight
## mod9a   0.0  13 1
## mod11a 62.9  13 <0.001
```

```
anova(mod9a, mod11a)
```

```
## Data: kbs_flwr_spp
## Models:
## mod9a: log(flwr_duration_scaled) ~ state + origin + factor(year_factor) + (1 | plot)
## mod11a: log(flwr_duration_scaled) ~ state + growth_habit + factor(year_factor) + (1 | plot)
##        npar  AIC    BIC  logLik deviance Chisq Df Pr(>Chisq)
## mod9a    13 3305 3370.4 -1639.5     3279
## mod11a   13 3368 3433.3 -1671.0     3342     0  0
```

```
summary(mod7a)
```

```
## Linear mixed model fit by maximum likelihood . t-tests use Satterthwaite's
##   method [lmerModLmerTest]
## Formula: log(flwr_duration_scaled) ~ state + species + factor(year_factor) +
##     (1 | plot)
##    Data: kbs_flwr_spp
##
##      AIC      BIC   logLik deviance df.resid
##   3199.6   3411.6  -1557.8   3115.6     1109
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.6381 -0.3669  0.1663  0.5936  2.8919
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  plot     (Intercept) 0.0000   0.0000
##  Residual             0.8772   0.9366
## Number of obs: 1151, groups:  plot, 24
##
## Fixed effects:
##                       Estimate Std. Error         df t value Pr(>|t|)
## (Intercept)            1.37159    0.16646 1151.00000   8.240 4.65e-16 ***
## stateambient          -0.02860    0.05754 1151.00000  -0.497 0.619258
## speciesArel           -0.92604    0.16877 1151.00000  -5.487 5.03e-08 ***
## speciesAspi           -1.37385    0.40594 1151.00000  -3.384 0.000737 ***
## speciesAssp           -2.39186    0.33958 1151.00000  -7.044 3.22e-12 ***
## speciesBavu           -0.56878    0.30029 1151.00000  -1.894 0.058463 .
## speciesCahi           -1.11291    0.24634 1151.00000  -4.518 6.89e-06 ***
## speciesCest            0.11516    0.16872 1151.00000   0.683 0.495036
## speciesDaca           -0.14226    0.23258 1151.00000  -0.612 0.540895
## speciesDagl           -0.81921    0.17977 1151.00000  -4.557 5.74e-06 ***
## speciesDlre           -3.43605    0.94731 1151.00000  -3.627 0.000299 ***
## speciesElre           -0.58567    0.16696 1151.00000  -3.508 0.000469 ***
## speciesEugr            0.02179    0.18744 1151.00000   0.116 0.907472
## speciesHisp           -1.17902    0.16935 1151.00000  -6.962 5.63e-12 ***
## speciesHype           -0.05845    0.20898 1151.00000  -0.280 0.779767
## speciesLapu           -2.51215    0.95033 1151.00000  -2.643 0.008318 **
## speciesLesp           -1.24721    0.94810 1151.00000  -1.315 0.188611
## speciesPhpr           -0.68003    0.15614 1151.00000  -4.355 1.45e-05 ***
## speciesPoco           -0.91746    0.18682 1151.00000  -4.911 1.04e-06 ***
## speciesPopr           -0.52308    0.15310 1151.00000  -3.417 0.000656 ***
## speciesPore           -1.02770    0.18212 1151.00000  -5.643 2.10e-08 ***
## speciesPosp           -1.35729    0.49611 1151.00000  -2.736 0.006317 **
## speciesRusp           -1.12566    0.25520 1151.00000  -4.411 1.13e-05 ***
```

```
## speciesSila              0.22187    0.94706 1151.00000   0.234 0.814814
## speciesSoca              0.37146    0.15097 1151.00000   2.461 0.014019 *
## speciesSoga             -3.53550    0.67748 1151.00000  -5.219 2.14e-07 ***
## speciesSogr             -0.27801    0.32506 1151.00000  -0.855 0.392575
## speciesSora             -0.50070    0.37997 1151.00000  -1.318 0.187849
## speciesSyla             -2.48355    0.94999 1151.00000  -2.614 0.009058 **
## speciesSypi             -1.08779    0.25955 1151.00000  -4.191 2.99e-05 ***
## speciesSyur              0.46089    0.94999 1151.00000   0.485 0.627662
## speciesTaof             -2.03824    0.28063 1151.00000  -7.263 6.96e-13 ***
## speciesTrsp              0.11860    0.21049 1151.00000   0.563 0.573252
## speciesVear             -3.47862    0.67519 1151.00000  -5.152 3.03e-07 ***
## factor(year_factor)2     1.87227    0.13083 1151.00000  14.311  < 2e-16 ***
## factor(year_factor)3     2.06446    0.13882 1151.00000  14.872  < 2e-16 ***
## factor(year_factor)4     2.17821    0.13884 1151.00000  15.689  < 2e-16 ***
## factor(year_factor)5     1.59855    0.14194 1151.00000  11.262  < 2e-16 ***
## factor(year_factor)6     1.62751    0.14448 1151.00000  11.265  < 2e-16 ***
## factor(year_factor)7     1.14056    0.15036 1151.00000   7.586 6.79e-14 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

##
## Correlation matrix not shown by default, as p = 40 > 12.
## Use print(x, correlation=TRUE)  or
##     vcov(x)        if you need it

## optimizer (nloptwrap) convergence code: 0 (OK)
## boundary (singular) fit: see help('isSingular')
```

```
anova(mod7a)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##                      Sum Sq Mean Sq NumDF DenDF F value Pr(>F)
## state                  0.22   0.217     1  1151   0.247 0.6193
## species              396.26  12.383    32  1151  14.117 <2e-16 ***
## factor(year_factor) 292.34  48.723     6  1151  55.543 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

KBS Plot-level Mixed Effects Models:

```
mod1p <- lmer(log(flwr_duration_scaled) ~ state + (1|plot), kbs_flwr_plot, REML=FALSE)
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod2p <- lmer(log(flwr_duration_scaled) ~ insecticide + (1|plot), kbs_flwr_plot, REML=FALSE)
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod3p <- lmer(log(flwr_duration_scaled) ~ insecticide + state + (1|plot), kbs_flwr_plot, REML=FALSE)
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod4p <- lmer(log(flwr_duration_scaled) ~ insecticide * state + (1|plot), kbs_flwr_plot, REML=FALSE)
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod5p <- lmer(log(flwr_duration_scaled) ~ state + year_factor + (1|plot), kbs_flwr_plot, REML=FALSE)
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod6p <- lmer(log(flwr_duration_scaled) ~ state + year_factor + insecticide + (1|plot), kbs_flwr_plot,
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod7p <- lmer(log(flwr_duration_scaled) ~ state * year_factor + (1|plot), kbs_flwr_plot, REML=FALSE)
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod8p <- lmer(log(flwr_duration_scaled) ~ state * year_factor + insecticide + (1|plot), kbs_flwr_plot,
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod9p <- lmer(log(flwr_duration_scaled) ~ state * insecticide + year_factor + (1|plot), kbs_flwr_plot,
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod10p <- lmer(log(flwr_duration_scaled) ~ state + insecticide * year_factor + (1|plot), kbs_flwr_plot,
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod11p <- lmer(log(flwr_duration_scaled) ~ state * year_factor * insecticide + (1|plot), kbs_flwr_plot,
```

```
## boundary (singular) fit: see help('isSingular')
```

```
AICctab(mod1p, mod2p, mod3p, mod4p, mod5p, mod6p, mod7p, mod8p, mod9p, mod10p, mod11p, weights=T) # mod
```

```
##        dAICc df weight
## mod5p   0.0  5  0.297
## mod7p   1.7  6  0.128
## mod6p   1.7  6  0.125
## mod2p   2.4  4  0.088
## mod1p   2.7  4  0.078
## mod9p   2.7  7  0.078
## mod10p  3.3  7  0.058
## mod8p   3.4  7  0.053
## mod11p  4.0  10 0.040
## mod3p   4.3  5  0.034
## mod4p   5.4  6  0.020
```

```r
anova(mod5p, mod7p) # go with 5p although they are nearly identical
```

```
## Data: kbs_flwr_plot
## Models:
## mod5p: log(flwr_duration_scaled) ~ state + year_factor + (1 | plot)
## mod7p: log(flwr_duration_scaled) ~ state * year_factor + (1 | plot)
##       npar    AIC    BIC  logLik deviance Chisq Df Pr(>Chisq)
## mod5p    5 337.40 352.96 -163.70   327.40
## mod7p    6 338.93 357.60 -163.47   326.93  0.47  1      0.493
```

```r
AICctab(mod5p, mod7p, weights=T)
```

```
##       dAICc df weight
## mod5p 0.0   5  0.7
## mod7p 1.7   6  0.3
```

```r
summ(mod5p)
```

```
## MODEL INFO:
## Observations: 166
## Dependent Variable: log(flwr_duration_scaled)
## Type: Mixed effects linear regression
##
## MODEL FIT:
## AIC = 337.40, BIC = 352.96
## Pseudo-R² (fixed effects) = 0.03
## Pseudo-R² (total) = 0.03
##
## FIXED EFFECTS:
## ----------------------------------------------------------
##                       Est.   S.E.   t val.     d.f.      p
## ------------------ ------- ------ -------- -------- ------
## (Intercept)           2.60   0.12    21.08   166.00   0.00
## stateambient         -0.04   0.10    -0.44   166.00   0.66
## year_factor           0.06   0.03     2.20   166.00   0.03
## ----------------------------------------------------------
##
## p values calculated using Satterthwaite d.f.
##
## RANDOM EFFECTS:
## -------------------------------------
##   Group      Parameter    Std. Dev.
## ---------- ------------- -----------
##    plot     (Intercept)     0.00
##  Residual                   0.65
## -------------------------------------
##
## Grouping variables:
## -------------------------
##  Group   # groups   ICC
## ------- ---------- ------
##  plot       24      0.00
## -------------------------
```

```
summary(mod5p)
```

```
## Linear mixed model fit by maximum likelihood . t-tests use Satterthwaite's
##   method [lmerModLmerTest]
## Formula: log(flwr_duration_scaled) ~ state + year_factor + (1 | plot)
##    Data: kbs_flwr_plot
##
##      AIC      BIC   logLik deviance df.resid
##    337.4    353.0   -163.7    327.4      161
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.0964 -0.3495  0.1479  0.6113  1.6450
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  plot     (Intercept) 0.0000   0.0000
##  Residual             0.4208   0.6487
## Number of obs: 166, groups:  plot, 24
##
## Fixed effects:
##               Estimate Std. Error        df t value Pr(>|t|)
## (Intercept)    2.60160    0.12341 166.00000  21.080   <2e-16 ***
## stateambient  -0.04417    0.10072 166.00000  -0.439   0.6615
## year_factor    0.05573    0.02528 166.00000   2.205   0.0288 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) sttmbn
## stateambint -0.416
## year_factor -0.819  0.015
## optimizer (nloptwrap) convergence code: 0 (OK)
## boundary (singular) fit: see help('isSingular')
```

```
emmeans(mod5p, list(pairwise ~ state), adjust = "tukey")
```

```
## boundary (singular) fit: see help('isSingular')

## $`emmeans of state`
##  state   emmean     SE   df lower.CL upper.CL
##  warmed    2.82 0.0714 22.3     2.67     2.97
##  ambient   2.78 0.0723 23.1     2.63     2.93
##
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of state`
##  1                estimate    SE   df t.ratio p.value
##  warmed - ambient   0.0442 0.102 22.7   0.435  0.6680
##
```

```
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
```

```
# including native vs. exotic
kbs_flwr_plot_origin <- within(kbs_flwr_plot_origin, origin <- relevel(factor(origin), ref = "Native"))
mod12p <- lmer(log(flwr_duration_scaled) ~ state * origin + (1+year_factor|plot), kbs_flwr_plot_origin,
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod13p <- lmer(log(flwr_duration_scaled) ~ state + origin + (1+year_factor|plot), kbs_flwr_plot_origin,
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod14p <- lmer(log(flwr_duration_scaled) ~ state + origin + year_factor + (1|plot), kbs_flwr_plot_origi
```

```
## boundary (singular) fit: see help('isSingular')
```

```
anova(mod12p, mod13p) # go with model 13p
```

```
## Data: kbs_flwr_plot_origin
## Models:
## mod13p: log(flwr_duration_scaled) ~ state + origin + (1 + year_factor | plot)
## mod12p: log(flwr_duration_scaled) ~ state * origin + (1 + year_factor | plot)
##        npar    AIC    BIC  logLik deviance  Chisq Df Pr(>Chisq)
## mod13p    9 1117.5 1153.8 -549.76   1099.5
## mod12p   12 1122.1 1170.6 -549.07   1098.1 1.3693  3     0.7127
```

```
anova(mod13p, mod14p)
```

```
## Data: kbs_flwr_plot_origin
## Models:
## mod14p: log(flwr_duration_scaled) ~ state + origin + year_factor + (1 | plot)
## mod13p: log(flwr_duration_scaled) ~ state + origin + (1 + year_factor | plot)
##        npar    AIC    BIC  logLik deviance  Chisq Df Pr(>Chisq)
## mod14p    8 1119.0 1151.3 -551.49   1103.0
## mod13p    9 1117.5 1153.8 -549.76   1099.5 3.4706  1    0.06247 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
AICctab(mod12p, mod13p, mod14p, weights=T) #model 13p
```

```
##        dAICc df weight
## mod13p  0.0  9  0.631
## mod14p  1.4  8  0.316
## mod12p  5.0  12 0.053
```

```
summary(mod13p)
```

```
## Linear mixed model fit by maximum likelihood . t-tests use Satterthwaite's
##   method [lmerModLmerTest]
## Formula: log(flwr_duration_scaled) ~ state + origin + (1 + year_factor |
##     plot)
##    Data: kbs_flwr_plot_origin
##
##      AIC      BIC   logLik deviance df.resid
##   1117.5   1153.8   -549.8   1099.5      409
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.7485 -0.2247  0.2478  0.5773  1.6953
##
## Random effects:
##  Groups   Name        Variance Std.Dev. Corr
##  plot     (Intercept) 0.154078 0.39253
##           year_factor 0.006986 0.08358  -1.00
##  Residual             0.789002 0.88826
## Number of obs: 418, groups:  plot, 24
##
## Fixed effects:
##               Estimate Std. Error        df t value Pr(>|t|)
## (Intercept)    3.22579    0.08556 313.11578  37.701  < 2e-16 ***
## statewarmed    0.06766    0.08999 157.86035   0.752    0.453
## origin        -3.18654    0.46589 397.11655  -6.840 3.01e-11 ***
## originBoth    -1.14030    0.11709 407.95495  -9.738  < 2e-16 ***
## originExotic  -0.73756    0.09965 396.96556  -7.402 8.11e-13 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) sttwrm origin orgnBt
## statewarmed -0.540
## origin      -0.128  0.007
## originBoth  -0.551  0.083  0.105
## originExotc -0.604  0.008  0.116  0.443
## optimizer (nloptwrap) convergence code: 0 (OK)
## boundary (singular) fit: see help('isSingular')
```

```
summ(mod13p)
```

```
## Warning: Could not calculate r-squared. Try removing missing data before fitting the
## model.

## MODEL INFO:
## Observations: 418
## Dependent Variable: log(flwr_duration_scaled)
## Type: Mixed effects linear regression
##
## MODEL FIT:
## AIC = 1117.51, BIC = 1153.83
##
## FIXED EFFECTS:
```

```
## ------------------------------------------------------------
##                       Est.   S.E.   t val.     d.f.      p
## ------------------ ------- ------ -------- -------- ------
## (Intercept)           3.23   0.09    37.70   313.12   0.00
## statewarmed           0.07   0.09     0.75   157.86   0.45
## origin               -3.19   0.47    -6.84   397.12   0.00
## originBoth           -1.14   0.12    -9.74   407.95   0.00
## originExotic         -0.74   0.10    -7.40   396.97   0.00
## ------------------------------------------------------------
##
## p values calculated using Satterthwaite d.f.
##
## RANDOM EFFECTS:
## -------------------------------------
##   Group      Parameter    Std. Dev.
## ---------- ------------- -----------
##    plot     (Intercept)     0.39
##    plot     year_factor     0.08
##  Residual                    0.89
## -------------------------------------
##
## Grouping variables:
## -------------------------
##  Group   # groups   ICC
## ------- ---------- ------
##  plot       24      0.16
## -------------------------
```

```
anova(mod13p)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##         Sum Sq Mean Sq NumDF  DenDF F value Pr(>F)
## state    0.446   0.446     1 157.86  0.5653 0.4533
## origin 108.918  36.306     3 400.53 46.0149 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
emmeans(mod13p, list(pairwise ~ state), adjust = "tukey")
```

```
## boundary (singular) fit: see help('isSingular')
```

```
## $`emmeans of state`
##  state   emmean    SE  df lower.CL upper.CL
##  ambient   1.96 0.132 201     1.70     2.22
##  warmed    2.03 0.134 213     1.76     2.29
##
## Results are averaged over the levels of: origin
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of state`
```

```
##  1                estimate     SE   df t.ratio p.value
##  ambient - warmed  -0.0677 0.0954 22.8  -0.710  0.4852
##
## Results are averaged over the levels of: origin
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
```

```
emmeans(mod13p, list(pairwise ~ origin), adjust = "tukey")
```

```
## boundary (singular) fit: see help('isSingular')
```

```
## $`emmeans of origin`
##  origin emmean     SE  df lower.CL upper.CL
##  Native 3.2596 0.0739 129    3.113    3.406
##         0.0731 0.4704 375   -0.852    0.998
##  Both   2.1193 0.0960 216    1.930    2.309
##  Exotic 2.5221 0.0717 119    2.380    2.664
##
## Results are averaged over the levels of: state
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of origin`
##  1               estimate    SE  df t.ratio p.value
##  Native -           3.187 0.475 386   6.704  <.0001
##  Native - Both      1.140 0.119 408   9.618  <.0001
##  Native - Exotic    0.738 0.100 380   7.354  <.0001
##   - Both           -2.046 0.478 390  -4.284  0.0001
##   - Exotic         -2.449 0.474 388  -5.164  <.0001
##  Both - Exotic     -0.403 0.117 405  -3.451  0.0034
##
## Results are averaged over the levels of: state
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## P value adjustment: tukey method for comparing a family of 4 estimates
```

```
# including growth form - first with interaction term
kbs_flwr_plot_growthhabit <- within(kbs_flwr_plot_growthhabit, growth_habit <- relevel(factor(growth_hal
mod15p <- lmer(log(flwr_duration_scaled) ~ state * growth_habit + (1+year_factor|plot), kbs_flwr_plot_gr
```

```
## fixed-effect model matrix is rank deficient so dropping 1 column / coefficient
## boundary (singular) fit: see help('isSingular')
```

```
mod16p <- lmer(log(flwr_duration_scaled) ~ state + growth_habit + (1+year_factor|plot), kbs_flwr_plot_gr
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod17p <- lmer(log(flwr_duration_scaled) ~ state + growth_habit + year_factor + (1|plot), kbs_flwr_plot_
```

```
## boundary (singular) fit: see help('isSingular')
```

```
anova(mod15p, mod16p) # go with model 16p
```

```
## Data: kbs_flwr_plot_growthhabit
## Models:
## mod16p: log(flwr_duration_scaled) ~ state + growth_habit + (1 + year_factor | plot)
## mod15p: log(flwr_duration_scaled) ~ state * growth_habit + (1 + year_factor | plot)
##        npar    AIC    BIC  logLik deviance  Chisq Df Pr(>Chisq)
## mod16p    9 1166.1 1202.4 -574.07   1148.1
## mod15p   11 1168.6 1212.9 -573.28   1146.6 1.5788  2     0.4541
```

```
anova(mod16p, mod17p) # mod 17p
```

```
## Data: kbs_flwr_plot_growthhabit
## Models:
## mod17p: log(flwr_duration_scaled) ~ state + growth_habit + year_factor + (1 | plot)
## mod16p: log(flwr_duration_scaled) ~ state + growth_habit + (1 + year_factor | plot)
##        npar    AIC    BIC  logLik deviance  Chisq Df Pr(>Chisq)
## mod17p    8 1164.8 1197.1 -574.42   1148.8
## mod16p    9 1166.1 1202.4 -574.07   1148.1 0.6978  1     0.4035
```

```
AICctab(mod15p, mod16p, mod17p, weights=T)
```

```
##        dAICc df weight
## mod17p  0.0  8  0.613
## mod16p  1.4  9  0.305
## mod15p  4.0  11 0.082
```

```
summary(mod17p)
```

```
## Linear mixed model fit by maximum likelihood . t-tests use Satterthwaite's
##   method [lmerModLmerTest]
## Formula: log(flwr_duration_scaled) ~ state + growth_habit + year_factor +
##     (1 | plot)
##    Data: kbs_flwr_plot_growthhabit
##
##      AIC      BIC   logLik deviance df.resid
##   1164.8   1197.1   -574.4   1148.8      409
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.1473 -0.2722  0.1793  0.6320  1.8000
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  plot     (Intercept) 0.0000   0.0000
##  Residual             0.9205   0.9594
## Number of obs: 417, groups:  plot, 24
##
## Fixed effects:
##                       Estimate Std. Error        df t value Pr(>|t|)
## (Intercept)            2.90589    0.13165 417.00000  22.073  < 2e-16 ***
```

```
## statewarmed             0.07858    0.09452 417.00000   0.831 0.406251
## growth_habit           -0.90964    0.12455 417.00000  -7.303 1.44e-12 ***
## growth_habitForb/herb  -3.23045    0.96627 417.00000  -3.343 0.000903 ***
## growth_habitGraminoid  -0.72659    0.10722 417.00000  -6.776 4.22e-11 ***
## year_factor             0.03514    0.02449 417.00000   1.435 0.152077
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) sttwrm grwth_ grw_F/ grwt_G
## statewarmed -0.358
## growth_habt -0.441  0.078
## grwth_hbtF/  0.030 -0.048  0.035
## grwth_hbtGr -0.365 -0.003  0.414  0.057
## year_factor -0.740 -0.005  0.099 -0.076 -0.039
## optimizer (nloptwrap) convergence code: 0 (OK)
## boundary (singular) fit: see help('isSingular')
```

```
summ(mod17p)
```

```
## MODEL INFO:
## Observations: 417
## Dependent Variable: log(flwr_duration_scaled)
## Type: Mixed effects linear regression
##
## MODEL FIT:
## AIC = 1164.84, BIC = 1197.11
## Pseudo-R² (fixed effects) = 0.17
## Pseudo-R² (total) = 0.17
##
## FIXED EFFECTS:
## ----------------------------------------------------------------------
##                               Est.   S.E.   t val.     d.f.      p
## -------------------------- ------- ------ -------- -------- ------
## (Intercept)                  2.91   0.13    22.07   417.00   0.00
## statewarmed                  0.08   0.09     0.83   417.00   0.41
## growth_habit                -0.91   0.12    -7.30   417.00   0.00
## growth_habitForb/herb       -3.23   0.97    -3.34   417.00   0.00
## growth_habitGraminoid       -0.73   0.11    -6.78   417.00   0.00
## year_factor                  0.04   0.02     1.43   417.00   0.15
## ----------------------------------------------------------------------
##
## p values calculated using Satterthwaite d.f.
##
## RANDOM EFFECTS:
## -------------------------------------
##   Group      Parameter    Std. Dev.
## ---------- ------------- -----------
##    plot     (Intercept)     0.00
##  Residual                   0.96
## -------------------------------------
##
## Grouping variables:
## -------------------------
```

```
##  Group   # groups   ICC
## ------- ---------- ------
##  plot       24      0.00
## -------------------------
```

```
anova(mod17p)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##               Sum Sq Mean Sq NumDF DenDF F value    Pr(>F)
## state          0.636  0.6362     1   417  0.6911    0.4063
## growth_habit 72.498 24.1659     3   417 26.2537 1.422e-15 ***
## year_factor   1.895  1.8951     1   417  2.0588    0.1521
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
emmeans(mod17p, list(pairwise ~ state + growth_habit), adjust = "tukey")
```

```
## boundary (singular) fit: see help('isSingular')
```

```
## $`emmeans of state, growth_habit`
##  state   growth_habit emmean     SE    df lower.CL upper.CL
##  ambient Forb          3.045 0.0892  67.6     2.87     3.22
##  warmed  Forb          3.123 0.0889  67.6     2.95     3.30
##  ambient               2.135 0.1071 114.0     1.92     2.35
##  warmed                2.213 0.1154 136.8     1.99     2.44
##  ambient Forb/herb    -0.186 0.9787 423.0    -2.11     1.74
##  warmed  Forb/herb    -0.107 0.9741 422.9    -2.02     1.81
##  ambient Graminoid     2.318 0.0914  73.3     2.14     2.50
##  warmed  Graminoid     2.397 0.0907  72.7     2.22     2.58
##
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of state, growth_habit`
##  1                                      estimate     SE    df t.ratio p.value
##  ambient Forb - warmed Forb              -0.0786 0.0953  22.7  -0.825  0.9897
##  ambient Forb - ambient                   0.9096 0.1258 418.3   7.231  <.0001
##  ambient Forb - warmed                    0.8311 0.1637 145.4   5.077  <.0001
##  ambient Forb - (ambient Forb/herb)       3.2304 0.9780 423.1   3.303  0.0229
##  ambient Forb - (warmed Forb/herb)        3.1519 0.9781 422.5   3.222  0.0295
##  ambient Forb - ambient Graminoid         0.7266 0.1080 401.6   6.727  <.0001
##  ambient Forb - warmed Graminoid          0.6480 0.1438 107.8   4.505  0.0004
##  warmed Forb - ambient                    0.9882 0.1517 122.4   6.514  <.0001
##  warmed Forb - warmed                     0.9096 0.1258 418.3   7.231  <.0001
##  warmed Forb - (ambient Forb/herb)        3.3090 0.9872 422.7   3.352  0.0196
##  warmed Forb - (warmed Forb/herb)         3.2304 0.9780 423.1   3.303  0.0229
##  warmed Forb - ambient Graminoid          0.8052 0.1442 108.4   5.582  <.0001
##  warmed Forb - warmed Graminoid           0.7266 0.1080 401.6   6.727  <.0001
##  ambient  - warmed                       -0.0786 0.0953  22.7  -0.825  0.9897
##  ambient  - (ambient Forb/herb)           2.3208 0.9818 423.1   2.364  0.2621
##  ambient  - (warmed Forb/herb)            2.2422 0.9809 422.4   2.286  0.3038
```

```
##  ambient  - ambient Graminoid              -0.1831 0.1276 419.0  -1.434  0.8409
##  ambient  - warmed Graminoid               -0.2616 0.1530 125.2  -1.710  0.6810
##  warmed  - (ambient Forb/herb)              2.3994 0.9919 422.6   2.419  0.2348
##  warmed  - (warmed Forb/herb)               2.3208 0.9818 423.1   2.364  0.2621
##  warmed  - ambient Graminoid               -0.1045 0.1653 148.5  -0.632  0.9984
##  warmed  - warmed Graminoid                -0.1831 0.1276 419.0  -1.434  0.8409
##  (ambient Forb/herb) - (warmed Forb/herb)  -0.0786 0.0953  22.7  -0.825  0.9897
##  (ambient Forb/herb) - ambient Graminoid   -2.5039 0.9779 423.1  -2.561  0.1736
##  (ambient Forb/herb) - warmed Graminoid    -2.5824 0.9870 422.7  -2.616  0.1528
##  (warmed Forb/herb) - ambient Graminoid    -2.4253 0.9780 422.5  -2.480  0.2069
##  (warmed Forb/herb) - warmed Graminoid     -2.5039 0.9779 423.1  -2.561  0.1736
##  ambient Graminoid - warmed Graminoid      -0.0786 0.0953  22.7  -0.825  0.9897
##
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## P value adjustment: tukey method for comparing a family of 8 estimates
```

```
emmeans(mod17p, list(pairwise ~ growth_habit), adjust = "tukey")
```

```
## boundary (singular) fit: see help('isSingular')
```

```
## $`emmeans of growth_habit`
##  growth_habit emmean     SE  df lower.CL upper.CL
##  Forb          3.084 0.0753 127     2.93     3.23
##                2.174 0.1006 225     1.98     2.37
##  Forb/herb    -0.147 0.9752 423    -2.06     1.77
##  Graminoid     2.357 0.0776 139     2.20     2.51
##
## Results are averaged over the levels of: state
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of growth_habit`
##  1                      estimate    SE  df t.ratio p.value
##  Forb -                    0.910 0.126 418   7.231  <.0001
##  Forb - (Forb/herb)        3.230 0.978 423   3.303  0.0057
##  Forb - Graminoid          0.727 0.108 402   6.727  <.0001
##   - (Forb/herb)            2.321 0.982 423   2.364  0.0858
##   - Graminoid             -0.183 0.128 419  -1.434  0.4786
##  (Forb/herb) - Graminoid  -2.504 0.978 423  -2.561  0.0525
##
## Results are averaged over the levels of: state
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## P value adjustment: tukey method for comparing a family of 4 estimates
```

```
emmeans(mod17p, list(pairwise ~ growth_habit + year_factor), adjust = "tukey")
```

```
## boundary (singular) fit: see help('isSingular')
```

```
## $`emmeans of growth_habit, year_factor`
```

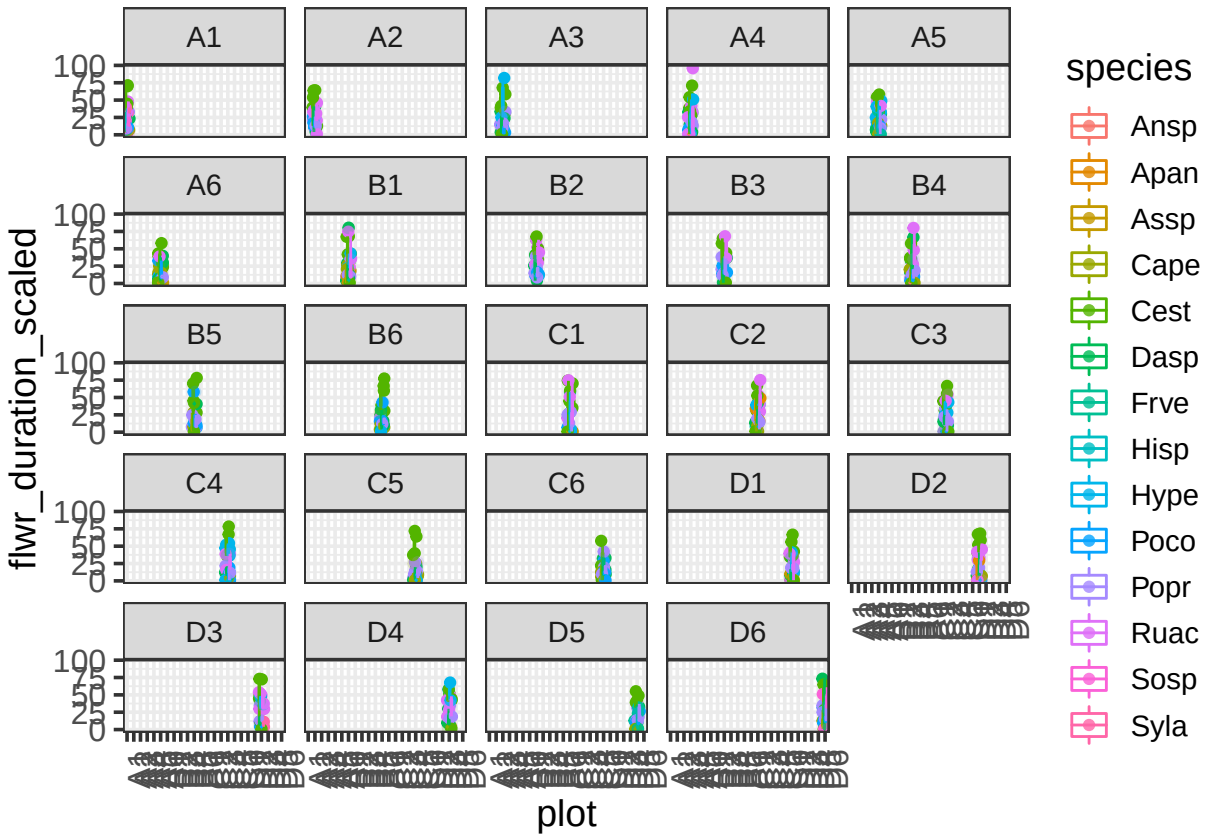
```
##  growth_habit year_factor emmean     SE  df lower.CL upper.CL
##  Forb                3.94  3.084 0.0753 127     2.93     3.23
##                      3.94  2.174 0.1006 225     1.98     2.37
##  Forb/herb           3.94 -0.147 0.9752 423    -2.06     1.77
##  Graminoid           3.94  2.357 0.0776 139     2.20     2.51
##
## Results are averaged over the levels of: state
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of growth_habit, year_factor`
##  1
##  Forb year_factor3.94484412470024 -  year_factor3.94484412470024
##  Forb year_factor3.94484412470024 - (Forb/herb year_factor3.94484412470024)
##  Forb year_factor3.94484412470024 - Graminoid year_factor3.94484412470024
##   year_factor3.94484412470024 - (Forb/herb year_factor3.94484412470024)
##   year_factor3.94484412470024 - Graminoid year_factor3.94484412470024
##  (Forb/herb year_factor3.94484412470024) - Graminoid year_factor3.94484412470024
##  estimate    SE  df t.ratio p.value
##     0.910 0.126 418   7.231  <.0001
##     3.230 0.978 423   3.303  0.0057
##     0.727 0.108 402   6.727  <.0001
##     2.321 0.982 423   2.364  0.0858
##    -0.183 0.128 419  -1.434  0.4786
##    -2.504 0.978 423  -2.561  0.0525
##
## Results are averaged over the levels of: state
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## P value adjustment: tukey method for comparing a family of 4 estimates
```

UMBS

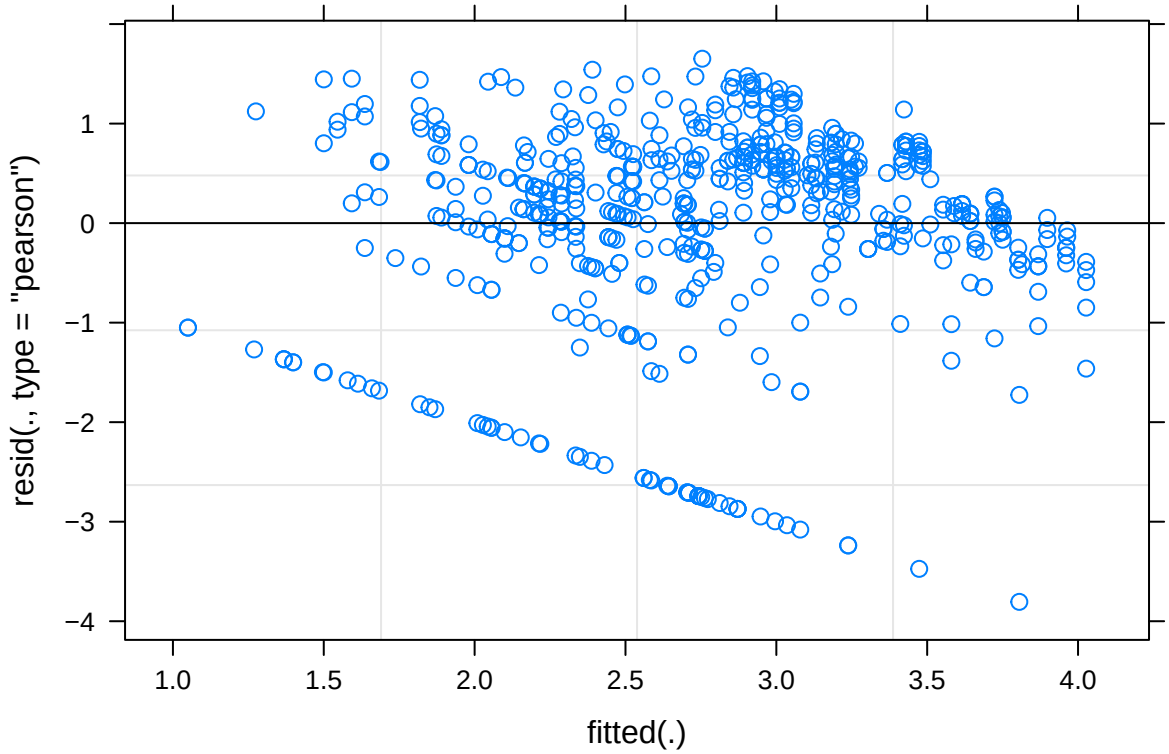
```
# UMBS SPECIES LEVEL - Looking at DURATION of flowering
mod1u <- lmer(log(flwr_duration_scaled) ~ state*year_factor + insecticide*year_factor + (1|species) + (
```

```
## boundary (singular) fit: see help('isSingular')
```

```
ggplot(umbs_flwr_spp,aes(x=plot,y=flwr_duration_scaled,col=species)) + geom_jitter() + geom_boxplot(alp
```




```
# Check Assumptions:
# (1) Linearity: if covariates are not categorical (year isn't)
# (2) Homogeneity: Need to Check by plotting residuals vs predicted values.
par(mfrow=c(1,2))
plot(mod1u) # the zeros in the data are making this look weird
```




```
# Homogeneity of variance is ok here (increasing variance in resids is not increasing with fitted value
# Check for homogeneity of variances (true if p>0.05). If the result is not significant, the assumption
# *****Levene's Test - tests whether or not the variance among two or more groups is equal - If the p-v

leveneTest(residuals(mod1u) ~ umbs_flwr_spp$state)
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##        Df F value Pr(>F)
## group   1   2e-04 0.9898
##       605
```

```
# Assumption not met
leveneTest(residuals(mod1u) ~ umbs_flwr_spp$species)
```

```
## Warning in leveneTest.default(y = y, group = group, ...): group coerced to
## factor.

## Levene's Test for Homogeneity of Variance (center = median)
##        Df F value  Pr(>F)
## group  13  1.6229 0.07447 .
##       593
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# Assumption met
leveneTest(residuals(mod1u) ~ umbs_flwr_spp$insecticide)
```

```
## Warning in leveneTest.default(y = y, group = group, ...): group coerced to
## factor.

## Levene's Test for Homogeneity of Variance (center = median)
##        Df F value Pr(>F)
## group   1  0.4681 0.4941
##       605
```

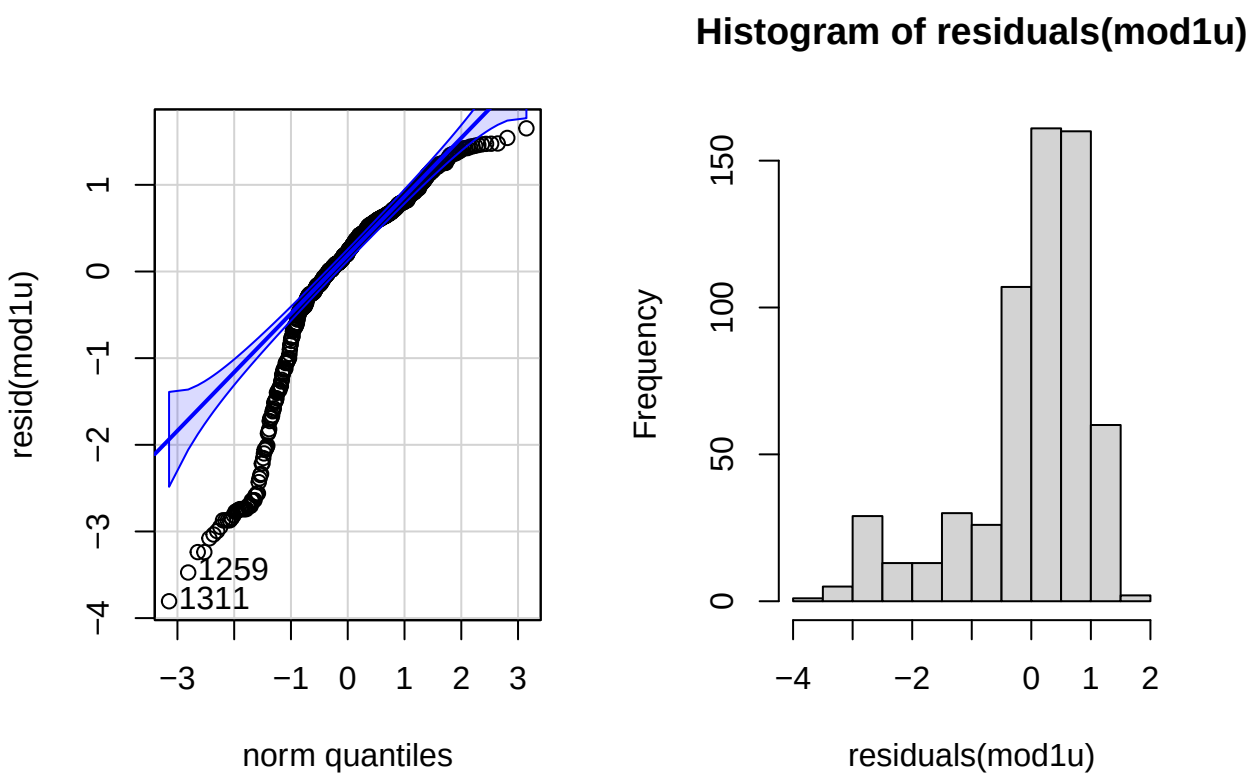
```
# Assumption not met
leveneTest(residuals(mod1u) ~ umbs_flwr_spp$plot)
```

```
## Warning in leveneTest.default(y = y, group = group, ...): group coerced to
## factor.

## Levene's Test for Homogeneity of Variance (center = median)
##        Df F value Pr(>F)
## group  23  0.6974 0.8507
##       583
```

```
# Assumption not met

# (3) Normality of error term: need to check by histogram, QQplot of residuals, could do Kolmogorov-Smi
# Check for normal residuals
qqPlot(resid(mod1u))
```

```
## 1311 1259
##  465  447
```

```
hist(residuals(mod1u))
```



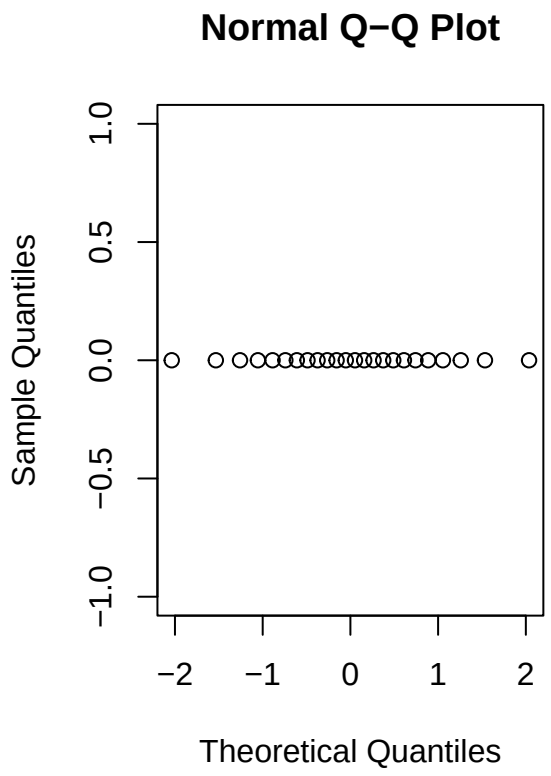
```
shapiro.test(resid(mod1u)) # not normally distributed resids bc p<0.05
```

```
##
##  Shapiro-Wilk normality test
##
## data:  resid(mod1u)
## W = 0.87388, p-value < 2.2e-16
```

```
outlierTest(mod1u) # outliers
```

```
## No Studentized residuals with Bonferroni p < 0.05
## Largest |rstudent|:
##       rstudent unadjusted p-value Bonferroni p
## 1311 -3.720292         0.00021778      0.13219
```

```
# (4) Normality of random effect: Get the estimate of random effect (e.g., random intercepts), and chec
require(lme4)
r_int <- ranef(mod1u)$plot$`(Intercept)`
qqnorm(r_int)
# qqline(r_int) doesn't work
# shapiro.test(r_int)  # this doesnt work
```




```
# Do we need to include plot as a random effect with the KBS models?
mod1u <- lmer(log(flwr_duration_scaled) ~ state*year_factor + insecticide*year_factor + (1|species) + (
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod2u <- lmer(log(flwr_duration_scaled) ~ state*year_factor + insecticide*year_factor + (1|species), uml
# Run analysis of variance on each model (see this for more explanation on how anova on a linear mixed
anova(mod1u)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##                          Sum Sq Mean Sq NumDF  DenDF F value    Pr(>F)
## state                     1.119   1.119     1 590.54  1.0384    0.3086
## year_factor              69.814  69.814     1 598.80 64.7835 4.514e-15 ***
## insecticide               0.337   0.337     1 593.06  0.3127    0.5762
## state:year_factor         0.903   0.903     1 590.25  0.8375    0.3605
## year_factor:insecticide   0.518   0.518     1 593.71  0.4806    0.4884
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
anova(mod2u)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##                          Sum Sq Mean Sq NumDF  DenDF F value    Pr(>F)
## state                     1.119   1.119     1 590.54  1.0384    0.3086
## year_factor              69.814  69.814     1 598.80 64.7835 4.514e-15 ***
## insecticide               0.337   0.337     1 593.06  0.3127    0.5762
## state:year_factor         0.903   0.903     1 590.25  0.8375    0.3605
## year_factor:insecticide   0.518   0.518     1 593.71  0.4806    0.4884
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
anova(mod1u, mod2u) # Go with model 2 since pvalue >0.05, aka more complex model does not have somethin
```

```
## Data: umbs_flwr_spp
## Models:
## mod2u: log(flwr_duration_scaled) ~ state * year_factor + insecticide * year_factor + (1 | species)
## mod1u: log(flwr_duration_scaled) ~ state * year_factor + insecticide * year_factor + (1 | species) +
##       npar    AIC    BIC  logLik deviance Chisq Df Pr(>Chisq)
## mod2u    8 1816.6 1851.9 -900.32   1800.6
## mod1u    9 1818.6 1858.3 -900.32   1800.6     0  1          1
```

```
summ(mod1u)
```

```
## MODEL INFO:
## Observations: 607
## Dependent Variable: log(flwr_duration_scaled)
## Type: Mixed effects linear regression
##
## MODEL FIT:
## AIC = 1818.64, BIC = 1858.31
## Pseudo-R² (fixed effects) = 0.08
## Pseudo-R² (total) = 0.33
##
## FIXED EFFECTS:
## ----------------------------------------------------------------------------
##                                        Est.   S.E.   t val.     d.f.      p
```

```
## ------------------------------------- ------- ------ -------- -------- ------
## (Intercept)                             3.71   0.29    12.62    60.96   0.00
## stateambient                           -0.26   0.26    -1.02   590.54   0.31
## year_factor                            -0.28   0.05    -5.47   590.83   0.00
## insecticideno_insects                  -0.14   0.26    -0.56   593.06   0.58
## stateambient:year_factor                0.05   0.06     0.92   590.25   0.36
## year_factor:insecticideno_insects       0.04   0.06     0.69   593.71   0.49
## ------------------------------------------------------------------------------
##
## p values calculated using Satterthwaite d.f.
##
## RANDOM EFFECTS:
## -----------------------------------
##   Group      Parameter    Std. Dev.
## ---------- ------------- -----------
##    plot     (Intercept)     0.00
##  species    (Intercept)     0.63
##  Residual                   1.04
## -----------------------------------
##
## Grouping variables:
## ---------------------------
##   Group    # groups   ICC
## --------- ---------- ------
##   plot        24      0.00
##  species      14      0.27
## ---------------------------
```

```
summ(mod2u)
```

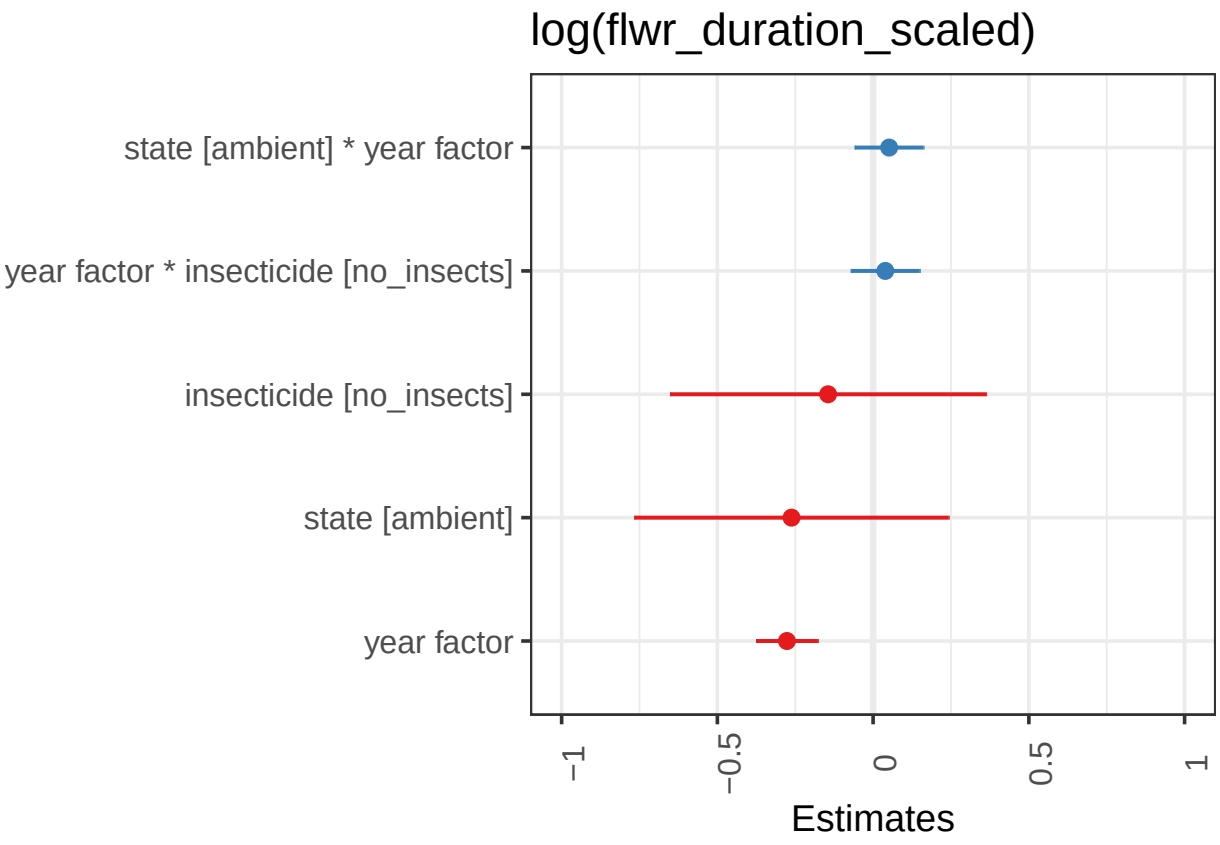
```
## MODEL INFO:
## Observations: 607
## Dependent Variable: log(flwr_duration_scaled)
## Type: Mixed effects linear regression
##
## MODEL FIT:
## AIC = 1816.64, BIC = 1851.91
## Pseudo-R² (fixed effects) = 0.08
## Pseudo-R² (total) = 0.33
##
## FIXED EFFECTS:
## ------------------------------------------------------------------------------
##                                         Est.   S.E.   t val.     d.f.      p
## ------------------------------------- ------- ------ -------- -------- ------
## (Intercept)                             3.71   0.29    12.62    60.96   0.00
## stateambient                           -0.26   0.26    -1.02   590.54   0.31
## year_factor                            -0.28   0.05    -5.47   590.83   0.00
## insecticideno_insects                  -0.14   0.26    -0.56   593.06   0.58
## stateambient:year_factor                0.05   0.06     0.92   590.25   0.36
## year_factor:insecticideno_insects       0.04   0.06     0.69   593.71   0.49
## ------------------------------------------------------------------------------
##
## p values calculated using Satterthwaite d.f.
##
```

```
## RANDOM EFFECTS:
## ------------------------------------
##   Group      Parameter    Std. Dev.
## ---------- ------------- -----------
##  species    (Intercept)     0.63
##  Residual                   1.04
## ------------------------------------
##
## Grouping variables:
## ---------------------------
##   Group    # groups   ICC
## --------- ---------- ------
##  species      14      0.27
## ---------------------------
```

```
AICctab(mod1u, mod2u, weights=T)
```

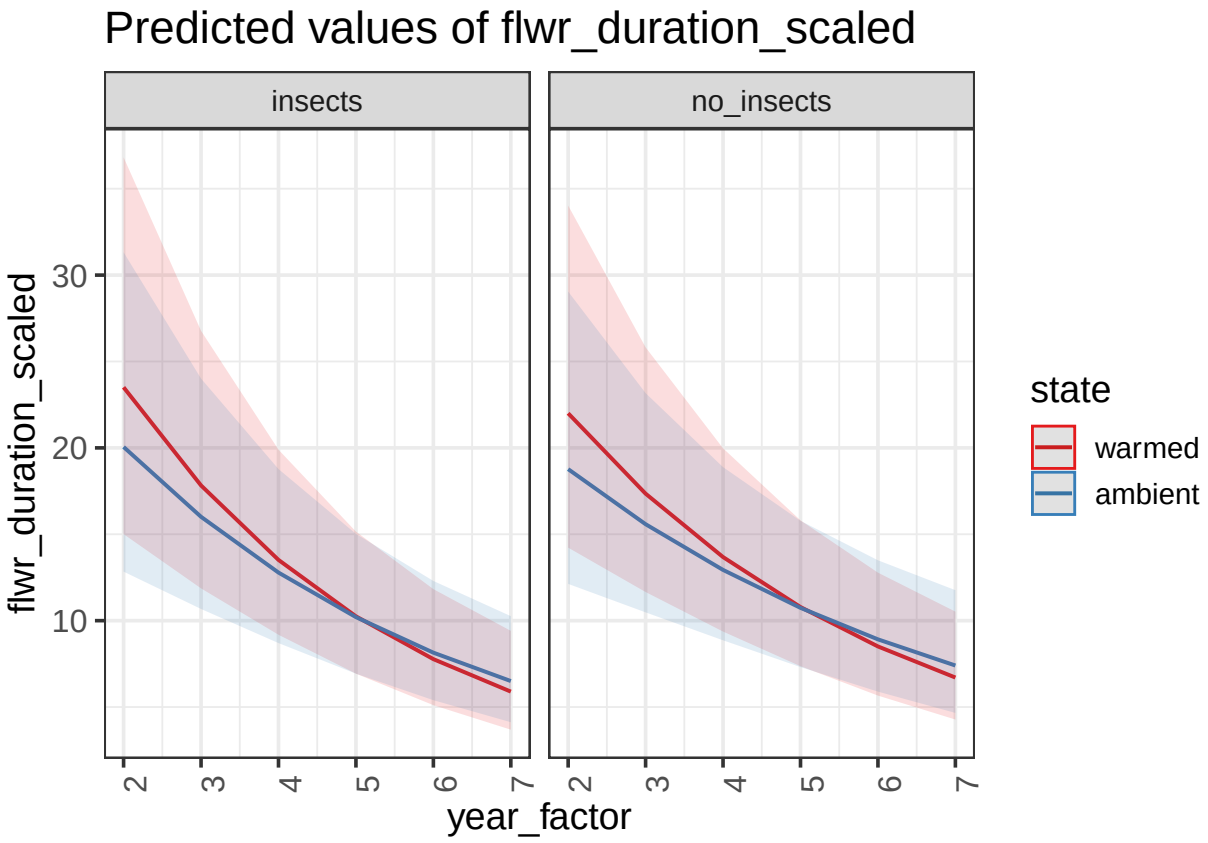
```
##       dAICc df weight
## mod2u 0.0   8  0.74
## mod1u 2.1   9  0.26
```

```
# Plot the fixed effects estimates for different models
# these are the fixed effects estimates from summary(mod1)
plot_model(mod2u, sort.est = TRUE)
```

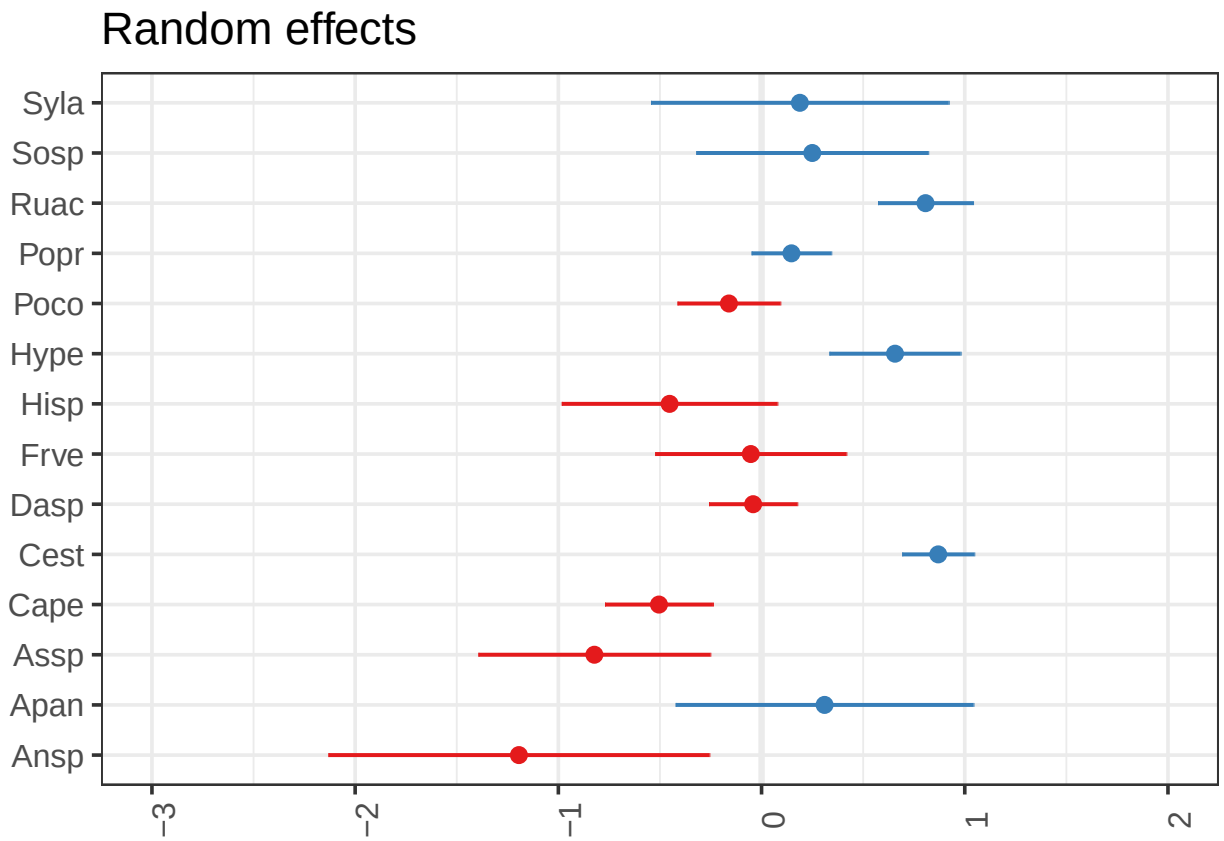


```
# these are the fixed predicted values:
plot_model(mod2u, type = "pred", terms = c("year_factor", "state", "insecticide"))
```

```
## Model has log-transformed response. Back-transforming predictions to original response scale. Standa
```




```
# these are the random effects estimates
plot_model(mod2u, type = "re", terms = c("species"))
```




```
# Do we need to include insecticide? (dropping insecticide from the model)
# mod2 <- lmer(log(relabun) ~ state*year_factor + insecticide*year_factor + (1|species), comp_kbs_spp, 
mod3u <- lmer(log(flwr_duration_scaled) ~ state*year_factor + (1|species), umbs_flwr_spp, REML=FALSE)
anova(mod2u, mod3u)
```

```
## Data: umbs_flwr_spp
## Models:
## mod3u: log(flwr_duration_scaled) ~ state * year_factor + (1 | species)
## mod2u: log(flwr_duration_scaled) ~ state * year_factor + insecticide * year_factor + (1 | species)
##       npar    AIC    BIC  logLik deviance  Chisq Df Pr(>Chisq)
## mod3u    6 1813.2 1839.7 -900.60   1801.2
## mod2u    8 1816.6 1851.9 -900.32   1800.6 0.5584  2     0.7564
```

```
AICctab(mod2u, mod3u, weights=T) # go with model 3u
```

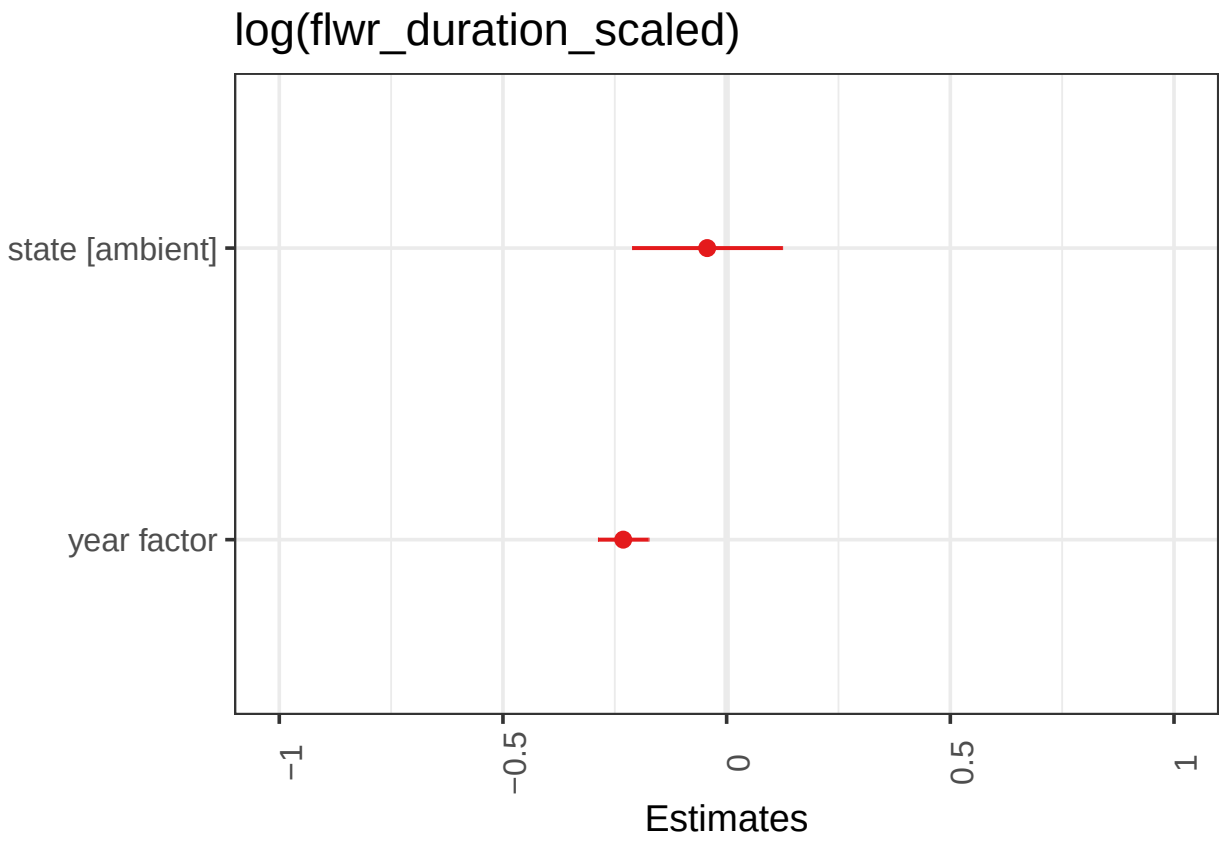
```
##       dAICc df weight
## mod3u 0.0   6  0.85
## mod2u 3.5   8  0.15
```

```
# Looks like no, pvalue > 0.05, so insecticide does not improve model fit so we will go with mod 3

# Does year need to be interactive with insecticide? - already removed insecticide
# mod4 <- lmer(log(julian_median) ~ state*year_factor + insecticide + (1|species) + (1|plot), umbs_flwr

# Does year need to be interactive with state?
```

```
mod5u <- lmer(log(flwr_duration_scaled) ~ state + year_factor + (1|species), umbs_flwr_spp, REML=FALSE)
anova(mod3u, mod5u)
```

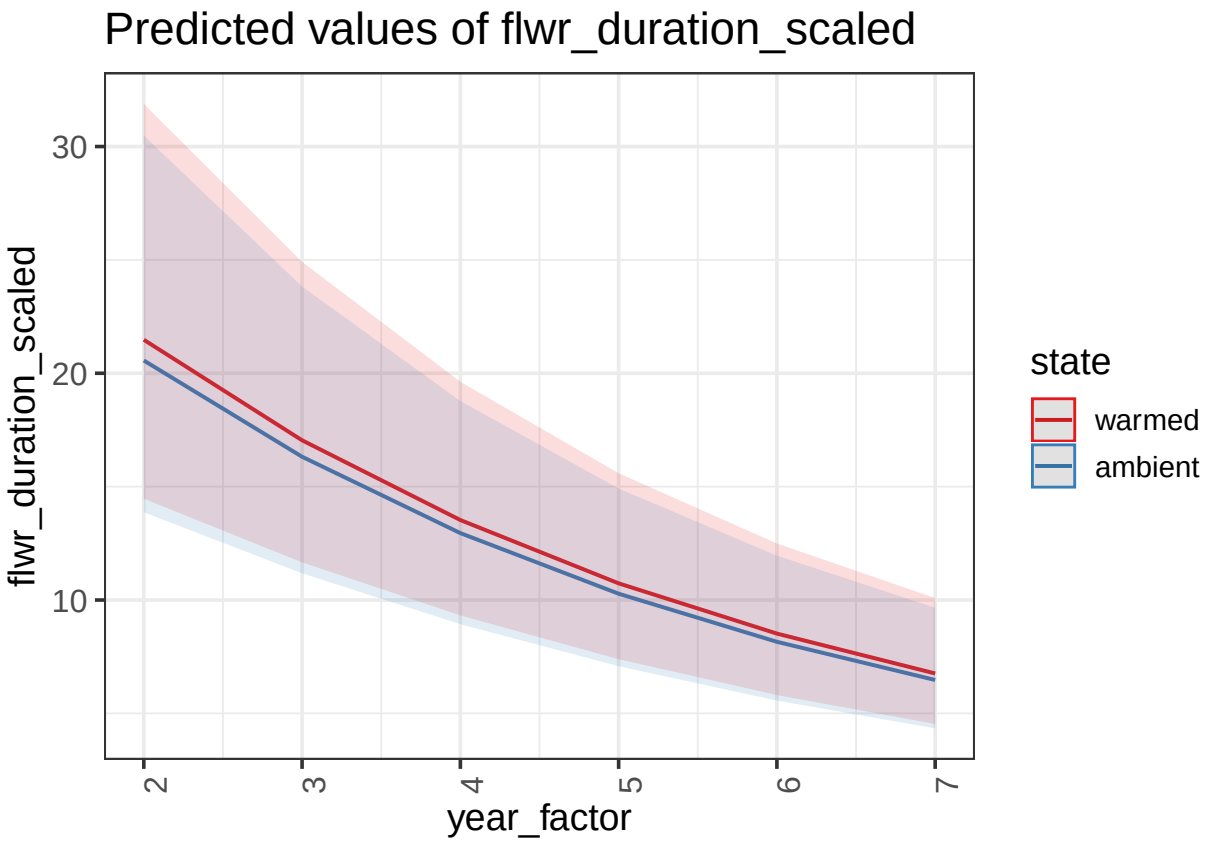
```
## Data: umbs_flwr_spp
## Models:
## mod5u: log(flwr_duration_scaled) ~ state + year_factor + (1 | species)
## mod3u: log(flwr_duration_scaled) ~ state * year_factor + (1 | species)
##       npar    AIC    BIC  logLik deviance  Chisq Df Pr(>Chisq)
## mod5u    5 1811.9 1834.0 -900.97   1801.9
## mod3u    6 1813.2 1839.7 -900.60   1801.2 0.7394  1     0.3899
```

```
# No, P>0.05 so state*year_factor doesn't strongly improve model fit so we will shift to mod5, but AIC
# Plot the fixed effects estimates for different models
# these are the fixed effects estimates from summary(mod5)
plot_model(mod5u, sort.est = TRUE)
```

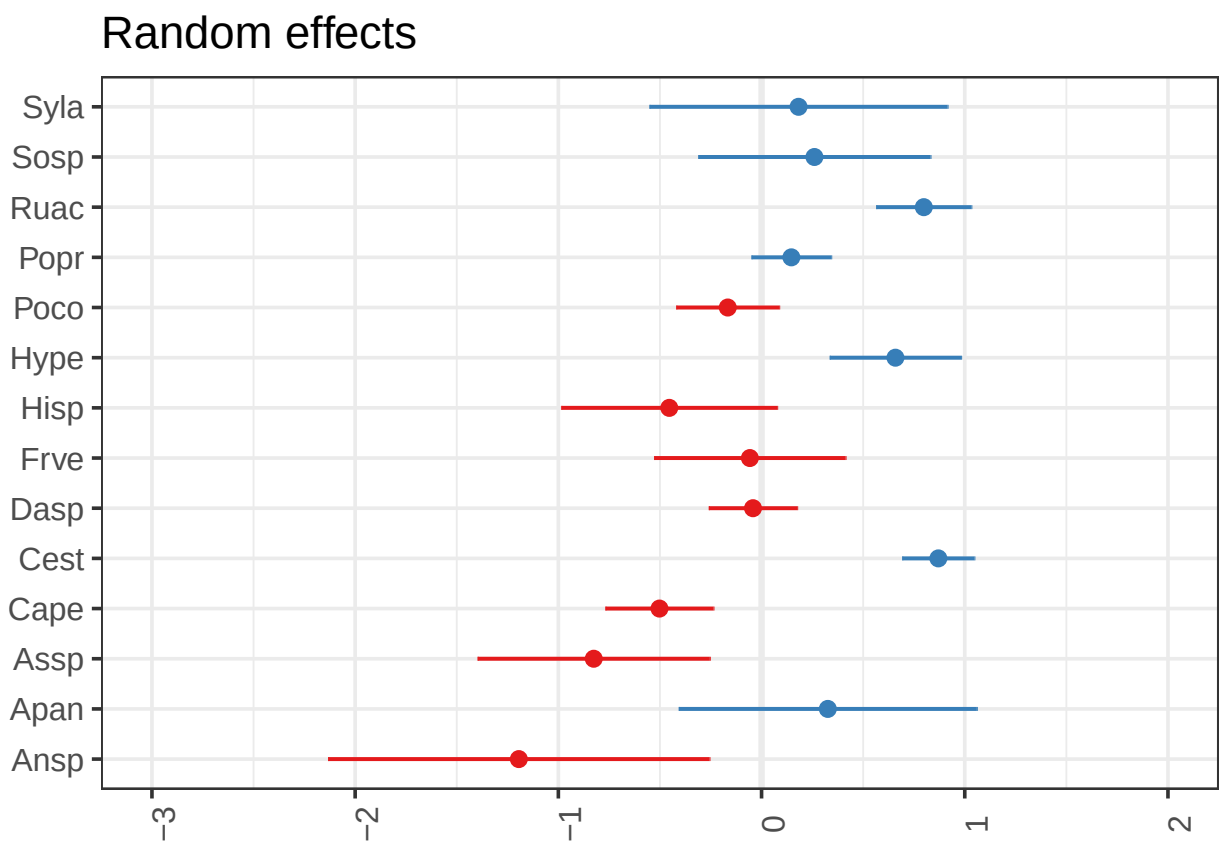



```
# these are the fixed predicted values:
plot_model(mod5u, type = "pred", terms = c("year_factor", "state"))
```

```
## Model has log-transformed response. Back-transforming predictions to original response scale. Standa
```




```
# these are the random effects estimates
plot_model(mod5u, type = "re", terms = c("species"))
```




```
# If we wanted to include plots nested within year it would look like this:
mod6u <- lmer(log(flwr_duration_scaled) ~ state + year_factor + (1|species) + (1 + year_factor|plot), u
```

```
## boundary (singular) fit: see help('isSingular')
```

```
# Model failed to converge with 1 negative eigenvalue: -1.9e+00
anova(mod5u, mod6u)
```

```
## Data: umbs_flwr_spp
## Models:
## mod5u: log(flwr_duration_scaled) ~ state + year_factor + (1 | species)
## mod6u: log(flwr_duration_scaled) ~ state + year_factor + (1 | species) + (1 + year_factor | plot)
##       npar    AIC    BIC  logLik deviance  Chisq Df Pr(>Chisq)
## mod5u    5 1811.9 1834.0 -900.97   1801.9
## mod6u    8 1816.8 1852.1 -900.42   1800.8 1.0946  3     0.7784
```

```
anova(mod5u)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##             Sum Sq Mean Sq NumDF  DenDF F value   Pr(>F)
## state        0.281   0.281     1 594.22  0.2601   0.6102
## year_factor 69.841  69.841     1 599.10 64.6702 4.75e-15 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# mod4 (and mod5) are pretty complex in terms of interpretation (they actually don't have many paramete
mod7u <- lmer(log(flwr_duration_scaled) ~ state + species + (1+factor(year_factor)|plot), umbs_flwr_spp

## boundary (singular) fit: see help('isSingular')

mod7au <- lmer(log(flwr_duration_scaled)  ~ state + species + factor(year_factor) + (1|plot), umbs_flwr

## boundary (singular) fit: see help('isSingular')

mod7bu <- lmer(log(flwr_duration_scaled)  ~ state * factor(year_factor) + species + (1|plot), umbs_flwr

## boundary (singular) fit: see help('isSingular')

mod7cu <- lmer(log(flwr_duration_scaled)  ~ state + species + factor(year_factor) + insecticide + (1|pl

## boundary (singular) fit: see help('isSingular')

anova(mod5u, mod7u) # model 7 is a better fit to data

## Data: umbs_flwr_spp
## Models:
## mod5u: log(flwr_duration_scaled) ~ state + year_factor + (1 | species)
## mod7u: log(flwr_duration_scaled) ~ state + species + (1 + factor(year_factor) | plot)
##       npar    AIC    BIC  logLik deviance  Chisq Df Pr(>Chisq)
## mod5u    5 1811.9 1834.0 -900.97   1801.9
## mod7u   37 1631.2 1794.3 -778.59   1557.2 244.76 32  < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

anova(mod7u, mod7au) #mod 7a

## Data: umbs_flwr_spp
## Models:
## mod7au: log(flwr_duration_scaled) ~ state + species + factor(year_factor) + (1 | plot)
## mod7u: log(flwr_duration_scaled) ~ state + species + (1 + factor(year_factor) | plot)
##        npar    AIC    BIC  logLik deviance Chisq Df Pr(>Chisq)
## mod7au   22 1527.8 1624.8 -741.89   1483.8
## mod7u    37 1631.2 1794.3 -778.59   1557.2     0 15          1

anova(mod7au, mod7bu) #mod 7a - interaction between state and year does not improve model go with simpl

## Data: umbs_flwr_spp
## Models:
## mod7au: log(flwr_duration_scaled) ~ state + species + factor(year_factor) + (1 | plot)
## mod7bu: log(flwr_duration_scaled) ~ state * factor(year_factor) + species + (1 | plot)
##        npar    AIC    BIC  logLik deviance  Chisq Df Pr(>Chisq)
## mod7au   22 1527.8 1624.8 -741.89   1483.8
## mod7bu   27 1535.7 1654.7 -740.84   1481.7 2.1152  5      0.833
```

```
anova(mod7au, mod7cu) #models are not different than one another, go with simpler model = mod7a
```

```
## Data: umbs_flwr_spp
## Models:
## mod7au: log(flwr_duration_scaled) ~ state + species + factor(year_factor) + (1 | plot)
## mod7cu: log(flwr_duration_scaled) ~ state + species + factor(year_factor) + insecticide + (1 | plot)
##        npar    AIC    BIC  logLik deviance  Chisq Df Pr(>Chisq)
## mod7au   22 1527.8 1624.8 -741.89   1483.8
## mod7cu   23 1529.3 1630.7 -741.63   1483.3 0.5278  1     0.4675
```

```
summary(mod7au)
```

```
## Linear mixed model fit by maximum likelihood . t-tests use Satterthwaite's
##   method [lmerModLmerTest]
## Formula: log(flwr_duration_scaled) ~ state + species + factor(year_factor) +
##     (1 | plot)
##    Data: umbs_flwr_spp
##
##      AIC      BIC   logLik deviance df.resid
##   1527.8   1624.8   -741.9   1483.8      585
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.3218 -0.3727  0.1703  0.6354  3.8210
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  plot     (Intercept) 0.0000   0.0000
##  Residual             0.6747   0.8214
## Number of obs: 607, groups:  plot, 24
##
## Fixed effects:
##                       Estimate Std. Error        df t value Pr(>|t|)
## (Intercept)           -0.07351    0.59361 607.00000  -0.124 0.901486
## stateambient          -0.06749    0.06758 607.00000  -0.999 0.318362
## speciesApan            3.57941    0.69353 607.00000   5.161 3.33e-07 ***
## speciesAssp            2.23459    0.64355 607.00000   3.472 0.000553 ***
## speciesCape            2.49538    0.59604 607.00000   4.187 3.25e-05 ***
## speciesCest            3.90468    0.58986 607.00000   6.620 7.93e-11 ***
## speciesDasp            2.76117    0.59188 607.00000   4.665 3.80e-06 ***
## speciesFrve            3.00296    0.62124 607.00000   4.834 1.70e-06 ***
## speciesHisp            2.41140    0.63195 607.00000   3.816 0.000150 ***
## speciesHype            3.55081    0.60224 607.00000   5.896 6.18e-09 ***
## speciesPoco            2.51672    0.59414 607.00000   4.236 2.63e-05 ***
## speciesPopr            2.88727    0.59051 607.00000   4.889 1.30e-06 ***
## speciesRuac            3.69109    0.59319 607.00000   6.222 9.12e-10 ***
## speciesSosp            3.29779    0.64027 607.00000   5.151 3.51e-07 ***
## speciesSyla            2.92062    0.69340 607.00000   4.212 2.91e-05 ***
## factor(year_factor)3   0.10726    0.11790 607.00000   0.910 0.363338
## factor(year_factor)4  -0.29265    0.11766 607.00000  -2.487 0.013143 *
## factor(year_factor)5  -0.10140    0.11450 607.00000  -0.886 0.376194
## factor(year_factor)6  -0.11476    0.11455 607.00000  -1.002 0.316821
```

```
## factor(year_factor)7  -3.14537    0.16765 607.00000 -18.762  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

##
## Correlation matrix not shown by default, as p = 20 > 12.
## Use print(x, correlation=TRUE)  or
##     vcov(x)        if you need it

## optimizer (nloptwrap) convergence code: 0 (OK)
## boundary (singular) fit: see help('isSingular')
```

```
anova(mod7au) # investigates whether at least one of the levels within each factor is significantly dif
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##                      Sum Sq Mean Sq NumDF DenDF F value Pr(>F)
## state                 0.673   0.673     1   607  0.9973 0.3184
## species             203.599  15.661    13   607 23.2107 <2e-16 ***
## factor(year_factor) 299.769  59.954     5   607 88.8535 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# Yes, at least one of the species is different (they do not all have the same relative abundances).
emmeans(mod7au, list(pairwise ~ state + year_factor), adjust = "tukey")
```

```
## boundary (singular) fit: see help('isSingular')

## $`emmeans of state, year_factor`
##  state   year_factor emmean    SE  df lower.CL upper.CL
##  warmed            2  2.730 0.114 333    2.506    2.954
##  ambient           2  2.663 0.114 300    2.439    2.886
##  warmed            3  2.838 0.107 265    2.628    3.048
##  ambient           3  2.770 0.106 239    2.562    2.979
##  warmed            4  2.438 0.107 259    2.227    2.648
##  ambient           4  2.370 0.106 232    2.161    2.579
##  warmed            5  2.629 0.104 253    2.424    2.833
##  ambient           5  2.561 0.103 234    2.358    2.765
##  warmed            6  2.616 0.103 238    2.414    2.818
##  ambient           6  2.548 0.102 212    2.347    2.749
##  warmed            7 -0.415 0.159 519   -0.727   -0.103
##  ambient           7 -0.483 0.160 529   -0.797   -0.168
##
## Results are averaged over the levels of: species
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of state, year_factor`
##  1                                          estimate     SE    df t.ratio
##  warmed year_factor2 - ambient year_factor2   0.0675 0.0691  21.4   0.977
##  warmed year_factor2 - warmed year_factor3   -0.1073 0.1200 610.6  -0.894
##  warmed year_factor2 - ambient year_factor3  -0.0398 0.1380 262.1  -0.288
```

```
##  warmed year_factor2 - warmed year_factor4     0.2927 0.1198 615.0   2.444
##  warmed year_factor2 - ambient year_factor4    0.3601 0.1379 255.0   2.611
##  warmed year_factor2 - warmed year_factor5     0.1014 0.1165 614.0   0.870
##  warmed year_factor2 - ambient year_factor5    0.1689 0.1353 248.3   1.249
##  warmed year_factor2 - warmed year_factor6     0.1148 0.1166 614.8   0.984
##  warmed year_factor2 - ambient year_factor6    0.1823 0.1352 242.8   1.348
##  warmed year_factor2 - warmed year_factor7     3.1454 0.1708 622.2  18.414
##  warmed year_factor2 - ambient year_factor7    3.2129 0.1853 459.8  17.335
##  ambient year_factor2 - warmed year_factor3   -0.1747 0.1388 256.6  -1.259
##  ambient year_factor2 - ambient year_factor3  -0.1073 0.1200 610.6  -0.894
##  ambient year_factor2 - warmed year_factor4    0.2252 0.1385 252.6   1.625
##  ambient year_factor2 - ambient year_factor4   0.2927 0.1198 615.0   2.444
##  ambient year_factor2 - warmed year_factor5    0.0339 0.1357 234.3   0.250
##  ambient year_factor2 - ambient year_factor5   0.1014 0.1165 614.0   0.870
##  ambient year_factor2 - warmed year_factor6    0.0473 0.1358 238.6   0.348
##  ambient year_factor2 - ambient year_factor6   0.1148 0.1166 614.8   0.984
##  ambient year_factor2 - warmed year_factor7    3.0779 0.1831 411.5  16.805
##  ambient year_factor2 - ambient year_factor7   3.1454 0.1708 622.2  18.414
##  warmed year_factor3 - ambient year_factor3    0.0675 0.0691  21.4   0.977
##  warmed year_factor3 - warmed year_factor4     0.3999 0.1135 609.0   3.522
##  warmed year_factor3 - ambient year_factor4    0.4674 0.1330 231.8   3.514
##  warmed year_factor3 - warmed year_factor5     0.2087 0.1103 608.0   1.892
##  warmed year_factor3 - ambient year_factor5    0.2762 0.1304 224.5   2.118
##  warmed year_factor3 - warmed year_factor6     0.2220 0.1099 608.5   2.020
##  warmed year_factor3 - ambient year_factor6    0.2895 0.1299 217.8   2.228
##  warmed year_factor3 - warmed year_factor7     3.2526 0.1679 621.0  19.371
##  warmed year_factor3 - ambient year_factor7    3.3201 0.1830 451.4  18.144
##  ambient year_factor3 - warmed year_factor4    0.3324 0.1328 234.5   2.504
##  ambient year_factor3 - ambient year_factor4   0.3999 0.1135 609.0   3.522
##  ambient year_factor3 - warmed year_factor5    0.1412 0.1299 215.7   1.087
##  ambient year_factor3 - ambient year_factor5   0.2087 0.1103 608.0   1.892
##  ambient year_factor3 - warmed year_factor6    0.1545 0.1297 218.5   1.191
##  ambient year_factor3 - ambient year_factor6   0.2220 0.1099 608.5   2.020
##  ambient year_factor3 - warmed year_factor7    3.1851 0.1801 408.0  17.683
##  ambient year_factor3 - ambient year_factor7   3.2526 0.1679 621.0  19.371
##  warmed year_factor4 - ambient year_factor4    0.0675 0.0691  21.4   0.977
##  warmed year_factor4 - warmed year_factor5    -0.1912 0.1089 609.6  -1.756
##  warmed year_factor4 - ambient year_factor5   -0.1238 0.1291 218.8  -0.959
##  warmed year_factor4 - warmed year_factor6    -0.1779 0.1083 611.4  -1.643
##  warmed year_factor4 - ambient year_factor6   -0.1104 0.1284 209.9  -0.860
##  warmed year_factor4 - warmed year_factor7     2.8527 0.1659 620.6  17.193
##  warmed year_factor4 - ambient year_factor7    2.9202 0.1811 448.1  16.127
##  ambient year_factor4 - warmed year_factor5   -0.2587 0.1289 207.6  -2.008
##  ambient year_factor4 - ambient year_factor5  -0.1912 0.1089 609.6  -1.756
##  ambient year_factor4 - warmed year_factor6   -0.2454 0.1284 208.1  -1.911
##  ambient year_factor4 - ambient year_factor6  -0.1779 0.1083 611.4  -1.643
##  ambient year_factor4 - warmed year_factor7    2.7852 0.1784 400.8  15.615
##  ambient year_factor4 - ambient year_factor7   2.8527 0.1659 620.6  17.193
##  warmed year_factor5 - ambient year_factor5    0.0675 0.0691  21.4   0.977
##  warmed year_factor5 - warmed year_factor6     0.0134 0.1045 608.1   0.128
##  warmed year_factor5 - ambient year_factor6    0.0809 0.1251 191.5   0.646
##  warmed year_factor5 - warmed year_factor7     3.0440 0.1632 619.2  18.653
##  warmed year_factor5 - ambient year_factor7    3.1115 0.1785 437.8  17.432
##  ambient year_factor5 - warmed year_factor6   -0.0541 0.1254 200.5  -0.432
```

```
##  ambient year_factor5 - ambient year_factor6   0.0134 0.1045 608.1   0.128
##  ambient year_factor5 - warmed year_factor7    2.9765 0.1759 400.1  16.921
##  ambient year_factor5 - ambient year_factor7   3.0440 0.1632 619.2  18.653
##  warmed year_factor6 - ambient year_factor6    0.0675 0.0691  21.4   0.977
##  warmed year_factor6 - warmed year_factor7     3.0306 0.1632 621.4  18.575
##  warmed year_factor6 - ambient year_factor7    3.0981 0.1786 436.5  17.351
##  ambient year_factor6 - warmed year_factor7    2.9631 0.1758 390.0  16.858
##  ambient year_factor6 - ambient year_factor7   3.0306 0.1632 621.4  18.575
##  warmed year_factor7 - ambient year_factor7    0.0675 0.0691  21.4   0.977
##  p.value
##   0.9967
##   0.9992
##   1.0000
##   0.3782
##   0.2792
##   0.9994
##   0.9843
##   0.9980
##   0.9717
##   <.0001
##   <.0001
##   0.9833
##   0.9992
##   0.8983
##   0.3782
##   1.0000
##   0.9994
##   1.0000
##   0.9980
##   <.0001
##   <.0001
##   0.9967
##   0.0231
##   0.0260
##   0.7642
##   0.6103
##   0.6799
##   0.5310
##   <.0001
##   <.0001
##   0.3429
##   0.0231
##   0.9950
##   0.7642
##   0.9892
##   0.6799
##   <.0001
##   <.0001
##   0.9967
##   0.8411
##   0.9983
##   0.8923
##   0.9994
##   <.0001
```

```
##   <.0001
##   0.6877
##   0.8411
##   0.7514
##   0.8923
##   <.0001
##   <.0001
##   0.9967
##   1.0000
##   1.0000
##   <.0001
##   <.0001
##   1.0000
##   1.0000
##   <.0001
##   <.0001
##   0.9967
##   <.0001
##   <.0001
##   <.0001
##   <.0001
##   0.9967
##
## Results are averaged over the levels of: species
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## P value adjustment: tukey method for comparing a family of 12 estimates
```

```
emmeans(mod7au, list(pairwise ~ year_factor), adjust = "tukey")
```

```
## boundary (singular) fit: see help('isSingular')

## $`emmeans of year_factor`
##  year_factor emmean     SE  df lower.CL upper.CL
##            2  2.697 0.1083 480    2.484    2.909
##            3  2.804 0.1004 407    2.606    3.001
##            4  2.404 0.1008 394    2.206    2.602
##            5  2.595 0.0976 402    2.403    2.787
##            6  2.582 0.0962 374    2.393    2.771
##            7 -0.449 0.1556 602   -0.754   -0.143
##
## Results are averaged over the levels of: state, species
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of year_factor`
##  1                          estimate    SE  df t.ratio p.value
##  year_factor2 - year_factor3  -0.1073 0.120 611  -0.894  0.9479
##  year_factor2 - year_factor4   0.2927 0.120 615   2.444  0.1430
##  year_factor2 - year_factor5   0.1014 0.117 614   0.870  0.9535
##  year_factor2 - year_factor6   0.1148 0.117 615   0.984  0.9229
##  year_factor2 - year_factor7   3.1454 0.171 622  18.414  <.0001
```

```
##  year_factor3 - year_factor4   0.3999 0.114 609   3.522  0.0061
##  year_factor3 - year_factor5   0.2087 0.110 608   1.892  0.4082
##  year_factor3 - year_factor6   0.2220 0.110 608   2.020  0.3322
##  year_factor3 - year_factor7   3.2526 0.168 621  19.371  <.0001
##  year_factor4 - year_factor5  -0.1912 0.109 610  -1.756  0.4955
##  year_factor4 - year_factor6  -0.1779 0.108 611  -1.643  0.5700
##  year_factor4 - year_factor7   2.8527 0.166 621  17.193  <.0001
##  year_factor5 - year_factor6   0.0134 0.104 608   0.128  1.0000
##  year_factor5 - year_factor7   3.0440 0.163 619  18.653  <.0001
##  year_factor6 - year_factor7   3.0306 0.163 621  18.575  <.0001
##
## Results are averaged over the levels of: state, species
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## P value adjustment: tukey method for comparing a family of 6 estimates
```

```
emmeans(mod7au, list(pairwise ~ species), adjust = "tukey")
```

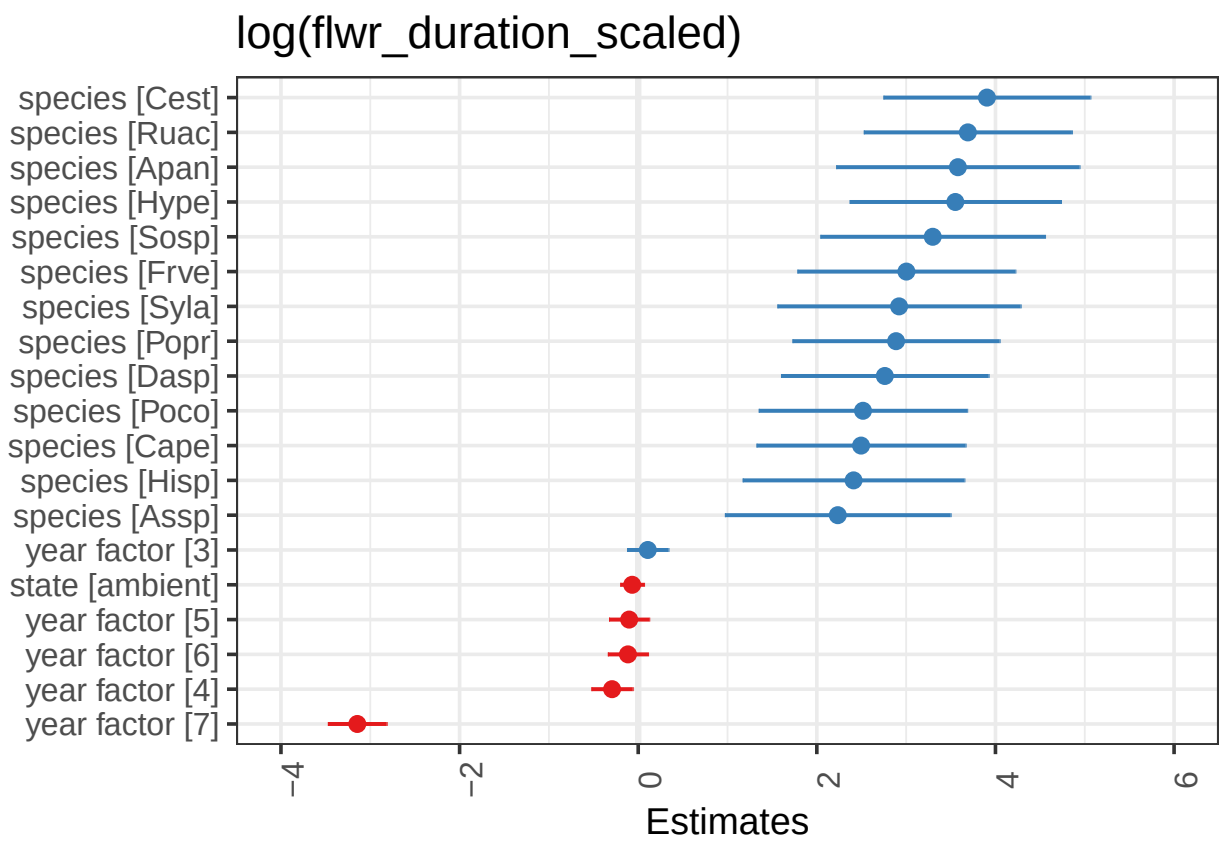
```
## boundary (singular) fit: see help('isSingular')
```

```
## $`emmeans of species`
##  species emmean     SE  df lower.CL upper.CL
##  Ansp    -0.698 0.5980 627    -1.87    0.476
##  Apan     2.881 0.3778 555     2.14    3.623
##  Assp     1.536 0.2685 580     1.01    2.063
##  Cape     1.797 0.1129 380     1.58    2.019
##  Cest     3.206 0.0741 323     3.06    3.352
##  Dasp     2.063 0.0947 453     1.88    2.249
##  Frve     2.305 0.2130 377     1.89    2.723
##  Hisp     1.713 0.2472 569     1.23    2.198
##  Hype     2.852 0.1399 514     2.58    3.127
##  Poco     1.818 0.1106 488     1.60    2.036
##  Popr     2.189 0.0855 420     2.02    2.357
##  Ruac     2.993 0.0999 377     2.80    3.189
##  Sosp     2.599 0.2695 341     2.07    3.130
##  Syla     2.222 0.3796 558     1.48    2.968
##
## Results are averaged over the levels of: state, year_factor
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of species`
##  1           estimate    SE  df t.ratio p.value
##  Ansp - Apan  -3.5794 0.709 619  -5.046  0.0001
##  Ansp - Assp  -2.2346 0.658 625  -3.397  0.0455
##  Ansp - Cape  -2.4954 0.609 628  -4.101  0.0037
##  Ansp - Cest  -3.9047 0.602 628  -6.485  <.0001
##  Ansp - Dasp  -2.7612 0.604 628  -4.571  0.0005
##  Ansp - Frve  -3.0030 0.636 620  -4.725  0.0002
##  Ansp - Hisp  -2.4114 0.645 627  -3.739  0.0144
##  Ansp - Hype  -3.5508 0.615 627  -5.774  <.0001
##  Ansp - Poco  -2.5167 0.606 628  -4.150  0.0030
```

```
##  Ansp - Popr  -2.8873 0.603 628  -4.790  0.0002
##  Ansp - Ruac  -3.6911 0.605 628  -6.098  <.0001
##  Ansp - Sosp  -3.2978 0.656 608  -5.029  0.0001
##  Ansp - Syla  -2.9206 0.710 619  -4.116  0.0034
##  Apan - Assp   1.3448 0.464 557   2.899  0.1812
##  Apan - Cape   1.0840 0.394 569   2.751  0.2528
##  Apan - Cest  -0.3253 0.385 576  -0.845  0.9999
##  Apan - Dasp   0.8182 0.390 576   2.095  0.7043
##  Apan - Frve   0.5764 0.434 510   1.328  0.9885
##  Apan - Hisp   1.1680 0.453 585   2.576  0.3584
##  Apan - Hype   0.0286 0.402 578   0.071  1.0000
##  Apan - Poco   1.0627 0.394 550   2.699  0.2823
##  Apan - Popr   0.6921 0.388 575   1.786  0.8819
##  Apan - Ruac  -0.1117 0.391 592  -0.286  1.0000
##  Apan - Sosp   0.2816 0.465 484   0.606  1.0000
##  Apan - Syla   0.6588 0.535 556   1.231  0.9943
##  Assp - Cape  -0.2608 0.291 596  -0.895  0.9998
##  Assp - Cest  -1.6701 0.279 610  -5.994  <.0001
##  Assp - Dasp  -0.5266 0.285 618  -1.850  0.8523
##  Assp - Frve  -0.7684 0.341 573  -2.256  0.5884
##  Assp - Hisp  -0.1768 0.365 617  -0.484  1.0000
##  Assp - Hype  -1.3162 0.303 608  -4.342  0.0014
##  Assp - Poco  -0.2821 0.293 591  -0.964  0.9995
##  Assp - Popr  -0.6527 0.283 607  -2.309  0.5489
##  Assp - Ruac  -1.4565 0.287 618  -5.079  <.0001
##  Assp - Sosp  -1.0632 0.381 534  -2.793  0.2312
##  Assp - Syla  -0.6860 0.466 599  -1.474  0.9718
##  Cape - Cest  -1.4093 0.135 599 -10.466  <.0001
##  Cape - Dasp  -0.2658 0.146 621  -1.814  0.8692
##  Cape - Frve  -0.5076 0.241 468  -2.108  0.6952
##  Cape - Hisp   0.0840 0.272 597   0.309  1.0000
##  Cape - Hype  -1.0554 0.179 578  -5.901  <.0001
##  Cape - Poco  -0.0213 0.156 624  -0.136  1.0000
##  Cape - Popr  -0.3919 0.140 612  -2.792  0.2310
##  Cape - Ruac  -1.1957 0.150 492  -7.948  <.0001
##  Cape - Sosp  -0.8024 0.292 442  -2.752  0.2533
##  Cape - Syla  -0.4252 0.396 548  -1.074  0.9985
##  Cest - Dasp   1.1435 0.119 620   9.640  <.0001
##  Cest - Frve   0.9017 0.225 467   4.004  0.0055
##  Cest - Hisp   1.4933 0.258 607   5.798  <.0001
##  Cest - Hype   0.3539 0.158 625   2.246  0.5956
##  Cest - Poco   1.3880 0.131 627  10.556  <.0001
##  Cest - Popr   1.0174 0.111 612   9.156  <.0001
##  Cest - Ruac   0.2136 0.123 627   1.735  0.9029
##  Cest - Sosp   0.6069 0.279 385   2.172  0.6500
##  Cest - Syla   0.9841 0.386 579   2.548  0.3766
##  Dasp - Frve  -0.2418 0.232 481  -1.040  0.9990
##  Dasp - Hisp   0.3498 0.261 615   1.340  0.9876
##  Dasp - Hype  -0.7896 0.167 627  -4.715  0.0003
##  Dasp - Poco   0.2444 0.143 628   1.713  0.9110
##  Dasp - Popr  -0.1261 0.123 623  -1.026  0.9991
##  Dasp - Ruac  -0.9299 0.135 627  -6.906  <.0001
##  Dasp - Sosp  -0.5366 0.285 407  -1.883  0.8348
##  Dasp - Syla  -0.1594 0.390 584  -0.409  1.0000
```

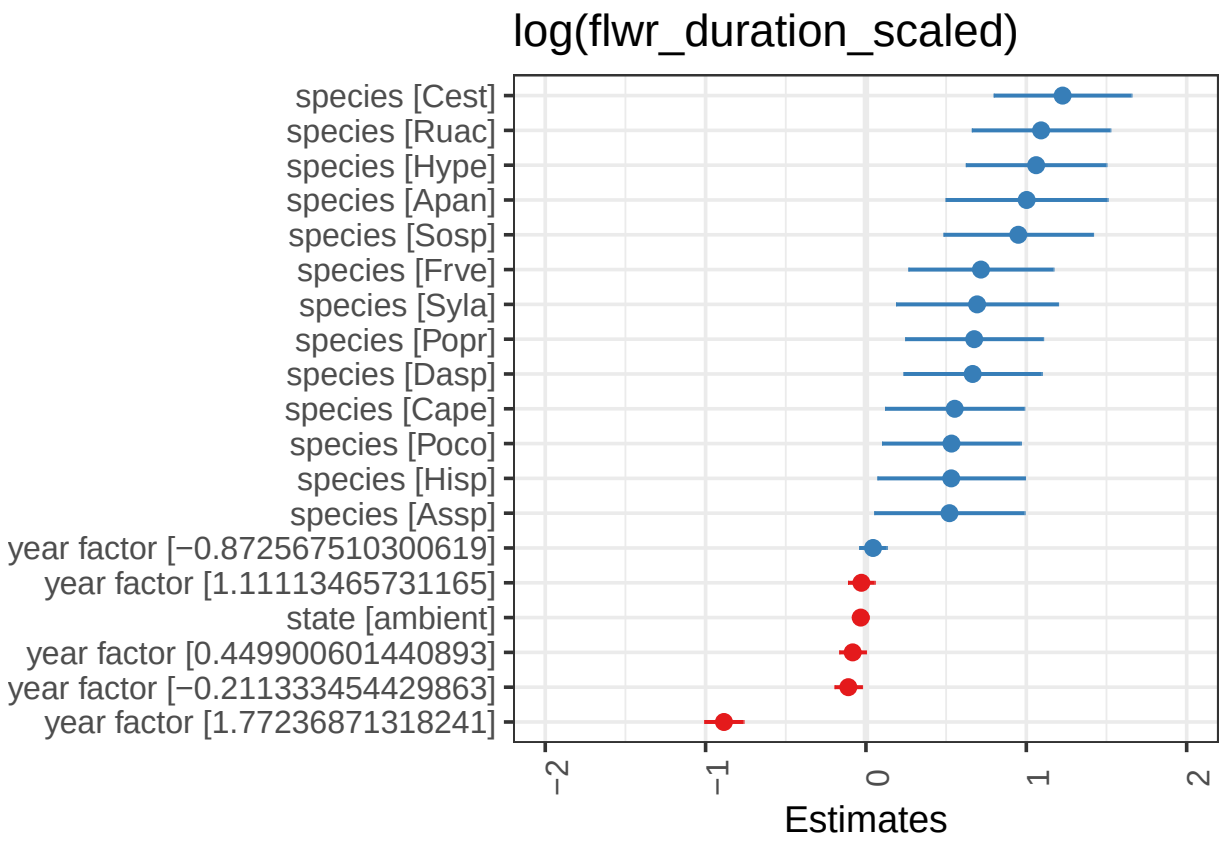
```
##  Frve - Hisp   0.5916 0.324 621   1.824  0.8645
##  Frve - Hype  -0.5478 0.255 483  -2.151  0.6655
##  Frve - Poco   0.4862 0.240 523   2.029  0.7488
##  Frve - Popr   0.1157 0.229 489   0.506  1.0000
##  Frve - Ruac  -0.6881 0.235 446  -2.926  0.1705
##  Frve - Sosp  -0.2948 0.342 481  -0.861  0.9999
##  Frve - Syla   0.0823 0.434 587   0.190  1.0000
##  Hisp - Hype  -1.1394 0.284 616  -4.014  0.0052
##  Hisp - Poco  -0.1053 0.271 600  -0.389  1.0000
##  Hisp - Popr  -0.4759 0.260 606  -1.833  0.8606
##  Hisp - Ruac  -1.2797 0.265 613  -4.827  0.0002
##  Hisp - Sosp  -0.8864 0.364 529  -2.432  0.4580
##  Hisp - Syla  -0.5092 0.452 602  -1.126  0.9977
##  Hype - Poco   1.0341 0.176 594   5.875  <.0001
##  Hype - Popr   0.6635 0.162 624   4.102  0.0036
##  Hype - Ruac  -0.1403 0.170 624  -0.825  0.9999
##  Hype - Sosp   0.2530 0.304 371   0.833  0.9999
##  Hype - Syla   0.6302 0.403 590   1.565  0.9542
##  Poco - Popr  -0.3706 0.135 625  -2.747  0.2549
##  Poco - Ruac  -1.1744 0.146 579  -8.030  <.0001
##  Poco - Sosp  -0.7811 0.290 433  -2.696  0.2849
##  Poco - Syla  -0.4039 0.393 569  -1.027  0.9991
##  Popr - Ruac  -0.8038 0.128 626  -6.276  <.0001
##  Popr - Sosp  -0.4105 0.282 406  -1.457  0.9741
##  Popr - Syla  -0.0333 0.387 577  -0.086  1.0000
##  Ruac - Sosp   0.3933 0.287 376   1.371  0.9846
##  Ruac - Syla   0.7705 0.391 594   1.972  0.7848
##  Sosp - Syla   0.3772 0.463 569   0.815  0.9999
##
## Results are averaged over the levels of: state, year_factor
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## P value adjustment: tukey method for comparing a family of 14 estimates
```

```
# Take a look at the estimates for each fixed effect. These are the estimates from summary(mod7a). You'
plot_model(mod7au, sort.est = TRUE)
```



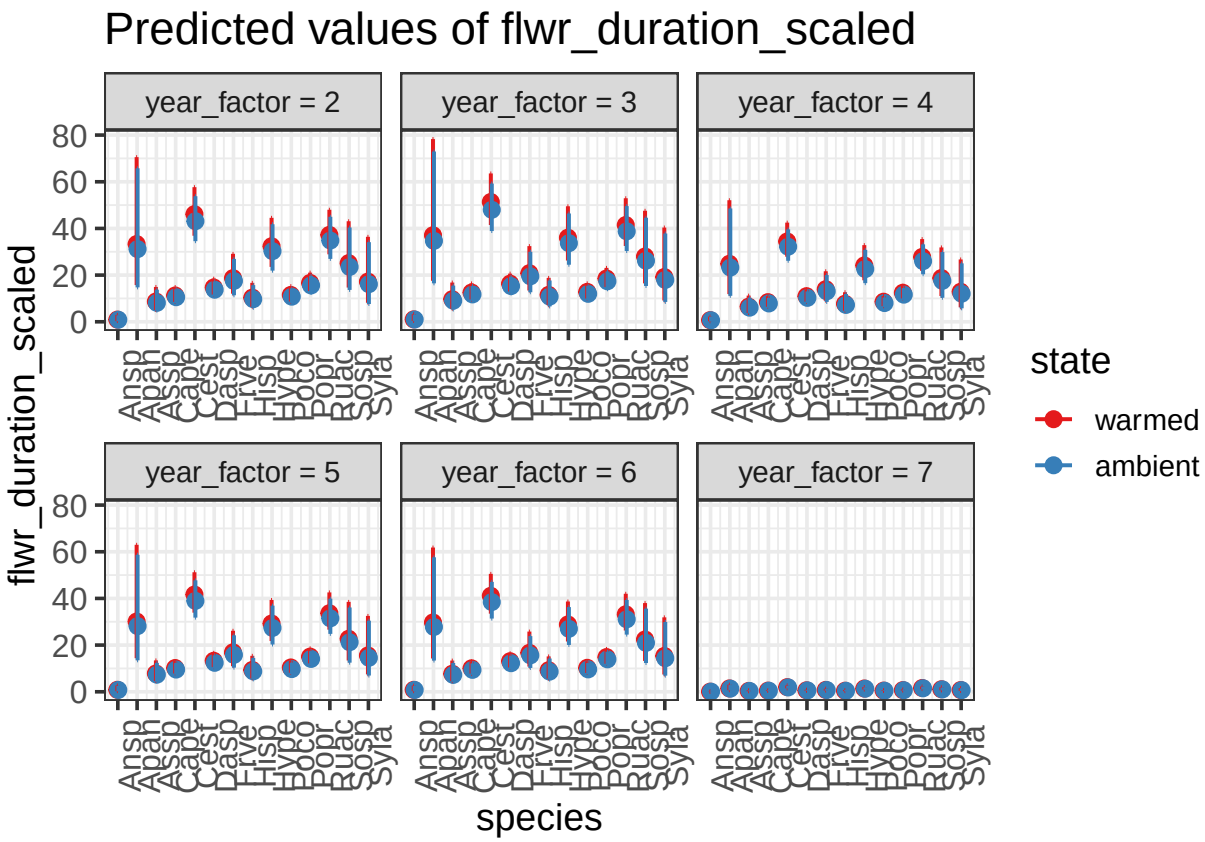

```
# if you want to standardize the estimates:
plot_model(mod7au, sort.est = TRUE, type="std")
```

```
## Formula contains log- or sqrt-terms. See help("standardize") for how
##   such terms are standardized.
## boundary (singular) fit: see help('isSingular')
```

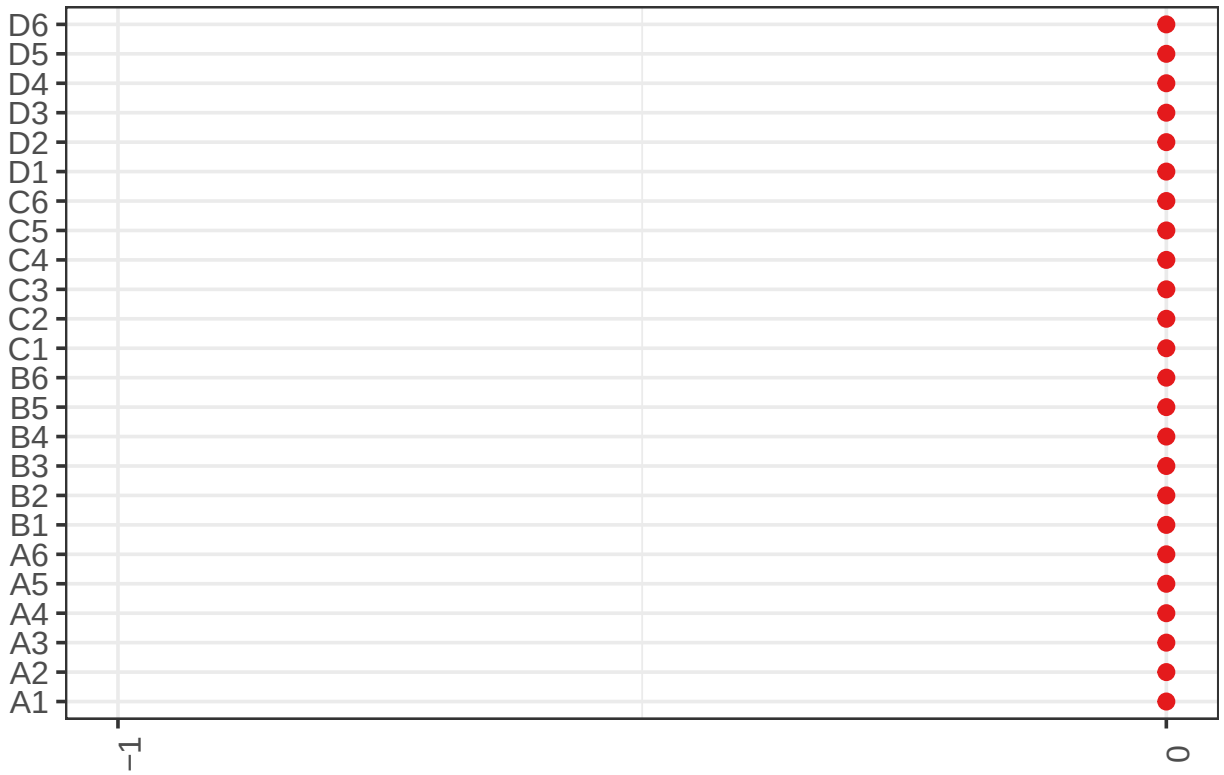



```
# these are the fixed predicted values: - note this is a new plot
plot_model(mod7au, type = "pred", terms = c("species", "state", "year_factor"))
```

```
## Model has log-transformed response. Back-transforming predictions to original response scale. Standa
```




```
# these are the random effects estimates
plot_model(mod7au, type = "re")
```




```
# including native vs. exotic
umbs_flwr_spp <- within(umbs_flwr_spp, origin <- relevel(factor(origin), ref = "Native")) # releveling
mod8u <- lmer(log(flwr_duration_scaled) ~ state * origin + (1+factor(year_factor)|plot), umbs_flwr_spp,
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod9u <- lmer(log(flwr_duration_scaled) ~ state + origin + (1+factor(year_factor)|plot), umbs_flwr_spp,
```

```
## boundary (singular) fit: see help('isSingular')

## Warning: Model failed to converge with 3 negative eigenvalues: -8.0e-03 -5.1e-02
## -2.1e+00
```

```
mod9au <- lmer(log(flwr_duration_scaled) ~ state + origin + factor(year_factor) + (1|plot), umbs_flwr_sp
```

```
## boundary (singular) fit: see help('isSingular')
```

```
anova(mod8u, mod9u) # model 9 is a better fit to data
```

```
## Data: umbs_flwr_spp
## Models:
## mod9u: log(flwr_duration_scaled) ~ state + origin + (1 + factor(year_factor) | plot)
## mod8u: log(flwr_duration_scaled) ~ state * origin + (1 + factor(year_factor) | plot)
##       npar    AIC  BIC  logLik deviance  Chisq Df Pr(>Chisq)
## mod9u   26 1783.3 1898 -865.67   1731.3
## mod8u   28 1785.6 1909 -864.78   1729.6 1.7713  2     0.4124
```

```
anova(mod9u, mod9au) # mod 9a
```

```
## Data: umbs_flwr_spp
## Models:
## mod9au: log(flwr_duration_scaled) ~ state + origin + factor(year_factor) + (1 | plot)
## mod9u: log(flwr_duration_scaled) ~ state + origin + (1 + factor(year_factor) | plot)
##        npar    AIC    BIC  logLik deviance Chisq Df Pr(>Chisq)
## mod9au   11 1681.0 1729.5 -829.51   1659.0
## mod9u    26 1783.3 1898.0 -865.67   1731.3     0 15          1
```

```
summary(mod9au)
```

```
## Linear mixed model fit by maximum likelihood . t-tests use Satterthwaite's
##   method [lmerModLmerTest]
## Formula: log(flwr_duration_scaled) ~ state + origin + factor(year_factor) +
##     (1 | plot)
##    Data: umbs_flwr_spp
##
##      AIC      BIC   logLik deviance df.resid
##   1681.0   1729.5   -829.5   1659.0      596
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.5551 -0.5085  0.2231  0.6551  3.4014
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  plot     (Intercept) 0.0000   0.000
##  Residual             0.9006   0.949
## Number of obs: 607, groups:  plot, 24
##
## Fixed effects:
##                       Estimate Std. Error        df t value Pr(>|t|)
## (Intercept)            2.72867    0.11871 607.00000  22.986  < 2e-16 ***
## stateambient          -0.03161    0.07712 607.00000  -0.410  0.68201
## originBoth            -0.43568    0.21590 607.00000  -2.018  0.04403 *
## originExotic           0.64506    0.08557 607.00000   7.539 1.74e-13 ***
## factor(year_factor)3  -0.08897    0.13435 607.00000  -0.662  0.50809
## factor(year_factor)4  -0.40628    0.13422 607.00000  -3.027  0.00257 **
## factor(year_factor)5  -0.22610    0.13035 607.00000  -1.735  0.08333 .
## factor(year_factor)6  -0.24082    0.13005 607.00000  -1.852  0.06454 .
## factor(year_factor)7  -2.99071    0.18818 607.00000 -15.892  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) sttmbn orgnBt orgnEx fc(_)3 fc(_)4 fc(_)5 fc(_)6
## stateambint -0.329
## originBoth  -0.264 -0.030
## originExotc -0.436  0.023  0.261
## fctr(yr_f)3 -0.590  0.000  0.085 -0.067
## fctr(yr_f)4 -0.584 -0.003  0.082 -0.080  0.548
```

```
## fctr(yr_f)5 -0.605 -0.004  0.092 -0.074  0.564  0.566
## fctr(yr_f)6 -0.605 -0.002  0.102 -0.086  0.568  0.569  0.586
## fctr(yr_f)7 -0.423  0.003  0.033 -0.032  0.386  0.386  0.398  0.400
## optimizer (nloptwrap) convergence code: 0 (OK)
## boundary (singular) fit: see help('isSingular')
```

```
anova(mod9au)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##                       Sum Sq Mean Sq NumDF DenDF F value    Pr(>F)
## state                  0.151   0.151     1   607   0.168     0.682
## origin                66.522  33.261     2   607  36.933 7.305e-16 ***
## factor(year_factor) 266.817  53.363     5   607  59.255 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
emmeans(mod9au, list(pairwise ~ state + origin), adjust = "tukey")
```

```
## boundary (singular) fit: see help('isSingular')
```

```
## $`emmeans of state, origin`
##  state   origin emmean     SE    df lower.CL upper.CL
##  warmed  Native   2.07 0.0841  84.8     1.90     2.24
##  ambient Native   2.04 0.0836  85.1     1.87     2.20
##  warmed  Both     1.63 0.2126 455.3     1.22     2.05
##  ambient Both     1.60 0.2102 430.5     1.19     2.02
##  warmed  Exotic   2.71 0.0639  38.3     2.59     2.84
##  ambient Exotic   2.68 0.0656  43.1     2.55     2.82
##
## Results are averaged over the levels of: year_factor
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of state, origin`
##  1                              estimate     SE    df t.ratio p.value
##  warmed Native - ambient Native   0.0316 0.0781  21.1   0.405  0.9984
##  warmed Native - warmed Both      0.4357 0.2189 601.6   1.990  0.3493
##  warmed Native - ambient Both     0.4673 0.2304 377.2   2.028  0.3285
##  warmed Native - warmed Exotic   -0.6451 0.0869 583.0  -7.427  <.0001
##  warmed Native - ambient Exotic  -0.6134 0.1181  87.4  -5.194  <.0001
##  ambient Native - warmed Both     0.4041 0.2344 420.5   1.724  0.5169
##  ambient Native - ambient Both    0.4357 0.2189 601.6   1.990  0.3493
##  ambient Native - warmed Exotic  -0.6767 0.1154  81.6  -5.862  <.0001
##  ambient Native - ambient Exotic -0.6451 0.0869 583.0  -7.427  <.0001
##  warmed Both - ambient Both       0.0316 0.0781  21.1   0.405  0.9984
##  warmed Both - warmed Exotic     -1.0807 0.2139 582.6  -5.053  <.0001
##  warmed Both - ambient Exotic    -1.0491 0.2304 384.3  -4.554  0.0001
##  ambient Both - warmed Exotic    -1.1124 0.2249 338.5  -4.945  <.0001
##  ambient Both - ambient Exotic   -1.0807 0.2139 582.6  -5.053  <.0001
##  warmed Exotic - ambient Exotic   0.0316 0.0781  21.1   0.405  0.9984
##
```

```
## Results are averaged over the levels of: year_factor
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## P value adjustment: tukey method for comparing a family of 6 estimates
```

```
emmeans(mod9au, list(pairwise ~ origin), adjust = "tukey")
```

```
## boundary (singular) fit: see help('isSingular')
```

```
## $`emmeans of origin`
##  origin emmean     SE    df lower.CL upper.CL
##  Native   2.05 0.0742 155.7     1.91     2.20
##  Both     1.62 0.2078 509.1     1.21     2.03
##  Exotic   2.70 0.0516  66.1     2.60     2.80
##
## Results are averaged over the levels of: state, year_factor
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of origin`
##  1               estimate     SE  df t.ratio p.value
##  Native - Both      0.436 0.2189 602   1.990  0.1155
##  Native - Exotic   -0.645 0.0869 583  -7.427  <.0001
##  Both - Exotic     -1.081 0.2139 583  -5.053  <.0001
##
## Results are averaged over the levels of: state, year_factor
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## P value adjustment: tukey method for comparing a family of 3 estimates
```

```
emmeans(mod9au, list(pairwise ~ factor(year_factor)), adjust = "tukey")
```

```
## boundary (singular) fit: see help('isSingular')
```

```
## $`emmeans of year_factor`
##  year_factor emmean    SE  df lower.CL upper.CL
##            2  2.783 0.111 425    2.564     3.00
##            3  2.694 0.113 406    2.472     2.92
##            4  2.376 0.113 392    2.154     2.60
##            5  2.557 0.108 379    2.343     2.77
##            6  2.542 0.109 356    2.327     2.76
##            7 -0.208 0.172 590   -0.547     0.13
##
## Results are averaged over the levels of: state, origin
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of year_factor`
##  1                          estimate    SE  df t.ratio p.value
##  year_factor2 - year_factor3   0.0890 0.135 601   0.657  0.9864
```

```
##  year_factor2 - year_factor4   0.4063 0.135 604   3.002  0.0332
##  year_factor2 - year_factor5   0.2261 0.131 601   1.721  0.5186
##  year_factor2 - year_factor6   0.2408 0.131 602   1.837  0.4428
##  year_factor2 - year_factor7   2.9907 0.190 610  15.747  <.0001
##  year_factor3 - year_factor4   0.3173 0.129 600   2.465  0.1361
##  year_factor3 - year_factor5   0.1371 0.125 599   1.101  0.8811
##  year_factor3 - year_factor6   0.1519 0.124 599   1.225  0.8245
##  year_factor3 - year_factor7   2.9017 0.186 609  15.601  <.0001
##  year_factor4 - year_factor5  -0.1802 0.124 601  -1.449  0.6966
##  year_factor4 - year_factor6  -0.1655 0.124 601  -1.338  0.7637
##  year_factor4 - year_factor7   2.5844 0.186 610  13.904  <.0001
##  year_factor5 - year_factor6   0.0147 0.119 597   0.123  1.0000
##  year_factor5 - year_factor7   2.7646 0.183 608  15.110  <.0001
##  year_factor6 - year_factor7   2.7499 0.183 610  15.051  <.0001
##
## Results are averaged over the levels of: state, origin
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## P value adjustment: tukey method for comparing a family of 6 estimates
```

```
# including growth form - first with interaction term
umbs_flwr_spp <- within(umbs_flwr_spp, growth_habit <- relevel(factor(growth_habit), ref = "Forb")) # r
mod10u <- lmer(log(flwr_duration_scaled) ~ state * growth_habit + (1+factor(year_factor)|plot), umbs_flw
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod11u <- lmer(log(flwr_duration_scaled) ~ state + growth_habit + (1+factor(year_factor)|plot), umbs_flw
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod11au <- lmer(log(flwr_duration_scaled) ~ state + growth_habit + factor(year_factor) + (1|plot), umbs_
```

```
## boundary (singular) fit: see help('isSingular')
```

```
anova(mod10u, mod11u) # model 11 is a better fit to data
```

```
## Data: umbs_flwr_spp
## Models:
## mod11u: log(flwr_duration_scaled) ~ state + growth_habit + (1 + factor(year_factor) | plot)
## mod10u: log(flwr_duration_scaled) ~ state * growth_habit + (1 + factor(year_factor) | plot)
##        npar    AIC    BIC  logLik deviance  Chisq Df Pr(>Chisq)
## mod11u   26 1711.7 1826.3 -829.83   1659.7
## mod10u   28 1714.0 1837.4 -828.98   1658.0 1.7121  2     0.4248
```

```
anova(mod11u, mod11au) # model 11a
```

```
## Data: umbs_flwr_spp
## Models:
## mod11au: log(flwr_duration_scaled) ~ state + growth_habit + factor(year_factor) + (1 | plot)
## mod11u: log(flwr_duration_scaled) ~ state + growth_habit + (1 + factor(year_factor) | plot)
##         npar    AIC    BIC  logLik deviance Chisq Df Pr(>Chisq)
## mod11au   11 1606.5 1655.0 -792.26   1584.5
## mod11u    26 1711.7 1826.3 -829.83   1659.7     0 15          1
```

```
summary(mod11au)
```

```
## Linear mixed model fit by maximum likelihood . t-tests use Satterthwaite's
##   method [lmerModLmerTest]
## Formula:
## log(flwr_duration_scaled) ~ state + growth_habit + factor(year_factor) +
##     (1 | plot)
##    Data: umbs_flwr_spp
##
##      AIC      BIC   logLik deviance df.resid
##   1606.5   1655.0   -792.3   1584.5      596
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.1081 -0.2915  0.1571  0.6218  3.6365
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  plot     (Intercept) 0.0000   0.0000
##  Residual             0.7965   0.8925
## Number of obs: 607, groups:  plot, 24
##
## Fixed effects:
##                         Estimate Std. Error        df t value Pr(>|t|)
## (Intercept)              3.59767    0.10846 607.00000  33.170  < 2e-16 ***
## stateambient            -0.10519    0.07260 607.00000  -1.449    0.148
## growth_habit            -1.23469    0.26667 607.00000  -4.630 4.47e-06 ***
## growth_habitGraminoid   -0.92366    0.07416 607.00000 -12.455  < 2e-16 ***
## factor(year_factor)3     0.06875    0.12582 607.00000   0.546    0.585
## factor(year_factor)4    -0.30076    0.12568 607.00000  -2.393    0.017 *
## factor(year_factor)5    -0.13464    0.12259 607.00000  -1.098    0.273
## factor(year_factor)6    -0.13331    0.12174 607.00000  -1.095    0.274
## factor(year_factor)7    -3.23229    0.17889 607.00000 -18.069  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) sttmbn grwth_ grwt_G fc(_)3 fc(_)4 fc(_)5 fc(_)6
## stateambint -0.357
## growth_habt -0.225  0.053
## grwth_hbtGr -0.373  0.043  0.152
## fctr(yr_f)3 -0.622  0.007  0.070 -0.037
## fctr(yr_f)4 -0.639  0.007  0.095  0.001  0.543
## fctr(yr_f)5 -0.661  0.009  0.135 -0.002  0.560  0.563
## fctr(yr_f)6 -0.665  0.010  0.121  0.003  0.562  0.566  0.584
## fctr(yr_f)7 -0.501  0.015  0.112  0.123  0.379  0.386  0.399  0.401
## optimizer (nloptwrap) convergence code: 0 (OK)
## boundary (singular) fit: see help('isSingular')
```

```
anova(mod11au)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##                      Sum Sq Mean Sq NumDF DenDF F value Pr(>F)
```

```
## state                 1.67   1.672     1   607  2.0993 0.1479
## growth_habit        129.67  64.834     2   607 81.3943 <2e-16 ***
## factor(year_factor) 323.29  64.658     5   607 81.1725 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
emmeans(mod11au, list(pairwise ~ factor(year_factor)), adjust = "tukey")
```

```
## boundary (singular) fit: see help('isSingular')
```

```
## $`emmeans of year_factor`
##  year_factor emmean    SE  df lower.CL upper.CL
##            2  2.826 0.118 465    2.594   3.0571
##            3  2.894 0.119 444    2.660   3.1284
##            4  2.525 0.120 444    2.288   2.7615
##            5  2.691 0.120 453    2.455   2.9267
##            6  2.692 0.118 428    2.461   2.9241
##            7 -0.407 0.178 597   -0.756  -0.0576
##
## Results are averaged over the levels of: state, growth_habit
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of year_factor`
##  1                          estimate    SE  df t.ratio p.value
##  year_factor2 - year_factor3 -0.06875 0.127 600  -0.542  0.9944
##  year_factor2 - year_factor4  0.30076 0.127 603   2.373  0.1673
##  year_factor2 - year_factor5  0.13464 0.124 600   1.090  0.8856
##  year_factor2 - year_factor6  0.13331 0.123 600   1.086  0.8868
##  year_factor2 - year_factor7  3.23229 0.181 611  17.900  <.0001
##  year_factor3 - year_factor4  0.36951 0.121 599   3.050  0.0287
##  year_factor3 - year_factor5  0.20339 0.117 599   1.731  0.5115
##  year_factor3 - year_factor6  0.20206 0.117 599   1.731  0.5120
##  year_factor3 - year_factor7  3.30104 0.177 610  18.647  <.0001
##  year_factor4 - year_factor5 -0.16612 0.117 600  -1.420  0.7150
##  year_factor4 - year_factor6 -0.16745 0.116 601  -1.440  0.7026
##  year_factor4 - year_factor7  2.93152 0.176 611  16.644  <.0001
##  year_factor5 - year_factor6 -0.00133 0.112 597  -0.012  1.0000
##  year_factor5 - year_factor7  3.09764 0.173 609  17.864  <.0001
##  year_factor6 - year_factor7  3.09898 0.173 611  17.918  <.0001
##
## Results are averaged over the levels of: state, growth_habit
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## P value adjustment: tukey method for comparing a family of 6 estimates
```

```
emmeans(mod11au, list(pairwise ~ growth_habit), adjust = "tukey")
```

```
## boundary (singular) fit: see help('isSingular')
```

```
## $`emmeans of growth_habit`
```

```
##  growth_habit emmean     SE    df lower.CL upper.CL
##  Forb           2.92 0.0548  85.8     2.81     3.03
##                 1.69 0.2658 563.2     1.17     2.21
##  Graminoid      2.00 0.0563 101.1     1.89     2.11
##
## Results are averaged over the levels of: state, year_factor
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of growth_habit`
##  1                estimate     SE  df t.ratio p.value
##  Forb -              1.235 0.2705 606   4.564  <.0001
##  Forb - Graminoid    0.924 0.0752 585  12.279  <.0001
##   - Graminoid       -0.311 0.2699 594  -1.152  0.4822
##
## Results are averaged over the levels of: state, year_factor
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## P value adjustment: tukey method for comparing a family of 3 estimates
```

```
emmeans(mod11au, list(pairwise ~ state + growth_habit), adjust = "tukey")
```

```
## boundary (singular) fit: see help('isSingular')
```

```
## $`emmeans of state, growth_habit`
##  state   growth_habit emmean     SE    df lower.CL upper.CL
##  warmed  Forb           2.98 0.0667  54.0     2.84     3.11
##  ambient Forb           2.87 0.0654  46.8     2.74     3.00
##  warmed                 1.74 0.2665 529.0     1.22     2.26
##  ambient                1.64 0.2701 532.7     1.11     2.17
##  warmed  Graminoid      2.05 0.0662  51.3     1.92     2.18
##  ambient Graminoid      1.95 0.0682  61.1     1.81     2.08
##
## Results are averaged over the levels of: year_factor
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of state, growth_habit`
##  1                                   estimate     SE    df t.ratio p.value
##  warmed Forb - ambient Forb             0.105 0.0735  21.3   1.431  0.7086
##  warmed Forb - warmed                   1.235 0.2705 605.9   4.564  0.0001
##  warmed Forb - ambient                  1.340 0.2840 505.7   4.717  <.0001
##  warmed Forb - warmed Graminoid         0.924 0.0752 585.2  12.279  <.0001
##  warmed Forb - ambient Graminoid        1.029 0.1072  84.5   9.599  <.0001
##  ambient Forb - warmed                  1.129 0.2766 490.8   4.084  0.0007
##  ambient Forb - ambient                 1.235 0.2705 605.9   4.564  0.0001
##  ambient Forb - warmed Graminoid        0.818 0.1031  64.7   7.938  <.0001
##  ambient Forb - ambient Graminoid       0.924 0.0752 585.2  12.279  <.0001
##  warmed  - ambient                      0.105 0.0735  21.3   1.431  0.7086
##  warmed  - warmed Graminoid            -0.311 0.2699 593.5  -1.152  0.8590
##  warmed  - ambient Graminoid           -0.206 0.2767 471.6  -0.744  0.9763
```

```
##  ambient  - warmed Graminoid            -0.416 0.2827 475.3  -1.473  0.6820
##  ambient  - ambient Graminoid           -0.311 0.2699 593.5  -1.152  0.8590
##  warmed Graminoid - ambient Graminoid    0.105 0.0735  21.3   1.431  0.7086
##
## Results are averaged over the levels of: year_factor
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## P value adjustment: tukey method for comparing a family of 6 estimates
```

```
# New version of our model incorporating interaction term and species within year so that there is a se
# updated mod4
mod12u <- lmer(log(flwr_duration_scaled) ~ state * factor(year_factor) + (1+factor(year_factor)|species)
```

```
## boundary (singular) fit: see help('isSingular')
```

```
# So another version of this model would include the interaction but not include the nesting (and thus
# updated mod5
mod13u <- lmer(log(flwr_duration_scaled) ~ state * factor(year_factor) + (1|species), umbs_flwr_spp)

# All the models ran:
mod1u <- lmer(log(flwr_duration_scaled) ~ state*year_factor + insecticide*year_factor + (1|species) + (
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod2u <- lmer(log(flwr_duration_scaled) ~ state*year_factor + insecticide*year_factor + (1|species), uml
mod3u <- lmer(log(flwr_duration_scaled) ~ state*year_factor + (1|species), umbs_flwr_spp, REML=FALSE)
mod4u <- lmer(log(flwr_duration_scaled) ~ state*year_factor + insecticide + (1|species) + (1|plot), umbs
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod5u <- lmer(log(flwr_duration_scaled) ~ state + year_factor + (1|species), umbs_flwr_spp, REML=FALSE)
mod6u <- lmer(log(flwr_duration_scaled) ~ state + year_factor + (1|species) + (1 + year|plot), umbs_flwr
```

```
## boundary (singular) fit: see help('isSingular')

## Warning: Model failed to converge with 1 negative eigenvalue: -9.3e-02
```

```
mod7u <- lmer(log(flwr_duration_scaled) ~ state + species + (1+factor(year_factor)|plot), umbs_flwr_spp
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod7au <- lmer(log(flwr_duration_scaled) ~ state + species + factor(year_factor) + (1|plot), umbs_flwr_s
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod7bu <- lmer(log(flwr_duration_scaled) ~ state * factor(year_factor) + species + (1|plot), umbs_flwr_s
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod7cu <- lmer(log(flwr_duration_scaled) ~ state + species + factor(year_factor) + insecticide + (1|plo
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod8u <- lmer(log(flwr_duration_scaled) ~ state * origin + (1+factor(year_factor)|plot), umbs_flwr_spp,
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod9u <- lmer(log(flwr_duration_scaled) ~ state + origin + (1+factor(year_factor)|plot), umbs_flwr_spp,
```

```
## boundary (singular) fit: see help('isSingular')
```

```
## Warning: Model failed to converge with 3 negative eigenvalues: -8.0e-03 -5.1e-02
## -2.1e+00
```

```
mod9au <- lmer(log(flwr_duration_scaled) ~ state + origin + factor(year_factor) + (1|plot), umbs_flwr_s
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod10u <- lmer(log(flwr_duration_scaled) ~ state * growth_habit + (1+factor(year_factor)|plot), umbs_flu
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod11u <- lmer(log(flwr_duration_scaled) ~ state + growth_habit + (1+factor(year_factor)|plot), umbs_flu
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod11au <- lmer(log(flwr_duration_scaled) ~ state + growth_habit + factor(year_factor) + (1|plot), umbs
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod12u <- lmer(log(flwr_duration_scaled) ~ state * factor(year_factor) + (1+factor(year_factor)|species
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod13u <- lmer(log(flwr_duration_scaled) ~ state * factor(year_factor) + (1|species), umbs_flwr_spp, REI
AICctab(mod1u, mod2u, mod3u, mod5u, mod6u, mod7u, mod7au, mod7bu, mod7cu, mod8u, mod9u, mod9au, mod10u,
```

```
##         dAICc df weight
## mod12u    0.0 34 1
## mod7au   59.9 22 <0.001
## mod7cu   61.6 23 <0.001
## mod7bu   68.7 27 <0.001
## mod13u   98.6 14 <0.001
## mod11au 137.4 11 <0.001
## mod7u   166.5 37 <0.001
```

```
## mod9au  211.9 11 <0.001
## mod11u  244.5 26 <0.001
## mod10u  247.2 28 <0.001
## mod9u   316.2 26 <0.001
## mod8u   318.8 28 <0.001
## mod5u   342.4 5  <0.001
## mod3u   343.7 6  <0.001
## mod2u   347.3 8  <0.001
## mod1u   349.3 9  <0.001
## mod6u   352.7 8  <0.001
```

```
AICctab(mod12u, mod7au, weights=T)
```

```
##        dAICc df weight
## mod12u  0.0  34 1
## mod7au 59.9  22 <0.001
```

```
summary(mod12u)
```

```
## Linear mixed model fit by maximum likelihood . t-tests use Satterthwaite's
##   method [lmerModLmerTest]
## Formula: log(flwr_duration_scaled) ~ state * factor(year_factor) + (1 +
##     factor(year_factor) | species)
##    Data: umbs_flwr_spp
##
##      AIC      BIC   logLik deviance df.resid
##   1465.4   1615.3   -698.7   1397.4      573
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -5.6356 -0.1819  0.1346  0.4516  4.5592
##
## Random effects:
##  Groups   Name                 Variance Std.Dev. Corr
##  species  (Intercept)          0.5289   0.7273
##           factor(year_factor)3 1.3707   1.1708   -0.66
##           factor(year_factor)4 0.6085   0.7801   -0.41  0.75
##           factor(year_factor)5 0.5915   0.7691   -0.73  0.88  0.87
##           factor(year_factor)6 0.8753   0.9356   -0.56  0.68  0.95  0.90
##           factor(year_factor)7 0.5583   0.7472   -0.98  0.70  0.43  0.79  0.58
##  Residual                      0.5055   0.7110
## Number of obs: 607, groups:  species, 14
##
## Fixed effects:
##                                   Estimate Std. Error        df t value
## (Intercept)                        2.90256    0.25264  12.78839  11.489
## stateambient                      -0.13689    0.14951 564.14930  -0.916
## factor(year_factor)3              -0.17042    0.39074   7.63237  -0.436
## factor(year_factor)4              -0.29820    0.27862  13.55748  -1.070
## factor(year_factor)5              -0.19092    0.27917  11.03893  -0.684
## factor(year_factor)6              -0.04189    0.32023  14.61590  -0.131
## factor(year_factor)7              -2.73440    0.30876  12.70567  -8.856
## stateambient:factor(year_factor)3 -0.01230    0.20349 565.89433  -0.060
```

```
## stateambient:factor(year_factor)4   0.02846    0.20193 565.18553   0.141
## stateambient:factor(year_factor)5   0.23051    0.19626 566.14466   1.175
## stateambient:factor(year_factor)6   0.10962    0.19525 564.93953   0.561
## stateambient:factor(year_factor)7  -0.06036    0.28712 294.43136  -0.210
##                                   Pr(>|t|)
## (Intercept)                       4.15e-08 ***
## stateambient                         0.360
## factor(year_factor)3                 0.675
## factor(year_factor)4                 0.303
## factor(year_factor)5                 0.508
## factor(year_factor)6                 0.898
## factor(year_factor)7              8.58e-07 ***
## stateambient:factor(year_factor)3    0.952
## stateambient:factor(year_factor)4    0.888
## stateambient:factor(year_factor)5    0.241
## stateambient:factor(year_factor)6    0.575
## stateambient:factor(year_factor)7    0.834
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) sttmbn fc(_)3 fc(_)4 fc(_)5 fc(_)6 fc(_)7 s:(_)3 s:(_)4
## stateambint -0.300
## fctr(yr_f)3 -0.695  0.196
## fctr(yr_f)4 -0.552  0.271  0.701
## fctr(yr_f)5 -0.769  0.272  0.802  0.791
## fctr(yr_f)6 -0.653  0.237  0.646  0.865  0.825
## fctr(yr_f)7 -0.822  0.245  0.603  0.467  0.679  0.552
## sttmbn:(_)3  0.220 -0.737 -0.258 -0.199 -0.200 -0.174 -0.180
## sttmbn:(_)4  0.222 -0.739 -0.149 -0.371 -0.205 -0.181 -0.182  0.545
## sttmbn:(_)5  0.228 -0.762 -0.157 -0.212 -0.359 -0.185 -0.188  0.561  0.565
## sttmbn:(_)6  0.228 -0.766 -0.148 -0.208 -0.207 -0.306 -0.186  0.565  0.567
## sttmbn:(_)7  0.156 -0.521 -0.102 -0.142 -0.139 -0.123 -0.446  0.384  0.384
##             s:(_)5 s:(_)6
## stateambint
## fctr(yr_f)3
## fctr(yr_f)4
## fctr(yr_f)5
## fctr(yr_f)6
## fctr(yr_f)7
## sttmbn:(_)3
## sttmbn:(_)4
## sttmbn:(_)5
## sttmbn:(_)6  0.585
## sttmbn:(_)7  0.400  0.399
## optimizer (nloptwrap) convergence code: 0 (OK)
## boundary (singular) fit: see help('isSingular')
```

```
anova(mod12u)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##                            Sum Sq Mean Sq NumDF  DenDF F value    Pr(>F)
## state                       0.915  0.9152     1 444.76  1.8104    0.1792
## factor(year_factor)       141.530 28.3060     5   8.81 55.9925 2.057e-06 ***
```

```
## state:factor(year_factor)   1.343  0.2687     5 464.36  0.5314    0.7525
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
emmeans(mod12u, list(pairwise ~ state * factor(year_factor)), adjust = "tukey")
```

```
## boundary (singular) fit: see help('isSingular')
```

```
## $`emmeans of state, year_factor`
##  state   year_factor  emmean    SE    df lower.CL upper.CL
##  warmed            2  2.9026 0.283 14.35    2.297    3.508
##  ambient           2  2.7657 0.283 14.14    2.160    3.371
##  warmed            3  2.7321 0.310 15.47    2.073    3.392
##  ambient           3  2.5829 0.312 15.76    1.920    3.245
##  warmed            4  2.6044 0.268 16.41    2.037    3.171
##  ambient           4  2.4959 0.266 16.15    1.933    3.059
##  warmed            5  2.7116 0.198 17.85    2.296    3.127
##  ambient           5  2.8053 0.195 17.60    2.395    3.215
##  warmed            6  2.8607 0.260 15.64    2.309    3.413
##  ambient           6  2.8334 0.259 15.64    2.282    3.385
##  warmed            7  0.1682 0.234 16.38   -0.327    0.664
##  ambient           7 -0.0291 0.379  4.33   -1.050    0.991
##
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of state, year_factor`
##  1                                          estimate    SE     df t.ratio
##  warmed year_factor2 - ambient year_factor2    0.1369 0.152 568.14   0.903
##  warmed year_factor2 - warmed year_factor3     0.1704 0.433  14.72   0.394
##  warmed year_factor2 - ambient year_factor3    0.3196 0.434  14.89   0.737
##  warmed year_factor2 - warmed year_factor4     0.2982 0.314  16.23   0.949
##  warmed year_factor2 - ambient year_factor4    0.4066 0.312  16.07   1.302
##  warmed year_factor2 - warmed year_factor5     0.1909 0.312  15.42   0.611
##  warmed year_factor2 - ambient year_factor5    0.0973 0.311  15.27   0.313
##  warmed year_factor2 - warmed year_factor6     0.0419 0.350  15.31   0.120
##  warmed year_factor2 - ambient year_factor6    0.0692 0.350  15.35   0.198
##  warmed year_factor2 - warmed year_factor7     2.7344 0.369  16.62   7.420
##  warmed year_factor2 - ambient year_factor7    2.9316 0.474  12.08   6.181
##  ambient year_factor2 - warmed year_factor3    0.0335 0.432  14.67   0.078
##  ambient year_factor2 - ambient year_factor3   0.1827 0.433  14.83   0.422
##  ambient year_factor2 - warmed year_factor4    0.1613 0.314  16.16   0.514
##  ambient year_factor2 - ambient year_factor4   0.2697 0.312  15.94   0.866
##  ambient year_factor2 - warmed year_factor5    0.0540 0.312  15.26   0.173
##  ambient year_factor2 - ambient year_factor5  -0.0396 0.310  15.06  -0.128
##  ambient year_factor2 - warmed year_factor6   -0.0950 0.350  15.18  -0.272
##  ambient year_factor2 - ambient year_factor6  -0.0677 0.350  15.20  -0.194
##  ambient year_factor2 - warmed year_factor7    2.5975 0.368  16.45   7.056
##  ambient year_factor2 - ambient year_factor7   2.7948 0.474  11.92   5.896
##  warmed year_factor3 - ambient year_factor3    0.1492 0.140 567.53   1.069
##  warmed year_factor3 - warmed year_factor4     0.1278 0.312  15.46   0.409
##  warmed year_factor3 - ambient year_factor4    0.2362 0.312  15.65   0.758
```

```
##  warmed year_factor3 - warmed year_factor5     0.0205 0.275  17.27   0.075
##  warmed year_factor3 - ambient year_factor5   -0.0731 0.275  17.69  -0.266
##  warmed year_factor3 - warmed year_factor6    -0.1285 0.341  15.42  -0.377
##  warmed year_factor3 - ambient year_factor6   -0.1013 0.341  15.55  -0.297
##  warmed year_factor3 - warmed year_factor7     2.5640 0.378  16.06   6.791
##  warmed year_factor3 - ambient year_factor7    2.7612 0.482  12.46   5.732
##  ambient year_factor3 - warmed year_factor4   -0.0214 0.314  15.77  -0.068
##  ambient year_factor3 - ambient year_factor4   0.0870 0.314  15.90   0.277
##  ambient year_factor3 - warmed year_factor5   -0.1287 0.277  17.72  -0.464
##  ambient year_factor3 - ambient year_factor5  -0.2223 0.277  18.11  -0.802
##  ambient year_factor3 - warmed year_factor6   -0.2777 0.343  15.71  -0.810
##  ambient year_factor3 - ambient year_factor6  -0.2505 0.342  15.83  -0.732
##  ambient year_factor3 - warmed year_factor7    2.4148 0.379  16.40   6.373
##  ambient year_factor3 - ambient year_factor7   2.6120 0.483  12.59   5.411
##  warmed year_factor4 - ambient year_factor4    0.1084 0.138 567.73   0.785
##  warmed year_factor4 - warmed year_factor5    -0.1073 0.207  20.82  -0.518
##  warmed year_factor4 - ambient year_factor5   -0.2009 0.205  21.82  -0.978
##  warmed year_factor4 - warmed year_factor6    -0.2563 0.185  20.79  -1.389
##  warmed year_factor4 - ambient year_factor6   -0.2290 0.185  21.56  -1.240
##  warmed year_factor4 - warmed year_factor7     2.4362 0.353  18.52   6.908
##  warmed year_factor4 - ambient year_factor7    2.6335 0.457  14.28   5.763
##  ambient year_factor4 - warmed year_factor5   -0.2157 0.205  21.56  -1.053
##  ambient year_factor4 - ambient year_factor5  -0.3093 0.203  22.16  -1.524
##  ambient year_factor4 - warmed year_factor6   -0.3647 0.183  22.03  -1.989
##  ambient year_factor4 - ambient year_factor6  -0.3375 0.183  22.65  -1.841
##  ambient year_factor4 - warmed year_factor7    2.3278 0.351  18.33   6.630
##  ambient year_factor4 - ambient year_factor7   2.5250 0.457  14.04   5.530
##  warmed year_factor5 - ambient year_factor5   -0.0936 0.129 567.83  -0.727
##  warmed year_factor5 - warmed year_factor6    -0.1490 0.204  19.22  -0.731
##  warmed year_factor5 - ambient year_factor6   -0.1218 0.203  19.62  -0.600
##  warmed year_factor5 - warmed year_factor7     2.5435 0.293  17.20   8.677
##  warmed year_factor5 - ambient year_factor7    2.7407 0.425   7.68   6.453
##  ambient year_factor5 - warmed year_factor6   -0.0554 0.202  20.03  -0.274
##  ambient year_factor5 - ambient year_factor6  -0.0281 0.201  20.17  -0.140
##  ambient year_factor5 - warmed year_factor7    2.6371 0.291  17.44   9.068
##  ambient year_factor5 - ambient year_factor7   2.8343 0.422   7.52   6.713
##  warmed year_factor6 - ambient year_factor6    0.0273 0.127 564.07   0.215
##  warmed year_factor6 - warmed year_factor7     2.6925 0.347  17.92   7.769
##  warmed year_factor6 - ambient year_factor7    2.8898 0.455  13.54   6.348
##  ambient year_factor6 - warmed year_factor7    2.6652 0.346  17.91   7.696
##  ambient year_factor6 - ambient year_factor7   2.8625 0.455  13.45   6.288
##  warmed year_factor7 - ambient year_factor7    0.1973 0.366  38.31   0.540
##  p.value
##   0.9991
##   1.0000
##   0.9997
##   0.9970
##   0.9670
##   0.9999
##   1.0000
##   1.0000
##   1.0000
##   0.0001
##   0.0016
```

```
##   1.0000
##   1.0000
##   1.0000
##   0.9986
##   1.0000
##   1.0000
##   1.0000
##   1.0000
##   0.0001
##   0.0026
##   0.9958
##   1.0000
##   0.9996
##   1.0000
##   1.0000
##   1.0000
##   1.0000
##   0.0002
##   0.0029
##   1.0000
##   1.0000
##   1.0000
##   0.9994
##   0.9992
##   0.9997
##   0.0004
##   0.0046
##   0.9998
##   1.0000
##   0.9967
##   0.9533
##   0.9788
##   0.0001
##   0.0018
##   0.9939
##   0.9181
##   0.6957
##   0.7804
##   0.0001
##   0.0028
##   0.9999
##   0.9997
##   1.0000
##   <.0001
##   0.0057
##   1.0000
##   1.0000
##   <.0001
##   0.0048
##   1.0000
##   <.0001
##   0.0008
##   <.0001
##   0.0009
```

```
##   1.0000
##
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## P value adjustment: tukey method for comparing a family of 12 estimates
```

```
emmeans(mod12u, list(pairwise ~ state ), adjust = "tukey")
```

```
## boundary (singular) fit: see help('isSingular')
```

```
## NOTE: Results may be misleading due to involvement in interactions
```

```
## $`emmeans of state`
##  state   emmean    SE   df lower.CL upper.CL
##  warmed    2.33 0.161 15.8     1.99     2.67
##  ambient   2.24 0.168 15.8     1.89     2.60
##
## Results are averaged over the levels of: year_factor
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of state`
##  1                estimate     SE  df t.ratio p.value
##  warmed - ambient   0.0876 0.0796 192   1.100  0.2726
##
## Results are averaged over the levels of: year_factor
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
```

UMBS Plot-level Mixed Effects Models:

```
mod1up <- lmer(log(flwr_duration_scaled) ~ state + (1|plot), umbs_flwr_plot, REML=FALSE)
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod2up <- lmer(log(flwr_duration_scaled) ~ insecticide + (1|plot), umbs_flwr_plot, REML=FALSE)
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod3up <- lmer(log(flwr_duration_scaled) ~ insecticide + state + (1|plot), umbs_flwr_plot, REML=FALSE)
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod4up <- lmer(log(flwr_duration_scaled) ~ insecticide * state + (1|plot), umbs_flwr_plot, REML=FALSE)
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod5up <- lmer(log(flwr_duration_scaled) ~ state + year_factor + (1|plot), umbs_flwr_plot, REML=FALSE)
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod6up <- lmer(log(flwr_duration_scaled) ~ state + year_factor + insecticide + (1|plot), umbs_flwr_plot
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod7up <- lmer(log(flwr_duration_scaled) ~ state * year_factor + (1|plot), umbs_flwr_plot, REML=FALSE)
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod8up <- lmer(log(flwr_duration_scaled) ~ state * year_factor + insecticide + (1|plot), umbs_flwr_plot
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod9up <- lmer(log(flwr_duration_scaled) ~ state * insecticide + year_factor + (1|plot), umbs_flwr_plot
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod10up <- lmer(log(flwr_duration_scaled) ~ state + insecticide * year_factor + (1|plot), umbs_flwr_plo
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod11up <- lmer(log(flwr_duration_scaled) ~ state * year_factor * insecticide + (1|plot), umbs_flwr_plo
```

```
## boundary (singular) fit: see help('isSingular')
```

```
AICctab(mod1up, mod2up, mod3up, mod4up, mod5up, mod6up, mod7up, mod8up, mod9up, mod10up, mod11up, weigh
```

```
##         dAICc df weight
## mod5up   0.0  5  0.4848
## mod6up   2.1  6  0.1725
## mod7up   2.2  6  0.1638
## mod9up   4.1  7  0.0610
## mod10up  4.2  7  0.0581
## mod8up   4.3  7  0.0574
## mod11up 10.6  10 0.0024
## mod1up  66.1  4  <0.001
## mod2up  66.1  4  <0.001
## mod3up  68.1  5  <0.001
## mod4up  70.2  6  <0.001
```

```
anova(mod5up, mod6up) # go with simpler model 5up
```

```
## Data: umbs_flwr_plot
## Models:
## mod5up: log(flwr_duration_scaled) ~ state + year_factor + (1 | plot)
## mod6up: log(flwr_duration_scaled) ~ state + year_factor + insecticide + (1 | plot)
##        npar    AIC    BIC  logLik deviance  Chisq Df Pr(>Chisq)
## mod5up    5 394.04 408.82 -192.02   384.04
## mod6up    6 395.92 413.66 -191.96   383.92 0.1148  1     0.7347
```

```
AICctab(mod5up, mod6up, weights=T)
```

```
##        dAICc df weight
## mod5up 0.0   5  0.74
## mod6up 2.1   6  0.26
```

```
summ(mod5up)
```

```
## MODEL INFO:
## Observations: 142
## Dependent Variable: log(flwr_duration_scaled)
## Type: Mixed effects linear regression
##
## MODEL FIT:
## AIC = 394.04, BIC = 408.82
## Pseudo-R² (fixed effects) = 0.38
## Pseudo-R² (total) = 0.38
##
## FIXED EFFECTS:
## ----------------------------------------------------------
##                       Est.   S.E.   t val.     d.f.      p
## ------------------ ------- ------ -------- -------- ------
## (Intercept)           4.78   0.23    20.37   142.00   0.00
## stateambient         -0.09   0.16    -0.55   142.00   0.58
## year_factor          -0.43   0.05    -9.36   142.00   0.00
## ----------------------------------------------------------
##
## p values calculated using Satterthwaite d.f.
##
## RANDOM EFFECTS:
## -------------------------------------
##   Group      Parameter    Std. Dev.
## ---------- ------------- -----------
##    plot     (Intercept)     0.00
##  Residual                   0.94
## -------------------------------------
##
## Grouping variables:
## -------------------------
##  Group   # groups   ICC
## ------- ---------- ------
##  plot       24      0.00
## -------------------------
```

```
summary(mod5up)
```

```
## Linear mixed model fit by maximum likelihood . t-tests use Satterthwaite's
##   method [lmerModLmerTest]
## Formula: log(flwr_duration_scaled) ~ state + year_factor + (1 | plot)
##    Data: umbs_flwr_plot
##
##      AIC      BIC   logLik deviance df.resid
##    394.0    408.8   -192.0    384.0      137
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -1.86735 -0.53650  0.08702  0.70084  1.70883
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  plot     (Intercept) 0.0000   0.0000
##  Residual             0.8751   0.9355
## Number of obs: 142, groups:  plot, 24
##
## Fixed effects:
##               Estimate Std. Error        df t value Pr(>|t|)
## (Intercept)    4.78424    0.23485 142.00000  20.372   <2e-16 ***
## stateambient  -0.08632    0.15701 142.00000  -0.550    0.583
## year_factor   -0.43391    0.04635 142.00000  -9.361   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) sttmbn
## stateambint -0.334
## year_factor -0.881  0.000
## optimizer (nloptwrap) convergence code: 0 (OK)
## boundary (singular) fit: see help('isSingular')
```

```
emmeans(mod5up, list(pairwise ~ state), adjust = "tukey")
```

```
## boundary (singular) fit: see help('isSingular')

## $`emmeans of state`
##  state   emmean    SE   df lower.CL upper.CL
##  warmed    2.85 0.112 22.9     2.61     3.08
##  ambient   2.76 0.112 22.9     2.53     2.99
##
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of state`
##  1                estimate    SE   df t.ratio p.value
##  warmed - ambient   0.0863 0.159 22.9   0.544  0.5918
##
```

```
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
```

```
# including native vs. exotic
umbs_flwr_plot_origin <- within(umbs_flwr_plot_origin, origin <- relevel(factor(origin), ref = "Native"))
mod12up <- lmer(log(flwr_duration_scaled) ~ state * origin + (1+year_factor|plot), umbs_flwr_plot_origin
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod13up <- lmer(log(flwr_duration_scaled) ~ state + origin + (1+year_factor|plot), umbs_flwr_plot_origin
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod14up <- lmer(log(flwr_duration_scaled) ~ state + origin + year_factor + (1|plot), umbs_flwr_plot_orig
```

```
## boundary (singular) fit: see help('isSingular')
```

```
anova(mod12up, mod13up) # go with model 13p
```

```
## Data: umbs_flwr_plot_origin
## Models:
## mod13up: log(flwr_duration_scaled) ~ state + origin + (1 + year_factor | plot)
## mod12up: log(flwr_duration_scaled) ~ state * origin + (1 + year_factor | plot)
##         npar    AIC    BIC  logLik deviance  Chisq Df Pr(>Chisq)
## mod13up    8 805.43 834.22 -394.72   789.43
## mod12up   10 808.44 844.42 -394.22   788.44 0.9913  2     0.6092
```

```
anova(mod13up, mod14up)
```

```
## Data: umbs_flwr_plot_origin
## Models:
## mod14up: log(flwr_duration_scaled) ~ state + origin + year_factor + (1 | plot)
## mod13up: log(flwr_duration_scaled) ~ state + origin + (1 + year_factor | plot)
##         npar    AIC    BIC  logLik deviance Chisq Df Pr(>Chisq)
## mod14up    7 754.08 779.27 -370.04   740.08
## mod13up    8 805.43 834.22 -394.72   789.43     0  1          1
```

```
AICctab(mod12up, mod13up, mod14up, weights=T) #model 13p
```

```
##         dAICc df weight
## mod14up  0.0  7  1
## mod13up 51.5  8  <0.001
## mod12up 54.8  10 <0.001
```

```
summary(mod14up)
```

```
## Linear mixed model fit by maximum likelihood . t-tests use Satterthwaite's
##   method [lmerModLmerTest]
## Formula: log(flwr_duration_scaled) ~ state + origin + year_factor + (1 |
##     plot)
##    Data: umbs_flwr_plot_origin
##
##      AIC      BIC   logLik deviance df.resid
##    754.1    779.3   -370.0    740.1      263
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.0348 -0.4512  0.1799  0.6398  1.8830
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  plot     (Intercept) 0.0000   0.0000
##  Residual             0.9077   0.9527
## Number of obs: 270, groups:  plot, 24
##
## Fixed effects:
##               Estimate Std. Error        df t value Pr(>|t|)
## (Intercept)    4.01404    0.18207 270.00000  22.047  < 2e-16 ***
## statewarmed    0.04847    0.11625 270.00000   0.417   0.6771
## originBoth    -0.58050    0.23682 270.00000  -2.451   0.0149 *
## originExotic   0.64939    0.12135 270.00000   5.351 1.87e-07 ***
## year_factor   -0.39039    0.03517 270.00000 -11.100  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) sttwrm orgnBt orgnEx
## statewarmed -0.337
## originBoth  -0.240  0.028
## originExotc -0.298 -0.025  0.277
## year_factor -0.815  0.043  0.055 -0.076
## optimizer (nloptwrap) convergence code: 0 (OK)
## boundary (singular) fit: see help('isSingular')
```

```
summ(mod14up)
```

```
## MODEL INFO:
## Observations: 270
## Dependent Variable: log(flwr_duration_scaled)
## Type: Mixed effects linear regression
##
## MODEL FIT:
## AIC = 754.08, BIC = 779.27
## Pseudo-R² (fixed effects) = 0.37
## Pseudo-R² (total) = 0.37
##
## FIXED EFFECTS:
## ----------------------------------------------------------
##                       Est.   S.E.   t val.     d.f.      p
## ------------------ ------- ------ -------- -------- ------
```

```
## (Intercept)           4.01   0.18    22.05   270.00   0.00
## statewarmed           0.05   0.12     0.42   270.00   0.68
## originBoth           -0.58   0.24    -2.45   270.00   0.01
## originExotic          0.65   0.12     5.35   270.00   0.00
## year_factor          -0.39   0.04   -11.10   270.00   0.00
## ------------------------------------------------------------
##
## p values calculated using Satterthwaite d.f.
##
## RANDOM EFFECTS:
## -------------------------------------
##   Group      Parameter    Std. Dev.
## ---------- ------------- -----------
##    plot     (Intercept)     0.00
##  Residual                   0.95
## -------------------------------------
##
## Grouping variables:
## -------------------------
##  Group   # groups   ICC
## ------- ---------- ------
##  plot       24      0.00
## -------------------------
```

```
anova(mod14up)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##              Sum Sq Mean Sq NumDF DenDF  F value    Pr(>F)
## state         0.158   0.158     1   270   0.1738    0.6771
## origin       41.218  20.609     2   270  22.7042 7.695e-10 ***
## year_factor 111.837 111.837     1   270 123.2079 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
emmeans(mod14up, list(pairwise ~ state), adjust = "tukey")
```

```
## boundary (singular) fit: see help('isSingular')
```

```
## $`emmeans of state`
##  state   emmean    SE   df lower.CL upper.CL
##  ambient   2.37 0.101 37.5     2.17     2.58
##  warmed    2.42 0.106 43.2     2.21     2.64
##
## Results are averaged over the levels of: origin
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of state`
##  1                estimate    SE   df t.ratio p.value
##  ambient - warmed  -0.0485 0.118 21.9  -0.412  0.6844
##
```

```
## Results are averaged over the levels of: origin
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
```

```
emmeans(mod14up, list(pairwise ~ origin), adjust = "tukey")
```

```
## boundary (singular) fit: see help('isSingular')
```

```
## $`emmeans of origin`
##  origin emmean     SE    df lower.CL upper.CL
##  Native   2.38 0.0913  99.2     2.19     2.56
##  Both     1.79 0.2251 210.5     1.35     2.24
##  Exotic   3.02 0.0818  79.7     2.86     3.19
##
## Results are averaged over the levels of: state
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of origin`
##  1               estimate    SE  df t.ratio p.value
##  Native - Both      0.580 0.242 263   2.395  0.0455
##  Native - Exotic   -0.649 0.123 263  -5.291  <.0001
##  Both - Exotic     -1.230 0.240 260  -5.127  <.0001
##
## Results are averaged over the levels of: state
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## P value adjustment: tukey method for comparing a family of 3 estimates
```

```
# including growth form - first with interaction term
umbs_flwr_plot_growthhabit <- within(umbs_flwr_plot_growthhabit, growth_habit <- relevel(factor(growth_
mod15up <- lmer(log(flwr_duration_scaled) ~ state * growth_habit + (1+year_factor|plot), umbs_flwr_plot
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod16up <- lmer(log(flwr_duration_scaled) ~ state + growth_habit + (1+year_factor|plot), umbs_flwr_plot
```

```
## boundary (singular) fit: see help('isSingular')
```

```
mod17up <- lmer(log(flwr_duration_scaled) ~ state + growth_habit + year_factor + (1|plot), umbs_flwr_pl
```

```
## boundary (singular) fit: see help('isSingular')
```

```
anova(mod15up, mod16up) # go with model 16p
```

```
## Data: umbs_flwr_plot_growthhabit
## Models:
## mod16up: log(flwr_duration_scaled) ~ state + growth_habit + (1 + year_factor | plot)
## mod15up: log(flwr_duration_scaled) ~ state * growth_habit + (1 + year_factor | plot)
##         npar    AIC    BIC  logLik deviance  Chisq Df Pr(>Chisq)
## mod16up    8 830.27 859.23 -407.13   814.27
## mod15up   10 833.13 869.33 -406.56   813.13 1.1397  2     0.5656
```

```
anova(mod16up, mod17up) # mod 17p
```

```
## Data: umbs_flwr_plot_growthhabit
## Models:
## mod17up: log(flwr_duration_scaled) ~ state + growth_habit + year_factor + (1 | plot)
## mod16up: log(flwr_duration_scaled) ~ state + growth_habit + (1 + year_factor | plot)
##         npar    AIC    BIC  logLik deviance Chisq Df Pr(>Chisq)
## mod17up    7 778.91 804.26 -382.46   764.91
## mod16up    8 830.27 859.23 -407.13   814.27     0  1          1
```

```
AICctab(mod15up, mod16up, mod17up, weights=T)
```

```
##         dAICc df weight
## mod17up  0.0  7  1
## mod16up 51.5  8  <0.001
## mod15up 54.6  10 <0.001
```

```
summary(mod17up)
```

```
## Linear mixed model fit by maximum likelihood . t-tests use Satterthwaite's
##   method [lmerModLmerTest]
## Formula: log(flwr_duration_scaled) ~ state + growth_habit + year_factor +
##     (1 | plot)
##    Data: umbs_flwr_plot_growthhabit
##
##      AIC      BIC   logLik deviance df.resid
##    778.9    804.3   -382.5    764.9      269
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.4420 -0.4137  0.1634  0.6160  1.8955
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  plot     (Intercept) 0.0000   0.0000
##  Residual             0.9357   0.9673
## Number of obs: 276, groups:  plot, 24
##
## Fixed effects:
##                        Estimate Std. Error        df t value Pr(>|t|)
## (Intercept)             4.74940    0.19256 276.00000  24.664  < 2e-16 ***
## statewarmed             0.06425    0.11674 276.00000   0.550    0.583
## growth_habit           -1.42617    0.29742 276.00000  -4.795 2.66e-06 ***
## growth_habitGraminoid  -0.65658    0.11969 276.00000  -5.486 9.32e-08 ***
## year_factor            -0.37104    0.03665 276.00000 -10.124  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) sttwrm grwth_ grwt_G
## statewarmed -0.301
```

```
## growth_habt -0.263 -0.067
## grwth_hbtGr -0.377  0.000  0.210
## year_factor -0.852  0.000  0.192  0.095
## optimizer (nloptwrap) convergence code: 0 (OK)
## boundary (singular) fit: see help('isSingular')
```

```
summ(mod17up)
```

```
## MODEL INFO:
## Observations: 276
## Dependent Variable: log(flwr_duration_scaled)
## Type: Mixed effects linear regression
##
## MODEL FIT:
## AIC = 778.91, BIC = 804.26
## Pseudo-R² (fixed effects) = 0.32
## Pseudo-R² (total) = 0.32
##
## FIXED EFFECTS:
## ----------------------------------------------------------------------
##                               Est.   S.E.   t val.     d.f.      p
## --------------------------- ------- ------ -------- -------- ------
## (Intercept)                    4.75   0.19    24.66   276.00   0.00
## statewarmed                    0.06   0.12     0.55   276.00   0.58
## growth_habit                  -1.43   0.30    -4.80   276.00   0.00
## growth_habitGraminoid         -0.66   0.12    -5.49   276.00   0.00
## year_factor                   -0.37   0.04   -10.12   276.00   0.00
## ----------------------------------------------------------------------
##
## p values calculated using Satterthwaite d.f.
##
## RANDOM EFFECTS:
## -------------------------------------
##   Group      Parameter    Std. Dev.
## ---------- ------------- -----------
##    plot     (Intercept)     0.00
##  Residual                   0.97
## -------------------------------------
##
## Grouping variables:
## -------------------------
##  Group   # groups   ICC
## ------- ---------- ------
##  plot       24      0.00
## -------------------------
```

```
anova(mod17up)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##              Sum Sq Mean Sq NumDF DenDF  F value    Pr(>F)
## state         0.283   0.283     1   276   0.3029    0.5825
## growth_habit 41.149  20.574     2   276  21.9880 1.378e-09 ***
## year_factor  95.900  95.900     1   276 102.4893 < 2.2e-16 ***
```

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
emmeans(mod17up, list(pairwise ~ state + growth_habit), adjust = "tukey")
```

```
## boundary (singular) fit: see help('isSingular')
```

```
## $`emmeans of state, growth_habit`
##  state   growth_habit emmean    SE    df lower.CL upper.CL
##  ambient Forb           3.17 0.102  49.7     2.96     3.37
##  warmed  Forb           3.23 0.103  49.7     3.02     3.44
##  ambient                1.74 0.301 217.8     1.15     2.33
##  warmed                 1.81 0.293 205.2     1.23     2.38
##  ambient Graminoid      2.51 0.105  54.2     2.30     2.72
##  warmed  Graminoid      2.57 0.105  55.0     2.36     2.79
##
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of state, growth_habit`
##  1                                   estimate    SE    df t.ratio p.value
##  ambient Forb - warmed Forb           -0.0642 0.118  22.4  -0.545  0.9935
##  ambient Forb - ambient                1.4262 0.305 264.7   4.684  0.0001
##  ambient Forb - warmed                 1.3619 0.319 183.1   4.264  0.0005
##  ambient Forb - ambient Graminoid      0.6566 0.121 262.8   5.432  <.0001
##  ambient Forb - warmed Graminoid       0.5923 0.169  85.4   3.507  0.0092
##  warmed Forb - ambient                 1.4904 0.334 204.5   4.468  0.0002
##  warmed Forb - warmed                  1.4262 0.305 264.7   4.684  0.0001
##  warmed Forb - ambient Graminoid       0.7208 0.169  84.2   4.268  0.0007
##  warmed Forb - warmed Graminoid        0.6566 0.121 262.8   5.432  <.0001
##  ambient  - warmed                    -0.0642 0.118  22.4  -0.545  0.9935
##  ambient  - ambient Graminoid         -0.7696 0.303 264.2  -2.536  0.1174
##  ambient  - warmed Graminoid          -0.8338 0.333 203.9  -2.507  0.1268
##  warmed  - ambient Graminoid          -0.7053 0.318 181.6  -2.216  0.2357
##  warmed  - warmed Graminoid           -0.7696 0.303 264.2  -2.536  0.1174
##  ambient Graminoid - warmed Graminoid -0.0642 0.118  22.4  -0.545  0.9935
##
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## P value adjustment: tukey method for comparing a family of 6 estimates
```

```
emmeans(mod17up, list(pairwise ~ growth_habit), adjust = "tukey")
```

```
## boundary (singular) fit: see help('isSingular')
```

```
## $`emmeans of growth_habit`
##  growth_habit emmean     SE    df lower.CL upper.CL
##  Forb           3.20 0.0838  83.0     3.03     3.37
##                 1.77 0.2914 233.1     1.20     2.35
##  Graminoid      2.54 0.0867  94.3     2.37     2.71
##
```

```
## Results are averaged over the levels of: state
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of growth_habit`
##  1                estimate    SE  df t.ratio p.value
##  Forb -              1.426 0.305 265   4.684  <.0001
##  Forb - Graminoid    0.657 0.121 263   5.432  <.0001
##   - Graminoid       -0.770 0.303 264  -2.536  0.0315
##
## Results are averaged over the levels of: state
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## P value adjustment: tukey method for comparing a family of 3 estimates
```

```
emmeans(mod17up, list(pairwise ~ growth_habit + year_factor), adjust = "tukey")
```

```
## boundary (singular) fit: see help('isSingular')
```

```
## $`emmeans of growth_habit, year_factor`
##  growth_habit year_factor emmean     SE    df lower.CL upper.CL
##  Forb                4.26   3.20 0.0838  83.0     3.03     3.37
##                      4.26   1.77 0.2914 233.1     1.20     2.35
##  Graminoid           4.26   2.54 0.0867  94.3     2.37     2.71
##
## Results are averaged over the levels of: state
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
##
## $`pairwise differences of growth_habit, year_factor`
##  1
##  Forb year_factor4.26449275362319 -  year_factor4.26449275362319
##  Forb year_factor4.26449275362319 - Graminoid year_factor4.26449275362319
##   year_factor4.26449275362319 - Graminoid year_factor4.26449275362319
##  estimate    SE  df t.ratio p.value
##     1.426 0.305 265   4.684  <.0001
##     0.657 0.121 263   5.432  <.0001
##    -0.770 0.303 264  -2.536  0.0315
##
## Results are averaged over the levels of: state
## Degrees-of-freedom method: kenward-roger
## Results are given on the log (not the response) scale.
## P value adjustment: tukey method for comparing a family of 3 estimates
```