

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

```

# 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"

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

## [1] "warmed"   "ambient"

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

## [1] "ambient" "warmed"

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

## [1] "warmed"   "ambient"

# [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))

```

```

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

umbss_flwr_plot <- subset(flwr_plot, site == "umbss") # pull out umbss only data at plot level
umbss_flwr_spp <- subset(flwr_species, site == "umbss") # pull out umbss 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")
umbss_flwr_plot_origin <- subset(flwr_plot_origin, site == "umbss")
umbss_flwr_plot_growthhabit <- subset(flwr_plot_growthhabit, site == "umbss")

```

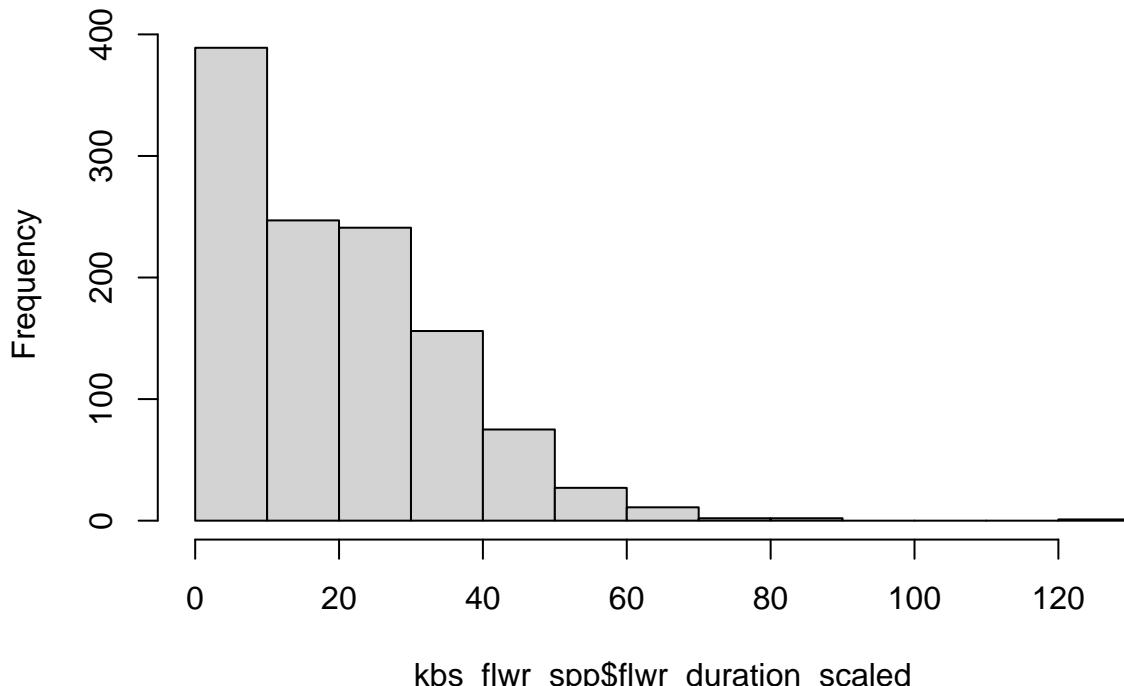
KBS SPECIES LEVEL - Looking at DURATION of flowering

```

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

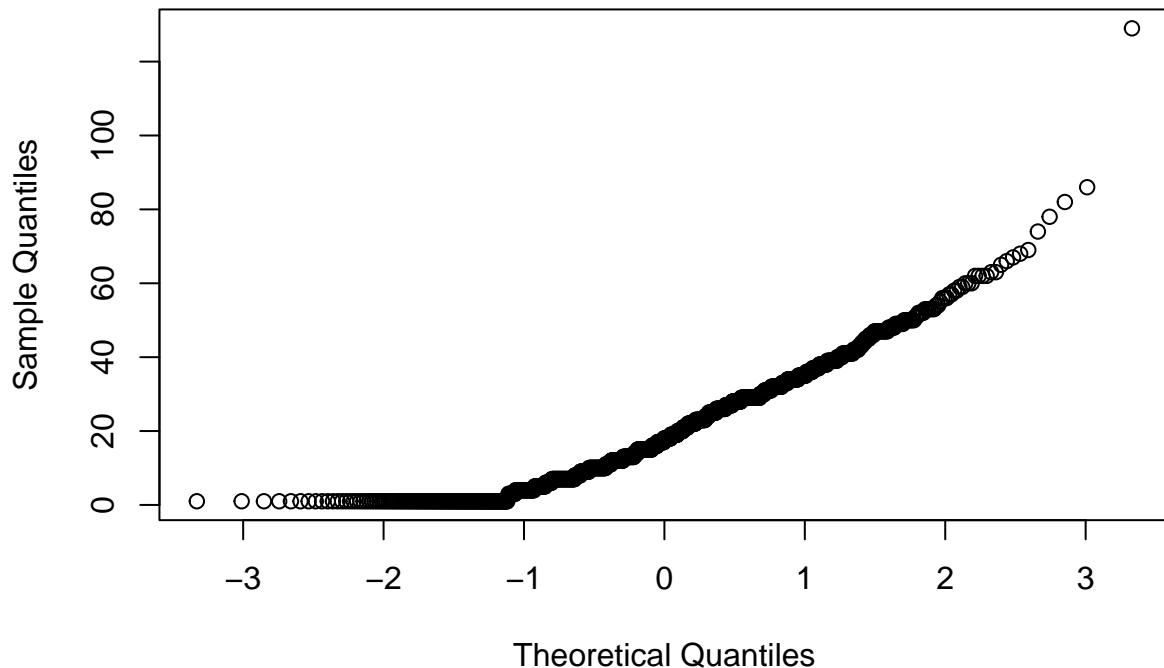
```

Histogram of kbs_flwr_spp\$flwr_duration_scaled



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

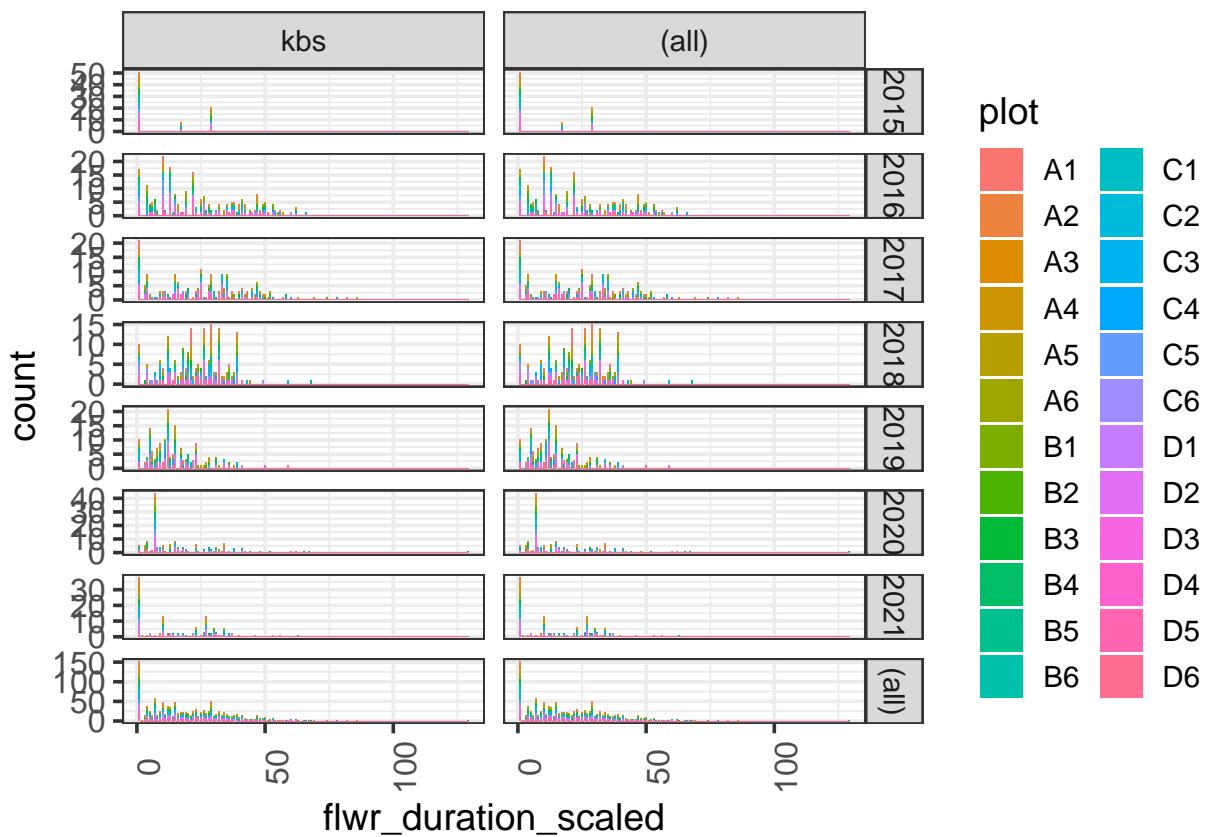
Normal Q-Q Plot



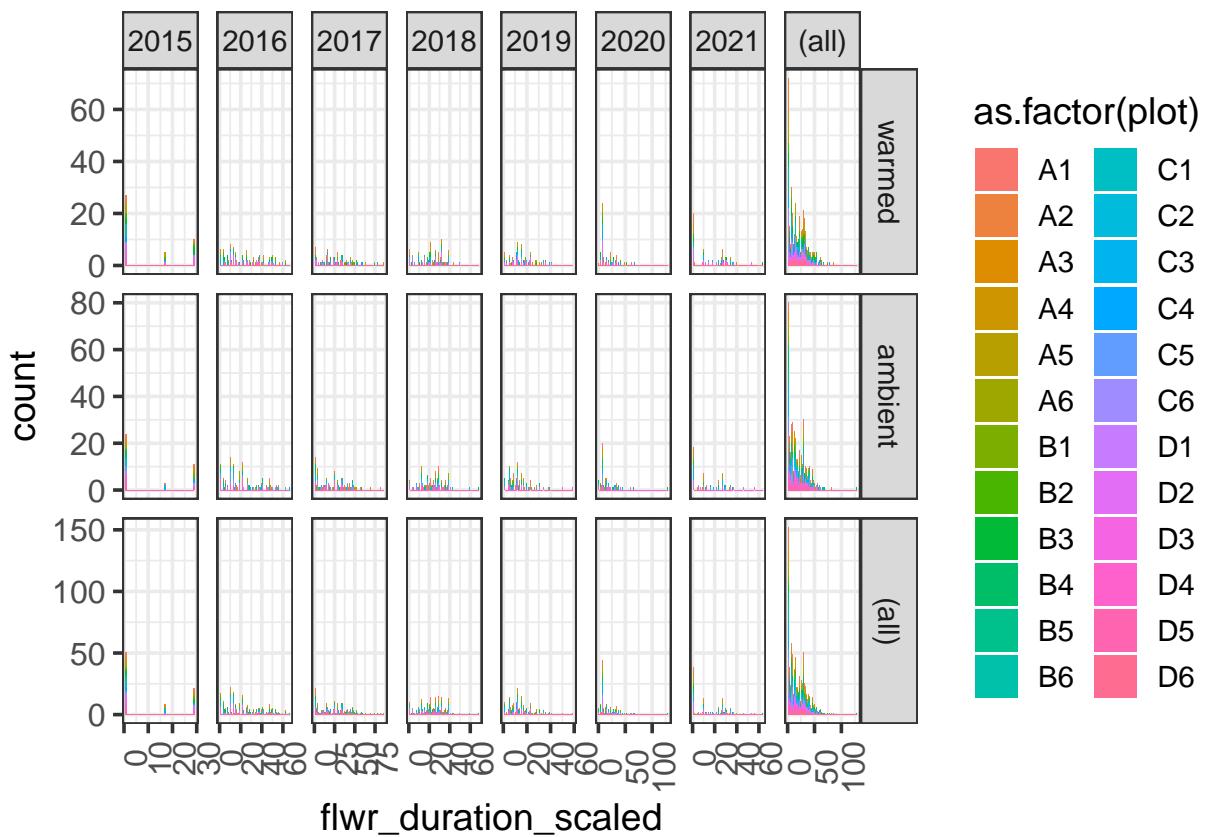
```
shapiro.test(kbs_flwr_spp$flwr_duration_scaled) # pvalue is < 0.05 so we reject the null hypothesis that the data follows a normal distribution

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

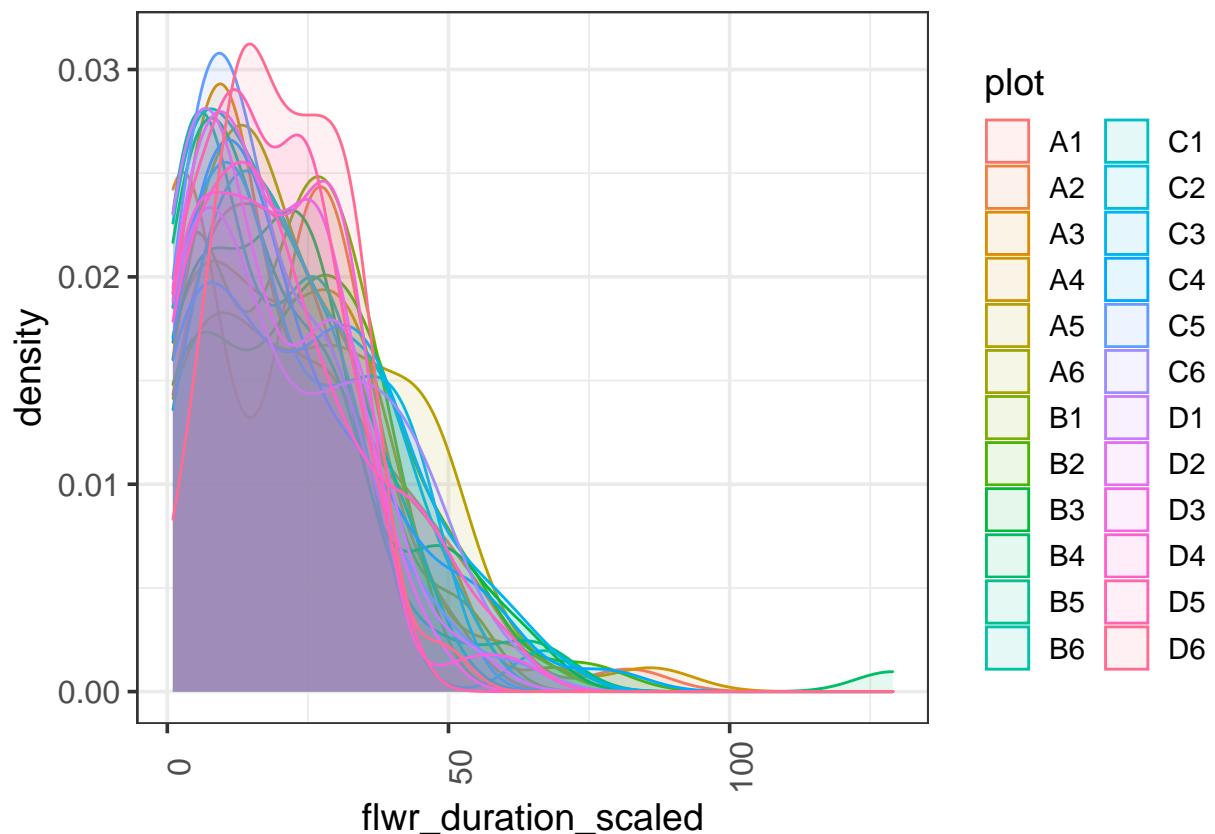
# Visualizing median Julian date for umbs at the PLOT LEVEL
ggplot(kbs_flwr_spp, aes(flwr_duration_scaled, fill = plot)) +
  geom_histogram(binwidth = 0.5) +
  facet_grid(year ~ site, margins = TRUE, scales = "free")
```



```
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")
```



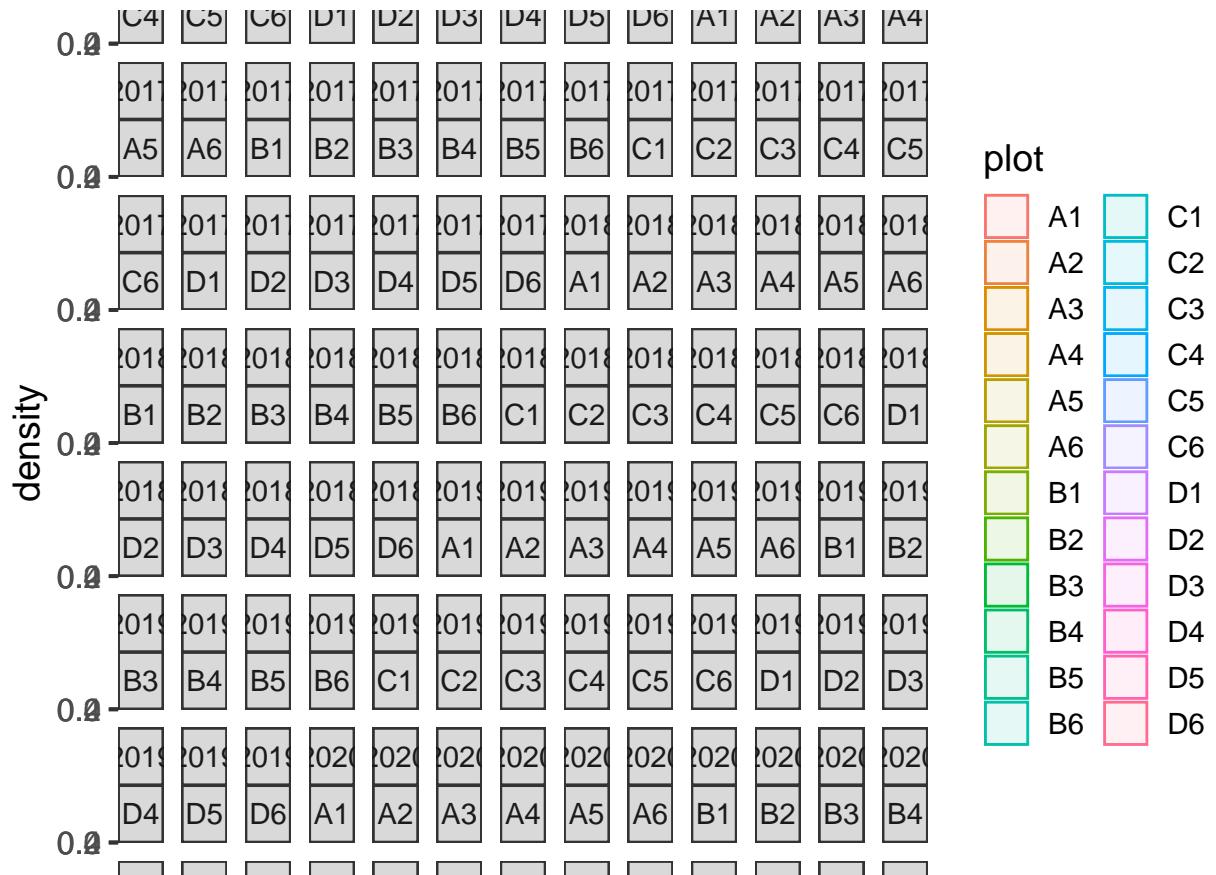
```
ggplot(kbs_flwr_spp, aes(flwr_duration_scaled, fill = plot, color=plot)) +
  geom_density(alpha = 0.1)
```



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

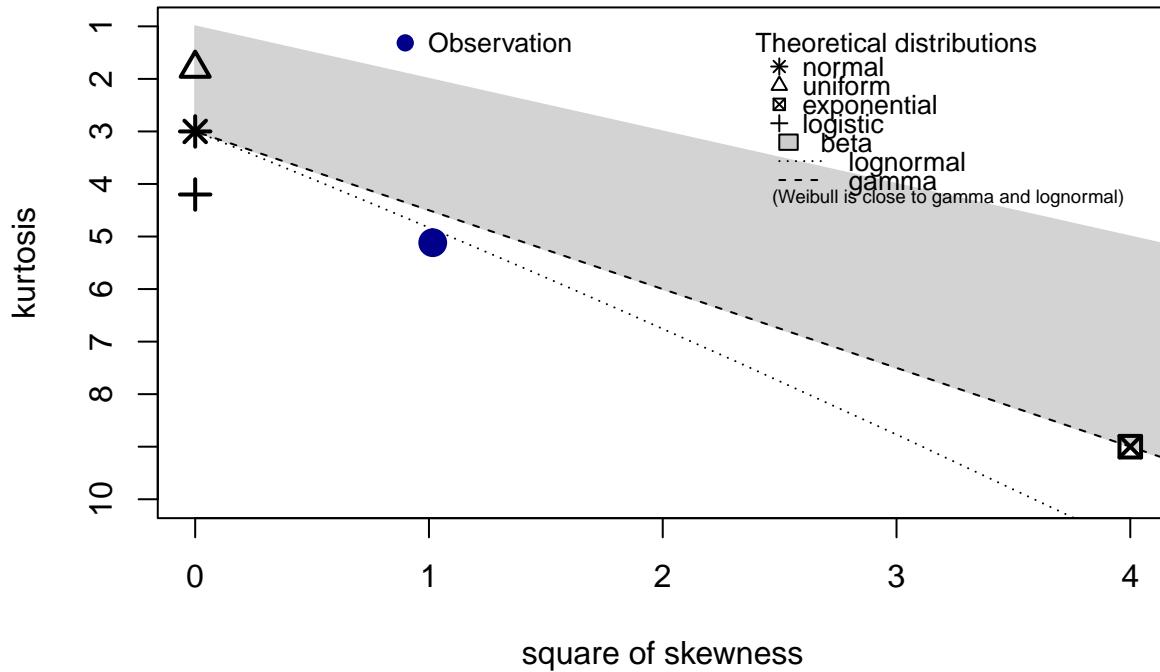


```
ggplot(kbs_flwr_spp, aes(flwr_duration_scaled, fill = plot, color=plot)) +
  geom_density(alpha = 0.1) +
  facet_wrap(~year + plot)
```



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

Cullen and Frey graph



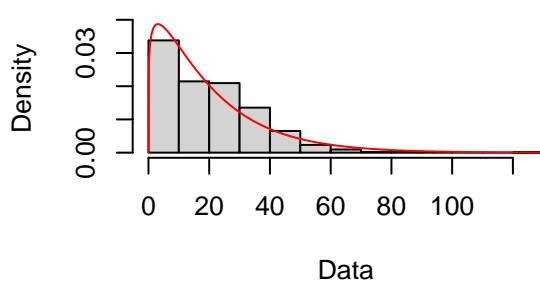
```

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

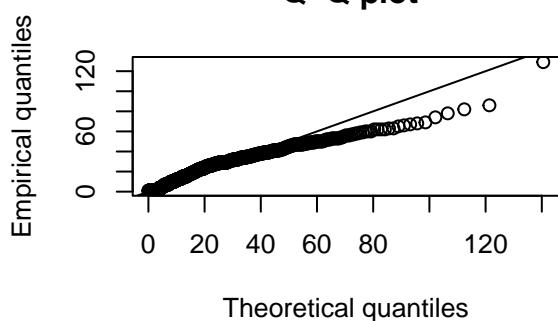
# Gamma distribution
fit.gamma <- fitdist(kbs_flwr_spp$flwr_duration_scaled, "gamma")
plot(fit.gamma)

```

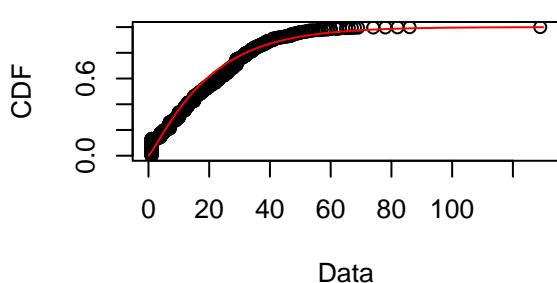
Empirical and theoretical dens.



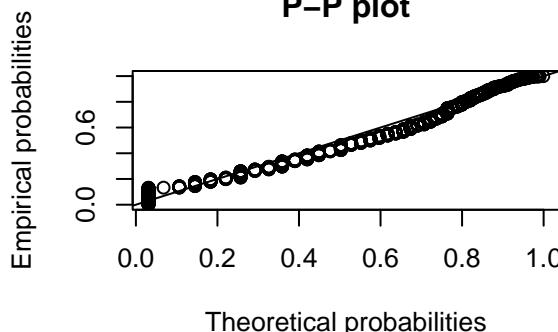
Q-Q plot



Empirical and theoretical CDFs

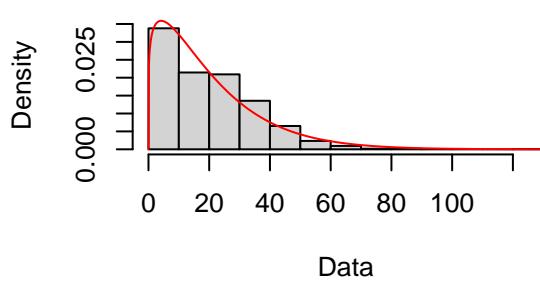


P-P plot

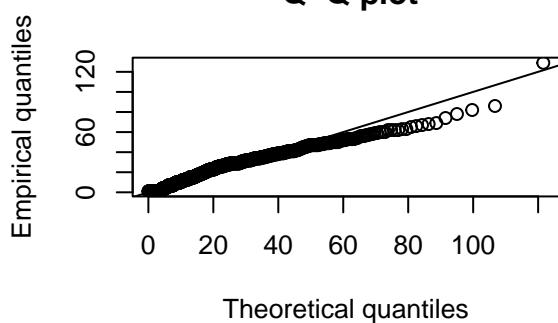


```
# Weibull distribution  
fit.weibull <- fitdist(kbs_flwr_spp$flwr_duration_scaled, "weibull")  
plot(fit.weibull)
```

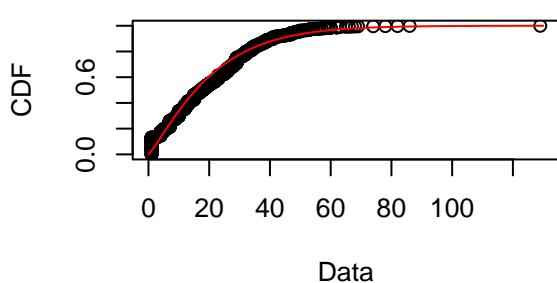
Empirical and theoretical dens.



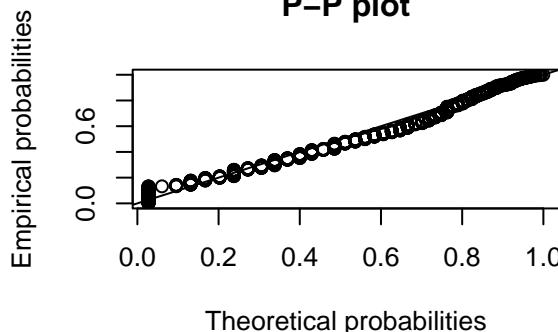
Q-Q plot



Empirical and theoretical CDFs

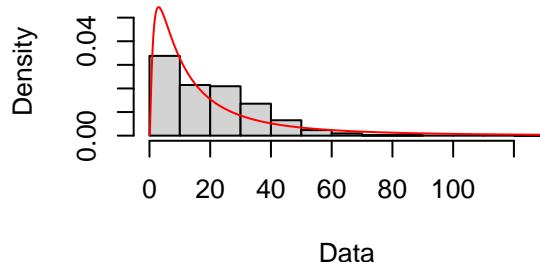


P-P plot

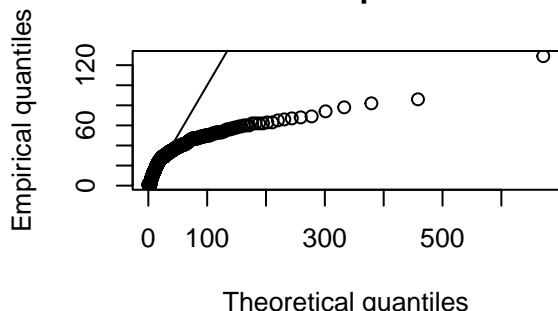


```
# Lognormal distribution
fit.ln <- fitdist(kbs_flwr_spp$flwr_duration_scaled, "lnorm")
plot(fit.ln)
```

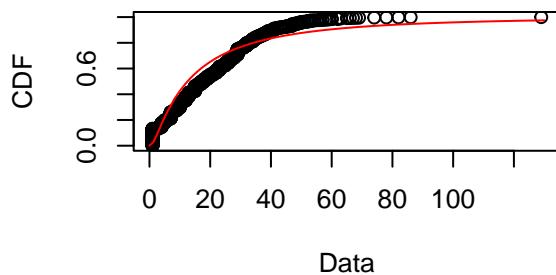
Empirical and theoretical dens.



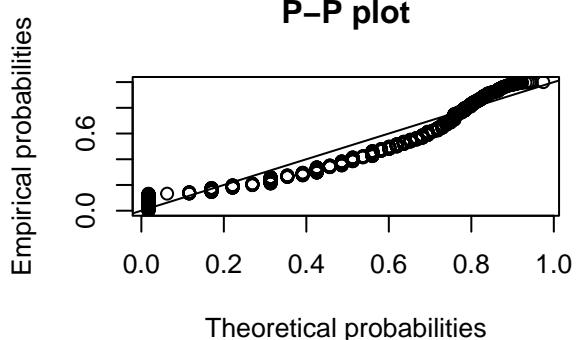
Q-Q plot



Empirical and theoretical CDFs

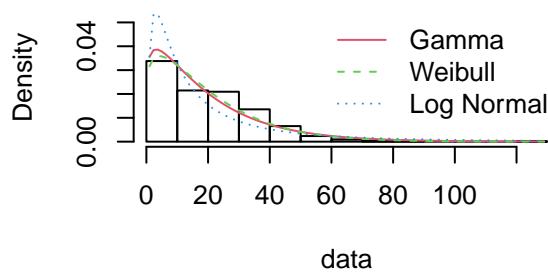


P-P plot

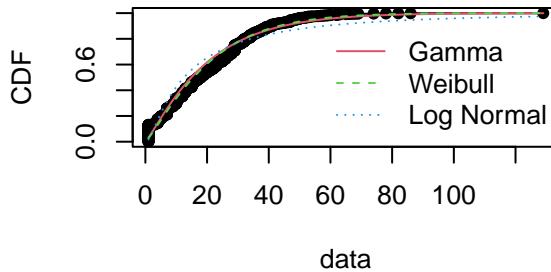


```
par(mfrow=c(2,2))
plot.legend <- c("Gamma", "Weibull", "Log Normal")
denscomp(list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
cdfcomp (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
qqcomp (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
ppcomp (list(fit.gamma,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

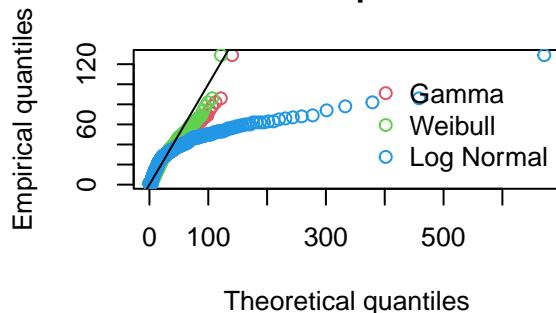
Histogram and theoretical densities



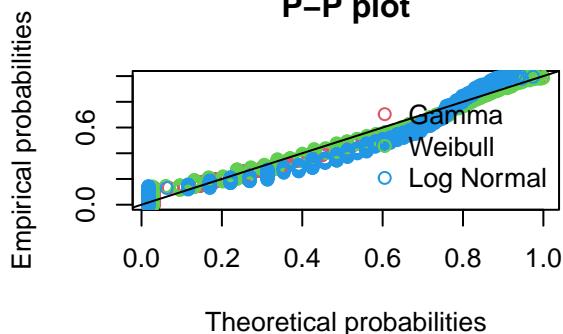
Empirical and theoretical CDFs



Q-Q plot



P-P plot



```
# 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"))
```

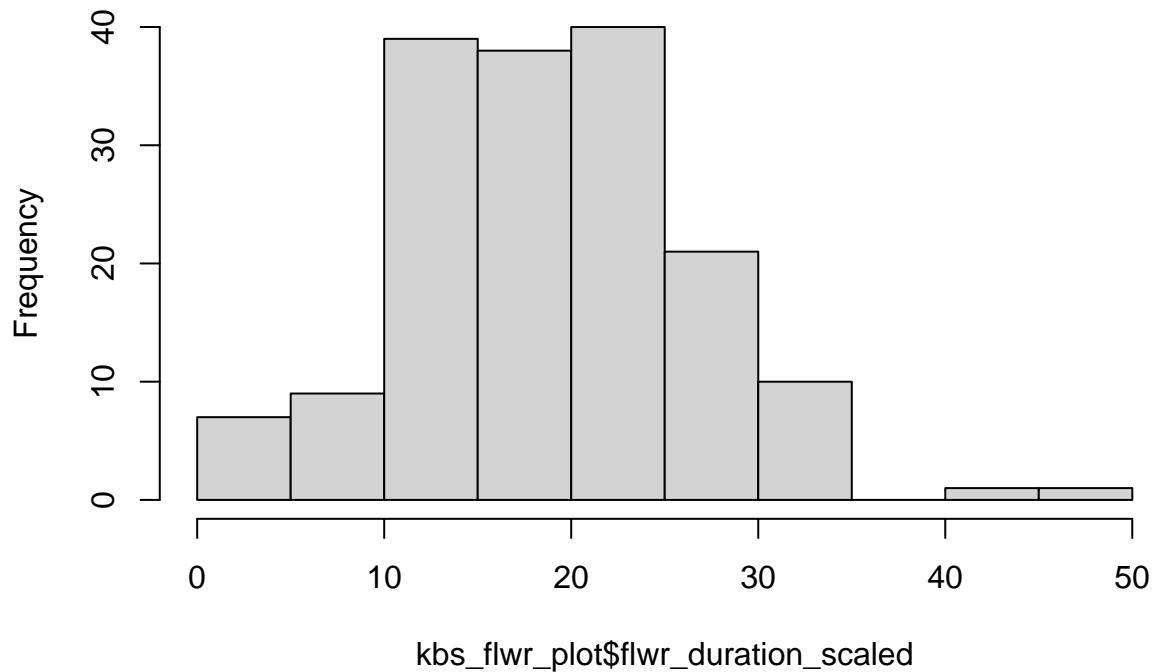
```
## Goodness-of-fit statistics
##                                     Gamma   Weibull Log Normal
## Kolmogorov-Smirnov statistic 0.1012177 0.1047727 0.1360167
## Cramer-von Mises statistic  2.5633225 1.9099784 7.3586400
## Anderson-Darling statistic 19.9451679 17.9655150 52.0510035
##
## Goodness-of-fit 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

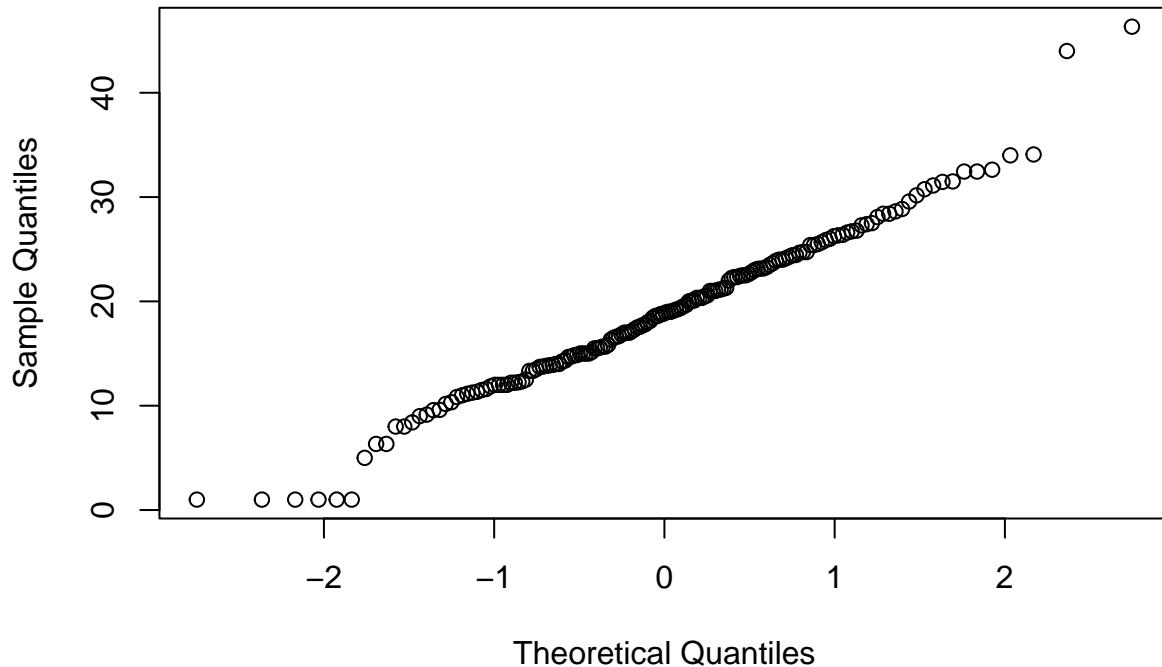
```
### KBS ####
hist(kbs_flwr_plot$flwr_duration_scaled)
```

Histogram of kbs_flwr_plot\$flwr_duration_scaled



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

Normal Q-Q Plot



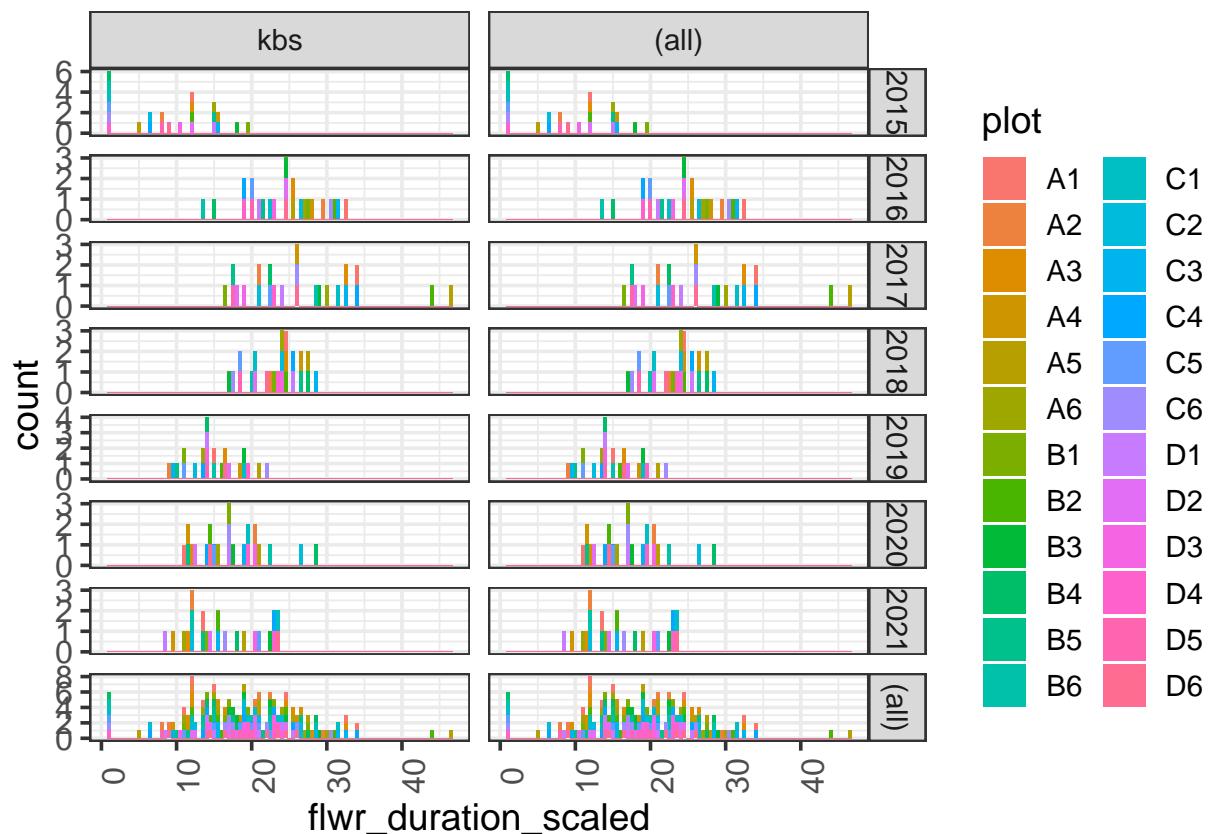
```

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

## 
## 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")

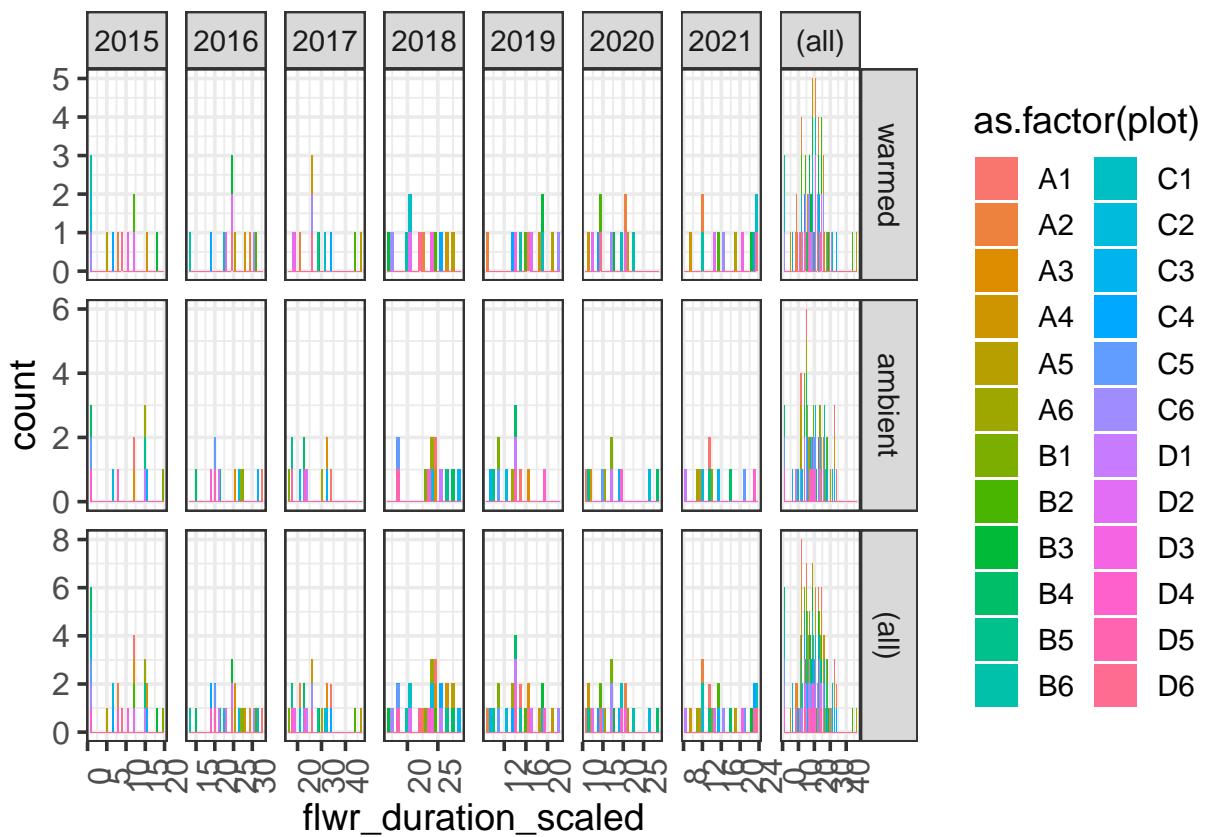
```



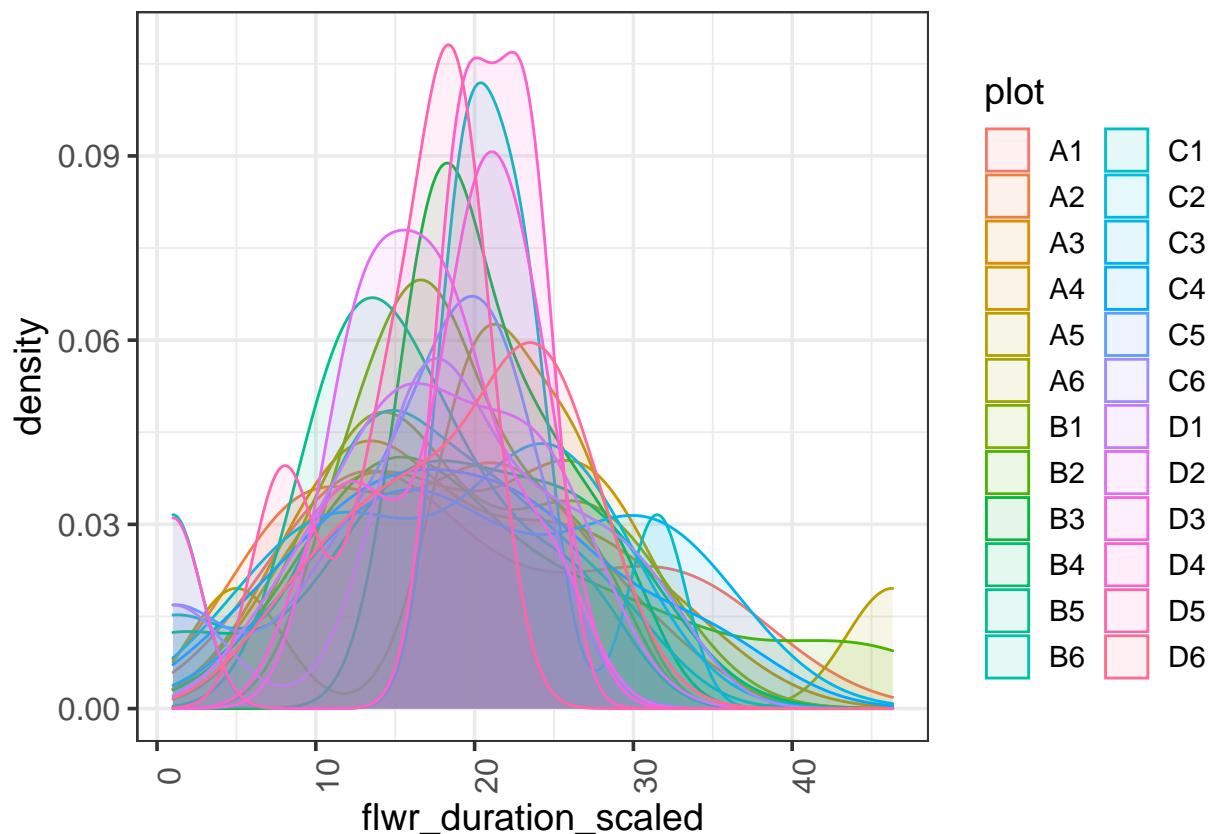
```

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")

```



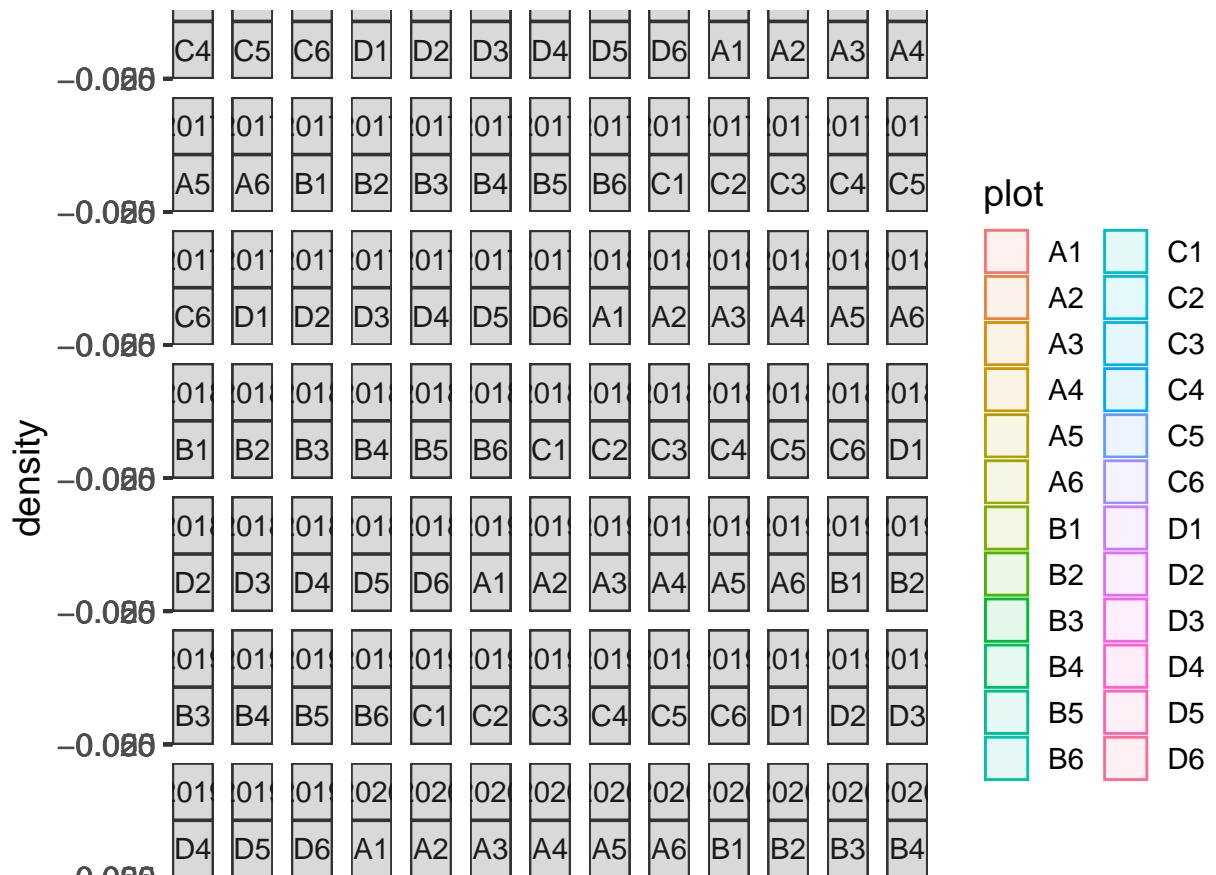
```
ggplot(kbs_flwr_plot, aes(flwr_duration_scaled, fill = plot, color=plot)) +
  geom_density(alpha = 0.1)
```



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

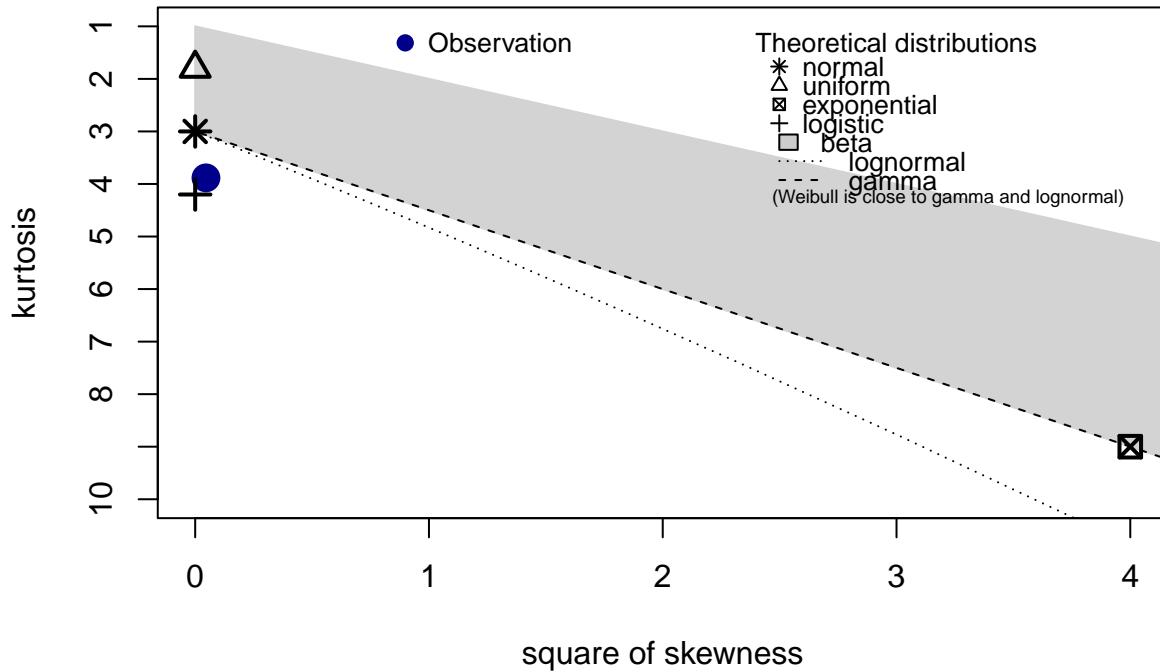


```
ggplot(kbs_flwr_plot, aes(flwr_duration_scaled, fill = plot, color=plot)) +
  geom_density(alpha = 0.1) +
  facet_wrap(~year + plot)
```



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

Cullen and Frey graph

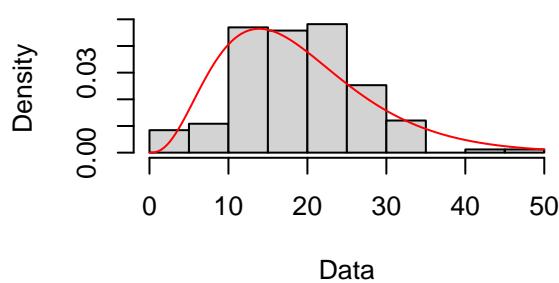
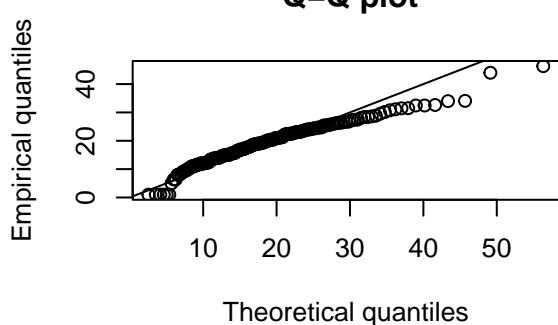
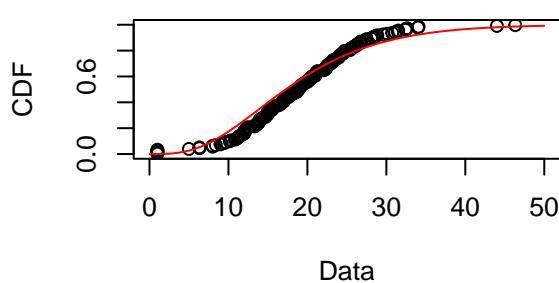
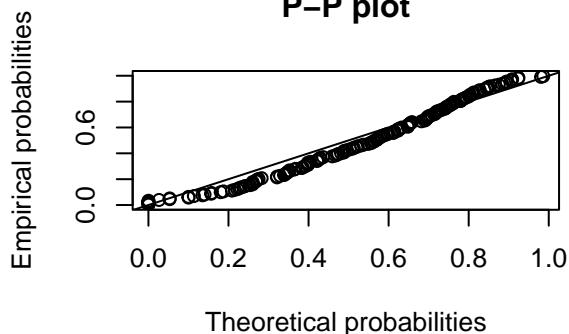


```

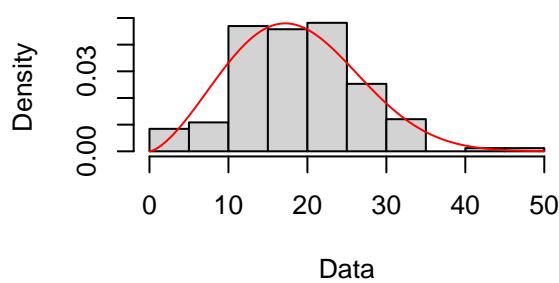
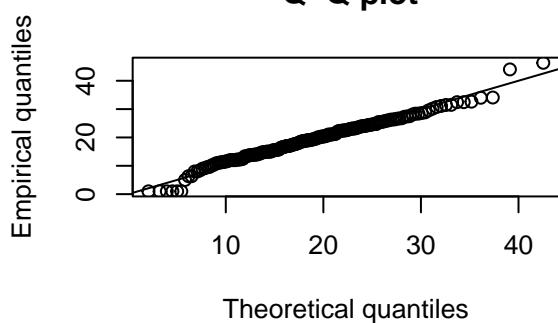
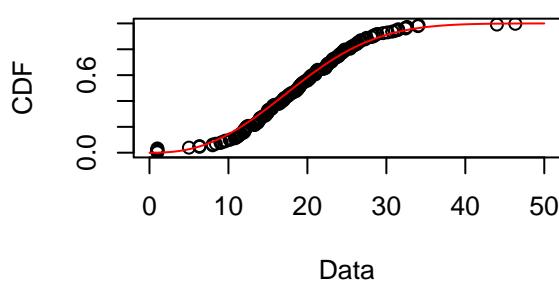
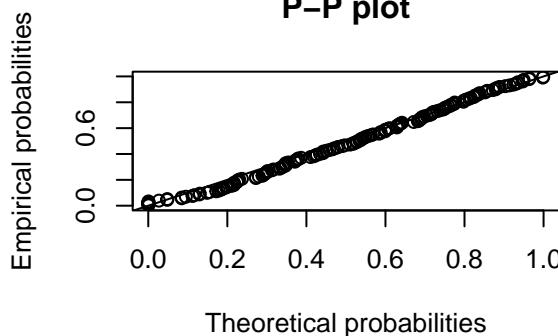
## summary statistics
## -----
## min: 1   max: 46.33333
## median: 18.86429
## mean: 18.89765
## estimated sd: 7.73299
## estimated skewness: 0.2148509
## estimated kurtosis: 3.883797

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

```

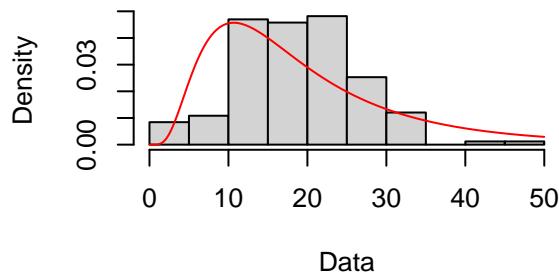
Empirical and theoretical dens.**Q-Q plot****Empirical and theoretical CDFs****P-P plot**

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

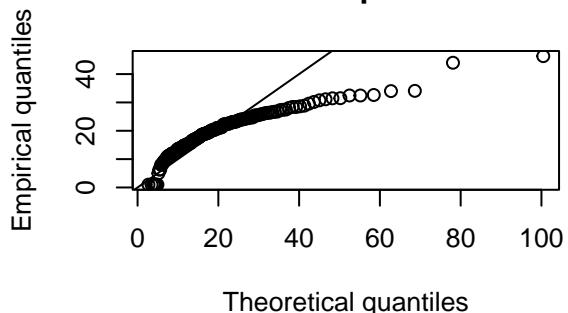
Empirical and theoretical dens.**Q-Q plot****Empirical and theoretical CDFs****P-P plot**

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

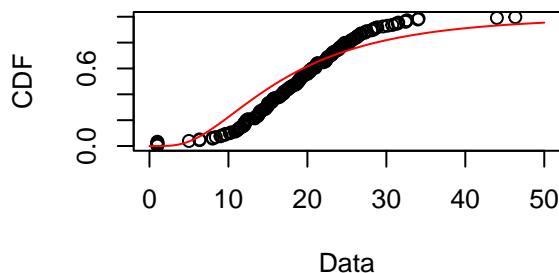
Empirical and theoretical dens.



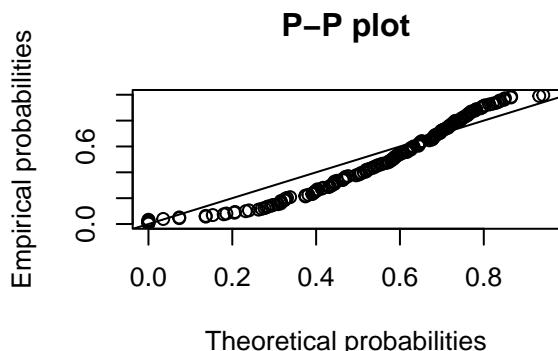
Q–Q plot



Empirical and theoretical CDFs

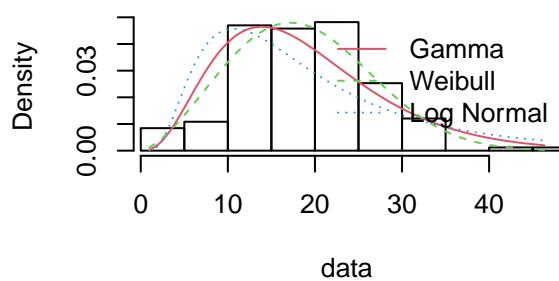


P–P plot

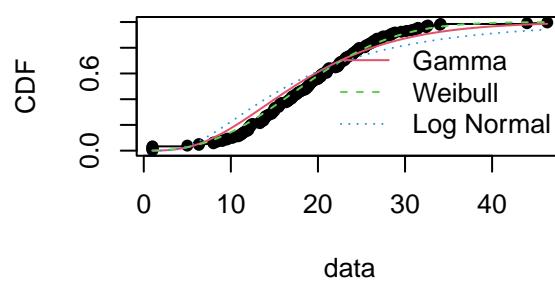


```
par(mfrow=c(2,2))
plot.legend <- c("Gamma", "Weibull", "Log Normal")
denscomp(list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
cdfcomp (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
qqcomp (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
ppcomp (list(fit.gamma,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

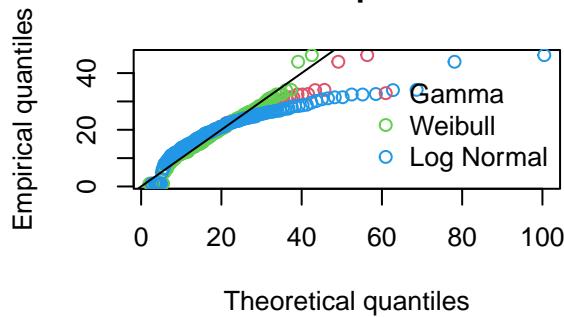
Histogram and theoretical densities



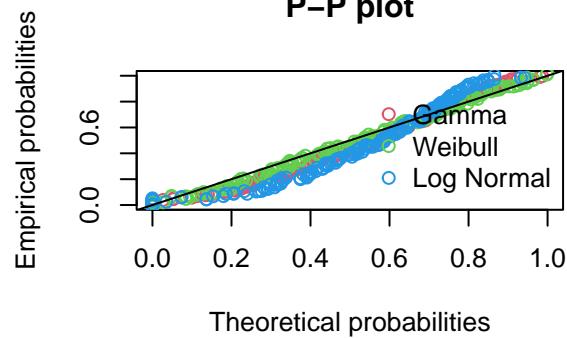
Empirical and theoretical CDFs



Q-Q plot



P-P plot



```
# 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"))
```

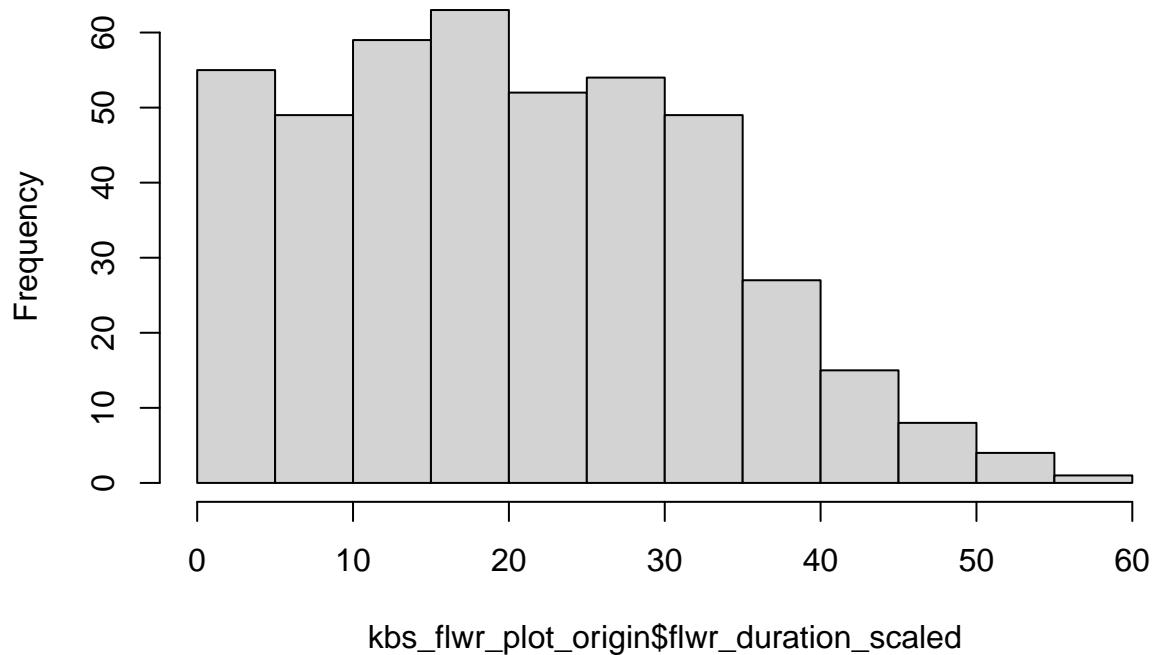
```
## Goodness-of-fit statistics
##                                     Gamma    Weibull   Log Normal
## Kolmogorov-Smirnov statistic 0.1103947 0.06380716 0.1636293
## Cramer-von Mises statistic   0.6493450 0.14666364 1.5887202
## Anderson-Darling statistic   4.6911012 1.56654597 10.4217087
##
## Goodness-of-fit 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

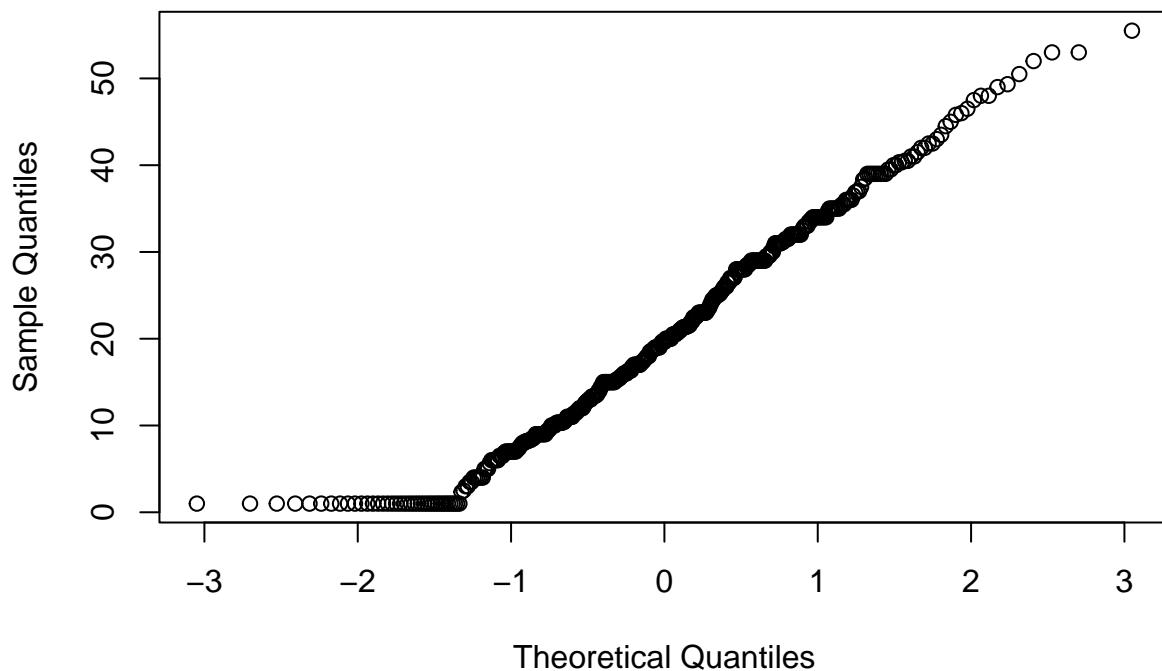
```
### KBS ####
hist(kbs_flwr_plot_origin$flwr_duration_scaled)
```

Histogram of kbs_flwr_plot_origin\$flwr_duration_scaled



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

Normal Q-Q Plot



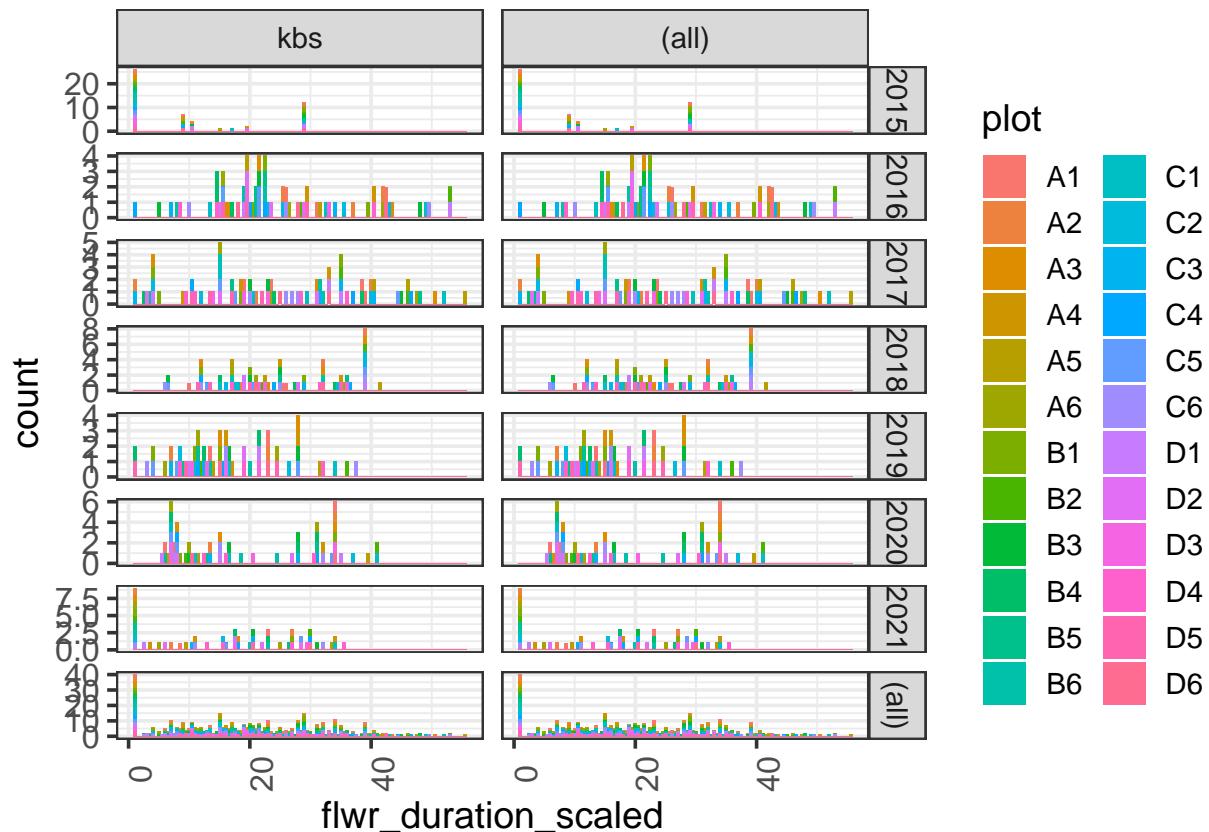
```

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

## 
## 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")

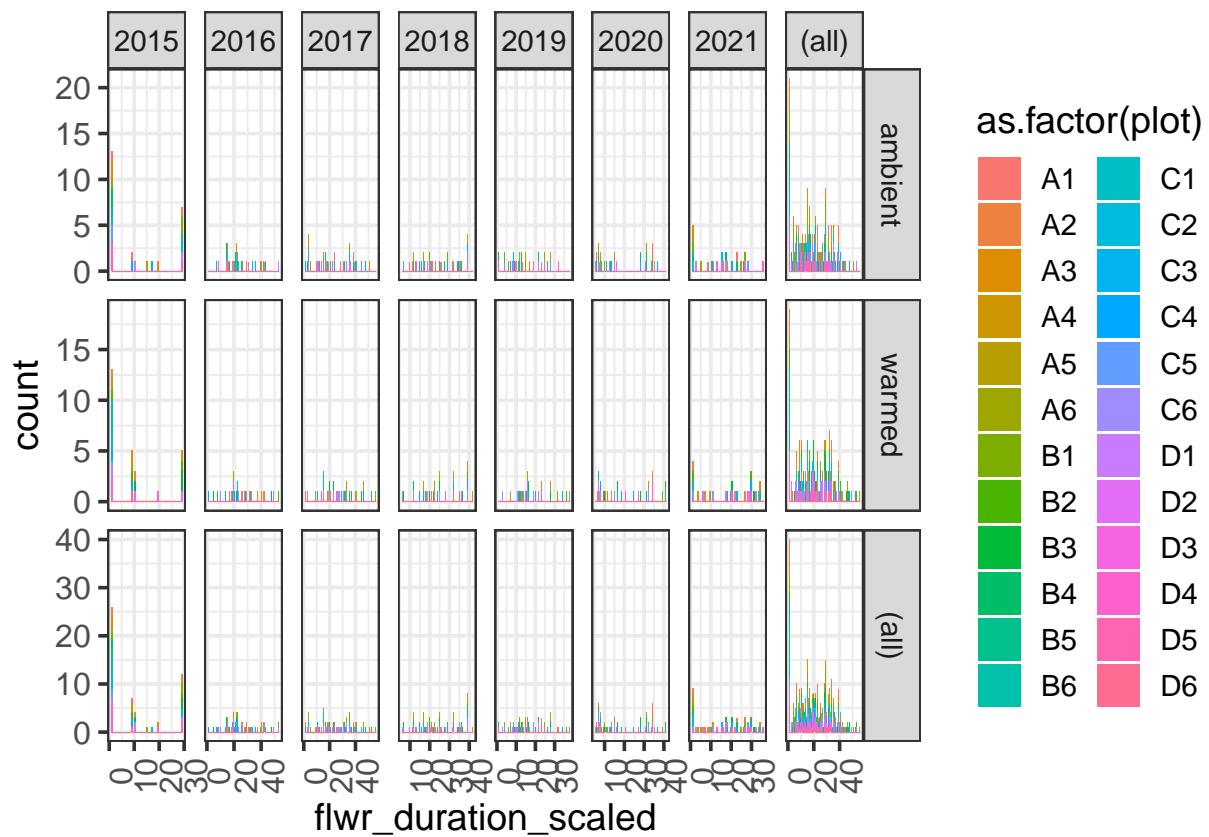
```



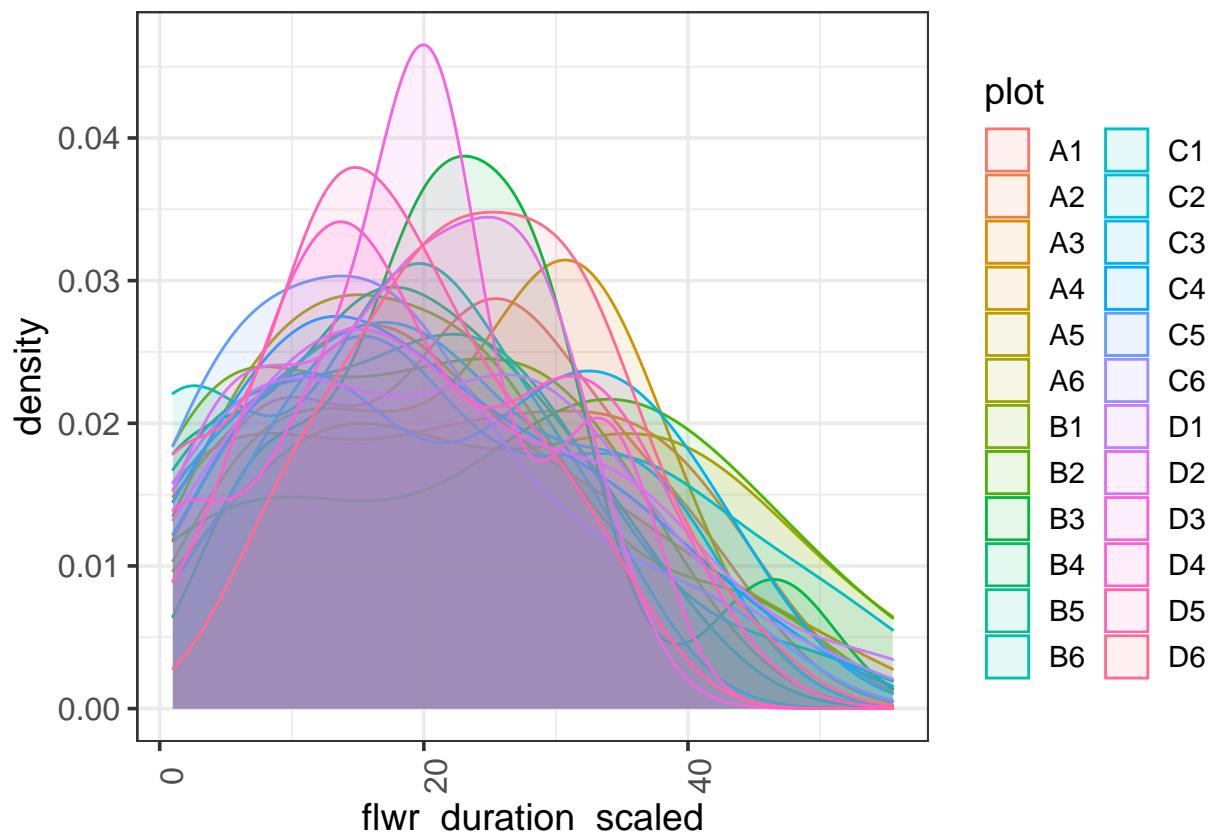
```

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

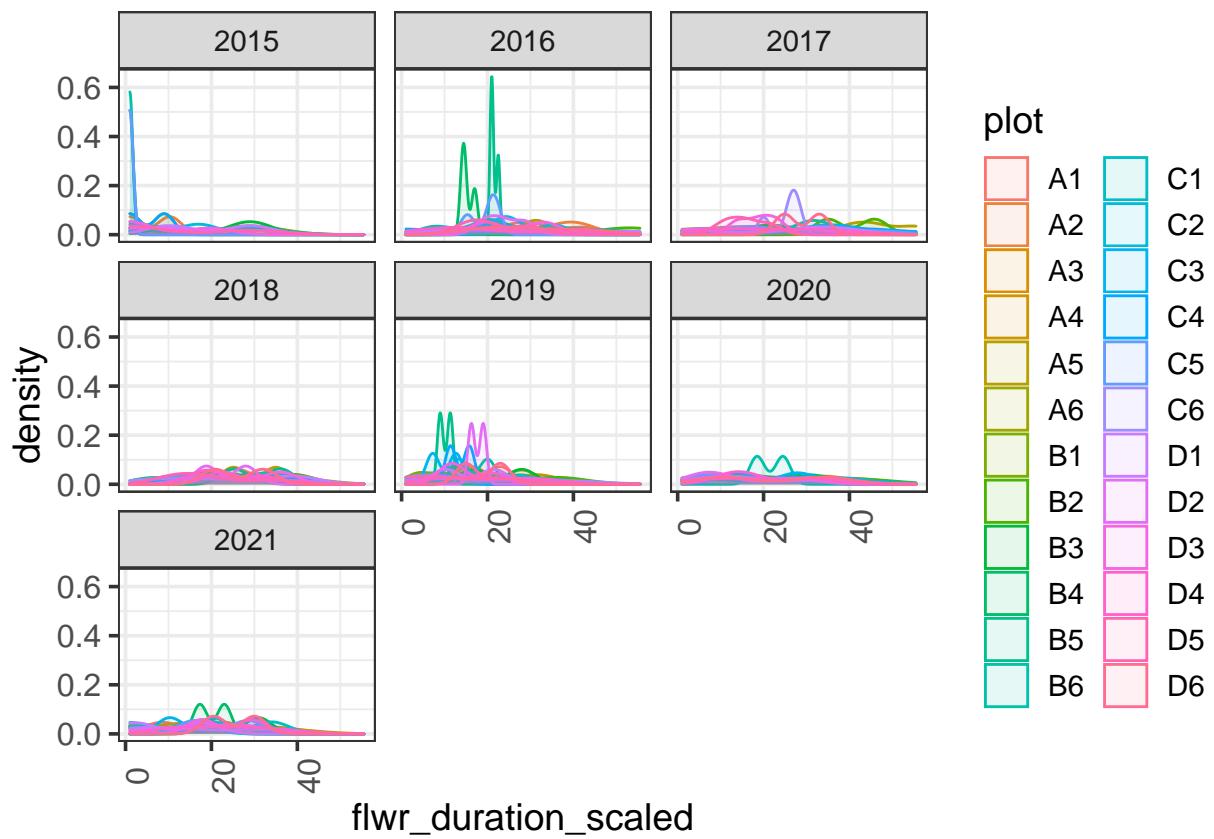
```



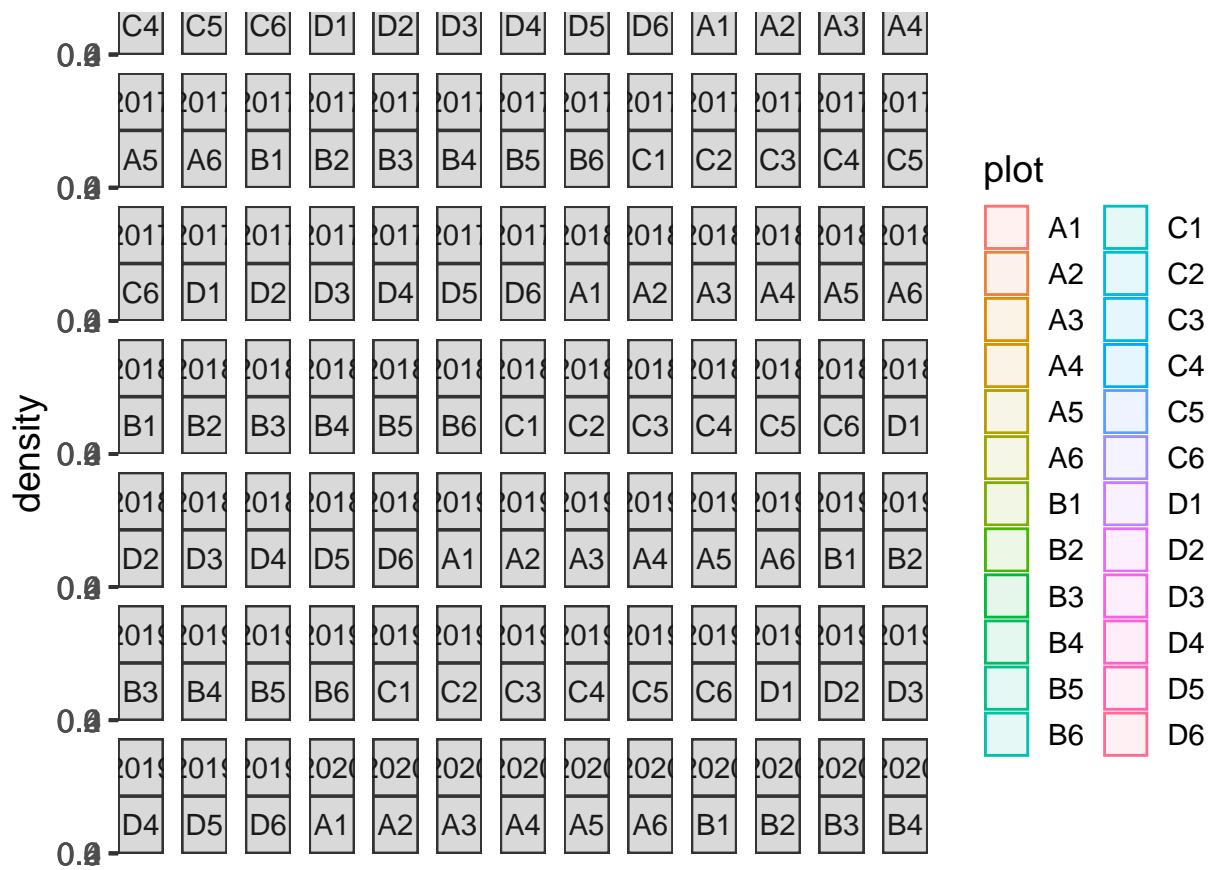
```
ggplot(kbs_flwr_plot_origin, aes(flwr_duration_scaled, fill = plot, color=plot)) +
  geom_density(alpha = 0.1)
```



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

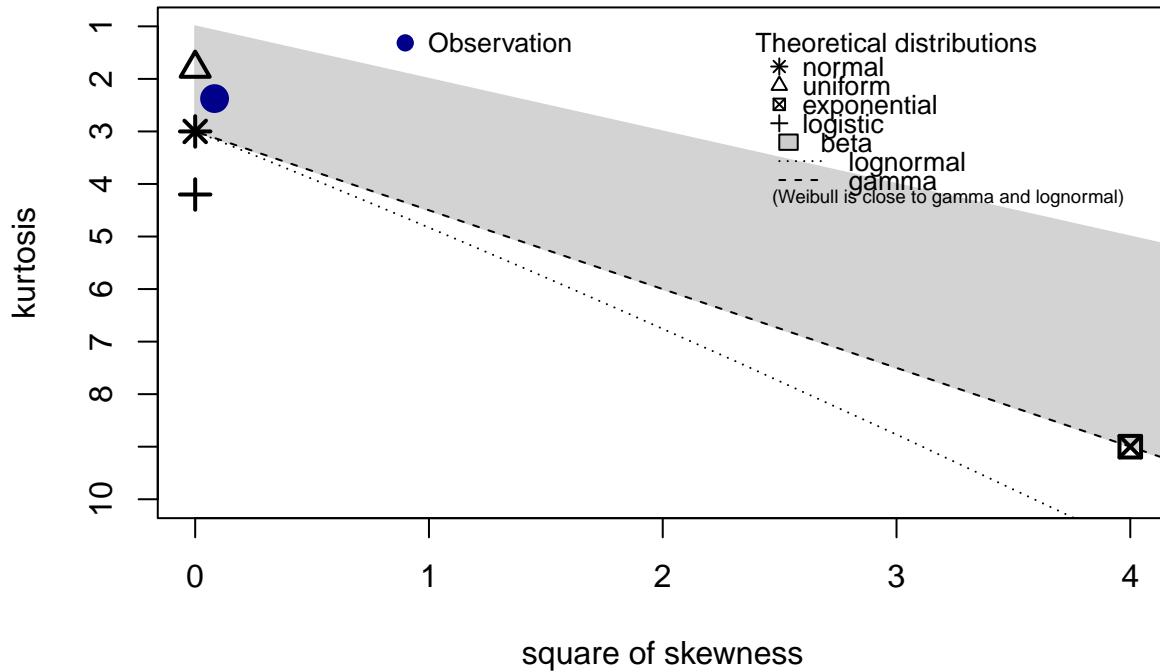


```
ggplot(kbs_flwr_plot_origin, aes(flwr_duration_scaled, fill = plot, color=plot)) +
  geom_density(alpha = 0.1) +
  facet_wrap(~year + plot)
```



```
# Exploring distributions for these data:  
descdist(kbs flwr plot origin$flwr duration scaled, discrete = FALSE)
```

Cullen and Frey graph

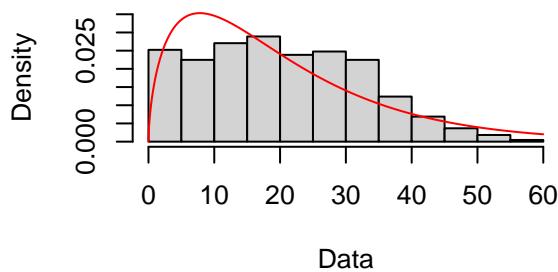
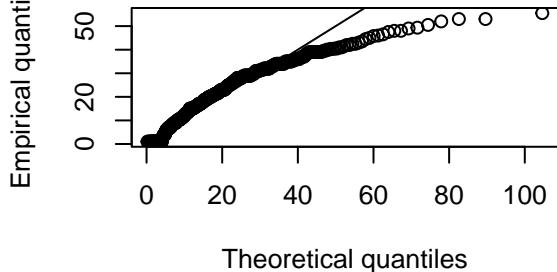
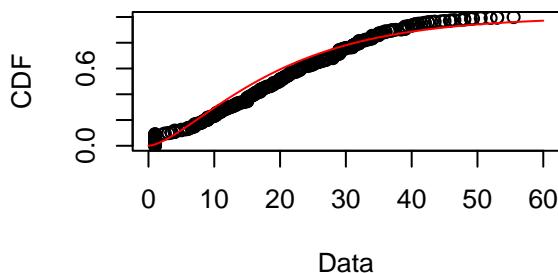
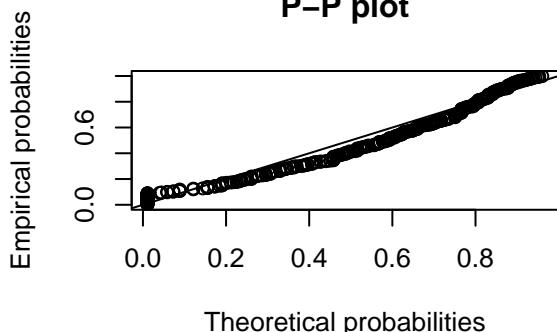


```

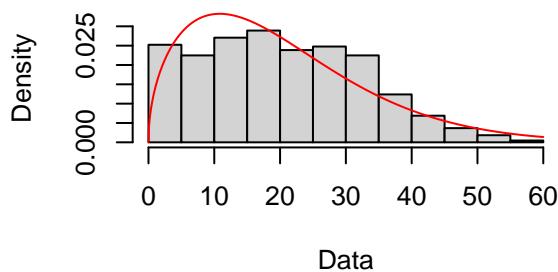
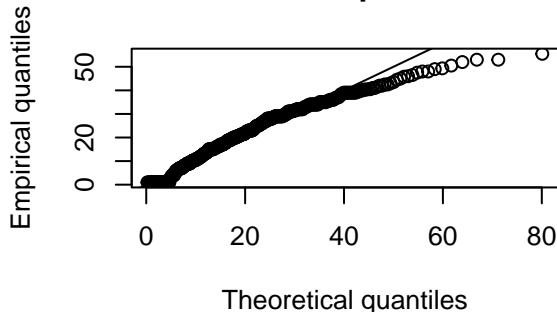
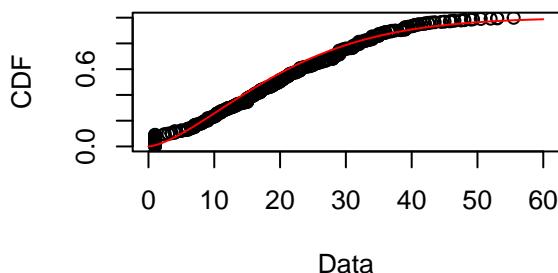
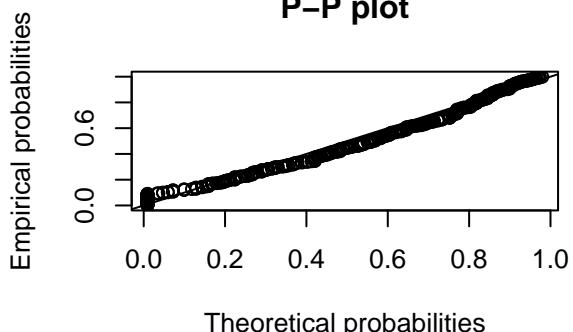
## summary statistics
## -----
## min: 1   max: 55.5
## median: 19.66667
## mean: 20.4813
## estimated sd: 12.57484
## estimated skewness: 0.2880935
## estimated kurtosis: 2.374742

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

```

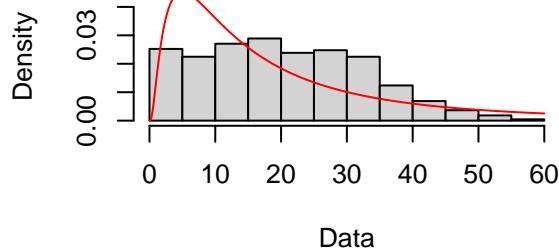
Empirical and theoretical dens.**Q-Q plot****Empirical and theoretical CDFs****P-P plot**

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

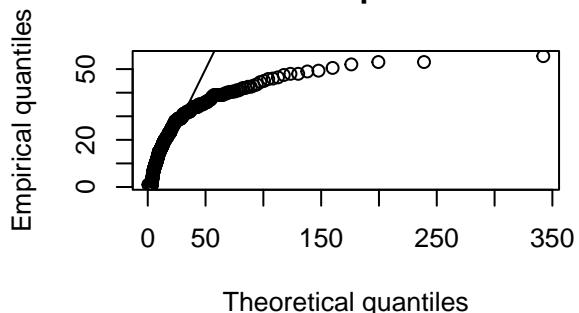
Empirical and theoretical dens.**Q-Q plot****Empirical and theoretical CDFs****P-P plot**

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

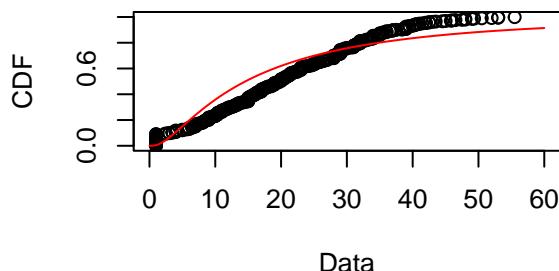
Empirical and theoretical dens.



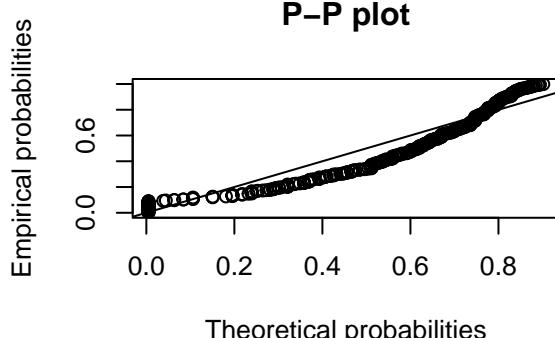
Q–Q plot



Empirical and theoretical CDFs

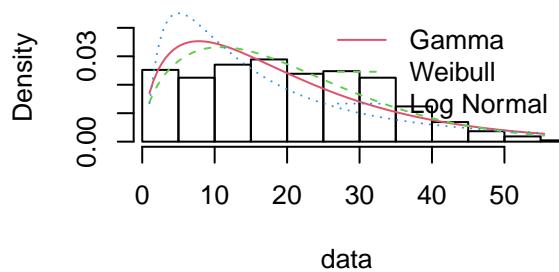


P–P plot

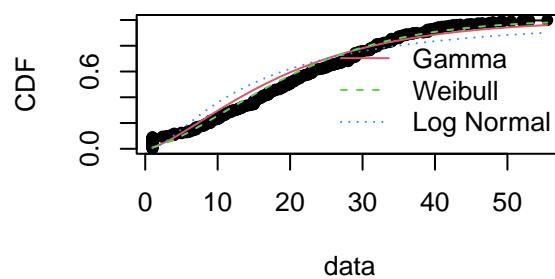


```
par(mfrow=c(2,2))
plot.legend <- c("Gamma", "Weibull", "Log Normal")
denscomp(list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
cdfcomp (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
qqcomp (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
ppcomp (list(fit.gamma,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

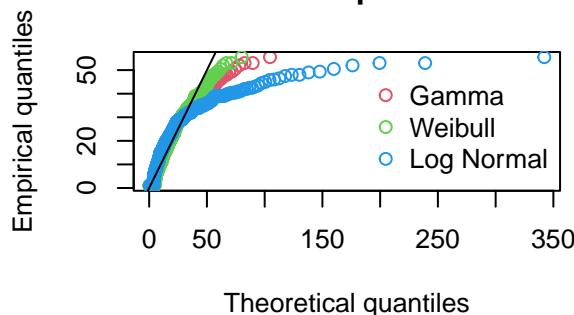
Histogram and theoretical densities



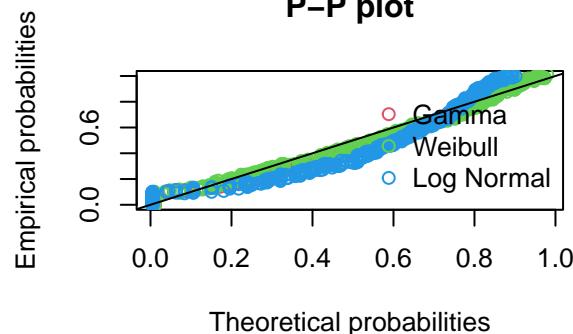
Empirical and theoretical CDFs



Q-Q plot



P-P plot



```
# 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"))
```

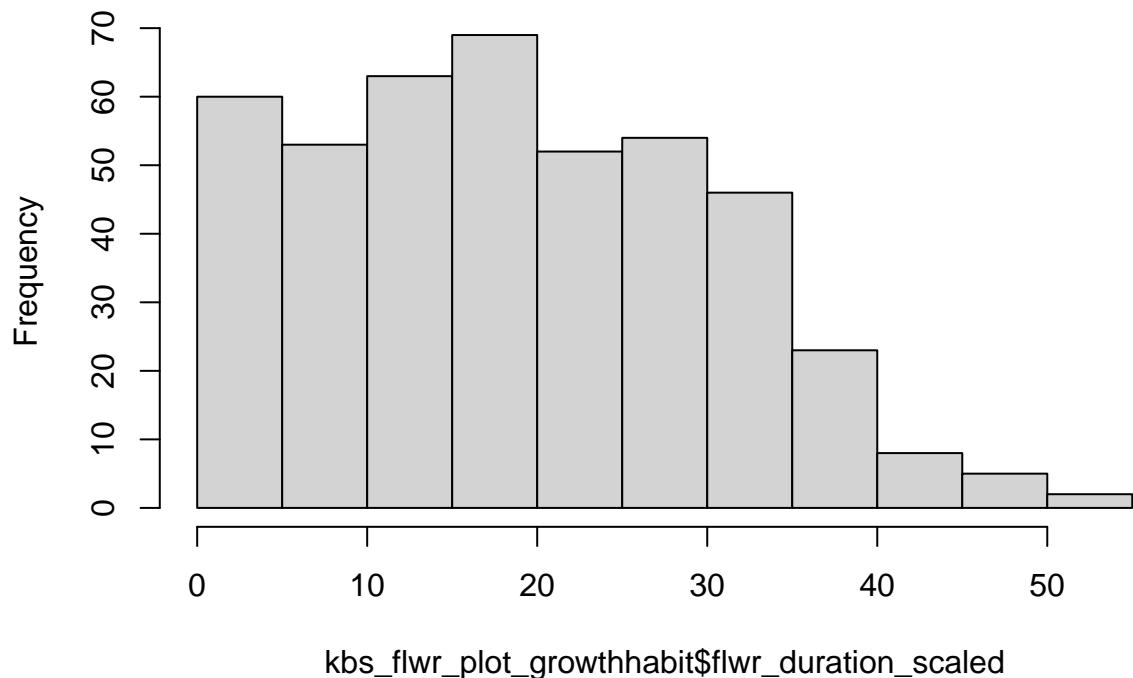
```
## Goodness-of-fit statistics
##                                     Gamma   Weibull Log Normal
## Kolmogorov-Smirnov statistic 0.1139634 0.08246571 0.1671529
## Cramer-von Mises statistic  1.5552914 0.76255050 3.7540550
## Anderson-Darling statistic 11.1245128 7.55672816 25.2157916
##
## Goodness-of-fit 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

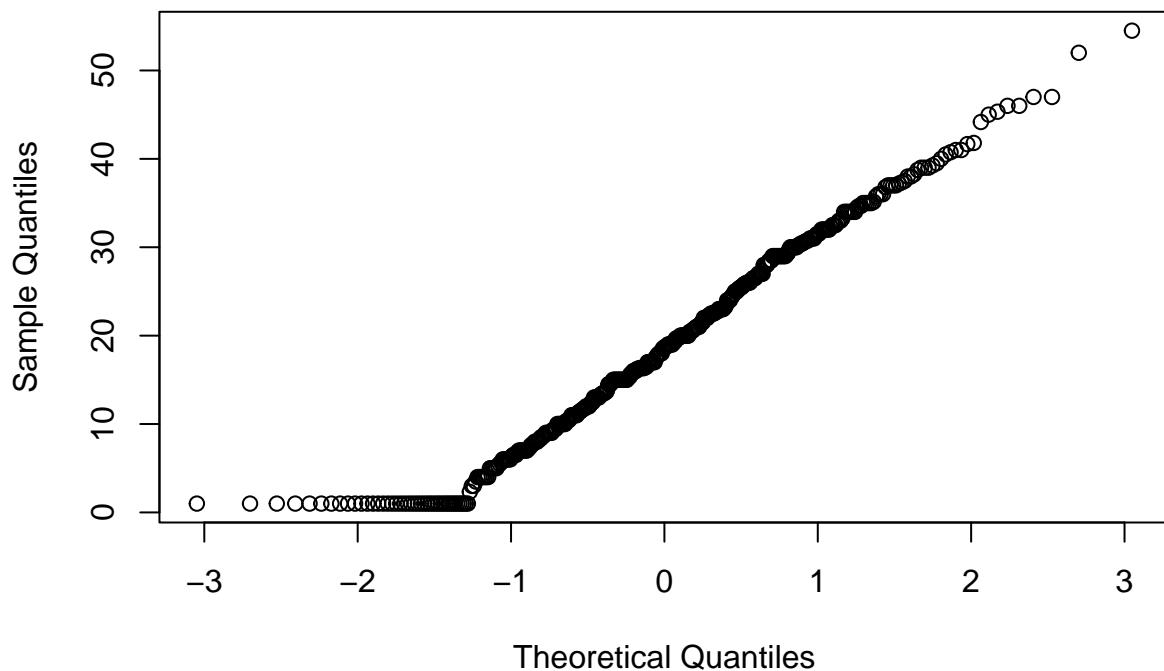
```
### KBS ####
hist(kbs_flwr_plot_growthhabit$flwr_duration_scaled)
```

Histogram of kbs_flwr_plot_growthhabit\$flwr_duration_scaled



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

Normal Q-Q Plot



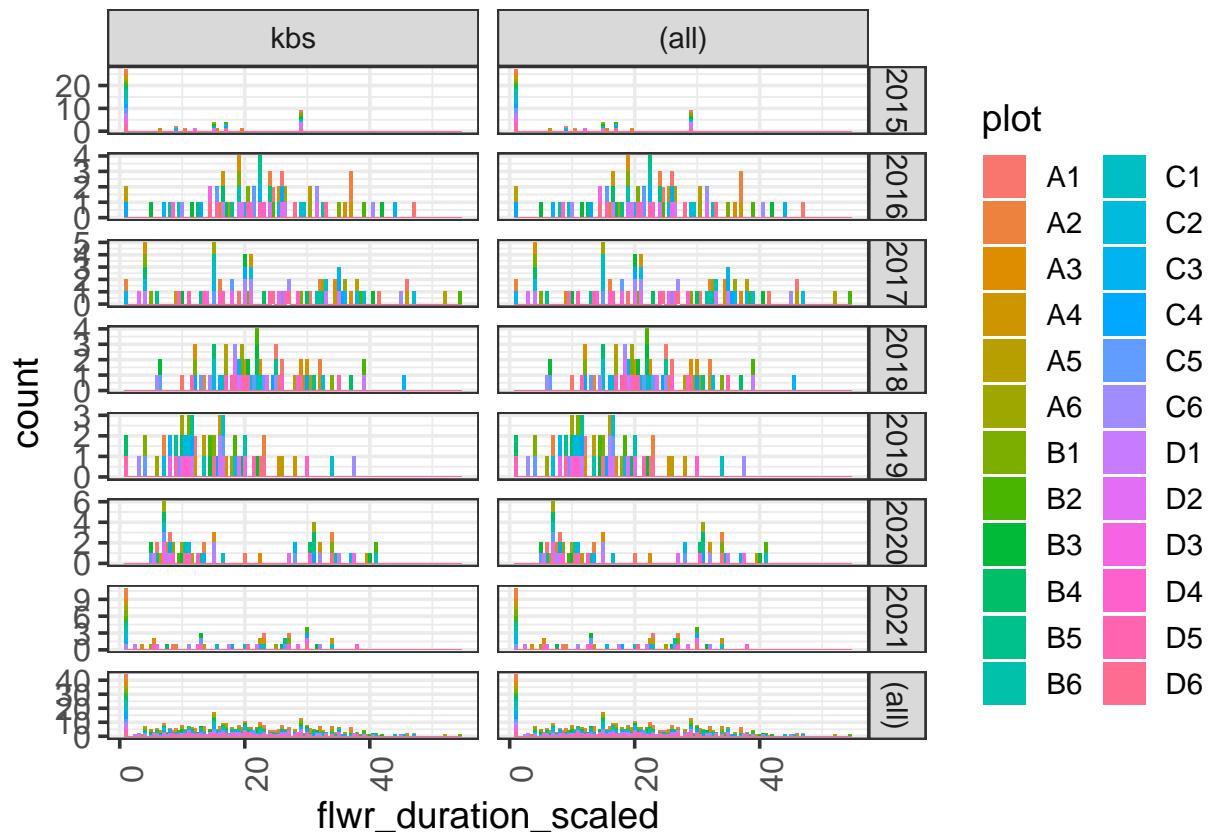
```

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

## 
## 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")

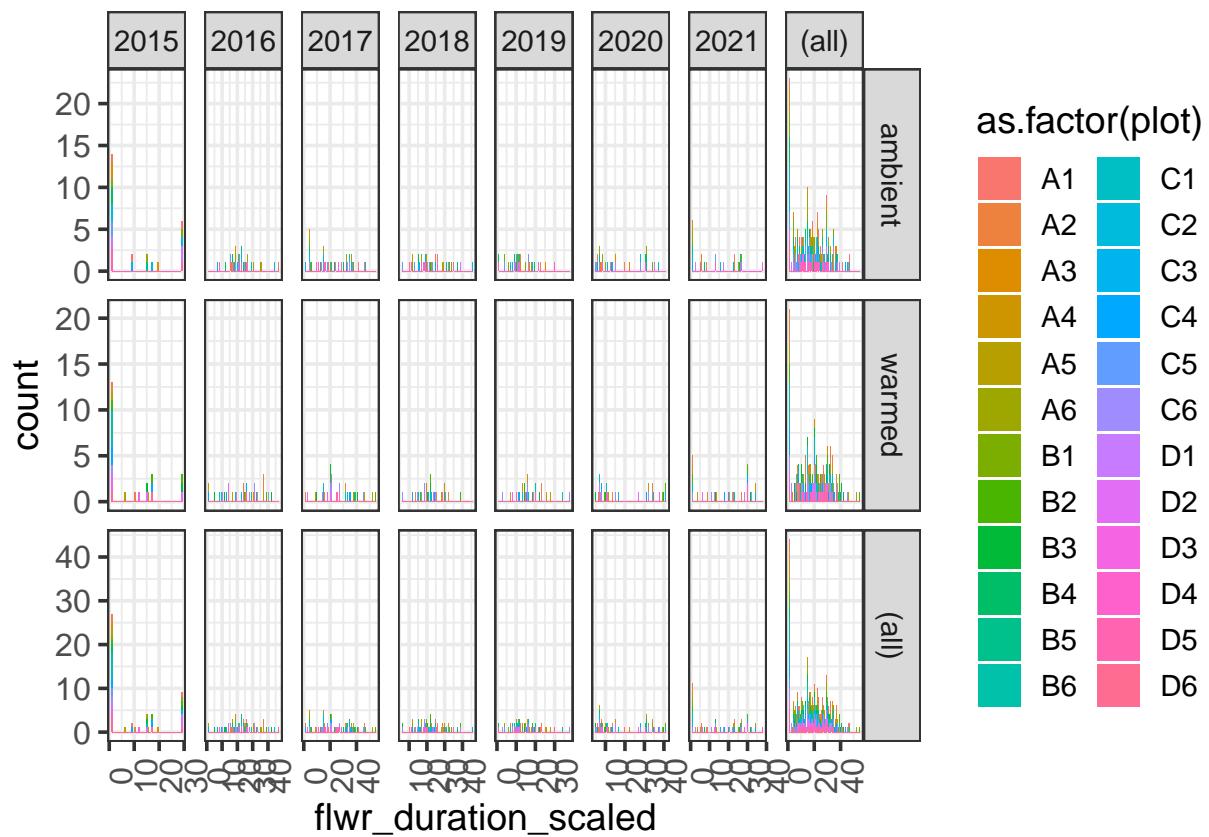
```



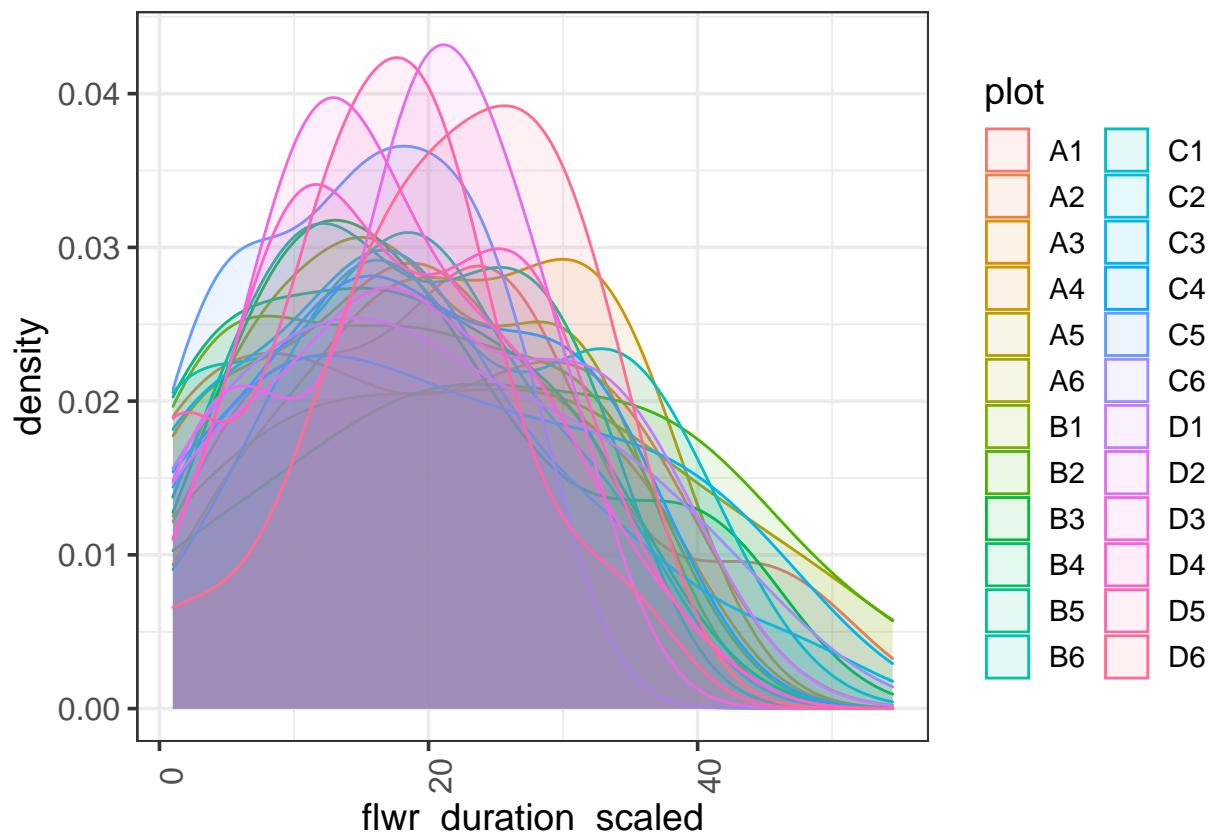
```

ggplot(kbs_flwr_plot_growthhabit, aes(flwr_duration_scaled, fill = as.factor(plot))) + geom_histogram(bins = 100)
  facet_grid(state ~ year, margins = TRUE, scales = "free")

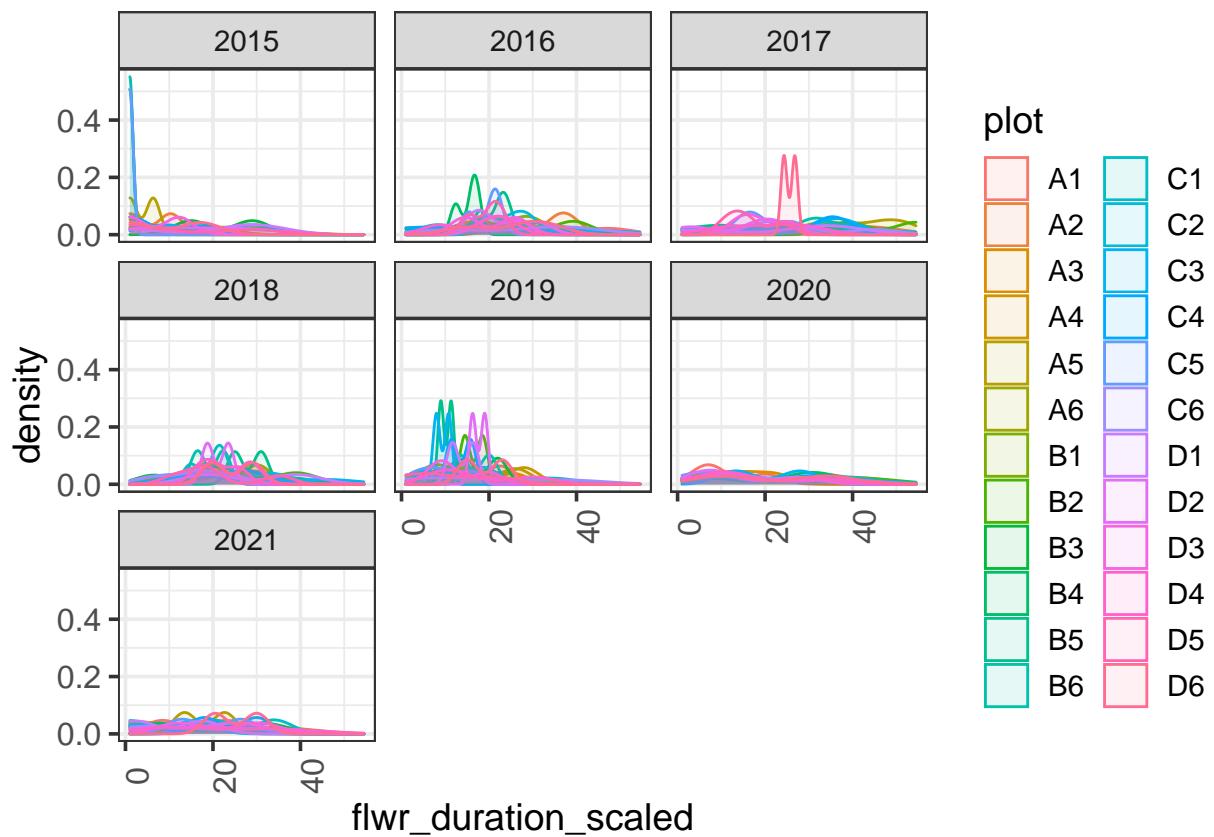
```



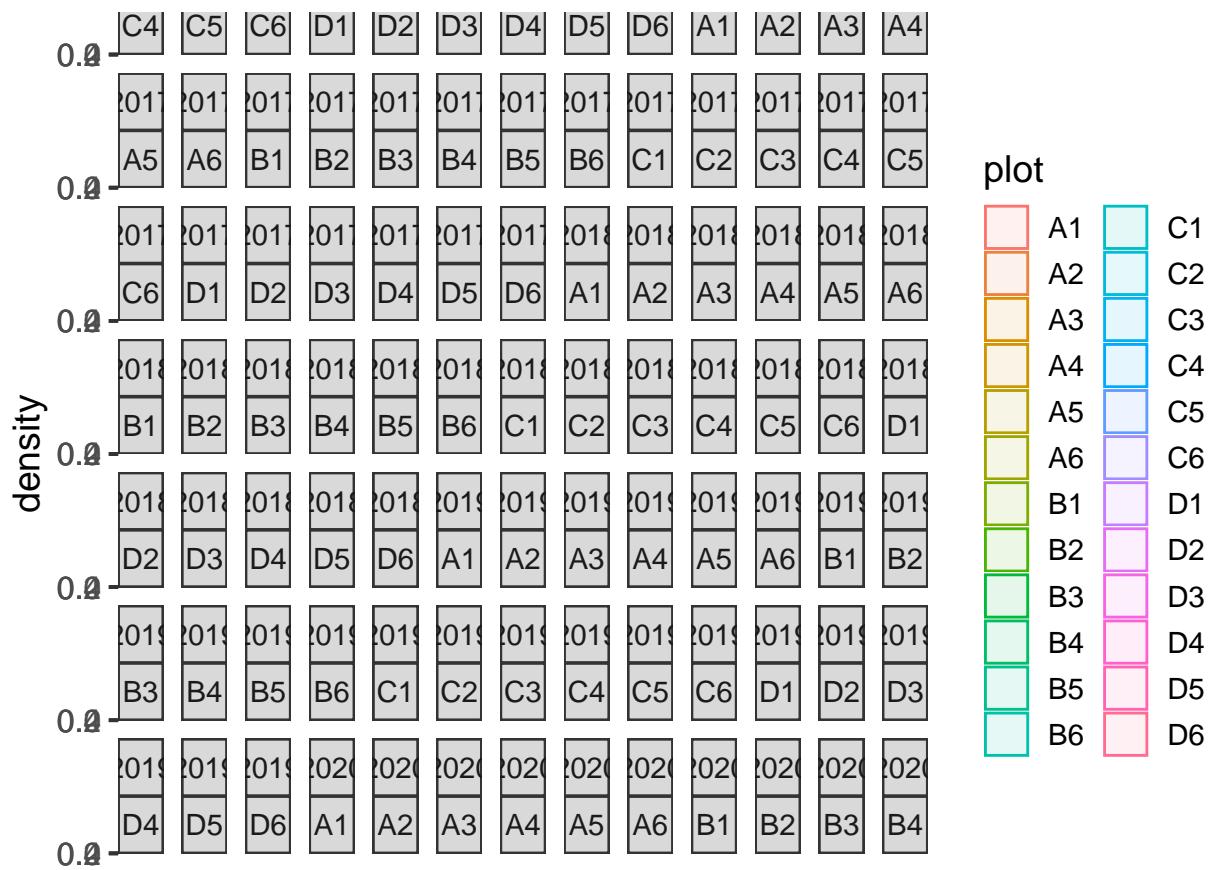
```
ggplot(kbs_flwr_plot_growthhabit, aes(flwr_duration_scaled, fill = plot, color=plot)) +
  geom_density(alpha = 0.1)
```



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

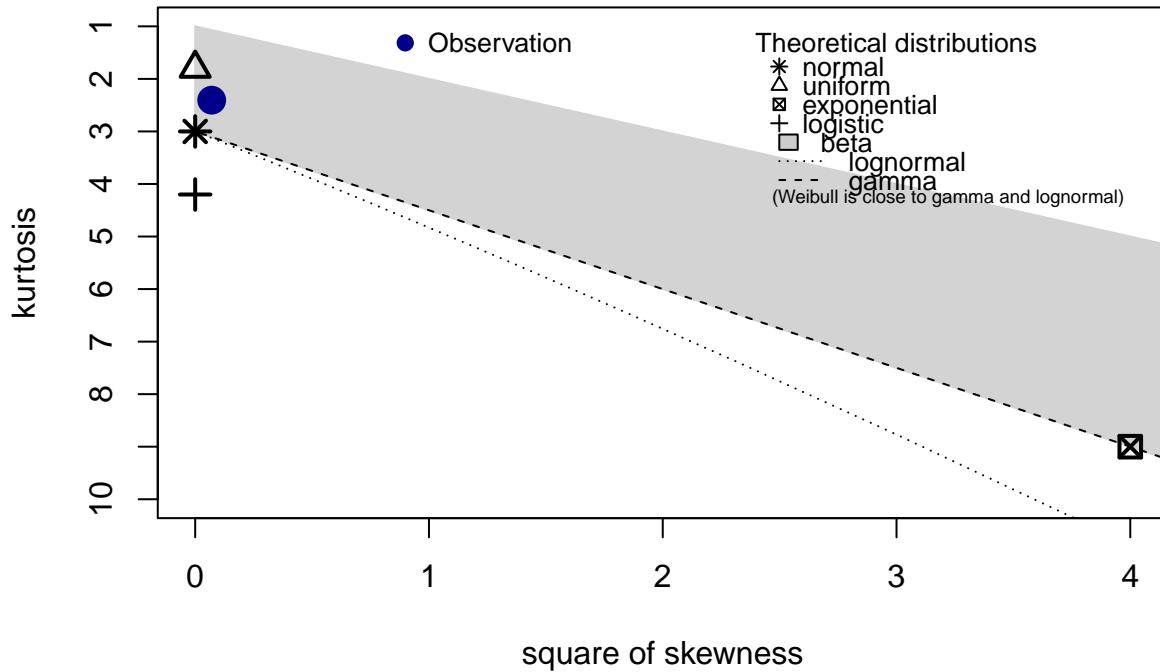


```
ggplot(kbs_flwr_plot_growthhabit, aes(flwr_duration_scaled, fill = plot, color=plot)) +
  geom_density(alpha = 0.1) +
  facet_wrap(~year + plot)
```



```
# Exploring distributions for these data:  
descdist(kbs flwr plot growthhabit$flwr duration scaled, discrete = FALSE)
```

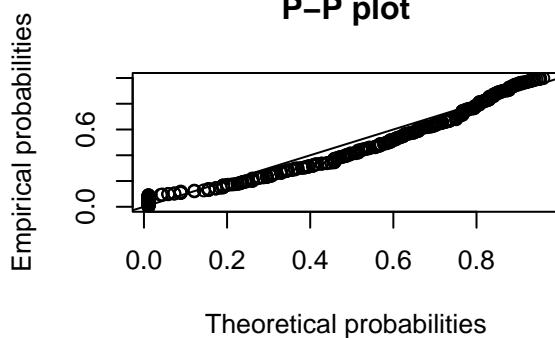
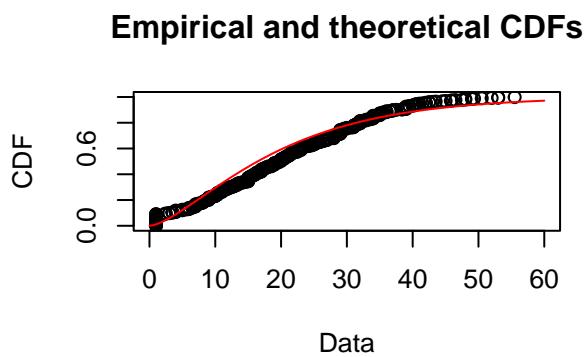
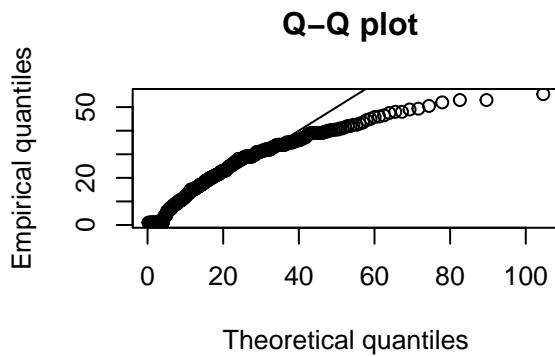
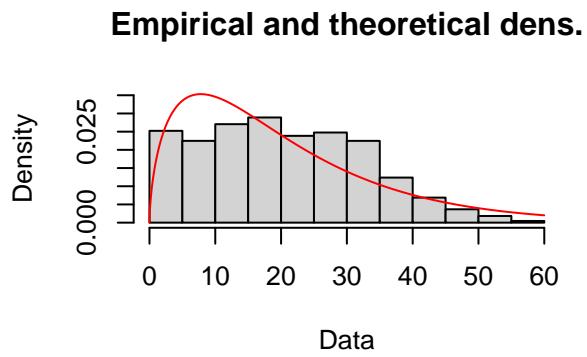
Cullen and Frey graph



```
## 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 estimate
##               with the error code 100
plot(fit.gamma)
```



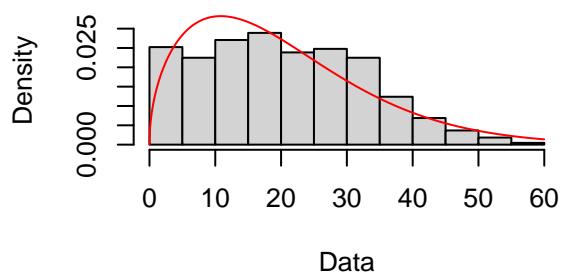
```
# Weibull distribution
```

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

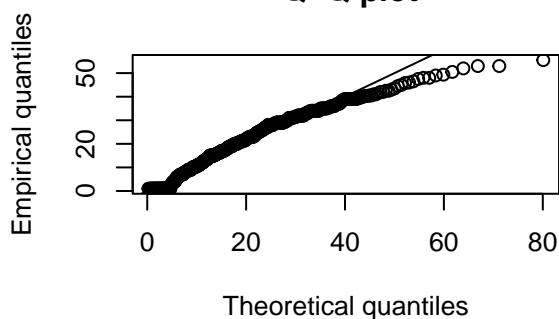
```
## Error in checkparamlist(arg_startfix$start.arg, arg_startfix$fix.arg, : 'start' should not have NA or
```

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

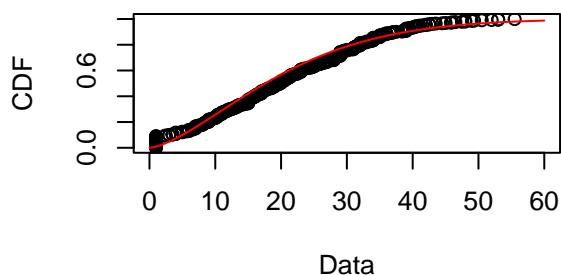
Empirical and theoretical dens.



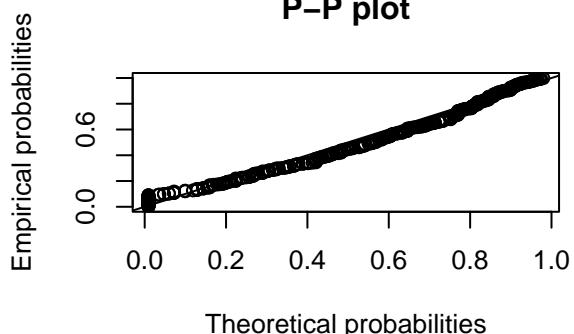
Q-Q plot



Empirical and theoretical CDFs



P-P plot



```
# Lognormal distribution
```

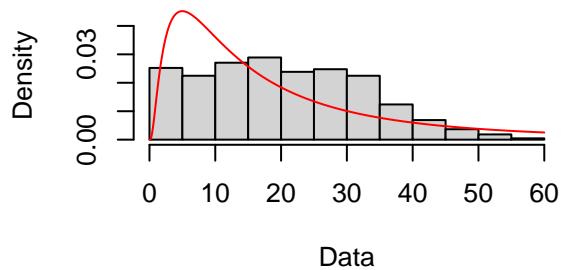
```
fit.ln <- fitdist(kbs_flwr_plot_growthhabit$flwr_duration, "lnorm")
```

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

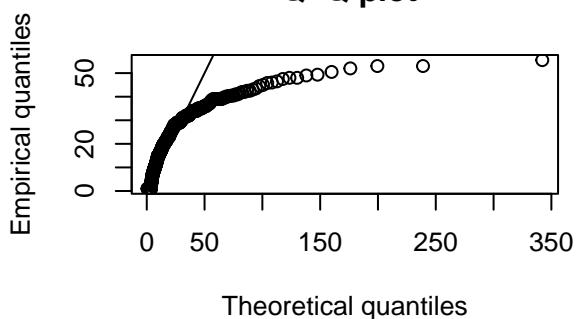
```
## Error in manageparam(start.arg = start, fix.arg = fix.arg, obs = data, : Error in start.arg.default(  
##   values must be positive to fit a lognormal distribution
```

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

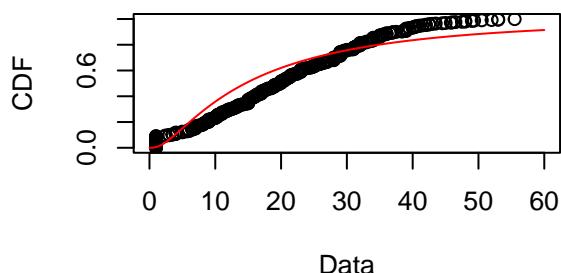
Empirical and theoretical dens.



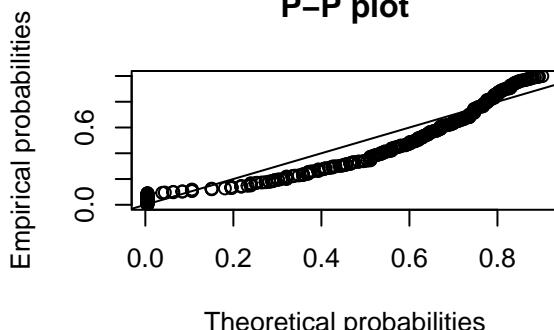
Q-Q plot



Empirical and theoretical CDFs

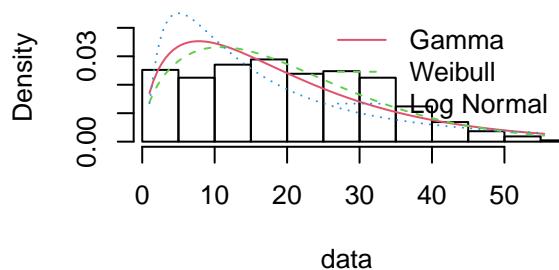


P-P plot

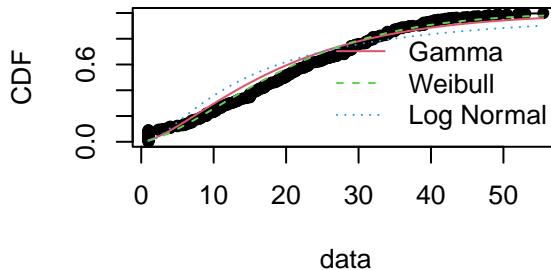


```
par(mfrow=c(2,2))
plot.legend <- c("Gamma", "Weibull", "Log Normal")
denscomp(list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
cdfcomp (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
qqcomp  (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
ppcomp  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

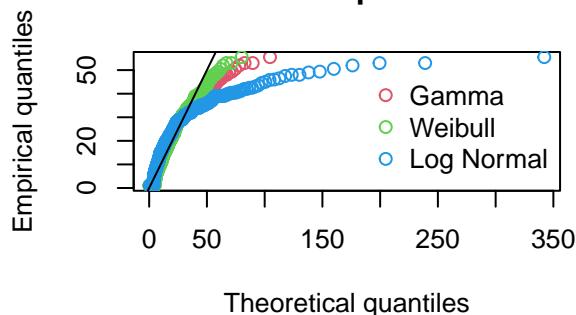
Histogram and theoretical densities



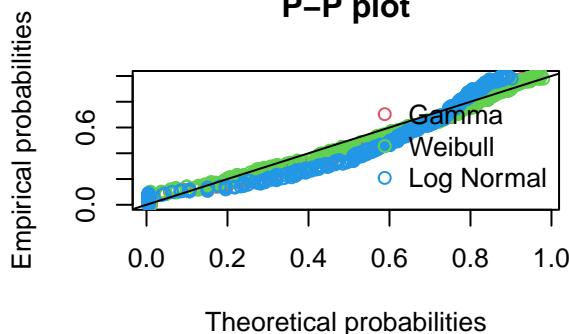
Empirical and theoretical CDFs



Q-Q plot



P-P plot



```
# 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"))
```

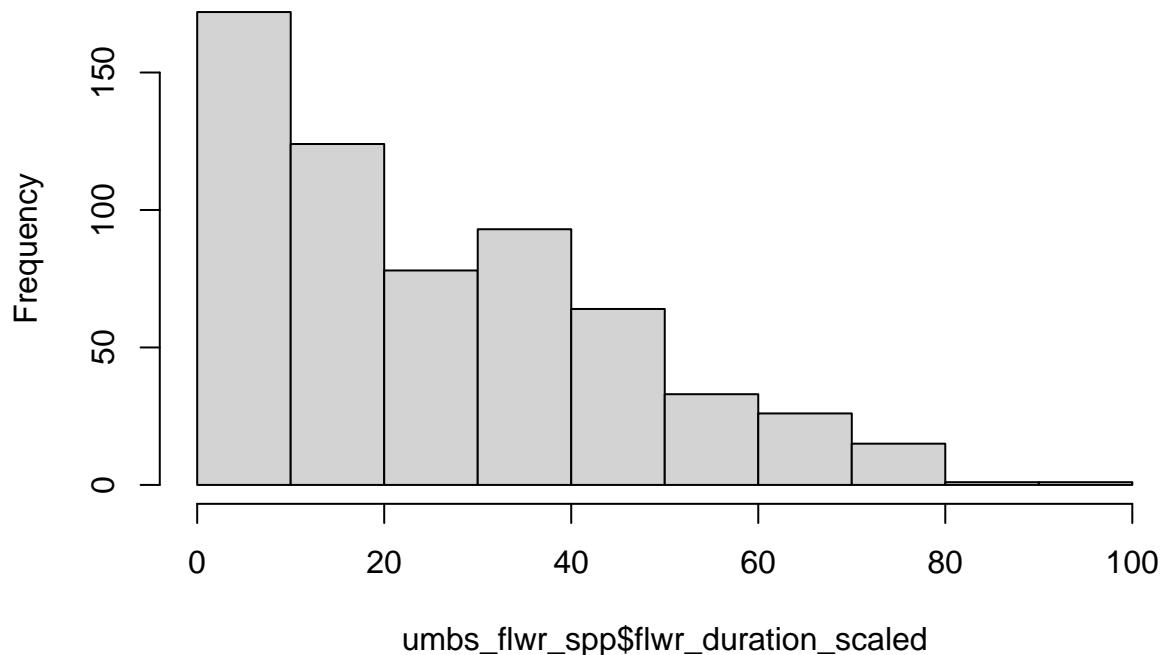
```
## Goodness-of-fit statistics
##                                     Gamma   Weibull Log Normal
## Kolmogorov-Smirnov statistic 0.1139634 0.08246571 0.1671529
## Cramer-von Mises statistic   1.5552914 0.76255050 3.7540550
## Anderson-Darling statistic  11.1245128 7.55672816 25.2157916
##
## Goodness-of-fit 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

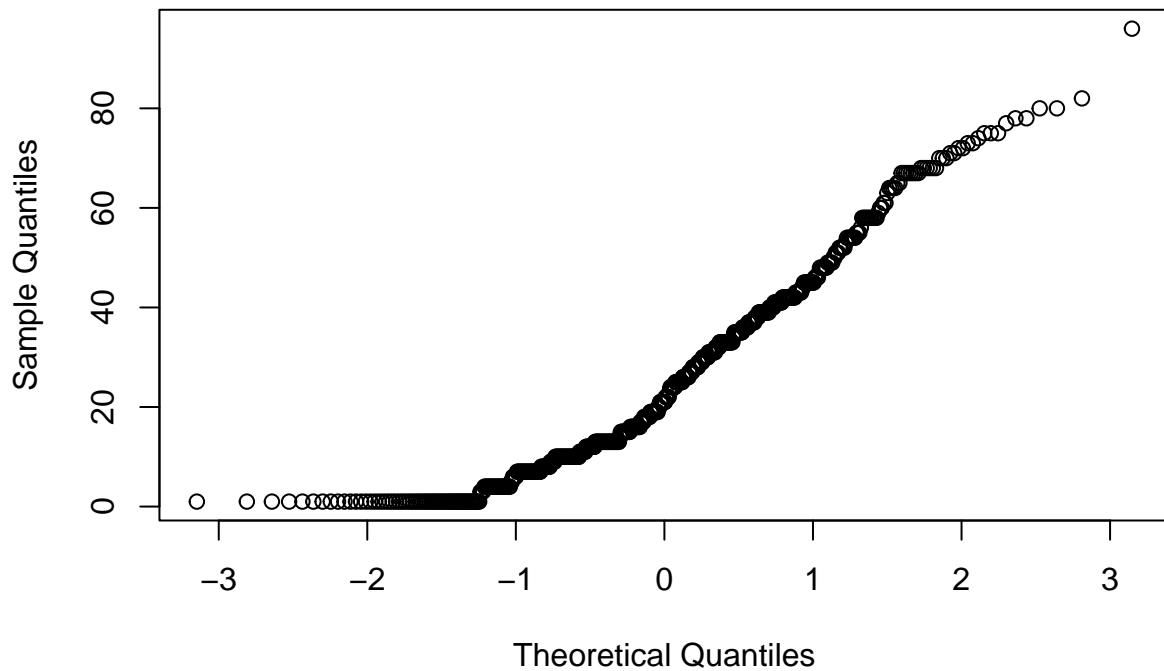
```
### UMBS ###
hist(umbs_flwr_spp$flwr_duration_scaled)
```

Histogram of umbs_flwr_spp\$flwr_duration_scaled



```
qqnorm(umb...)
```

Normal Q-Q Plot



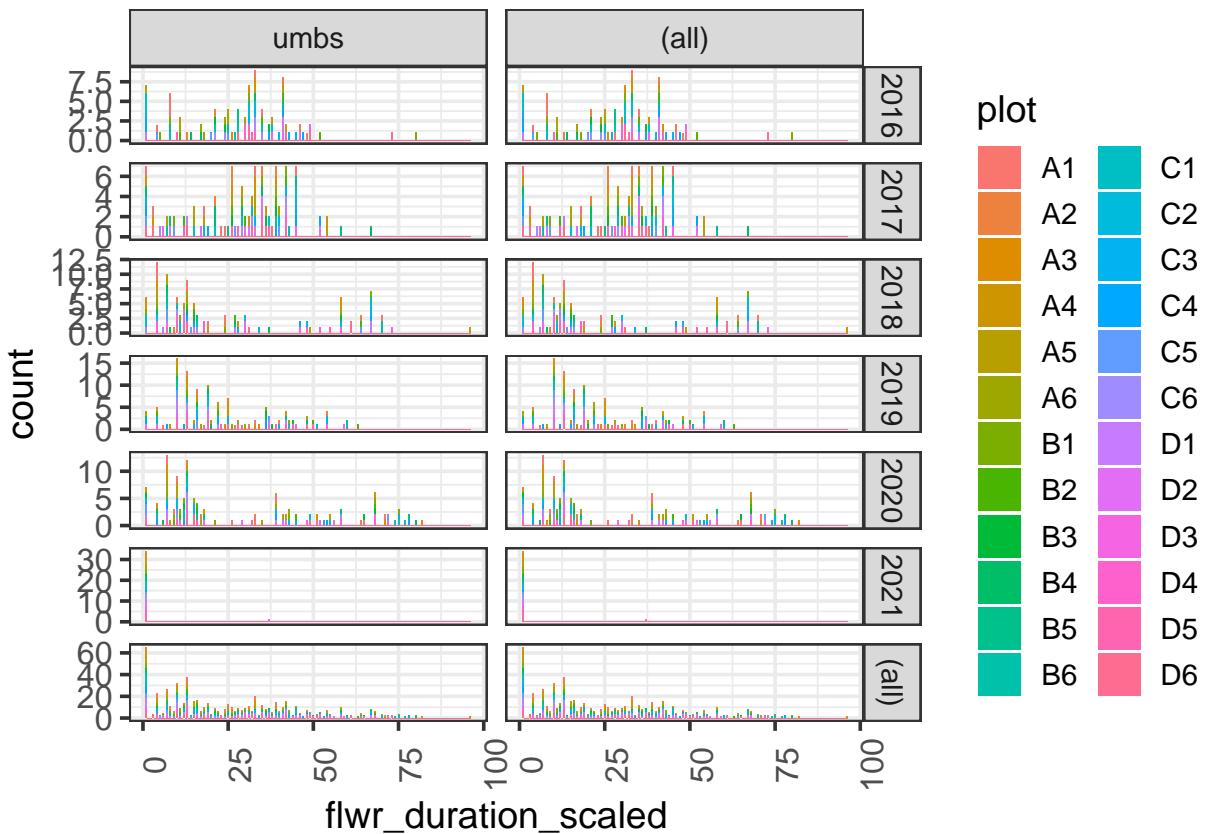
```

shapiro.test(umbs_flwr_spp$flwr_duration_scaled) # pvalue is < 0.05 so we reject the null hypothesis that the data is normally distributed

## 
## 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")

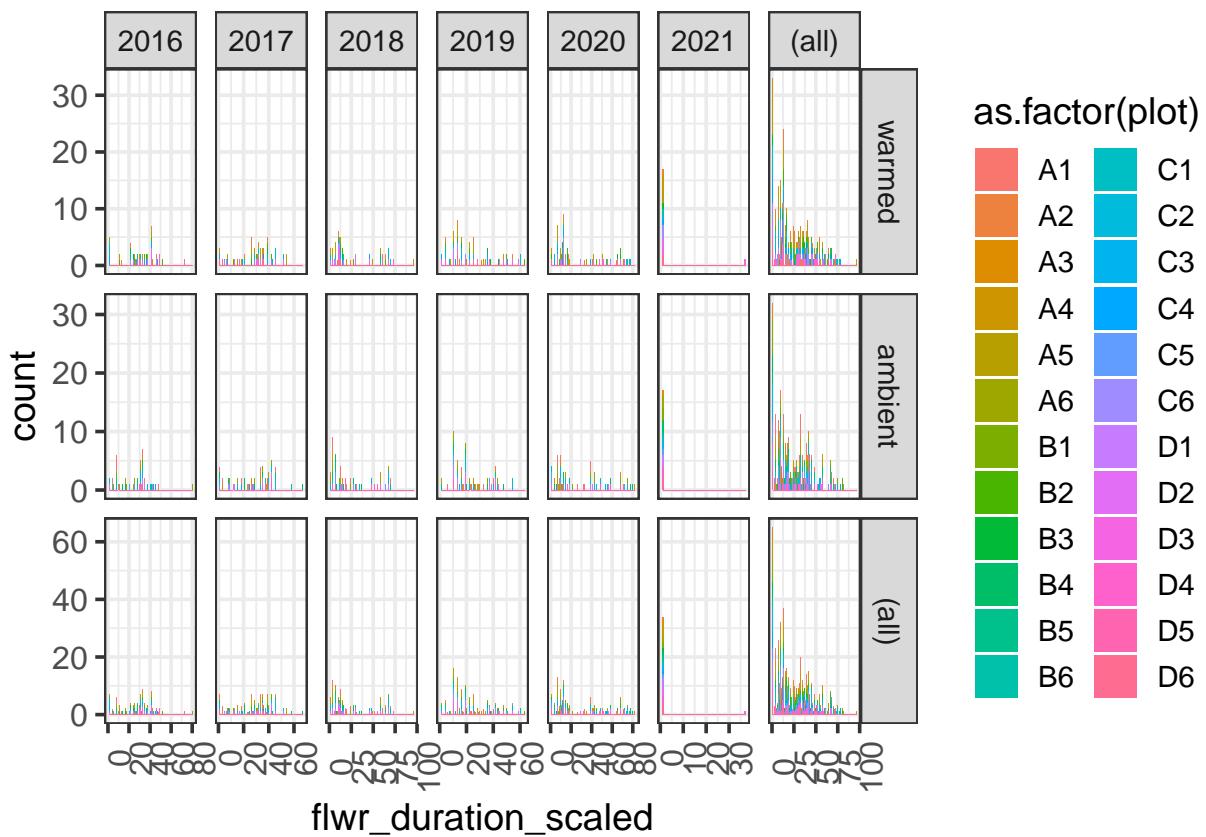
```



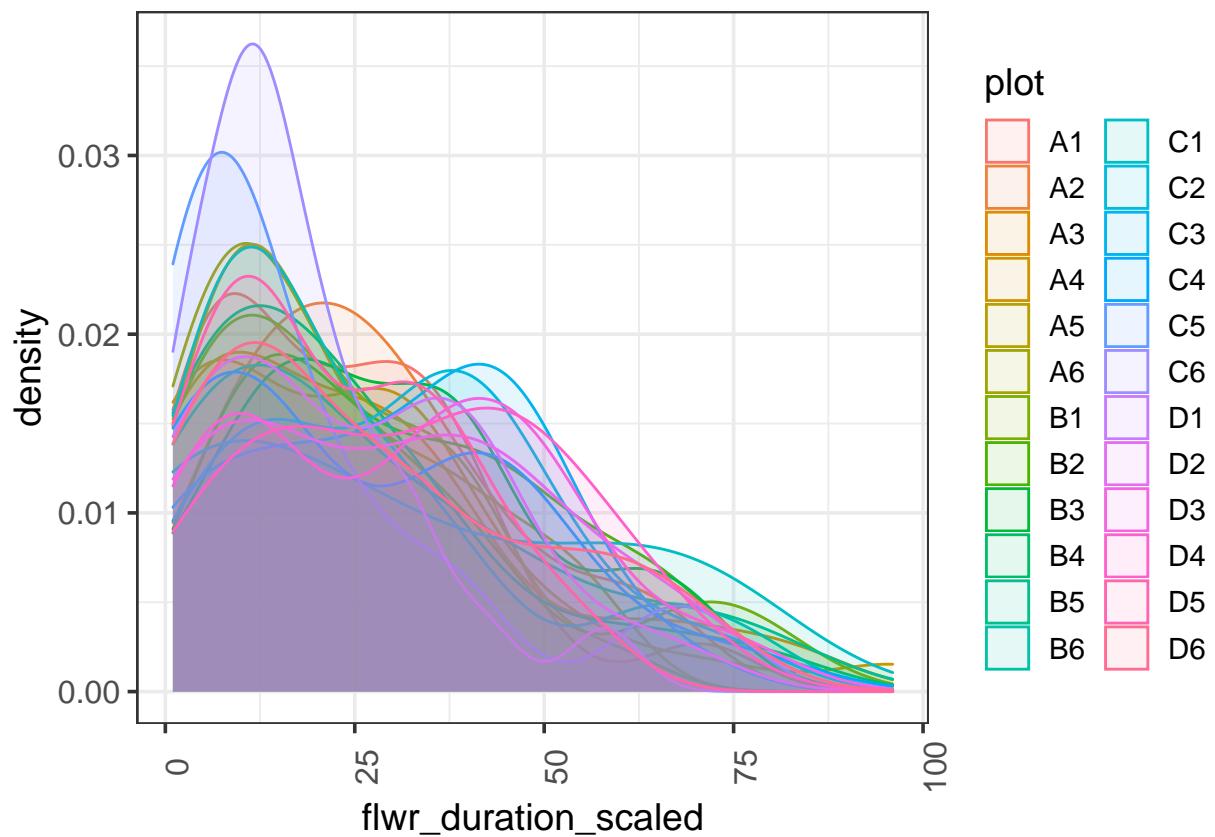
```

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")

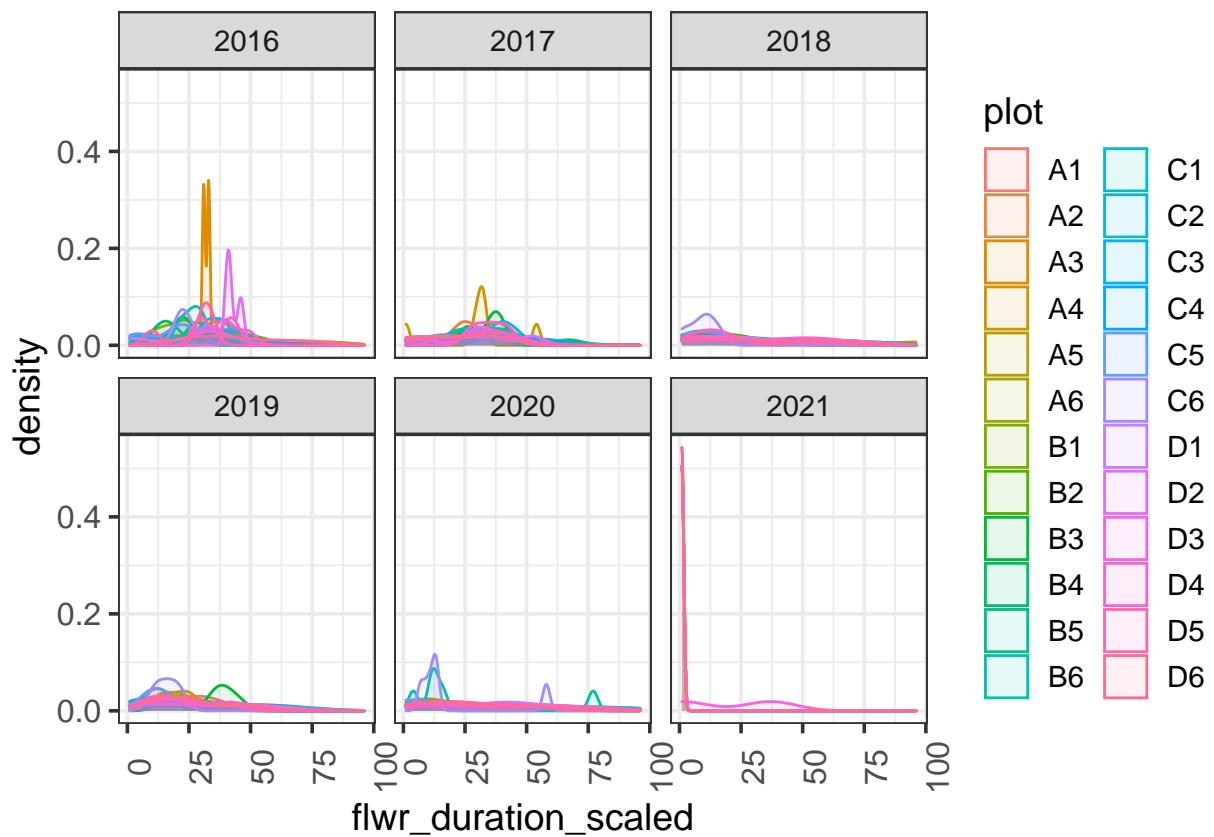
```



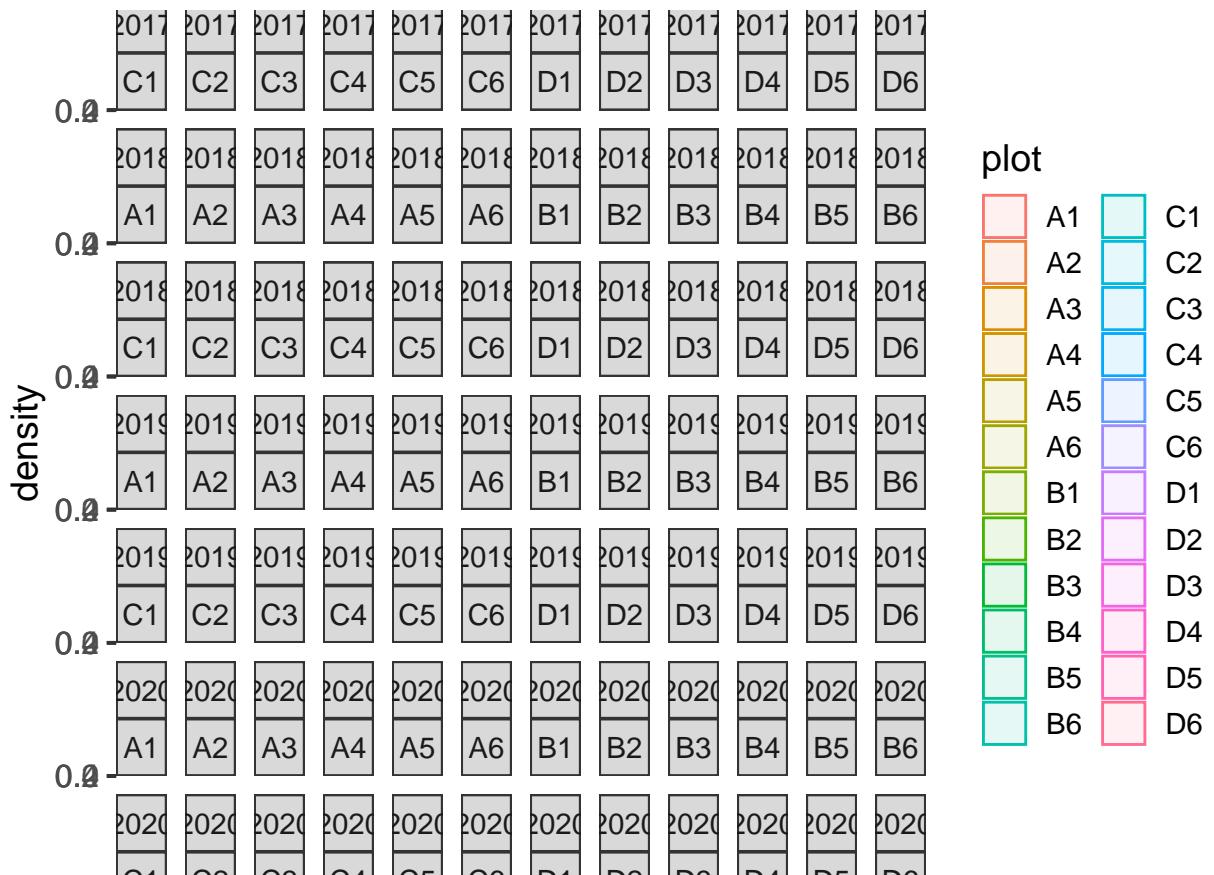
```
ggplot(umbs_flwr_spp, aes(flwr_duration_scaled, fill = plot, color=plot)) +
  geom_density(alpha = 0.1)
```



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

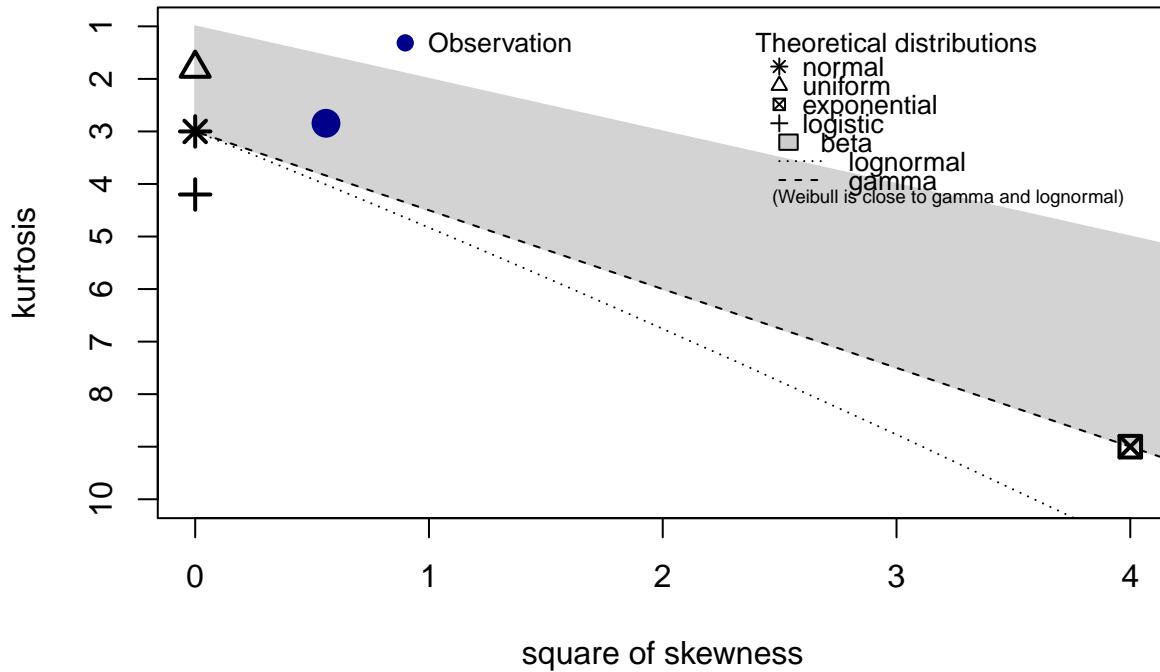


```
ggplot(umbs_flwr_spp, aes(flwr_duration_scaled, fill = plot, color=plot)) +
  geom_density(alpha = 0.1) +
  facet_wrap(~year + plot)
```



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

Cullen and Frey graph

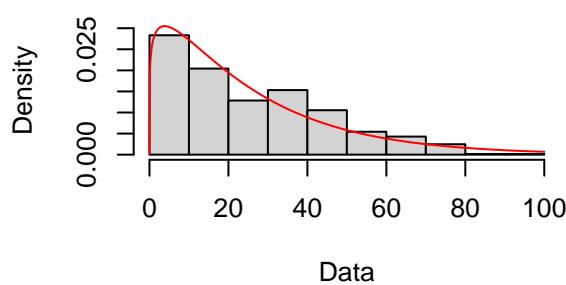
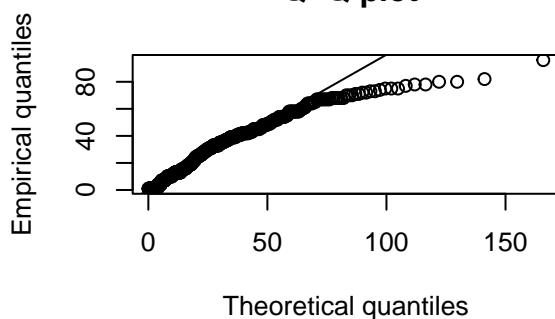
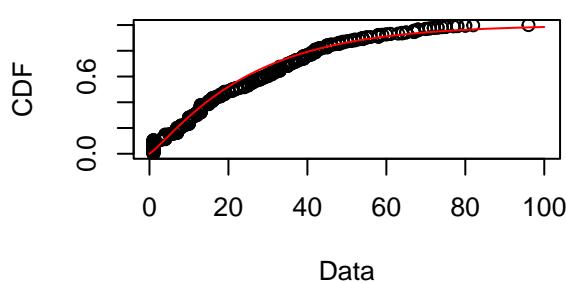
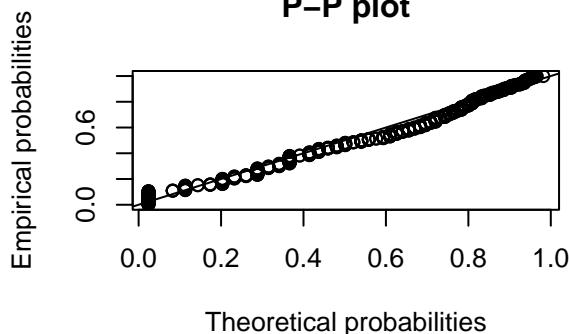


```

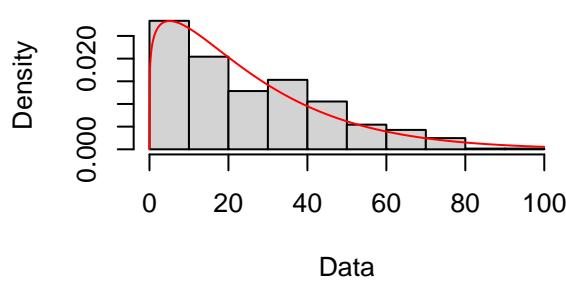
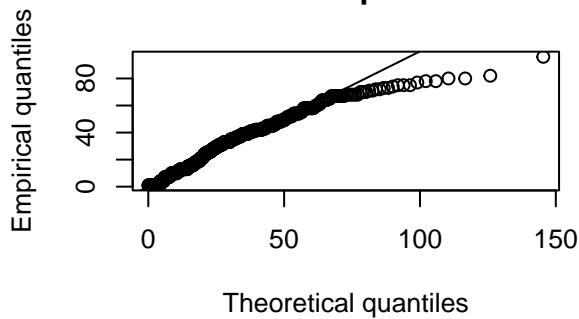
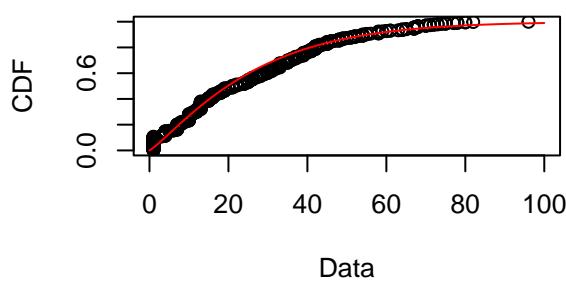
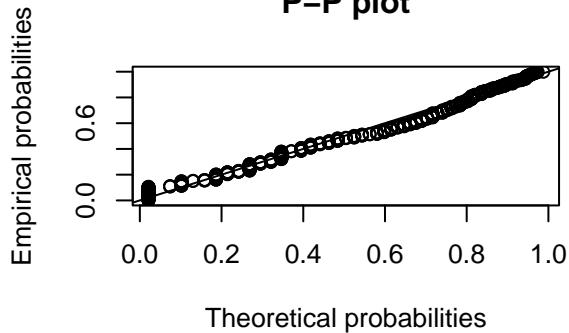
## summary statistics
## -----
## min: 1   max: 96
## median: 21
## mean: 25.78089
## estimated sd: 19.96209
## estimated skewness: 0.7480551
## estimated kurtosis: 2.844753

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

```

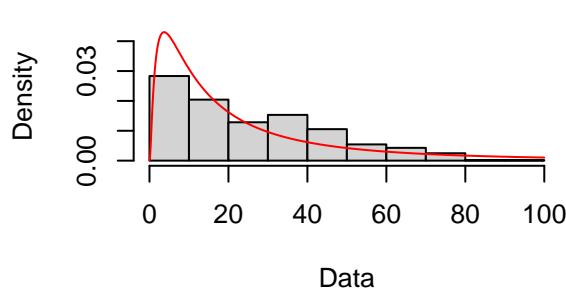
Empirical and theoretical dens.**Q-Q plot****Empirical and theoretical CDFs****P-P plot**

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

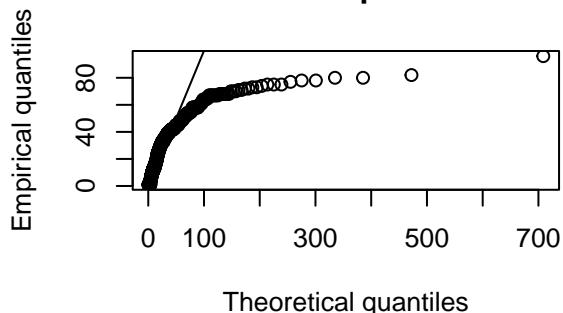
Empirical and theoretical dens.**Q-Q plot****Empirical and theoretical CDFs****P-P plot**

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

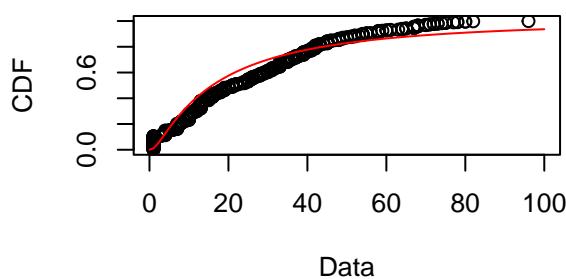
Empirical and theoretical dens.



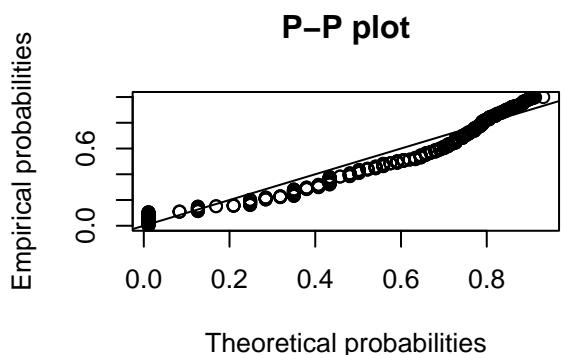
Q-Q plot



Empirical and theoretical CDFs

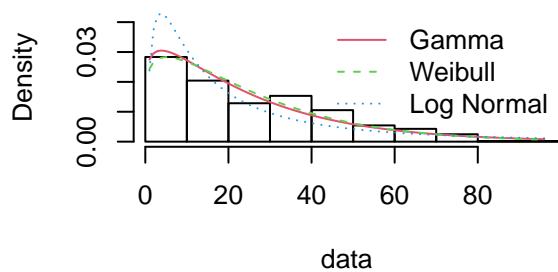


P-P plot

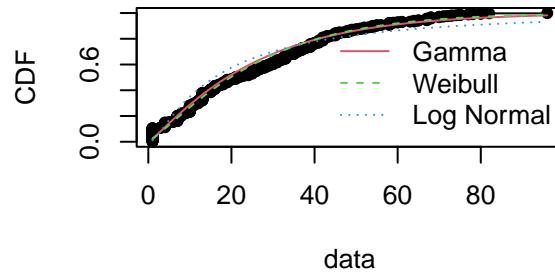


```
par(mfrow=c(2,2))
plot.legend <- c("Gamma", "Weibull", "Log Normal")
denscomp(list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
cdfcomp (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
qqcomp (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
ppcomp (list(fit.gamma,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

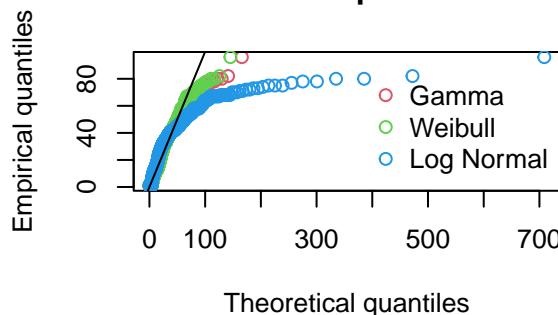
Histogram and theoretical densities



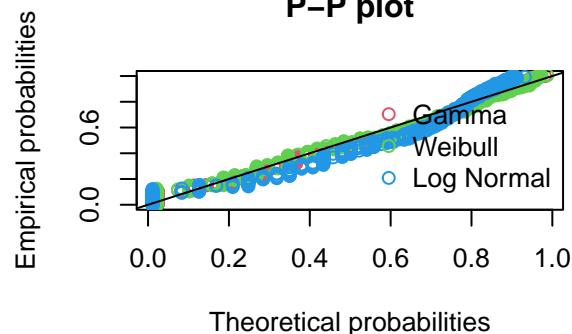
Empirical and theoretical CDFs



Q-Q plot



P-P plot



```
# 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"))
```

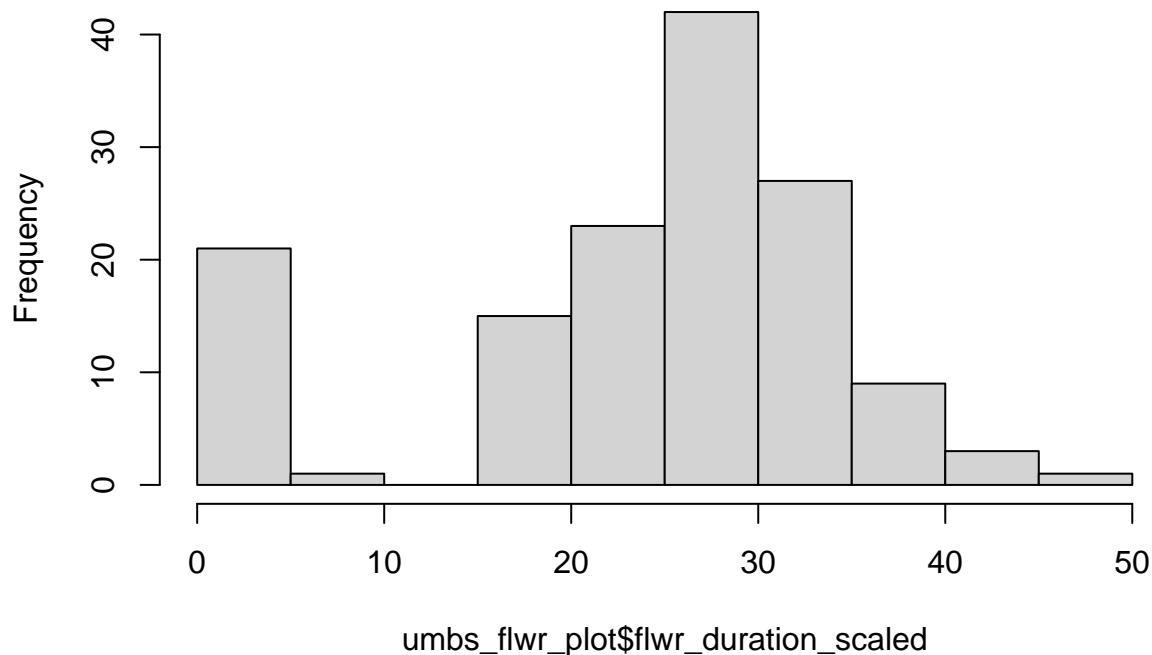
```
## Goodness-of-fit statistics
##                                     Gamma   Weibull Log Normal
## Kolmogorov-Smirnov statistic 0.08319317 0.08597213 0.1194855
## Cramer-von Mises statistic   0.93573126 0.71102909 3.1067790
## Anderson-Darling statistic   7.68325283 6.94267550 23.1991121
##
## Goodness-of-fit 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

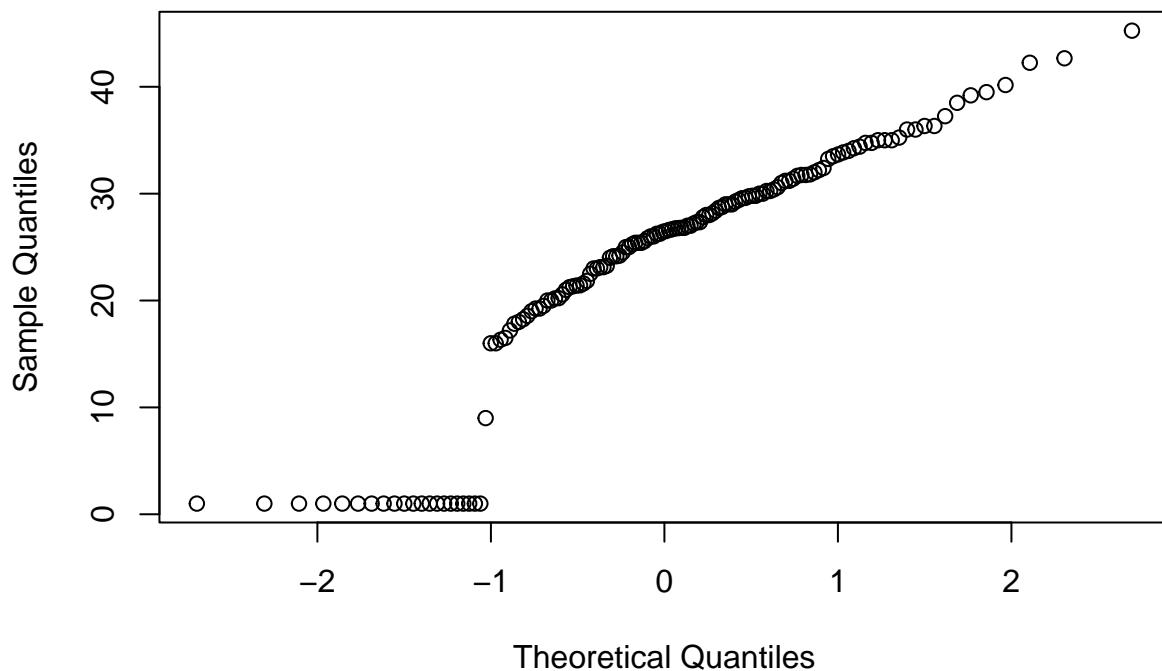
```
### UMBS ###
hist(umbs_flwr_plot$flwr_duration_scaled)
```

Histogram of umbs_flwr_plot\$flwr_duration_scaled



```
qqnorm(umb...)
```

Normal Q-Q Plot



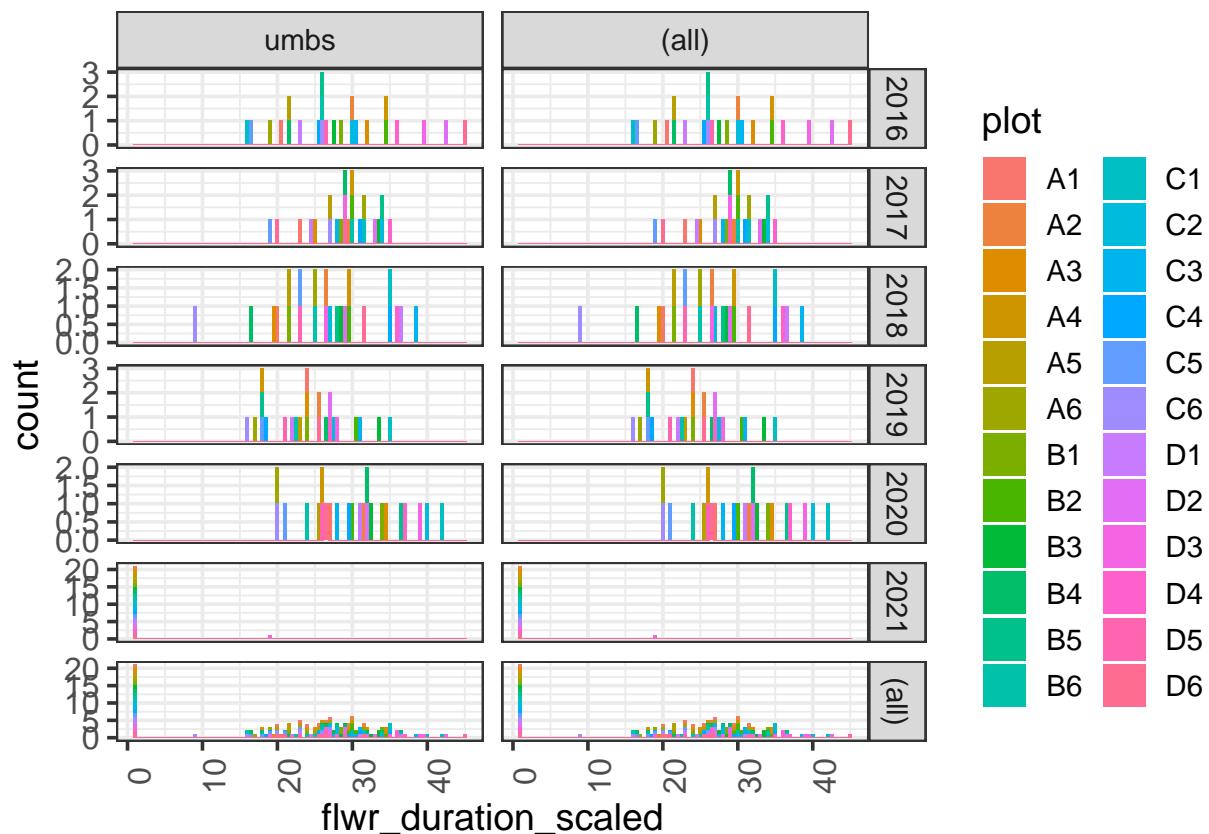
```

shapiro.test(umbs_flwr_plot$flwr_duration_scaled) # pvalue is > 0.05 so we accept the null hypothesis that the data is normally distributed

## 
## 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")

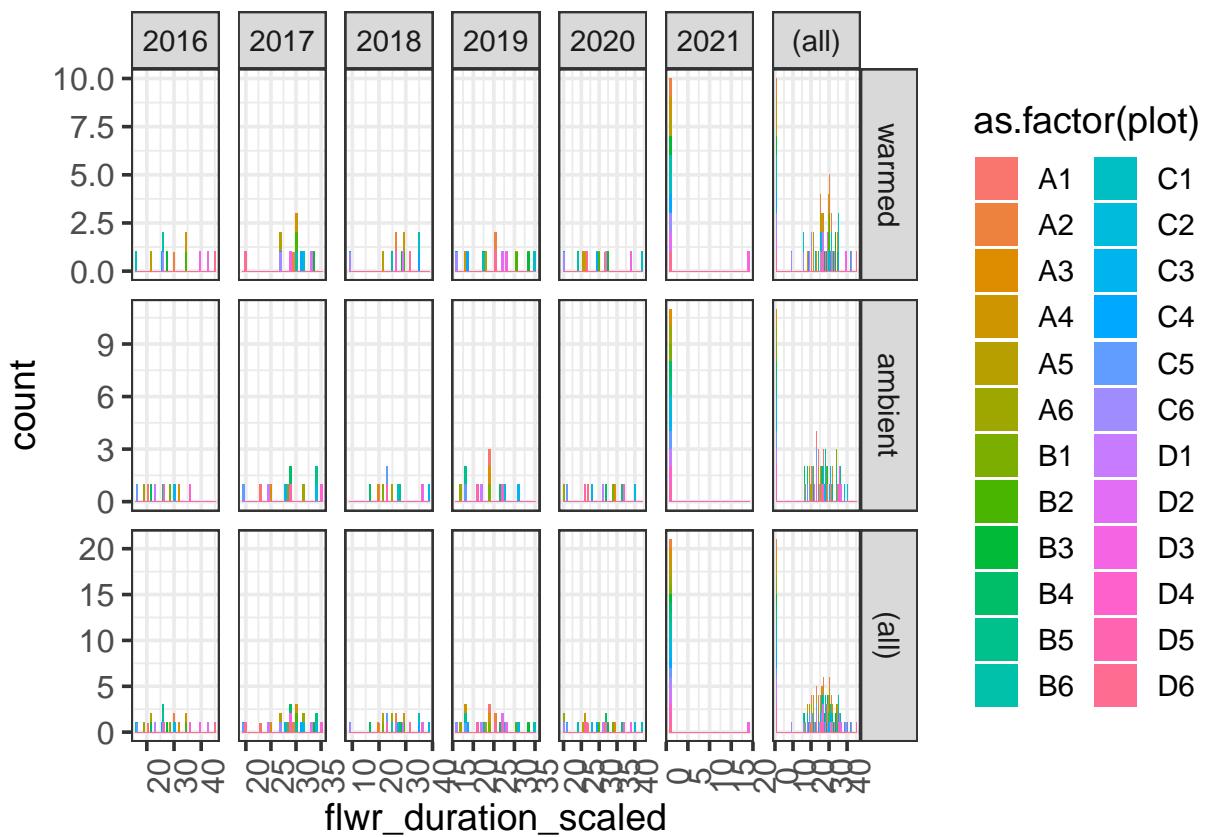
```



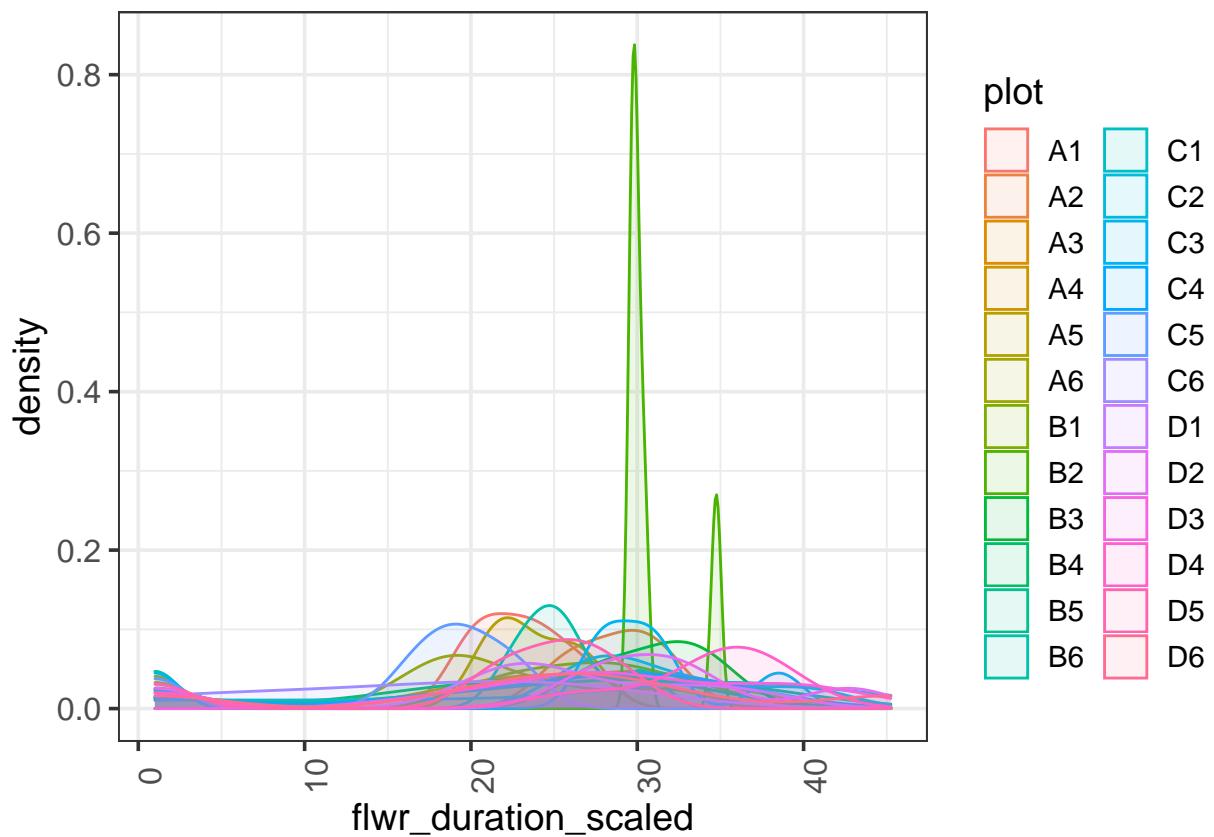
```

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

```



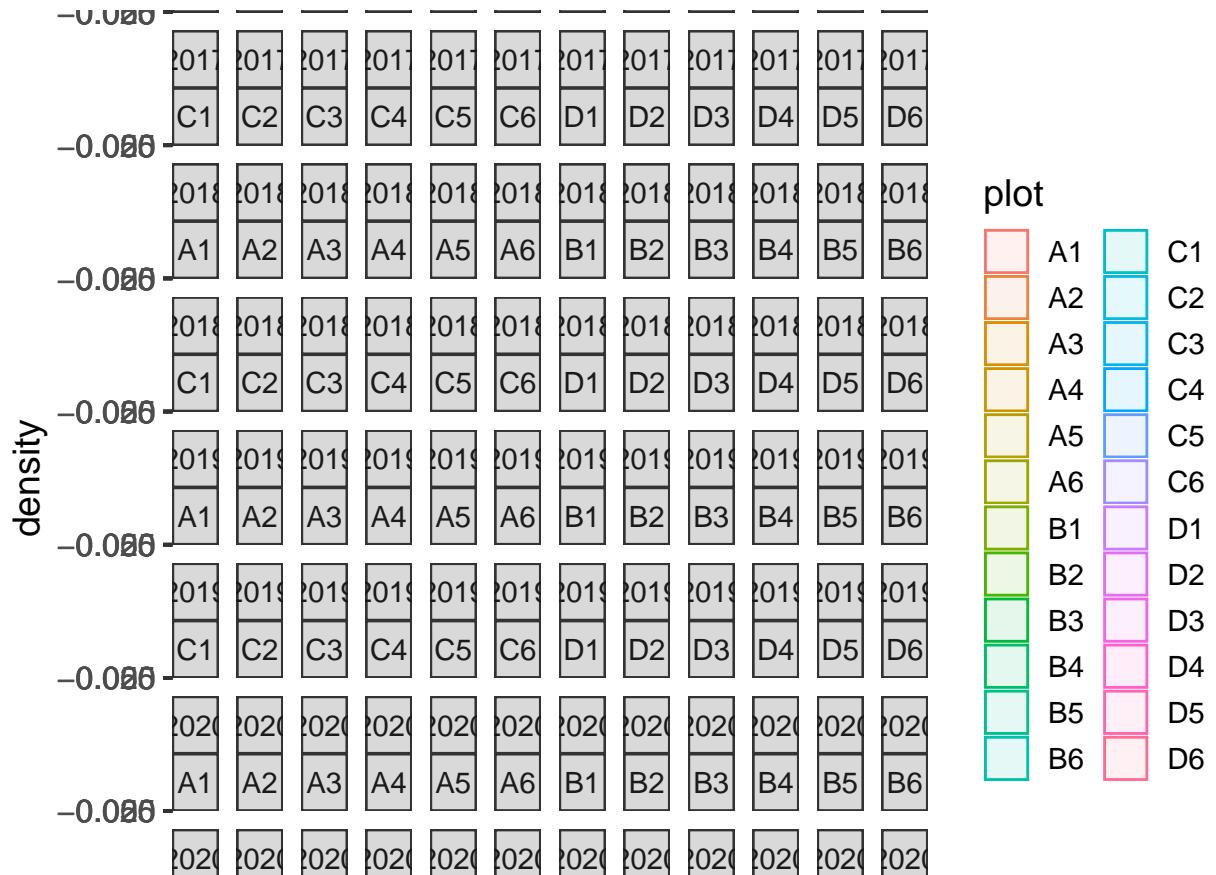
```
ggplot(umbs_flwr_plot, aes(flwr_duration_scaled, fill = plot, color=plot)) +
  geom_density(alpha = 0.1)
```



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

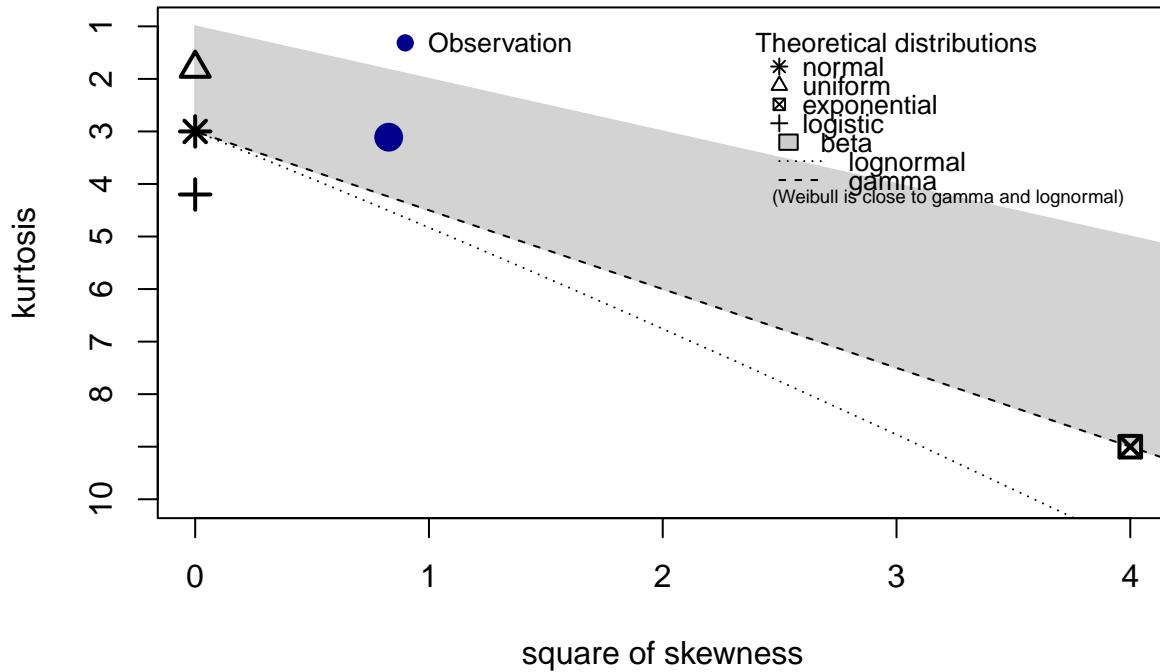


```
ggplot(umbs_flwr_plot, aes(flwr_duration_scaled, fill = plot, color=plot)) +
  geom_density(alpha = 0.1) +
  facet_wrap(~year + plot)
```



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

Cullen and Frey graph



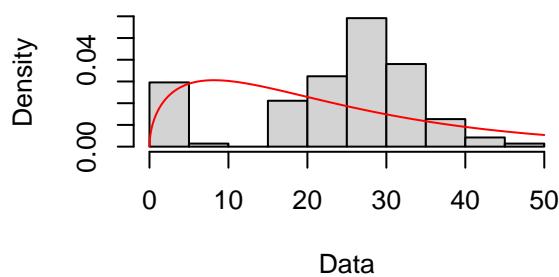
```

## 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

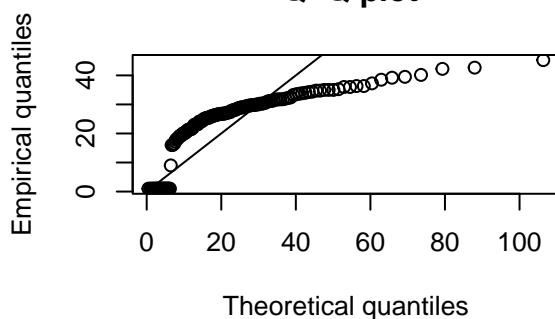
# Gamma distribution
fit.gamma <- fitdist(umbs_flwr_plot$flwr_duration_scaled, "gamma")
plot(fit.gamma)

```

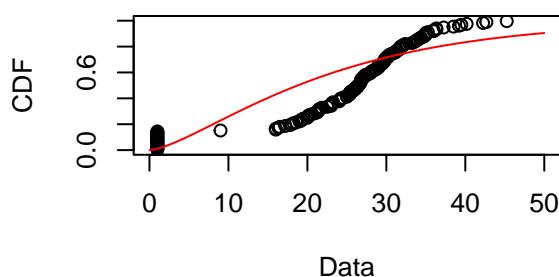
Empirical and theoretical dens.



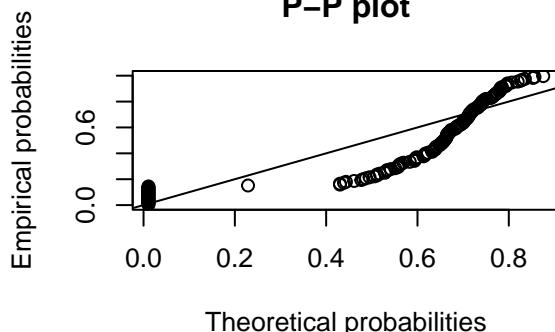
Q-Q plot



Empirical and theoretical CDFs

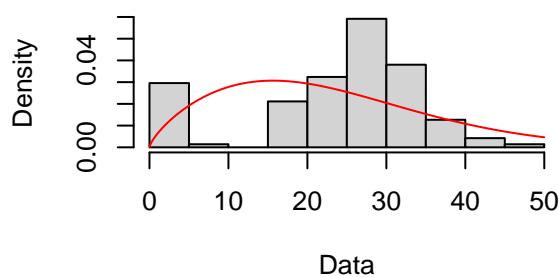


P-P plot

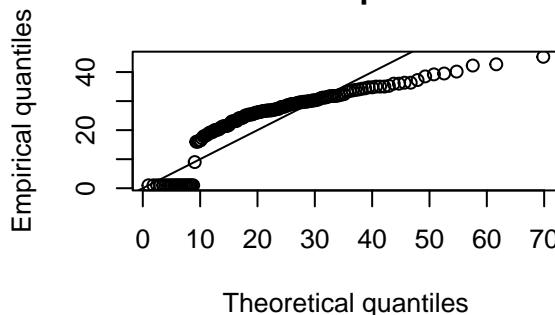


```
# Weibull distribution
fit.weibull <- fitdist(umbss_flwr_plot$flwr_duration_scaled, "weibull")
plot(fit.weibull)
```

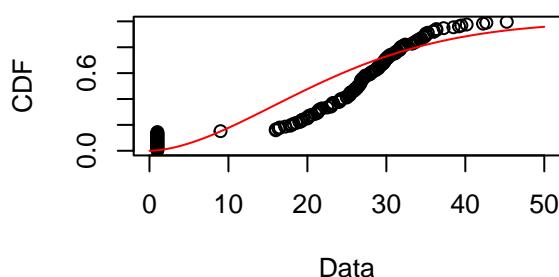
Empirical and theoretical dens.



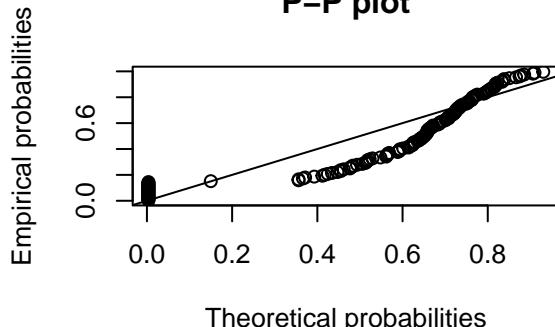
Q-Q plot



Empirical and theoretical CDFs

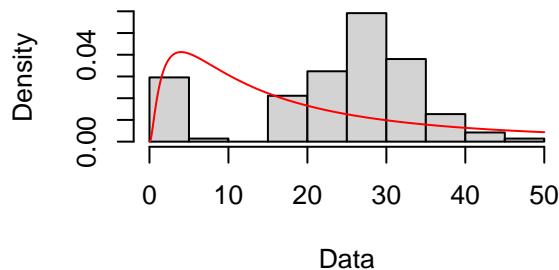


P-P plot

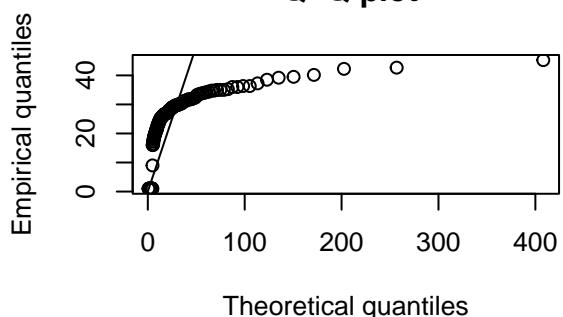


```
# Lognormal distribution
fit.ln <- fitdist(umbs_flwr_plot$flwr_duration_scaled, "lnorm")
plot(fit.ln)
```

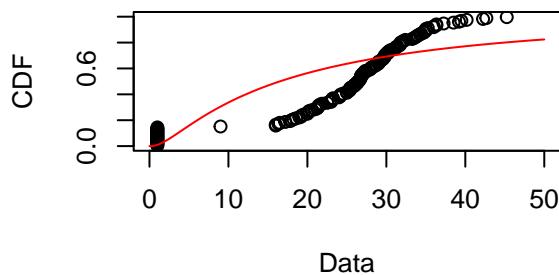
Empirical and theoretical dens.



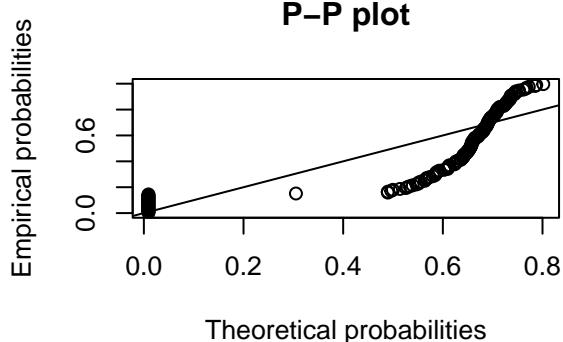
Q-Q plot



Empirical and theoretical CDFs

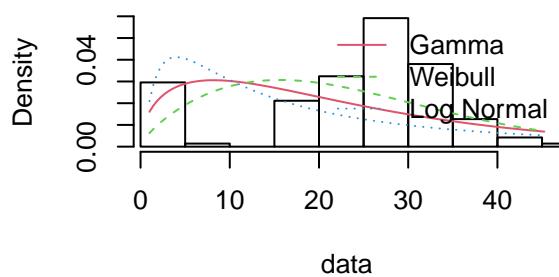


P-P plot

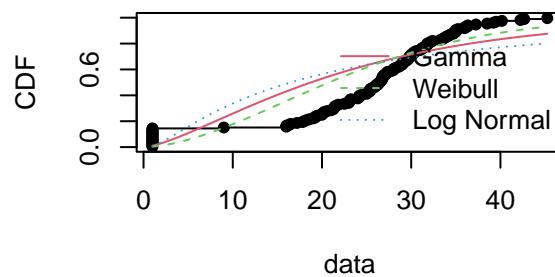


```
par(mfrow=c(2,2))
plot.legend <- c("Gamma", "Weibull", "Log Normal")
denscomp(list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
cdfcomp (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
qqcomp (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
ppcomp (list(fit.gamma,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

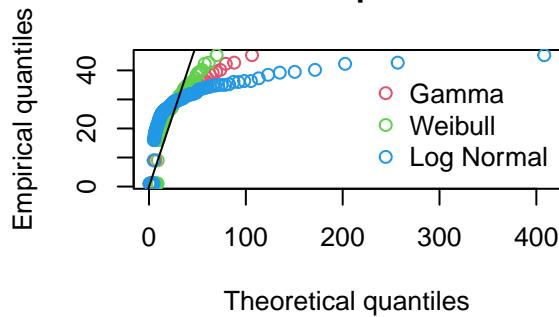
Histogram and theoretical densities



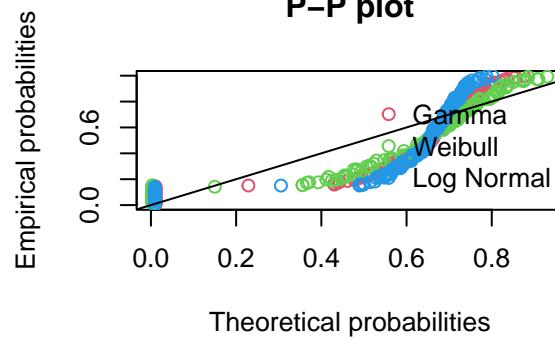
Empirical and theoretical CDFs



Q-Q plot



P-P plot



```
# 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"))
```

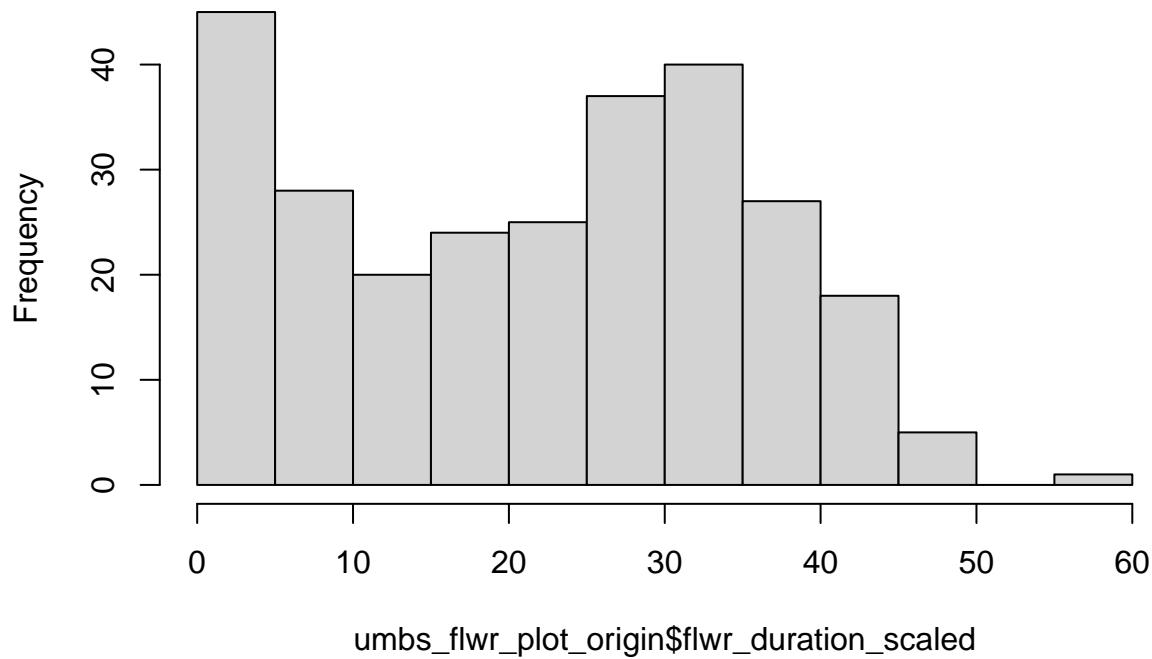
```
## Goodness-of-fit statistics
##                                     Gamma   Weibull Log Normal
## Kolmogorov-Smirnov statistic 0.2870677 0.2301924 0.3357487
## Cramer-von Mises statistic  3.6271289 2.5535214 4.6646117
## Anderson-Darling statistic 20.3475079 18.3334439 25.6766144
##
## Goodness-of-fit 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

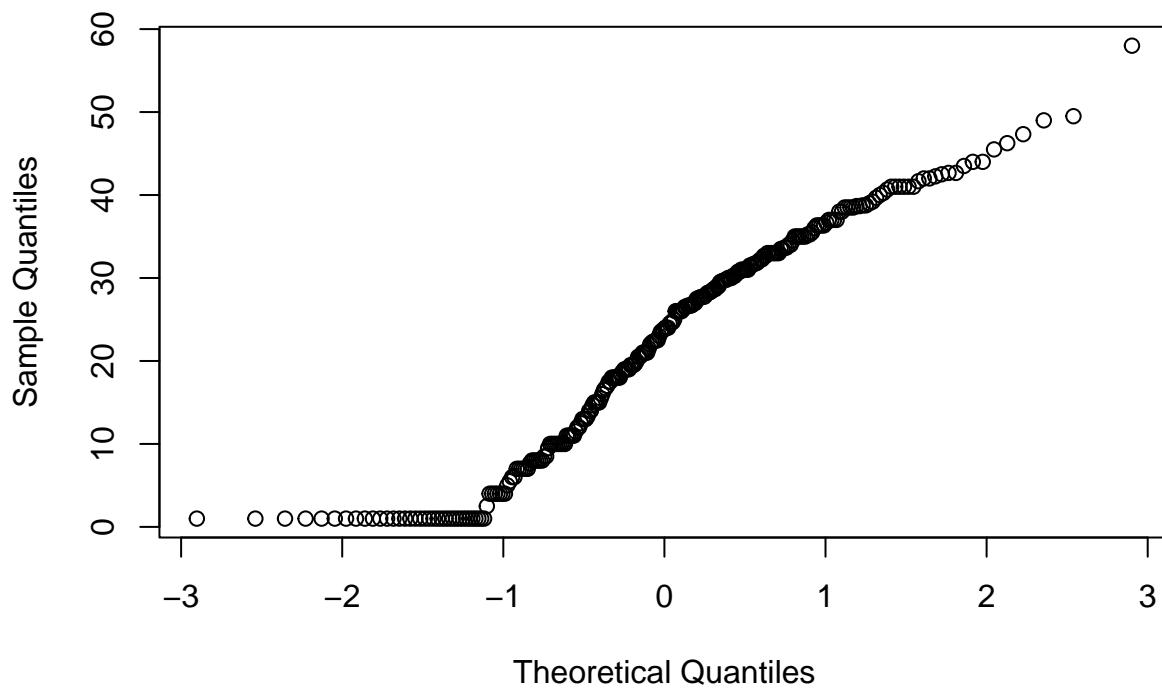
```
### UMBS ####
hist(umbs_flwr_plot_origin$flwr_duration_scaled)
```

Histogram of umbs_flwr_plot_origin\$flwr_duration_scaled



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

Normal Q-Q Plot



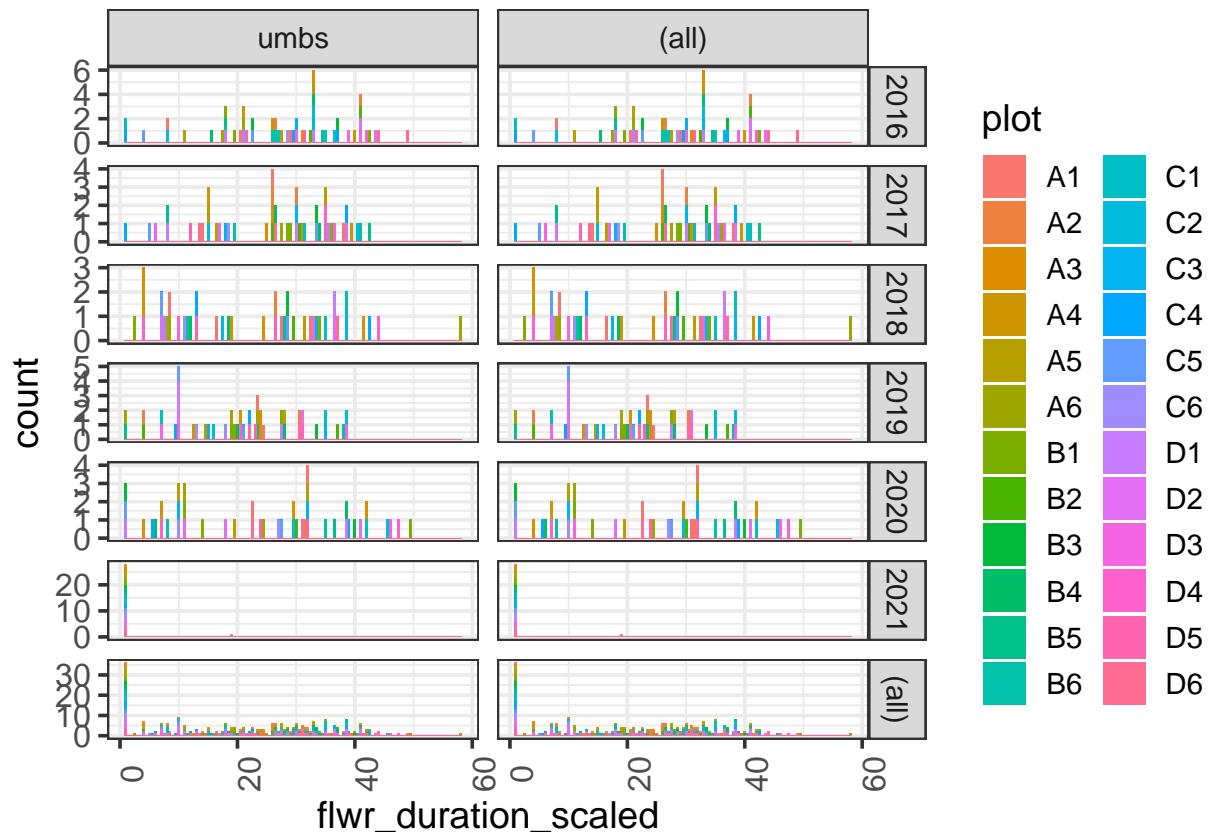
```

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

## 
## 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")

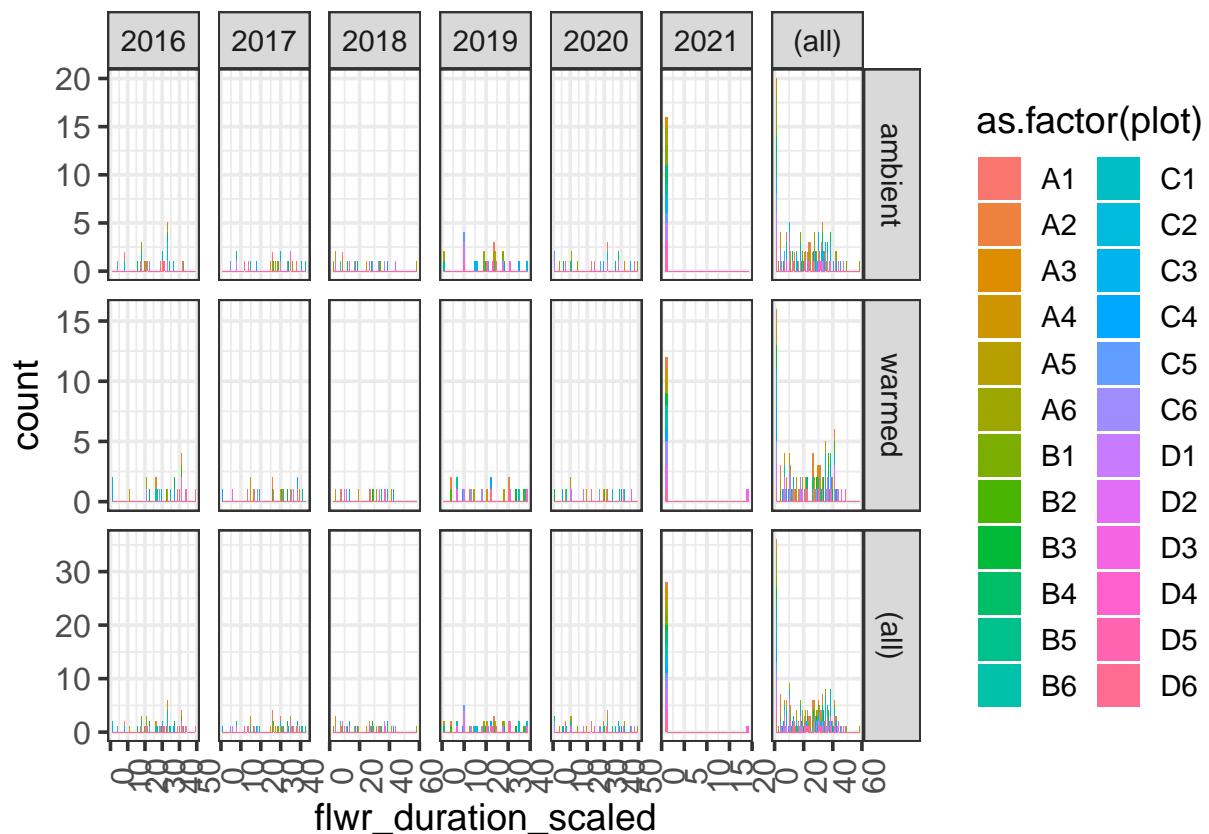
```



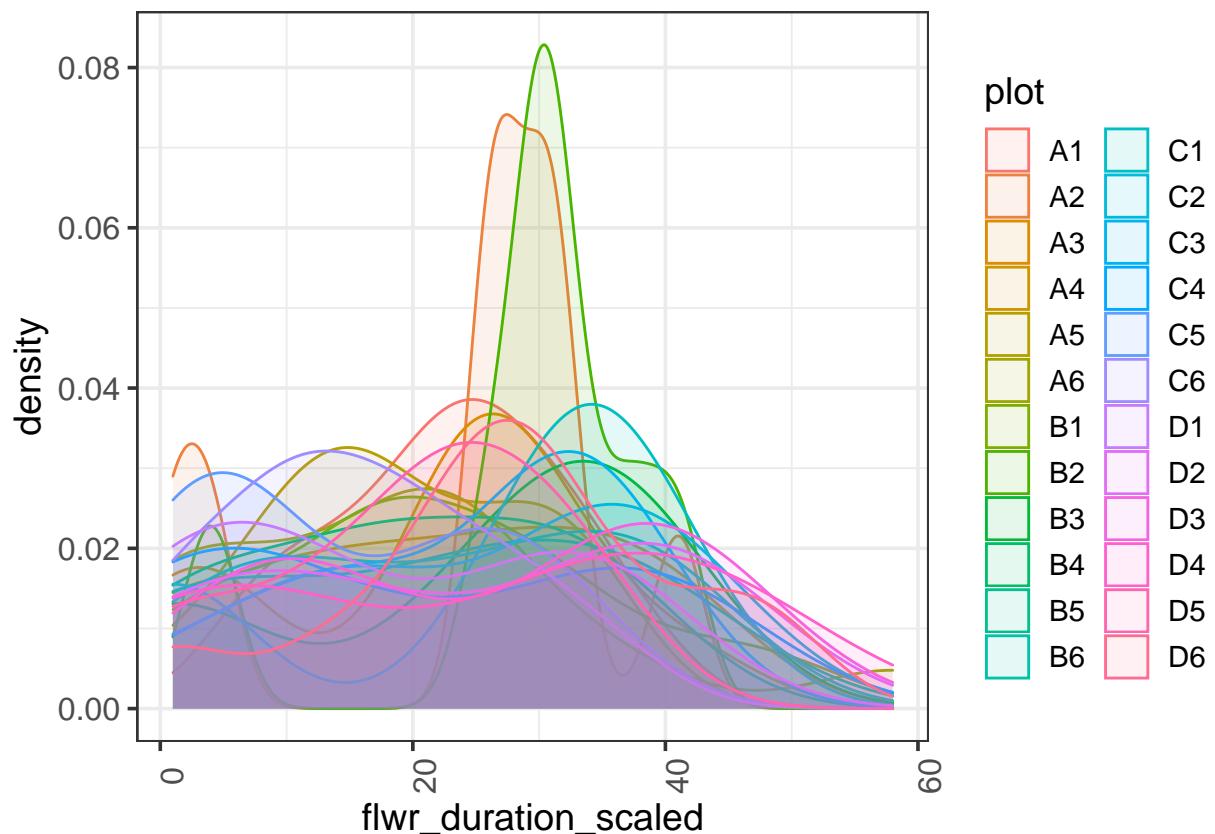
```

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

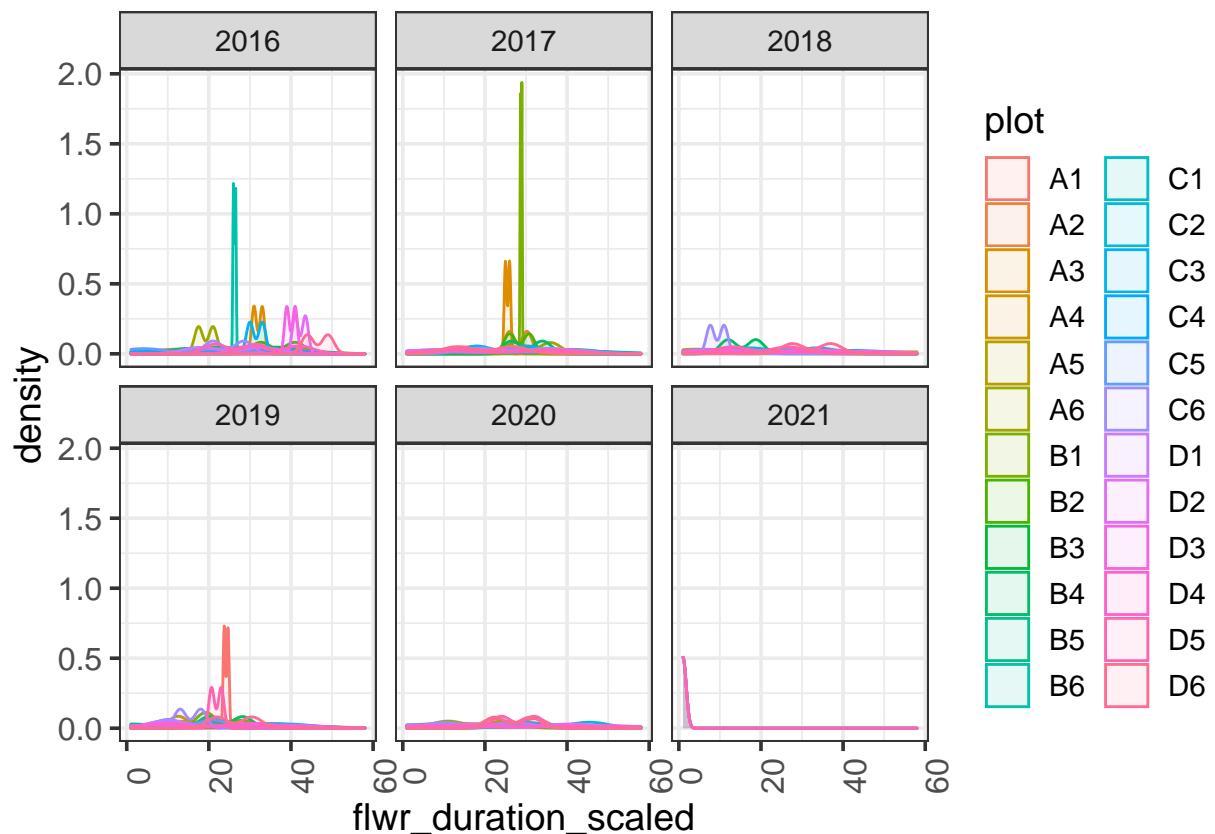
```



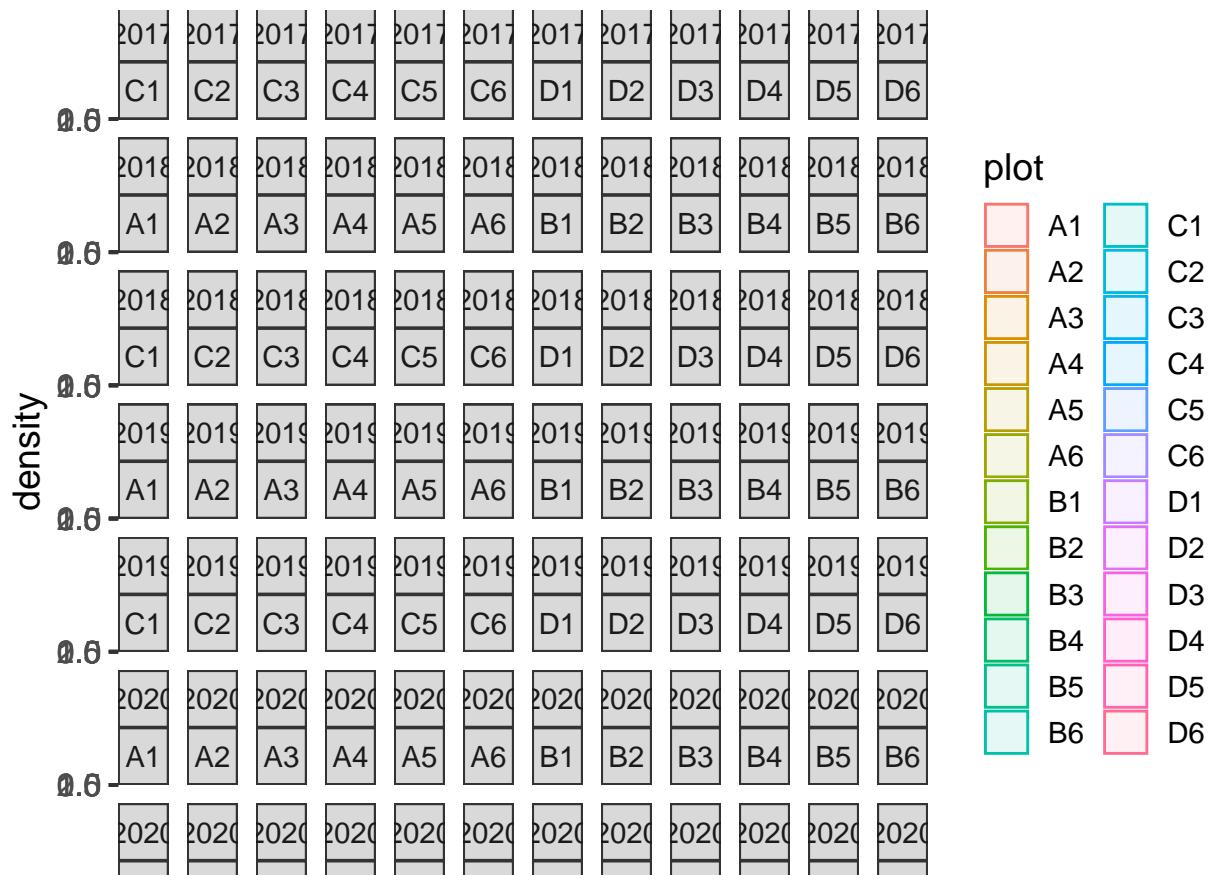
```
ggplot(umbs_flwr_plot_origin, aes(flwr_duration_scaled, fill = plot, color=plot)) +
  geom_density(alpha = 0.1)
```



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

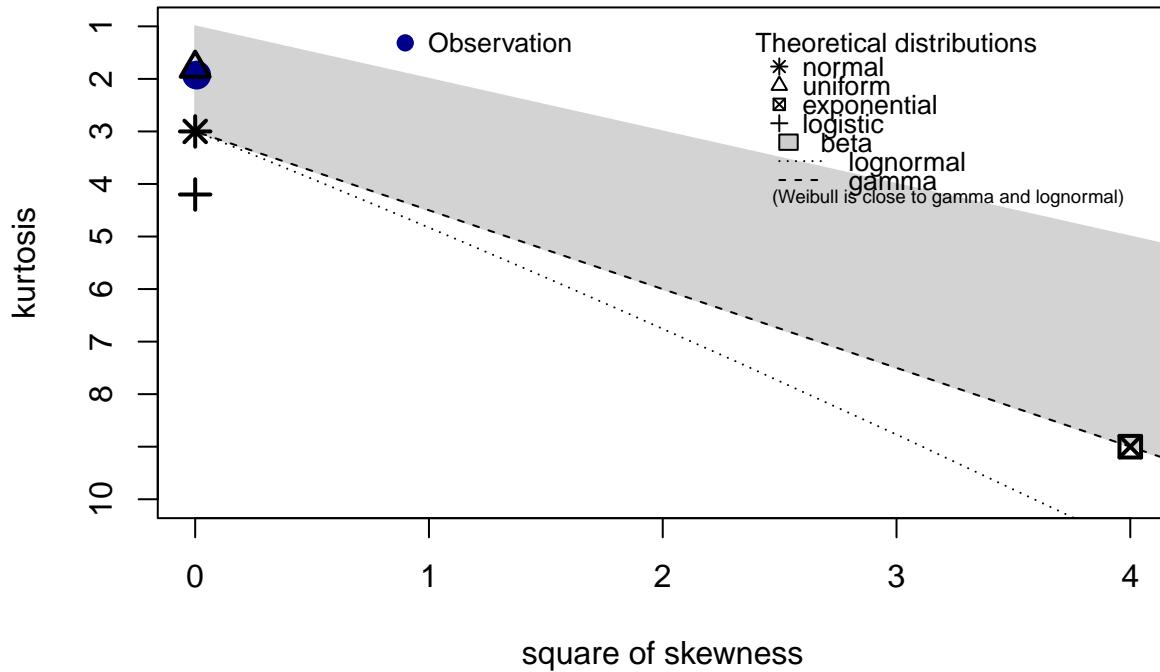


```
ggplot(umbs_flwr_plot_origin, aes(flwr_duration_scaled, fill = plot, color=plot)) +
  geom_density(alpha = 0.1) +
  facet_wrap(~year + plot)
```



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

Cullen and Frey graph



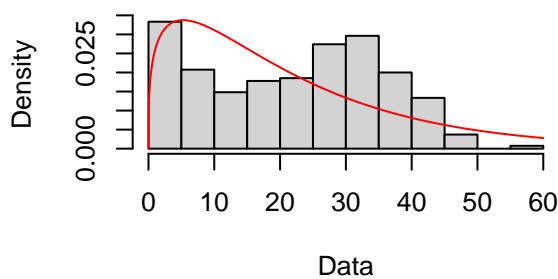
```

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

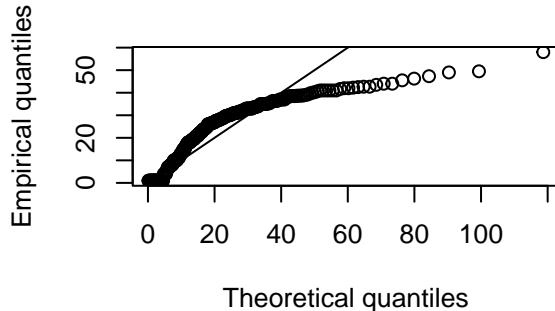
# Gamma distribution
fit.gamma <- fitdist(umbs_flwr_plot_origin$flwr_duration_scaled, "gamma")
plot(fit.gamma)

```

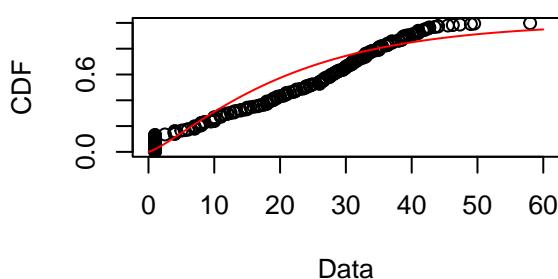
Empirical and theoretical dens.



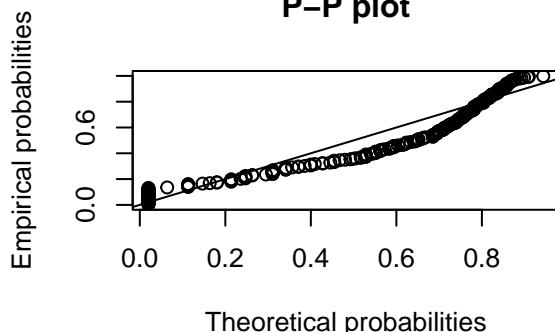
Q-Q plot



Empirical and theoretical CDFs



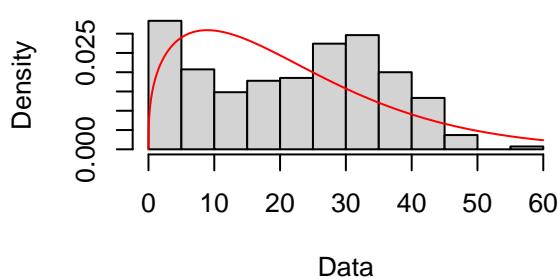
P-P plot



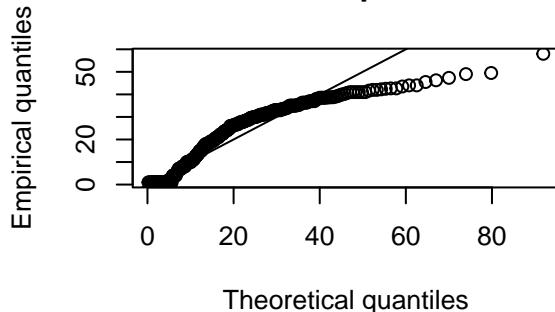
```
# Weibull distribution
```

```
fit.weibull <- fitdist(umbss_flwr_plot_origin$flwr_duration_scaled, "weibull")  
plot(fit.weibull)
```

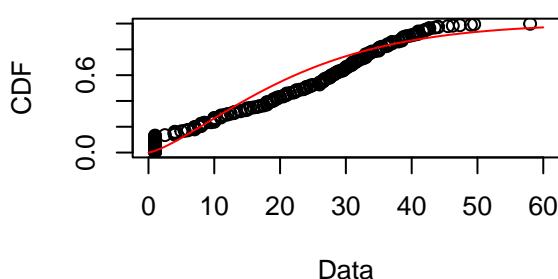
Empirical and theoretical dens.



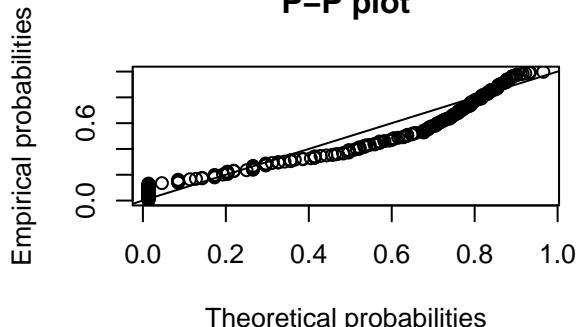
Q-Q plot



Empirical and theoretical CDFs

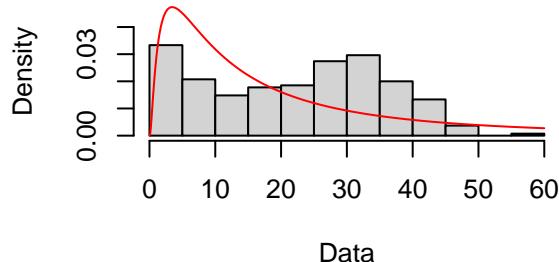


P-P plot

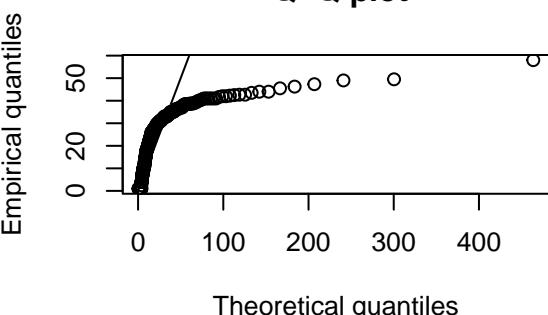


```
# Lognormal distribution
fit.ln <- fitdist(umbs_flwr_plot_origin$flwr_duration_scaled, "lnorm")
plot(fit.ln)
```

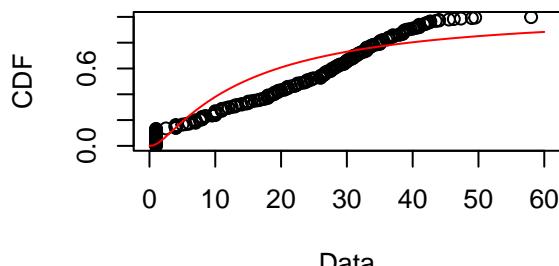
Empirical and theoretical dens.



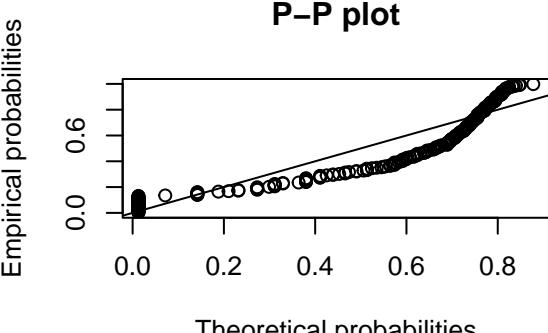
Q-Q plot



Empirical and theoretical CDFs

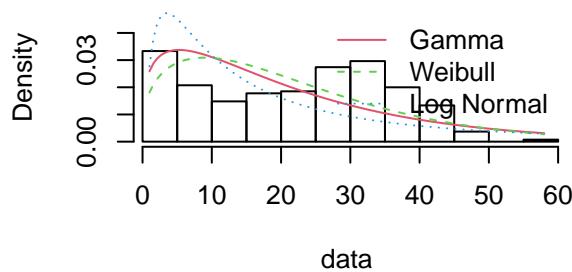


P-P plot

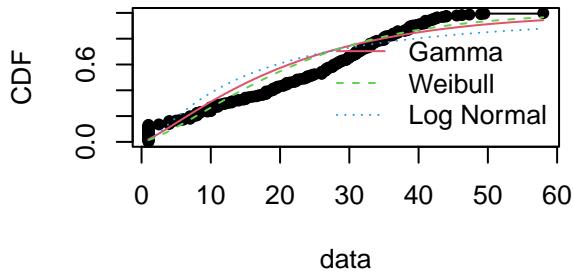


```
par(mfrow=c(2,2))
plot.legend <- c("Gamma", "Weibull", "Log Normal")
denscomp(list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
cdfcomp (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
qqcomp (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
ppcomp (list(fit.gamma,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

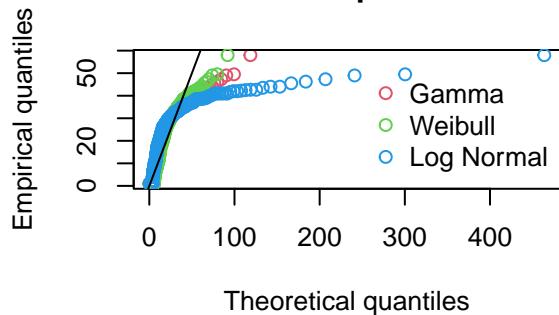
Histogram and theoretical densities



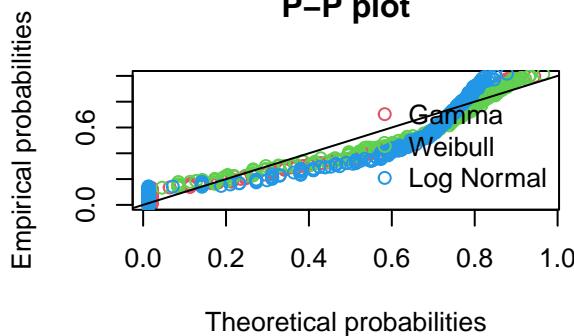
Empirical and theoretical CDFs



Q-Q plot



P-P plot



```
# 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"))
```

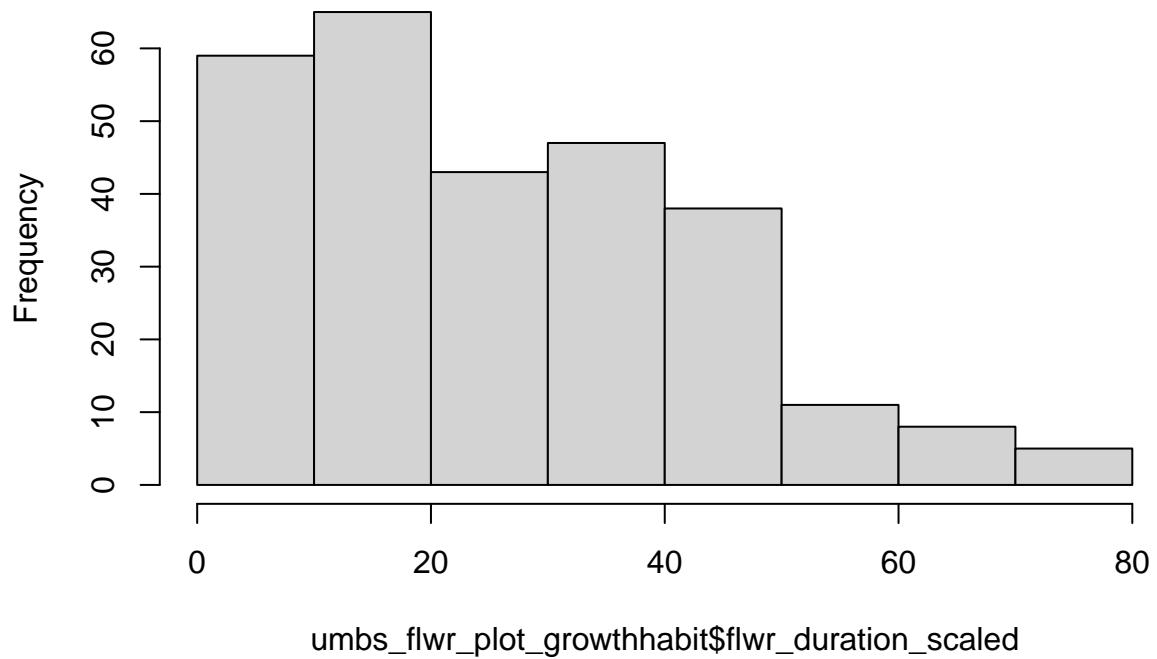
```
## Goodness-of-fit statistics
##                                     Gamma   Weibull Log Normal
## Kolmogorov-Smirnov statistic 0.1593733 0.1512241 0.2033579
## Cramer-von Mises statistic   2.2091498 1.6856777 3.6195315
## Anderson-Darling statistic  14.0374874 12.9499947 22.7722135
##
## Goodness-of-fit 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

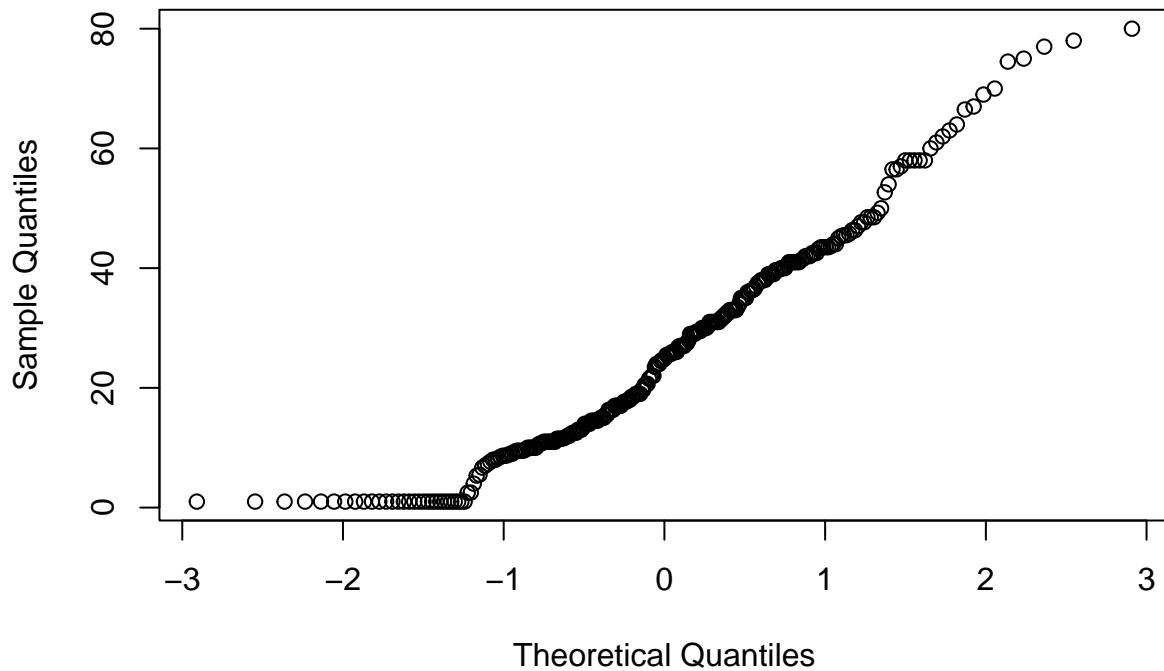
```
### KBS ###
hist(umbs_flwr_plot_growthhabit$flwr_duration_scaled)
```

Histogram of umbs_flwr_plot_growthhabit\$flwr_duration_scaled



```
qqnorm(umb..._flwr..._plot..._growthhabit$flwr..._duration..._scaled)
```

Normal Q-Q Plot



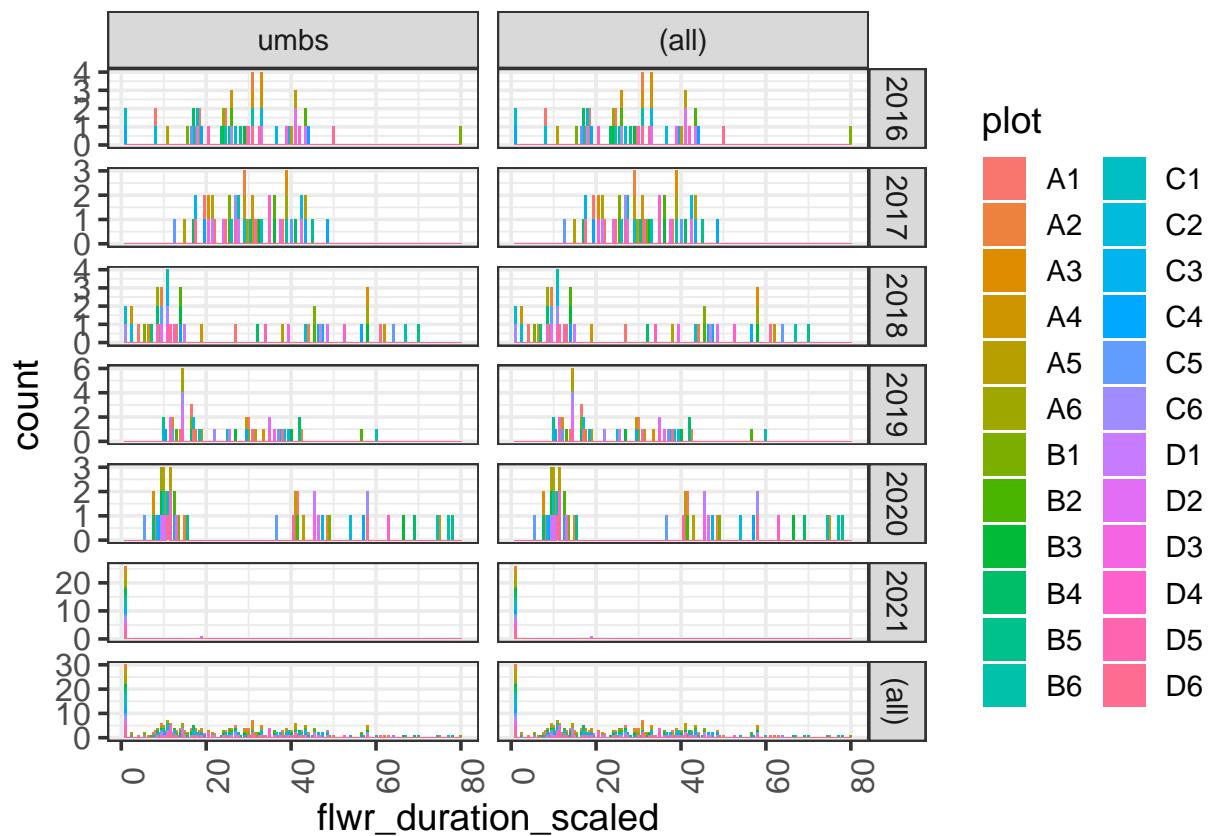
```

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

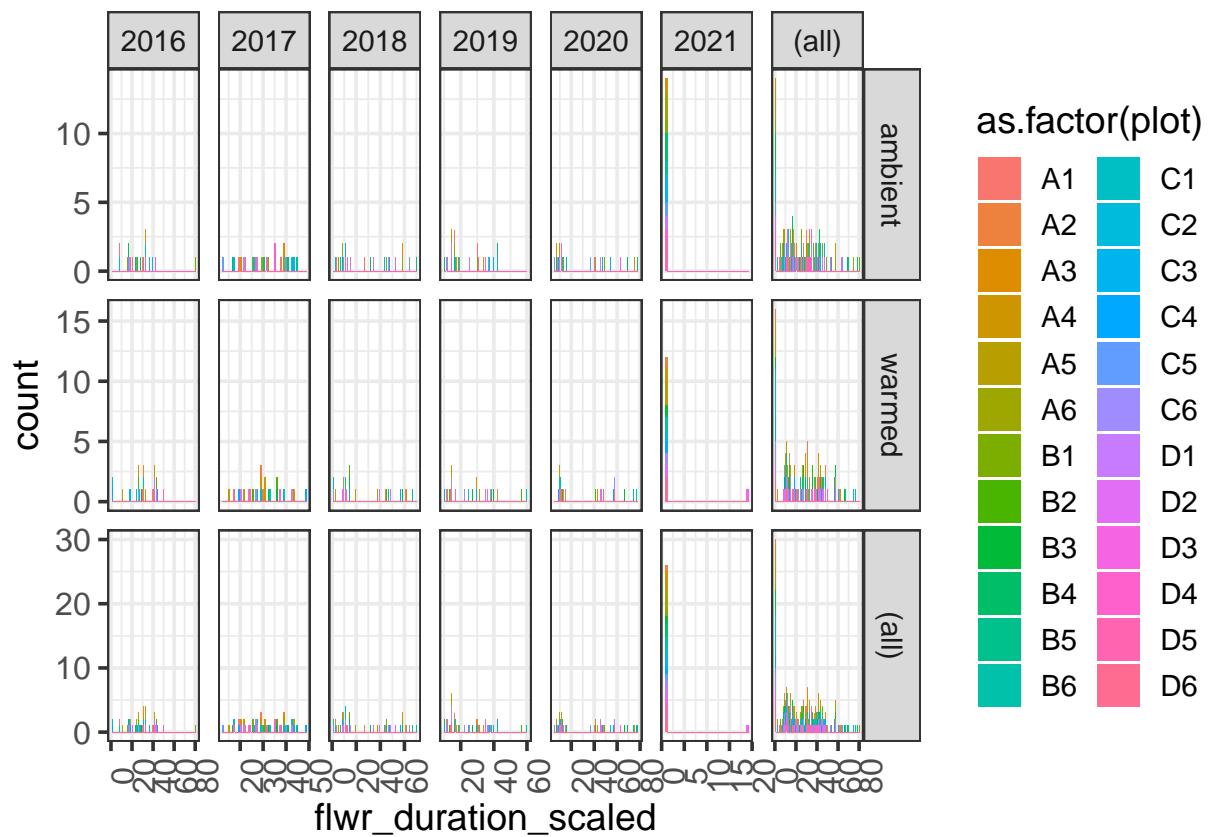
## 
## Shapiro-Wilk normality test
## 
## data: umbs_flwr_plot_growthhabit$flwr_duration_scaled
## W = 0.95137, p-value = 5.992e-08

# 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")

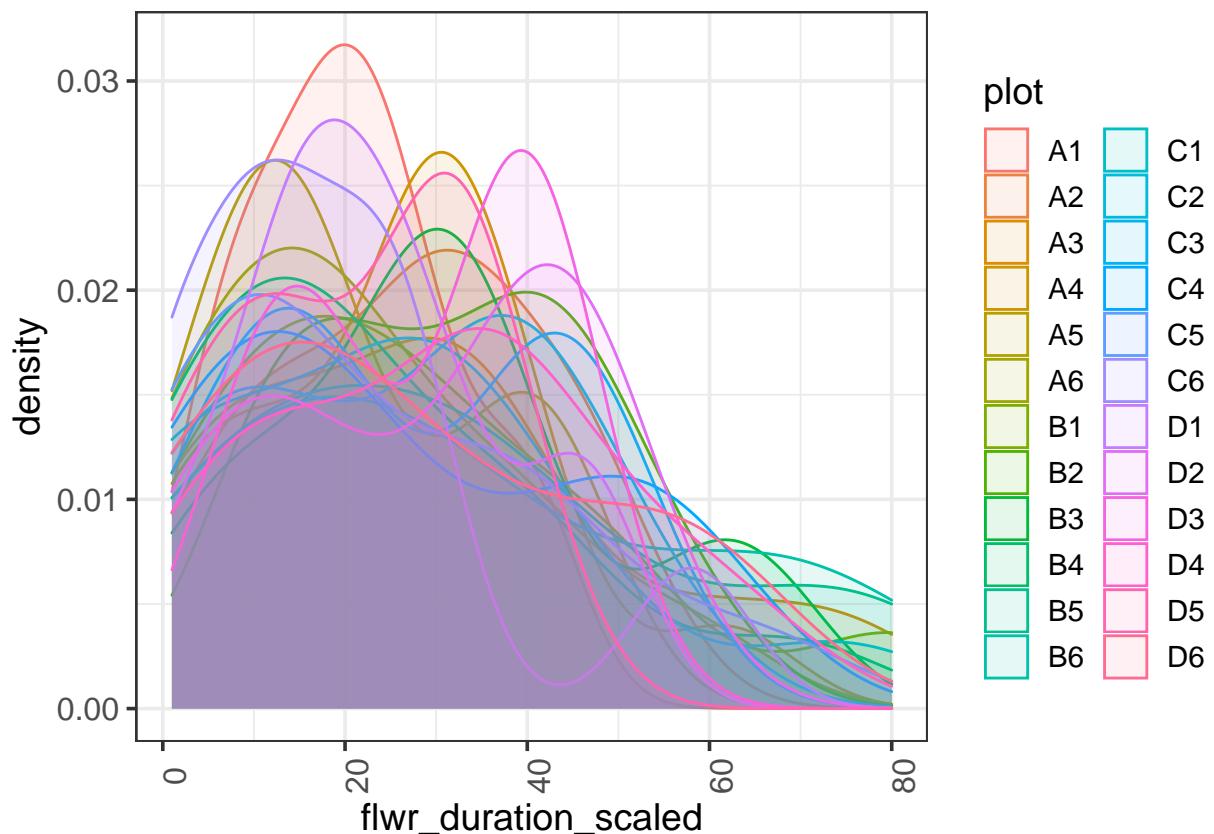
```



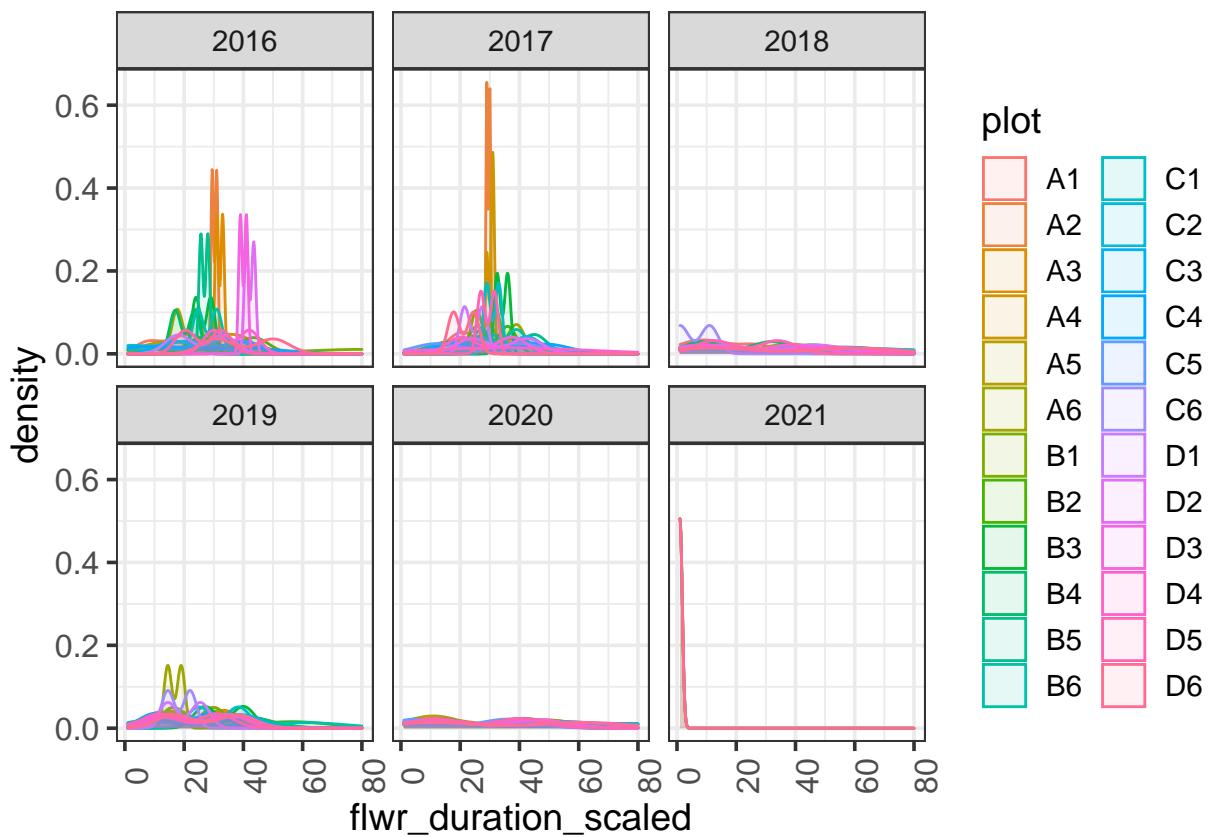
```
ggplot(umbs_flwr_plot_growthhabit, aes(flwr_duration_scaled, fill = as.factor(plot))) + geom_histogram()
```



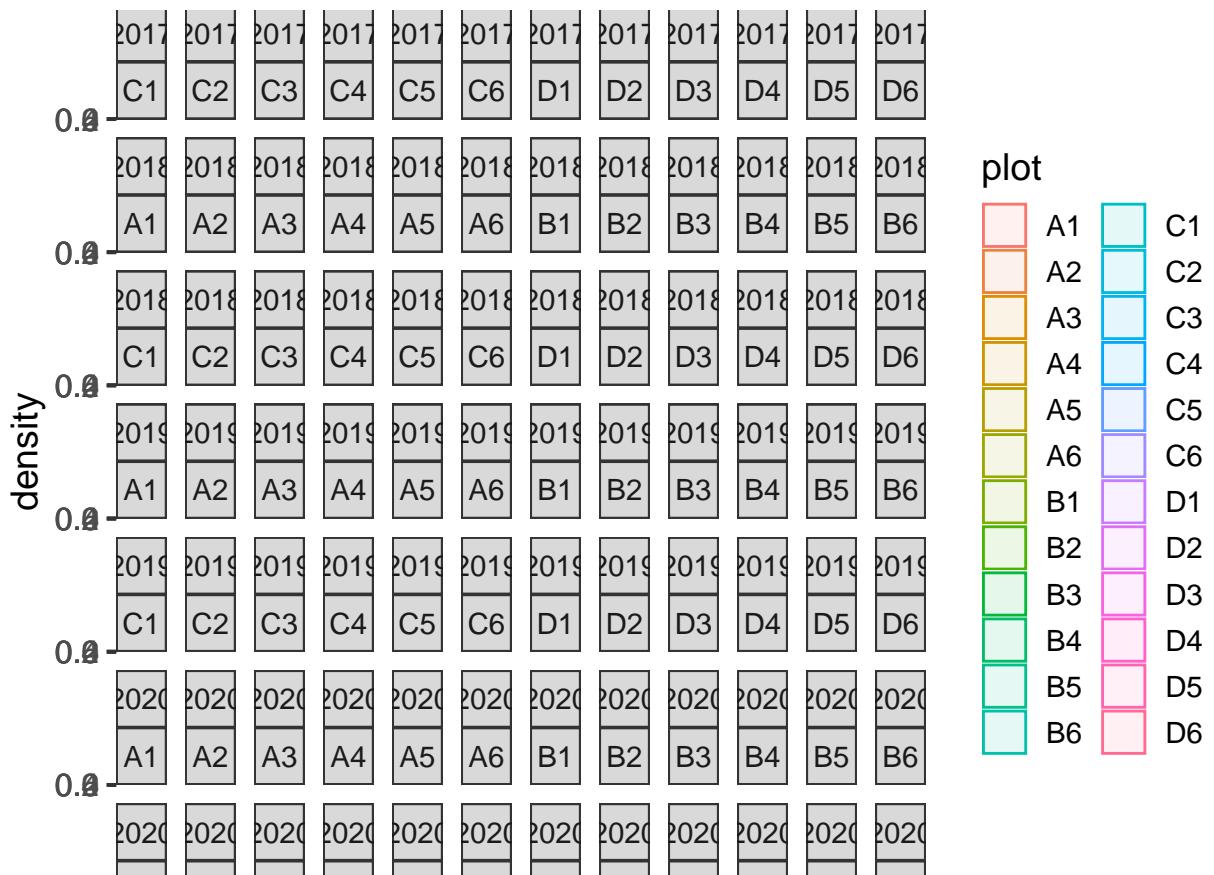
```
ggplot(umbs_flwr_plot_growthhabit, aes(flwr_duration_scaled, fill = plot, color=plot)) +
  geom_density(alpha = 0.1)
```



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

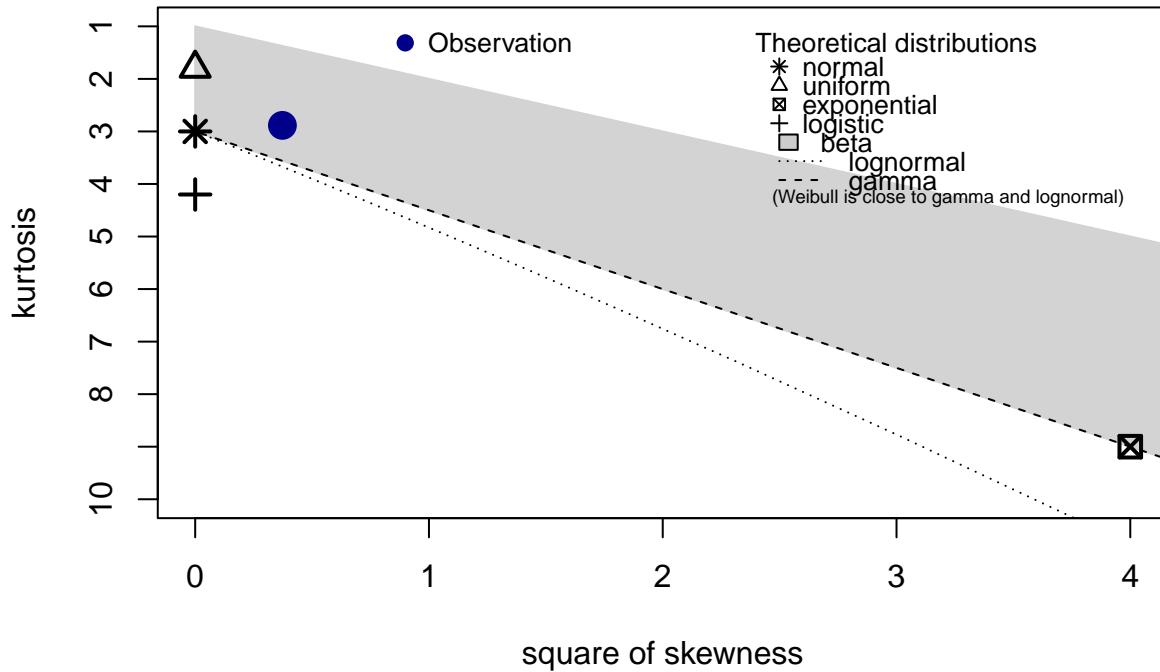


```
ggplot(umbs_flwr_plot_growthhabit, aes(flwr_duration_scaled, fill = plot, color=plot)) +
  geom_density(alpha = 0.1) +
  facet_wrap(~year + plot)
```



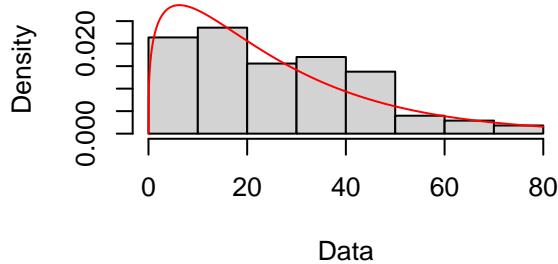
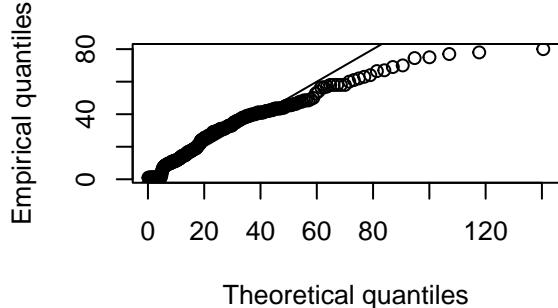
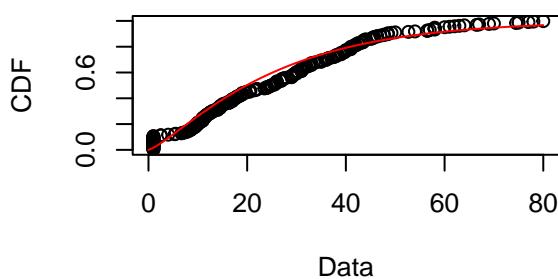
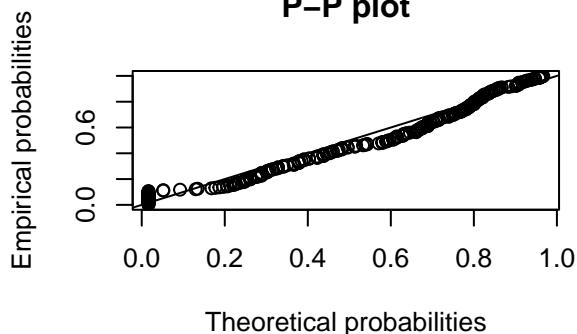
```
# Exploring distributions for these data:  
descdist(umbs_flwr_plot_growthhabit$flwr_duration_scaled, discrete = FALSE)
```

Cullen and Frey graph

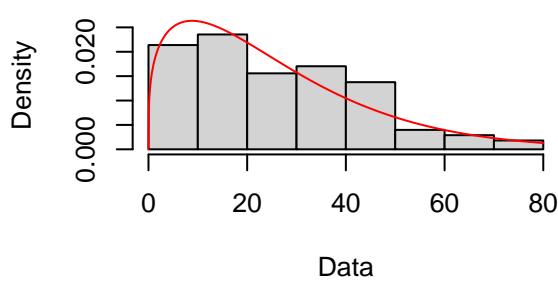
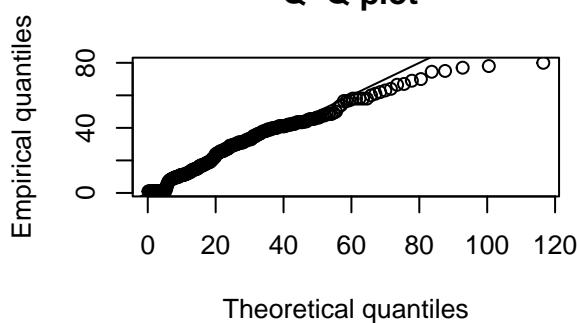
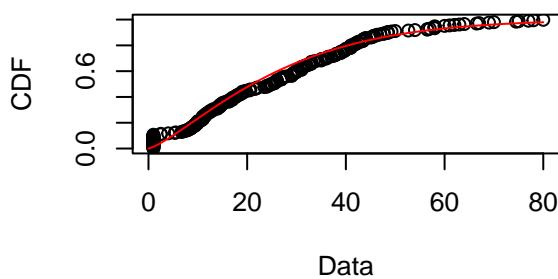
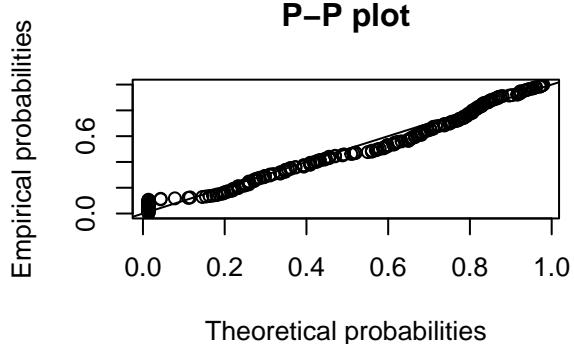


```
## summary statistics
## -----
## min: 1   max: 80
## median: 24.875
## mean: 26.08581
## estimated sd: 18.16827
## estimated skewness: 0.6108626
## estimated kurtosis: 2.884994
```

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

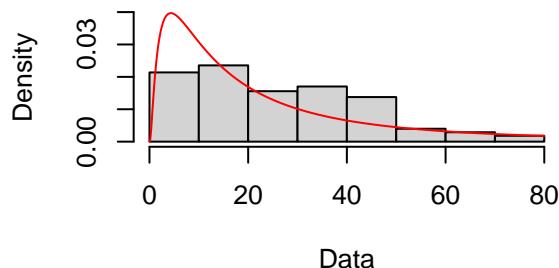
Empirical and theoretical dens.**Q-Q plot****Empirical and theoretical CDFs****P-P plot**

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

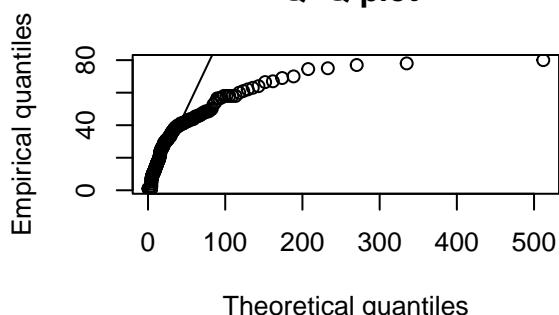
Empirical and theoretical dens.**Q-Q plot****Empirical and theoretical CDFs****P-P plot**

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

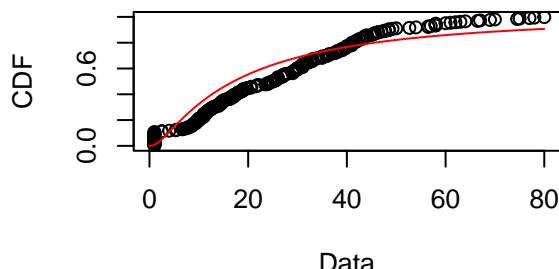
Empirical and theoretical dens.



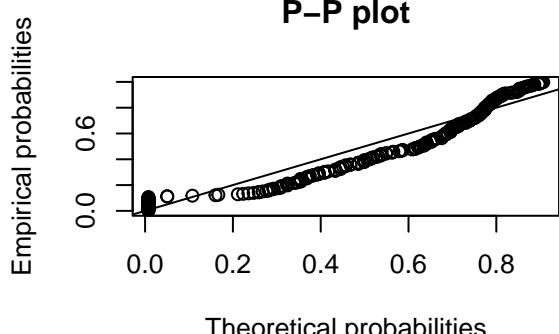
Q–Q plot



Empirical and theoretical CDFs

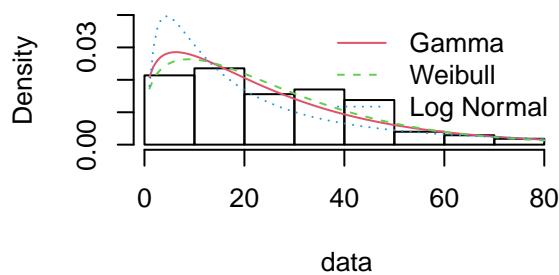


P–P plot

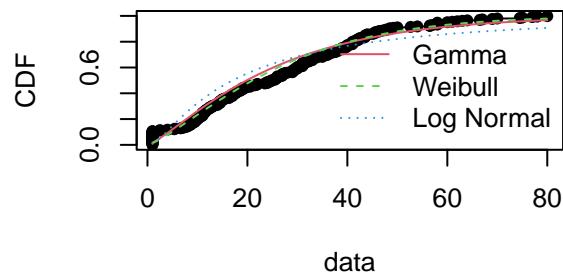


```
par(mfrow=c(2,2))
plot.legend <- c("Gamma", "Weibull", "Log Normal")
denscomp(list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
cdfcomp (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
qqcomp (list(fit.gamma, fit.weibull, fit.ln), legendtext = plot.legend)
ppcomp (list(fit.gamma,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

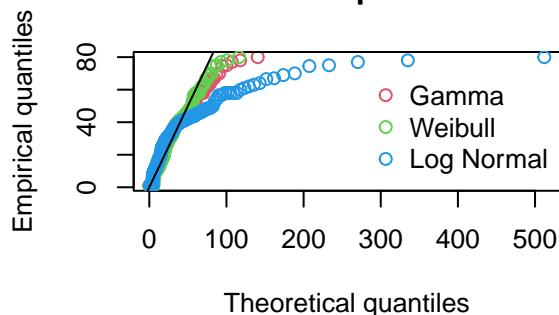
Histogram and theoretical densities



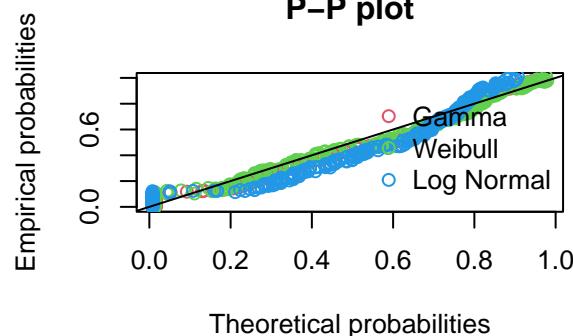
Empirical and theoretical CDFs



Q-Q plot



P-P plot



```
# 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>

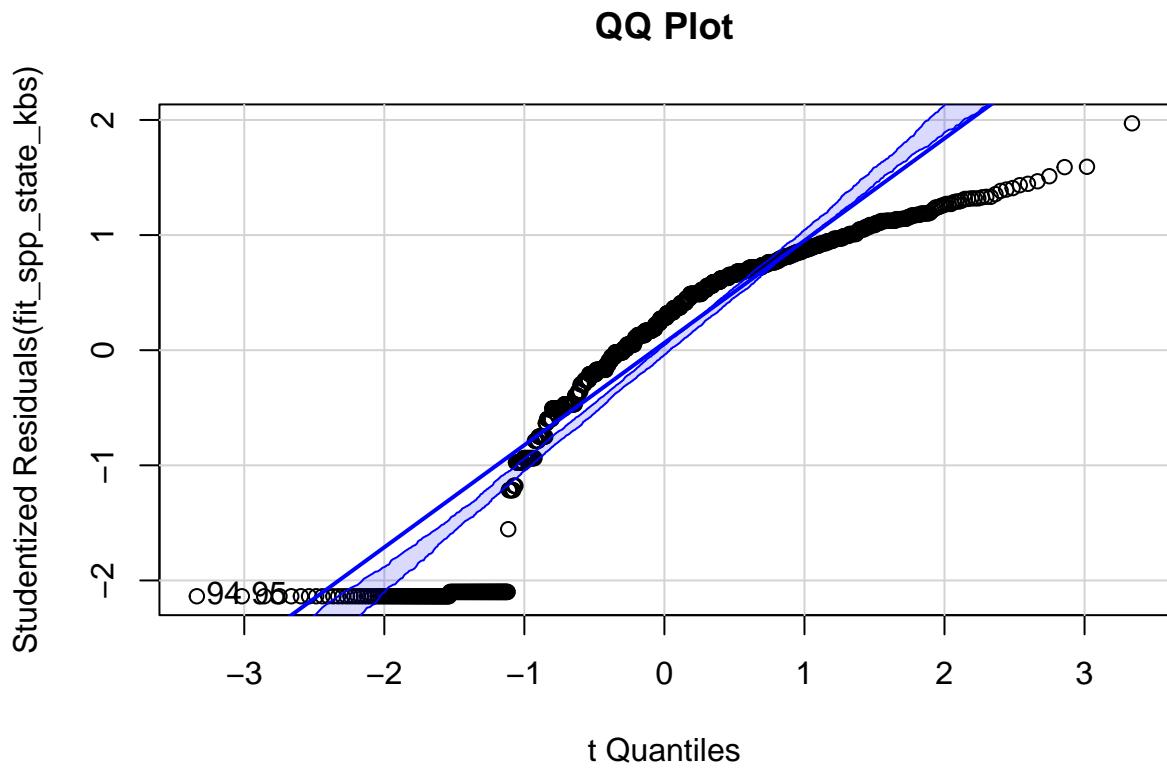
These illustrate whether certain data points have more leverage (more influence), and thus could be outliers. It's a way of detecting outliers. Leverage plots can help identify whether a point has high or low influence, based on its leverage and residual and determining model fit with and without the 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

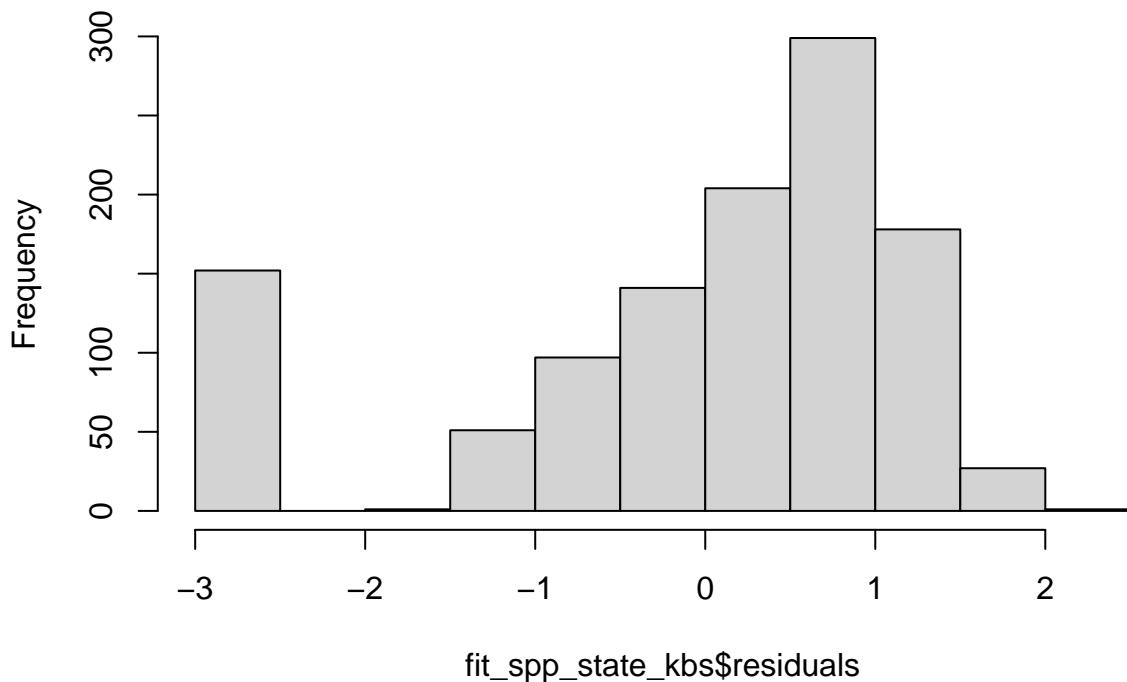
qqPlot(fit_spp_state_kbs, main="QQ Plot")
```



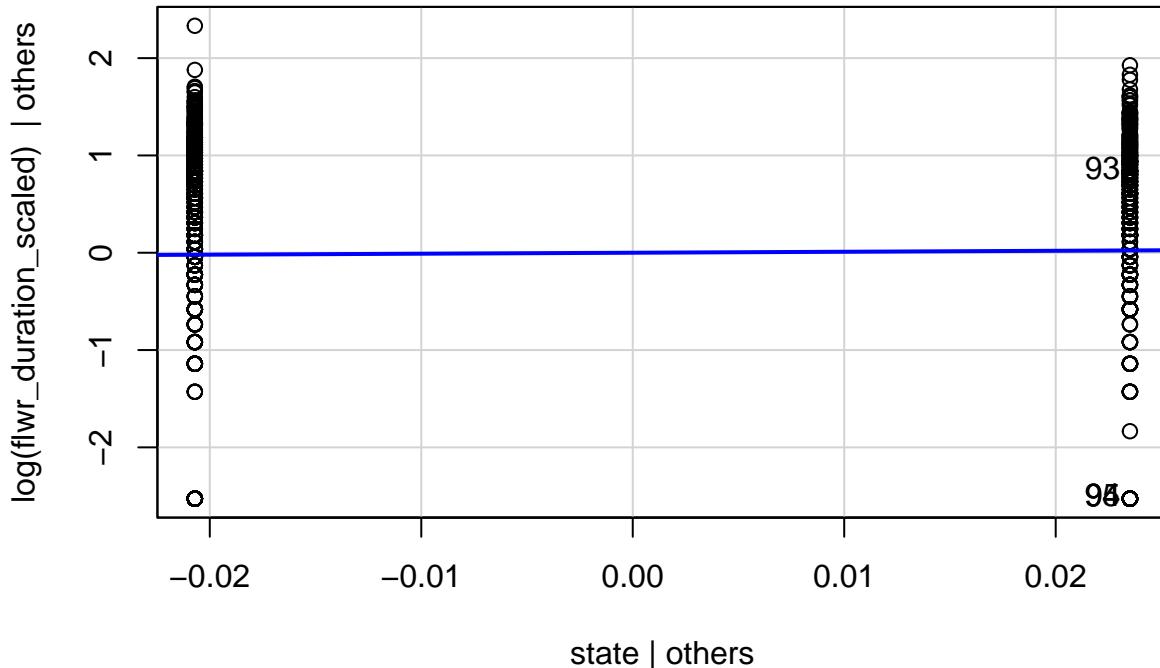
```
## 94 95
## 54 55
```

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

Histogram of fit_spp_state_kbs\$residuals



```
leveragePlots(fit_spp_state_kbs)
```



```
ols_test_normality(fit_spp_state_kbs)
```

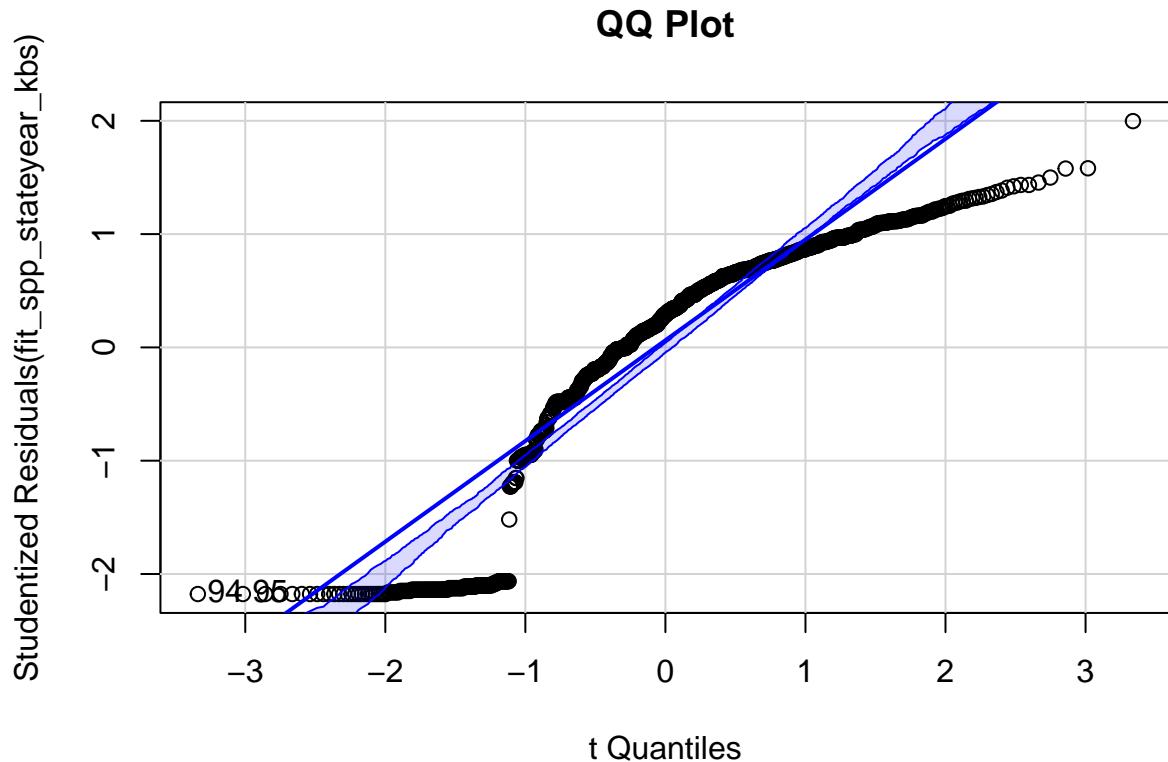
```
## Warning in ks.test.default(y, "pnorm", mean(y), sd(y)): ties should not be  
## present for the Kolmogorov-Smirnov test
```

```
## -----  
## 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
```

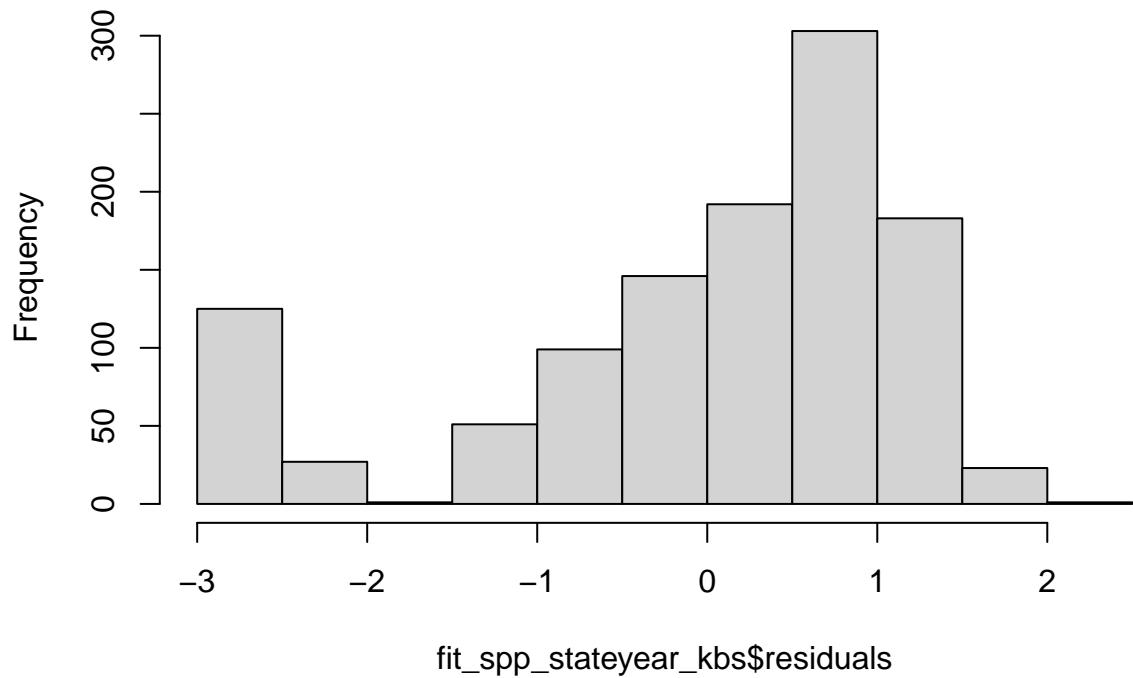
```
qqPlot(fit_spp_stateyear_kbs, main="QQ Plot")
```



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

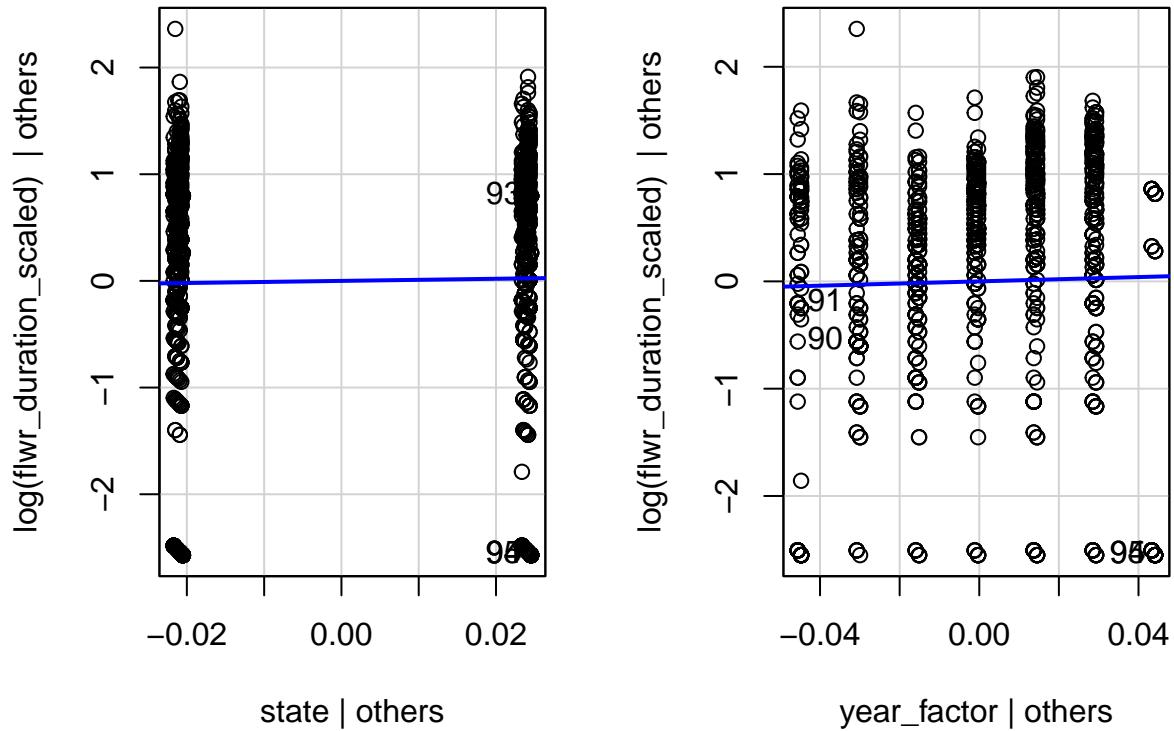
```
hist(fit_spp_stateyear_kbs$residuals)
```

Histogram of fit_spp_stateyear_kbs\$residuals



```
leveragePlots(fit_spp_stateyear_kbs)
```

Leverage Plots



```

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

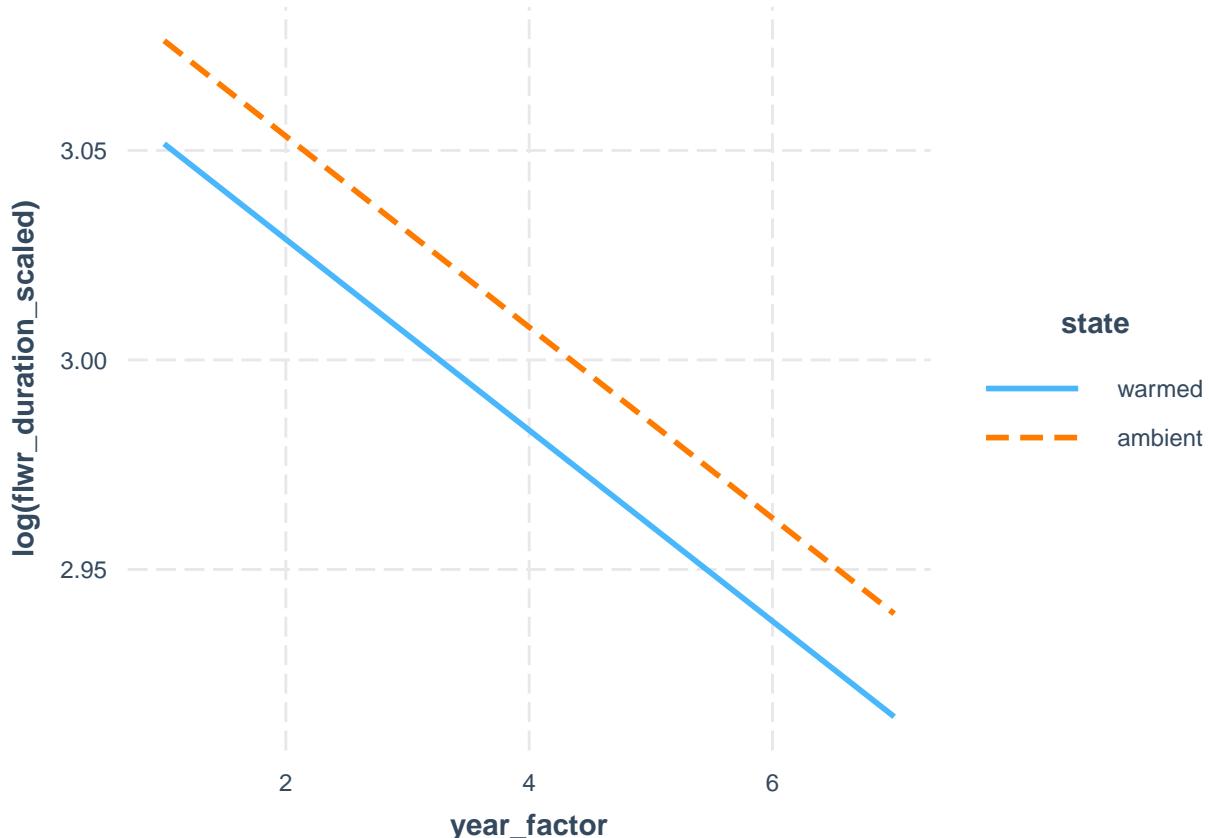
## -----
##          Test      Statistic     pvalue
## -----
## Shapiro-Wilk      0.8674    0.0000
## Kolmogorov-Smirnov 0.1297    0.0000
## Cramer-von Mises   38.3089    0.0000
## Anderson-Darling    52.0009    0.0000
## -----
# Interaction plot (ignore for now the repeated measures with species); see: 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.

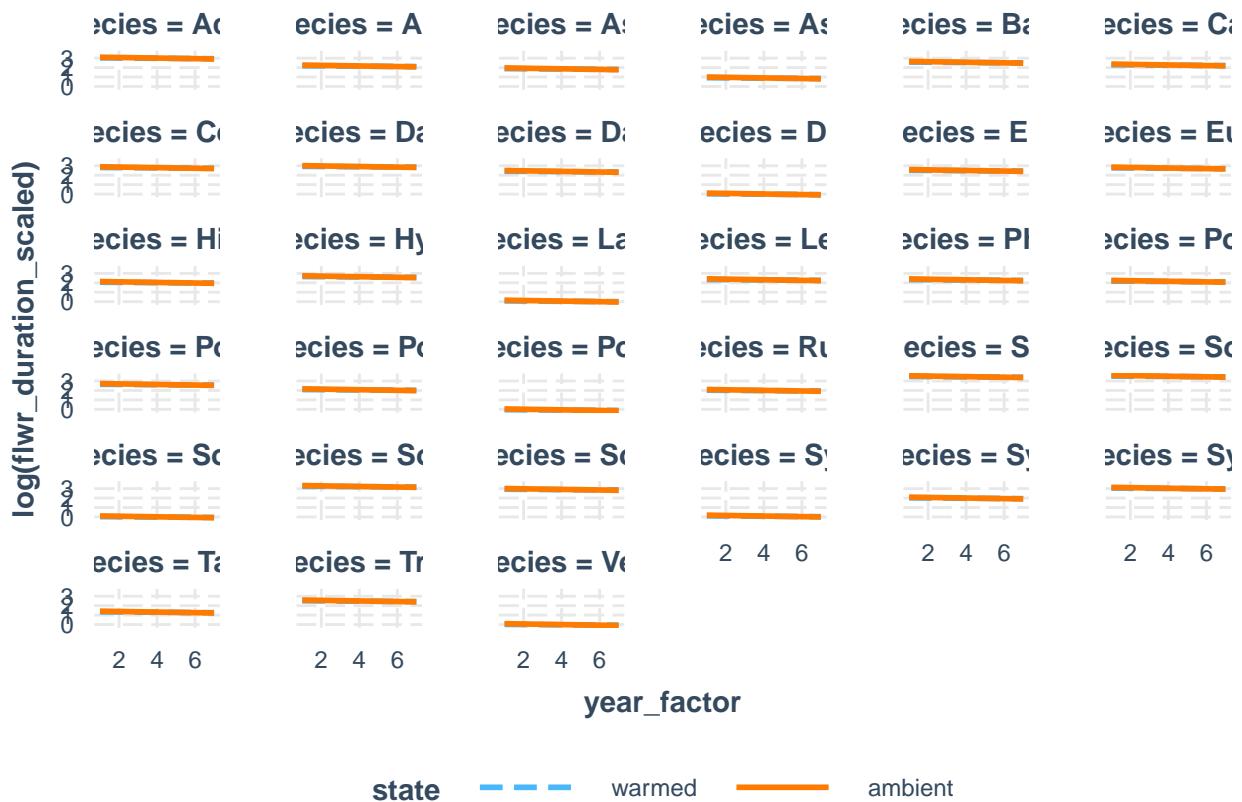
```



```
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.

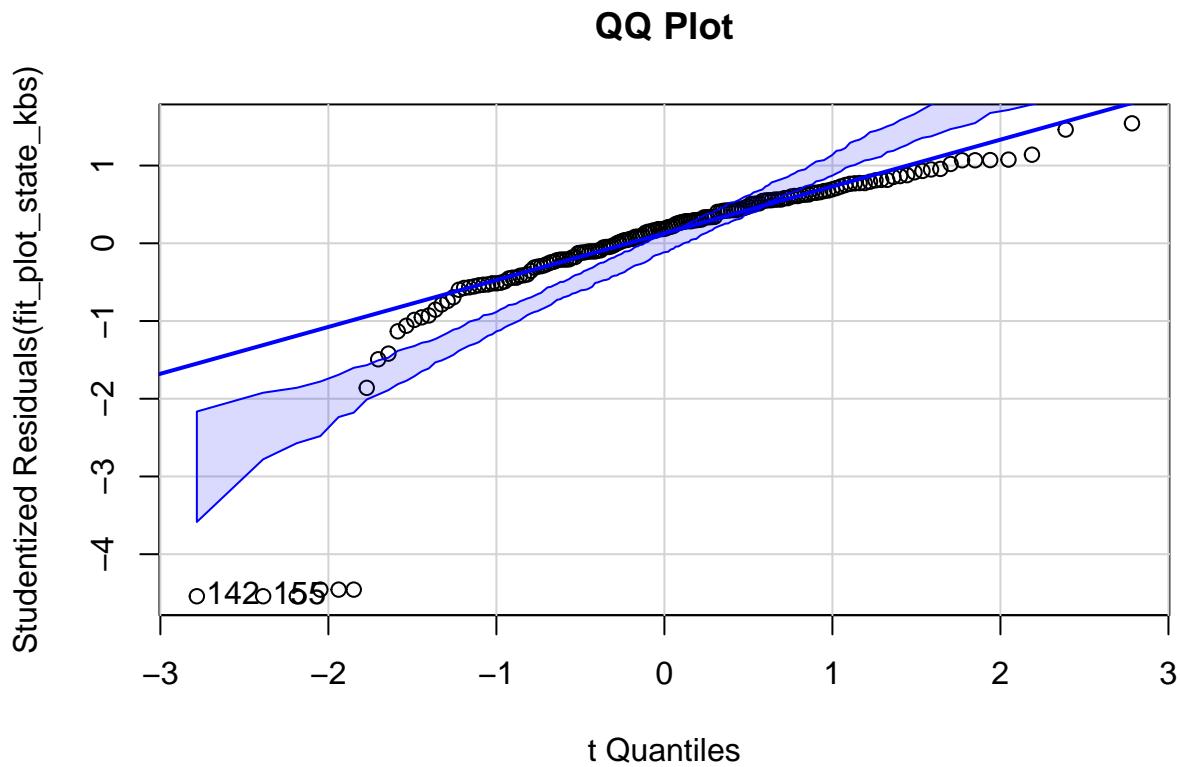
Warning: year_factor and state and species are not included in an interaction with
one another in the model.



```
# 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
```

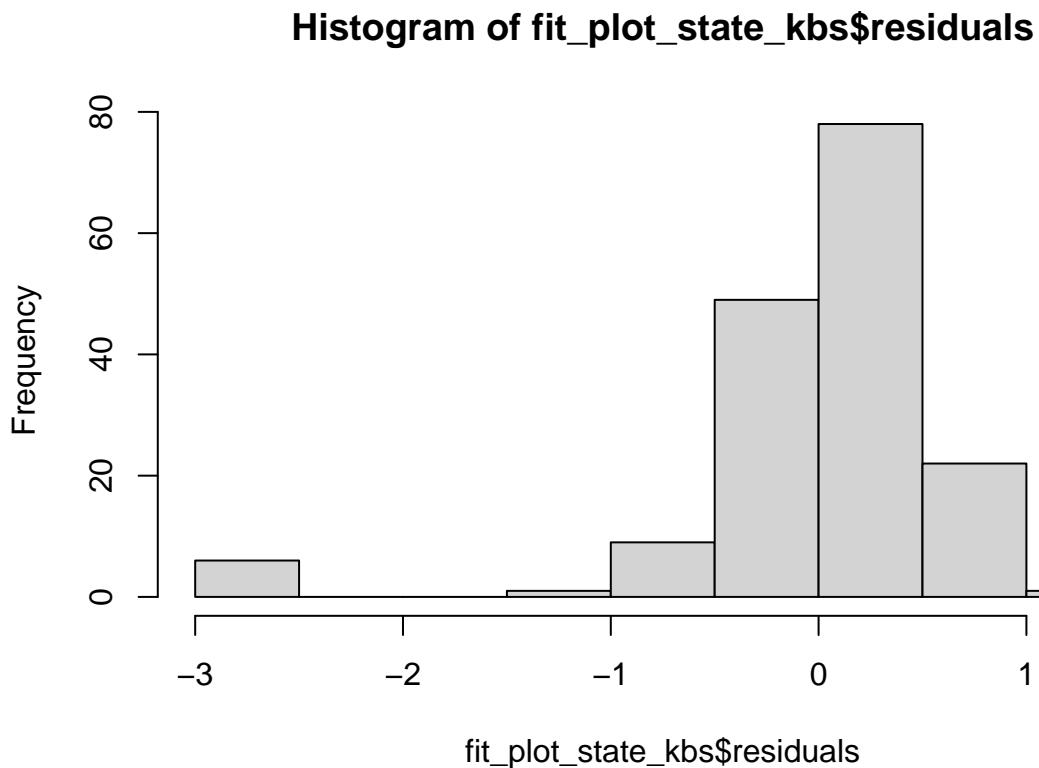
```
##      rstudent unadjusted p-value Bonferroni p
## 142 -4.540917    1.0840e-05   0.0017995
## 155 -4.540917    1.0840e-05   0.0017995
## 220 -4.540917    1.0840e-05   0.0017995
## 116 -4.455768    1.5476e-05   0.0025691
## 207 -4.455768    1.5476e-05   0.0025691
## 272 -4.455768    1.5476e-05  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

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

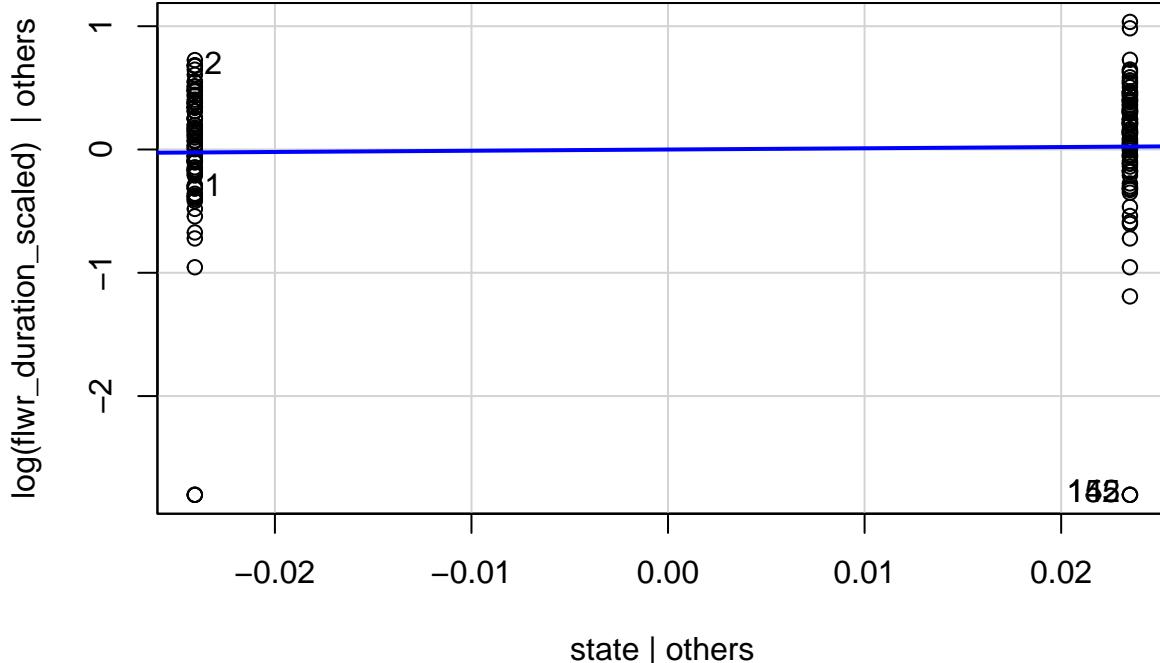


```
## 142 155
## 78 85
```

```
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
## -----
```

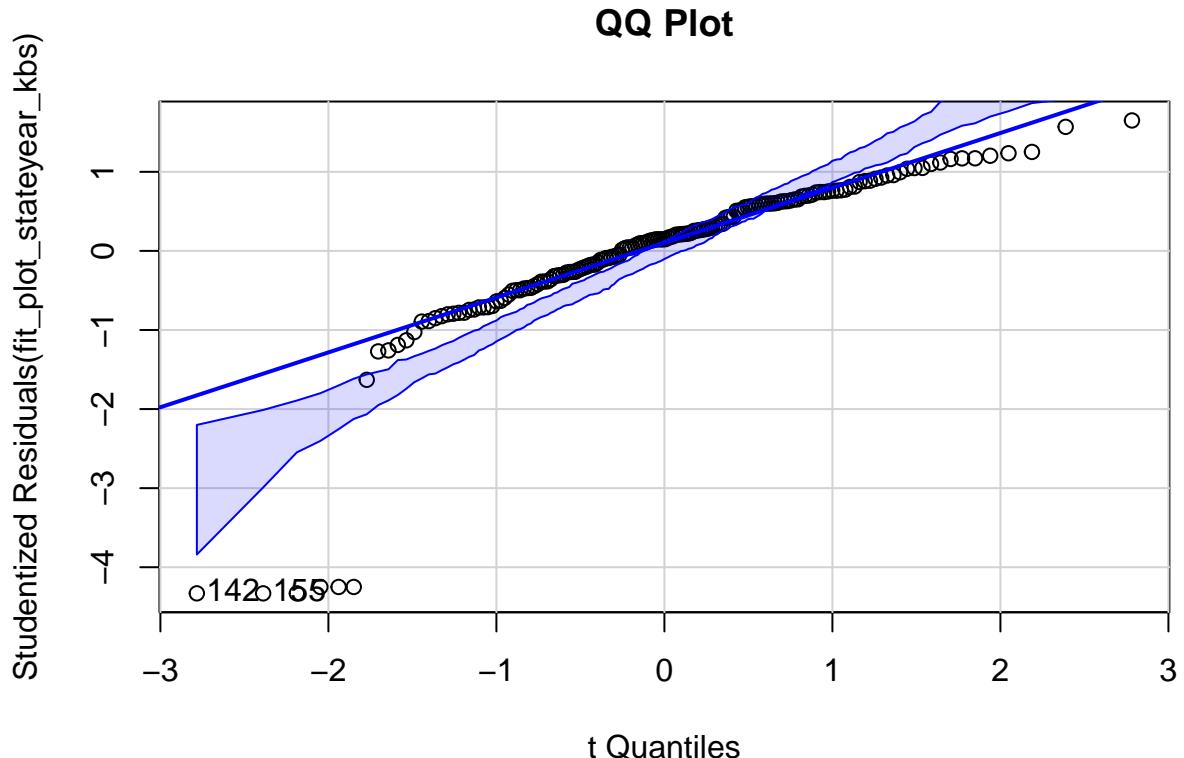
```
# KBS State and year model
```

```
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
```

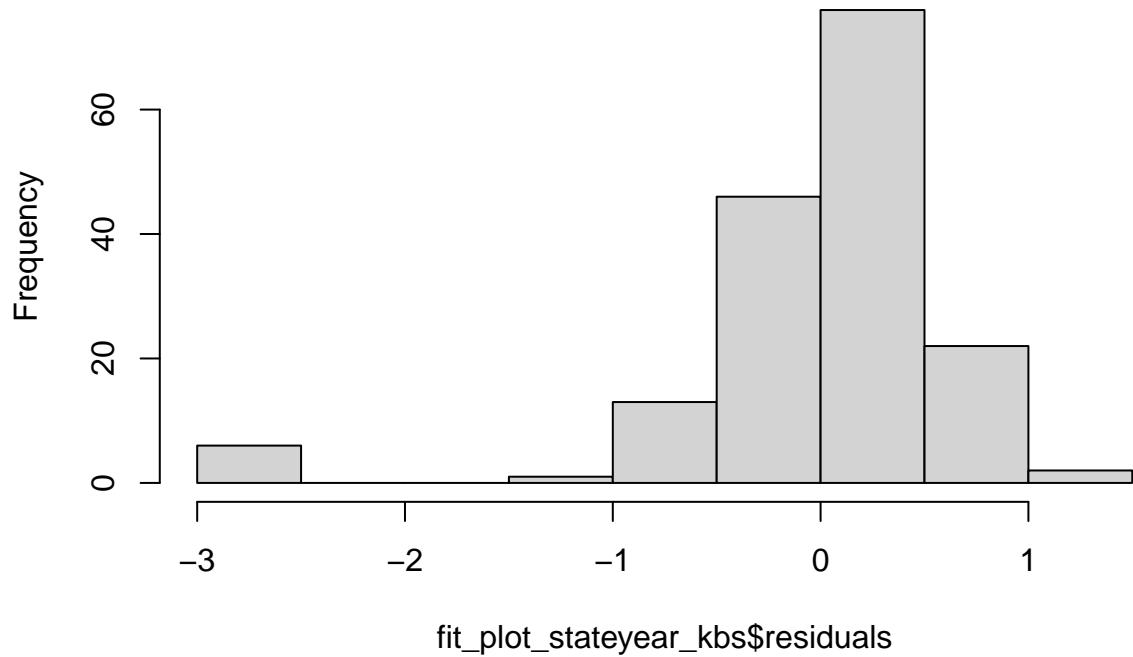
```
qqPlot(fit_plot_stateyear_kbs, main="QQ Plot")
```



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

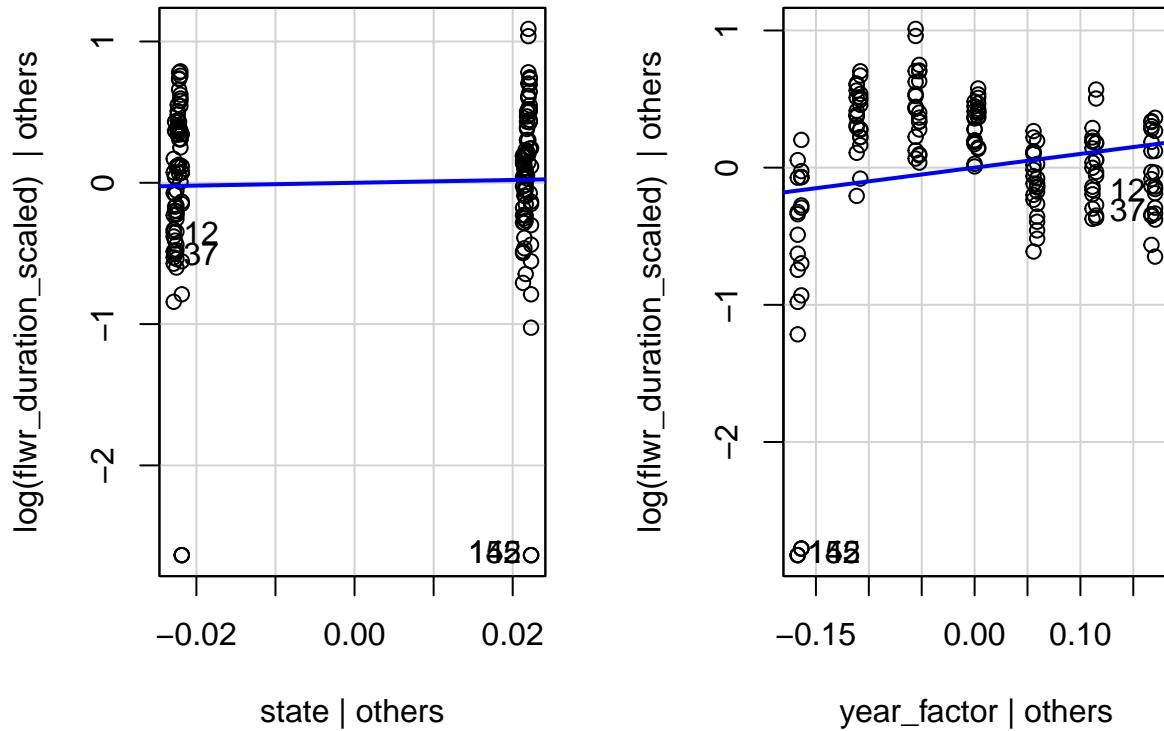
```
hist(fit_plot_stateyear_kbs$residuals)
```

Histogram of fit_plot_stateyear_kbs\$residuals



```
leveragePlots(fit_plot_stateyear_kbs)
```

Leverage Plots



```

ols_test_normality(fit_plot_stateyear_kbs) # a couple tests say not normal

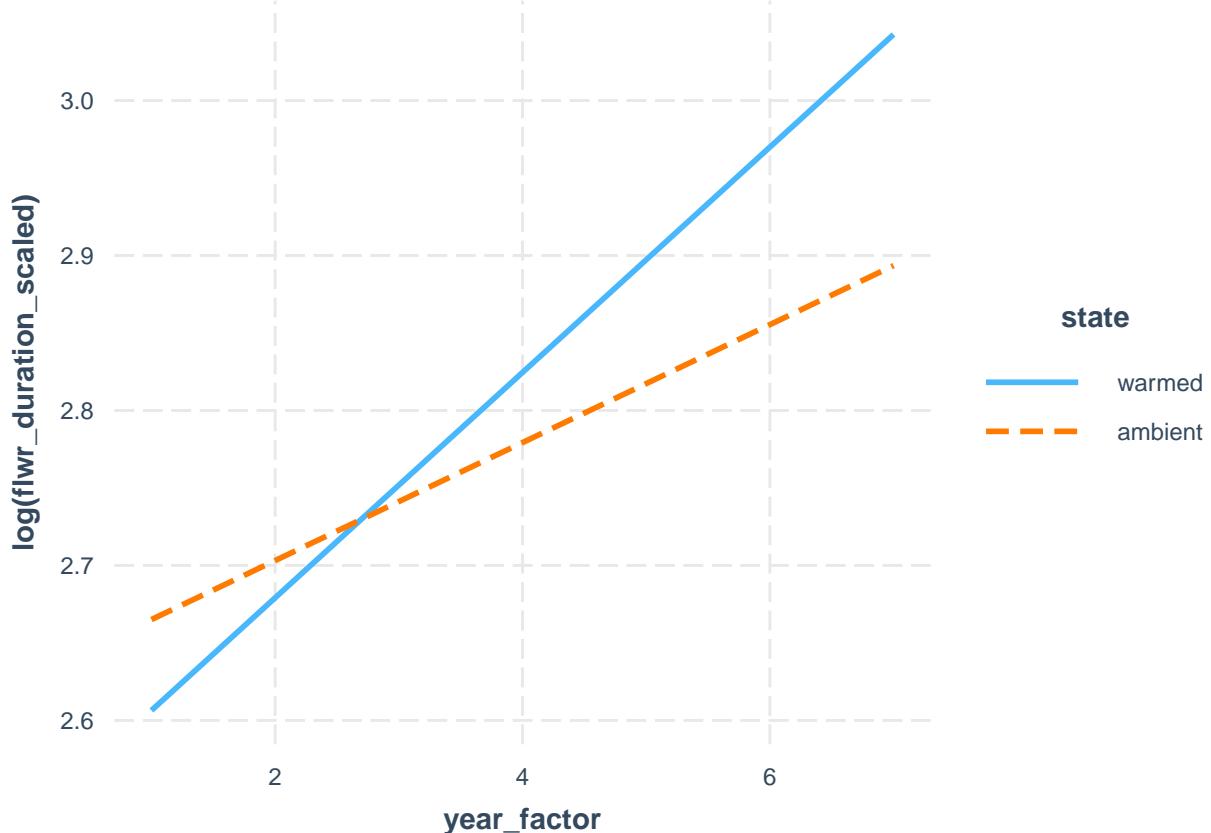
## Warning in ks.test.default(y, "pnorm", mean(y), sd(y)): ties should not be
## present for the Kolmogorov-Smirnov test

## -----
##          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

```

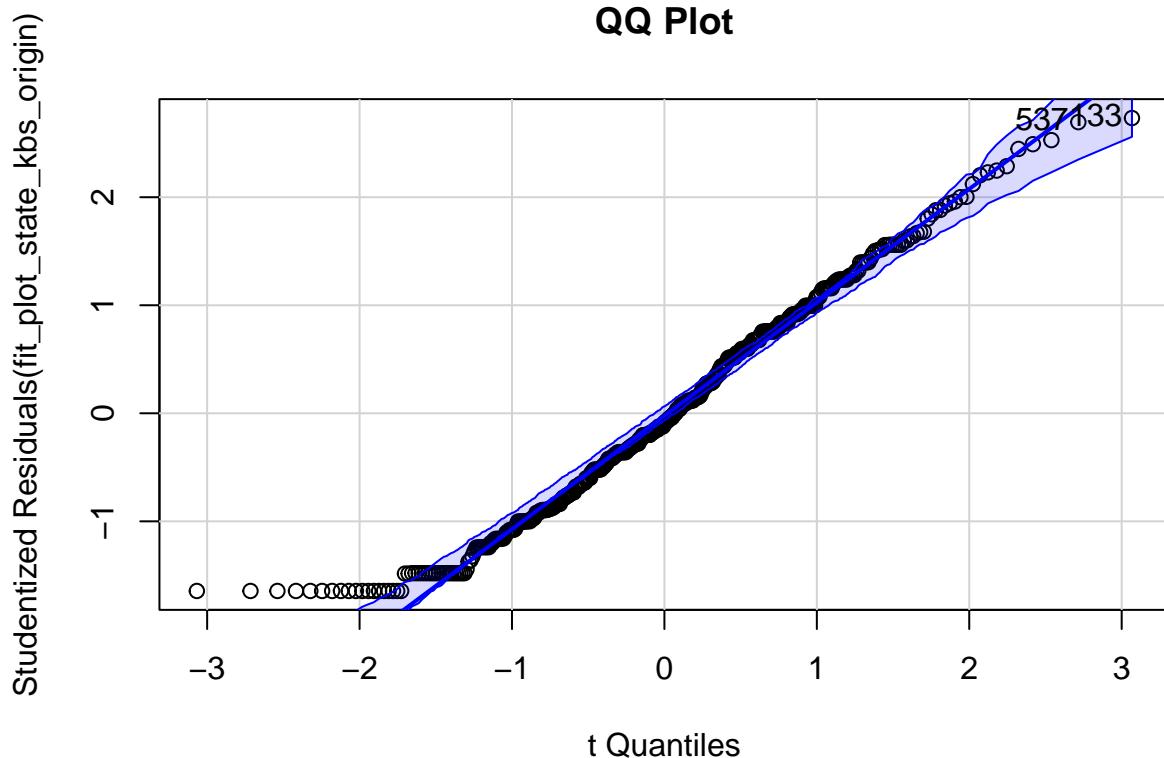
Using data kbs_flwr_plot from global environment. This could cause
 ## incorrect results if kbs_flwr_plot has been altered since the model was
 ## fit. You can manually provide the data to the "data =" argument.



```
# 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
```

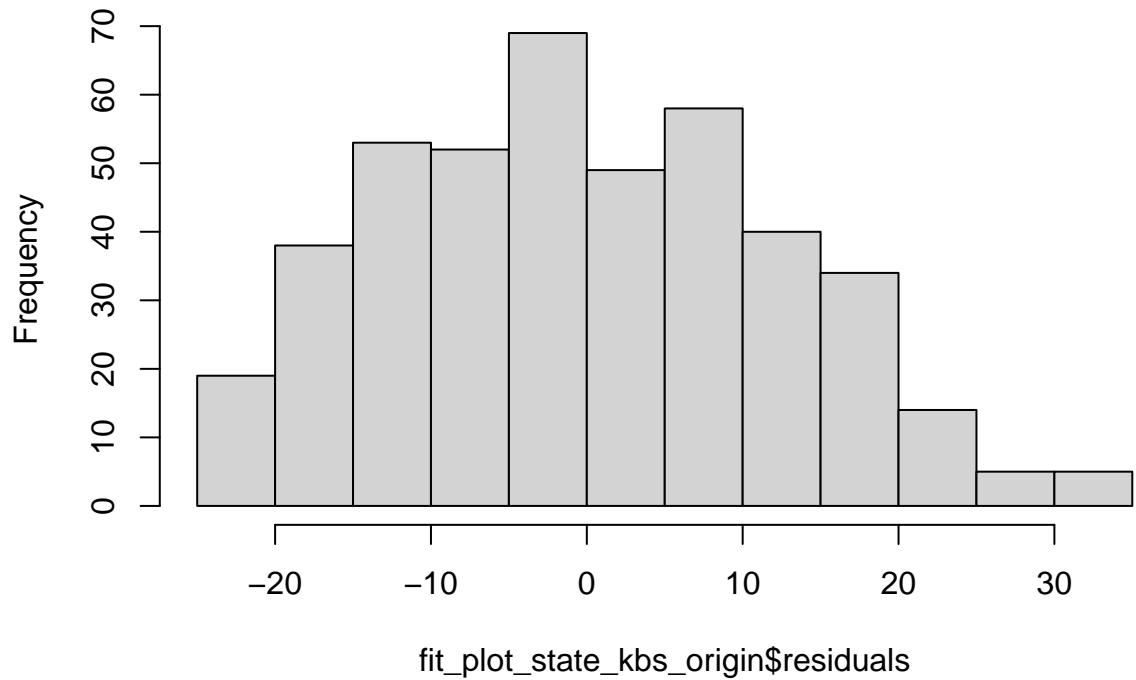
```
qqPlot(fit_plot_state_kbs_origin, main="QQ Plot")
```



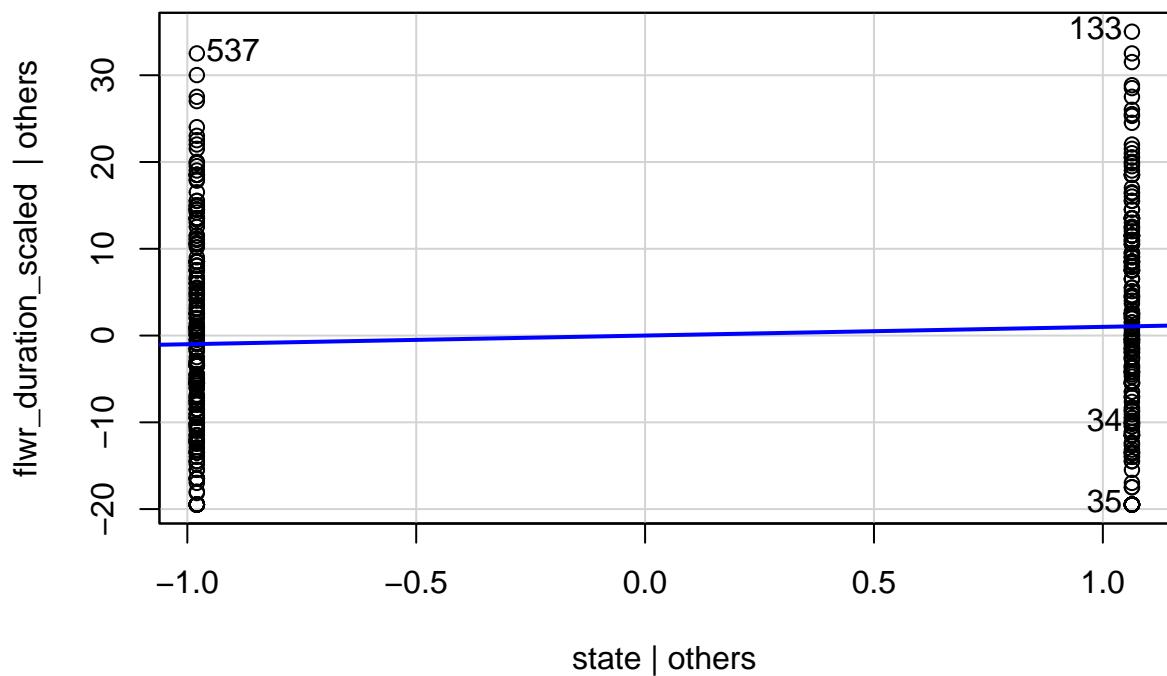
```
## 133 537
## 83 335
```

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

Histogram of 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
## -----
```

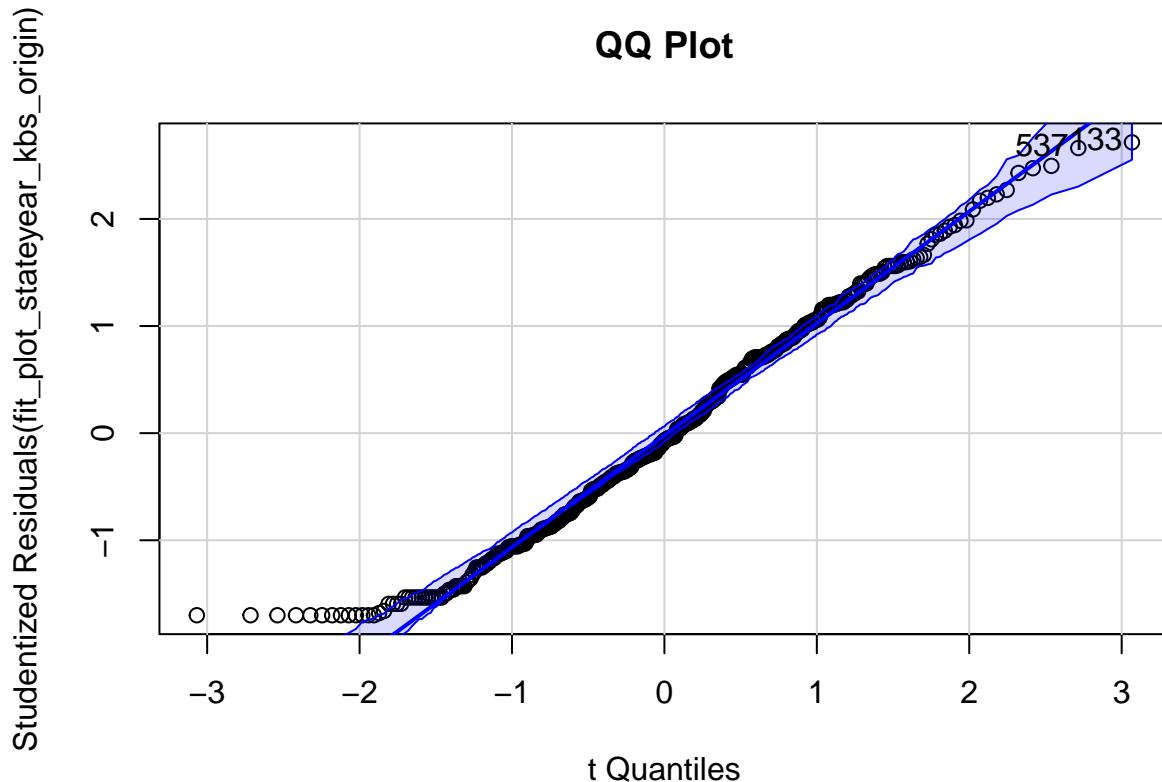
```
# KBS State and year model
```

```
fit_plot_stateyear_kbs_origin <- lm(flwr_duration_scaled ~ state + year_factor, data = kbs_flwr_plot_origin)
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           0.00688888        NA
```

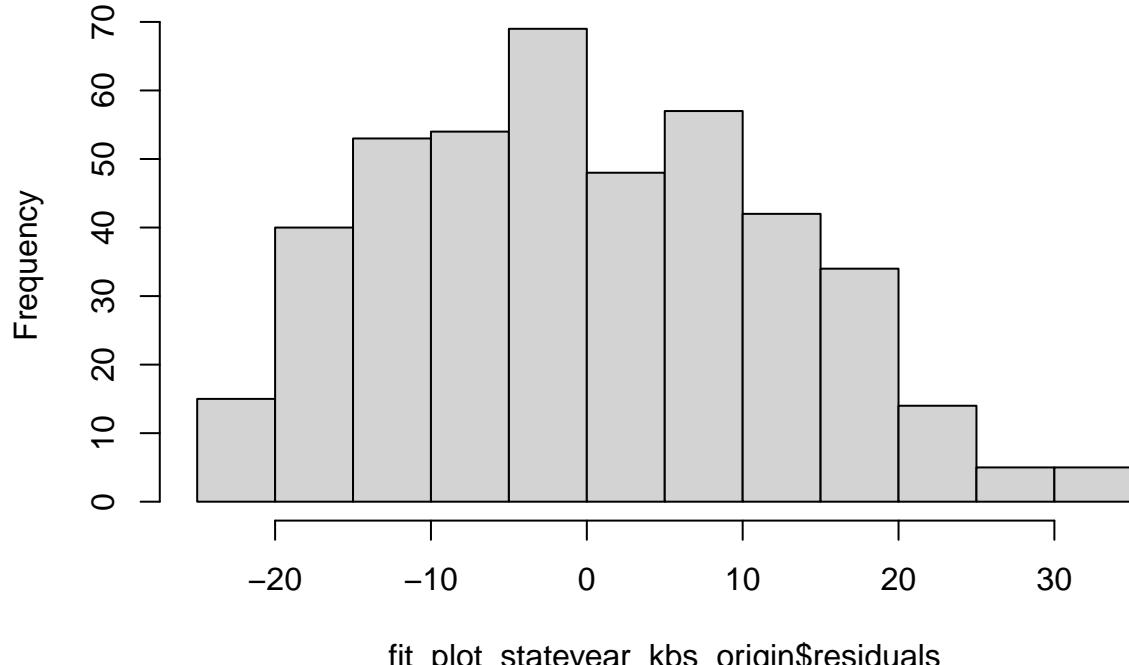
```
qqPlot(fit_plot_stateyear_kbs_origin, main="QQ Plot")
```



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

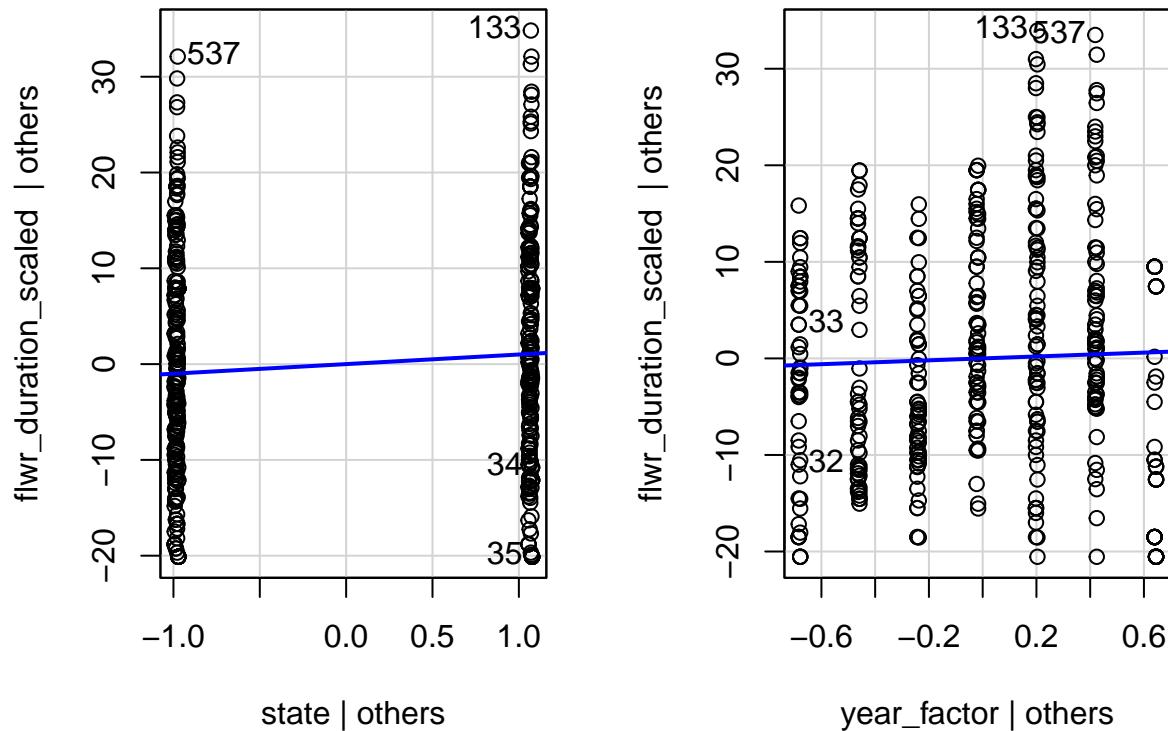
```
hist(fit_plot_stateyear_kbs_origin$residuals)
```

Histogram of fit_plot_stateyear_kbs_origin\$residuals



```
leveragePlots(fit_plot_stateyear_kbs_origin)
```

Leverage Plots



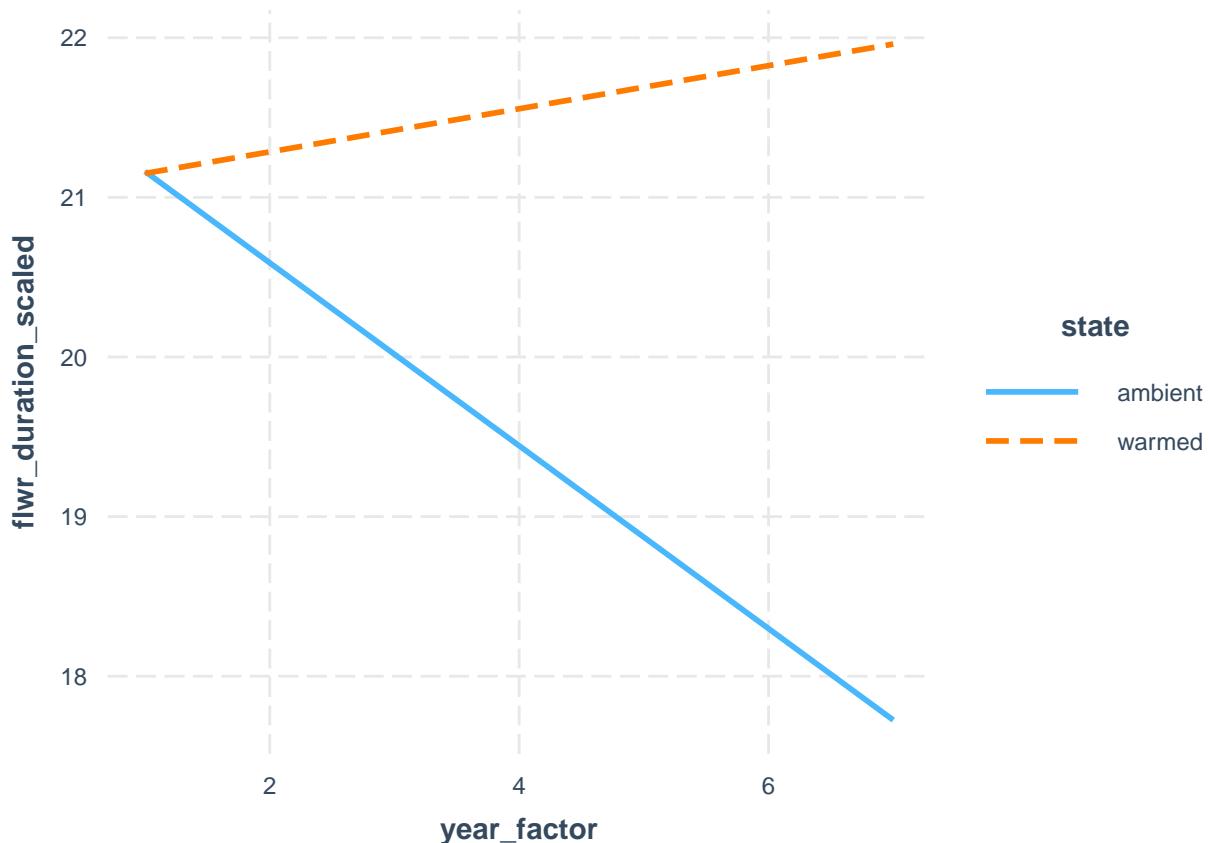
```
ols_test_normality(fit_plot_stateyear_kbs_origin) # a couple tests say not normal
```

```
## 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
```

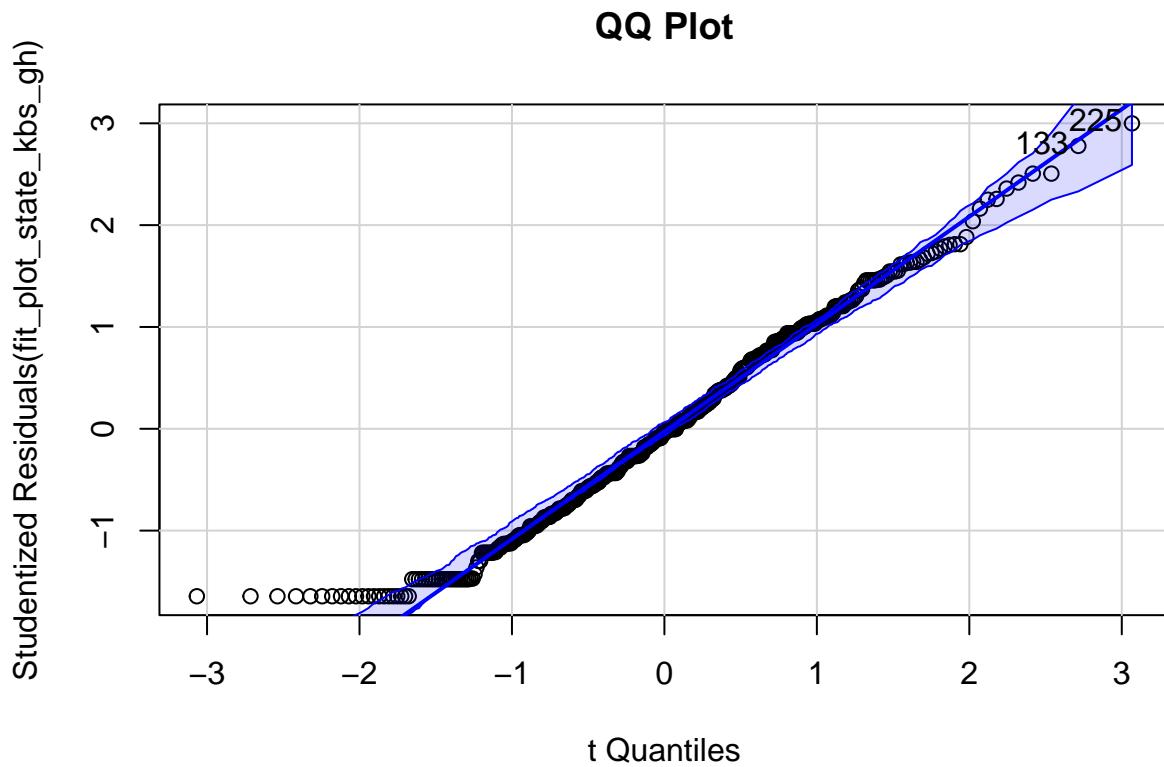
```
fit3 <- lm(flwr_duration_scaled ~ state * year_factor, data = kbs_flwr_plot_origin)
interact_plot(fit3, pred = year_factor, modx = state) # this looks very strange to me
```



```
# 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

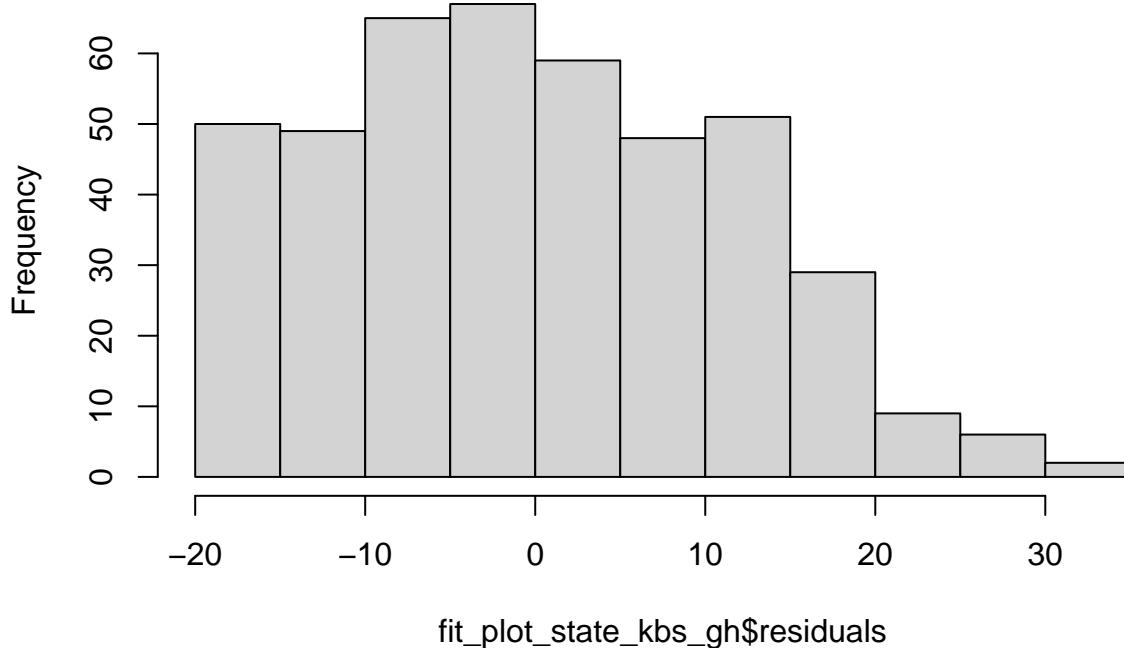
qqPlot(fit_plot_state_kbs_gh, main="QQ Plot")
```



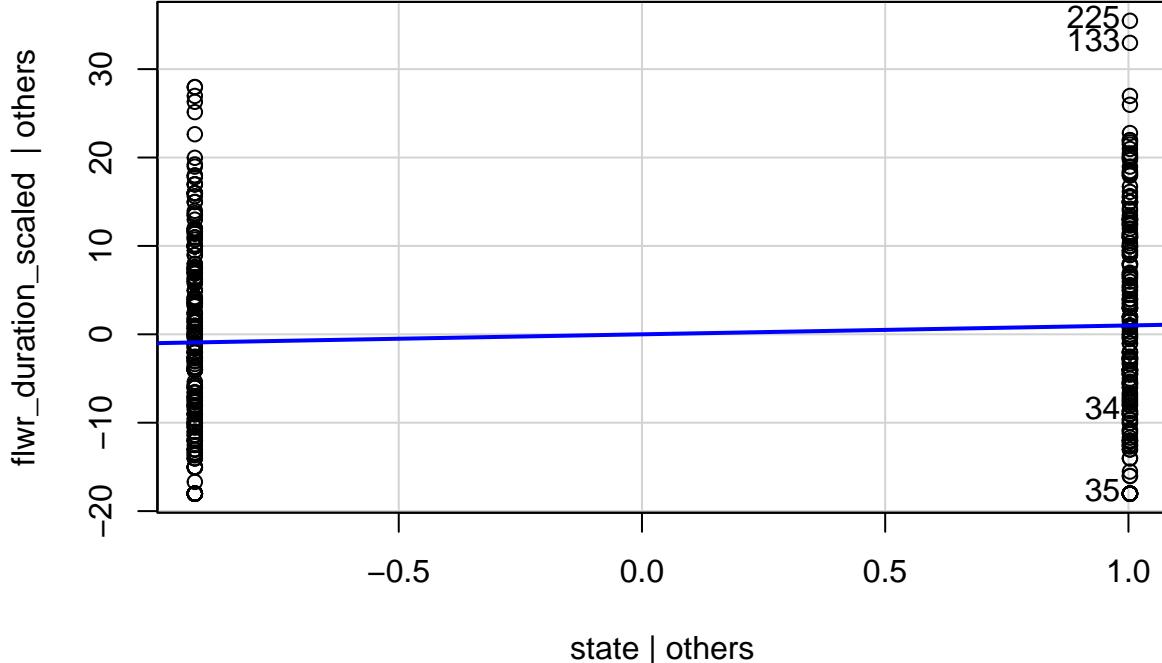
```
## 133 225
## 81 136
```

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

Histogram of 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
```

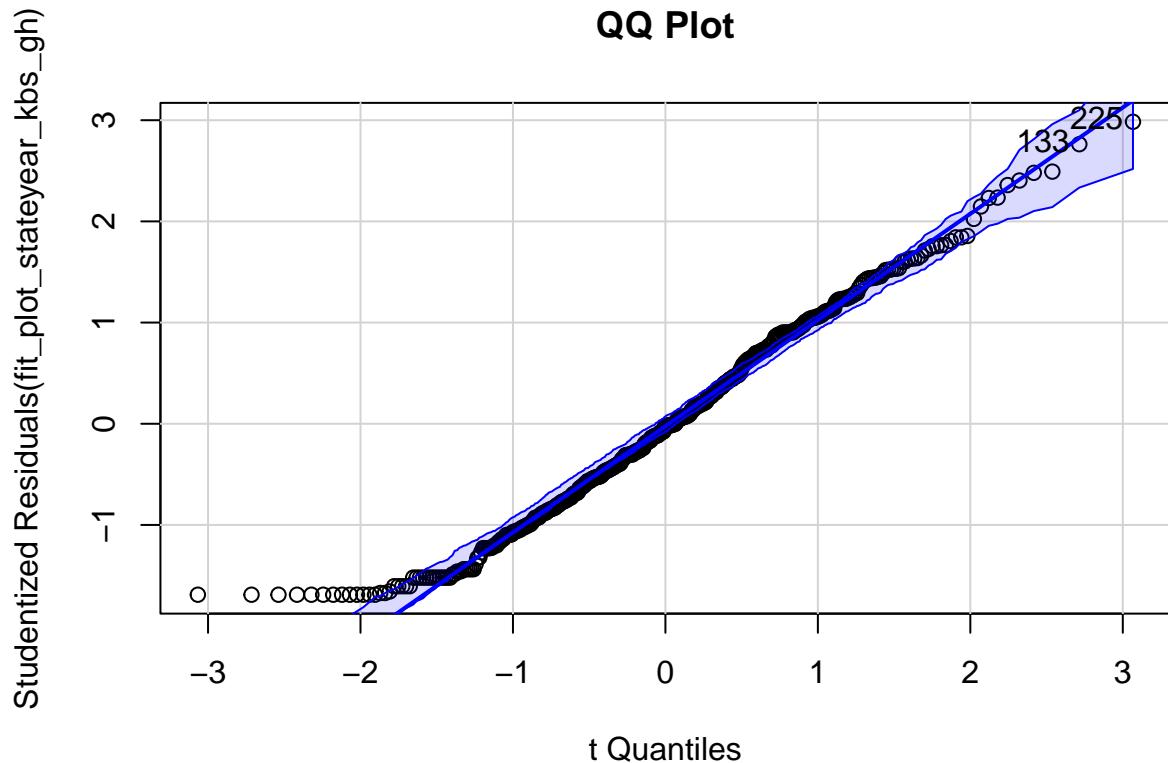
```
## -----
##      Test       Statistic     pvalue
## -----
## Shapiro-Wilk      0.9779    0.0000
## Kolmogorov-Smirnov 0.0506    0.2158
## Cramer-von Mises  35.1778   0.0000
## Anderson-Darling   1.815     1e-04
## -----
```

```
# KBS State and year model
```

```
fit_plot_stateyear_kbs_gh <- lm(flwr_duration_scaled ~ state + year_factor, data = kbs_flwr_plot_growth)
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
```

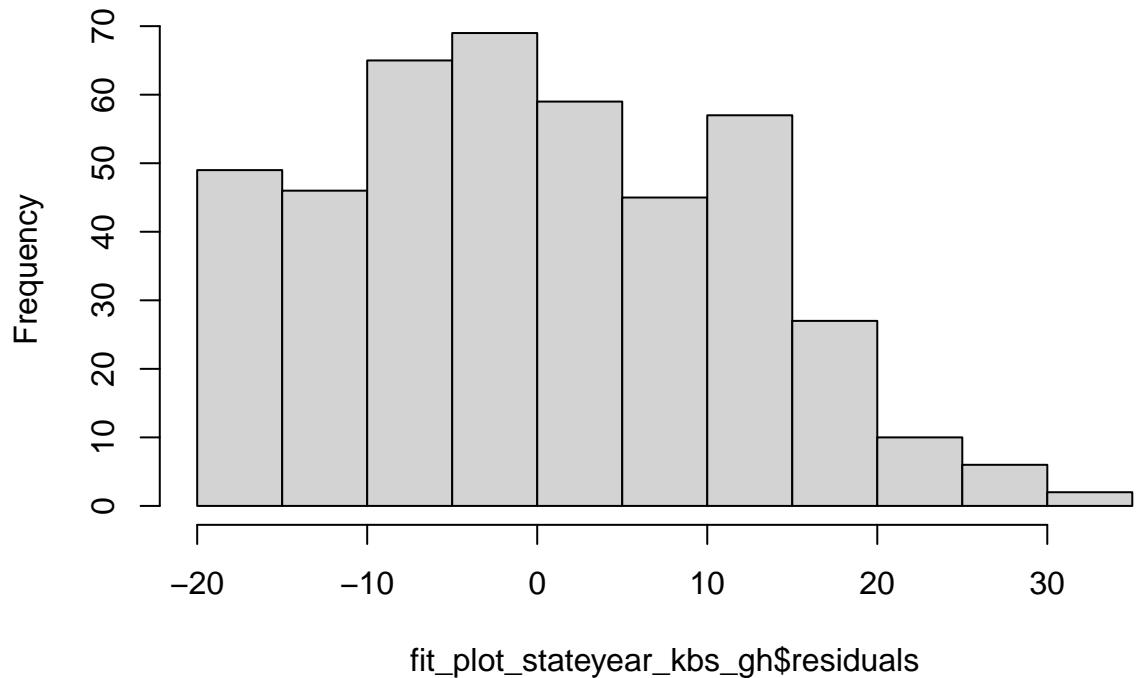
```
qqPlot(fit_plot_stateyear_kbs_gh, main="QQ Plot")
```



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

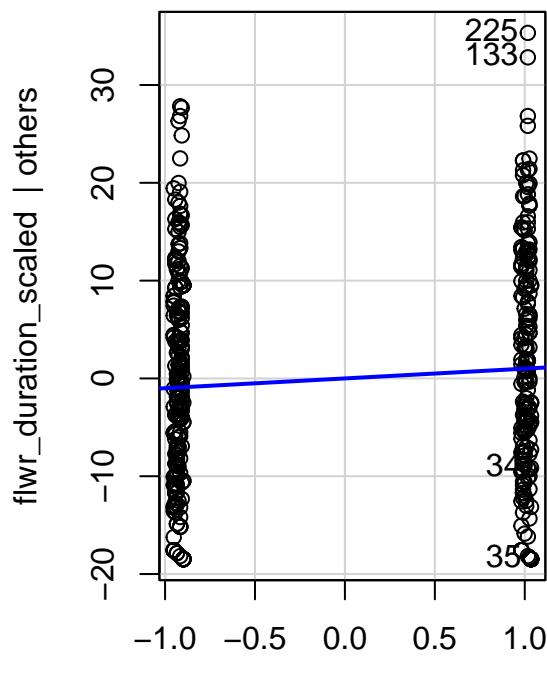
```
hist(fit_plot_stateyear_kbs_gh$residuals)
```

Histogram of fit_plot_stateyear_kbs_gh\$residuals

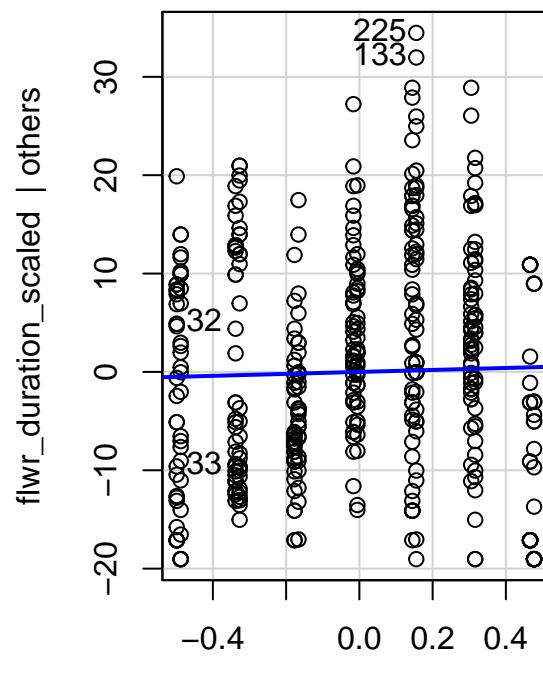


```
leveragePlots(fit_plot_stateyear_kbs_gh)
```

Leverage Plots



state | others



year_factor | others

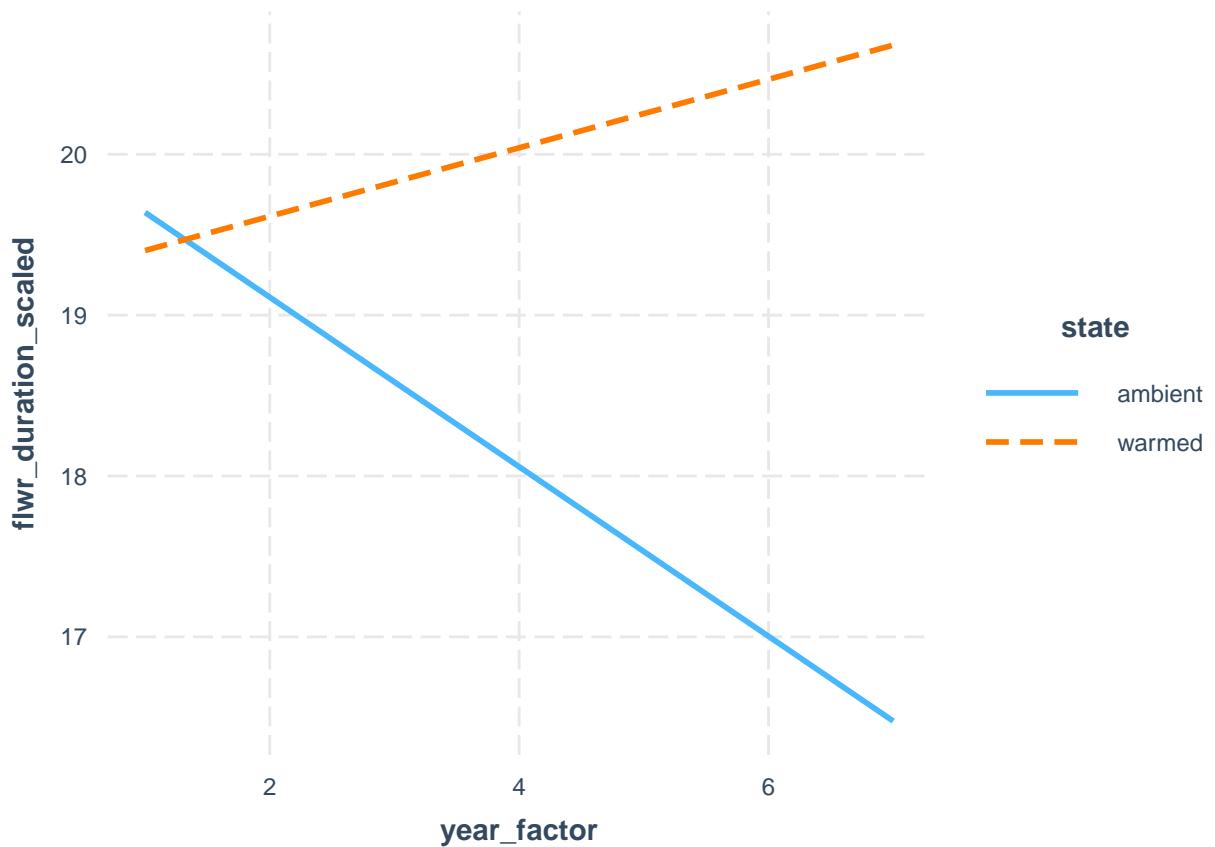
```
ols_test_normality(fit_plot_stateyear_kbs_gh) # a couple tests say not normal
```

```
## 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

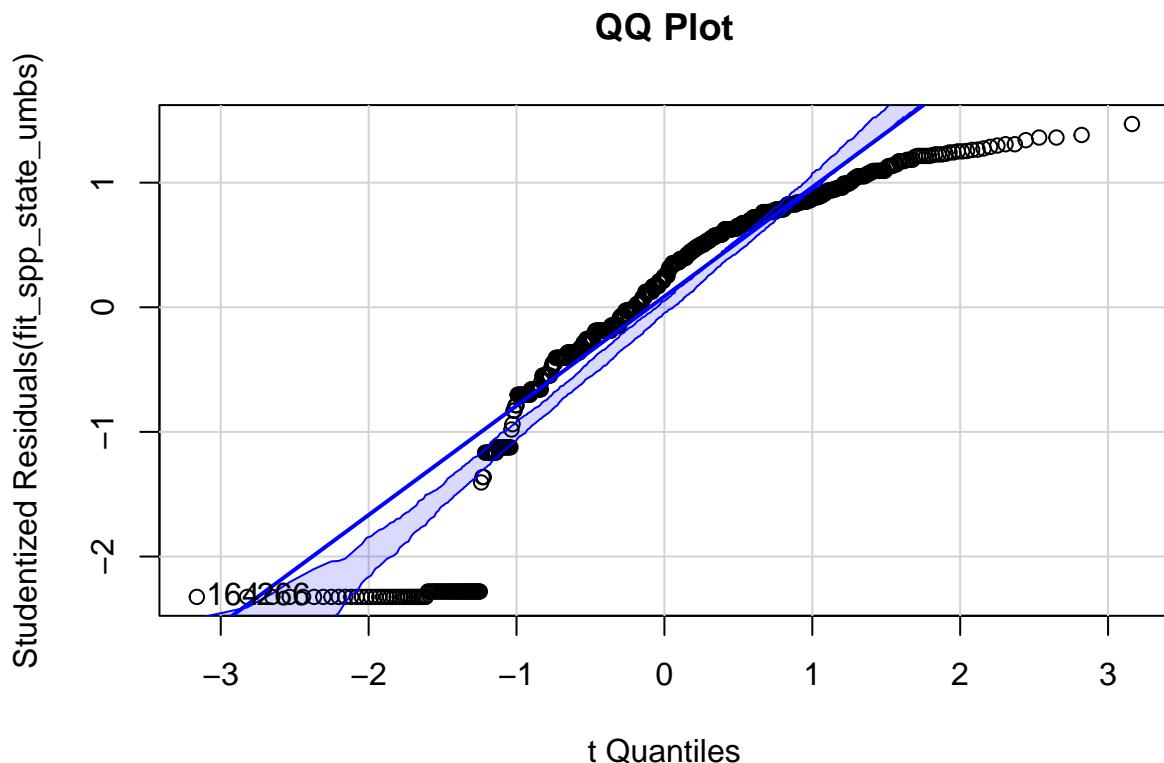
```

# 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

qqPlot(fit_spp_state_umbs, main="QQ Plot")

```



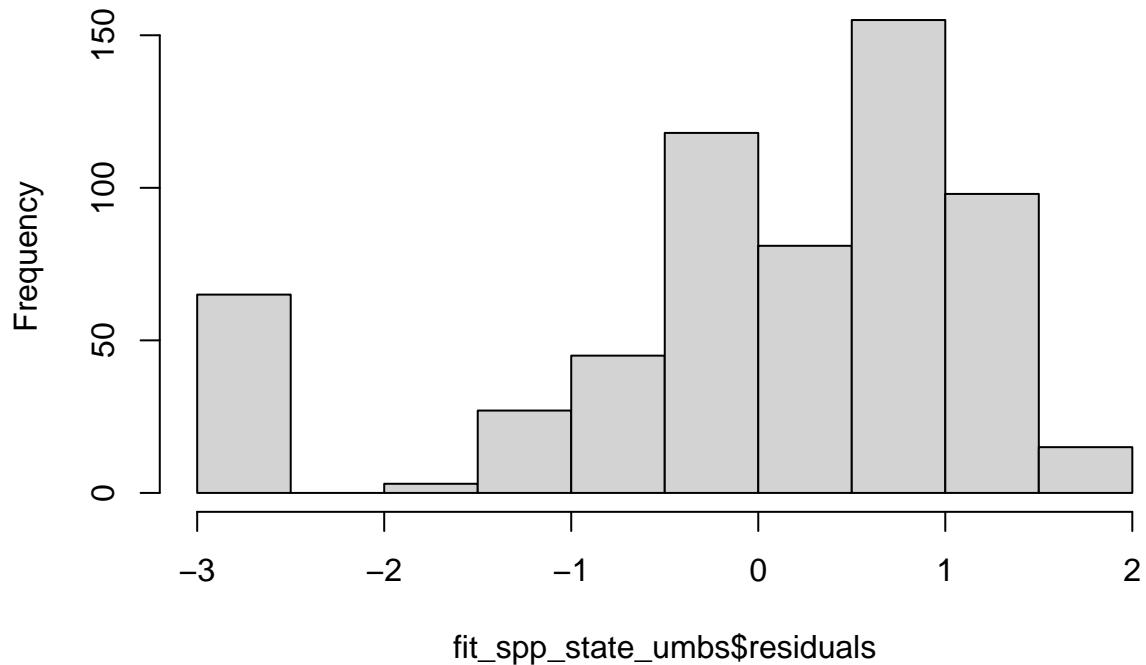
```

## 164 266
## 63 89

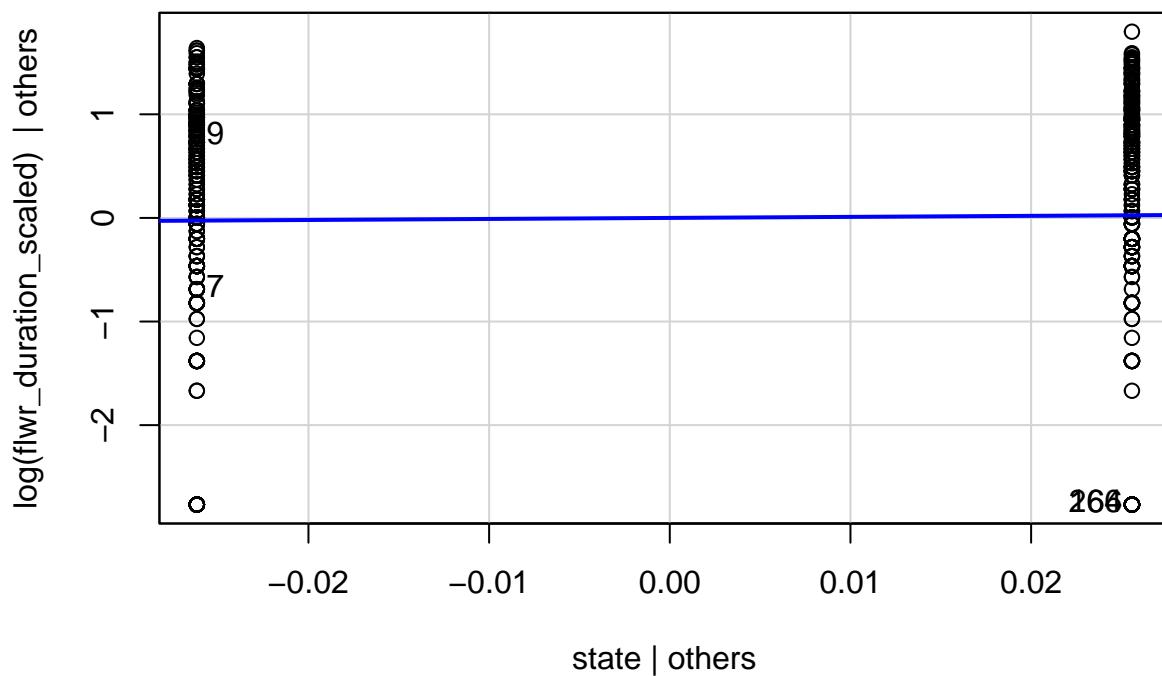
hist(fit_spp_state_umbs$residuals)

```

Histogram of fit_spp_state_umbs\$residuals



```
leveragePlots(fit_spp_state_umbs)
```



```

ols_test_normality(fit_spp_state_umbs) # ok except Kol-Smir test

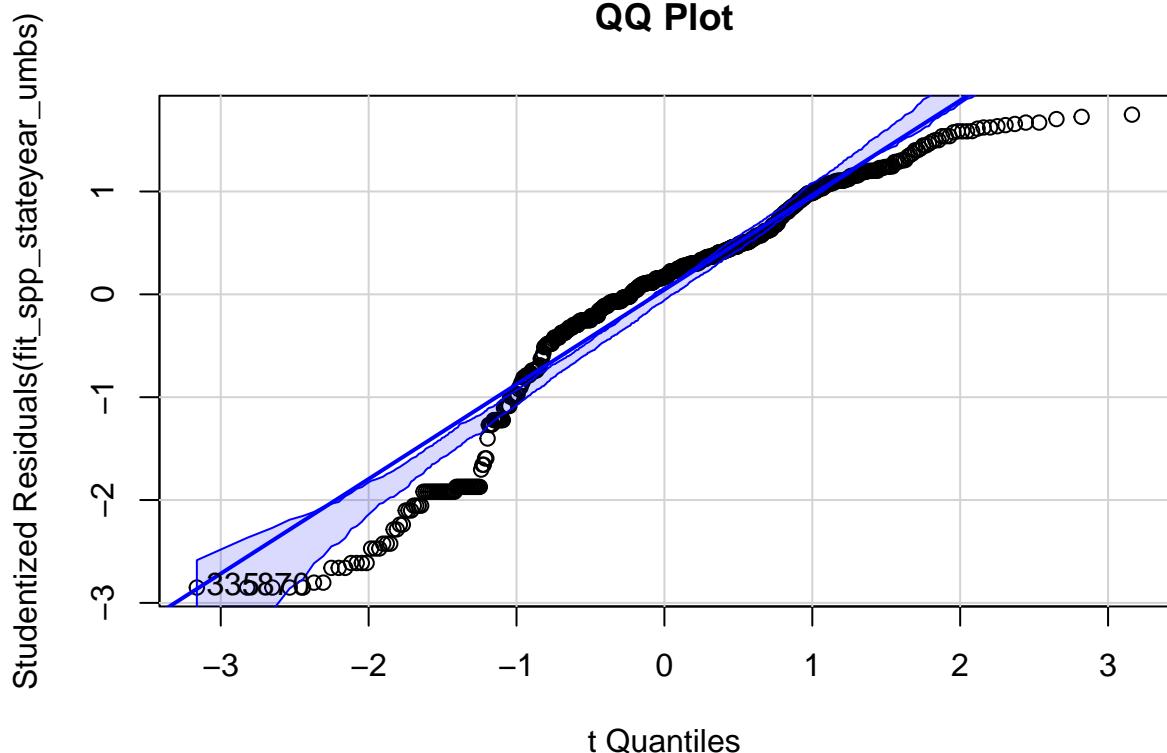
## Warning in ks.test.default(y, "pnorm", mean(y), sd(y)): ties should not be
## present for the Kolmogorov-Smirnov test

## -----
##          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")

```



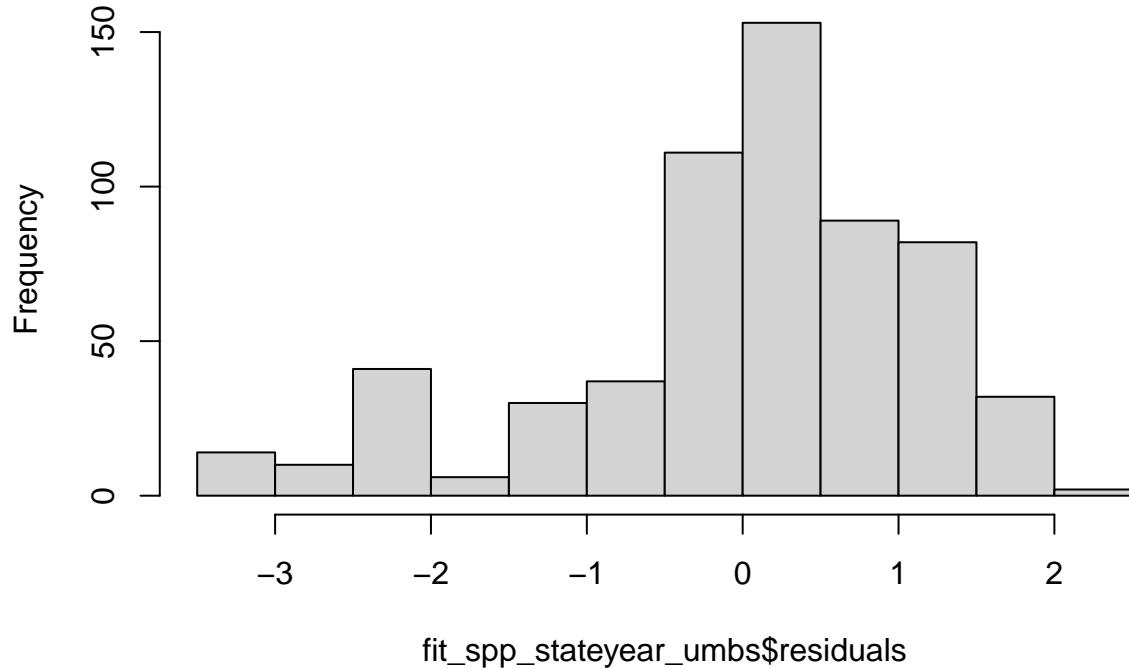
```

## 335 870
## 119 317

```

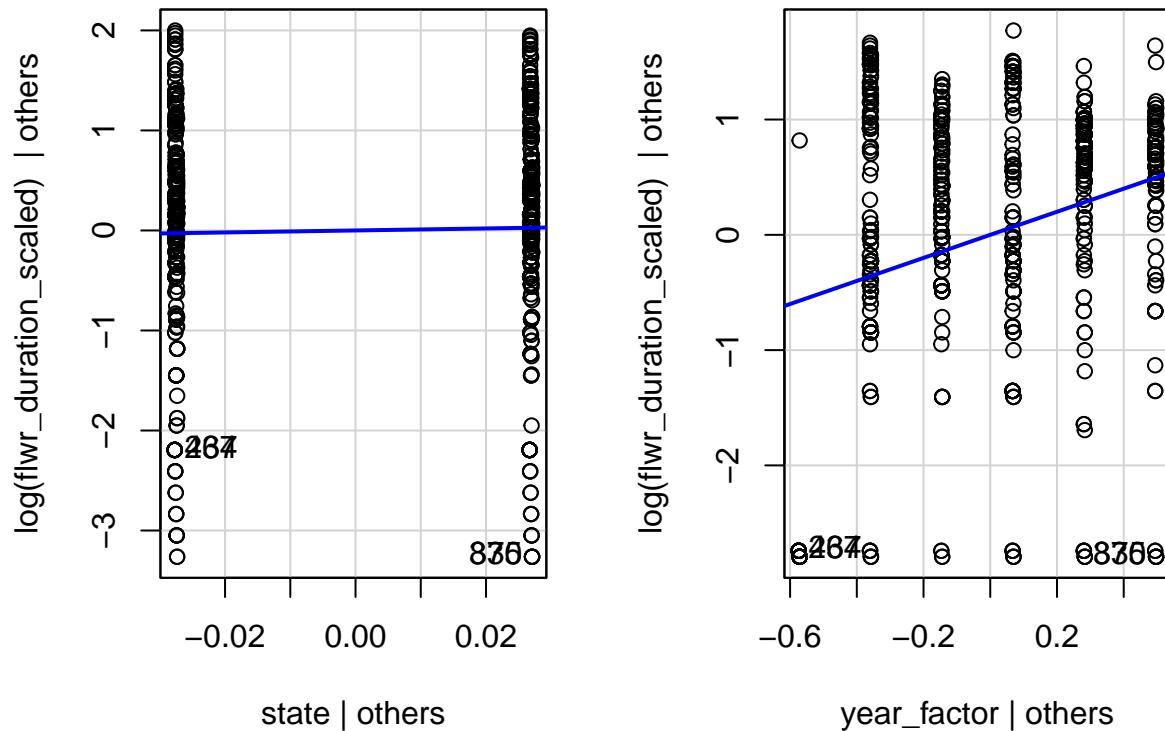
```
hist(fit_spp_stateyear_umbs$residuals)
```

Histogram of fit_spp_stateyear_umbs\$residuals



```
leveragePlots(fit_spp_stateyear_umbs)
```

Leverage Plots



```
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
```

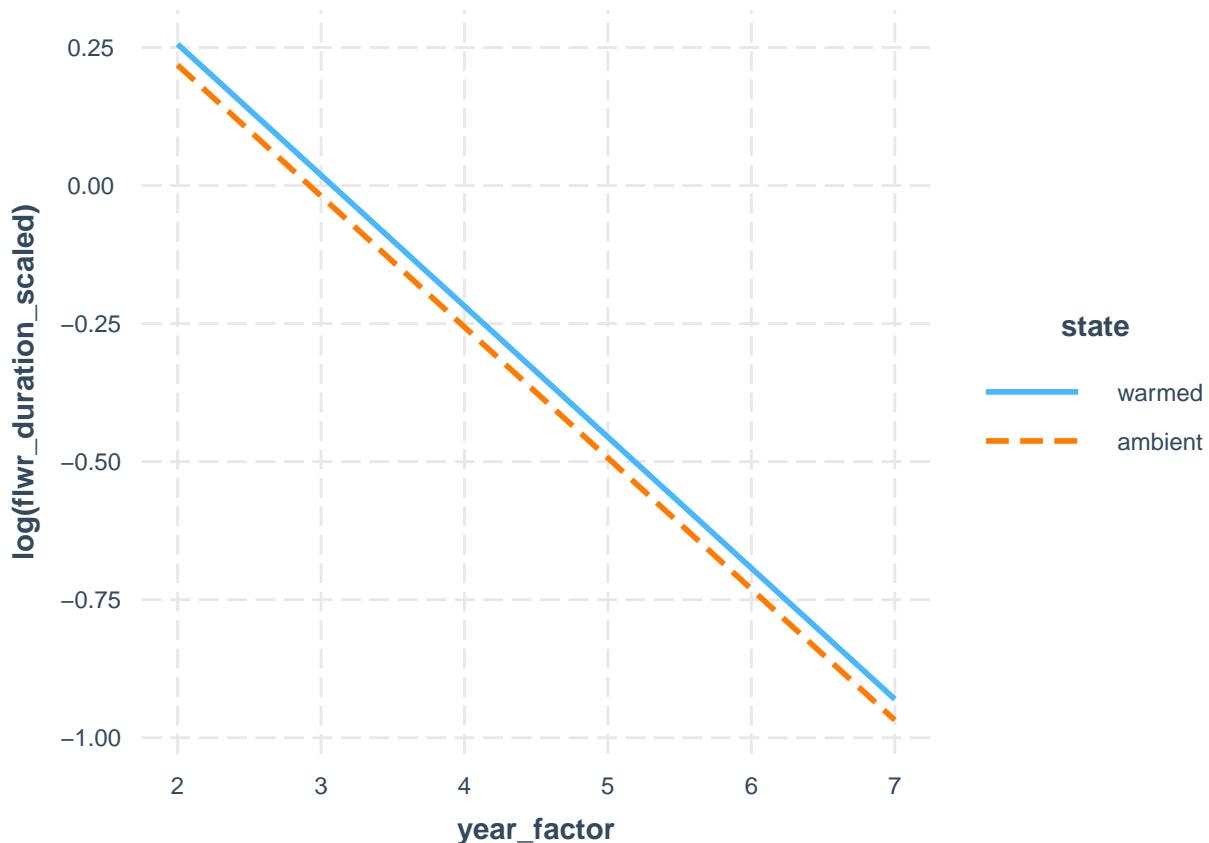
```
## -----
##          Test      Statistic     pvalue
## -----
## Shapiro-Wilk      0.9326    0.0000
## Kolmogorov-Smirnov 0.1145    0.0000
## Cramer-von Mises   27.6891   0.0000
## Anderson-Darling    13.2353   0.0000
## -----
```

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.

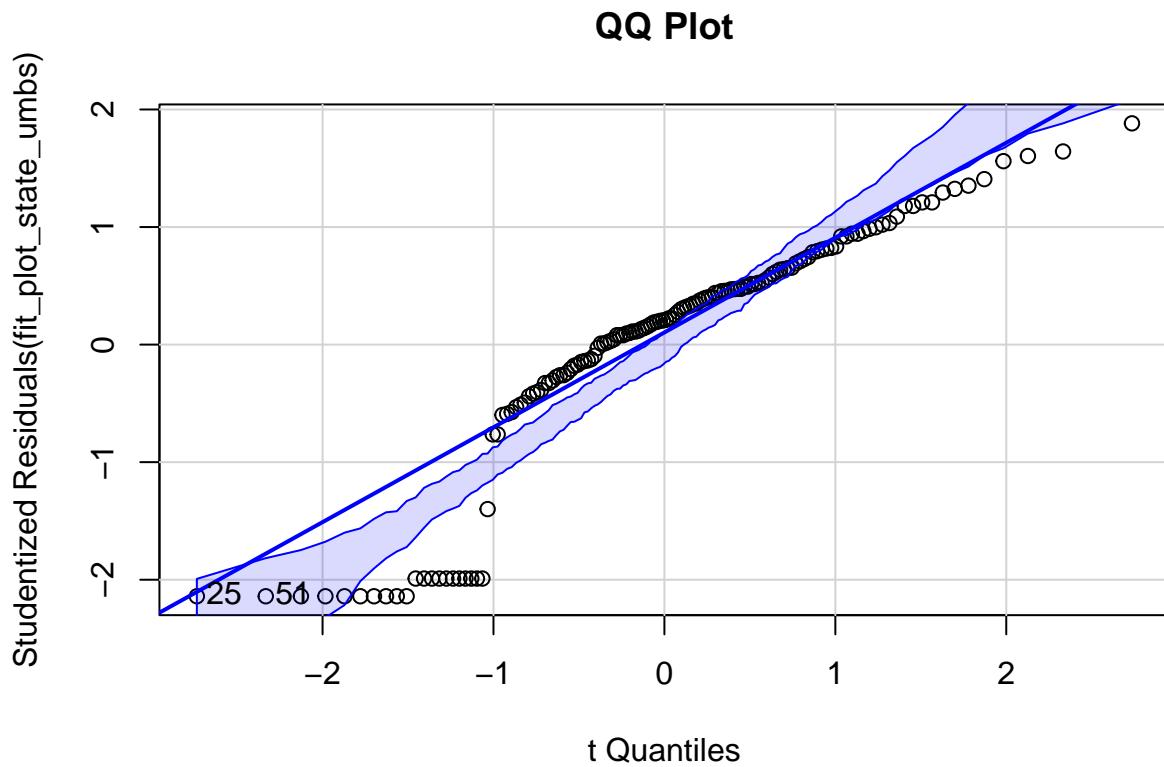


```
# Plot level data
# UMBS State-only model
fit_plot_state_umbs <- lm(flower_duration_scaled ~ state, data = umbs_flwr_plot)
outlierTest(fit_plot_state_umbs) # no outliers
```

```
## 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")
```

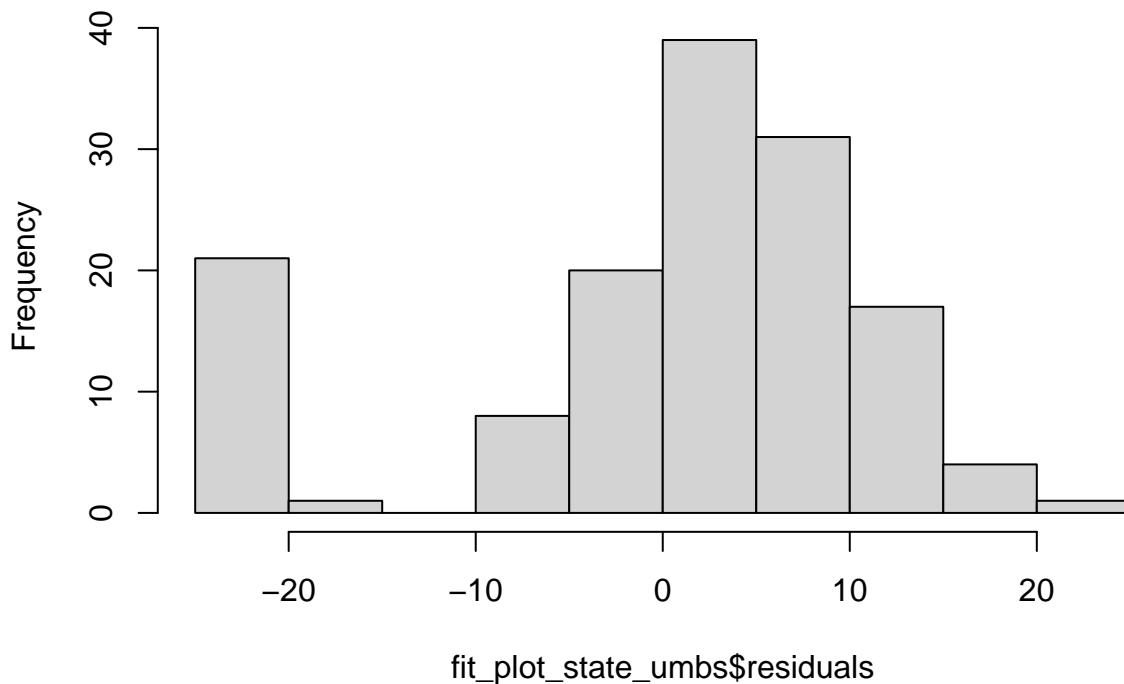
```
## Warning in rlm.default(x, y, weights, method = method, wt.method = wt.method, :
## 'rlm' failed to converge in 20 steps
```



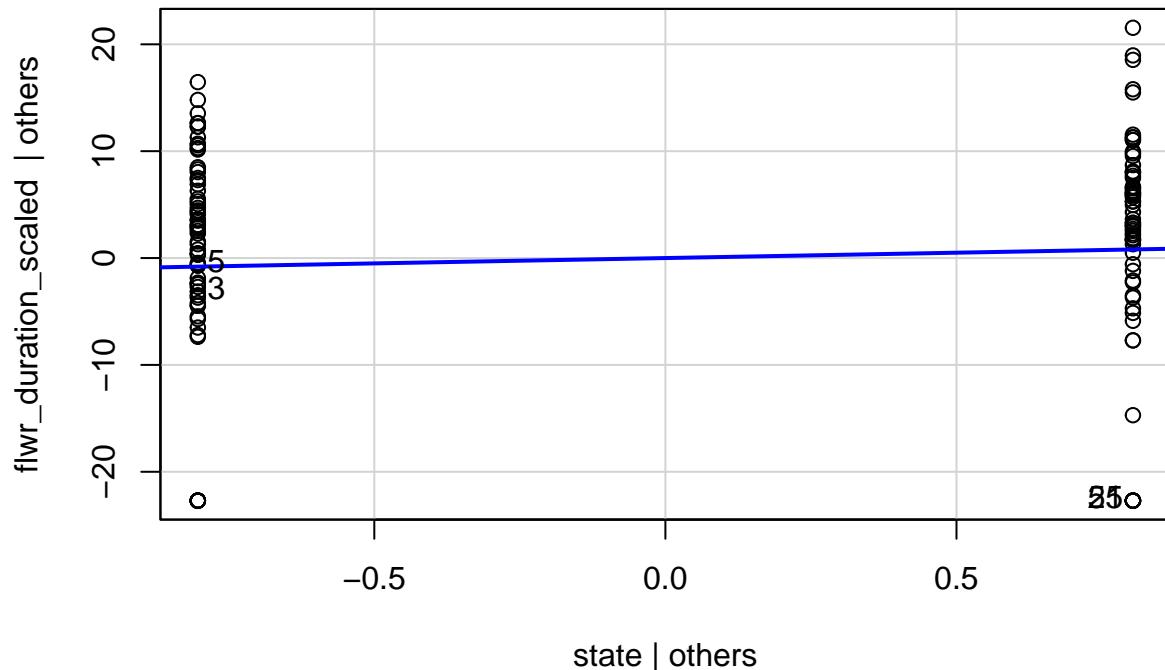
```
## 25 51
## 11 23
```

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

Histogram of 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
```

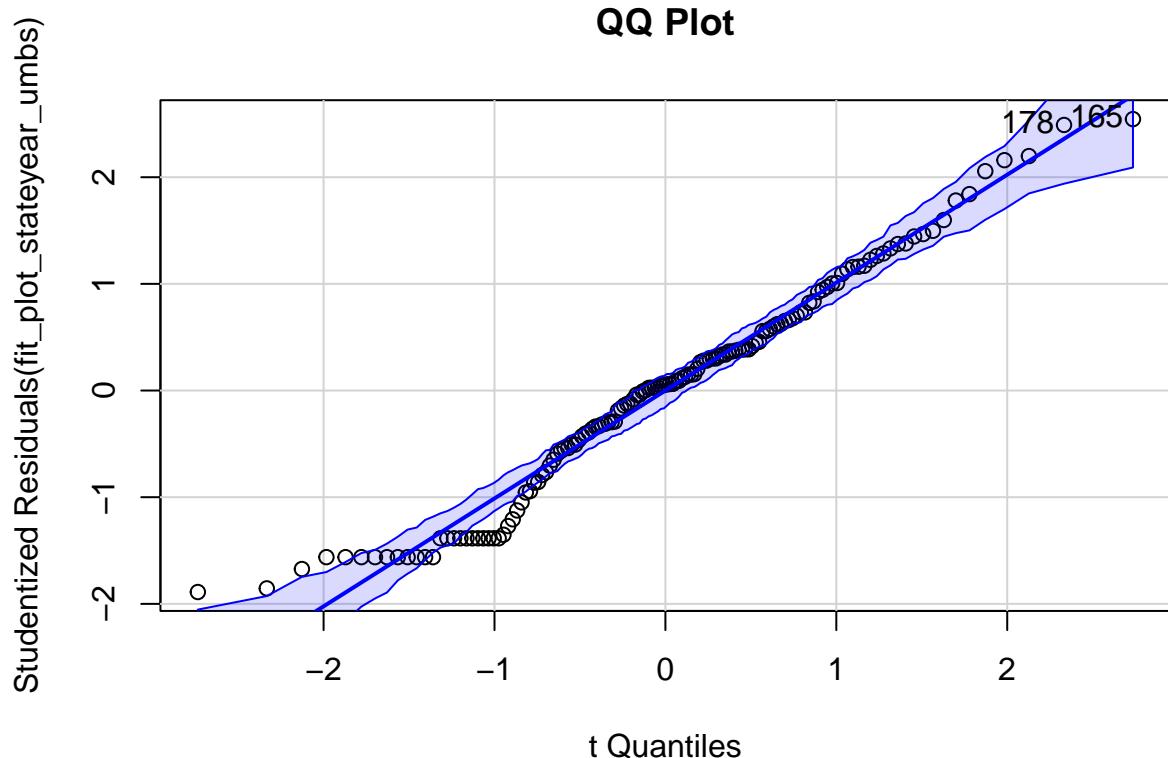
```
## -----  
## Test Statistic pvalue  
## -----  
## Shapiro-Wilk 0.8842 0.0000  
## Kolmogorov-Smirnov 0.1514 0.0030  
## Cramer-von Mises 12.7686 0.0000  
## Anderson-Darling 6.0738 0.0000  
## -----
```

```
# 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
```

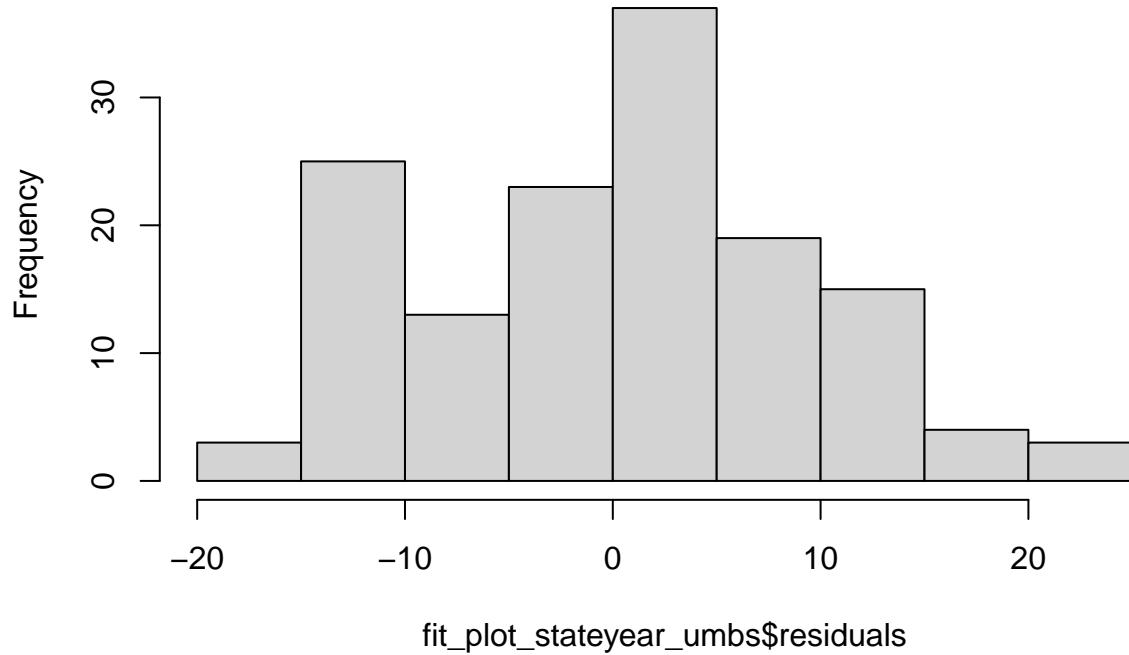
```
qqPlot(fit_plot_stateyear_umbs, main="QQ Plot")
```



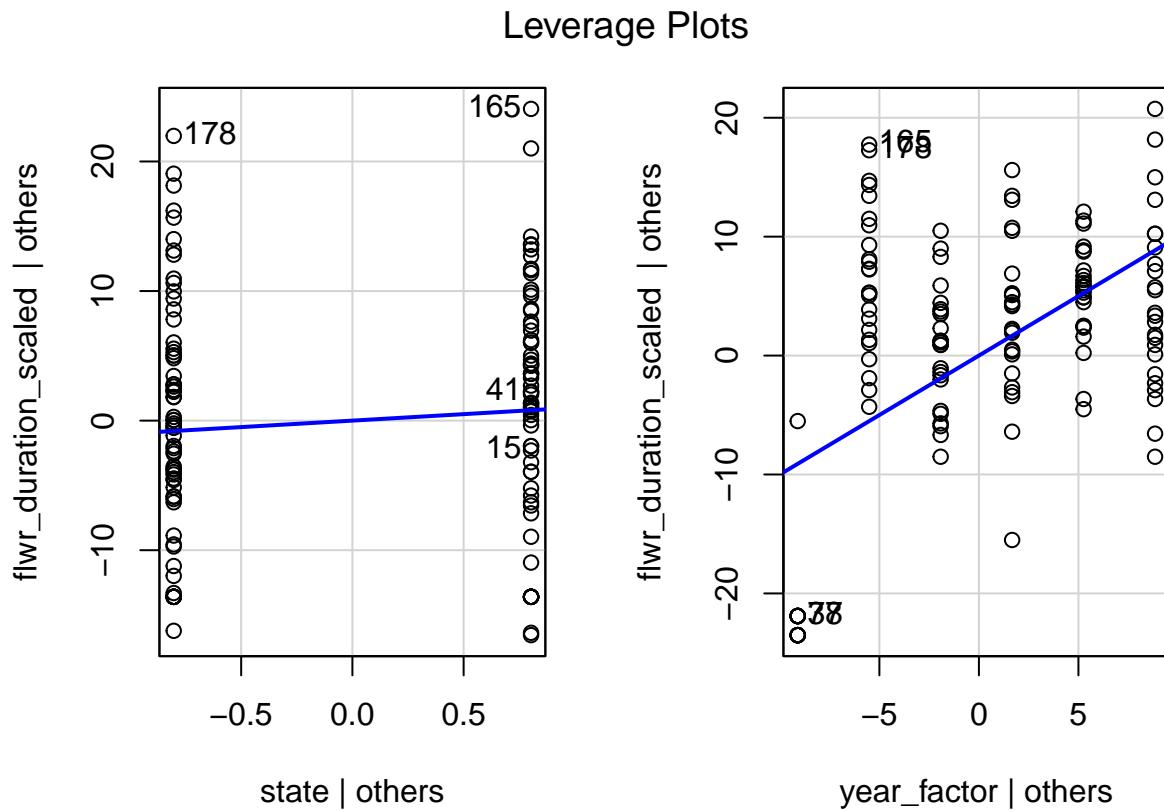
```
## 165 178  
## 75 81
```

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

Histogram of fit_plot_stateyear_umbs\$residuals



```
leveragePlots(fit_plot_stateyear_umbs)
```



```

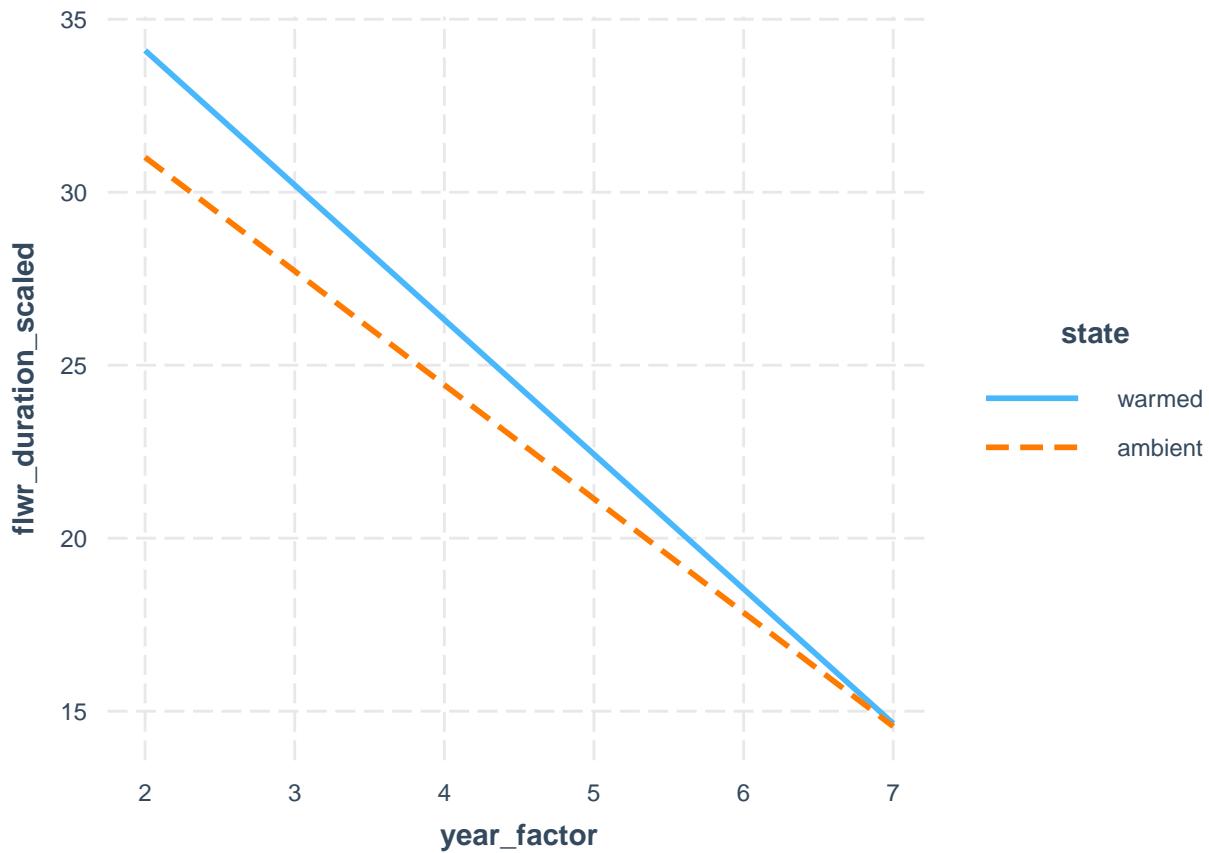
ols_test_normality(fit_plot_stateyear_umbs) # these look good except Kolmogorov-Smirnov which is > 0.05

## 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)

```



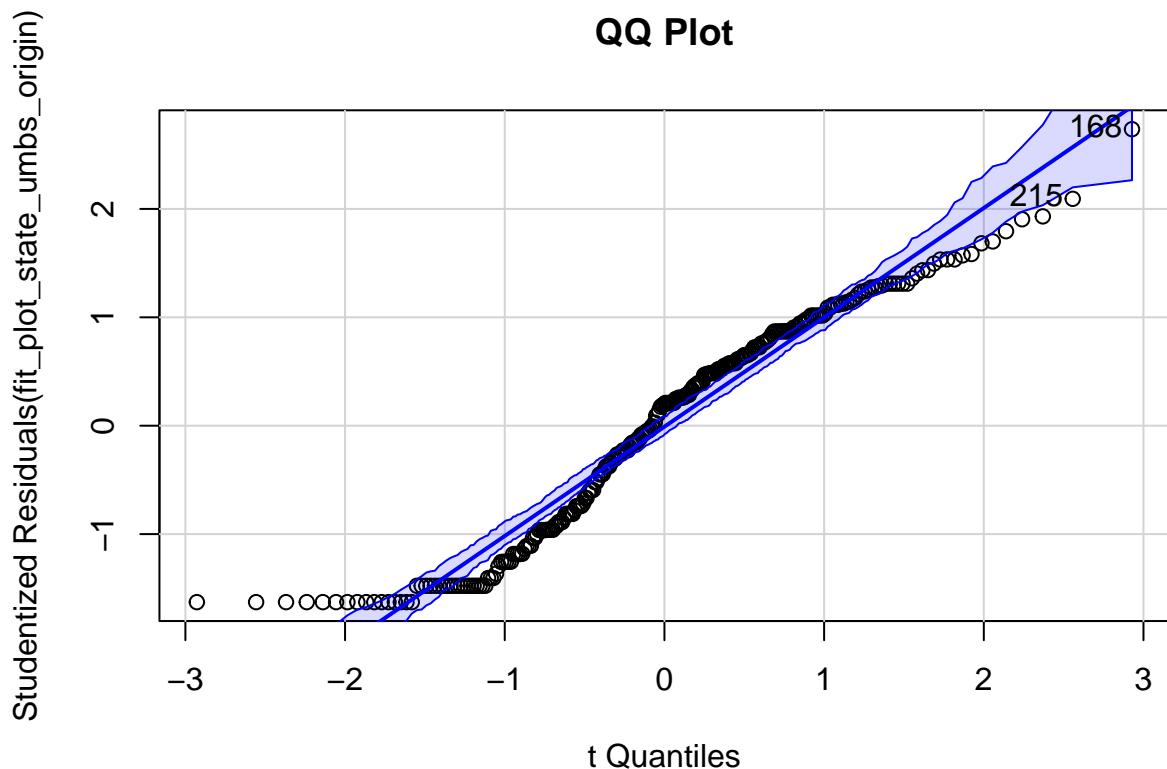
```

# 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
```

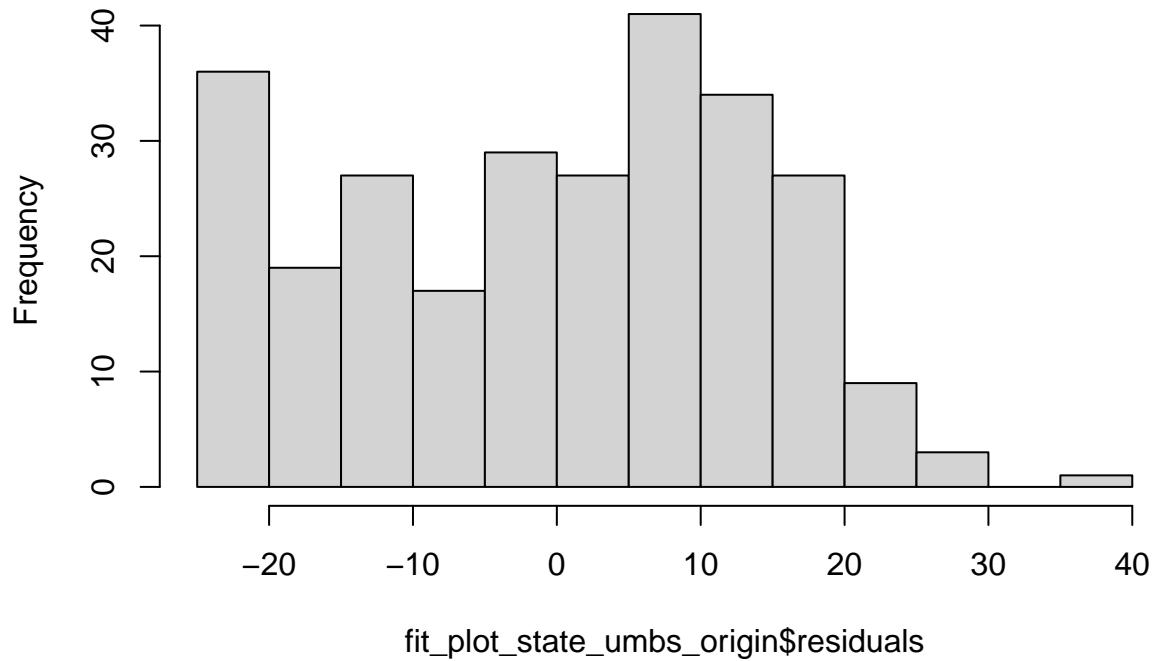
```
qqPlot(fit_plot_state_umbs_origin, main="QQ Plot")
```



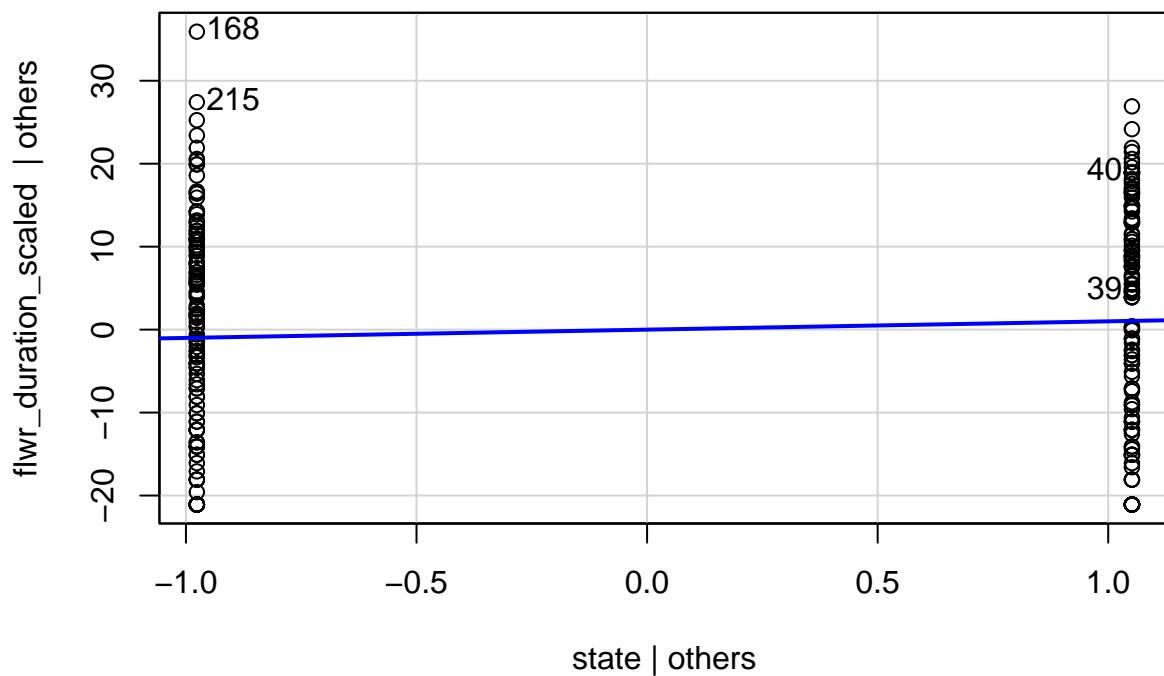
```
## 168 215
## 66 86
```

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

Histogram of 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
```

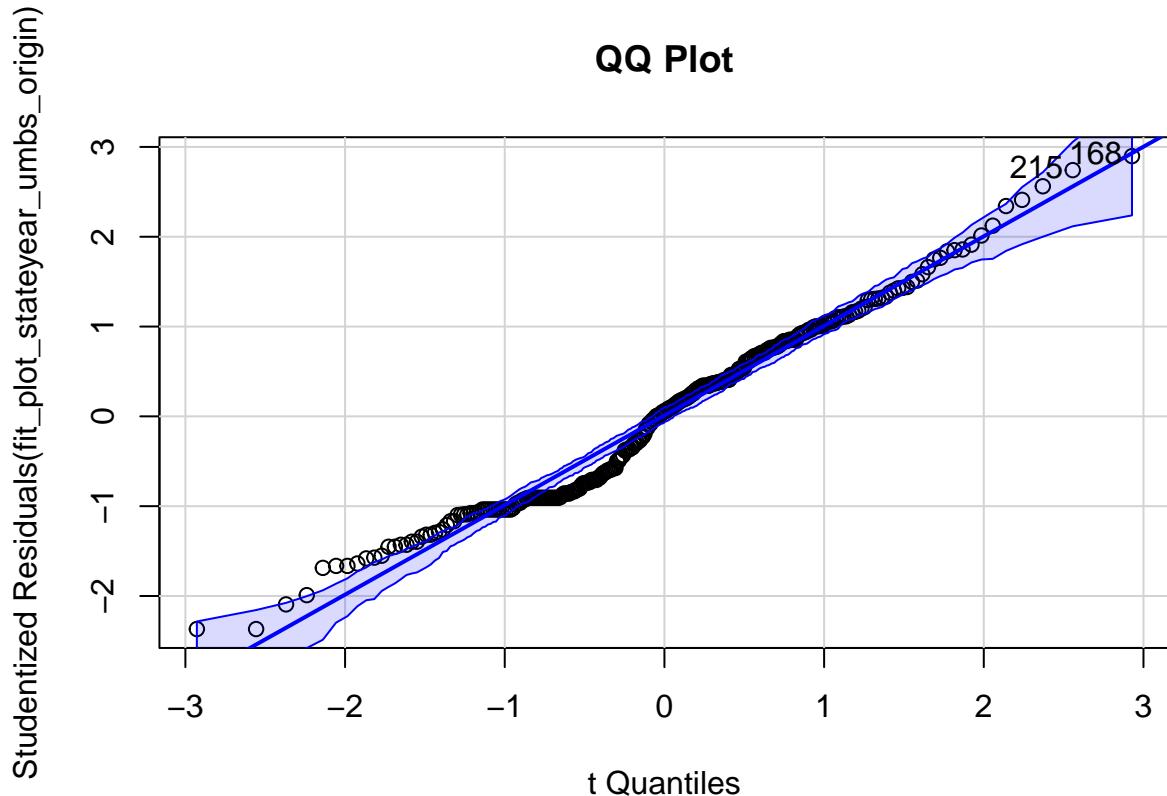
```
## -----
##          Test      Statistic     pvalue
## -----
## Shapiro-Wilk      0.9547    0.0000
## Kolmogorov-Smirnov   0.0836    0.0461
## Cramer-von Mises   22.4145    0.0000
## Anderson-Darling    3.7544    0.0000
## -----
```

```
# 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
```

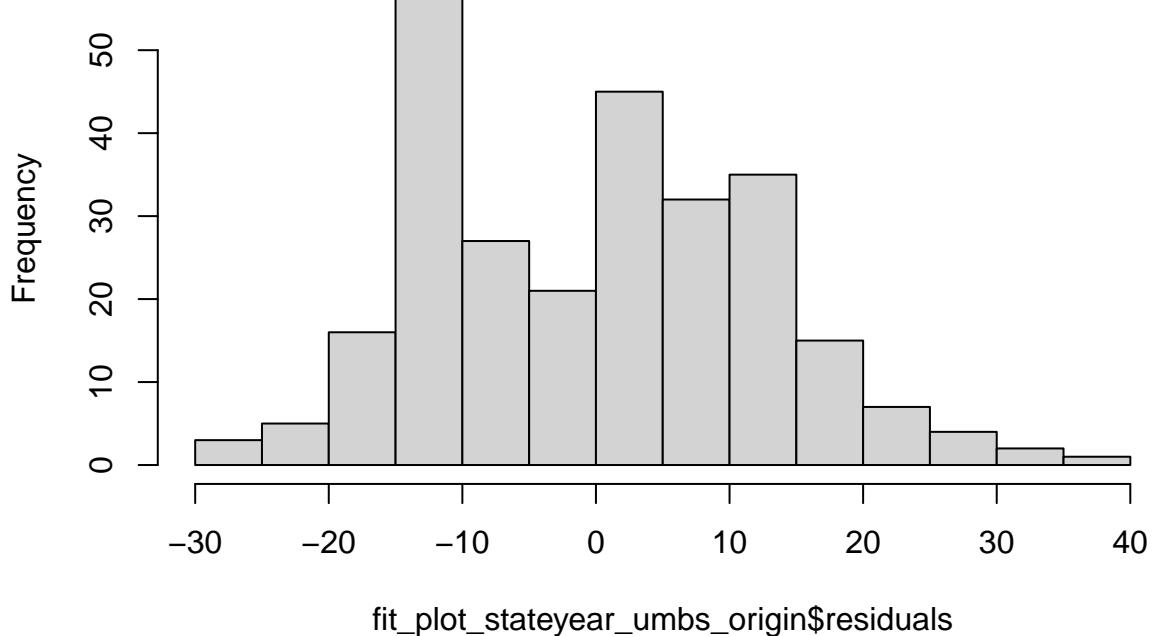
```
qqPlot(fit_plot_stateyear_umbs_origin, main="QQ Plot")
```



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

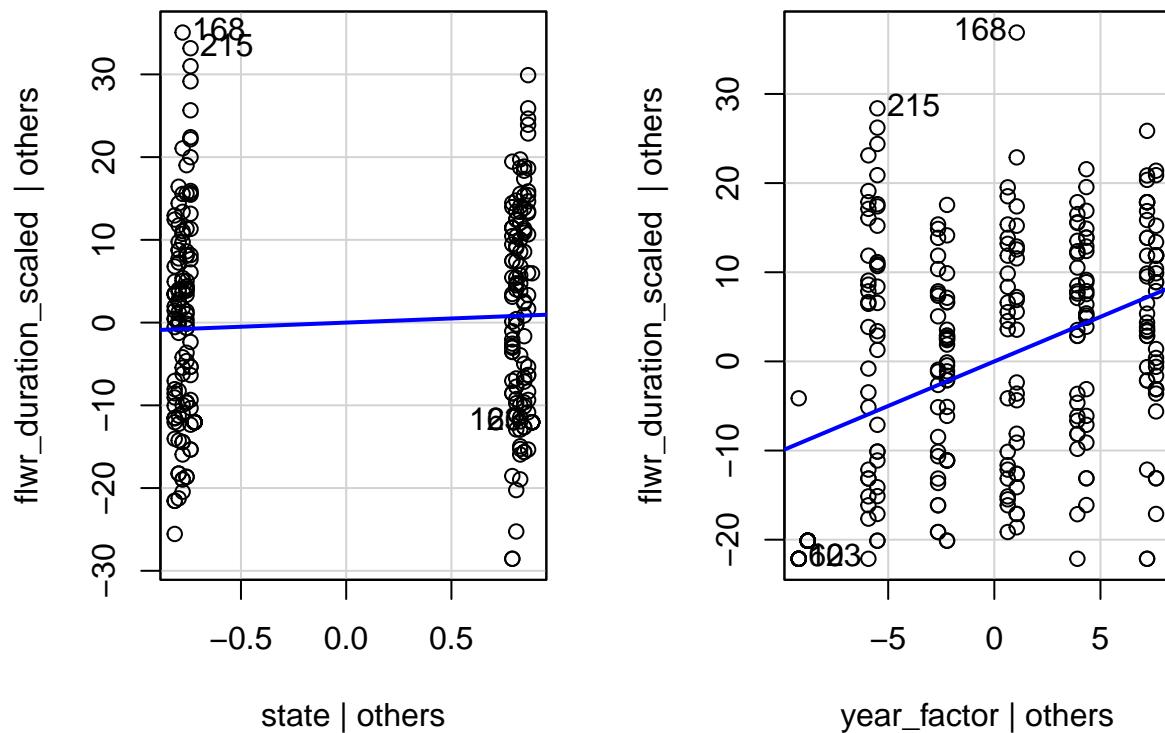
```
hist(fit_plot_stateyear_umbs_origin$residuals)
```

Histogram of fit_plot_stateyear_umbs_origin\$residuals



```
leveragePlots(fit_plot_stateyear_umbs_origin)
```

Leverage Plots



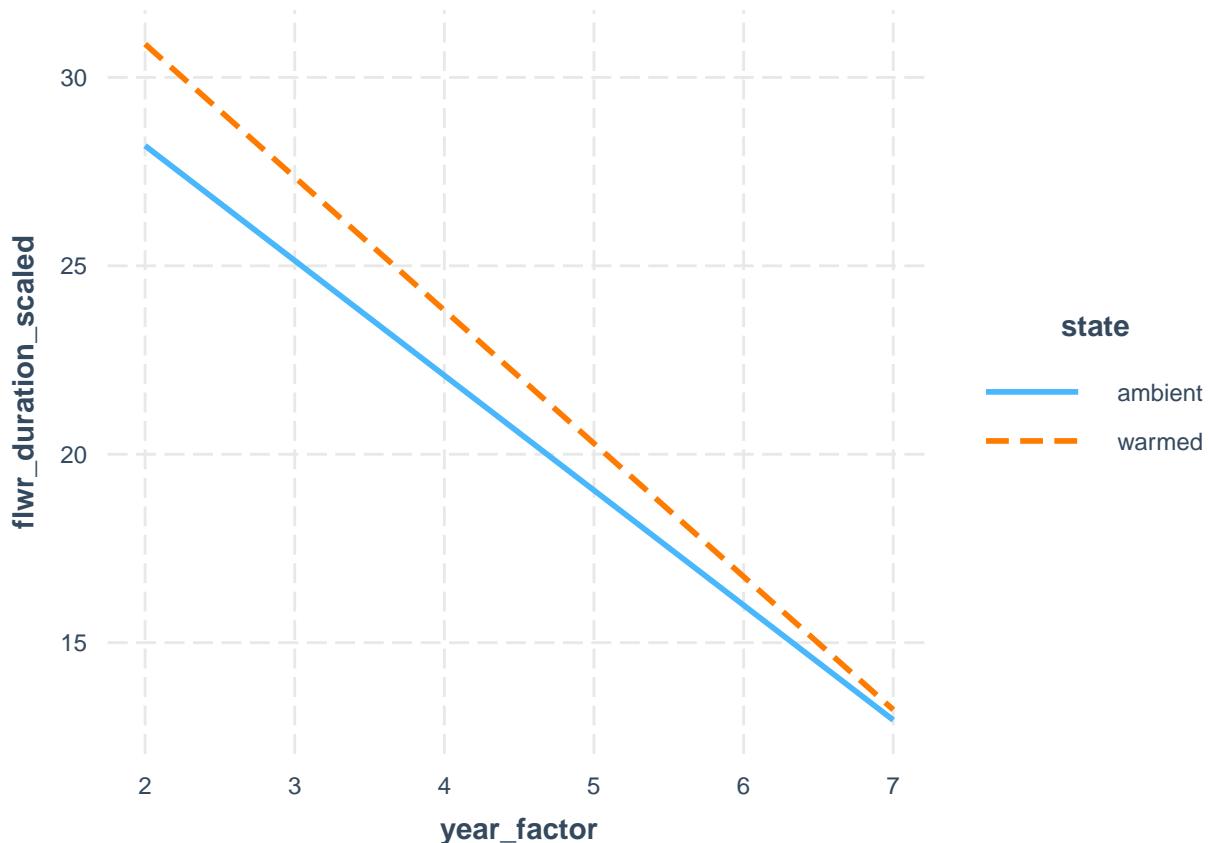
```
ols_test_normality(fit_plot_stateyear_umbs_origin) # these don't look great either
```

```
## 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)
```



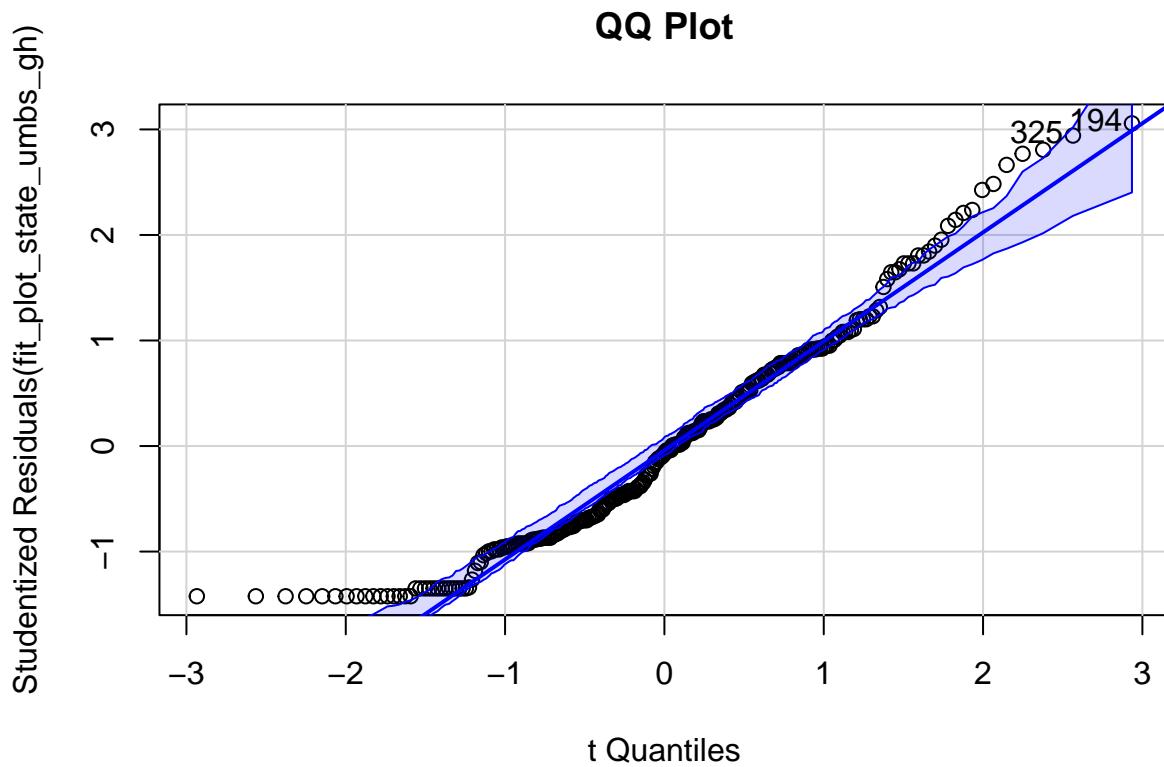
```

# 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")

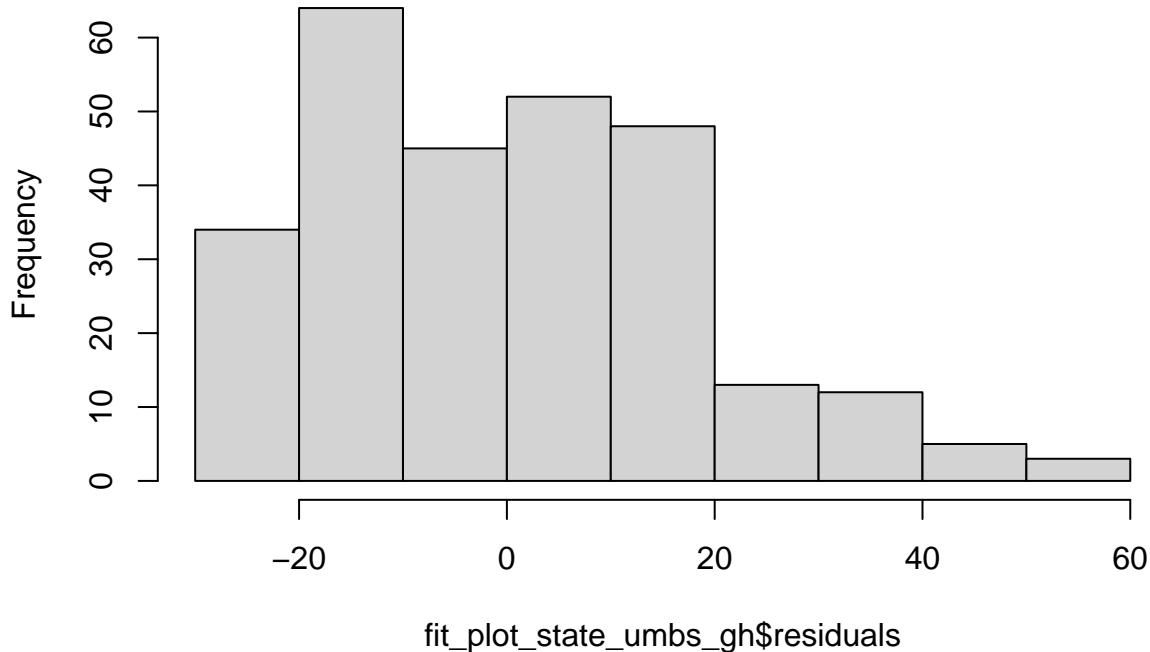
```



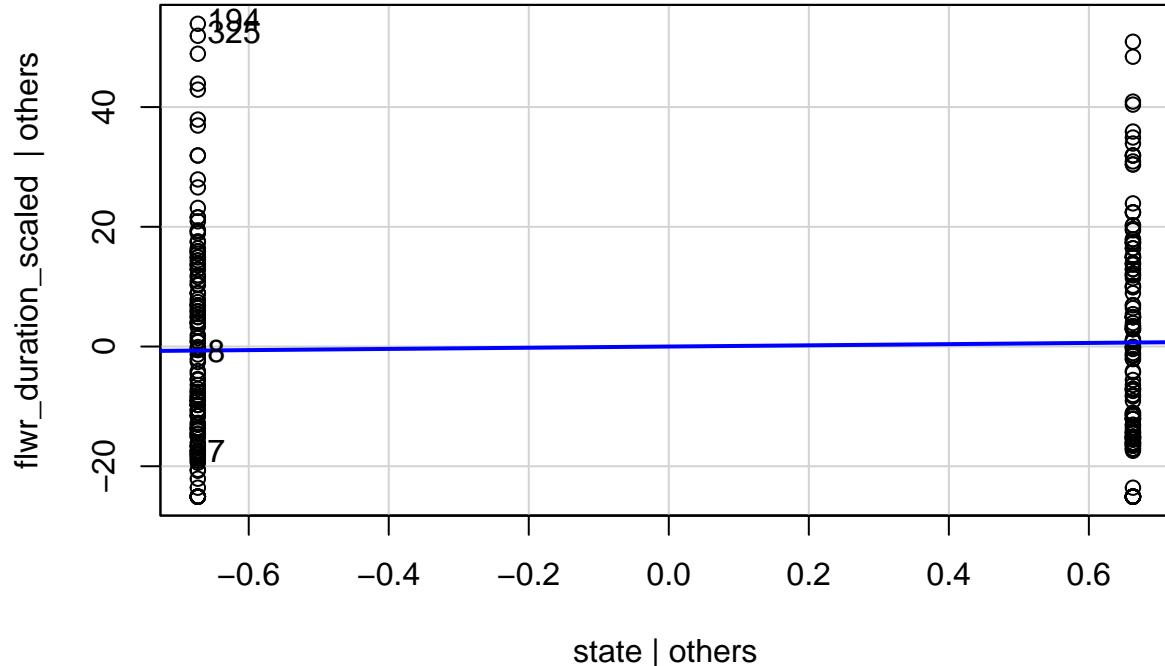
```
## 194 325
## 78 129
```

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

Histogram of 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
```

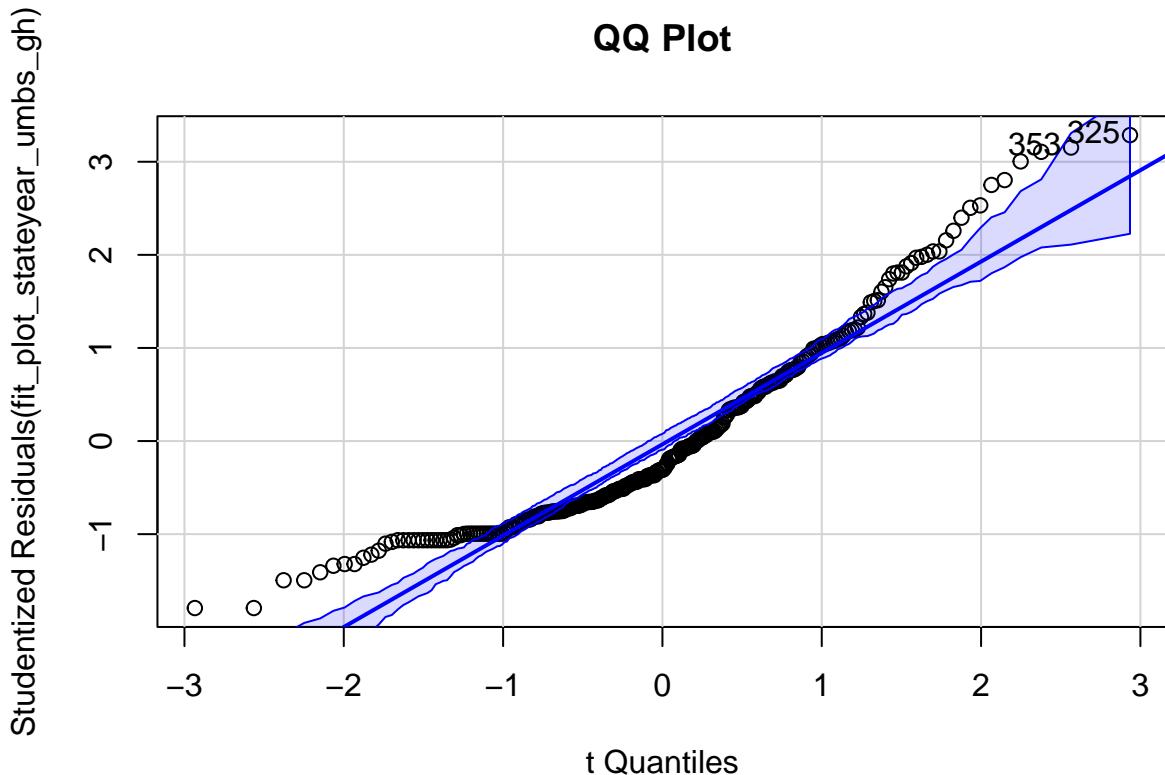
```
## -----
##      Test       Statistic     pvalue
## -----
## Shapiro-Wilk      0.954     0.0000
## Kolmogorov-Smirnov 0.0927    0.0174
## Cramer-von Mises  22.0397   0.0000
## Anderson-Darling   2.8599    0.0000
## -----
```

```
# 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
```

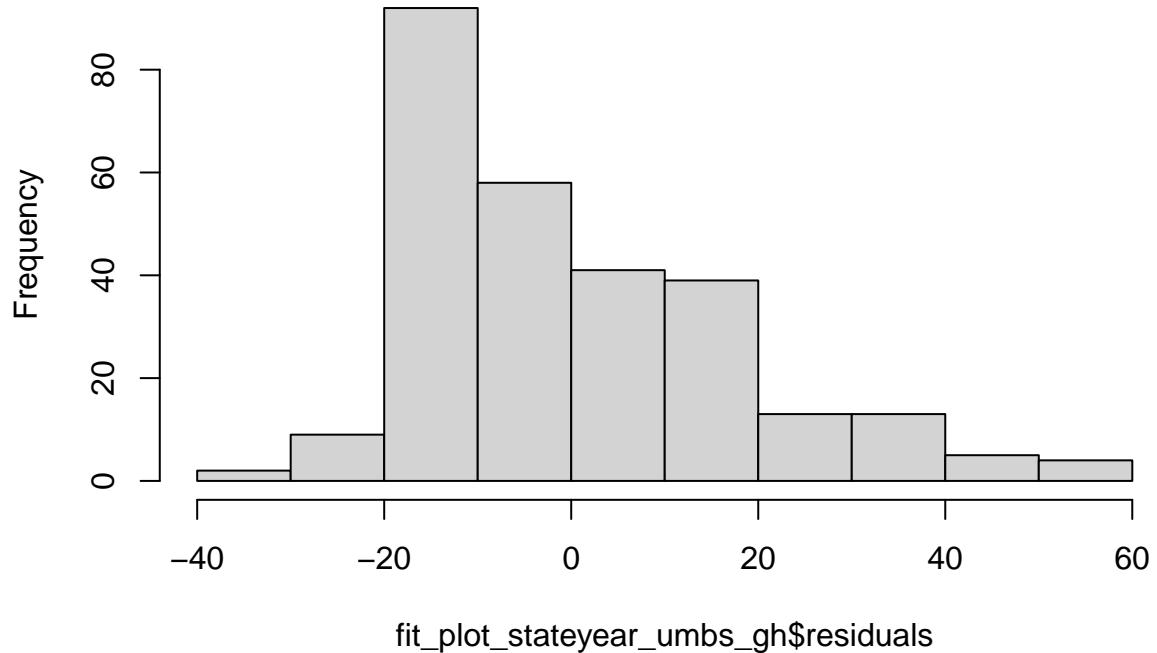
```
qqPlot(fit_plot_stateyear_umbs_gh, main="QQ Plot")
```



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

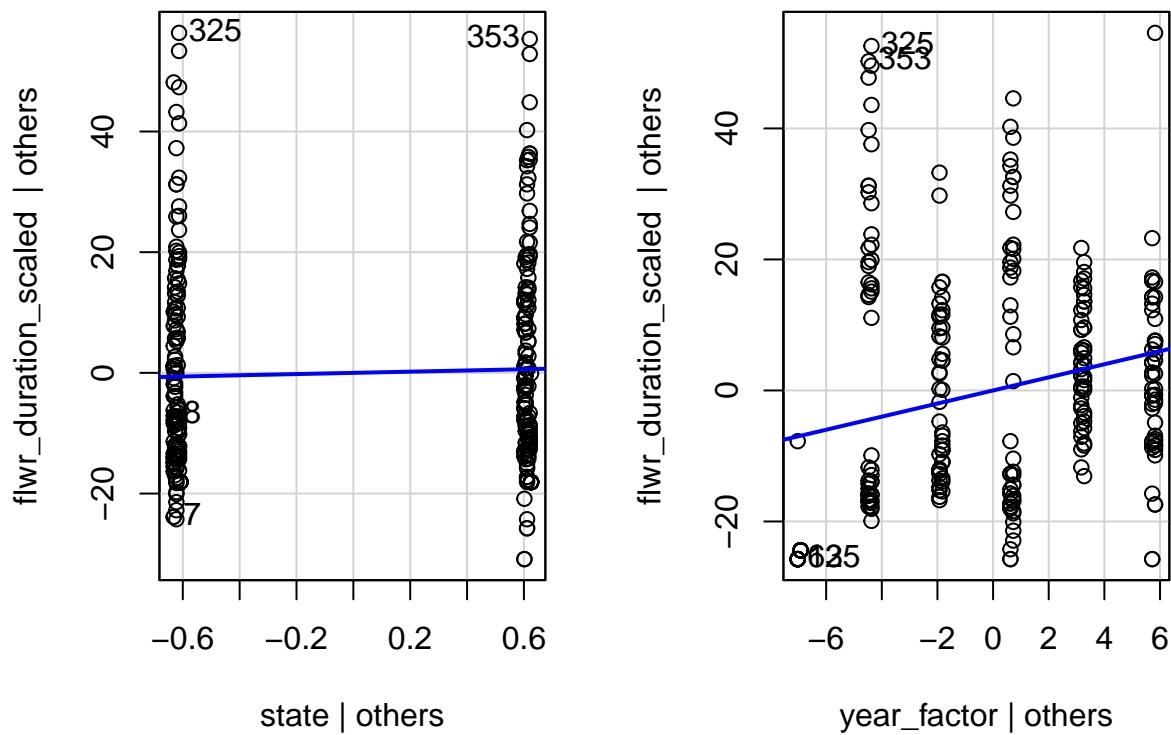
```
hist(fit_plot_stateyear_umbs_gh$residuals)
```

Histogram of fit_plot_stateyear_umbs_gh\$residuals



```
leveragePlots(fit_plot_stateyear_umbs_gh)
```

Leverage Plots

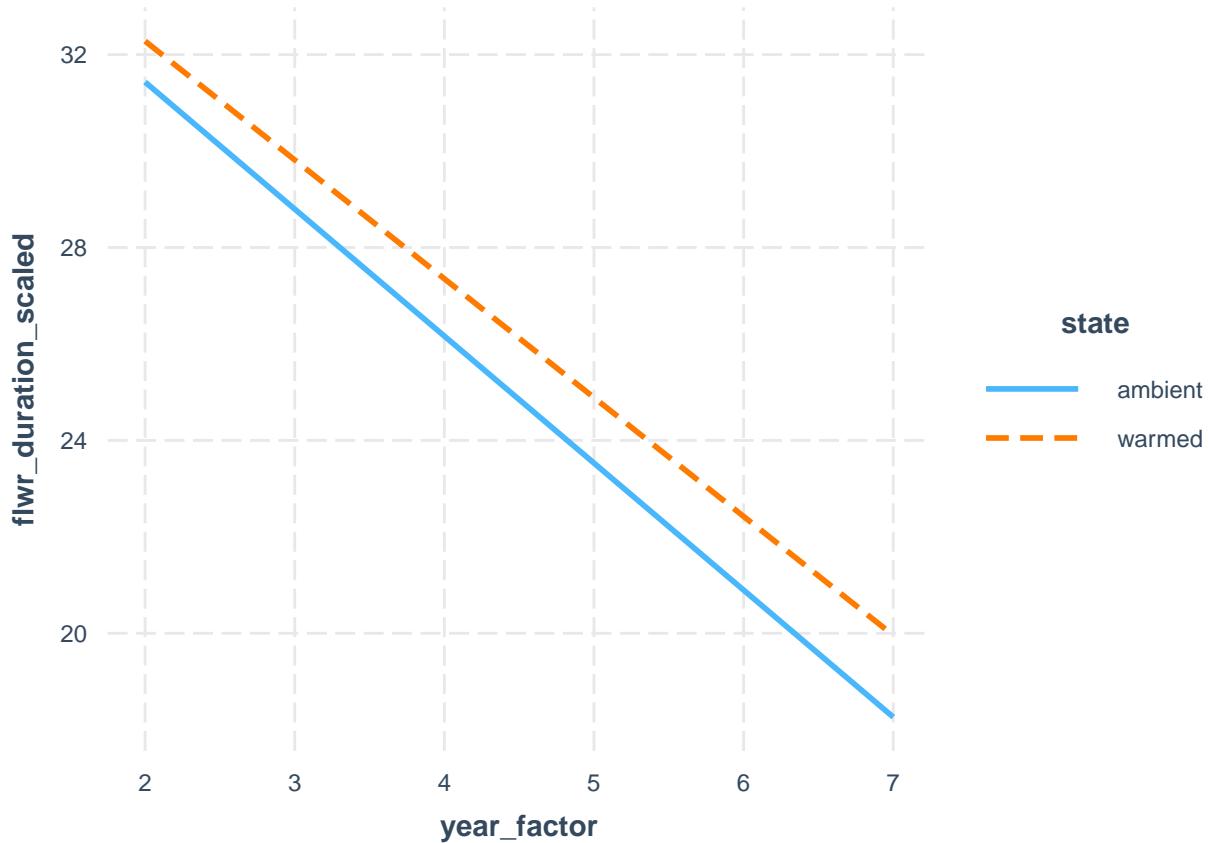


```
ols_test_normality(fit_plot_stateyear_umbs_gh) # these don't look great either
```

```
## 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

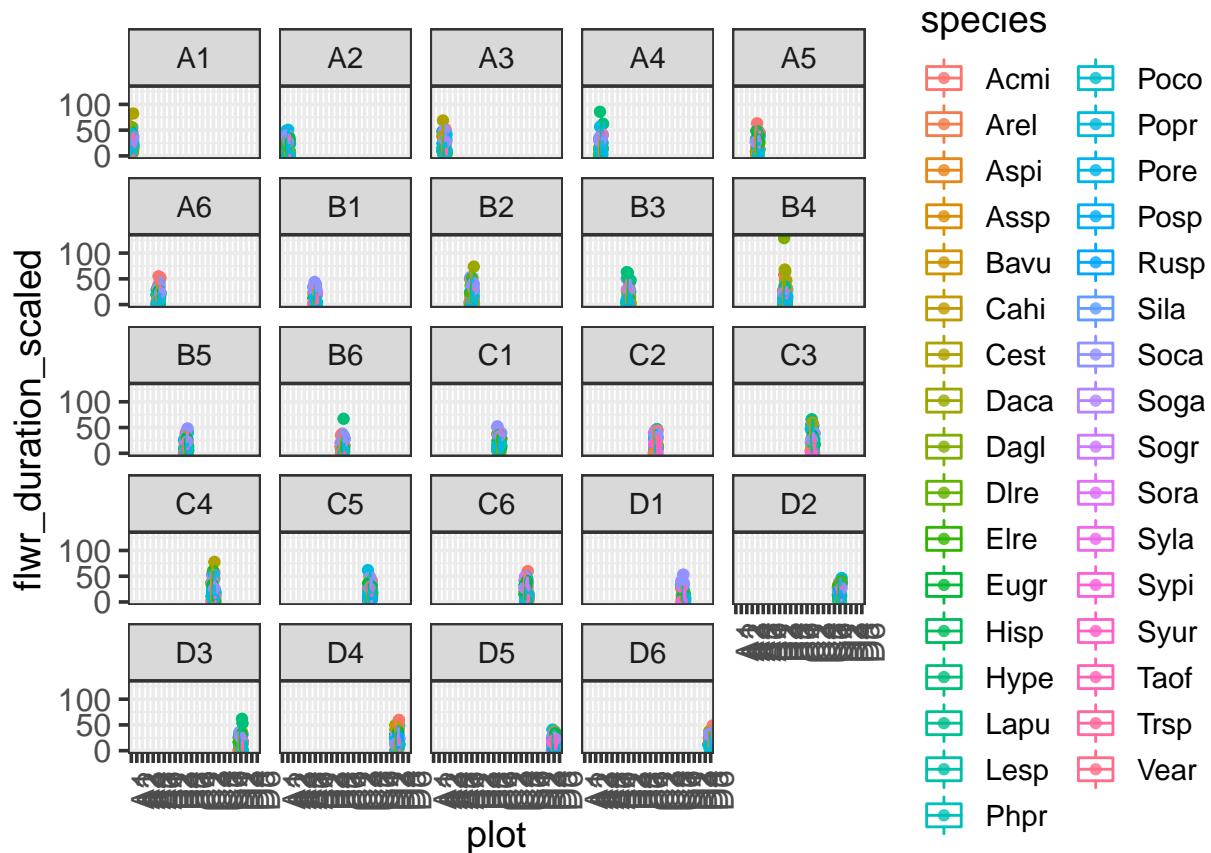
KBS

```
# 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=0.5)
```



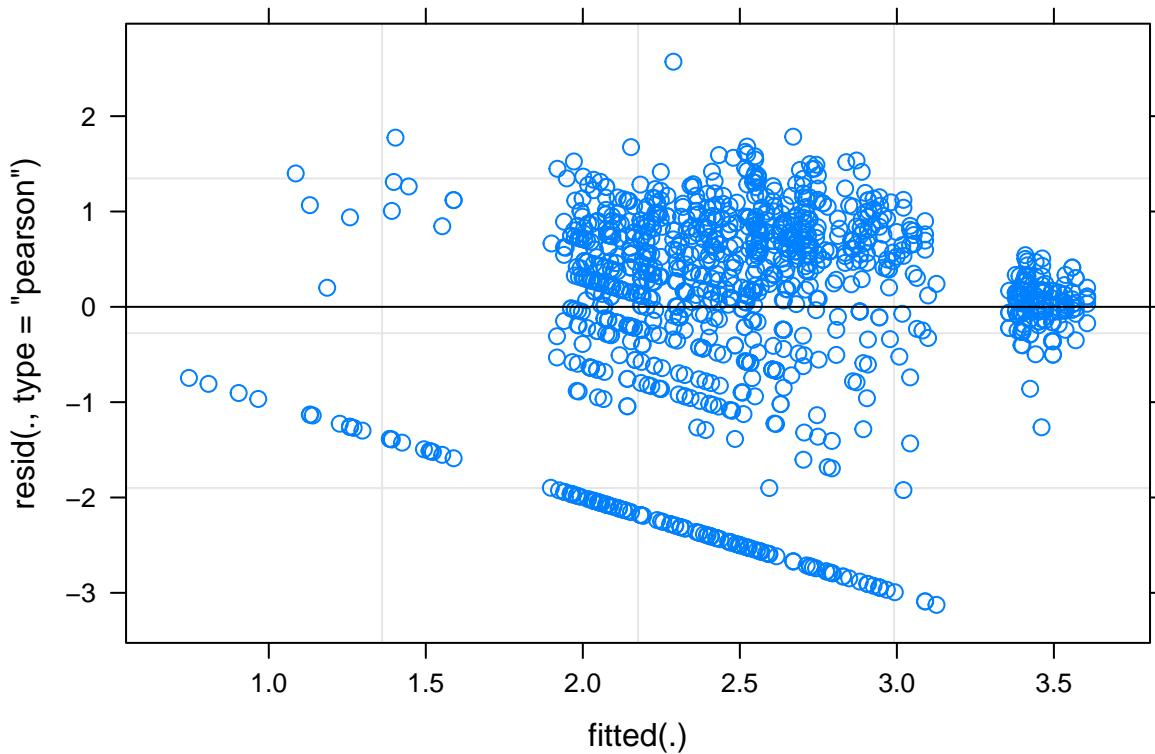
```
# Check Assumptions:
```

```
# (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-value
# is less than 0.05, then the null hypothesis is rejected

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

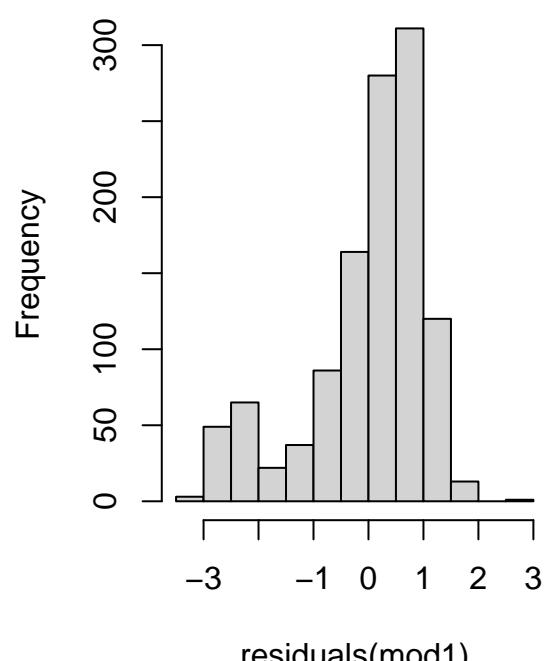
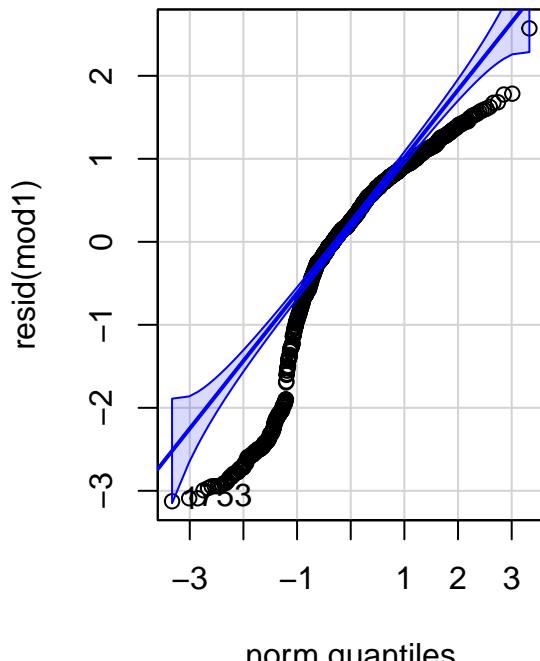
```

```

hist(residuals(mod1))

```

Histogram of 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
```

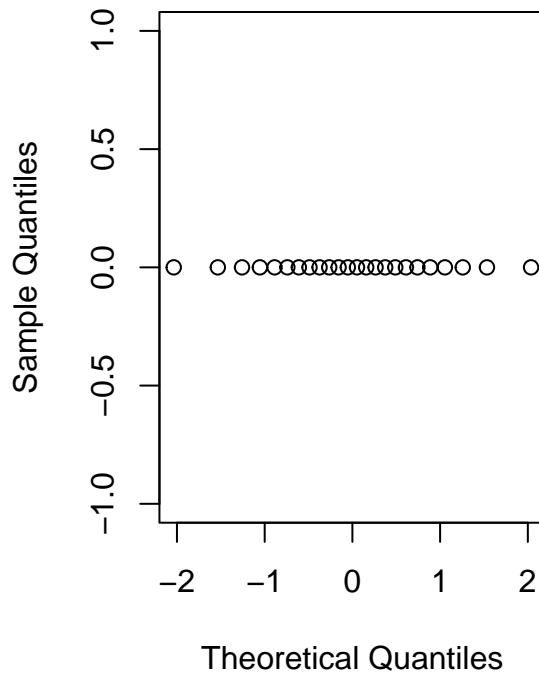
```
# (4) Normality of random effect: Get the estimate of random effect (e.g., random intercepts), and check
```

```
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
```

Normal Q–Q Plot



```

# 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|plot)

## 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)
```

```

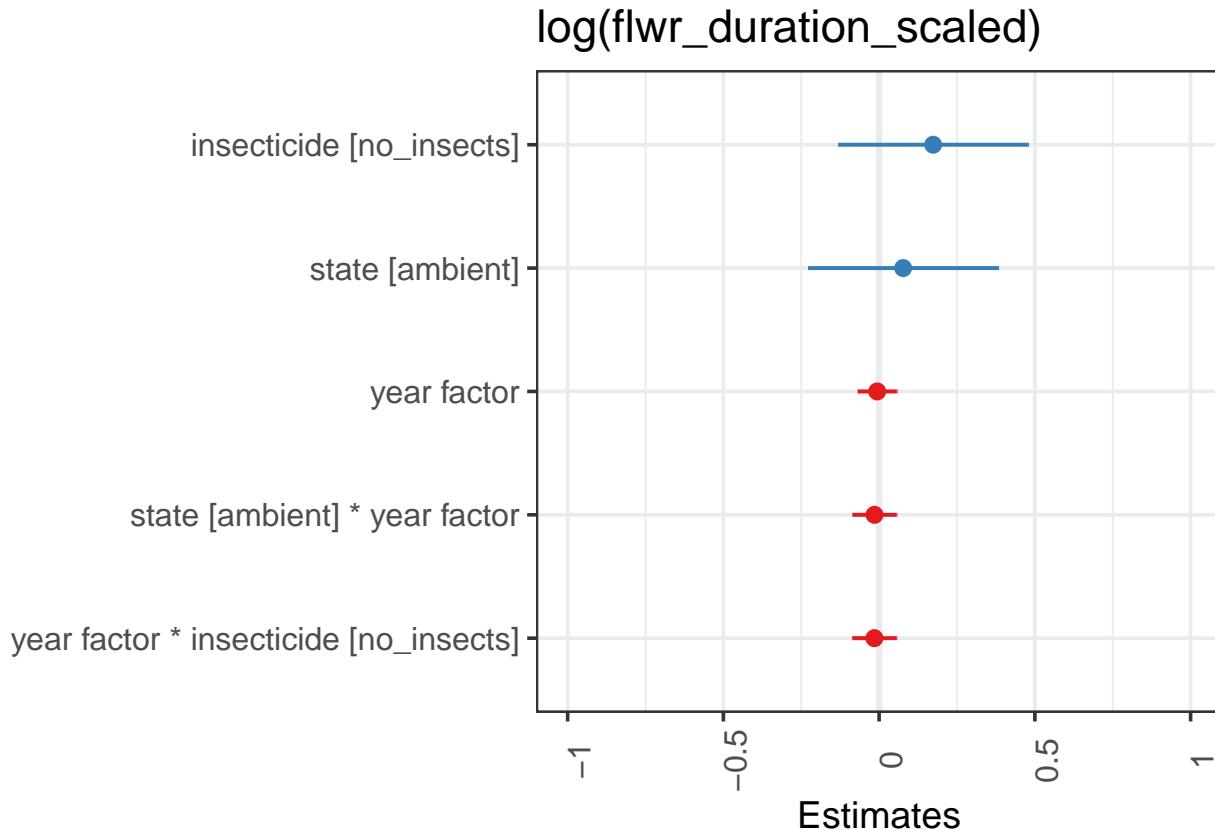
##      dAICc df weight
## mod2 0.0   8  0.73
## mod1 2.0   9  0.27

```

```

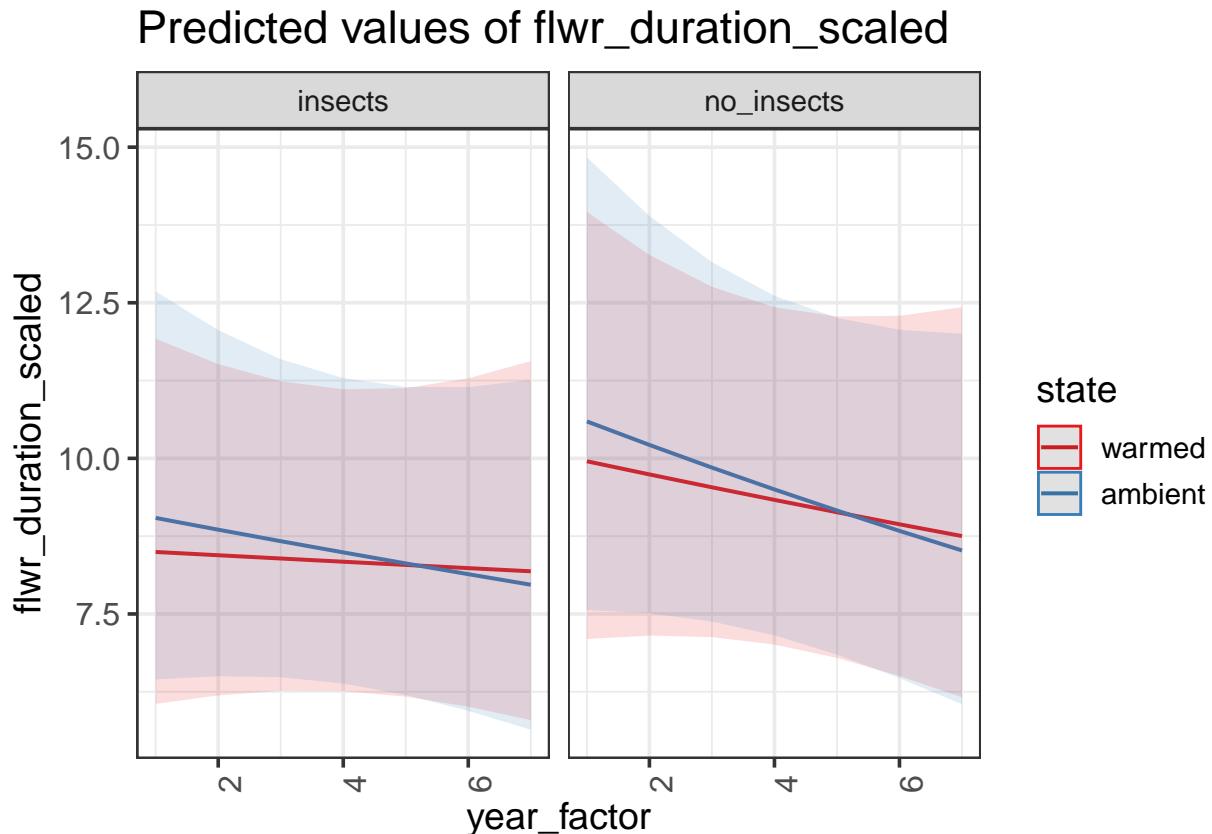
# Plot the fixed effects estimates for different models
# these are the fixed effects estimates from summary(mod1)
plot_model(mod2, sort.est = TRUE)

```



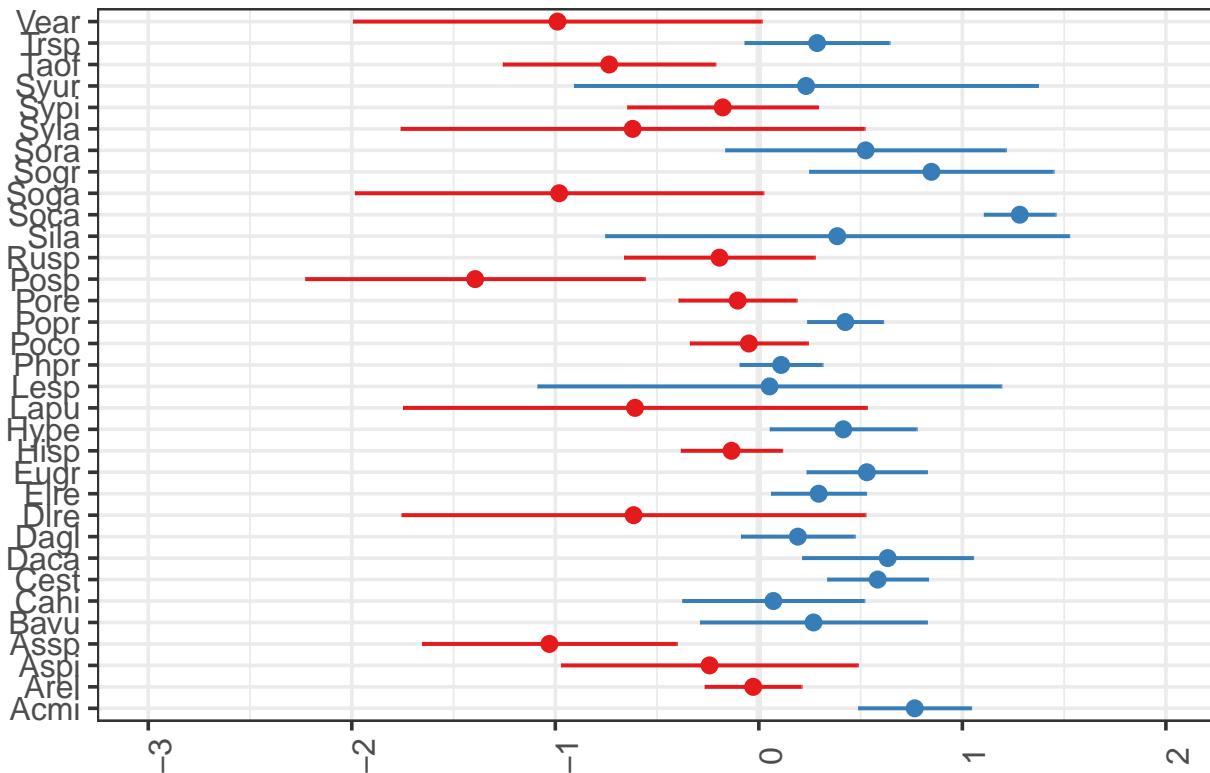
```
# these are the fixed predicted values:  
plot_model(mod2, type = "pred", terms = c("year_factor", "state", "insecticide"))
```

Model has log-transformed response. Back-transforming predictions to original response scale. Standard errors are back-transformed and so do not sum to zero.



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

Random effects



```

# 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, REML=TRUE)
mod3 <- lmer(log(fltr_duration_scaled) ~ state*year_factor + (1|species), kbs_filtr_spp, REML=FALSE)
anova(mod2, mod3)

## Data: kbs_filtr_spp
## Models:
## mod3: log(filtr_duration_scaled) ~ state * year_factor + (1 | species)
## mod2: log(filtr_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_filtr_spp, REML=TRUE)

# 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)

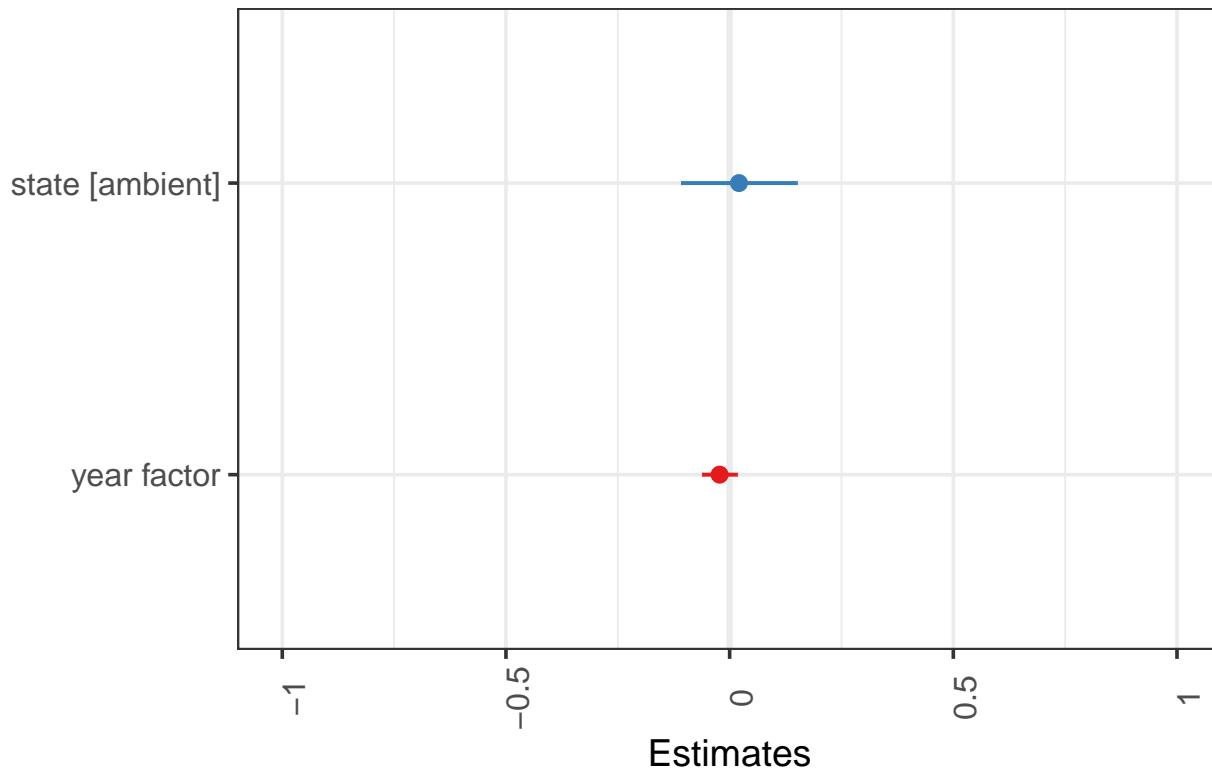
## Data: kbs_flwr_spp
## Models:
## mod5: log(flwr_duration_scaled) ~ state + year_factor + (1 | species)
## mod3: log(flwr_duration_scaled) ~ state * year_factor + (1 | species)
##      npar   AIC   BIC  logLik deviance Chisq Df Pr(>Chisq)
## mod5     5 3527.6 3552.9 -1758.8    3517.6
## mod3     6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

```

log(flwr_duration_scaled)



```

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

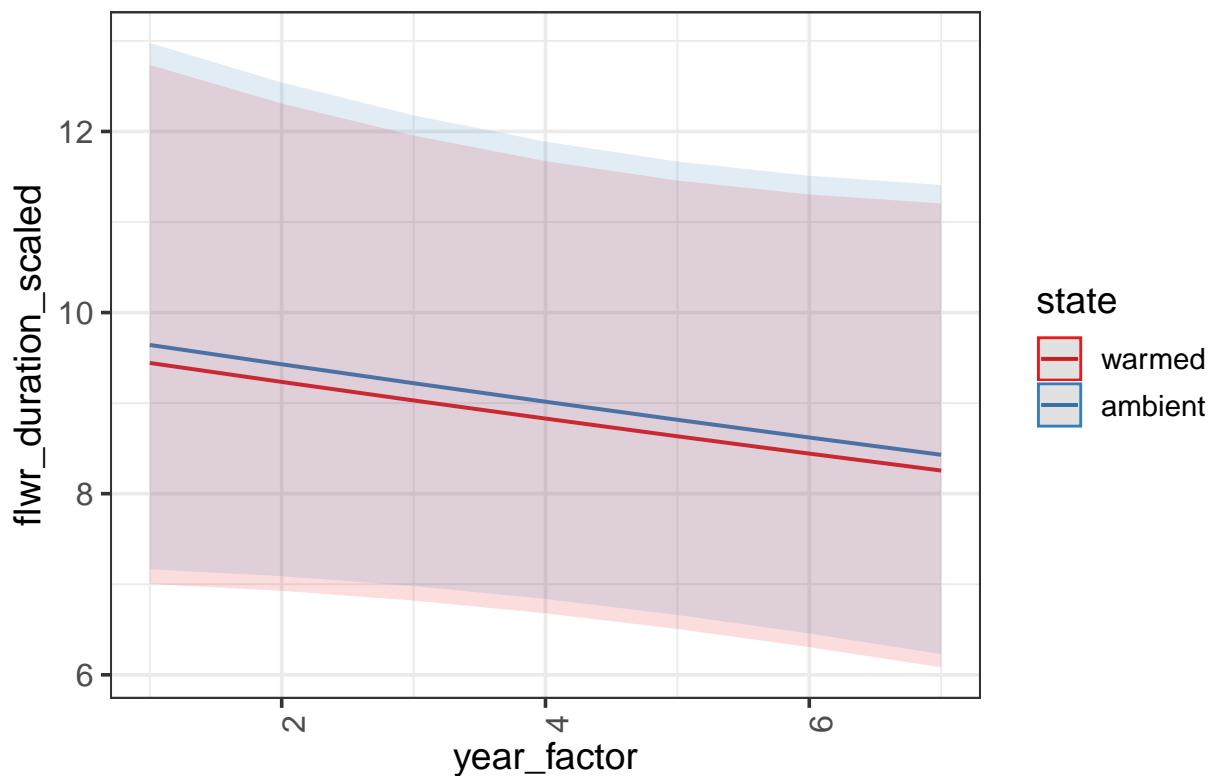
```

```

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

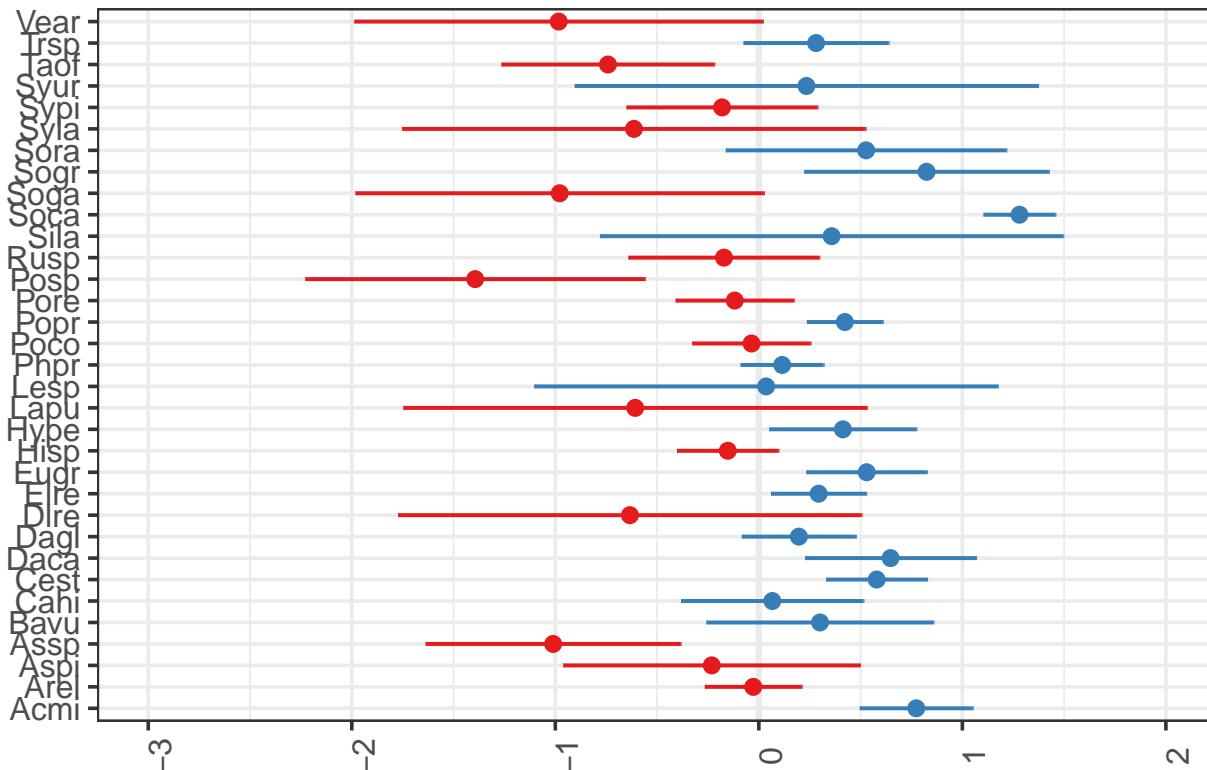
```

Predicted values of flwr_duration_scaled



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

Random effects



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

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

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

## 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')

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
## 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

```



```

## <.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")
```

```

## $'emmmeans 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 - Cahí  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

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##  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 - Cahи  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 - Eogr -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 - Cahи  -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 - Eogr -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

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## 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 - Cahí -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 - Cahí 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

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##  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
##  Cahи - Cest -1.22806 0.246 1192 -4.983 0.0003
##  Cahи - Daca -0.97065 0.295 1192 -3.290 0.2288
##  Cahи - Dagl -0.29370 0.251 1192 -1.170 1.0000
##  Cahи - Dlre  2.32314 0.981 1191  2.369 0.8910
##  Cahи - Elre -0.52724 0.241 1192 -2.186 0.9556
##  Cahи - Eugr -1.13470 0.258 1192 -4.391 0.0053
##  Cahи - Hisp  0.06611 0.245 1192  0.270 1.0000
##  Cahи - Hype -1.05446 0.276 1191 -3.815 0.0484
##  Cahи - Lapu  1.39924 0.984 1192  1.422 1.0000
##  Cahи - Lesp  0.13431 0.980 1191  0.137 1.0000
##  Cahи - Phpr -0.43287 0.235 1192 -1.839 0.9963
##  Cahи - Poco -0.19544 0.257 1192 -0.761 1.0000
##  Cahи - Popr -0.58982 0.233 1192 -2.536 0.7968
##  Cahи - Pore -0.08520 0.255 1192 -0.334 1.0000
##  Cahи - Posp  0.24438 0.539 1192  0.454 1.0000
##  Cahи - Rusp  0.01275 0.314 1189  0.041 1.0000
##  Cahи - Sila -1.33478 0.980 1191 -1.362 1.0000
##  Cahи - Soca -1.48437 0.231 1192 -6.424 <.0001
##  Cahи - Soga  2.42259 0.711 1192  3.408 0.1683
##  Cahи - Sogr -0.83489 0.372 1192 -2.244 0.9394
##  Cahи - Sora -0.61220 0.424 1187 -1.443 1.0000
##  Cahи - Syla  1.37064 0.985 1192  1.392 1.0000
##  Cahи - Sypi -0.02512 0.318 1192 -0.079 1.0000
##  Cahи - Syur -1.57379 0.985 1192 -1.598 0.9997
##  Cahи - Taof  0.92533 0.334 1184  2.767 0.6211
##  Cahи - Trsp -1.23150 0.278 1191 -4.424 0.0046
##  Cahи - 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

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## 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 - Eogr -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 - Eogr -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

```

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##  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 - Eogr -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 - Sogr  0.09945 1.174 1192   0.085  1.0000
##  Dlre - Sora -3.15803 1.004 1191  -3.145  0.3203
##  Dlre - Syla -2.93534 1.021 1190  -2.876  0.5305
##  Dlre - Syur -0.95249 1.357 1192  -0.702  1.0000
##  Dlre - Sypi -2.34826 0.987 1192  -2.380  0.8860
##  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 - Eogr -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 - Sogr  2.94983 0.686 1192   4.298  0.0078
##  Elre - Sora -0.30766 0.323 1191  -0.951  1.0000
##  Elre - Syla -0.08497 0.383 1190  -0.222  1.0000
##  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

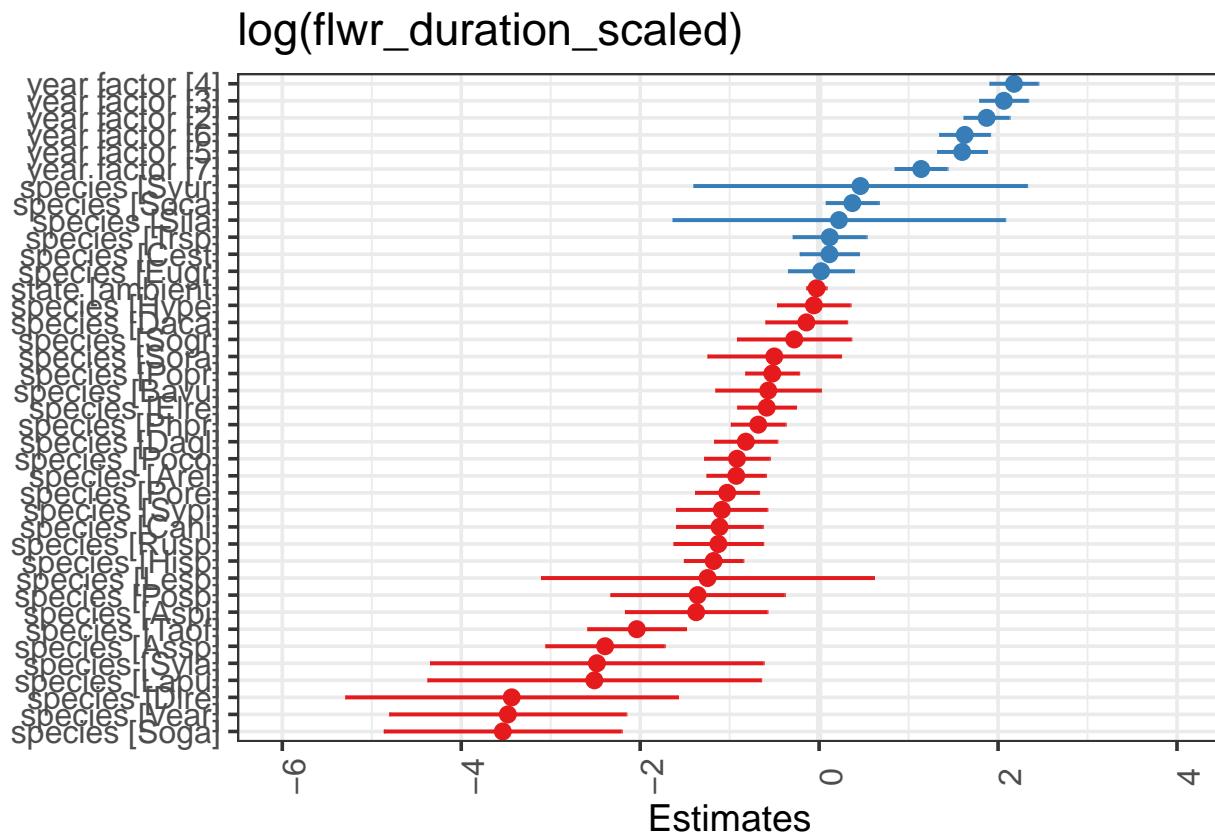
```

```

##  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

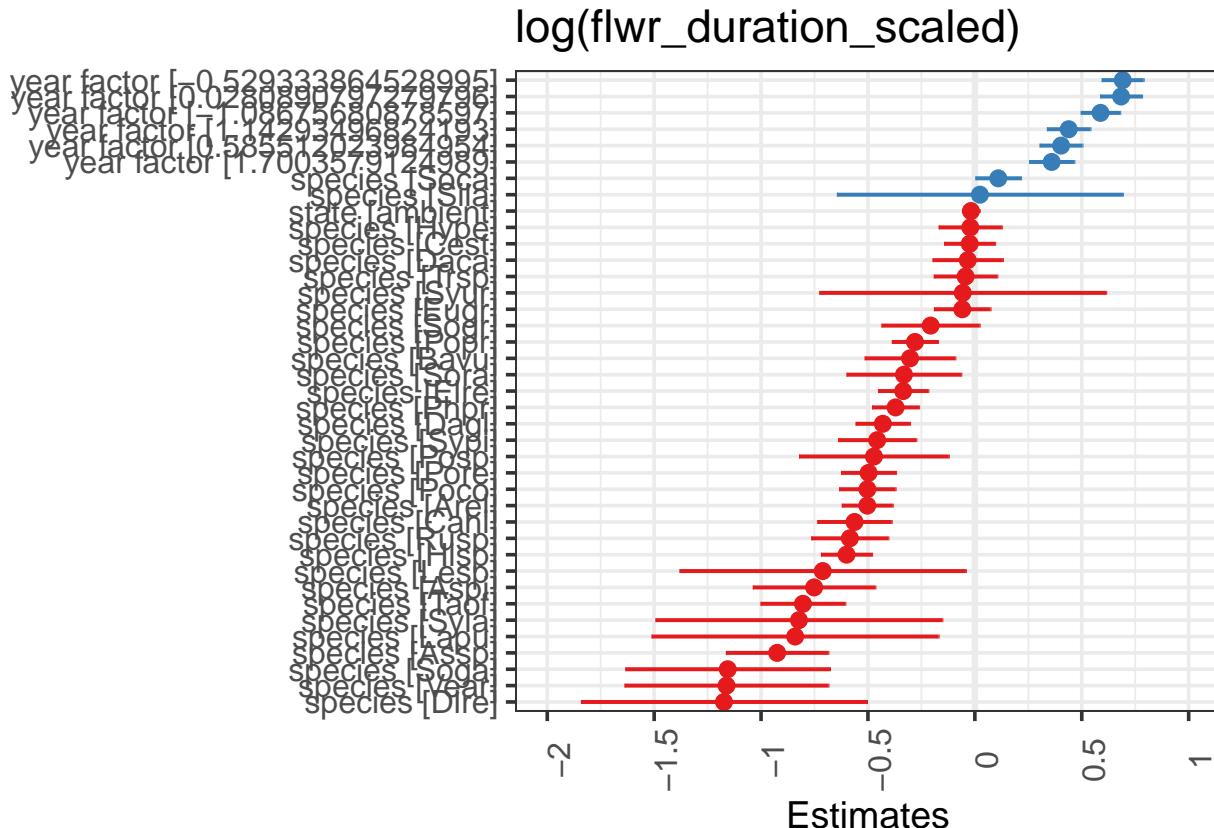
```

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



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

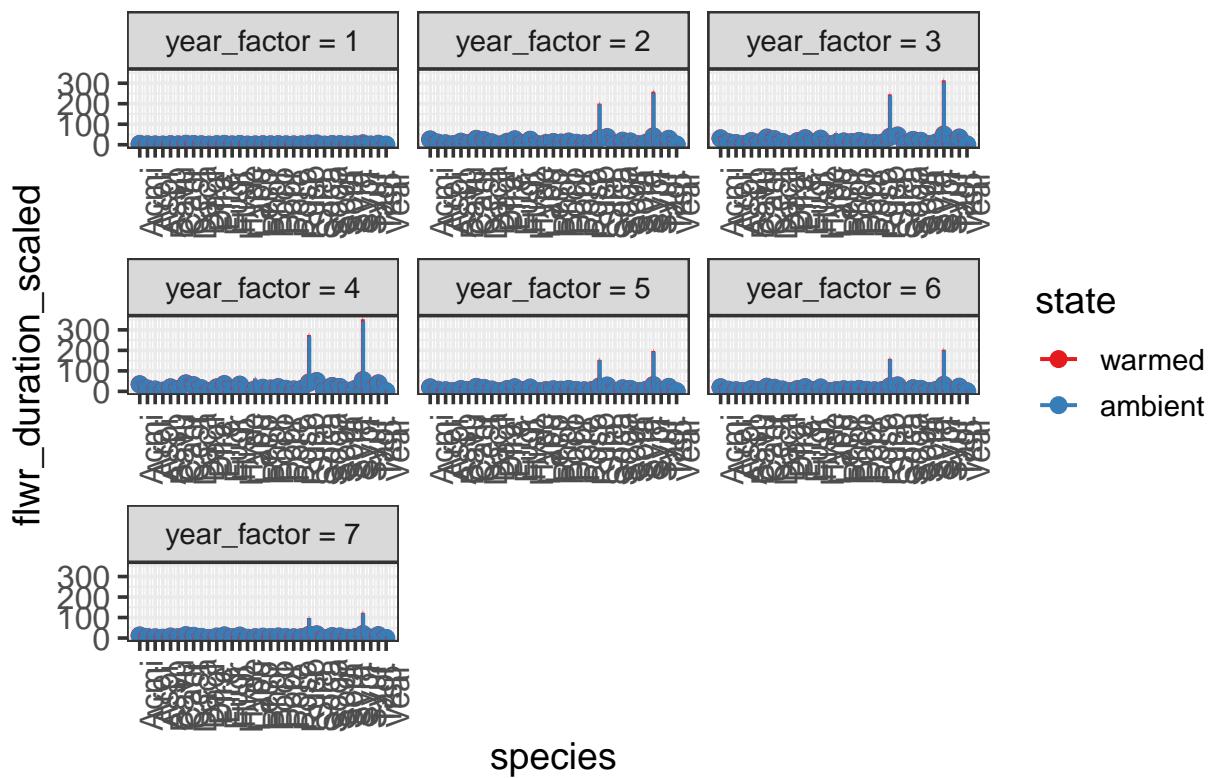
```
## Formula contains log- or sqrt-terms. See help("standardize") for how
## such terms are standardized.
```



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

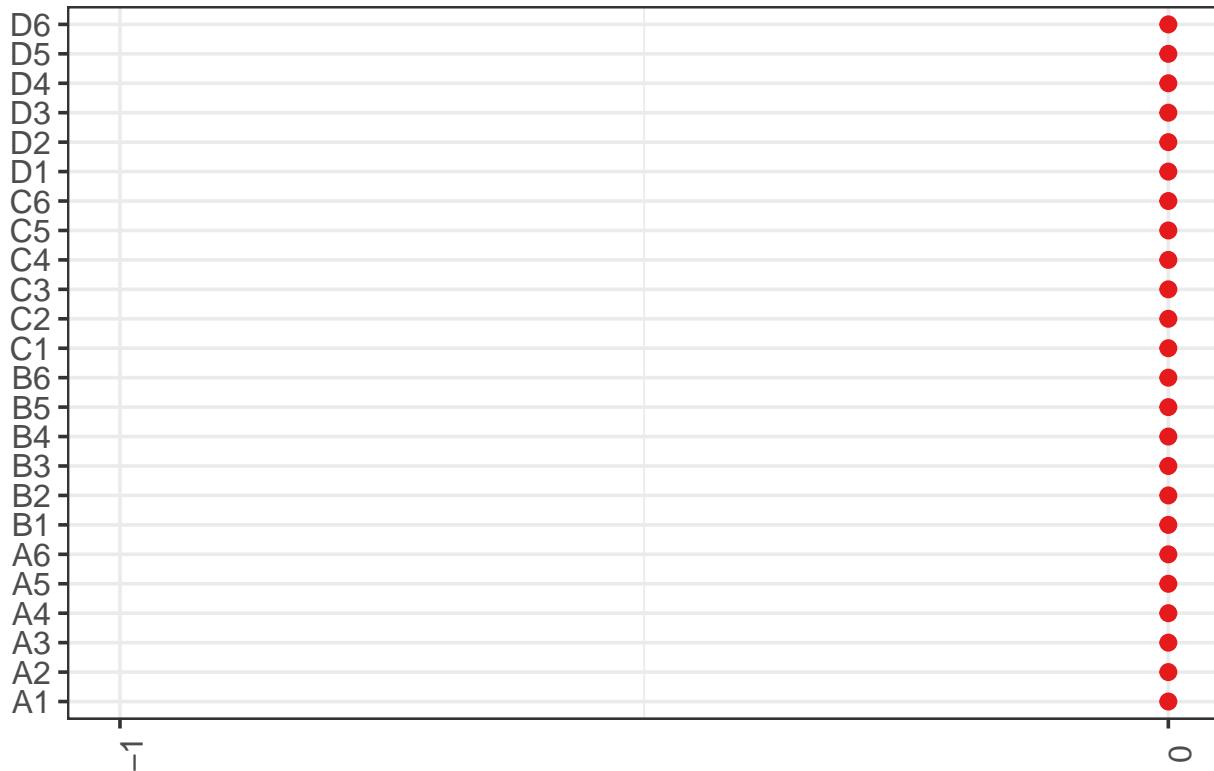
Model has log-transformed response. Back-transforming predictions to original response scale. Standard error of prediction is also provided.

Predicted values of flwr_duration_scaled



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

Random effects



```
# 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, R

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

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

## 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')

## 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)
## stateambient -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      Both      1  0.0372 0.5239 1135 -0.990690  1.065
##   ambient      Both      1 -0.0372 0.5240 1134 -1.065228  0.991
##   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      Both      2  1.5640 0.5422 1134  0.500134  2.628
##   ambient      Both      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

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## 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

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## 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

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## 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

```

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## 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

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## 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

```

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## 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

```

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## 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

```

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## 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

```

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## 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

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## 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

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##  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

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## 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

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##   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

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## 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

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## 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

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## 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

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## 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

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```

##   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

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```

## 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

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```

##   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

```

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## 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

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## 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
## 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_f

## 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_ grwt_G fc(_2 fc(_3 fc(_4 fc(_5
## stateambint -0.245
## growth_habit -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_habit
## 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_1

## 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_s

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

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

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

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

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

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

## 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, REML=TRUE)

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

mod9 <- lmer(log(flwr_duration_scaled) ~ state + origin + (1+factor(year_factor)|plot), kbs_flwr_spp, REML=TRUE)

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

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

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

mod10 <- lmer(log(flwr_duration_scaled) ~ state * growth_habit + (1+factor(year_factor)|plot), kbs_flwr_spp, REML=TRUE)

## 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_spp, REML=TRUE)

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

mod11a <- lmer(log(flwr_duration_scaled) ~ state + growth_habit + factor(year_factor) + (1|plot), kbs_flwr_spp, REML=TRUE)

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

mod12 <- lmer(log(flwr_duration_scaled) ~ state * factor(year_factor) + (1+factor(year_factor)|species), kbs_flwr_spp, REML=TRUE)

## 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, REML=TRUE)
AICctab(mod1, mod2, mod3, mod5, mod7, mod7a, mod7b, mod7c, mod8, mod9, mod9a, mod10, mod11, mod11a, mod12)

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

# 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, REML=FALSE)

## 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, REML=FALSE)

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

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

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

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

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

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

## 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

```

```

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

AICctab(mod5p, mod7p, weights=T)

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

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,
                REML=FALSE)

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

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

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

mod14p <- lmer(log(flwr_duration_scaled) ~ state + origin + year_factor + (1|plot), kbs_flwr_plot_origin,
                REML=FALSE)

## 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(fltr_duration_scaled) ~ state + origin + (1 + year_factor |
##   plot)
## Data: kbs_filtr_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
## originExotic -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(filtr_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_habit), ref = "Annual"))
mod15p <- lmer(log(flwr_duration_scaled) ~ state * growth_habit + (1+year_factor|plot), kbs_flwr_plot_growths)

## 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_growths)

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

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

## 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) sttfrm grwth_ grw_F/ grwt_G
## statewarmed -0.358
## growth_habit -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   ambient     2.135 0.1071 114.0   1.92    2.35
## warmed   ambient     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

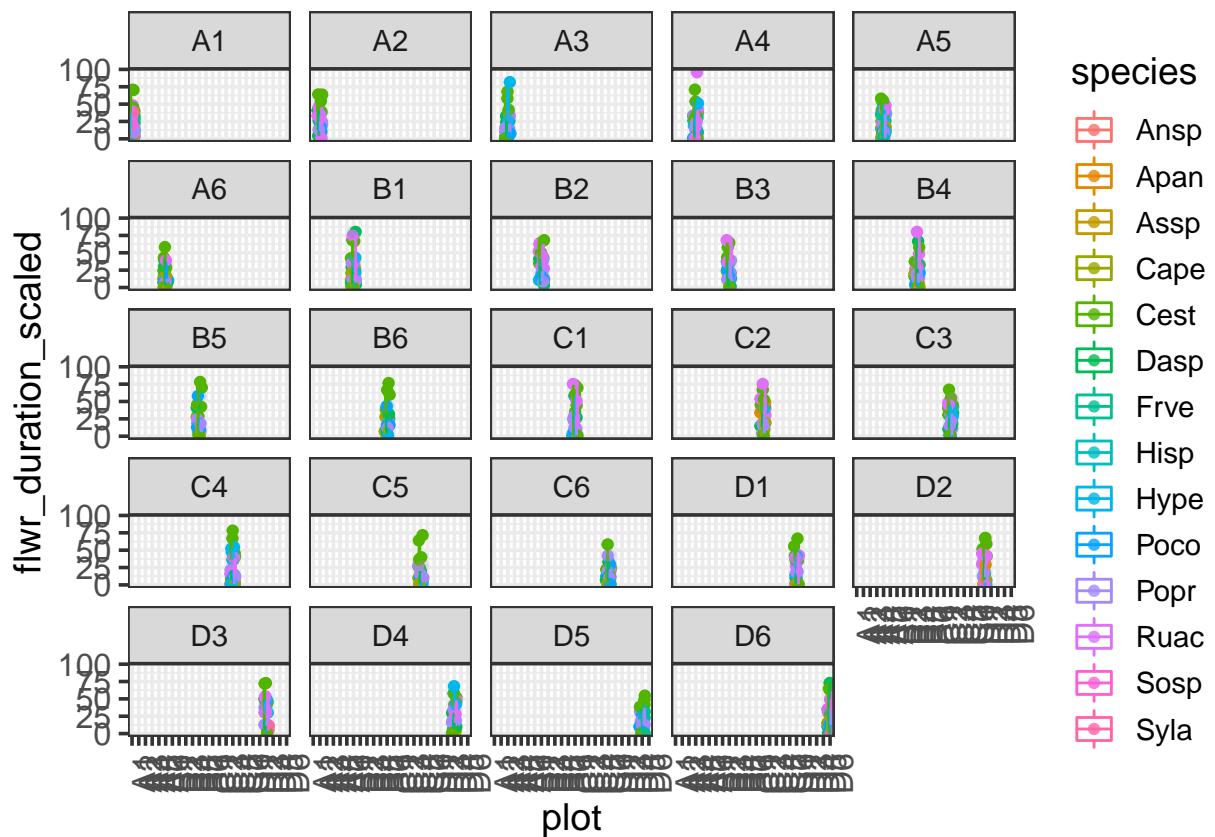
```

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

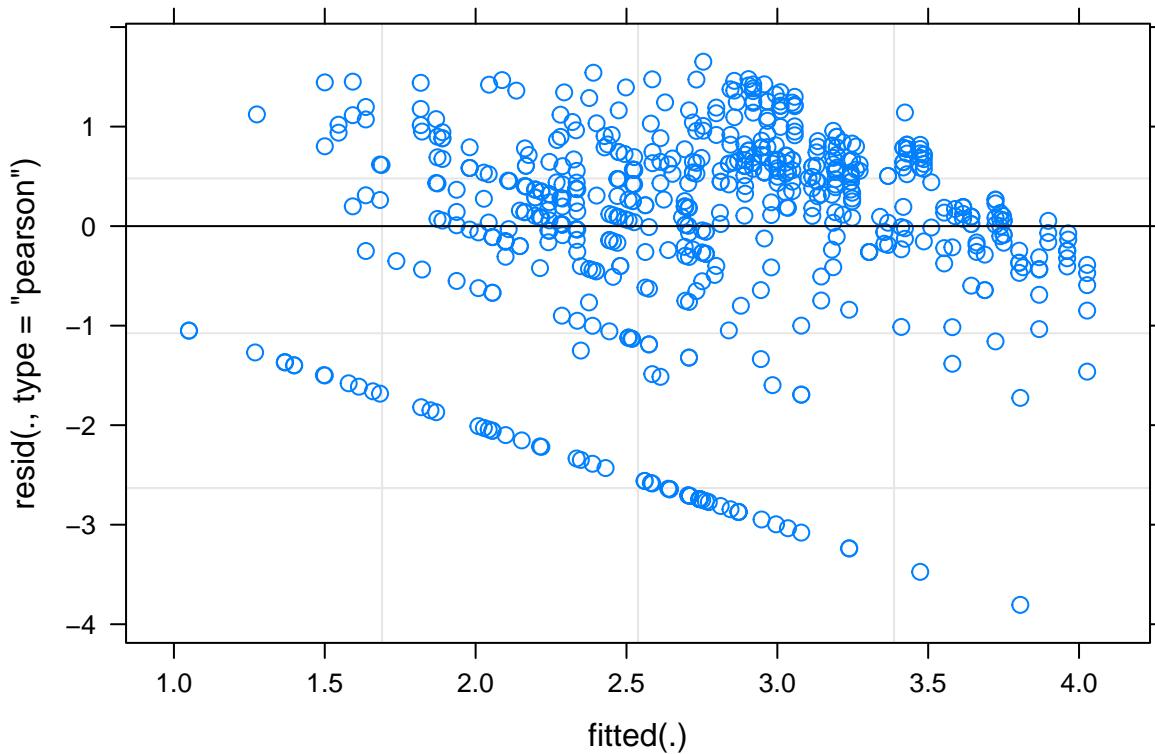
## boundary (singular) fit: see help('isSingular')

ggplot(umbs_flwr_spp,aes(x=plot,y=flwr_duration_scaled,col=species)) + geom_jitter() + geom_boxplot(alpha=0.2)

```



```
# 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 values)
# 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-value
# is > 0.05, then the assumption is met.

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
```

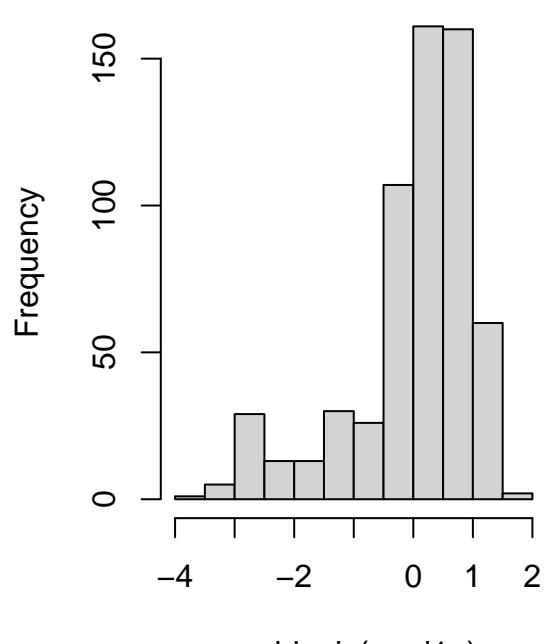
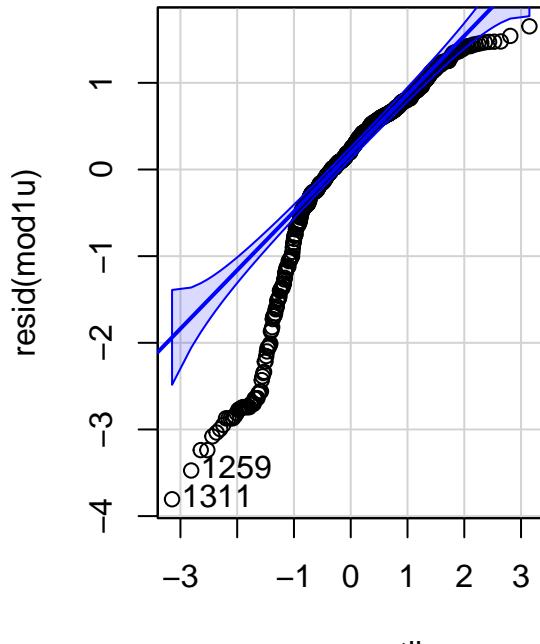
```
# (3) Normality of error term: need to check by histogram, QQplot of residuals, could do Kolmogorov-Smi
# Check for normal residuals
qqPlot(resid(mod1u))
```

```
## 1311 1259
```

```
## 465 447
```

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

Histogram of 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

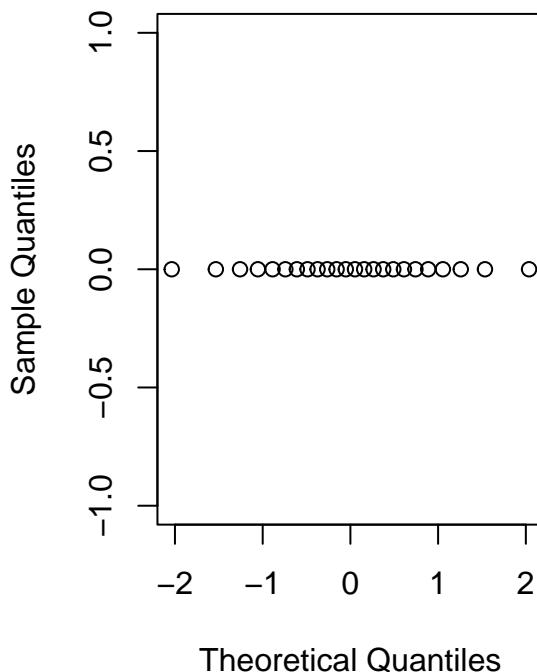
outlierTest(mod1u) # outliers

## 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 check
require(lme4)
r_int <- ranef(mod1u)$plot$`Intercept`^
qqnorm(r_int)
# qqline(r_int) doesn't work
# shapiro.test(r_int) # this doesn't work

```

Normal Q-Q Plot



```

# 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) + (1|plot)

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

```

```

mod2u <- lmer(log(flwr_duration_scaled) ~ state*year_factor + insecticide*year_factor + (1|species), um
# 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 something

## 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)
```

```

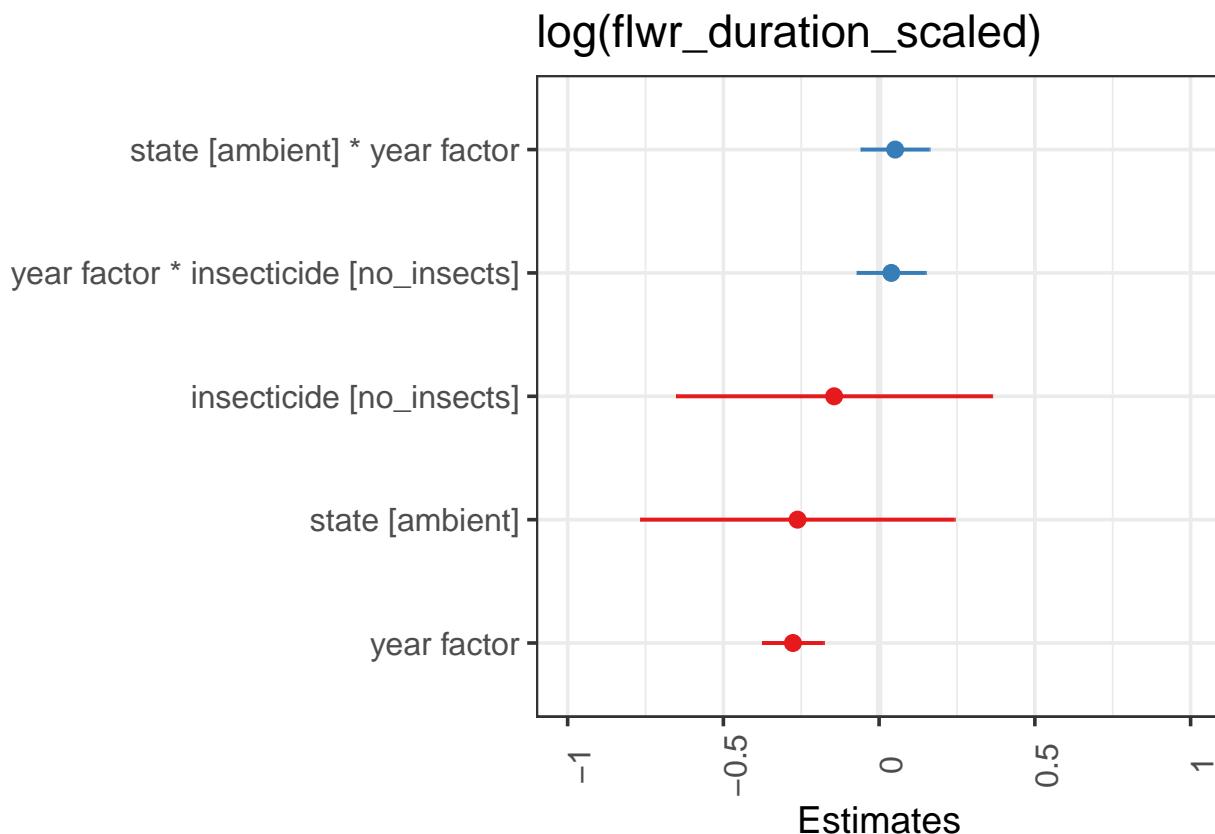
##          dAICc df weight
## mod2u  0.0    8  0.74
## mod1u  2.1    9  0.26

```

```

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

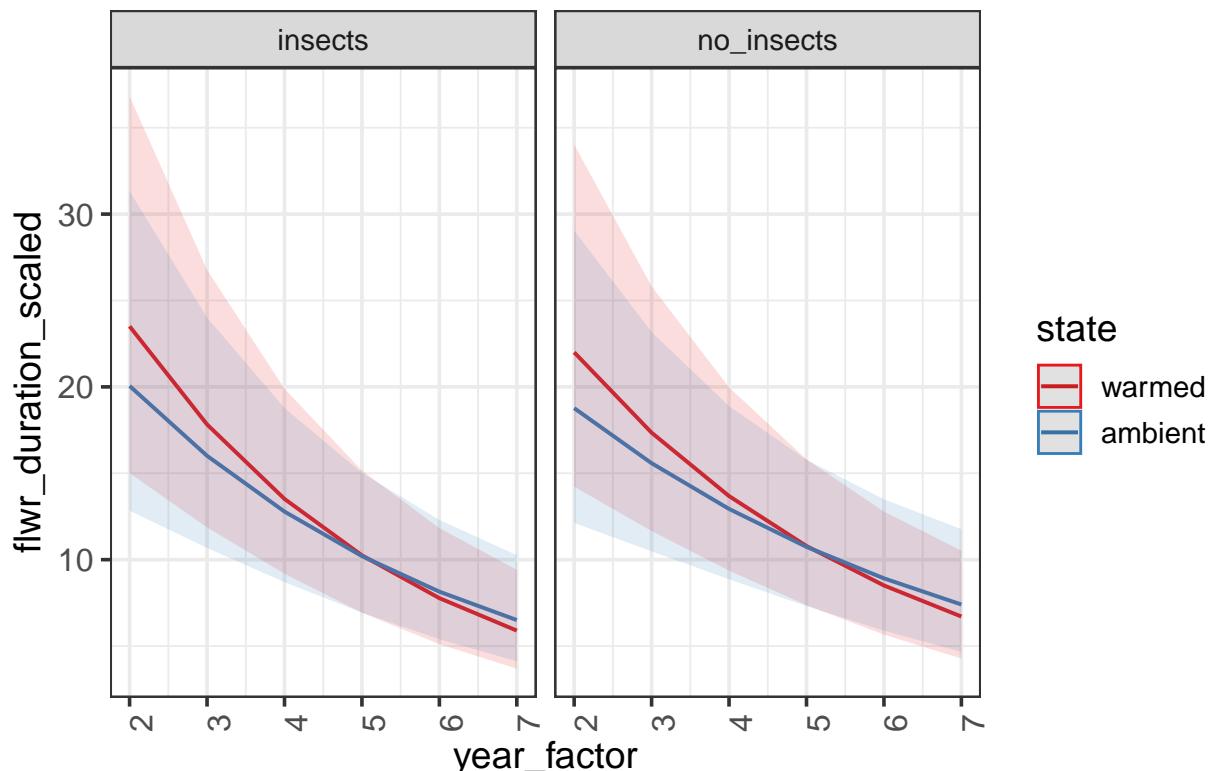
```



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

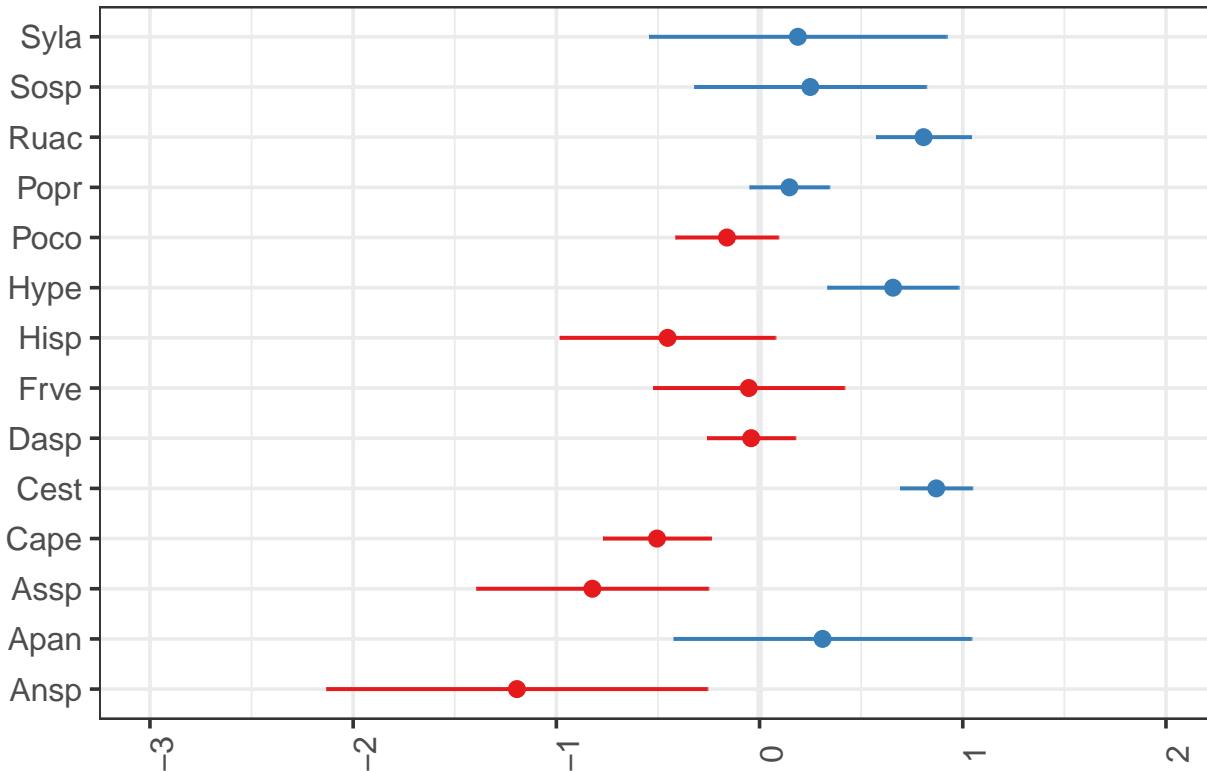
Model has log-transformed response. Back-transforming predictions to original response scale. Standard errors are back-transformed and so do not sum to zero.

Predicted values of flwr_duration_scaled



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

Random effects



```
# 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, REML=TRUE)
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_spp)
```

```
# 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)

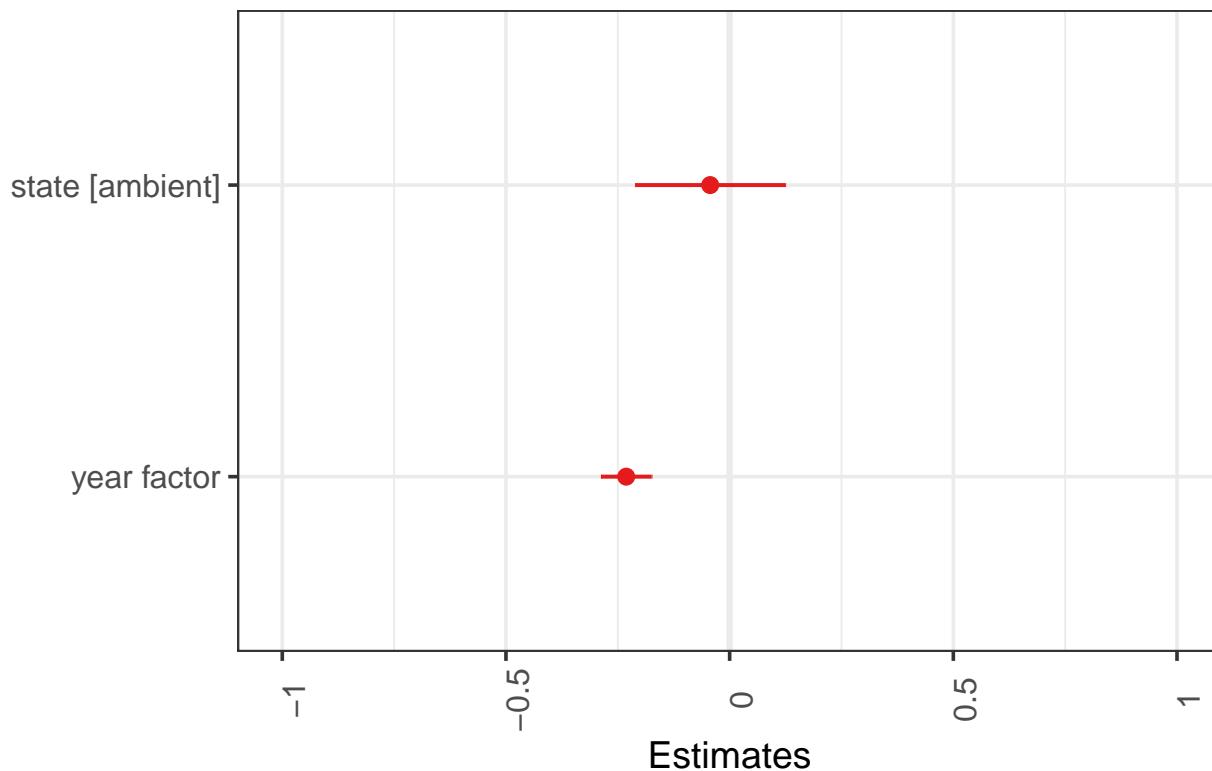
## Data: umbs_flwr_spp
## Models:
## mod5u: log(flwr_duration_scaled) ~ state + year_factor + (1 | species)
## mod3u: log(flwr_duration_scaled) ~ state * year_factor + (1 | species)
##      npar   AIC   BIC  logLik deviance Chisq Df Pr(>Chisq)
## mod5u     5 1811.9 1834.0 -900.97    1801.9
## mod3u 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

```

log(flwr_duration_scaled)



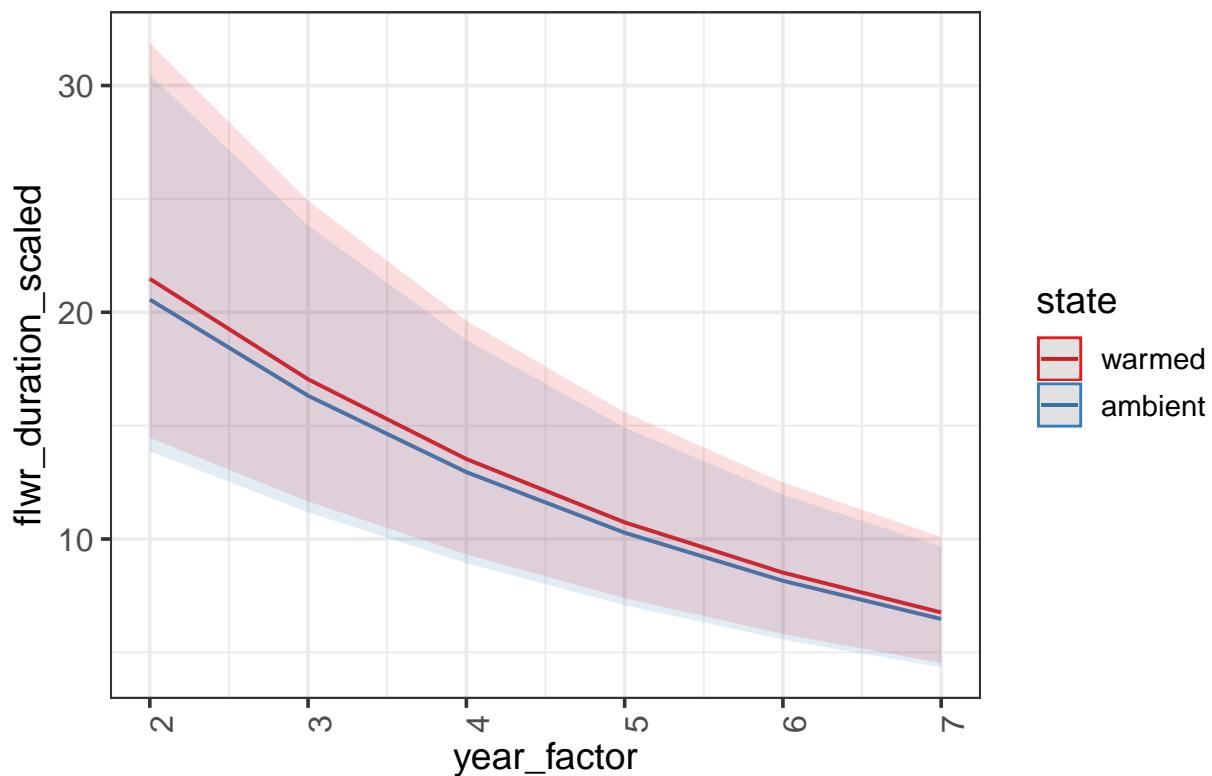
```

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

```

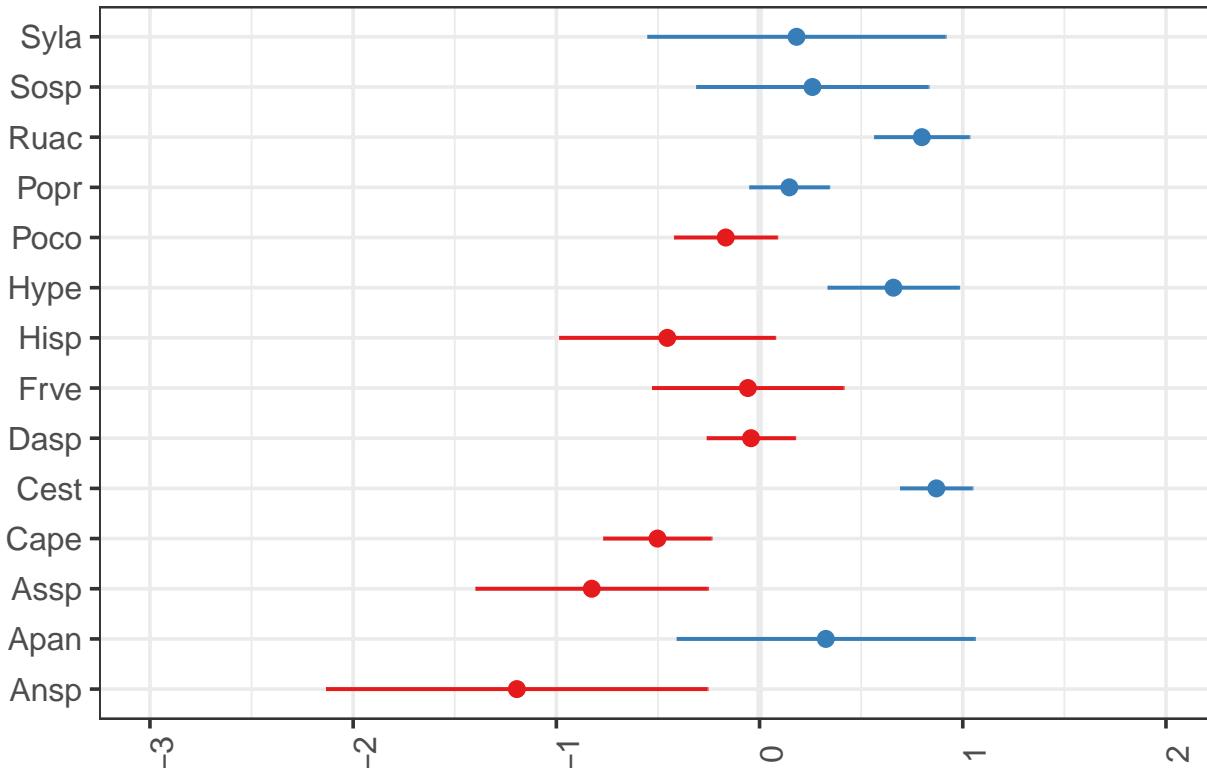
Model has log-transformed response. Back-transforming predictions to original response scale. Standardized residuals.

Predicted values of flwr_duration_scaled



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

Random effects



```
# 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), un

## 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 parameters)
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_spp)

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

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

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

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

## 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 simpler models

## 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 different

## 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
## <.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

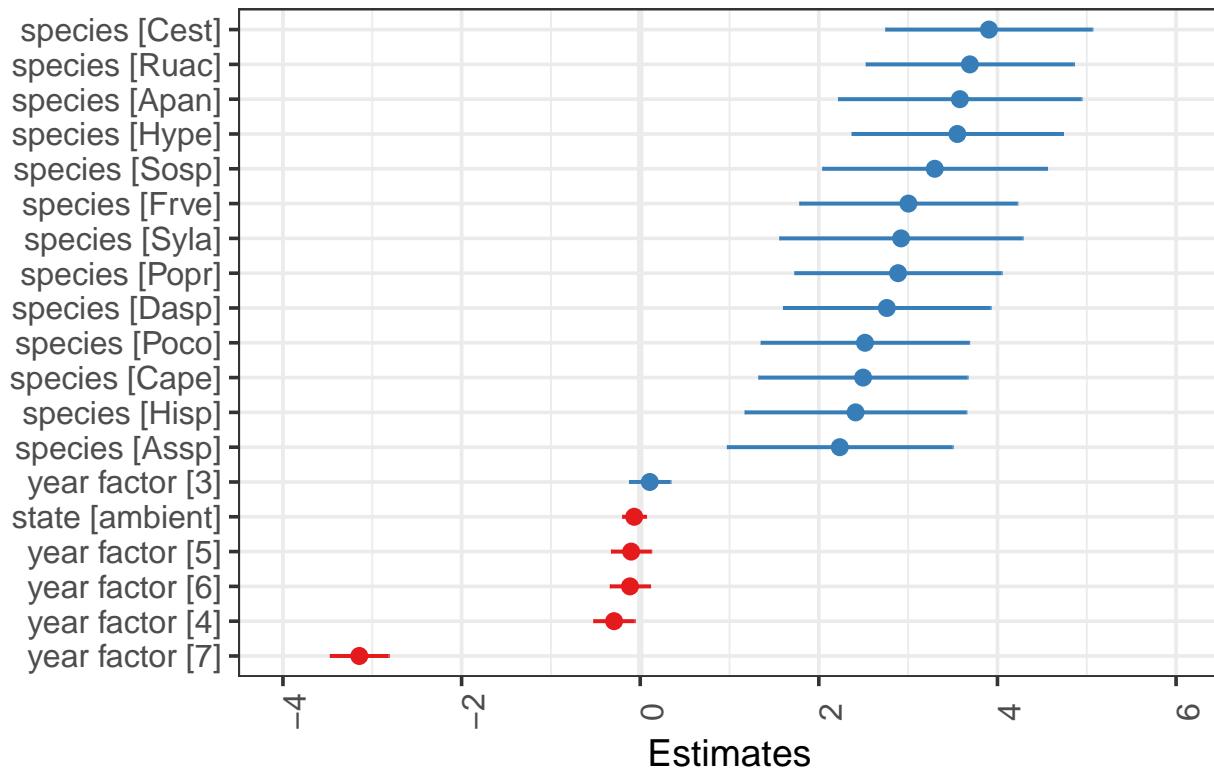
```

## 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(mod7au). You can plot_model(mod7au, sort.est = TRUE)

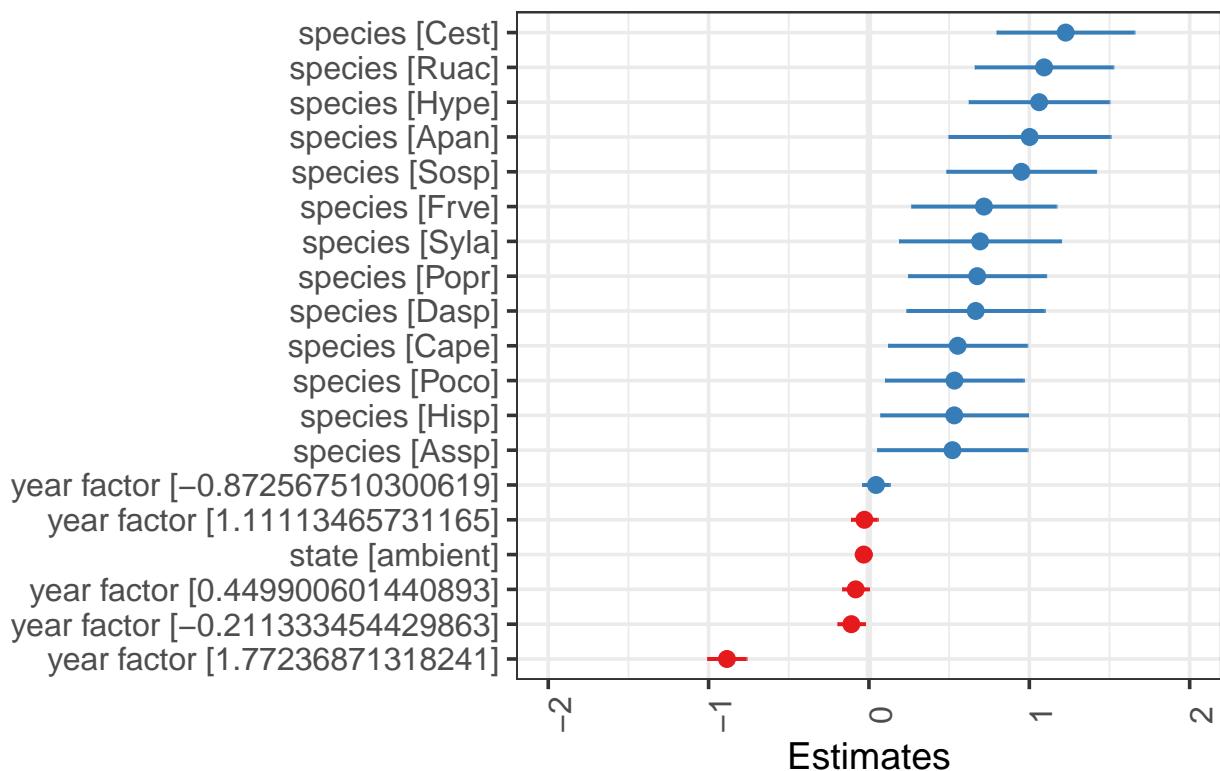
log(flwr_duration_scaled)



```
# 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')
```

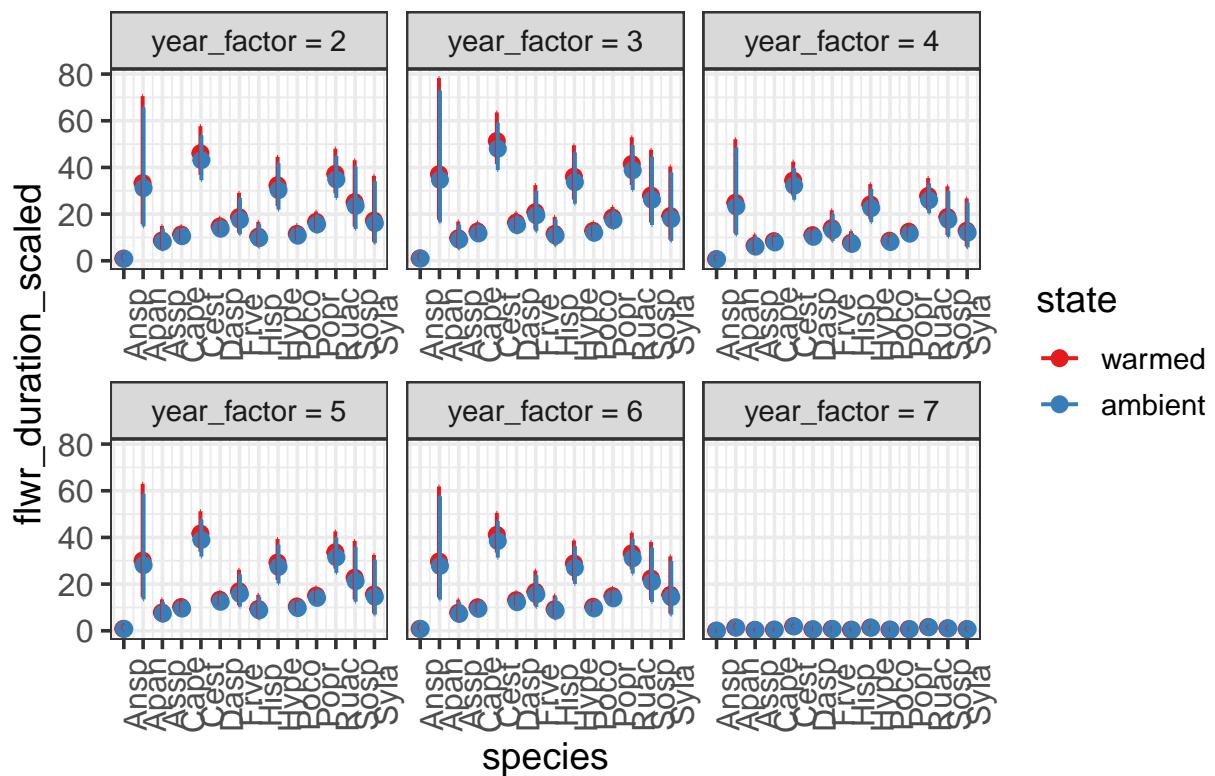
log(flwr_duration_scaled)



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

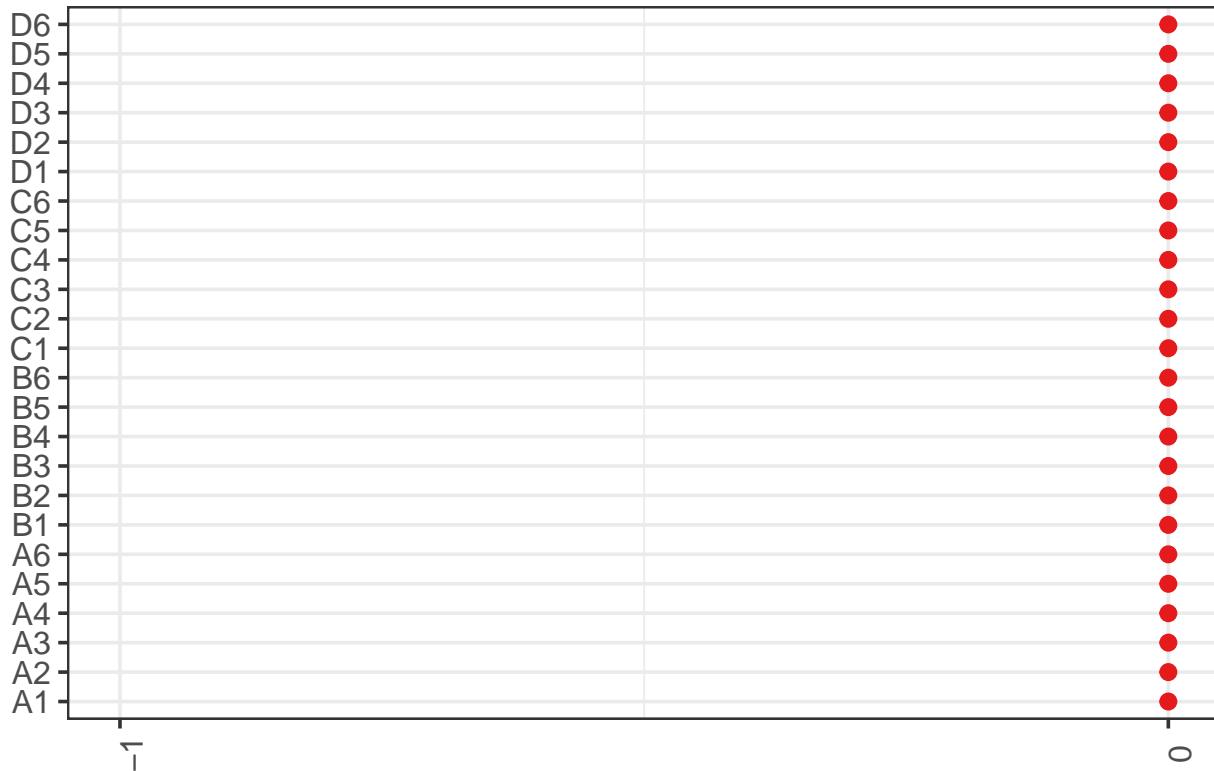
```
## Model has log-transformed response. Back-transforming predictions to original response scale. Standard
```

Predicted values of flwr_duration_scaled



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

Random effects



```
# including native vs. exotic
umb_spp <- within(umb_spp, origin <- relevel(factor(origin), ref = "Native")) # releveling
mod8u <- lmer(log(flower_duration_scaled) ~ state * origin + (1+factor(year_factor)|plot), umb_spp,
               REML = FALSE)
## boundary (singular) fit: see help('isSingular')

mod9u <- lmer(log(flower_duration_scaled) ~ state + origin + (1+factor(year_factor)|plot), umb_spp,
               REML = FALSE)
## 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(flower_duration_scaled) ~ state + origin + factor(year_factor) + (1|plot), umb_spp,
                REML = FALSE)
## boundary (singular) fit: see help('isSingular')

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

## Data: umb_spp
## Models:
## mod9u: log(flower_duration_scaled) ~ state + origin + (1 + factor(year_factor) | plot)
## mod8u: log(flower_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_fl

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

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

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

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

## 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_habit -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`
##   estimate    SE  df t.ratio p.value
##   1          -0.06875 0.127 600  -0.542  0.9944
##   year_factor2 - year_factor3  0.30076 0.127 603   2.373  0.1673
##   year_factor2 - year_factor4  0.13464 0.124 600   1.090  0.8856
##   year_factor2 - year_factor5  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   ambient       1.74 0.2665 529.0     1.22    2.26
## ambient   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 i
# updated mod5
mod13u <- lmer(log(flwr_duration_scaled) ~ state * factor(year_factor) + (1|species), umbs_flwr_spp)

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

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

mod2u <- lmer(log(flwr_duration_scaled) ~ state*year_factor + insecticide*year_factor + (1|species), umbs_flwr_spp)
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_flwr_spp)

## 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_spp)

## 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_spp)

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

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

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

```

```

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

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

mod8u <- lmer(log(flwr_duration_scaled) ~ state * origin + (1+factor(year_factor)|plot), umbs_flwr_spp, REML=TRUE

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

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

## 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_spp, REML=TRUE

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

mod10u <- lmer(log(flwr_duration_scaled) ~ state * growth_habit + (1+factor(year_factor)|plot), umbs_flwr_spp, REML=TRUE

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

mod11u <- lmer(log(flwr_duration_scaled) ~ state + growth_habit + (1+factor(year_factor)|plot), umbs_flwr_spp, REML=TRUE

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

mod11au <- lmer(log(flwr_duration_scaled) ~ state + growth_habit + factor(year_factor) + (1|plot), umbs_flwr_spp, REML=TRUE

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

mod12u <- lmer(log(flwr_duration_scaled) ~ state * factor(year_factor) + (1+factor(year_factor)|species), umbs_flwr_spp, REML=TRUE

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

mod13u <- lmer(log(flwr_duration_scaled) ~ state * factor(year_factor) + (1|species), umbs_flwr_spp, REML=TRUE
AICctab(mod1u, mod2u, mod3u, mod5u, mod6u, mod7u, mod7au, mod7bu, mod7cu, mod8u, mod9u, mod9au, mod10u, mod13u)

##          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
## 1.0000
## 0.0001
## 0.0026
## 0.9958
## 1.0000
## 0.9996
## 1.0000
## 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_plot

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

mod11up <- lmer(log(flwr_duration_scaled) ~ state * year_factor * insecticide + (1|plot), umbs_flwr_plot

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

AICctab(mod1up, mod2up, mod3up, mod4up, mod5up, mod6up, mod7up, mod8up, mod9up, mod10up, mod11up, weight=TRUE)

##          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(fltr_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_origin)

## 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(fltr_duration_scaled) ~ state + origin + year_factor + (1 |
##   plot)
## Data: umbs_filtr_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(filtr_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_habit), ref = "Annual"))
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_plot)

## 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_habit -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
##   Graminoid     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
##   Forb          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
##
```