Assignment 3: Data Exploration

Key

OVERVIEW

This exercise accompanies the lessons in Environmental Data Analytics on Data Exploration.

Directions

1. Rename this file `<FirstLast>_A03_DataExploration.Rmd` (replacing `<FirstLast>` with your first and last name).
2. Change "Student Name" on line 3 (above) with your name.
3. Work through the steps, **creating code and output** that fulfill each instruction.
4. Be sure to **answer the questions** in this assignment document.
5. When you have completed the assignment, **Knit** the text and code into a single PDF file.
6. After Knitting, submit the completed exercise (PDF file) to the dropbox in Sakai.

The completed exercise is due on Sept 30th.

Set up your R session

1. Check your working directory, load necessary packages (tidyverse), and upload two datasets: the ECOTOX neonicotinoid dataset (ECOTOX_Neonicotinoids_Insects_raw.csv) and the Niwot Ridge NEON dataset for litter and woody debris (NEON_NIWO_Litter_massdata_2018-08_raw.csv). Name these datasets "Neonics" and "Litter", respectively. Be sure to include the subcommand to read strings in as factors.

```
#Set up: Check working directory
getwd()
```

```
## [1] "/home/guest/EDE"
```

```
#Set up: Load libraries
library(tidyverse)

#Read datasets
Neonics <- read.csv('./Data/Raw/ECOTOX_Neonicotinoids_Insects_raw.csv',stringsAsFactors = TRUE)
Litter <- read.csv('./Data/Raw/NIWO_Litter/NEON_NIWO_Litter_massdata_2018-08_raw.csv',stringsAsFactors =
```

Learn about your system

2. The neonicotinoid dataset was collected from the Environmental Protection Agency's ECOTOX Knowledgebase, a database for ecotoxicology research. Neonicotinoids are a class of insecticides used widely

in agriculture. The dataset that has been pulled includes all studies published on insects. Why might we be interested in the ecotoxicology of neonicotinoids on insects? Feel free to do a brief internet search if you feel you need more background information.

Answer: Neonicotinoids persist in the environment for long durations. They can harm non-target species and, therefore, can cause unintended ecological effects. We might be interested in their ecotoxicology on insects in order to determine the insects that could be vulnerable to neonicotinoids.

3. The Niwot Ridge litter and woody debris dataset was collected from the National Ecological Observatory Network, which collectively includes 81 aquatic and terrestrial sites across 20 ecoclimatic domains. 32 of these sites sample forest litter and woody debris, and we will focus on the Niwot Ridge long-term ecological research (LTER) station in Colorado. Why might we be interested in studying litter and woody debris that falls to the ground in forests? Feel free to do a brief internet search if you feel you need more background information.

   Answer: We might be interested in forest litter and woody debris to study the relationship between climatic varibales such as temperature, humidity etc and forest ecosystems. Decomposition of such litter is also crucial for nutrient cycles and, therefore, the amount of litter and woody debris might be of interest to foresters, ecologists and/or biogeochemists.

4. How is litter and woody debris sampled as part of the NEON network? Read the NEON_Litterfall_UserGuide.pdf document to learn more. List three pieces of salient information about the sampling methods here:

   Answer: 1. A single observation of litter data is recorded from a single collection event and a single trap (1 spatial-temporal observation). 2. The number and placement (targeted or randomized) of elevated and ground traps deployed depends on physical features of vegetation. 3. Frequency of sampling also depends on types of vegetation ranging from once every two-weeks to once a year.

Obtain basic summaries of your data (Neonics)

5. What are the dimensions of the dataset?

```
#Show dimensions of the Neonics dataset
dim(Neonics)
```

```
## [1] 4623   30
```

6. Using the `summary` function on the "Effect" column, determine the most common effects that are studied. Why might these effects specifically be of interest?

```
#Show summary of Effect Neonics dataset
summary(Neonics$Effect)
```

```
##     Accumulation        Avoidance         Behavior     Biochemistry
##               12              102              360               11
##          Cell(s)      Development        Enzyme(s) Feeding behavior
##                9              136               62              255
##         Genetics           Growth        Histology       Hormone(s)
```

```
##              82              38               5               1
##  Immunological     Intoxication      Morphology       Mortality
##              16              12              22            1493
##      Physiology      Population    Reproduction
##               7            1803             197
```

Answer: Population has the most records (1803), followed by Mortality (1493), and then Behavior at a distant third. This indicates that most studies just counted the number of individual spider/insects exposed, while the second one recorded only deaths, and the third looks more carefully for impacts on behavior.

7. Using the `summary` function, determine the six most commonly studied species in the dataset (common name). What do these species have in common, and why might they be of interest over other insects? Feel free to do a brief internet search for more information if needed.

```
#Show summary of Common name
summary(Neonics$Species.Common.Name)
```

```
##                          Honey Bee                     Parasitic Wasp
##                                667                                285
##               Buff Tailed Bumblebee                Carniolan Honey Bee
##                                183                                152
##                          Bumble Bee                   Italian Honeybee
##                                140                                113
##                     Japanese Beetle                  Asian Lady Beetle
##                                 94                                 76
##                     Euonymus Scale                           Wireworm
##                                 75                                 69
##                  European Dark Bee                  Minute Pirate Bug
##                                 66                                 62
##                 Asian Citrus Psyllid                     Parastic Wasp
##                                 60                                 58
##              Colorado Potato Beetle                   Parasitoid Wasp
##                                 57                                 51
##                Erythrina Gall Wasp                     Beetle Order
##                                 49                                 47
##         Snout Beetle Family, Weevil           Sevenspotted Lady Beetle
##                                 47                                 46
##                     True Bug Order              Buff-tailed Bumblebee
##                                 45                                 39
##                      Aphid Family                     Cabbage Looper
##                                 38                                 38
##                Sweetpotato Whitefly                    Braconid Wasp
##                                 37                                 33
##                      Cotton Aphid                    Predatory Mite
##                                 33                                 33
##              Ladybird Beetle Family                       Parasitoid
##                                 30                                 30
##                     Scarab Beetle                    Spring Tiphia
##                                 29                                 29
##                       Thrip Order                Ground Beetle Family
##                                 29                                 27
##                  Rove Beetle Family                     Tobacco Aphid
```

```
##                              27                              27
##                     Chalcid Wasp          Convergent Lady Beetle
##                              25                              25
##                    Stingless Bee               Spider/Mite Class
##                              25                              24
##               Tobacco Flea Beetle               Citrus Leafminer
##                              24                              23
##                  Ladybird Beetle                      Mason Bee
##                              23                              22
##                         Mosquito                  Argentine Ant
##                              22                              21
##                            Beetle       Flatheaded Appletree Borer
##                              21                              20
##              Horned Oak Gall Wasp              Leaf Beetle Family
##                              20                              20
##                Potato Leafhopper       Tooth-necked Fungus Beetle
##                              20                              20
##                     Codling Moth        Black-spotted Lady Beetle
##                              19                              18
##                     Calico Scale              Fairyfly Parasitoid
##                              18                              18
##                      Lady Beetle          Minute Parasitic Wasps
##                              18                              18
##                        Mirid Bug              Mulberry Pyralid
##                              18                              18
##                         Silkworm                Vedalia Beetle
##                              18                              18
##             Araneoid Spider Order                      Bee Order
##                              17                              17
##                   Egg Parasitoid                   Insect Class
##                              17                              17
##          Moth And Butterfly Order     Oystershell Scale Parasitoid
##                              17                              17
## Hemlock Woolly Adelgid Lady Beetle             Hemlock Wooly Adelgid
##                              16                              16
##                            Mite                    Onion Thrip
##                              16                              16
##             Western Flower Thrips                   Corn Earworm
##                              15                              14
##                Green Peach Aphid                      House Fly
##                              14                              14
##                         Ox Beetle              Red Scale Parasite
##                              14                              14
##                Spined Soldier Bug          Armoured Scale Family
##                              14                              13
##                 Diamondback Moth                  Eulophid Wasp
##                              13                              13
##                Monarch Butterfly                  Predatory Bug
##                              13                              13
##             Yellow Fever Mosquito            Braconid Parasitoid
##                              13                              12
##                    Common Thrip   Eastern Subterranean Termite
##                              12                              12
##                           Jassid                     Mite Order
```

```
##                                12                                12
##                         Pea Aphid                  Pond Wolf Spider
##                                12                                12
##          Spotless Ladybird Beetle            Glasshouse Potato Wasp
##                                11                                10
##                          Lacewing          Southern House Mosquito
##                                10                                10
##           Two Spotted Lady Beetle                       Ant Family
##                                10                                 9
##                      Apple Maggot                          (Other)
##                                 9                               670
```

Answer: Bees appear to be the most studied group, which makes sense given their importance to agriculture.

8. Concentrations are always a numeric value. What is the class of Conc.1..Author. in the dataset, and why is it not numeric?

```
#Show class of `Conc.1..Author.`
class(Neonics$Conc.1..Author.)
```

```
## [1] "factor"
```

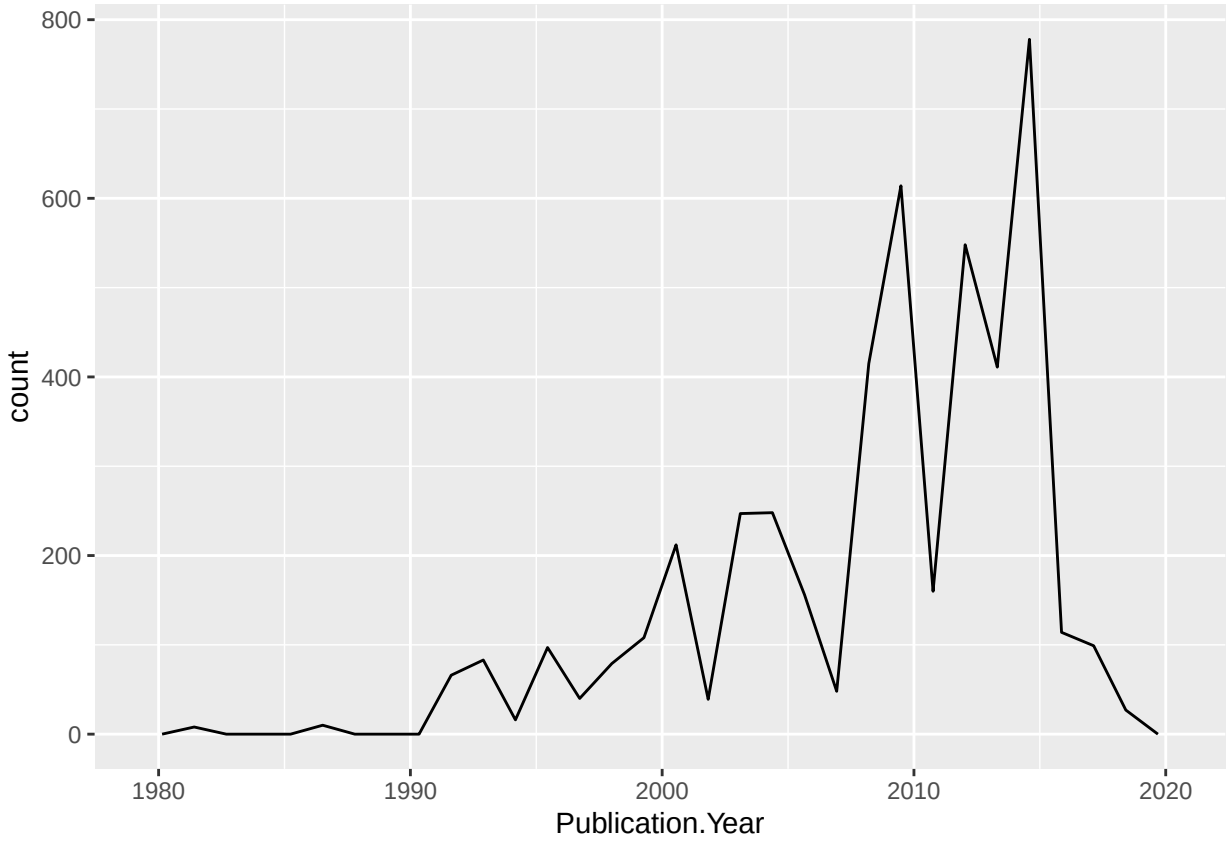
Answer: The field is of type "factor" because of some records listed as "NR" or not recorded.

Explore your data graphically (Neonics)

9. Using `geom_freqpoly`, generate a plot of the number of studies conducted by publication year.

```
#Create frequency polygon plot of publications by year
ggplot(data = Neonics) +
  geom_freqpoly(aes(x=Publication.Year))
```

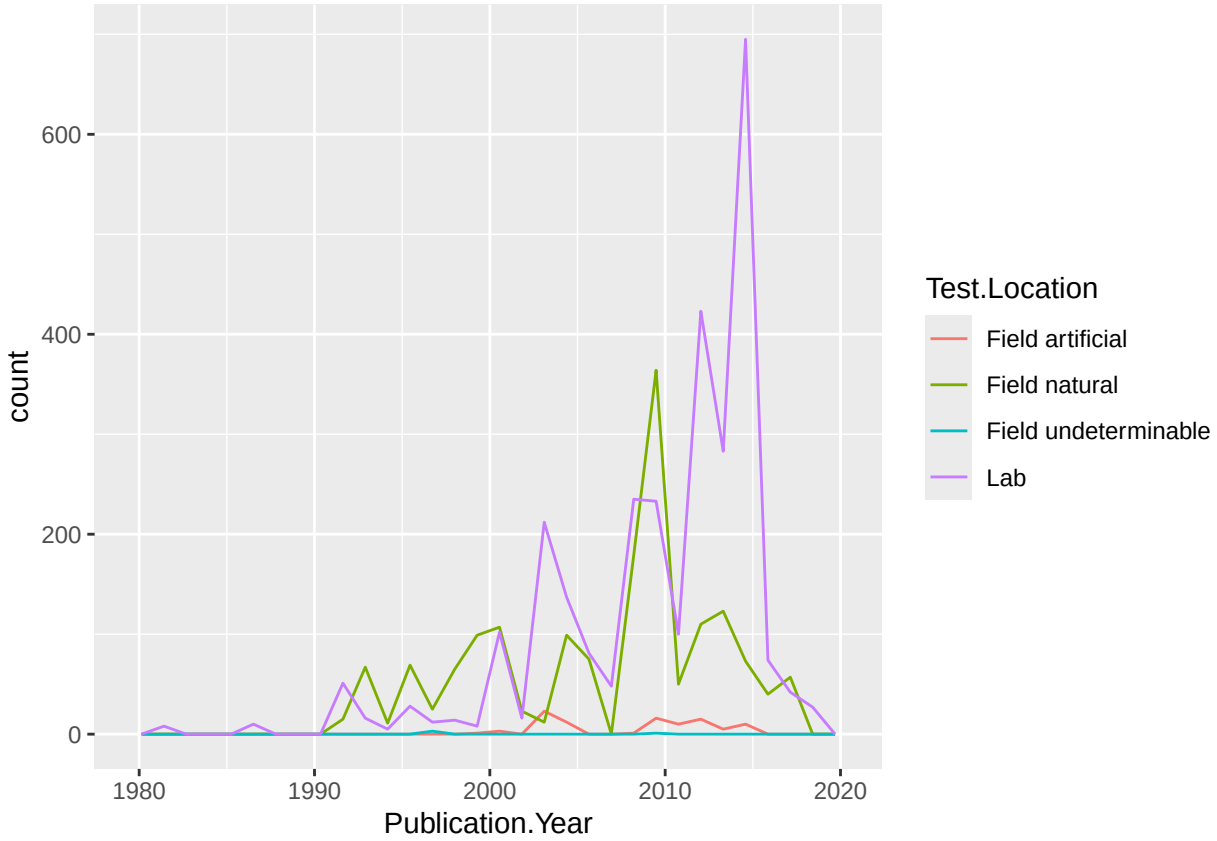
```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



10. Reproduce the same graph but now add a color aesthetic so that different Test.Location are displayed as different colors.

```
#Create frequency polygon plot of publications by year, colored by location
ggplot(data = Neonics) +
  geom_freqpoly(aes(x=Publication.Year,color=Test.Location))
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

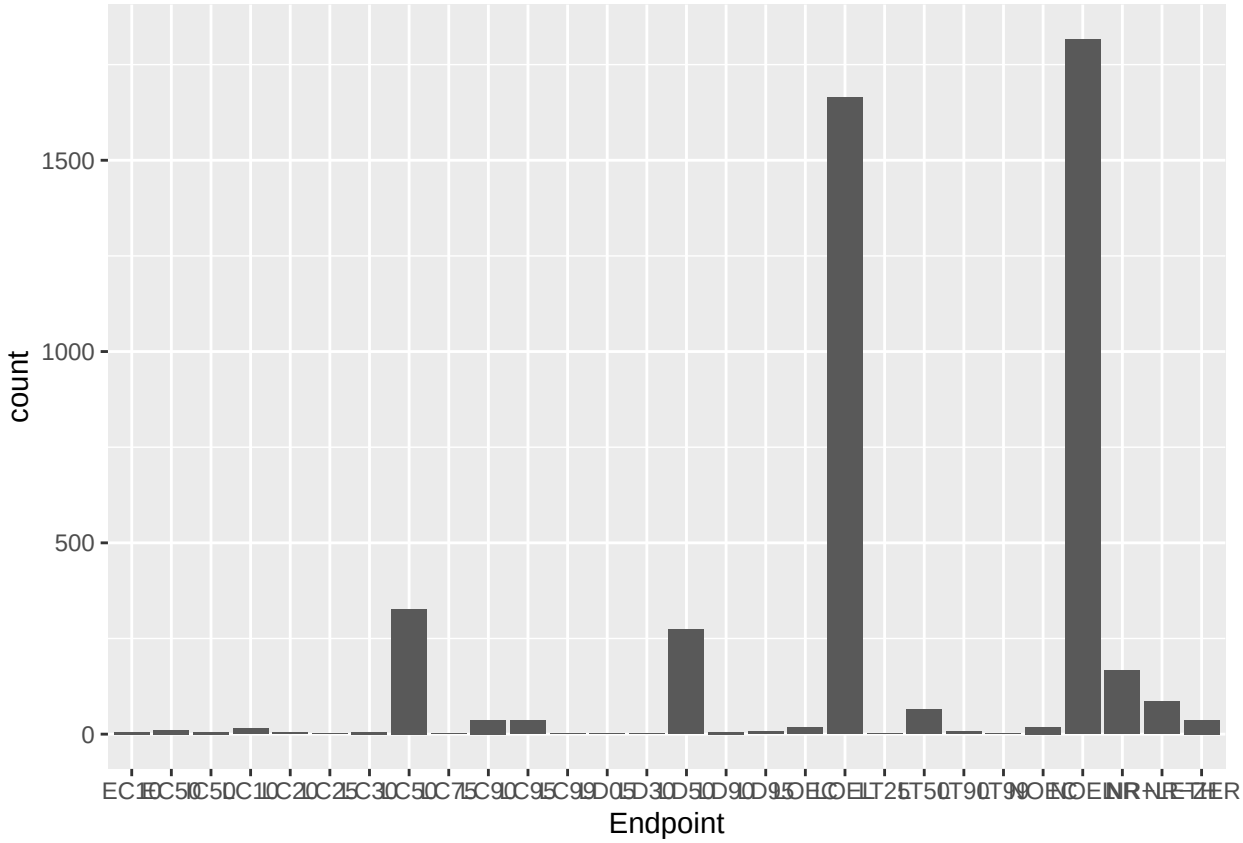


Interpret this graph. What are the most common test locations, and do they differ over time?

Answer: The lab is overall the most common test location, but not always, with Field natural sometimes overtaking it.

11. Create a bar graph of Endpoint counts. What are the two most common end points, and how are they defined? Consult the ECOTOX_CodeAppendix for more information.

```
#Create bar plot of Endpoint counts
ggplot(Neonics) +
  geom_bar(aes(x=Endpoint))
```



Answer: "NOEL" or No observable effect level is the most common effect, with LOEL or lowest observable effect level the 2nd most common. These are defined as: * `NOEL` - No-observable-effect-level: highest dose (concentration) producing effects not significantly different from responses of controls according to author's reported statistical test * `LOEL` - Lowest Observed Effects Residue: The lowest residue concentration producing effects that were significantly different from responses of controls according to author's reported statistical test

Explore your data (Litter)

12. Determine the class of collectDate. Is it a date? If not, change to a date and confirm the new class of the variable. Using the `unique` function, determine which dates litter was sampled in August 2018.

```
#Show class of collectData field
class(Litter$collectDate) #It's a factor, not a date!
```

```
## [1] "factor"
```

```
#Convert to a date
Litter$collectDate <- as.Date(Litter$collectDate,format='%Y-%m-%d')

#Confirm change
class(Litter$collectDate)
```

```
## [1] "Date"
```

13. Using the `unique` function, determine how many plots were sampled at Niwot Ridge. How is the information obtained from `unique` different from that obtained from `summary`?

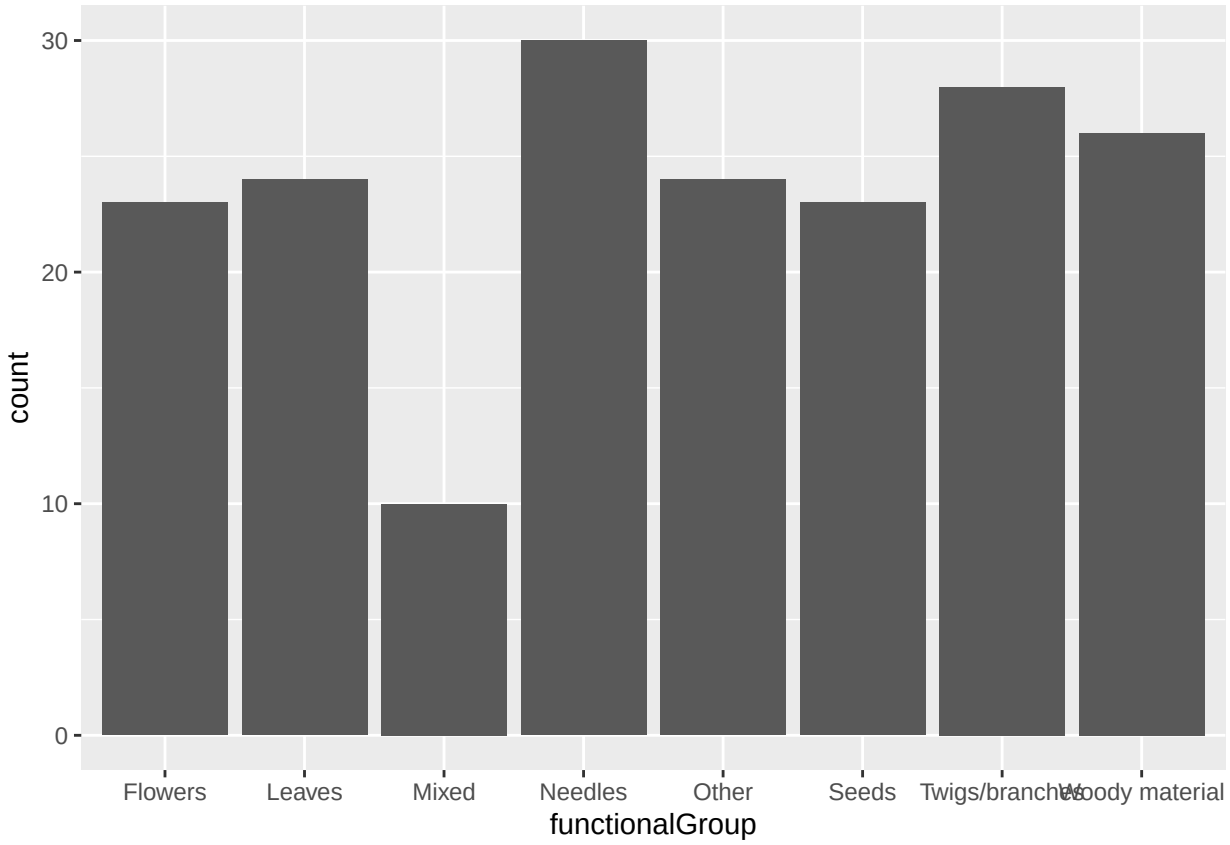
```
#List the unique dates
unique(Litter$plotID)
```

```
##  [1] NIWO_061 NIWO_064 NIWO_067 NIWO_040 NIWO_041 NIWO_063 NIWO_047 NIWO_051
##  [9] NIWO_058 NIWO_046 NIWO_062 NIWO_057
## 12 Levels: NIWO_040 NIWO_041 NIWO_046 NIWO_047 NIWO_051 NIWO_057 ... NIWO_067
```

Answer: Unique only lists the unique dates in the study. Summarize will include how many records associate with each.

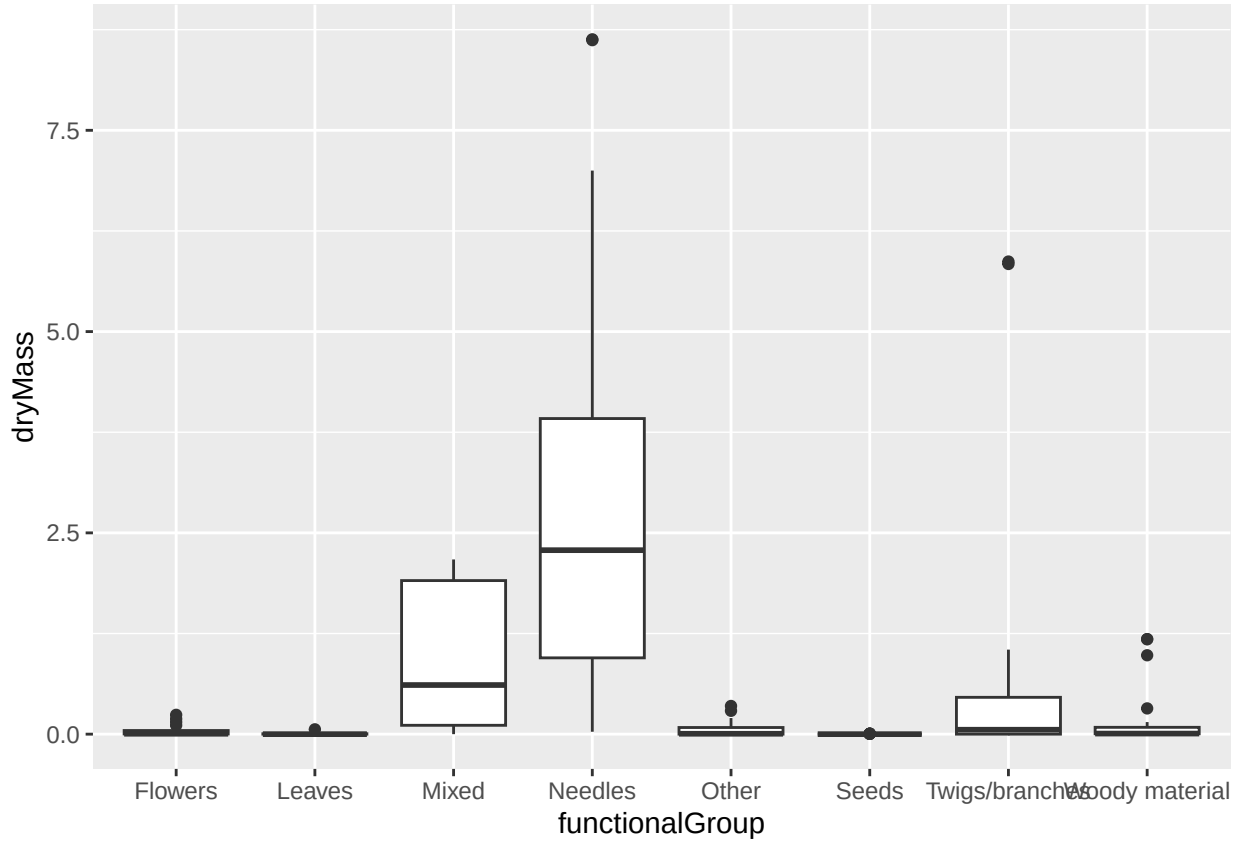
14. Create a bar graph of functionalGroup counts. This shows you what type of litter is collected at the Niwot Ridge sites. Notice that litter types are fairly equally distributed across the Niwot Ridge sites.

```
#Create bar graph of functional group counts
ggplot(Litter) +
  geom_bar(aes(x=functionalGroup))
```

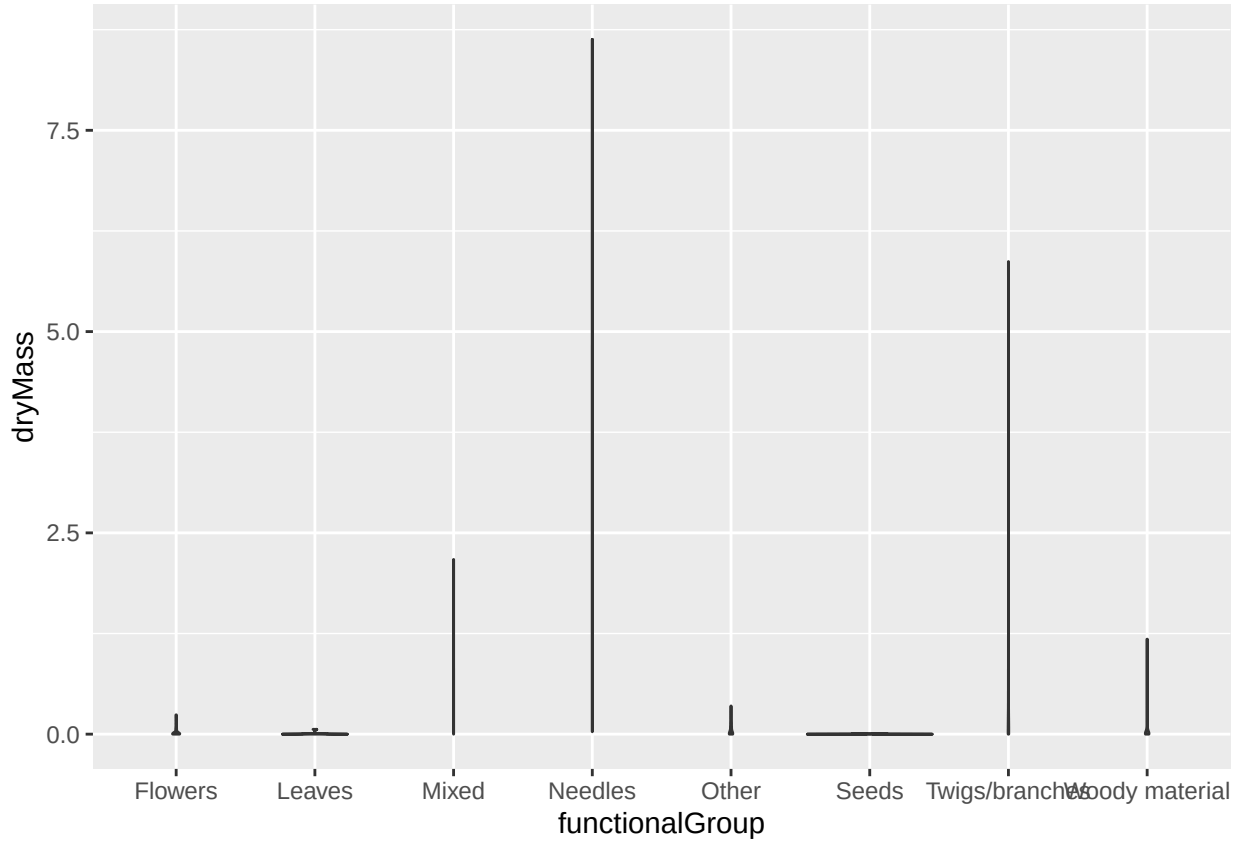


15. Using `geom_boxplot` and `geom_violin`, create a boxplot and a violin plot of dryMass by functionalGroup.

```
#Create a box plot of dry mass across functional groups
ggplot(Litter) +
  geom_boxplot(aes(y=dryMass,x=functionalGroup))
```




```
#Create a violin plot of dry mass across functional groups
ggplot(Litter) +
  geom_violin(aes(y=dryMass,x=functionalGroup))
```



Why is the boxplot a more effective visualization option than the violin plot in this case?

Answer: Not enough values across the distribution of values to reveal densities in a violin plot.

What type(s) of litter tend to have the highest biomass at these sites?

Answer: Needs has the highest biomas