

11: Generalized Linear Models (ANOVA)

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Objectives

2. Apply special cases of the GLM (ANOVA) to real datasets
3. Interpret and report the results of ANOVA in publication-style formats

Set up

```
getwd()

## [1] "C:/Users/thoma/Thomas/2018 Grad School/Duke MEM/ENV 872/Environmental_Data_Analytics_2020"

library(tidyverse)
library(agricolae)

Litter <- read.csv("./Data/Processed/NEON_NIWO_Litter_mass_trap_Processed.csv")

# Set date to date format
Litter$collectDate <- as.Date(Litter$collectDate , format = "%Y-%m-%d")

# Set theme
mytheme <- theme_classic(base_size = 14) +
  theme(axis.text = element_text(color = "black"),
        legend.position = "top")
theme_set(mytheme) # Can you "save" a theme?
```

One-way ANOVA

A one-way ANOVA is the same test in practice as a two-sample t-test but for three or more groups. In R, we can run the model with the function `lm` or `aov`, the latter of which will allow us to run post-hoc tests to determine pairwise differences. ANOVA lets you know if there is significant difference between the group means (i.e., is that grouping a significant predictor of output change).

Does total litter biomass differ among sites at the Niwot Ridge LTER?

```
# Wrangle the data
Litter.Totals <- Litter %>%
  group_by(plotID, collectDate, nlcdClass) %>% # What does group_by do, exactly?
  summarise(dryMass = sum(dryMass))

# Test for normality.
# Note: the important assumption for GLMs is normality of residuals,
# not necessarily normality of raw data. See below when we plot the model.
shapiro.test(Litter.Totals$dryMass[Litter.Totals$plotID == "NIWO_040"])
```

```

##
## Shapiro-Wilk normality test
##
## data: Litter.Totals$dryMass[Litter.Totals$plotID == "NIWO_040"]
## W = 0.71852, p-value = 9.319e-05
shapiro.test(Litter.Totals$dryMass[Litter.Totals$plotID == "NIWO_041"])

##
## Shapiro-Wilk normality test
##
## data: Litter.Totals$dryMass[Litter.Totals$plotID == "NIWO_041"]
## W = 0.75222, p-value = 0.0006757
shapiro.test(Litter.Totals$dryMass[Litter.Totals$plotID == "NIWO_046"])

##
## Shapiro-Wilk normality test
##
## data: Litter.Totals$dryMass[Litter.Totals$plotID == "NIWO_046"]
## W = 0.9464, p-value = 0.4021
shapiro.test(Litter.Totals$dryMass[Litter.Totals$plotID == "NIWO_047"])

##
## Shapiro-Wilk normality test
##
## data: Litter.Totals$dryMass[Litter.Totals$plotID == "NIWO_047"]
## W = 0.34128, p-value = 2.353e-07
shapiro.test(Litter.Totals$dryMass[Litter.Totals$plotID == "NIWO_051"])

##
## Shapiro-Wilk normality test
##
## data: Litter.Totals$dryMass[Litter.Totals$plotID == "NIWO_051"]
## W = 0.71303, p-value = 0.0002357
shapiro.test(Litter.Totals$dryMass[Litter.Totals$plotID == "NIWO_057"])

##
## Shapiro-Wilk normality test
##
## data: Litter.Totals$dryMass[Litter.Totals$plotID == "NIWO_057"]
## W = 0.92093, p-value = 0.1343
shapiro.test(Litter.Totals$dryMass[Litter.Totals$plotID == "NIWO_058"])

##
## Shapiro-Wilk normality test
##
## data: Litter.Totals$dryMass[Litter.Totals$plotID == "NIWO_058"]
## W = 0.82393, p-value = 0.0026
shapiro.test(Litter.Totals$dryMass[Litter.Totals$plotID == "NIWO_061"])

##
## Shapiro-Wilk normality test
##

```

```

## data: Litter.Totals$dryMass[Litter.Totals$plotID == "NIWO_061"]
## W = 0.81814, p-value = 0.002772
shapiro.test(Litter.Totals$dryMass[Litter.Totals$plotID == "NIWO_062"])

##
## Shapiro-Wilk normality test
##
## data: Litter.Totals$dryMass[Litter.Totals$plotID == "NIWO_062"]
## W = 0.87455, p-value = 0.01728
shapiro.test(Litter.Totals$dryMass[Litter.Totals$plotID == "NIWO_063"])

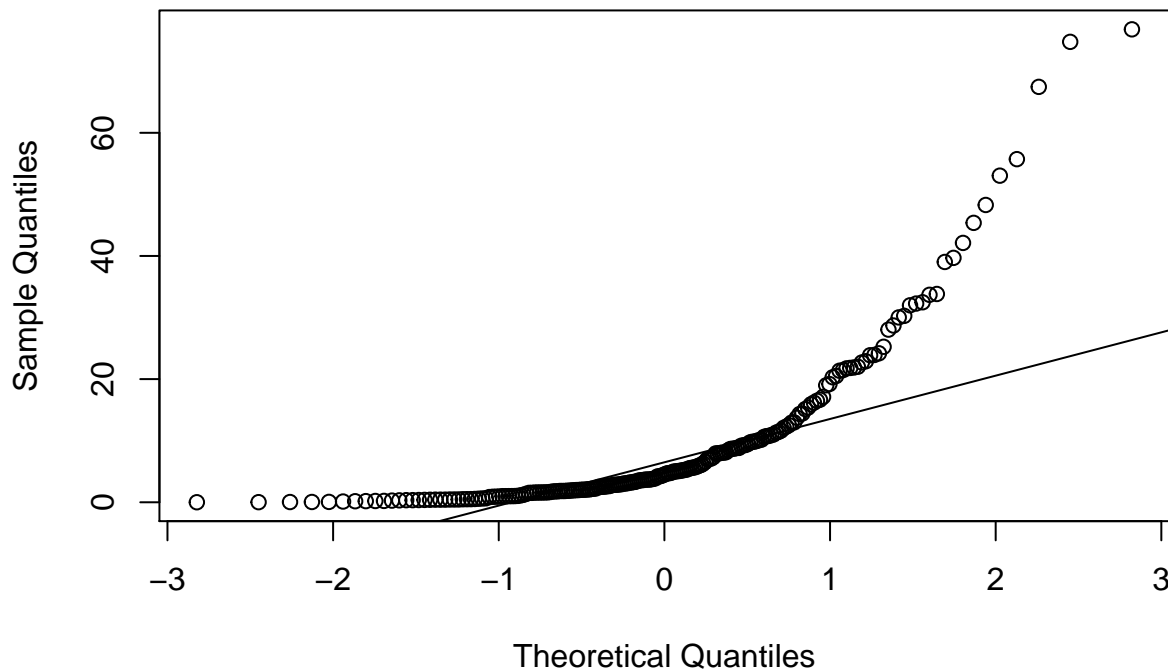
##
## Shapiro-Wilk normality test
##
## data: Litter.Totals$dryMass[Litter.Totals$plotID == "NIWO_063"]
## W = 0.70053, p-value = 8.099e-05
shapiro.test(Litter.Totals$dryMass[Litter.Totals$plotID == "NIWO_064"])

##
## Shapiro-Wilk normality test
##
## data: Litter.Totals$dryMass[Litter.Totals$plotID == "NIWO_064"]
## W = 0.70383, p-value = 6.176e-05
shapiro.test(Litter.Totals$dryMass[Litter.Totals$plotID == "NIWO_067"])

##
## Shapiro-Wilk normality test
##
## data: Litter.Totals$dryMass[Litter.Totals$plotID == "NIWO_067"]
## W = 0.642, p-value = 4.147e-05
qqnorm(Litter.Totals$dryMass); qqline(Litter.Totals$dryMass)

```

Normal Q-Q Plot



```
# Test for equal variance
# ANOVA is robust against departures from equal variance.
bartlett.test(Litter.Totals$dryMass ~ Litter.Totals$plotID)

##
## Bartlett test of homogeneity of variances
##
## data:  Litter.Totals$dryMass by Litter.Totals$plotID
## Bartlett's K-squared = 158.67, df = 11, p-value < 2.2e-16

# Format ANOVA as aov
Litter.Totals.anova <- aov(data = Litter.Totals, dryMass ~ plotID)
summary(Litter.Totals.anova)

##              Df Sum Sq Mean Sq F value    Pr(>F)
## plotID         11   7584    689.5    4.813 1.45e-06 ***
## Residuals      198  28363    143.2
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

# Format ANOVA as lm
Litter.Totals.anova2 <- lm(data = Litter.Totals, dryMass ~ plotID)
summary(Litter.Totals.anova2) # In this case, intercept is first grouping (alphabetically)

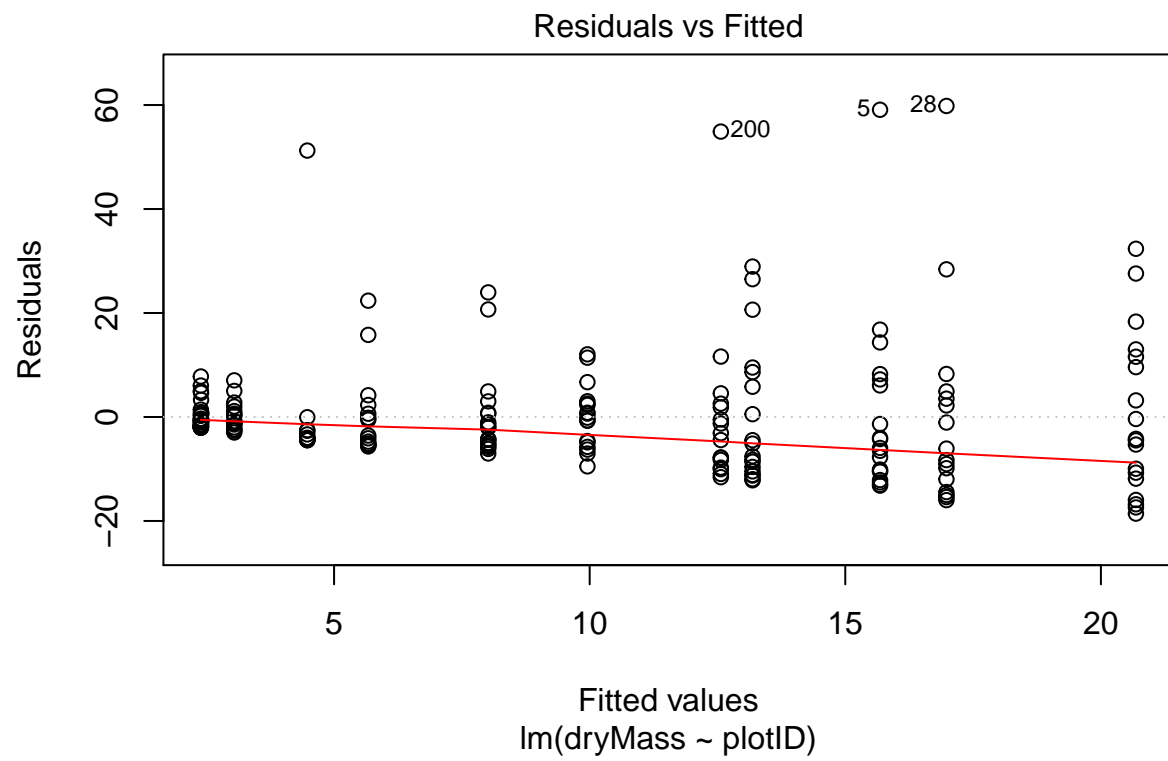
##
## Call:
## lm(formula = dryMass ~ plotID, data = Litter.Totals)
##
```

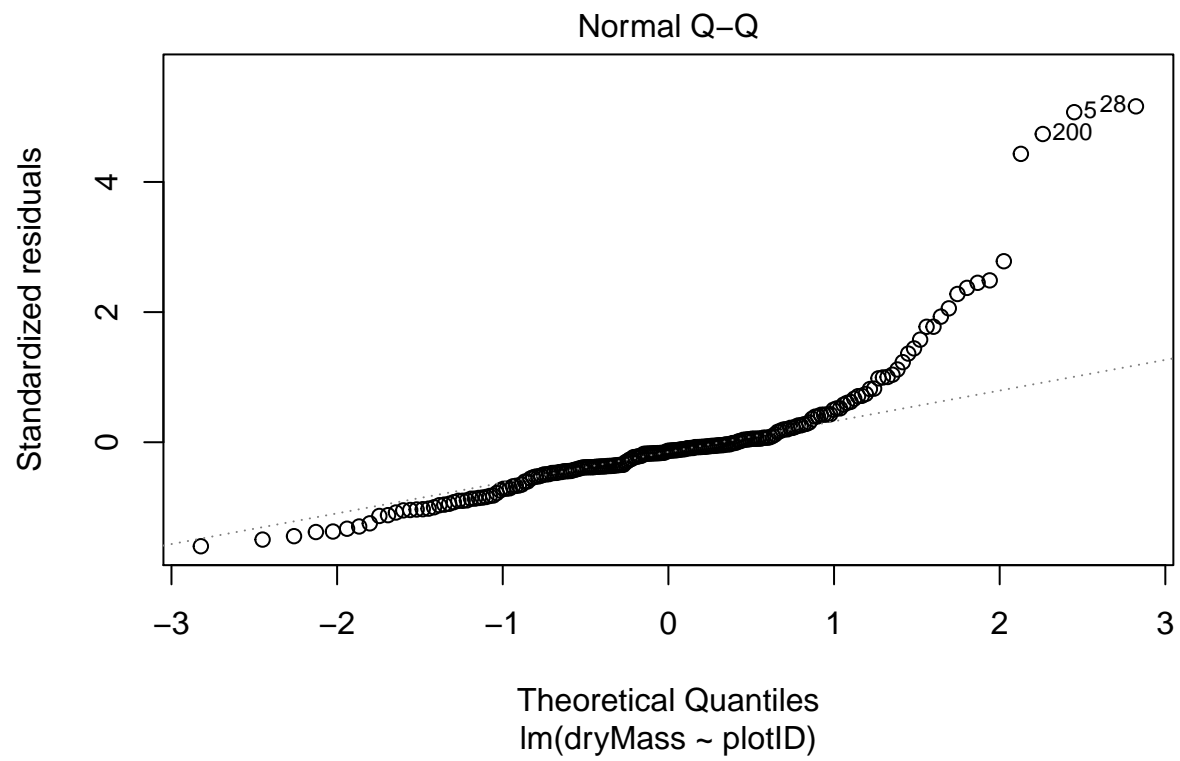
```
## Residuals:
##      Min       1Q   Median       3Q      Max
## -18.586  -5.419  -1.529   1.964  59.821
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    15.680     2.746   5.711 4.08e-08 ***
## plotIDNIWO_041     1.299     4.061   0.320 0.749396
## plotIDNIWO_046    -5.724     3.996  -1.432 0.153580
## plotIDNIWO_047   -11.204     4.134  -2.710 0.007315 **
## plotIDNIWO_051   -10.011     4.061  -2.465 0.014546 *
## plotIDNIWO_057     5.006     3.937   1.272 0.205013
## plotIDNIWO_058   -13.282     3.883  -3.420 0.000760 ***
## plotIDNIWO_061    -2.494     3.937  -0.633 0.527140
## plotIDNIWO_062   -12.632     3.883  -3.253 0.001342 **
## plotIDNIWO_063   -13.286     3.937  -3.375 0.000888 ***
## plotIDNIWO_064    -7.664     3.883  -1.974 0.049805 *
## plotIDNIWO_067    -3.114     4.061  -0.767 0.444110
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 11.97 on 198 degrees of freedom
## Multiple R-squared:  0.211, Adjusted R-squared:  0.1671
## F-statistic: 4.813 on 11 and 198 DF, p-value: 1.452e-06
```

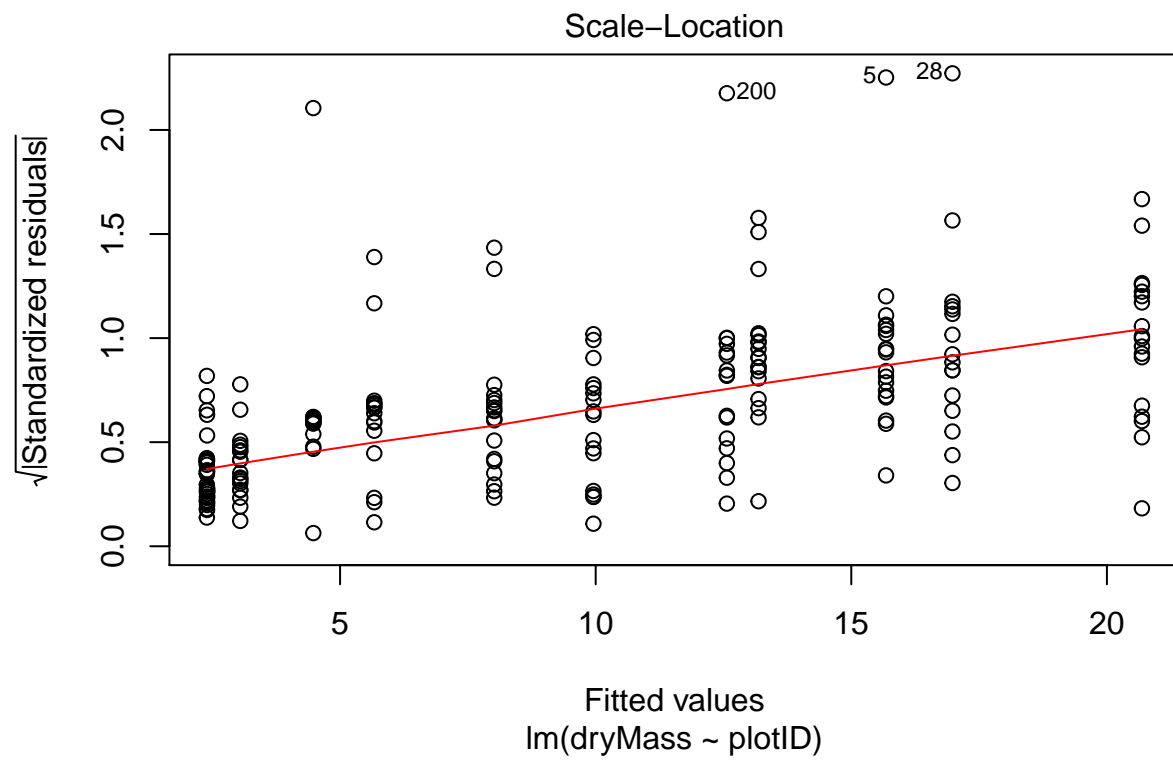
```
# Checking model fit and assumptions
```

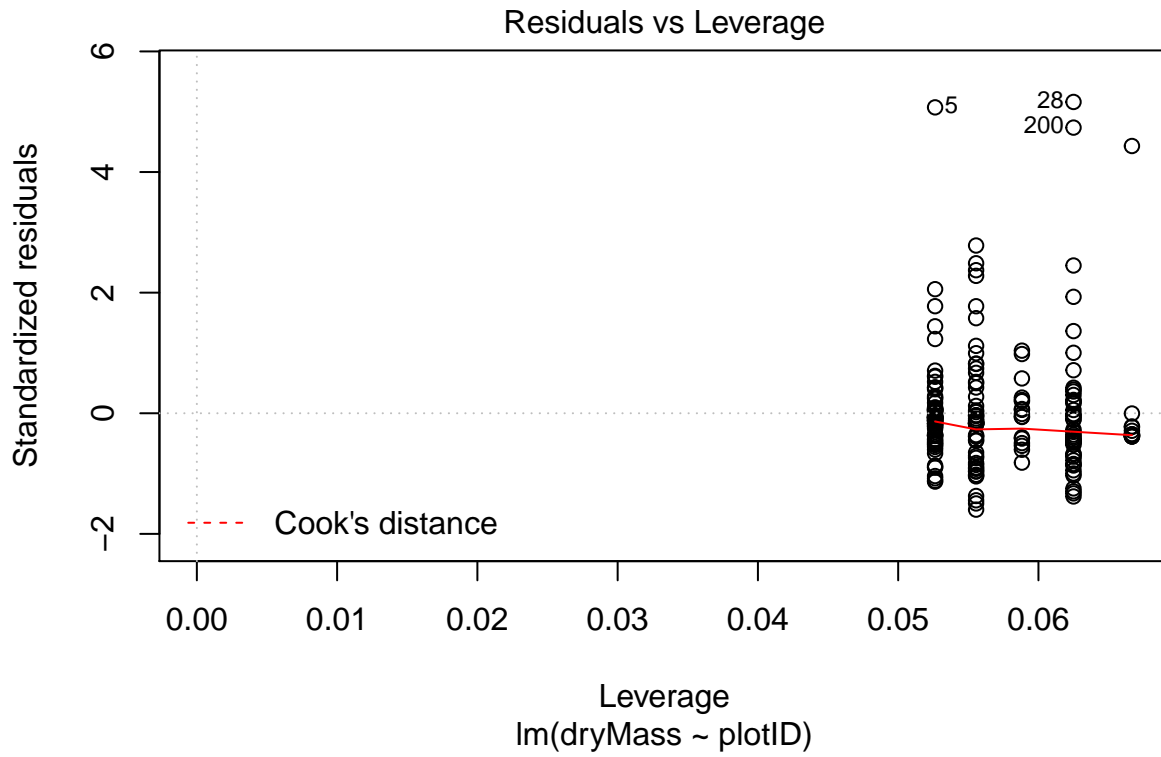
```
# ANOVA is robust against departures from normality.
```

```
plot(Litter.Totals.anova2) # Can you get it to plot just one of the plots?
```









```
# Post-hoc test
TukeyHSD(Litter.Totals.anova) # Only works on "aov" object
```

```
## Tukey multiple comparisons of means
## 95% family-wise confidence level
##
## Fit: aov(formula = dryMass ~ plotID, data = Litter.Totals)
##
## $plotID
##              diff          lwr          upr      p adj
## NIWO_041-NIWO_040  1.299062500 -12.133507 14.7316317 1.0000000
## NIWO_046-NIWO_040 -5.723823529 -18.940183  7.4925361 0.9556786
## NIWO_047-NIWO_040 -11.203666667 -24.877141  2.4698079 0.2291635
## NIWO_051-NIWO_040 -10.011250000 -23.443819  3.4213192 0.3682118
## NIWO_057-NIWO_040  5.005833333  -8.015326 18.0269931 0.9817155
## NIWO_058-NIWO_040 -13.281578947 -26.125572 -0.4375861 0.0356138
## NIWO_061-NIWO_040 -2.493888889 -15.515049 10.5272709 0.9999695
## NIWO_062-NIWO_040 -12.632368421 -25.476361  0.2116244 0.0585895
## NIWO_063-NIWO_040 -13.286111111 -26.307271 -0.2649514 0.0409036
## NIWO_064-NIWO_040 -7.664210526 -20.508203  5.1797823 0.7105434
## NIWO_067-NIWO_040 -3.114062500 -16.546632 10.3185067 0.9997965
## NIWO_046-NIWO_041 -7.022886029 -20.811937  6.7661649 0.8732142
## NIWO_047-NIWO_041 -12.502729167 -26.730507  1.7250490 0.1467092
## NIWO_051-NIWO_041 -11.310312500 -25.306729  2.6861042 0.2478220
## NIWO_057-NIWO_041  3.706770833  -9.895301 17.3088429 0.9990520
## NIWO_058-NIWO_041 -14.580641447 -28.013211 -1.1480722 0.0207531
```

```
## NIWO_061-NIWO_041 -3.792951389 -17.395023 9.8091207 0.9988277
## NIWO_062-NIWO_041 -13.931430921 -27.364000 -0.4988617 0.0345161
## NIWO_063-NIWO_041 -14.585173611 -28.187246 -0.9831015 0.0239137
## NIWO_064-NIWO_041 -8.963273026 -22.395842 4.4692962 0.5465386
## NIWO_067-NIWO_041 -4.413125000 -18.409542 9.5832917 0.9964654
## NIWO_047-NIWO_046 -5.479843137 -19.503677 8.5439907 0.9792588
## NIWO_051-NIWO_046 -4.287426471 -18.076477 9.5016245 0.9968732
## NIWO_057-NIWO_046 10.729656863 -2.658943 24.1182569 0.2593203
## NIWO_058-NIWO_046 -7.557755418 -20.774115 5.6586042 0.7631683
## NIWO_061-NIWO_046 3.229934641 -10.158665 16.6185346 0.9997008
## NIWO_062-NIWO_046 -6.908544892 -20.124904 6.3078147 0.8526955
## NIWO_063-NIWO_046 -7.562287582 -20.950888 5.8263124 0.7772274
## NIWO_064-NIWO_046 -1.940386997 -15.156747 11.2759726 0.9999980
## NIWO_067-NIWO_046 2.609761029 -11.179290 16.3988120 0.9999730
## NIWO_051-NIWO_047 1.192416667 -13.035361 15.4201948 1.0000000
## NIWO_057-NIWO_047 16.209500000 2.369473 30.0495273 0.0078565
## NIWO_058-NIWO_047 -2.077912281 -15.751387 11.5955623 0.9999972
## NIWO_061-NIWO_047 8.709777778 -5.130249 22.5498050 0.6364556
## NIWO_062-NIWO_047 -1.428701754 -15.102176 12.2447728 0.9999999
## NIWO_063-NIWO_047 -2.082444444 -15.922472 11.7575828 0.9999975
## NIWO_064-NIWO_047 3.539456140 -10.134018 17.2129307 0.9994142
## NIWO_067-NIWO_047 8.089604167 -6.138174 22.3173823 0.7697669
## NIWO_057-NIWO_051 15.017083333 1.415011 28.6191554 0.0169404
## NIWO_058-NIWO_051 -3.270328947 -16.702898 10.1622403 0.9996733
## NIWO_061-NIWO_051 7.517361111 -6.084711 21.1194332 0.8006609
## NIWO_062-NIWO_051 -2.621118421 -16.053688 10.8114508 0.9999632
## NIWO_063-NIWO_051 -3.274861111 -16.876933 10.3272110 0.9997065
## NIWO_064-NIWO_051 2.347039474 -11.085530 15.7796087 0.9999880
## NIWO_067-NIWO_051 6.897187500 -7.099229 20.8936042 0.8959904
## NIWO_058-NIWO_057 -18.287412281 -31.308572 -5.2662525 0.0003779
## NIWO_061-NIWO_057 -7.499722222 -20.695670 5.6962260 0.7702539
## NIWO_062-NIWO_057 -17.638201754 -30.659361 -4.6170420 0.0007554
## NIWO_063-NIWO_057 -18.291944444 -31.487893 -5.0959962 0.0004883
## NIWO_064-NIWO_057 -12.670043860 -25.691204 0.3511159 0.0646857
## NIWO_067-NIWO_057 -8.119895833 -21.721968 5.4821763 0.7100063
## NIWO_061-NIWO_058 10.787690058 -2.233470 23.8088498 0.2148146
## NIWO_062-NIWO_058 0.649210526 -12.194782 13.4932034 1.0000000
## NIWO_063-NIWO_058 -0.004532164 -13.025692 13.0166276 1.0000000
## NIWO_064-NIWO_058 5.617368421 -7.226624 18.4613613 0.9525183
## NIWO_067-NIWO_058 10.167516447 -3.265053 23.6000857 0.3439343
## NIWO_062-NIWO_061 -10.138479532 -23.159639 2.8826802 0.3009668
## NIWO_063-NIWO_061 -10.792222222 -23.988170 2.4037260 0.2316348
## NIWO_064-NIWO_061 -5.170321637 -18.191481 7.8508381 0.9765523
## NIWO_067-NIWO_061 -0.620173611 -14.222246 12.9818985 1.0000000
## NIWO_063-NIWO_062 -0.653742690 -13.674902 12.3674170 1.0000000
## NIWO_064-NIWO_062 4.968157895 -7.875835 17.8121507 0.9808216
## NIWO_067-NIWO_062 9.518305921 -3.914263 22.9508752 0.4494776
## NIWO_064-NIWO_063 5.621900585 -7.399259 18.6430603 0.9566352
## NIWO_067-NIWO_063 10.172048611 -3.430023 23.7741207 0.3628551
## NIWO_067-NIWO_064 4.550148026 -8.882421 17.9827173 0.9934557
```

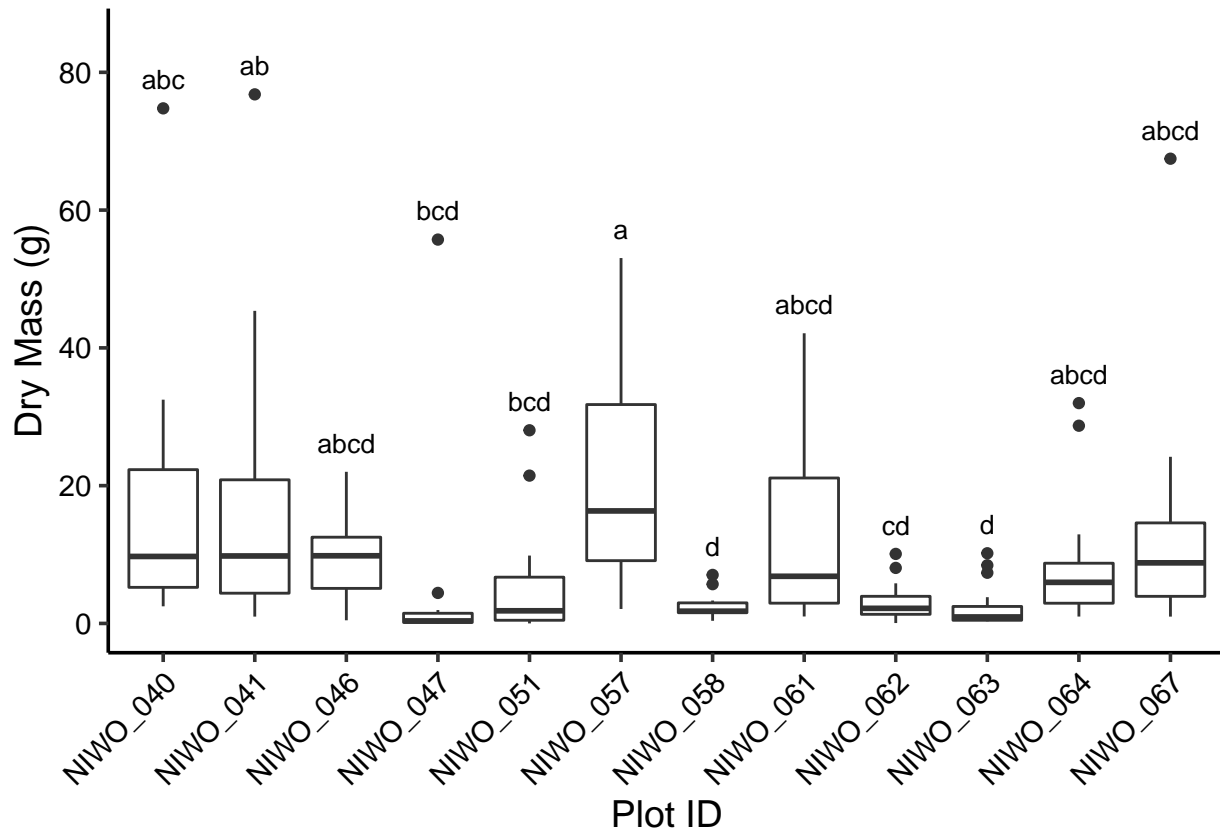
```
# Extract groupings for pairwise relationships - shows which statistical group a level is in (levels in
Litter.Totals.groups <- HSD.test(Litter.Totals.anova, "plotID", group = TRUE)
Litter.Totals.groups
```

```

## $statistics
##      MSerror Df      Mean      CV
##    143.2479 198 9.55381 125.2759
##
## $parameters
##      test name.t ntr StudentizedRange alpha
##    Tukey plotID 12          4.677704 0.05
##
## $means
##      dryMass      std  r   Min   Max   Q25   Q50   Q75
## NIWO_040 15.680000 17.127210 19 2.485 74.770 5.23750 9.7250 22.32500
## NIWO_041 16.979063 19.748656 16 0.990 76.800 4.38875 9.7950 20.84750
## NIWO_046 9.956176 6.125677 17 0.455 22.010 5.08500 9.8200 12.52000
## NIWO_047 4.476333 14.224853 15 0.015 55.720 0.14500 0.3650 1.47500
## NIWO_051 5.668750 8.158336 16 0.005 28.040 0.46000 1.8350 6.71625
## NIWO_057 20.685833 15.634036 18 2.100 53.040 9.11250 16.3300 31.77125
## NIWO_058 2.398421 1.636032 19 0.385 7.045 1.56000 1.7750 2.98500
## NIWO_061 13.186111 13.620037 18 1.010 42.120 2.94125 6.8450 21.11125
## NIWO_062 3.047632 2.666352 19 0.060 10.095 1.32250 2.1900 3.93500
## NIWO_063 2.393889 3.068145 18 0.310 10.185 0.46125 0.9425 2.46625
## NIWO_064 8.015789 8.517745 19 1.000 31.985 2.93500 5.9650 8.74000
## NIWO_067 12.565938 16.021432 16 0.990 67.460 3.93125 8.7950 14.59375
##
## $comparison
## NULL
##
## $groups
##      dryMass groups
## NIWO_057 20.685833      a
## NIWO_041 16.979063      ab
## NIWO_040 15.680000      abc
## NIWO_061 13.186111     abcd
## NIWO_067 12.565938     abcd
## NIWO_046 9.956176      abcd
## NIWO_064 8.015789      abcd
## NIWO_051 5.668750      bcd
## NIWO_047 4.476333      bcd
## NIWO_062 3.047632       cd
## NIWO_058 2.398421       d
## NIWO_063 2.393889       d
##
## attr("class")
## [1] "group"

# Graph the results
Litter.Totals.plot <- ggplot(Litter.Totals, aes(x = plotID, y = dryMass)) +
  geom_boxplot() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1)) +
  stat_summary(geom = "text", fun.y = max, vjust = -1, size = 3.5,
    label = c("abc", "ab", "abcd", "bcd", "bcd", "a",
      "d", "abcd", "cd", "d", "abcd", "abcd")) + # Assign labels in the order it wil
  labs(x = "Plot ID", y = "Dry Mass (g)") +
  ylim(0, 85)
print(Litter.Totals.plot)

```



What information does the output give us? How might we report this information in a report?

Total litter biomass differs significantly among sites at the Niwot Ridge LTER (Figure 1; ANOVA, $F_{11,198} = 4.813$, $p < 0.0001$).

Non-parametric equivalent of ANOVA: Kruskal-Wallis Test

As with the Wilcoxon test, the Kruskal-Wallis test is the non-parametric counterpart to the one-way ANOVA. Here, the data from two or more independent samples are replaced with their ranks without regard to the grouping AND based on the between-group sum of squares calculations.

For multiple comparisons, a p -value < 0.05 indicates that there is a significant difference between groups, but it does not indicate which groups, or in this case, months, differ from each other.

To analyze specific pairs in the data, you must use a *post hoc* test. These include the Dunn's test, a pairwise Mann-Whitney with the Bonferroni correction, or the Conover-Iman test.

```
Litter.kw <- kruskal.test(Litter.Totals$dryMass ~ Litter.Totals$plotID)
Litter.kw
```

```
##
## Kruskal-Wallis rank sum test
##
## data: Litter.Totals$dryMass by Litter.Totals$plotID
## Kruskal-Wallis chi-squared = 85.273, df = 11, p-value = 1.398e-13

# There are two functions to run the Dunn Test
# dunn.test(Litter.Totals$dryMass, Litter.Totals$plotID, kw = T,
#           table = F, list = T, method = "holm", altp = T) #From package dunn.test
```

```
# dunnTest(Litter.Totals$dryMass, Litter.Totals$plotID)
```

```
#From package FSA
```

TWO-WAY ANOVA

Main effects

A two-way ANOVA allows us to examine the effects of two categorical explanatory variables on a continuous response variable. What if we wanted to know how litter masses varied across functional groups and land cover class?

```
# Format as aov
```

```
Litter.anova.2way <- aov(data = Litter, dryMass ~ functionalGroup + nlcdClass)
summary(Litter.anova.2way)
```

```
##              Df Sum Sq Mean Sq F value    Pr(>F)
## functionalGroup    7   6193    884.7  71.540 < 2e-16 ***
## nlcdClass          2    223    111.7   9.033 0.000125 ***
## Residuals        1682  20800    12.4
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# Format as lm
```

```
Litter.anova.2way2 <- lm(data = Litter, dryMass ~ functionalGroup + nlcdClass)
summary(Litter.anova.2way2)
```

```
##
## Call:
## lm(formula = dryMass ~ functionalGroup + nlcdClass, data = Litter)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -5.487 -0.784 -0.208  0.259  48.738
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    0.523322   0.263954   1.983 0.047571 *
## functionalGroupLeaves    0.002287   0.335011   0.007 0.994554
## functionalGroupMixed    1.647412   0.417281   3.948 8.21e-05 ***
## functionalGroupNeedles    5.654391   0.329491  17.161 < 2e-16 ***
## functionalGroupOther    0.037433   0.337609   0.111 0.911728
## functionalGroupSeeds   -0.005358   0.338383  -0.016 0.987370
## functionalGroupTwigs/branches  1.120138   0.332841   3.365 0.000782 ***
## functionalGroupWoody material  0.466337   0.330164   1.412 0.158005
## nlcdClassgrasslandHerbaceous -0.685663   0.230666  -2.973 0.002995 **
## nlcdClassshrubScrub    -0.782095   0.193758  -4.036 5.67e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.517 on 1682 degrees of freedom
## Multiple R-squared:  0.2357, Adjusted R-squared:  0.2317
## F-statistic: 57.65 on 9 and 1682 DF, p-value: < 2.2e-16
```

```
# Run a post-hoc test for pairwise differences
```

```
TukeyHSD(Litter.anova.2way)
```

```
## Tukey multiple comparisons of means
```

```
##      95% family-wise confidence level
##
## Fit: aov(formula = dryMass ~ functionalGroup + nlcdClass, data = Litter)
##
## $functionalGroup
##
```

	diff	lwr	upr	p adj
Leaves-Flowers	-0.014519444	-1.03108186	1.00204297	1.0000000
Mixed-Flowers	1.709115566	0.44356059	2.97467054	0.0011317
Needles-Flowers	5.657419606	4.65752186	6.65731735	0.0000000
Other-Flowers	0.027849771	-0.99667539	1.05237493	1.0000000
Seeds-Flowers	-0.012152778	-1.03903588	1.01473033	1.0000000
Twigs/branches-Flowers	1.118146645	0.10807127	2.12822202	0.0181336
Woody material-Flowers	0.483062238	-0.51881096	1.48493544	0.8269243
Mixed-Leaves	1.723635010	0.46643987	2.98083015	0.0008712
Needles-Leaves	5.671939050	4.68264348	6.66123462	0.0000000
Other-Leaves	0.042369215	-0.97181126	1.05654969	1.0000000
Seeds-Leaves	0.002366667	-1.01419574	1.01892908	1.0000000
Twigs/branches-Leaves	1.132666089	0.13308494	2.13224724	0.0138750
Woody material-Leaves	0.497581683	-0.49371047	1.48887383	0.7949699
Needles-Mixed	3.948304040	2.70454523	5.19206285	0.0000000
Other-Mixed	-1.681265795	-2.94490826	-0.41762333	0.0014542
Seeds-Mixed	-1.721268344	-2.98682332	-0.45571337	0.0010019
Twigs/branches-Mixed	-0.590968921	-1.84292449	0.66098664	0.8421896
Woody material-Mixed	-1.226053328	-2.47140082	0.01929417	0.0572676
Other-Needles	-5.629569835	-6.62704585	-4.63209382	0.0000000
Seeds-Needles	-5.669572384	-6.66947013	-4.66967464	0.0000000
Twigs/branches-Needles	-4.539272961	-5.52190150	-3.55664442	0.0000000
Woody material-Needles	-5.174357367	-6.14855268	-4.20016206	0.0000000
Seeds-Other	-0.040002548	-1.06452771	0.98452261	1.0000000
Twigs/branches-Other	1.090296874	0.08261877	2.09797498	0.0232567
Woody material-Other	0.455212468	-0.54424379	1.45466872	0.8655279
Twigs/branches-Seeds	1.130299423	0.12022405	2.14037480	0.0160473
Woody material-Seeds	0.495215016	-0.50665818	1.49708822	0.8076616
Woody material-Twigs/branches	-0.635084407	-1.61972305	0.34955424	0.5113474

```
##
## $nlcdClass
##
```

	diff	lwr	upr	p adj
grasslandHerbaceous-evergreenForest	-0.68360994	-1.2242079	-0.1430120	0.0085817
shrubScrub-evergreenForest	-0.78026426	-1.2343255	-0.3262030	0.0001714
shrubScrub-grasslandHerbaceous	-0.09665431	-0.6283874	0.4350788	0.9046605

Interaction effects

We may expect the effects of functional group and land cover to be dependent on each other. For instance, we may expect needle biomass to be larger in evergreen forests than in other land types. In this case, we might choose to run an interaction effects two-way ANOVA, which will examine the individual effects of the explanatory variables as well as the interaction of the explanatory variables.

The output gives test statistics for each explanatory variable as well as the interaction effect of the explanatory variables. If the p-value for the interaction effect is less than 0.05, then we would consider the interaction among the explanatory variables to be significant.

```
# Format as aov
Litter.anova.2way3 <- aov(data = Litter, dryMass ~ functionalGroup * nlcdClass)
summary(Litter.anova.2way3)
```

```
##              Df Sum Sq Mean Sq F value    Pr(>F)
## functionalGroup      7   6193   884.7   72.445 < 2e-16 ***
## nlcdClass            2    223   111.7    9.147 0.000112 ***
## functionalGroup:nlcdClass 14    431    30.8    2.521 0.001444 **
## Residuals          1668  20369    12.2
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

# Format as lm
Litter.anova.2way4 <- lm(data = Litter, dryMass ~ functionalGroup * nlcdClass)
summary(Litter.anova.2way4)

##
## Call:
## lm(formula = dryMass ~ functionalGroup * nlcdClass, data = Litter)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -6.612  -0.480  -0.058  -0.005   49.051
##
## Coefficients:
##                                     Estimate Std. Error
## (Intercept)                        0.11963     0.39070
## functionalGroupLeaves               -0.10360     0.55606
## functionalGroupMixed                 1.50475     0.63800
## functionalGroupNeedles              7.31226     0.53696
## functionalGroupOther                -0.03482     0.55606
## functionalGroupSeeds               -0.04616     0.55606
## functionalGroupTwigs/branches       1.95967     0.54434
## functionalGroupWoody material       1.08431     0.53156
## nlcdClassgrasslandHerbaceous       -0.11420     0.64223
## nlcdClassshrubScrub                -0.10412     0.53838
## functionalGroupLeaves:nlcdClassgrasslandHerbaceous 0.12865     0.89410
## functionalGroupMixed:nlcdClassgrasslandHerbaceous -0.38118     1.13024
## functionalGroupNeedles:nlcdClassgrasslandHerbaceous -2.13880     0.87993
## functionalGroupOther:nlcdClassgrasslandHerbaceous 0.12606     0.90743
## functionalGroupSeeds:nlcdClassgrasslandHerbaceous 0.04615     0.90743
## functionalGroupTwigs/branches:nlcdClassgrasslandHerbaceous -1.01519     0.89462
## functionalGroupWoody material:nlcdClassgrasslandHerbaceous -1.04086     0.88971
## functionalGroupLeaves:nlcdClassshrubScrub 0.14703     0.75915
## functionalGroupMixed:nlcdClassshrubScrub 0.74593     0.93038
## functionalGroupNeedles:nlcdClassshrubScrub -2.92148     0.74258
## functionalGroupOther:nlcdClassshrubScrub 0.08589     0.76101
## functionalGroupSeeds:nlcdClassshrubScrub 0.05944     0.76295
## functionalGroupTwigs/branches:nlcdClassshrubScrub -1.49559     0.74881
## functionalGroupWoody material:nlcdClassshrubScrub -0.97185     0.73957
##                                     t value Pr(>|t|)
## (Intercept)                        0.306 0.759502
## functionalGroupLeaves              -0.186 0.852224
## functionalGroupMixed                2.359 0.018462 *
## functionalGroupNeedles             13.618 < 2e-16 ***
## functionalGroupOther               -0.063 0.950081
## functionalGroupSeeds               -0.083 0.933846
## functionalGroupTwigs/branches       3.600 0.000327 ***
## functionalGroupWoody material       2.040 0.041519 *
```



```
## nlcdClassgrasslandHerbaceous -0.178 0.858888
## nlcdClassshrubScrub -0.193 0.846673
## functionalGroupLeaves:nlcdClassgrasslandHerbaceous 0.144 0.885611
## functionalGroupMixed:nlcdClassgrasslandHerbaceous -0.337 0.735969
## functionalGroupNeedles:nlcdClassgrasslandHerbaceous -2.431 0.015177 *
## functionalGroupOther:nlcdClassgrasslandHerbaceous 0.139 0.889531
## functionalGroupSeeds:nlcdClassgrasslandHerbaceous 0.051 0.959441
## functionalGroupTwigs/branches:nlcdClassgrasslandHerbaceous -1.135 0.256634
## functionalGroupWoody material:nlcdClassgrasslandHerbaceous -1.170 0.242213
## functionalGroupLeaves:nlcdClassshrubScrub 0.194 0.846453
## functionalGroupMixed:nlcdClassshrubScrub 0.802 0.422814
## functionalGroupNeedles:nlcdClassshrubScrub -3.934 8.69e-05 ***
## functionalGroupOther:nlcdClassshrubScrub 0.113 0.910155
## functionalGroupSeeds:nlcdClassshrubScrub 0.078 0.937915
## functionalGroupTwigs/branches:nlcdClassshrubScrub -1.997 0.045956 *
## functionalGroupWoody material:nlcdClassshrubScrub -1.314 0.189001
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.494 on 1668 degrees of freedom
## Multiple R-squared: 0.2516, Adjusted R-squared: 0.2413
## F-statistic: 24.38 on 23 and 1668 DF, p-value: < 2.2e-16
```

If the interaction is significant, we interpret pairwise differences for the interaction. If the interaction is not significant, we interpret differences for the main effects only.

```
# Run a post-hoc test for pairwise differences
TukeyHSD(Litter.anova.2way3)
```

```
## Tukey multiple comparisons of means
## 95% family-wise confidence level
##
## Fit: aov(formula = dryMass ~ functionalGroup * nlcdClass, data = Litter)
##
## $functionalGroup
##
```

	diff	lwr	upr	p adj
Leaves-Flowers	-0.014519444	-1.02471810	0.9956792	1.0000000
Mixed-Flowers	1.709115566	0.45148307	2.9667481	0.0010161
Needles-Flowers	5.657419606	4.66378130	6.6510579	0.0000000
Other-Flowers	0.027849771	-0.99026179	1.0459613	1.0000000
Seeds-Flowers	-0.012152778	-1.03260752	1.0083020	1.0000000
Twigs/branches-Flowers	1.118146645	0.11439442	2.1218989	0.0168974
Woody material-Flowers	0.483062238	-0.51253916	1.4786636	0.8221892
Mixed-Leaves	1.723635010	0.47431001	2.9729600	0.0007796
Needles-Leaves	5.671939050	4.68883655	6.6550416	0.0000000
Other-Leaves	0.042369215	-0.96546241	1.0502008	1.0000000
Seeds-Leaves	0.002366667	-1.00783199	1.0125653	1.0000000
Twigs/branches-Leaves	1.132666089	0.13934239	2.1259898	0.0128809
Woody material-Leaves	0.497581683	-0.48750490	1.4826683	0.7896098
Needles-Mixed	3.948304040	2.71233125	5.1842768	0.0000000
Other-Mixed	-1.681265795	-2.93699776	-0.4255338	0.0013099
Seeds-Mixed	-1.721268344	-2.97890084	-0.4636358	0.0008982
Twigs/branches-Mixed	-0.590968921	-1.83508715	0.6531493	0.8377747
Woody material-Mixed	-1.226053328	-2.46360485	0.0114982	0.0542582
Other-Needles	-5.629569835	-6.62080157	-4.6383381	0.0000000


```

## Seeds-Needles -5.669572384 -6.66321069 -4.6759341 0.0000000
## Twigs/branches-Needles -4.539272961 -5.51575017 -3.5627957 0.0000000
## Woody material-Needles -5.174357367 -6.14245414 -4.2062606 0.0000000
## Seeds-Other -0.040002548 -1.05811410 0.9781090 1.0000000
## Twigs/branches-Other 1.090296874 0.08892692 2.0916668 0.0217473
## Woody material-Other 0.455212468 -0.53798711 1.4484120 0.8616311
## Twigs/branches-Seeds 1.130299423 0.12654720 2.1340516 0.0149277
## Woody material-Seeds 0.495215016 -0.50038638 1.4908164 0.8025426
## Woody material-Twigs/branches -0.635084407 -1.61355913 0.3433903 0.5028434
##
## $nlcdClass
## diff lwr upr p adj
## grasslandHerbaceous-evergreenForest -0.68360994 -1.2208220 -0.1463979 0.0080895
## shrubScrub-evergreenForest -0.78026426 -1.2314816 -0.3290469 0.0001541
## shrubScrub-grasslandHerbaceous -0.09665431 -0.6250571 0.4317485 0.9035143
##
## $functionalGroup:nlcdClass`
## diff
## Leaves:evergreenForest-Flowers:evergreenForest -1.035994e-01
## Mixed:evergreenForest-Flowers:evergreenForest 1.504750e+00
## Needles:evergreenForest-Flowers:evergreenForest 7.312264e+00
## Other:evergreenForest-Flowers:evergreenForest -3.481731e-02
## Seeds:evergreenForest-Flowers:evergreenForest -4.616346e-02
## Twigs/branches:evergreenForest-Flowers:evergreenForest 1.959669e+00
## Woody material:evergreenForest-Flowers:evergreenForest 1.084311e+00
## Flowers:grasslandHerbaceous-Flowers:evergreenForest -1.141995e-01
## Leaves:grasslandHerbaceous-Flowers:evergreenForest -8.915330e-02
## Mixed:grasslandHerbaceous-Flowers:evergreenForest 1.009375e+00
## Needles:grasslandHerbaceous-Flowers:evergreenForest 5.059264e+00
## Other:grasslandHerbaceous-Flowers:evergreenForest -2.295833e-02
## Seeds:grasslandHerbaceous-Flowers:evergreenForest -1.142083e-01
## Twigs/branches:grasslandHerbaceous-Flowers:evergreenForest 8.302750e-01
## Woody material:grasslandHerbaceous-Flowers:evergreenForest -7.074745e-02
## Flowers:shrubScrub-Flowers:evergreenForest -1.041194e-01
## Leaves:shrubScrub-Flowers:evergreenForest -6.068883e-02
## Mixed:shrubScrub-Flowers:evergreenForest 2.146559e+00
## Needles:shrubScrub-Flowers:evergreenForest 4.286664e+00
## Other:shrubScrub-Flowers:evergreenForest -5.304891e-02
## Seeds:shrubScrub-Flowers:evergreenForest -9.084722e-02
## Twigs/branches:shrubScrub-Flowers:evergreenForest 3.599583e-01
## Woody material:shrubScrub-Flowers:evergreenForest 8.343750e-03
## Mixed:evergreenForest-Leaves:evergreenForest 1.608349e+00
## Needles:evergreenForest-Leaves:evergreenForest 7.415863e+00
## Other:evergreenForest-Leaves:evergreenForest 6.878205e-02
## Seeds:evergreenForest-Leaves:evergreenForest 5.743590e-02
## Twigs/branches:evergreenForest-Leaves:evergreenForest 2.063268e+00
## Woody material:evergreenForest-Leaves:evergreenForest 1.187911e+00
## Flowers:grasslandHerbaceous-Leaves:evergreenForest -1.060011e-02
## Leaves:grasslandHerbaceous-Leaves:evergreenForest 1.444606e-02
## Mixed:grasslandHerbaceous-Leaves:evergreenForest 1.112974e+00
## Needles:grasslandHerbaceous-Leaves:evergreenForest 5.162863e+00
## Other:grasslandHerbaceous-Leaves:evergreenForest 8.064103e-02
## Seeds:grasslandHerbaceous-Leaves:evergreenForest -1.060897e-02
## Twigs/branches:grasslandHerbaceous-Leaves:evergreenForest 9.338744e-01

```

## Woody material:grasslandHerbaceous-Leaves:evergreenForest	3.285191e-02
## Flowers:shrubScrub-Leaves:evergreenForest	-5.200230e-04
## Leaves:shrubScrub-Leaves:evergreenForest	4.291053e-02
## Mixed:shrubScrub-Leaves:evergreenForest	2.250159e+00
## Needles:shrubScrub-Leaves:evergreenForest	4.390263e+00
## Other:shrubScrub-Leaves:evergreenForest	5.055045e-02
## Seeds:shrubScrub-Leaves:evergreenForest	1.275214e-02
## Twigs/branches:shrubScrub-Leaves:evergreenForest	4.635577e-01
## Woody material:shrubScrub-Leaves:evergreenForest	1.119431e-01
## Needles:evergreenForest-Mixed:evergreenForest	5.807514e+00
## Other:evergreenForest-Mixed:evergreenForest	-1.539567e+00
## Seeds:evergreenForest-Mixed:evergreenForest	-1.550913e+00
## Twigs/branches:evergreenForest-Mixed:evergreenForest	4.549191e-01
## Woody material:evergreenForest-Mixed:evergreenForest	-4.204388e-01
## Flowers:grasslandHerbaceous-Mixed:evergreenForest	-1.618949e+00
## Leaves:grasslandHerbaceous-Mixed:evergreenForest	-1.593903e+00
## Mixed:grasslandHerbaceous-Mixed:evergreenForest	-4.953750e-01
## Needles:grasslandHerbaceous-Mixed:evergreenForest	3.554514e+00
## Other:grasslandHerbaceous-Mixed:evergreenForest	-1.527708e+00
## Seeds:grasslandHerbaceous-Mixed:evergreenForest	-1.618958e+00
## Twigs/branches:grasslandHerbaceous-Mixed:evergreenForest	-6.744750e-01
## Woody material:grasslandHerbaceous-Mixed:evergreenForest	-1.575497e+00
## Flowers:shrubScrub-Mixed:evergreenForest	-1.608869e+00
## Leaves:shrubScrub-Mixed:evergreenForest	-1.565439e+00
## Mixed:shrubScrub-Mixed:evergreenForest	6.418092e-01
## Needles:shrubScrub-Mixed:evergreenForest	2.781914e+00
## Other:shrubScrub-Mixed:evergreenForest	-1.557799e+00
## Seeds:shrubScrub-Mixed:evergreenForest	-1.595597e+00
## Twigs/branches:shrubScrub-Mixed:evergreenForest	-1.144792e+00
## Woody material:shrubScrub-Mixed:evergreenForest	-1.496406e+00
## Other:evergreenForest-Needles:evergreenForest	-7.347081e+00
## Seeds:evergreenForest-Needles:evergreenForest	-7.358427e+00
## Twigs/branches:evergreenForest-Needles:evergreenForest	-5.352595e+00
## Woody material:evergreenForest-Needles:evergreenForest	-6.227953e+00
## Flowers:grasslandHerbaceous-Needles:evergreenForest	-7.426463e+00
## Leaves:grasslandHerbaceous-Needles:evergreenForest	-7.401417e+00
## Mixed:grasslandHerbaceous-Needles:evergreenForest	-6.302889e+00
## Needles:grasslandHerbaceous-Needles:evergreenForest	-2.253000e+00
## Other:grasslandHerbaceous-Needles:evergreenForest	-7.335222e+00
## Seeds:grasslandHerbaceous-Needles:evergreenForest	-7.426472e+00
## Twigs/branches:grasslandHerbaceous-Needles:evergreenForest	-6.481989e+00
## Woody material:grasslandHerbaceous-Needles:evergreenForest	-7.383011e+00
## Flowers:shrubScrub-Needles:evergreenForest	-7.416383e+00
## Leaves:shrubScrub-Needles:evergreenForest	-7.372953e+00
## Mixed:shrubScrub-Needles:evergreenForest	-5.165705e+00
## Needles:shrubScrub-Needles:evergreenForest	-3.025600e+00
## Other:shrubScrub-Needles:evergreenForest	-7.365313e+00
## Seeds:shrubScrub-Needles:evergreenForest	-7.403111e+00
## Twigs/branches:shrubScrub-Needles:evergreenForest	-6.952306e+00
## Woody material:shrubScrub-Needles:evergreenForest	-7.303920e+00
## Seeds:evergreenForest-Other:evergreenForest	-1.134615e-02
## Twigs/branches:evergreenForest-Other:evergreenForest	1.994486e+00
## Woody material:evergreenForest-Other:evergreenForest	1.119128e+00
## Flowers:grasslandHerbaceous-Other:evergreenForest	-7.938216e-02

## Leaves:grasslandHerbaceous-Other:evergreenForest	-5.433599e-02
## Mixed:grasslandHerbaceous-Other:evergreenForest	1.044192e+00
## Needles:grasslandHerbaceous-Other:evergreenForest	5.094081e+00
## Other:grasslandHerbaceous-Other:evergreenForest	1.185897e-02
## Seeds:grasslandHerbaceous-Other:evergreenForest	-7.939103e-02
## Twigs/branches:grasslandHerbaceous-Other:evergreenForest	8.650923e-01
## Woody material:grasslandHerbaceous-Other:evergreenForest	-3.593014e-02
## Flowers:shrubScrub-Other:evergreenForest	-6.930207e-02
## Leaves:shrubScrub-Other:evergreenForest	-2.587152e-02
## Mixed:shrubScrub-Other:evergreenForest	2.181377e+00
## Needles:shrubScrub-Other:evergreenForest	4.321481e+00
## Other:shrubScrub-Other:evergreenForest	-1.823161e-02
## Seeds:shrubScrub-Other:evergreenForest	-5.602991e-02
## Twigs/branches:shrubScrub-Other:evergreenForest	3.947756e-01
## Woody material:shrubScrub-Other:evergreenForest	4.316106e-02
## Twigs/branches:evergreenForest-Seeds:evergreenForest	2.005833e+00
## Woody material:evergreenForest-Seeds:evergreenForest	1.130475e+00
## Flowers:grasslandHerbaceous-Seeds:evergreenForest	-6.803601e-02
## Leaves:grasslandHerbaceous-Seeds:evergreenForest	-4.298984e-02
## Mixed:grasslandHerbaceous-Seeds:evergreenForest	1.055538e+00
## Needles:grasslandHerbaceous-Seeds:evergreenForest	5.105427e+00
## Other:grasslandHerbaceous-Seeds:evergreenForest	2.320513e-02
## Seeds:grasslandHerbaceous-Seeds:evergreenForest	-6.804487e-02
## Twigs/branches:grasslandHerbaceous-Seeds:evergreenForest	8.764385e-01
## Woody material:grasslandHerbaceous-Seeds:evergreenForest	-2.458399e-02
## Flowers:shrubScrub-Seeds:evergreenForest	-5.795592e-02
## Leaves:shrubScrub-Seeds:evergreenForest	-1.452537e-02
## Mixed:shrubScrub-Seeds:evergreenForest	2.192723e+00
## Needles:shrubScrub-Seeds:evergreenForest	4.332827e+00
## Other:shrubScrub-Seeds:evergreenForest	-6.885452e-03
## Seeds:shrubScrub-Seeds:evergreenForest	-4.468376e-02
## Twigs/branches:shrubScrub-Seeds:evergreenForest	4.061218e-01
## Woody material:shrubScrub-Seeds:evergreenForest	5.450721e-02
## Woody material:evergreenForest-Twigs/branches:evergreenForest	-8.753579e-01
## Flowers:grasslandHerbaceous-Twigs/branches:evergreenForest	-2.073869e+00
## Leaves:grasslandHerbaceous-Twigs/branches:evergreenForest	-2.048822e+00
## Mixed:grasslandHerbaceous-Twigs/branches:evergreenForest	-9.502941e-01
## Needles:grasslandHerbaceous-Twigs/branches:evergreenForest	3.099595e+00
## Other:grasslandHerbaceous-Twigs/branches:evergreenForest	-1.982627e+00
## Seeds:grasslandHerbaceous-Twigs/branches:evergreenForest	-2.073877e+00
## Twigs/branches:grasslandHerbaceous-Twigs/branches:evergreenForest	-1.129394e+00
## Woody material:grasslandHerbaceous-Twigs/branches:evergreenForest	-2.030417e+00
## Flowers:shrubScrub-Twigs/branches:evergreenForest	-2.063788e+00
## Leaves:shrubScrub-Twigs/branches:evergreenForest	-2.020358e+00
## Mixed:shrubScrub-Twigs/branches:evergreenForest	1.868901e-01
## Needles:shrubScrub-Twigs/branches:evergreenForest	2.326995e+00
## Other:shrubScrub-Twigs/branches:evergreenForest	-2.012718e+00
## Seeds:shrubScrub-Twigs/branches:evergreenForest	-2.050516e+00
## Twigs/branches:shrubScrub-Twigs/branches:evergreenForest	-1.599711e+00
## Woody material:shrubScrub-Twigs/branches:evergreenForest	-1.951325e+00
## Flowers:grasslandHerbaceous-Woody material:evergreenForest	-1.198511e+00
## Leaves:grasslandHerbaceous-Woody material:evergreenForest	-1.173464e+00
## Mixed:grasslandHerbaceous-Woody material:evergreenForest	-7.493617e-02
## Needles:grasslandHerbaceous-Woody material:evergreenForest	3.974953e+00

## Other:grasslandHerbaceous-Woody material:evergreenForest	-1.107270e+00
## Seeds:grasslandHerbaceous-Woody material:evergreenForest	-1.198520e+00
## Twigs/branches:grasslandHerbaceous-Woody material:evergreenForest	-2.540362e-01
## Woody material:grasslandHerbaceous-Woody material:evergreenForest	-1.155059e+00
## Flowers:shrubScrub-Woody material:evergreenForest	-1.188431e+00
## Leaves:shrubScrub-Woody material:evergreenForest	-1.145000e+00
## Mixed:shrubScrub-Woody material:evergreenForest	1.062248e+00
## Needles:shrubScrub-Woody material:evergreenForest	3.202352e+00
## Other:shrubScrub-Woody material:evergreenForest	-1.137360e+00
## Seeds:shrubScrub-Woody material:evergreenForest	-1.175158e+00
## Twigs/branches:shrubScrub-Woody material:evergreenForest	-7.243528e-01
## Woody material:shrubScrub-Woody material:evergreenForest	-1.075967e+00
## Leaves:grasslandHerbaceous-Flowers:grasslandHerbaceous	2.504617e-02
## Mixed:grasslandHerbaceous-Flowers:grasslandHerbaceous	1.123574e+00
## Needles:grasslandHerbaceous-Flowers:grasslandHerbaceous	5.173463e+00
## Other:grasslandHerbaceous-Flowers:grasslandHerbaceous	9.124113e-02
## Seeds:grasslandHerbaceous-Flowers:grasslandHerbaceous	-8.865248e-06
## Twigs/branches:grasslandHerbaceous-Flowers:grasslandHerbaceous	9.444745e-01
## Woody material:grasslandHerbaceous-Flowers:grasslandHerbaceous	4.345202e-02
## Flowers:shrubScrub-Flowers:grasslandHerbaceous	1.008009e-02
## Leaves:shrubScrub-Flowers:grasslandHerbaceous	5.351064e-02
## Mixed:shrubScrub-Flowers:grasslandHerbaceous	2.260759e+00
## Needles:shrubScrub-Flowers:grasslandHerbaceous	4.400863e+00
## Other:shrubScrub-Flowers:grasslandHerbaceous	6.115056e-02
## Seeds:shrubScrub-Flowers:grasslandHerbaceous	2.335225e-02
## Twigs/branches:shrubScrub-Flowers:grasslandHerbaceous	4.741578e-01
## Woody material:shrubScrub-Flowers:grasslandHerbaceous	1.225432e-01
## Mixed:grasslandHerbaceous-Leaves:grasslandHerbaceous	1.098528e+00
## Needles:grasslandHerbaceous-Leaves:grasslandHerbaceous	5.148417e+00
## Other:grasslandHerbaceous-Leaves:grasslandHerbaceous	6.619497e-02
## Seeds:grasslandHerbaceous-Leaves:grasslandHerbaceous	-2.505503e-02
## Twigs/branches:grasslandHerbaceous-Leaves:grasslandHerbaceous	9.194283e-01
## Woody material:grasslandHerbaceous-Leaves:grasslandHerbaceous	1.840585e-02
## Flowers:shrubScrub-Leaves:grasslandHerbaceous	-1.496608e-02
## Leaves:shrubScrub-Leaves:grasslandHerbaceous	2.846447e-02
## Mixed:shrubScrub-Leaves:grasslandHerbaceous	2.235713e+00
## Needles:shrubScrub-Leaves:grasslandHerbaceous	4.375817e+00
## Other:shrubScrub-Leaves:grasslandHerbaceous	3.610439e-02
## Seeds:shrubScrub-Leaves:grasslandHerbaceous	-1.693920e-03
## Twigs/branches:shrubScrub-Leaves:grasslandHerbaceous	4.491116e-01
## Woody material:shrubScrub-Leaves:grasslandHerbaceous	9.749705e-02
## Needles:grasslandHerbaceous-Mixed:grasslandHerbaceous	4.049889e+00
## Other:grasslandHerbaceous-Mixed:grasslandHerbaceous	-1.032333e+00
## Seeds:grasslandHerbaceous-Mixed:grasslandHerbaceous	-1.123583e+00
## Twigs/branches:grasslandHerbaceous-Mixed:grasslandHerbaceous	-1.791000e-01
## Woody material:grasslandHerbaceous-Mixed:grasslandHerbaceous	-1.080122e+00
## Flowers:shrubScrub-Mixed:grasslandHerbaceous	-1.113494e+00
## Leaves:shrubScrub-Mixed:grasslandHerbaceous	-1.070064e+00
## Mixed:shrubScrub-Mixed:grasslandHerbaceous	1.137184e+00
## Needles:shrubScrub-Mixed:grasslandHerbaceous	3.277289e+00
## Other:shrubScrub-Mixed:grasslandHerbaceous	-1.062424e+00
## Seeds:shrubScrub-Mixed:grasslandHerbaceous	-1.100222e+00
## Twigs/branches:shrubScrub-Mixed:grasslandHerbaceous	-6.494167e-01
## Woody material:shrubScrub-Mixed:grasslandHerbaceous	-1.001031e+00

## Other:grasslandHerbaceous-Needles:grasslandHerbaceous	-5.082222e+00
## Seeds:grasslandHerbaceous-Needles:grasslandHerbaceous	-5.173472e+00
## Twigs/branches:grasslandHerbaceous-Needles:grasslandHerbaceous	-4.228989e+00
## Woody material:grasslandHerbaceous-Needles:grasslandHerbaceous	-5.130011e+00
## Flowers:shrubScrub-Needles:grasslandHerbaceous	-5.163383e+00
## Leaves:shrubScrub-Needles:grasslandHerbaceous	-5.119953e+00
## Mixed:shrubScrub-Needles:grasslandHerbaceous	-2.912705e+00
## Needles:shrubScrub-Needles:grasslandHerbaceous	-7.726002e-01
## Other:shrubScrub-Needles:grasslandHerbaceous	-5.112313e+00
## Seeds:shrubScrub-Needles:grasslandHerbaceous	-5.150111e+00
## Twigs/branches:shrubScrub-Needles:grasslandHerbaceous	-4.699306e+00
## Woody material:shrubScrub-Needles:grasslandHerbaceous	-5.050920e+00
## Seeds:grasslandHerbaceous-Other:grasslandHerbaceous	-9.125000e-02
## Twigs/branches:grasslandHerbaceous-Other:grasslandHerbaceous	8.532333e-01
## Woody material:grasslandHerbaceous-Other:grasslandHerbaceous	-4.778912e-02
## Flowers:shrubScrub-Other:grasslandHerbaceous	-8.116105e-02
## Leaves:shrubScrub-Other:grasslandHerbaceous	-3.773050e-02
## Mixed:shrubScrub-Other:grasslandHerbaceous	2.169518e+00
## Needles:shrubScrub-Other:grasslandHerbaceous	4.309622e+00
## Other:shrubScrub-Other:grasslandHerbaceous	-3.009058e-02
## Seeds:shrubScrub-Other:grasslandHerbaceous	-6.788889e-02
## Twigs/branches:shrubScrub-Other:grasslandHerbaceous	3.829167e-01
## Woody material:shrubScrub-Other:grasslandHerbaceous	3.130208e-02
## Twigs/branches:grasslandHerbaceous-Seeds:grasslandHerbaceous	9.444833e-01
## Woody material:grasslandHerbaceous-Seeds:grasslandHerbaceous	4.346088e-02
## Flowers:shrubScrub-Seeds:grasslandHerbaceous	1.008895e-02
## Leaves:shrubScrub-Seeds:grasslandHerbaceous	5.351950e-02
## Mixed:shrubScrub-Seeds:grasslandHerbaceous	2.260768e+00
## Needles:shrubScrub-Seeds:grasslandHerbaceous	4.400872e+00
## Other:shrubScrub-Seeds:grasslandHerbaceous	6.115942e-02
## Seeds:shrubScrub-Seeds:grasslandHerbaceous	2.336111e-02
## Twigs/branches:shrubScrub-Seeds:grasslandHerbaceous	4.741667e-01
## Woody material:shrubScrub-Seeds:grasslandHerbaceous	1.225521e-01
## Woody material:grasslandHerbaceous-Twigs/branches:grasslandHerbaceous	-9.010224e-01
## Flowers:shrubScrub-Twigs/branches:grasslandHerbaceous	-9.343944e-01
## Leaves:shrubScrub-Twigs/branches:grasslandHerbaceous	-8.909638e-01
## Mixed:shrubScrub-Twigs/branches:grasslandHerbaceous	1.316284e+00
## Needles:shrubScrub-Twigs/branches:grasslandHerbaceous	3.456389e+00
## Other:shrubScrub-Twigs/branches:grasslandHerbaceous	-8.833239e-01
## Seeds:shrubScrub-Twigs/branches:grasslandHerbaceous	-9.211222e-01
## Twigs/branches:shrubScrub-Twigs/branches:grasslandHerbaceous	-4.703167e-01
## Woody material:shrubScrub-Twigs/branches:grasslandHerbaceous	-8.219313e-01
## Flowers:shrubScrub-Woody material:grasslandHerbaceous	-3.337193e-02
## Leaves:shrubScrub-Woody material:grasslandHerbaceous	1.005862e-02
## Mixed:shrubScrub-Woody material:grasslandHerbaceous	2.217307e+00
## Needles:shrubScrub-Woody material:grasslandHerbaceous	4.357411e+00
## Other:shrubScrub-Woody material:grasslandHerbaceous	1.769854e-02
## Seeds:shrubScrub-Woody material:grasslandHerbaceous	-2.009977e-02
## Twigs/branches:shrubScrub-Woody material:grasslandHerbaceous	4.307058e-01
## Woody material:shrubScrub-Woody material:grasslandHerbaceous	7.909120e-02
## Leaves:shrubScrub-Flowers:shrubScrub	4.343055e-02
## Mixed:shrubScrub-Flowers:shrubScrub	2.250679e+00
## Needles:shrubScrub-Flowers:shrubScrub	4.390783e+00
## Other:shrubScrub-Flowers:shrubScrub	5.107047e-02

## Seeds:shrubScrub-Flowers:shrubScrub	1.327216e-02
## Twigs/branches:shrubScrub-Flowers:shrubScrub	4.640777e-01
## Woody material:shrubScrub-Flowers:shrubScrub	1.124631e-01
## Mixed:shrubScrub-Leaves:shrubScrub	2.207248e+00
## Needles:shrubScrub-Leaves:shrubScrub	4.347352e+00
## Other:shrubScrub-Leaves:shrubScrub	7.639917e-03
## Seeds:shrubScrub-Leaves:shrubScrub	-3.015839e-02
## Twigs/branches:shrubScrub-Leaves:shrubScrub	4.206472e-01
## Woody material:shrubScrub-Leaves:shrubScrub	6.903258e-02
## Needles:shrubScrub-Mixed:shrubScrub	2.140104e+00
## Other:shrubScrub-Mixed:shrubScrub	-2.199608e+00
## Seeds:shrubScrub-Mixed:shrubScrub	-2.237406e+00
## Twigs/branches:shrubScrub-Mixed:shrubScrub	-1.786601e+00
## Woody material:shrubScrub-Mixed:shrubScrub	-2.138215e+00
## Other:shrubScrub-Needles:shrubScrub	-4.339713e+00
## Seeds:shrubScrub-Needles:shrubScrub	-4.377511e+00
## Twigs/branches:shrubScrub-Needles:shrubScrub	-3.926705e+00
## Woody material:shrubScrub-Needles:shrubScrub	-4.278320e+00
## Seeds:shrubScrub-Other:shrubScrub	-3.779831e-02
## Twigs/branches:shrubScrub-Other:shrubScrub	4.130072e-01
## Woody material:shrubScrub-Other:shrubScrub	6.139266e-02
## Twigs/branches:shrubScrub-Seeds:shrubScrub	4.508056e-01
## Woody material:shrubScrub-Seeds:shrubScrub	9.919097e-02
## Woody material:shrubScrub-Twigs/branches:shrubScrub	-3.516146e-01
##	lwr
## Leaves:evergreenForest-Flowers:evergreenForest	-2.129566790
## Mixed:evergreenForest-Flowers:evergreenForest	-0.819782291
## Needles:evergreenForest-Flowers:evergreenForest	5.355878443
## Other:evergreenForest-Flowers:evergreenForest	-2.060784739
## Seeds:evergreenForest-Flowers:evergreenForest	-2.072130893
## Twigs/branches:evergreenForest-Flowers:evergreenForest	-0.023609487
## Woody material:evergreenForest-Flowers:evergreenForest	-0.852386878
## Flowers:grasslandHerbaceous-Flowers:evergreenForest	-2.454136383
## Leaves:grasslandHerbaceous-Flowers:evergreenForest	-2.344114655
## Mixed:grasslandHerbaceous-Flowers:evergreenForest	-2.173621929
## Needles:grasslandHerbaceous-Flowers:evergreenForest	2.816896666
## Other:grasslandHerbaceous-Flowers:evergreenForest	-2.347490625
## Seeds:grasslandHerbaceous-Flowers:evergreenForest	-2.438740625
## Twigs/branches:grasslandHerbaceous-Flowers:evergreenForest	-1.465016727
## Woody material:grasslandHerbaceous-Flowers:evergreenForest	-2.380407340
## Flowers:shrubScrub-Flowers:evergreenForest	-2.065670211
## Leaves:shrubScrub-Flowers:evergreenForest	-1.997386878
## Mixed:shrubScrub-Flowers:evergreenForest	-0.361861760
## Needles:shrubScrub-Flowers:evergreenForest	2.363784540
## Other:shrubScrub-Flowers:evergreenForest	-1.999401547
## Seeds:shrubScrub-Flowers:evergreenForest	-2.047232668
## Twigs/branches:shrubScrub-Flowers:evergreenForest	-1.567442022
## Woody material:shrubScrub-Flowers:evergreenForest	-1.919056606
## Mixed:evergreenForest-Leaves:evergreenForest	-0.727331832
## Needles:evergreenForest-Leaves:evergreenForest	5.446243927
## Other:evergreenForest-Leaves:evergreenForest	-1.969967636
## Seeds:evergreenForest-Leaves:evergreenForest	-1.981313790
## Twigs/branches:evergreenForest-Leaves:evergreenForest	0.066934267
## Woody material:evergreenForest-Leaves:evergreenForest	-0.762155004

## Flowers:grasslandHerbaceous-Leaves:evergreenForest	-2.361612874
## Leaves:grasslandHerbaceous-Leaves:evergreenForest	-2.252006448
## Mixed:grasslandHerbaceous-Leaves:evergreenForest	-2.078173664
## Needles:grasslandHerbaceous-Leaves:evergreenForest	2.908940663
## Other:grasslandHerbaceous-Leaves:evergreenForest	-2.255040166
## Seeds:grasslandHerbaceous-Leaves:evergreenForest	-2.346290166
## Twigs/branches:grasslandHerbaceous-Leaves:evergreenForest	-1.372707607
## Woody material:grasslandHerbaceous-Leaves:evergreenForest	-2.288028325
## Flowers:shrubScrub-Leaves:evergreenForest	-1.975270111
## Leaves:shrubScrub-Leaves:evergreenForest	-1.907155004
## Mixed:shrubScrub-Leaves:evergreenForest	-0.268597476
## Needles:shrubScrub-Leaves:evergreenForest	2.453921013
## Other:shrubScrub-Leaves:evergreenForest	-1.909103817
## Seeds:shrubScrub-Leaves:evergreenForest	-1.956867184
## Twigs/branches:shrubScrub-Leaves:evergreenForest	-1.477274187
## Woody material:shrubScrub-Leaves:evergreenForest	-1.828888771
## Needles:evergreenForest-Mixed:evergreenForest	3.531924601
## Other:evergreenForest-Mixed:evergreenForest	-3.875248499
## Seeds:evergreenForest-Mixed:evergreenForest	-3.886594653
## Twigs/branches:evergreenForest-Mixed:evergreenForest	-1.843831981
## Woody material:evergreenForest-Mixed:evergreenForest	-2.679124714
## Flowers:grasslandHerbaceous-Mixed:evergreenForest	-4.231642975
## Leaves:grasslandHerbaceous-Mixed:evergreenForest	-4.130774071
## Mixed:grasslandHerbaceous-Mixed:evergreenForest	-3.883933992
## Needles:grasslandHerbaceous-Mixed:evergreenForest	1.028831138
## Other:grasslandHerbaceous-Mixed:evergreenForest	-4.126614443
## Seeds:grasslandHerbaceous-Mixed:evergreenForest	-4.217864443
## Twigs/branches:grasslandHerbaceous-Mixed:evergreenForest	-3.247260787
## Woody material:grasslandHerbaceous-Mixed:evergreenForest	-4.161109834
## Flowers:shrubScrub-Mixed:evergreenForest	-3.888901015
## Leaves:shrubScrub-Mixed:evergreenForest	-3.824124714
## Mixed:shrubScrub-Mixed:evergreenForest	-2.122795347
## Needles:shrubScrub-Mixed:evergreenForest	0.535065489
## Other:shrubScrub-Mixed:evergreenForest	-3.824768514
## Seeds:shrubScrub-Mixed:evergreenForest	-3.871186510
## Twigs/branches:shrubScrub-Mixed:evergreenForest	-3.395510380
## Woody material:shrubScrub-Mixed:evergreenForest	-3.747124963
## Other:evergreenForest-Needles:evergreenForest	-9.316700517
## Seeds:evergreenForest-Needles:evergreenForest	-9.328046671
## Twigs/branches:evergreenForest-Needles:evergreenForest	-7.278276535
## Woody material:evergreenForest-Needles:evergreenForest	-8.105625630
## Flowers:grasslandHerbaceous-Needles:evergreenForest	-9.717786337
## Leaves:grasslandHerbaceous-Needles:evergreenForest	-9.605891491
## Mixed:grasslandHerbaceous-Needles:evergreenForest	-9.450320490
## Needles:grasslandHerbaceous-Needles:evergreenForest	-4.444590062
## Other:grasslandHerbaceous-Needles:evergreenForest	-9.610811510
## Seeds:grasslandHerbaceous-Needles:evergreenForest	-9.702061510
## Twigs/branches:grasslandHerbaceous-Needles:evergreenForest	-8.727700435
## Woody material:grasslandHerbaceous-Needles:evergreenForest	-9.643406225
## Flowers:shrubScrub-Needles:evergreenForest	-9.319679856
## Leaves:shrubScrub-Needles:evergreenForest	-9.250625630
## Mixed:shrubScrub-Needles:evergreenForest	-7.628839266
## Needles:shrubScrub-Needles:evergreenForest	-4.889016539
## Other:shrubScrub-Needles:evergreenForest	-9.252942218

## Seeds:shrubScrub-Needles:evergreenForest	-9.301083779
## Twigs/branches:shrubScrub-Needles:evergreenForest	-8.820387022
## Woody material:shrubScrub-Needles:evergreenForest	-9.172001606
## Seeds:evergreenForest-Other:evergreenForest	-2.050095841
## Twigs/branches:evergreenForest-Other:evergreenForest	-0.001847784
## Woody material:evergreenForest-Other:evergreenForest	-0.830937055
## Flowers:grasslandHerbaceous-Other:evergreenForest	-2.430394925
## Leaves:grasslandHerbaceous-Other:evergreenForest	-2.320788499
## Mixed:grasslandHerbaceous-Other:evergreenForest	-2.146955715
## Needles:grasslandHerbaceous-Other:evergreenForest	2.840158612
## Other:grasslandHerbaceous-Other:evergreenForest	-2.323822217
## Seeds:grasslandHerbaceous-Other:evergreenForest	-2.415072217
## Twigs/branches:grasslandHerbaceous-Other:evergreenForest	-1.441489659
## Woody material:grasslandHerbaceous-Other:evergreenForest	-2.356810376
## Flowers:shrubScrub-Other:evergreenForest	-2.044052162
## Leaves:shrubScrub-Other:evergreenForest	-1.975937055
## Mixed:shrubScrub-Other:evergreenForest	-0.337379527
## Needles:shrubScrub-Other:evergreenForest	2.385138962
## Other:shrubScrub-Other:evergreenForest	-1.977885868
## Seeds:shrubScrub-Other:evergreenForest	-2.025649235
## Twigs/branches:shrubScrub-Other:evergreenForest	-1.546056239
## Woody material:shrubScrub-Other:evergreenForest	-1.897670822
## Twigs/branches:evergreenForest-Seeds:evergreenForest	0.009498370
## Woody material:evergreenForest-Seeds:evergreenForest	-0.819590901
## Flowers:grasslandHerbaceous-Seeds:evergreenForest	-2.419048771
## Leaves:grasslandHerbaceous-Seeds:evergreenForest	-2.309442346
## Mixed:grasslandHerbaceous-Seeds:evergreenForest	-2.135609561
## Needles:grasslandHerbaceous-Seeds:evergreenForest	2.851504766
## Other:grasslandHerbaceous-Seeds:evergreenForest	-2.312476063
## Seeds:grasslandHerbaceous-Seeds:evergreenForest	-2.403726063
## Twigs/branches:grasslandHerbaceous-Seeds:evergreenForest	-1.430143505
## Woody material:grasslandHerbaceous-Seeds:evergreenForest	-2.345464223
## Flowers:shrubScrub-Seeds:evergreenForest	-2.032706008
## Leaves:shrubScrub-Seeds:evergreenForest	-1.964590901
## Mixed:shrubScrub-Seeds:evergreenForest	-0.326033374
## Needles:shrubScrub-Seeds:evergreenForest	2.396485116
## Other:shrubScrub-Seeds:evergreenForest	-1.966539715
## Seeds:shrubScrub-Seeds:evergreenForest	-2.014303081
## Twigs/branches:shrubScrub-Seeds:evergreenForest	-1.534710085
## Woody material:shrubScrub-Seeds:evergreenForest	-1.886324668
## Woody material:evergreenForest-Twigs/branches:evergreenForest	-2.781035142
## Flowers:grasslandHerbaceous-Twigs/branches:evergreenForest	-4.388195920
## Leaves:grasslandHerbaceous-Twigs/branches:evergreenForest	-4.277197825
## Mixed:grasslandHerbaceous-Twigs/branches:evergreenForest	-4.114512140
## Needles:grasslandHerbaceous-Twigs/branches:evergreenForest	0.883964611
## Other:grasslandHerbaceous-Twigs/branches:evergreenForest	-4.281378550
## Seeds:grasslandHerbaceous-Twigs/branches:evergreenForest	-4.372628550
## Twigs/branches:grasslandHerbaceous-Twigs/branches:evergreenForest	-3.398572461
## Woody material:grasslandHerbaceous-Twigs/branches:evergreenForest	-4.314127375
## Flowers:shrubScrub-Twigs/branches:evergreenForest	-3.994717783
## Leaves:shrubScrub-Twigs/branches:evergreenForest	-3.926035142
## Mixed:shrubScrub-Twigs/branches:evergreenForest	-2.297658559
## Needles:shrubScrub-Twigs/branches:evergreenForest	0.435362879
## Other:shrubScrub-Twigs/branches:evergreenForest	-3.928206172

## Seeds:shrubScrub-Twigs/branches:evergreenForest	-3.976198104
## Twigs/branches:shrubScrub-Twigs/branches:evergreenForest	-3.495938190
## Woody material:shrubScrub-Twigs/branches:evergreenForest	-3.847552773
## Flowers:grasslandHerbaceous-Woody material:evergreenForest	-3.473047144
## Leaves:grasslandHerbaceous-Woody material:evergreenForest	-3.360485792
## Mixed:grasslandHerbaceous-Woody material:evergreenForest	-3.210168378
## Needles:grasslandHerbaceous-Woody material:evergreenForest	1.800919068
## Other:grasslandHerbaceous-Woody material:evergreenForest	-3.365955387
## Seeds:grasslandHerbaceous-Woody material:evergreenForest	-3.457205387
## Twigs/branches:grasslandHerbaceous-Woody material:evergreenForest	-2.482617706
## Woody material:grasslandHerbaceous-Woody material:evergreenForest	-3.398435618
## Flowers:shrubScrub-Woody material:evergreenForest	-3.071484775
## Leaves:shrubScrub-Woody material:evergreenForest	-3.002151280
## Mixed:shrubScrub-Woody material:evergreenForest	-1.385278734
## Needles:shrubScrub-Woody material:evergreenForest	1.359616573
## Other:shrubScrub-Woody material:evergreenForest	-3.004577298
## Seeds:shrubScrub-Woody material:evergreenForest	-3.052831304
## Twigs/branches:shrubScrub-Woody material:evergreenForest	-2.571806133
## Woody material:shrubScrub-Woody material:evergreenForest	-2.923420716
## Leaves:grasslandHerbaceous-Flowers:grasslandHerbaceous	-2.525947305
## Mixed:grasslandHerbaceous-Flowers:grasslandHerbaceous	-2.275570489
## Needles:grasslandHerbaceous-Flowers:grasslandHerbaceous	2.633595693
## Other:grasslandHerbaceous-Flowers:grasslandHerbaceous	-2.521452372
## Seeds:grasslandHerbaceous-Flowers:grasslandHerbaceous	-2.612702372
## Twigs/branches:grasslandHerbaceous-Flowers:grasslandHerbaceous	-1.642237944
## Woody material:grasslandHerbaceous-Flowers:grasslandHerbaceous	-2.556018273
## Flowers:shrubScrub-Flowers:grasslandHerbaceous	-2.285654795
## Leaves:shrubScrub-Flowers:grasslandHerbaceous	-2.221025867
## Mixed:shrubScrub-Flowers:grasslandHerbaceous	-0.516810898
## Needles:shrubScrub-Flowers:grasslandHerbaceous	2.138081412
## Other:shrubScrub-Flowers:grasslandHerbaceous	-2.221612149
## Seeds:shrubScrub-Flowers:grasslandHerbaceous	-2.267970735
## Twigs/branches:shrubScrub-Flowers:grasslandHerbaceous	-1.792467249
## Woody material:shrubScrub-Flowers:grasslandHerbaceous	-2.144081832
## Mixed:grasslandHerbaceous-Leaves:grasslandHerbaceous	-2.242688898
## Needles:grasslandHerbaceous-Leaves:grasslandHerbaceous	2.686614256
## Other:grasslandHerbaceous-Leaves:grasslandHerbaceous	-2.470675800
## Seeds:grasslandHerbaceous-Leaves:grasslandHerbaceous	-2.561925800
## Twigs/branches:grasslandHerbaceous-Leaves:grasslandHerbaceous	-1.590676684
## Woody material:grasslandHerbaceous-Leaves:grasslandHerbaceous	-2.504844380
## Flowers:shrubScrub-Leaves:grasslandHerbaceous	-2.224025740
## Leaves:shrubScrub-Leaves:grasslandHerbaceous	-2.158556848
## Mixed:shrubScrub-Leaves:grasslandHerbaceous	-0.470657508
## Needles:shrubScrub-Leaves:grasslandHerbaceous	2.201023401
## Other:shrubScrub-Leaves:grasslandHerbaceous	-2.159471049
## Seeds:shrubScrub-Leaves:grasslandHerbaceous	-2.206168220
## Twigs/branches:shrubScrub-Leaves:grasslandHerbaceous	-1.729680474
## Woody material:shrubScrub-Leaves:grasslandHerbaceous	-2.081295058
## Needles:grasslandHerbaceous-Mixed:grasslandHerbaceous	0.717158412
## Other:grasslandHerbaceous-Mixed:grasslandHerbaceous	-4.420892325
## Seeds:grasslandHerbaceous-Mixed:grasslandHerbaceous	-4.512142325
## Twigs/branches:grasslandHerbaceous-Mixed:grasslandHerbaceous	-3.547667319
## Woody material:grasslandHerbaceous-Mixed:grasslandHerbaceous	-4.458496390
## Flowers:shrubScrub-Mixed:grasslandHerbaceous	-4.264139288

## Leaves:shrubScrub-Mixed:grasslandHerbaceous	-4.205296038
## Mixed:shrubScrub-Mixed:grasslandHerbaceous	-2.380067193
## Needles:shrubScrub-Mixed:grasslandHerbaceous	0.150573806
## Other:shrubScrub-Mixed:grasslandHerbaceous	-4.203629135
## Seeds:shrubScrub-Mixed:grasslandHerbaceous	-4.247653823
## Twigs/branches:shrubScrub-Mixed:grasslandHerbaceous	-3.778914039
## Woody material:shrubScrub-Mixed:grasslandHerbaceous	-4.130528622
## Other:grasslandHerbaceous-Needles:grasslandHerbaceous	-7.607904973
## Seeds:grasslandHerbaceous-Needles:grasslandHerbaceous	-7.699154973
## Twigs/branches:grasslandHerbaceous-Needles:grasslandHerbaceous	-6.727786019
## Woody material:grasslandHerbaceous-Needles:grasslandHerbaceous	-7.642012890
## Flowers:shrubScrub-Needles:grasslandHerbaceous	-7.359585593
## Leaves:shrubScrub-Needles:grasslandHerbaceous	-7.293986369
## Mixed:shrubScrub-Needles:grasslandHerbaceous	-5.608590200
## Needles:shrubScrub-Needles:grasslandHerbaceous	-2.934332658
## Other:shrubScrub-Needles:grasslandHerbaceous	-7.294951471
## Seeds:shrubScrub-Needles:grasslandHerbaceous	-7.341701173
## Twigs/branches:shrubScrub-Needles:grasslandHerbaceous	-6.865060647
## Woody material:shrubScrub-Needles:grasslandHerbaceous	-7.216675230
## Seeds:grasslandHerbaceous-Other:grasslandHerbaceous	-2.690156110
## Twigs/branches:grasslandHerbaceous-Other:grasslandHerbaceous	-1.719552454
## Woody material:grasslandHerbaceous-Other:grasslandHerbaceous	-2.633401501
## Flowers:shrubScrub-Other:grasslandHerbaceous	-2.361192682
## Leaves:shrubScrub-Other:grasslandHerbaceous	-2.296416380
## Mixed:shrubScrub-Other:grasslandHerbaceous	-0.595087013
## Needles:shrubScrub-Other:grasslandHerbaceous	2.062773823
## Other:shrubScrub-Other:grasslandHerbaceous	-2.297060180
## Seeds:shrubScrub-Other:grasslandHerbaceous	-2.343478177
## Twigs/branches:shrubScrub-Other:grasslandHerbaceous	-1.867802046
## Woody material:shrubScrub-Other:grasslandHerbaceous	-2.219416630
## Twigs/branches:grasslandHerbaceous-Seeds:grasslandHerbaceous	-1.628302454
## Woody material:grasslandHerbaceous-Seeds:grasslandHerbaceous	-2.542151501
## Flowers:shrubScrub-Seeds:grasslandHerbaceous	-2.269942682
## Leaves:shrubScrub-Seeds:grasslandHerbaceous	-2.205166380
## Mixed:shrubScrub-Seeds:grasslandHerbaceous	-0.503837013
## Needles:shrubScrub-Seeds:grasslandHerbaceous	2.154023823
## Other:shrubScrub-Seeds:grasslandHerbaceous	-2.205810180
## Seeds:shrubScrub-Seeds:grasslandHerbaceous	-2.252228177
## Twigs/branches:shrubScrub-Seeds:grasslandHerbaceous	-1.776552046
## Woody material:shrubScrub-Seeds:grasslandHerbaceous	-2.128166630
## Woody material:grasslandHerbaceous-Twigs/branches:grasslandHerbaceous	-3.460378842
## Flowers:shrubScrub-Twigs/branches:grasslandHerbaceous	-3.184607259
## Leaves:shrubScrub-Twigs/branches:grasslandHerbaceous	-3.119545366
## Mixed:shrubScrub-Twigs/branches:grasslandHerbaceous	-1.423780040
## Needles:shrubScrub-Twigs/branches:grasslandHerbaceous	1.239805604
## Other:shrubScrub-Twigs/branches:grasslandHerbaceous	-3.120300648
## Seeds:shrubScrub-Twigs/branches:grasslandHerbaceous	-3.166833768
## Twigs/branches:shrubScrub-Twigs/branches:grasslandHerbaceous	-2.690823020
## Woody material:shrubScrub-Twigs/branches:grasslandHerbaceous	-3.042437603
## Flowers:shrubScrub-Woody material:grasslandHerbaceous	-2.298238969
## Leaves:shrubScrub-Woody material:grasslandHerbaceous	-2.233318380
## Mixed:shrubScrub-Woody material:grasslandHerbaceous	-0.534804675
## Needles:shrubScrub-Woody material:grasslandHerbaceous	2.125953034
## Other:shrubScrub-Woody material:grasslandHerbaceous	-2.234018500

## Seeds:shrubScrub-Woody material:grasslandHerbaceous	-2.280494661
## Twigs/branches:shrubScrub-Woody material:grasslandHerbaceous	-1.804649483
## Woody material:shrubScrub-Woody material:grasslandHerbaceous	-2.156264067
## Leaves:shrubScrub-Flowers:shrubScrub	-1.839623670
## Mixed:shrubScrub-Flowers:shrubScrub	-0.216560682
## Needles:shrubScrub-Flowers:shrubScrub	2.521944369
## Other:shrubScrub-Flowers:shrubScrub	-1.841911954
## Seeds:shrubScrub-Flowers:shrubScrub	-1.890024425
## Twigs/branches:shrubScrub-Flowers:shrubScrub	-1.409412612
## Woody material:shrubScrub-Flowers:shrubScrub	-1.761027196
## Mixed:shrubScrub-Leaves:shrubScrub	-0.240278734
## Needles:shrubScrub-Leaves:shrubScrub	2.504616573
## Other:shrubScrub-Leaves:shrubScrub	-1.859577298
## Seeds:shrubScrub-Leaves:shrubScrub	-1.907831304
## Twigs/branches:shrubScrub-Leaves:shrubScrub	-1.426806133
## Woody material:shrubScrub-Leaves:shrubScrub	-1.778420716
## Needles:shrubScrub-Mixed:shrubScrub	-0.296502226
## Other:shrubScrub-Mixed:shrubScrub	-4.654781551
## Seeds:shrubScrub-Mixed:shrubScrub	-4.700541021
## Twigs/branches:shrubScrub-Mixed:shrubScrub	-4.226777124
## Woody material:shrubScrub-Mixed:shrubScrub	-4.578391707
## Other:shrubScrub-Needles:shrubScrub	-6.192592738
## Seeds:shrubScrub-Needles:shrubScrub	-6.240927192
## Twigs/branches:shrubScrub-Needles:shrubScrub	-5.759666990
## Woody material:shrubScrub-Needles:shrubScrub	-6.111281573
## Seeds:shrubScrub-Other:shrubScrub	-1.925427725
## Twigs/branches:shrubScrub-Other:shrubScrub	-1.444564537
## Woody material:shrubScrub-Other:shrubScrub	-1.796179120
## Twigs/branches:shrubScrub-Seeds:shrubScrub	-1.417275911
## Woody material:shrubScrub-Seeds:shrubScrub	-1.768890494
## Woody material:shrubScrub-Twigs/branches:shrubScrub	-2.189318717
##	upr
## Leaves:evergreenForest-Flowers:evergreenForest	1.92236807
## Mixed:evergreenForest-Flowers:evergreenForest	3.82928229
## Needles:evergreenForest-Flowers:evergreenForest	9.26864934
## Other:evergreenForest-Flowers:evergreenForest	1.99115012
## Seeds:evergreenForest-Flowers:evergreenForest	1.97980397
## Twigs/branches:evergreenForest-Flowers:evergreenForest	3.94294772
## Woody material:evergreenForest-Flowers:evergreenForest	3.02100922
## Flowers:grasslandHerbaceous-Flowers:evergreenForest	2.22573745
## Leaves:grasslandHerbaceous-Flowers:evergreenForest	2.16580805
## Mixed:grasslandHerbaceous-Flowers:evergreenForest	4.19237193
## Needles:grasslandHerbaceous-Flowers:evergreenForest	7.30163111
## Other:grasslandHerbaceous-Flowers:evergreenForest	2.30157396
## Seeds:grasslandHerbaceous-Flowers:evergreenForest	2.21032396
## Twigs/branches:grasslandHerbaceous-Flowers:evergreenForest	3.12556673
## Woody material:grasslandHerbaceous-Flowers:evergreenForest	2.23891244
## Flowers:shrubScrub-Flowers:evergreenForest	1.85743145
## Leaves:shrubScrub-Flowers:evergreenForest	1.87600922
## Mixed:shrubScrub-Flowers:evergreenForest	4.65498018
## Needles:shrubScrub-Flowers:evergreenForest	6.20954278
## Other:shrubScrub-Flowers:evergreenForest	1.89330372
## Seeds:shrubScrub-Flowers:evergreenForest	1.86553822
## Twigs/branches:shrubScrub-Flowers:evergreenForest	2.28735869

## Woody material:shrubScrub-Flowers:evergreenForest	1.93574411
## Mixed:evergreenForest-Leaves:evergreenForest	3.94403055
## Needles:evergreenForest-Leaves:evergreenForest	9.38548257
## Other:evergreenForest-Leaves:evergreenForest	2.10753174
## Seeds:evergreenForest-Leaves:evergreenForest	2.09618558
## Twigs/branches:evergreenForest-Leaves:evergreenForest	4.05960269
## Woody material:evergreenForest-Leaves:evergreenForest	3.13797606
## Flowers:grasslandHerbaceous-Leaves:evergreenForest	2.34041266
## Leaves:grasslandHerbaceous-Leaves:evergreenForest	2.28089856
## Mixed:grasslandHerbaceous-Leaves:evergreenForest	4.30412238
## Needles:grasslandHerbaceous-Leaves:evergreenForest	7.41678583
## Other:grasslandHerbaceous-Leaves:evergreenForest	2.41632222
## Seeds:grasslandHerbaceous-Leaves:evergreenForest	2.32507222
## Twigs/branches:grasslandHerbaceous-Leaves:evergreenForest	3.24045633
## Woody material:grasslandHerbaceous-Leaves:evergreenForest	2.35373215
## Flowers:shrubScrub-Leaves:evergreenForest	1.97423006
## Leaves:shrubScrub-Leaves:evergreenForest	1.99297606
## Mixed:shrubScrub-Leaves:evergreenForest	4.76891462
## Needles:shrubScrub-Leaves:evergreenForest	6.32660502
## Other:shrubScrub-Leaves:evergreenForest	2.01020471
## Seeds:shrubScrub-Leaves:evergreenForest	1.98237146
## Twigs/branches:shrubScrub-Leaves:evergreenForest	2.40438957
## Woody material:shrubScrub-Leaves:evergreenForest	2.05277499
## Needles:evergreenForest-Mixed:evergreenForest	8.08310318
## Other:evergreenForest-Mixed:evergreenForest	0.79611388
## Seeds:evergreenForest-Mixed:evergreenForest	0.78476773
## Twigs/branches:evergreenForest-Mixed:evergreenForest	2.75367022
## Woody material:evergreenForest-Mixed:evergreenForest	1.83824705
## Flowers:grasslandHerbaceous-Mixed:evergreenForest	0.99374404
## Leaves:grasslandHerbaceous-Mixed:evergreenForest	0.94296747
## Mixed:grasslandHerbaceous-Mixed:evergreenForest	2.89318399
## Needles:grasslandHerbaceous-Mixed:evergreenForest	6.08019664
## Other:grasslandHerbaceous-Mixed:evergreenForest	1.07119778
## Seeds:grasslandHerbaceous-Mixed:evergreenForest	0.97994778
## Twigs/branches:grasslandHerbaceous-Mixed:evergreenForest	1.89831079
## Woody material:grasslandHerbaceous-Mixed:evergreenForest	1.01011494
## Flowers:shrubScrub-Mixed:evergreenForest	0.67116225
## Leaves:shrubScrub-Mixed:evergreenForest	0.69324705
## Mixed:shrubScrub-Mixed:evergreenForest	3.40641377
## Needles:shrubScrub-Mixed:evergreenForest	5.02876183
## Other:shrubScrub-Mixed:evergreenForest	0.70917069
## Seeds:shrubScrub-Mixed:evergreenForest	0.67999207
## Twigs/branches:shrubScrub-Mixed:evergreenForest	1.10592705
## Woody material:shrubScrub-Mixed:evergreenForest	0.75431246
## Other:evergreenForest-Needles:evergreenForest	-5.37746188
## Seeds:evergreenForest-Needles:evergreenForest	-5.38880803
## Twigs/branches:evergreenForest-Needles:evergreenForest	-3.42691301
## Woody material:evergreenForest-Needles:evergreenForest	-4.35027981
## Flowers:grasslandHerbaceous-Needles:evergreenForest	-5.13514038
## Leaves:grasslandHerbaceous-Needles:evergreenForest	-5.19694289
## Mixed:grasslandHerbaceous-Needles:evergreenForest	-3.15545729
## Needles:grasslandHerbaceous-Needles:evergreenForest	-0.06140994
## Other:grasslandHerbaceous-Needles:evergreenForest	-5.05963293
## Seeds:grasslandHerbaceous-Needles:evergreenForest	-5.15088293

## Twigs/branches:grasslandHerbaceous-Needles:evergreenForest	-4.23627734
## Woody material:grasslandHerbaceous-Needles:evergreenForest	-5.12261645
## Flowers:shrubScrub-Needles:evergreenForest	-5.51308669
## Leaves:shrubScrub-Needles:evergreenForest	-5.49527981
## Mixed:shrubScrub-Needles:evergreenForest	-2.70257009
## Needles:shrubScrub-Needles:evergreenForest	-1.16218392
## Other:shrubScrub-Needles:evergreenForest	-5.47768339
## Seeds:shrubScrub-Needles:evergreenForest	-5.50513844
## Twigs/branches:shrubScrub-Needles:evergreenForest	-5.08422409
## Woody material:shrubScrub-Needles:evergreenForest	-5.43583867
## Seeds:evergreenForest-Other:evergreenForest	2.02740353
## Twigs/branches:evergreenForest-Other:evergreenForest	3.99082063
## Woody material:evergreenForest-Other:evergreenForest	3.06919401
## Flowers:grasslandHerbaceous-Other:evergreenForest	2.27163060
## Leaves:grasslandHerbaceous-Other:evergreenForest	2.21211651
## Mixed:grasslandHerbaceous-Other:evergreenForest	4.23534033
## Needles:grasslandHerbaceous-Other:evergreenForest	7.34800378
## Other:grasslandHerbaceous-Other:evergreenForest	2.34754017
## Seeds:grasslandHerbaceous-Other:evergreenForest	2.25629017
## Twigs/branches:grasslandHerbaceous-Other:evergreenForest	3.17167427
## Woody material:grasslandHerbaceous-Other:evergreenForest	2.28495009
## Flowers:shrubScrub-Other:evergreenForest	1.90544801
## Leaves:shrubScrub-Other:evergreenForest	1.92419401
## Mixed:shrubScrub-Other:evergreenForest	4.70013256
## Needles:shrubScrub-Other:evergreenForest	6.25782297
## Other:shrubScrub-Other:evergreenForest	1.94142266
## Seeds:shrubScrub-Other:evergreenForest	1.91358941
## Twigs/branches:shrubScrub-Other:evergreenForest	2.33560752
## Woody material:shrubScrub-Other:evergreenForest	1.98399294
## Twigs/branches:evergreenForest-Seeds:evergreenForest	4.00216679
## Woody material:evergreenForest-Seeds:evergreenForest	3.08054016
## Flowers:grasslandHerbaceous-Seeds:evergreenForest	2.28297676
## Leaves:grasslandHerbaceous-Seeds:evergreenForest	2.22346266
## Mixed:grasslandHerbaceous-Seeds:evergreenForest	4.24668648
## Needles:grasslandHerbaceous-Seeds:evergreenForest	7.35934994
## Other:grasslandHerbaceous-Seeds:evergreenForest	2.35888632
## Seeds:grasslandHerbaceous-Seeds:evergreenForest	2.26763632
## Twigs/branches:grasslandHerbaceous-Seeds:evergreenForest	3.18302043
## Woody material:grasslandHerbaceous-Seeds:evergreenForest	2.29629625
## Flowers:shrubScrub-Seeds:evergreenForest	1.91679417
## Leaves:shrubScrub-Seeds:evergreenForest	1.93554016
## Mixed:shrubScrub-Seeds:evergreenForest	4.71147872
## Needles:shrubScrub-Seeds:evergreenForest	6.26916913
## Other:shrubScrub-Seeds:evergreenForest	1.95276881
## Seeds:shrubScrub-Seeds:evergreenForest	1.92493556
## Twigs/branches:shrubScrub-Seeds:evergreenForest	2.34695367
## Woody material:shrubScrub-Seeds:evergreenForest	1.99533909
## Woody material:evergreenForest-Twigs/branches:evergreenForest	1.03031925
## Flowers:grasslandHerbaceous-Twigs/branches:evergreenForest	0.24045875
## Leaves:grasslandHerbaceous-Twigs/branches:evergreenForest	0.17955299
## Mixed:grasslandHerbaceous-Twigs/branches:evergreenForest	2.21392390
## Needles:grasslandHerbaceous-Twigs/branches:evergreenForest	5.31522493
## Other:grasslandHerbaceous-Twigs/branches:evergreenForest	0.31612365
## Seeds:grasslandHerbaceous-Twigs/branches:evergreenForest	0.22487365

## Twigs/branches:grasslandHerbaceous-Twigs/branches:evergreenForest	1.13978423
## Woody material:grasslandHerbaceous-Twigs/branches:evergreenForest	0.25329424
## Flowers:shrubScrub-Twigs/branches:evergreenForest	-0.13285922
## Leaves:shrubScrub-Twigs/branches:evergreenForest	-0.11468075
## Mixed:shrubScrub-Twigs/branches:evergreenForest	2.67143875
## Needles:shrubScrub-Twigs/branches:evergreenForest	4.21862621
## Other:shrubScrub-Twigs/branches:evergreenForest	-0.09722989
## Seeds:shrubScrub-Twigs/branches:evergreenForest	-0.12483458
## Twigs/branches:shrubScrub-Twigs/branches:evergreenForest	0.29651662
## Woody material:shrubScrub-Twigs/branches:evergreenForest	-0.05509796
## Flowers:grasslandHerbaceous-Woody material:evergreenForest	1.07602587
## Leaves:grasslandHerbaceous-Woody material:evergreenForest	1.01355685
## Mixed:grasslandHerbaceous-Woody material:evergreenForest	3.06029604
## Needles:grasslandHerbaceous-Woody material:evergreenForest	6.14898637
## Other:grasslandHerbaceous-Woody material:evergreenForest	1.15141638
## Seeds:grasslandHerbaceous-Woody material:evergreenForest	1.06016638
## Twigs/branches:grasslandHerbaceous-Woody material:evergreenForest	1.97454537
## Woody material:grasslandHerbaceous-Woody material:evergreenForest	1.08831838
## Flowers:shrubScrub-Woody material:evergreenForest	0.69462367
## Leaves:shrubScrub-Woody material:evergreenForest	0.71215128
## Mixed:shrubScrub-Woody material:evergreenForest	3.50977481
## Needles:shrubScrub-Woody material:evergreenForest	5.04508841
## Other:shrubScrub-Woody material:evergreenForest	0.72985713
## Seeds:shrubScrub-Woody material:evergreenForest	0.70251452
## Twigs/branches:shrubScrub-Woody material:evergreenForest	1.12310046
## Woody material:shrubScrub-Woody material:evergreenForest	0.77148588
## Leaves:grasslandHerbaceous-Flowers:grasslandHerbaceous	2.57603964
## Mixed:grasslandHerbaceous-Flowers:grasslandHerbaceous	4.52271942
## Needles:grasslandHerbaceous-Flowers:grasslandHerbaceous	7.71333102
## Other:grasslandHerbaceous-Flowers:grasslandHerbaceous	2.70393464
## Seeds:grasslandHerbaceous-Flowers:grasslandHerbaceous	2.61268464
## Twigs/branches:grasslandHerbaceous-Flowers:grasslandHerbaceous	3.53118688
## Woody material:grasslandHerbaceous-Flowers:grasslandHerbaceous	2.64292231
## Flowers:shrubScrub-Flowers:grasslandHerbaceous	2.30581497
## Leaves:shrubScrub-Flowers:grasslandHerbaceous	2.32804714
## Mixed:shrubScrub-Flowers:grasslandHerbaceous	5.03832825
## Needles:shrubScrub-Flowers:grasslandHerbaceous	6.66364484
## Other:shrubScrub-Flowers:grasslandHerbaceous	2.34391326
## Seeds:shrubScrub-Flowers:grasslandHerbaceous	2.31467523
## Twigs/branches:shrubScrub-Flowers:grasslandHerbaceous	2.74078285
## Woody material:shrubScrub-Flowers:grasslandHerbaceous	2.38916827
## Mixed:grasslandHerbaceous-Leaves:grasslandHerbaceous	4.43974550
## Needles:grasslandHerbaceous-Leaves:grasslandHerbaceous	7.61022013
## Other:grasslandHerbaceous-Leaves:grasslandHerbaceous	2.60306574
## Seeds:grasslandHerbaceous-Leaves:grasslandHerbaceous	2.51181574
## Twigs/branches:grasslandHerbaceous-Leaves:grasslandHerbaceous	3.42953329
## Woody material:grasslandHerbaceous-Leaves:grasslandHerbaceous	2.54165609
## Flowers:shrubScrub-Leaves:grasslandHerbaceous	2.19409358
## Leaves:shrubScrub-Leaves:grasslandHerbaceous	2.21548579
## Mixed:shrubScrub-Leaves:grasslandHerbaceous	4.94208253
## Needles:shrubScrub-Leaves:grasslandHerbaceous	6.55061052
## Other:shrubScrub-Leaves:grasslandHerbaceous	2.23167983
## Seeds:shrubScrub-Leaves:grasslandHerbaceous	2.20278038
## Twigs/branches:shrubScrub-Leaves:grasslandHerbaceous	2.62790374

## Woody material:shrubScrub-Leaves:grasslandHerbaceous	2.27628916
## Needles:grasslandHerbaceous-Mixed:grasslandHerbaceous	7.38261937
## Other:grasslandHerbaceous-Mixed:grasslandHerbaceous	2.35622566
## Seeds:grasslandHerbaceous-Mixed:grasslandHerbaceous	2.26497566
## Twigs/branches:grasslandHerbaceous-Mixed:grasslandHerbaceous	3.18946732
## Woody material:grasslandHerbaceous-Mixed:grasslandHerbaceous	2.29825149
## Flowers:shrubScrub-Mixed:grasslandHerbaceous	2.03715052
## Leaves:shrubScrub-Mixed:grasslandHerbaceous	2.06516838
## Mixed:shrubScrub-Mixed:grasslandHerbaceous	4.65443561
## Needles:shrubScrub-Mixed:grasslandHerbaceous	6.40400351
## Other:shrubScrub-Mixed:grasslandHerbaceous	2.07878131
## Seeds:shrubScrub-Mixed:grasslandHerbaceous	2.04720938
## Twigs/branches:shrubScrub-Mixed:grasslandHerbaceous	2.48008071
## Woody material:shrubScrub-Mixed:grasslandHerbaceous	2.12846612
## Other:grasslandHerbaceous-Needles:grasslandHerbaceous	-2.55653947
## Seeds:grasslandHerbaceous-Needles:grasslandHerbaceous	-2.64778947
## Twigs/branches:grasslandHerbaceous-Needles:grasslandHerbaceous	-1.73019176
## Woody material:grasslandHerbaceous-Needles:grasslandHerbaceous	-2.61800979
## Flowers:shrubScrub-Needles:grasslandHerbaceous	-2.96718095
## Leaves:shrubScrub-Needles:grasslandHerbaceous	-2.94591907
## Mixed:shrubScrub-Needles:grasslandHerbaceous	-0.21681916
## Needles:shrubScrub-Needles:grasslandHerbaceous	1.38913220
## Other:shrubScrub-Needles:grasslandHerbaceous	-2.92967413
## Seeds:shrubScrub-Needles:grasslandHerbaceous	-2.95852105
## Twigs/branches:shrubScrub-Needles:grasslandHerbaceous	-2.53355046
## Woody material:shrubScrub-Needles:grasslandHerbaceous	-2.88516505
## Seeds:grasslandHerbaceous-Other:grasslandHerbaceous	2.50765611
## Twigs/branches:grasslandHerbaceous-Other:grasslandHerbaceous	3.42601912
## Woody material:grasslandHerbaceous-Other:grasslandHerbaceous	2.53782327
## Flowers:shrubScrub-Other:grasslandHerbaceous	2.19887058
## Leaves:shrubScrub-Other:grasslandHerbaceous	2.22095539
## Mixed:shrubScrub-Other:grasslandHerbaceous	4.93412210
## Needles:shrubScrub-Other:grasslandHerbaceous	6.55647016
## Other:shrubScrub-Other:grasslandHerbaceous	2.23687902
## Seeds:shrubScrub-Other:grasslandHerbaceous	2.20770040
## Twigs/branches:shrubScrub-Other:grasslandHerbaceous	2.63363538
## Woody material:shrubScrub-Other:grasslandHerbaceous	2.28202080
## Twigs/branches:grasslandHerbaceous-Seeds:grasslandHerbaceous	3.51726912
## Woody material:grasslandHerbaceous-Seeds:grasslandHerbaceous	2.62907327
## Flowers:shrubScrub-Seeds:grasslandHerbaceous	2.29012058
## Leaves:shrubScrub-Seeds:grasslandHerbaceous	2.31220539
## Mixed:shrubScrub-Seeds:grasslandHerbaceous	5.02537210
## Needles:shrubScrub-Seeds:grasslandHerbaceous	6.64772016
## Other:shrubScrub-Seeds:grasslandHerbaceous	2.32812902
## Seeds:shrubScrub-Seeds:grasslandHerbaceous	2.29895040
## Twigs/branches:shrubScrub-Seeds:grasslandHerbaceous	2.72488538
## Woody material:shrubScrub-Seeds:grasslandHerbaceous	2.37327080
## Woody material:grasslandHerbaceous-Twigs/branches:grasslandHerbaceous	1.65833394
## Flowers:shrubScrub-Twigs/branches:grasslandHerbaceous	1.31581849
## Leaves:shrubScrub-Twigs/branches:grasslandHerbaceous	1.33761771
## Mixed:shrubScrub-Twigs/branches:grasslandHerbaceous	4.05634846
## Needles:shrubScrub-Twigs/branches:grasslandHerbaceous	5.67297172
## Other:shrubScrub-Twigs/branches:grasslandHerbaceous	1.35365282
## Seeds:shrubScrub-Twigs/branches:grasslandHerbaceous	1.32458932

## Twigs/branches:shrubScrub-Twigs/branches:grasslandHerbaceous	1.75018969
## Woody material:shrubScrub-Twigs/branches:grasslandHerbaceous	1.39857510
## Flowers:shrubScrub-Woody material:grasslandHerbaceous	2.23149510
## Leaves:shrubScrub-Woody material:grasslandHerbaceous	2.25343562
## Mixed:shrubScrub-Woody material:grasslandHerbaceous	4.96941799
## Needles:shrubScrub-Woody material:grasslandHerbaceous	6.58886918
## Other:shrubScrub-Woody material:grasslandHerbaceous	2.26941557
## Seeds:shrubScrub-Woody material:grasslandHerbaceous	2.24029511
## Twigs/branches:shrubScrub-Woody material:grasslandHerbaceous	2.66606105
## Woody material:shrubScrub-Woody material:grasslandHerbaceous	2.31444646
## Leaves:shrubScrub-Flowers:shrubScrub	1.92648477
## Mixed:shrubScrub-Flowers:shrubScrub	4.71791787
## Needles:shrubScrub-Flowers:shrubScrub	6.25962171
## Other:shrubScrub-Flowers:shrubScrub	1.94405289
## Seeds:shrubScrub-Flowers:shrubScrub	1.91656874
## Twigs/branches:shrubScrub-Flowers:shrubScrub	2.33756804
## Woody material:shrubScrub-Flowers:shrubScrub	1.98595346
## Mixed:shrubScrub-Leaves:shrubScrub	4.65477481
## Needles:shrubScrub-Leaves:shrubScrub	6.19008841
## Other:shrubScrub-Leaves:shrubScrub	1.87485713
## Seeds:shrubScrub-Leaves:shrubScrub	1.84751452
## Twigs/branches:shrubScrub-Leaves:shrubScrub	2.26810046
## Woody material:shrubScrub-Leaves:shrubScrub	1.91648588
## Needles:shrubScrub-Mixed:shrubScrub	4.57671112
## Other:shrubScrub-Mixed:shrubScrub	0.25556530
## Seeds:shrubScrub-Mixed:shrubScrub	0.22572816
## Twigs/branches:shrubScrub-Mixed:shrubScrub	0.65357537
## Woody material:shrubScrub-Mixed:shrubScrub	0.30196079
## Other:shrubScrub-Needles:shrubScrub	-2.48683241
## Seeds:shrubScrub-Needles:shrubScrub	-2.51409457
## Twigs/branches:shrubScrub-Needles:shrubScrub	-2.09374366
## Woody material:shrubScrub-Needles:shrubScrub	-2.44535825
## Seeds:shrubScrub-Other:shrubScrub	1.84983111
## Twigs/branches:shrubScrub-Other:shrubScrub	2.27057903
## Woody material:shrubScrub-Other:shrubScrub	1.91896445
## Twigs/branches:shrubScrub-Seeds:shrubScrub	2.31888702
## Woody material:shrubScrub-Seeds:shrubScrub	1.96727244
## Woody material:shrubScrub-Twigs/branches:shrubScrub	1.48608955
##	p adj
## Leaves:evergreenForest-Flowers:evergreenForest	1.0000000
## Mixed:evergreenForest-Flowers:evergreenForest	0.7778267
## Needles:evergreenForest-Flowers:evergreenForest	0.0000000
## Other:evergreenForest-Flowers:evergreenForest	1.0000000
## Seeds:evergreenForest-Flowers:evergreenForest	1.0000000
## Twigs/branches:evergreenForest-Flowers:evergreenForest	0.0576184
## Woody material:evergreenForest-Flowers:evergreenForest	0.9348463
## Flowers:grasslandHerbaceous-Flowers:evergreenForest	1.0000000
## Leaves:grasslandHerbaceous-Flowers:evergreenForest	1.0000000
## Mixed:grasslandHerbaceous-Flowers:evergreenForest	0.9999809
## Needles:grasslandHerbaceous-Flowers:evergreenForest	0.0000000
## Other:grasslandHerbaceous-Flowers:evergreenForest	1.0000000
## Seeds:grasslandHerbaceous-Flowers:evergreenForest	1.0000000
## Twigs/branches:grasslandHerbaceous-Flowers:evergreenForest	0.9998164
## Woody material:grasslandHerbaceous-Flowers:evergreenForest	1.0000000

## Flowers:shrubScrub-Flowers:evergreenForest	1.0000000
## Leaves:shrubScrub-Flowers:evergreenForest	1.0000000
## Mixed:shrubScrub-Flowers:evergreenForest	0.2255973
## Needles:shrubScrub-Flowers:evergreenForest	0.0000000
## Other:shrubScrub-Flowers:evergreenForest	1.0000000
## Seeds:shrubScrub-Flowers:evergreenForest	1.0000000
## Twigs/branches:shrubScrub-Flowers:evergreenForest	1.0000000
## Woody material:shrubScrub-Flowers:evergreenForest	1.0000000
## Mixed:evergreenForest-Leaves:evergreenForest	0.6690792
## Needles:evergreenForest-Leaves:evergreenForest	0.0000000
## Other:evergreenForest-Leaves:evergreenForest	1.0000000
## Seeds:evergreenForest-Leaves:evergreenForest	1.0000000
## Twigs/branches:evergreenForest-Leaves:evergreenForest	0.0330188
## Woody material:evergreenForest-Leaves:evergreenForest	0.8603312
## Flowers:grasslandHerbaceous-Leaves:evergreenForest	1.0000000
## Leaves:grasslandHerbaceous-Leaves:evergreenForest	1.0000000
## Mixed:grasslandHerbaceous-Leaves:evergreenForest	0.9999002
## Needles:grasslandHerbaceous-Leaves:evergreenForest	0.0000000
## Other:grasslandHerbaceous-Leaves:evergreenForest	1.0000000
## Seeds:grasslandHerbaceous-Leaves:evergreenForest	1.0000000
## Twigs/branches:grasslandHerbaceous-Leaves:evergreenForest	0.9989083
## Woody material:grasslandHerbaceous-Leaves:evergreenForest	1.0000000
## Flowers:shrubScrub-Leaves:evergreenForest	1.0000000
## Leaves:shrubScrub-Leaves:evergreenForest	1.0000000
## Mixed:shrubScrub-Leaves:evergreenForest	0.1595595
## Needles:shrubScrub-Leaves:evergreenForest	0.0000000
## Other:shrubScrub-Leaves:evergreenForest	1.0000000
## Seeds:shrubScrub-Leaves:evergreenForest	1.0000000
## Twigs/branches:shrubScrub-Leaves:evergreenForest	0.9999999
## Woody material:shrubScrub-Leaves:evergreenForest	1.0000000
## Needles:evergreenForest-Mixed:evergreenForest	0.0000000
## Other:evergreenForest-Mixed:evergreenForest	0.7484244
## Seeds:evergreenForest-Mixed:evergreenForest	0.7358868
## Twigs/branches:evergreenForest-Mixed:evergreenForest	1.0000000
## Woody material:evergreenForest-Mixed:evergreenForest	1.0000000
## Flowers:grasslandHerbaceous-Mixed:evergreenForest	0.8397321
## Leaves:grasslandHerbaceous-Mixed:evergreenForest	0.8215293
## Mixed:grasslandHerbaceous-Mixed:evergreenForest	1.0000000
## Needles:grasslandHerbaceous-Mixed:evergreenForest	0.0000863
## Other:grasslandHerbaceous-Mixed:evergreenForest	0.8971129
## Seeds:grasslandHerbaceous-Mixed:evergreenForest	0.8329319
## Twigs/branches:grasslandHerbaceous-Mixed:evergreenForest	0.9999995
## Woody material:grasslandHerbaceous-Mixed:evergreenForest	0.8600140
## Flowers:shrubScrub-Mixed:evergreenForest	0.6203713
## Leaves:shrubScrub-Mixed:evergreenForest	0.6564316
## Mixed:shrubScrub-Mixed:evergreenForest	1.0000000
## Needles:shrubScrub-Mixed:evergreenForest	0.0016783
## Other:shrubScrub-Mixed:evergreenForest	0.6730863
## Seeds:shrubScrub-Mixed:evergreenForest	0.6332449
## Twigs/branches:shrubScrub-Mixed:evergreenForest	0.9767066
## Woody material:shrubScrub-Mixed:evergreenForest	0.7336731
## Other:evergreenForest-Needles:evergreenForest	0.0000000
## Seeds:evergreenForest-Needles:evergreenForest	0.0000000
## Twigs/branches:evergreenForest-Needles:evergreenForest	0.0000000

## Woody material:evergreenForest-Needles:evergreenForest	0.0000000
## Flowers:grasslandHerbaceous-Needles:evergreenForest	0.0000000
## Leaves:grasslandHerbaceous-Needles:evergreenForest	0.0000000
## Mixed:grasslandHerbaceous-Needles:evergreenForest	0.0000000
## Needles:grasslandHerbaceous-Needles:evergreenForest	0.0354026
## Other:grasslandHerbaceous-Needles:evergreenForest	0.0000000
## Seeds:grasslandHerbaceous-Needles:evergreenForest	0.0000000
## Twigs/branches:grasslandHerbaceous-Needles:evergreenForest	0.0000000
## Woody material:grasslandHerbaceous-Needles:evergreenForest	0.0000000
## Flowers:shrubScrub-Needles:evergreenForest	0.0000000
## Leaves:shrubScrub-Needles:evergreenForest	0.0000000
## Mixed:shrubScrub-Needles:evergreenForest	0.0000000
## Needles:shrubScrub-Needles:evergreenForest	0.0000011
## Other:shrubScrub-Needles:evergreenForest	0.0000000
## Seeds:shrubScrub-Needles:evergreenForest	0.0000000
## Twigs/branches:shrubScrub-Needles:evergreenForest	0.0000000
## Woody material:shrubScrub-Needles:evergreenForest	0.0000000
## Seeds:evergreenForest-Other:evergreenForest	1.0000000
## Twigs/branches:evergreenForest-Other:evergreenForest	0.0505597
## Woody material:evergreenForest-Other:evergreenForest	0.9173794
## Flowers:grasslandHerbaceous-Other:evergreenForest	1.0000000
## Leaves:grasslandHerbaceous-Other:evergreenForest	1.0000000
## Mixed:grasslandHerbaceous-Other:evergreenForest	0.9999668
## Needles:grasslandHerbaceous-Other:evergreenForest	0.0000000
## Other:grasslandHerbaceous-Other:evergreenForest	1.0000000
## Seeds:grasslandHerbaceous-Other:evergreenForest	1.0000000
## Twigs/branches:grasslandHerbaceous-Other:evergreenForest	0.9996690
## Woody material:grasslandHerbaceous-Other:evergreenForest	1.0000000
## Flowers:shrubScrub-Other:evergreenForest	1.0000000
## Leaves:shrubScrub-Other:evergreenForest	1.0000000
## Mixed:shrubScrub-Other:evergreenForest	0.2058815
## Needles:shrubScrub-Other:evergreenForest	0.0000000
## Other:shrubScrub-Other:evergreenForest	1.0000000
## Seeds:shrubScrub-Other:evergreenForest	1.0000000
## Twigs/branches:shrubScrub-Other:evergreenForest	1.0000000
## Woody material:shrubScrub-Other:evergreenForest	1.0000000
## Twigs/branches:evergreenForest-Seeds:evergreenForest	0.0472061
## Woody material:evergreenForest-Seeds:evergreenForest	0.9092750
## Flowers:grasslandHerbaceous-Seeds:evergreenForest	1.0000000
## Leaves:grasslandHerbaceous-Seeds:evergreenForest	1.0000000
## Mixed:grasslandHerbaceous-Seeds:evergreenForest	0.9999599
## Needles:grasslandHerbaceous-Seeds:evergreenForest	0.0000000
## Other:grasslandHerbaceous-Seeds:evergreenForest	1.0000000
## Seeds:grasslandHerbaceous-Seeds:evergreenForest	1.0000000
## Twigs/branches:grasslandHerbaceous-Seeds:evergreenForest	0.9995923
## Woody material:grasslandHerbaceous-Seeds:evergreenForest	1.0000000
## Flowers:shrubScrub-Seeds:evergreenForest	1.0000000
## Leaves:shrubScrub-Seeds:evergreenForest	1.0000000
## Mixed:shrubScrub-Seeds:evergreenForest	0.1976538
## Needles:shrubScrub-Seeds:evergreenForest	0.0000000
## Other:shrubScrub-Seeds:evergreenForest	1.0000000
## Seeds:shrubScrub-Seeds:evergreenForest	1.0000000
## Twigs/branches:shrubScrub-Seeds:evergreenForest	1.0000000
## Woody material:shrubScrub-Seeds:evergreenForest	1.0000000

## Woody material:evergreenForest-Twigs/branches:evergreenForest	0.9934408
## Flowers:grasslandHerbaceous-Twigs/branches:evergreenForest	0.1553770
## Leaves:grasslandHerbaceous-Twigs/branches:evergreenForest	0.1230330
## Mixed:grasslandHerbaceous-Twigs/branches:evergreenForest	0.9999929
## Needles:grasslandHerbaceous-Twigs/branches:evergreenForest	0.0001009
## Other:grasslandHerbaceous-Twigs/branches:evergreenForest	0.2125736
## Seeds:grasslandHerbaceous-Twigs/branches:evergreenForest	0.1463923
## Twigs/branches:grasslandHerbaceous-Twigs/branches:evergreenForest	0.9819556
## Woody material:grasslandHerbaceous-Twigs/branches:evergreenForest	0.1662533
## Flowers:shrubScrub-Twigs/branches:evergreenForest	0.0208356
## Leaves:shrubScrub-Twigs/branches:evergreenForest	0.0233702
## Mixed:shrubScrub-Twigs/branches:evergreenForest	1.0000000
## Needles:shrubScrub-Twigs/branches:evergreenForest	0.0019104
## Other:shrubScrub-Twigs/branches:evergreenForest	0.0264478
## Seeds:shrubScrub-Twigs/branches:evergreenForest	0.0219725
## Twigs/branches:shrubScrub-Twigs/branches:evergreenForest	0.2503203
## Woody material:shrubScrub-Twigs/branches:evergreenForest	0.0349431
## Flowers:grasslandHerbaceous-Woody material:evergreenForest	0.9653227
## Leaves:grasslandHerbaceous-Woody material:evergreenForest	0.9578392
## Mixed:grasslandHerbaceous-Woody material:evergreenForest	1.0000000
## Needles:grasslandHerbaceous-Woody material:evergreenForest	0.0000000
## Other:grasslandHerbaceous-Woody material:evergreenForest	0.9849724
## Seeds:grasslandHerbaceous-Woody material:evergreenForest	0.9625766
## Twigs/branches:grasslandHerbaceous-Woody material:evergreenForest	1.0000000
## Woody material:grasslandHerbaceous-Woody material:evergreenForest	0.9732104
## Flowers:shrubScrub-Woody material:evergreenForest	0.8153558
## Leaves:shrubScrub-Woody material:evergreenForest	0.8460174
## Mixed:shrubScrub-Woody material:evergreenForest	0.9969846
## Needles:shrubScrub-Woody material:evergreenForest	0.0000001
## Other:shrubScrub-Woody material:evergreenForest	0.8604142
## Seeds:shrubScrub-Woody material:evergreenForest	0.8267656
## Twigs/branches:shrubScrub-Woody material:evergreenForest	0.9993323
## Woody material:shrubScrub-Woody material:evergreenForest	0.9053484
## Leaves:grasslandHerbaceous-Flowers:grasslandHerbaceous	1.0000000
## Mixed:grasslandHerbaceous-Flowers:grasslandHerbaceous	0.9999603
## Needles:grasslandHerbaceous-Flowers:grasslandHerbaceous	0.0000000
## Other:grasslandHerbaceous-Flowers:grasslandHerbaceous	1.0000000
## Seeds:grasslandHerbaceous-Flowers:grasslandHerbaceous	1.0000000
## Twigs/branches:grasslandHerbaceous-Flowers:grasslandHerbaceous	0.9997859
## Woody material:grasslandHerbaceous-Flowers:grasslandHerbaceous	1.0000000
## Flowers:shrubScrub-Flowers:grasslandHerbaceous	1.0000000
## Leaves:shrubScrub-Flowers:grasslandHerbaceous	1.0000000
## Mixed:shrubScrub-Flowers:grasslandHerbaceous	0.3178625
## Needles:shrubScrub-Flowers:grasslandHerbaceous	0.0000000
## Other:shrubScrub-Flowers:grasslandHerbaceous	1.0000000
## Seeds:shrubScrub-Flowers:grasslandHerbaceous	1.0000000
## Twigs/branches:shrubScrub-Flowers:grasslandHerbaceous	1.0000000
## Woody material:shrubScrub-Flowers:grasslandHerbaceous	1.0000000
## Mixed:grasslandHerbaceous-Leaves:grasslandHerbaceous	0.9999639
## Needles:grasslandHerbaceous-Leaves:grasslandHerbaceous	0.0000000
## Other:grasslandHerbaceous-Leaves:grasslandHerbaceous	1.0000000
## Seeds:grasslandHerbaceous-Leaves:grasslandHerbaceous	1.0000000
## Twigs/branches:grasslandHerbaceous-Leaves:grasslandHerbaceous	0.9997744
## Woody material:grasslandHerbaceous-Leaves:grasslandHerbaceous	1.0000000

## Flowers:shrubScrub-Leaves:grasslandHerbaceous	1.0000000
## Leaves:shrubScrub-Leaves:grasslandHerbaceous	1.0000000
## Mixed:shrubScrub-Leaves:grasslandHerbaceous	0.2890489
## Needles:shrubScrub-Leaves:grasslandHerbaceous	0.0000000
## Other:shrubScrub-Leaves:grasslandHerbaceous	1.0000000
## Seeds:shrubScrub-Leaves:grasslandHerbaceous	1.0000000
## Twigs/branches:shrubScrub-Leaves:grasslandHerbaceous	1.0000000
## Woody material:shrubScrub-Leaves:grasslandHerbaceous	1.0000000
## Needles:grasslandHerbaceous-Mixed:grasslandHerbaceous	0.0024284
## Other:grasslandHerbaceous-Mixed:grasslandHerbaceous	0.9999908
## Seeds:grasslandHerbaceous-Mixed:grasslandHerbaceous	0.9999581
## Twigs/branches:grasslandHerbaceous-Mixed:grasslandHerbaceous	1.0000000
## Woody material:grasslandHerbaceous-Mixed:grasslandHerbaceous	0.9999779
## Flowers:shrubScrub-Mixed:grasslandHerbaceous	0.9998753
## Leaves:shrubScrub-Mixed:grasslandHerbaceous	0.9999310
## Mixed:shrubScrub-Mixed:grasslandHerbaceous	0.9999731
## Needles:shrubScrub-Mixed:grasslandHerbaceous	0.0273593
## Other:shrubScrub-Mixed:grasslandHerbaceous	0.9999409
## Seeds:shrubScrub-Mixed:grasslandHerbaceous	0.9998963
## Twigs/branches:shrubScrub-Mixed:grasslandHerbaceous	1.0000000
## Woody material:shrubScrub-Mixed:grasslandHerbaceous	0.9999778
## Other:grasslandHerbaceous-Needles:grasslandHerbaceous	0.0000000
## Seeds:grasslandHerbaceous-Needles:grasslandHerbaceous	0.0000000
## Twigs/branches:grasslandHerbaceous-Needles:grasslandHerbaceous	0.0000002
## Woody material:grasslandHerbaceous-Needles:grasslandHerbaceous	0.0000000
## Flowers:shrubScrub-Needles:grasslandHerbaceous	0.0000000
## Leaves:shrubScrub-Needles:grasslandHerbaceous	0.0000000
## Mixed:shrubScrub-Needles:grasslandHerbaceous	0.0178115
## Needles:shrubScrub-Needles:grasslandHerbaceous	0.9998496
## Other:shrubScrub-Needles:grasslandHerbaceous	0.0000000
## Seeds:shrubScrub-Needles:grasslandHerbaceous	0.0000000
## Twigs/branches:shrubScrub-Needles:grasslandHerbaceous	0.0000000
## Woody material:shrubScrub-Needles:grasslandHerbaceous	0.0000000
## Seeds:grasslandHerbaceous-Other:grasslandHerbaceous	1.0000000
## Twigs/branches:grasslandHerbaceous-Other:grasslandHerbaceous	0.9999580
## Woody material:grasslandHerbaceous-Other:grasslandHerbaceous	1.0000000
## Flowers:shrubScrub-Other:grasslandHerbaceous	1.0000000
## Leaves:shrubScrub-Other:grasslandHerbaceous	1.0000000
## Mixed:shrubScrub-Other:grasslandHerbaceous	0.3929171
## Needles:shrubScrub-Other:grasslandHerbaceous	0.0000000
## Other:shrubScrub-Other:grasslandHerbaceous	1.0000000
## Seeds:shrubScrub-Other:grasslandHerbaceous	1.0000000
## Twigs/branches:shrubScrub-Other:grasslandHerbaceous	1.0000000
## Woody material:shrubScrub-Other:grasslandHerbaceous	1.0000000
## Twigs/branches:grasslandHerbaceous-Seeds:grasslandHerbaceous	0.9997661
## Woody material:grasslandHerbaceous-Seeds:grasslandHerbaceous	1.0000000
## Flowers:shrubScrub-Seeds:grasslandHerbaceous	1.0000000
## Leaves:shrubScrub-Seeds:grasslandHerbaceous	1.0000000
## Mixed:shrubScrub-Seeds:grasslandHerbaceous	0.3086423
## Needles:shrubScrub-Seeds:grasslandHerbaceous	0.0000000
## Other:shrubScrub-Seeds:grasslandHerbaceous	1.0000000
## Seeds:shrubScrub-Seeds:grasslandHerbaceous	1.0000000
## Twigs/branches:shrubScrub-Seeds:grasslandHerbaceous	1.0000000
## Woody material:shrubScrub-Seeds:grasslandHerbaceous	1.0000000

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## Woody material:grasslandHerbaceous-Twigs/branches:grasslandHerbaceous 0.9998831
## Flowers:shrubScrub-Twigs/branches:grasslandHerbaceous 0.9984073
## Leaves:shrubScrub-Twigs/branches:grasslandHerbaceous 0.9990989
## Mixed:shrubScrub-Twigs/branches:grasslandHerbaceous 0.9883079
## Needles:shrubScrub-Twigs/branches:grasslandHerbaceous 0.0000043
## Other:shrubScrub-Twigs/branches:grasslandHerbaceous 0.9992548
## Seeds:shrubScrub-Twigs/branches:grasslandHerbaceous 0.9986731
## Twigs/branches:shrubScrub-Twigs/branches:grasslandHerbaceous 1.0000000
## Woody material:shrubScrub-Twigs/branches:grasslandHerbaceous 0.9997323
## Flowers:shrubScrub-Woody material:grasslandHerbaceous 1.0000000
## Leaves:shrubScrub-Woody material:grasslandHerbaceous 1.0000000
## Mixed:shrubScrub-Woody material:grasslandHerbaceous 0.3382995
## Needles:shrubScrub-Woody material:grasslandHerbaceous 0.0000000
## Other:shrubScrub-Woody material:grasslandHerbaceous 1.0000000
## Seeds:shrubScrub-Woody material:grasslandHerbaceous 1.0000000
## Twigs/branches:shrubScrub-Woody material:grasslandHerbaceous 1.0000000
## Woody material:shrubScrub-Woody material:grasslandHerbaceous 1.0000000
## Leaves:shrubScrub-Flowers:shrubScrub 1.0000000
## Mixed:shrubScrub-Flowers:shrubScrub 0.1324031
## Needles:shrubScrub-Flowers:shrubScrub 0.0000000
## Other:shrubScrub-Flowers:shrubScrub 1.0000000
## Seeds:shrubScrub-Flowers:shrubScrub 1.0000000
## Twigs/branches:shrubScrub-Flowers:shrubScrub 0.9999998
## Woody material:shrubScrub-Flowers:shrubScrub 1.0000000
## Mixed:shrubScrub-Leaves:shrubScrub 0.1468958
## Needles:shrubScrub-Leaves:shrubScrub 0.0000000
## Other:shrubScrub-Leaves:shrubScrub 1.0000000
## Seeds:shrubScrub-Leaves:shrubScrub 1.0000000
## Twigs/branches:shrubScrub-Leaves:shrubScrub 1.0000000
## Woody material:shrubScrub-Leaves:shrubScrub 1.0000000
## Needles:shrubScrub-Mixed:shrubScrub 0.1840347
## Other:shrubScrub-Mixed:shrubScrub 0.1556683
## Seeds:shrubScrub-Mixed:shrubScrub 0.1376605
## Twigs/branches:shrubScrub-Mixed:shrubScrub 0.5427234
## Woody material:shrubScrub-Mixed:shrubScrub 0.1875831
## Other:shrubScrub-Needles:shrubScrub 0.0000000
## Seeds:shrubScrub-Needles:shrubScrub 0.0000000
## Twigs/branches:shrubScrub-Needles:shrubScrub 0.0000000
## Woody material:shrubScrub-Needles:shrubScrub 0.0000000
## Seeds:shrubScrub-Other:shrubScrub 1.0000000
## Twigs/branches:shrubScrub-Other:shrubScrub 1.0000000
## Woody material:shrubScrub-Other:shrubScrub 1.0000000
## Twigs/branches:shrubScrub-Seeds:shrubScrub 0.9999999
## Woody material:shrubScrub-Seeds:shrubScrub 1.0000000
## Woody material:shrubScrub-Twigs/branches:shrubScrub 1.0000000

```

```

Litter.interaction <- with(Litter, interaction(functionalGroup, nlcdClass)) # Finds interaction between
Litter.anova.2way5 <- aov(data = Litter, dryMass ~ Litter.interaction)

```

```

Litter.groups <- HSD.test(Litter.anova.2way5, "Litter.interaction", group = TRUE)
Litter.groups

```

```

## $statistics
##      MSerror   Df      Mean      CV
##    12.21141 1668 1.185757 294.7049

```

```
##
## $parameters
##      test      name.t ntr StudentizedRange alpha
##      Tukey Litter.interaction 24      5.152623 0.05
##
## $means
##      dryMass      std  r  Min  Max
## Flowers.evergreenForest      0.119625000 0.17831805 80 0.000 0.96
## Flowers.grasslandHerbaceous      0.005425532 0.01342571 47 0.000 0.08
## Flowers.shrubScrub      0.015505618 0.06134406 89 0.000 0.51
## Leaves.evergreenForest      0.016025641 0.06633425 78 0.000 0.53
## Leaves.grasslandHerbaceous      0.030471698 0.06550297 53 0.000 0.30
## Leaves.shrubScrub      0.058936170 0.16177256 94 0.000 1.13
## Mixed.evergreenForest      1.624375000 2.17737389 48 0.000 9.36
## Mixed.grasslandHerbaceous      1.129000000 1.84876744 20 0.000 5.93
## Mixed.shrubScrub      2.266184211 6.21960191 38 0.005 24.60
## Needles.evergreenForest      7.431888889 8.73545377 90 0.820 42.84
## Needles.grasslandHerbaceous      5.178888889 10.50178752 54 0.005 54.23
## Needles.shrubScrub      4.406288660 5.04363343 97 0.040 25.32
## Other.evergreenForest      0.084807692 0.13335687 78 0.000 0.56
## Other.grasslandHerbaceous      0.096666667 0.34639378 48 0.000 2.29
## Other.shrubScrub      0.066576087 0.22538481 92 0.000 1.68
## Seeds.evergreenForest      0.073461538 0.23380715 78 0.000 1.29
## Seeds.grasslandHerbaceous      0.005416667 0.01573833 48 0.000 0.10
## Seeds.shrubScrub      0.028777778 0.10191236 90 0.000 0.73
## Twigs/branches.evergreenForest      2.079294118 5.10954482 85 0.000 26.64
## Twigs/branches.grasslandHerbaceous      0.949900000 3.70166020 50 0.000 21.13
## Twigs/branches.shrubScrub      0.479583333 0.92559331 96 0.000 5.21
## Woody material.evergreenForest      1.203936170 2.51804689 94 0.000 18.13
## Woody material.grasslandHerbaceous      0.048877551 0.11809365 49 0.000 0.58
## Woody material.shrubScrub      0.127968750 0.35611765 96 0.000 2.52
##      Q25      Q50      Q75
## Flowers.evergreenForest      0.0050 0.0600 0.1625
## Flowers.grasslandHerbaceous      0.0000 0.0000 0.0050
## Flowers.shrubScrub      0.0000 0.0050 0.0050
## Leaves.evergreenForest      0.0000 0.0000 0.0050
## Leaves.grasslandHerbaceous      0.0000 0.0050 0.0200
## Leaves.shrubScrub      0.0000 0.0050 0.0200
## Mixed.evergreenForest      0.3400 0.7450 1.6500
## Mixed.grasslandHerbaceous      0.0050 0.0500 1.8525
## Mixed.shrubScrub      0.0575 0.1500 0.9575
## Needles.evergreenForest      2.4100 3.7350 8.8475
## Needles.grasslandHerbaceous      0.3200 1.8950 4.1175
## Needles.shrubScrub      1.0600 2.1900 6.4000
## Other.evergreenForest      0.0000 0.0050 0.1500
## Other.grasslandHerbaceous      0.0000 0.0025 0.0400
## Other.shrubScrub      0.0000 0.0025 0.0325
## Seeds.evergreenForest      0.0000 0.0050 0.0400
## Seeds.grasslandHerbaceous      0.0000 0.0000 0.0050
## Seeds.shrubScrub      0.0000 0.0000 0.0050
## Twigs/branches.evergreenForest      0.0000 0.2400 1.3300
## Twigs/branches.grasslandHerbaceous      0.0050 0.0600 0.3375
## Twigs/branches.shrubScrub      0.0000 0.0700 0.4750
## Woody material.evergreenForest      0.0325 0.2400 1.2975
```

```
## Woody material.grasslandHerbaceous 0.0000 0.0050 0.0200
## Woody material.shrubScrub          0.0000 0.0050 0.0725
##
## $comparison
## NULL
##
## $groups
##
##              dryMass groups
## Needles.evergreenForest      7.431888889      a
## Needles.grasslandHerbaceous  5.178888889      b
## Needles.shrubScrub           4.406288660     bc
## Mixed.shrubScrub             2.266184211     cd
## Twigs/branches.evergreenForest 2.079294118      d
## Mixed.evergreenForest        1.624375000      d
## Woody material.evergreenForest 1.203936170      d
## Mixed.grasslandHerbaceous    1.129000000      d
## Twigs/branches.grasslandHerbaceous 0.949900000      d
## Twigs/branches.shrubScrub    0.479583333      d
## Woody material.shrubScrub    0.127968750      d
## Flowers.evergreenForest      0.119625000      d
## Other.grasslandHerbaceous    0.096666667      d
## Other.evergreenForest        0.084807692      d
## Seeds.evergreenForest        0.073461538      d
## Other.shrubScrub             0.066576087      d
## Leaves.shrubScrub            0.058936170      d
## Woody material.grasslandHerbaceous 0.048877551      d
## Leaves.grasslandHerbaceous   0.030471698      d
## Seeds.shrubScrub             0.028777778      d
## Leaves.evergreenForest       0.016025641      d
## Flowers.shrubScrub           0.015505618      d
## Flowers.grasslandHerbaceous  0.005425532      d
## Seeds.grasslandHerbaceous    0.005416667      d
##
## attr("class")
## [1] "group"

# Plot the results
# Edit this graph to make it more visually appealing.
# Add letters to represent statistical groupings.
stat.letters <- data.frame(match(rownames(Litter.groups$groups),levels(Litter.interaction)),
                           as.character(Litter.groups$groups[[2]]))
colnames(stat.letters) <- c("Order", "Letter")
rownames(stat.letters) <- rownames(Litter.groups$groups)
stat.letters <- stat.letters[order(stat.letters$Order),]

Litter.anova.plot <- ggplot(Litter, aes(y = dryMass, x = nlcdClass, color = functionalGroup)) +
  geom_boxplot() +
  labs(x = "nlcd Class", y = "Mass (g)", color = "") +
  scale_colour_ordinal() +
  stat_summary(geom = "text", fun.y = max, vjust = -1, size = 3.5,
               position = position_dodge(0.7),
               label = as.character(stat.letters$Letter))

print(Litter.anova.plot)
```

