Assignment 3: Data Exploration

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OVERVIEW

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

Directions

1. Change "Student Name, Section #" on line 3 (above) with your name and section number.
2. Work through the steps, **creating code and output** that fulfill each instruction.
3. Be sure to **answer the questions** in this assignment document.
4. When you have completed the assignment, **Knit** the text and code into a single PDF file.
5. After Knitting, submit the completed exercise (PDF file) to the dropbox in Sakai. Add your last name into the file name (e.g., "FirstLast_A03_DataExploration.Rmd") prior to submission.

The completed exercise is due on <>.

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 add the `stringsAsFactors = TRUE` parameter to the function when reading in the CSV files.**

```
# Check working directory
getwd()
```

```
## [1] "/Users/lydiecostes/Documents/Duke/DataAnalytics/GithubRepos/Environmental_Data_Analytics_2022/As
```

```
# Import packages
library(tidyverse)
# Read in the data
Neonics <- read.csv("../Data/Raw/ECOTOX_Neonicotinoids_Insects_raw.csv",
                    stringsAsFactors = T)
Litter <- read.csv("../Data/Raw/NEON_NIWO_Litter_massdata_2018-08_raw.csv",
                   stringsAsFactors = T)
```

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 ecotoxicologoy of neonicotinoids on insects? Feel free to do a brief internet search if you feel you need more background information.

Answer:

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: It could help inform knowledge of changes in nutrient cycling (nitrogen, carbon), biomass, and biodiversity.

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: * Plant debris samples are sorted into functional groups, such as leaves, needles, seeds, woody material, and other (lichens, mosses, unidentified). * Samples are collected in ground traps and elevated traps. * Sampling interval depends on multiple factors including vegetation type, access, and trap type, ranging from once per year to every two weeks.

Obtain basic summaries of your data (Neonics)

5. What are the dimensions of the dataset?

```
# Check data dimensions
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?

```
# summarize effects
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: The most commonly studied effects are population and mortality. Both of these variables are important to track because changes can indicate the health and success of a species.

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.

```
# Summarize species (by 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: 1. Honey Bee 2. Parasitic Wasp 3. Buff Tailed Bumblebee 4. Carniolan Honey Bee 5. Bumble Bee 6. Italian Honey Bee

Bees and wasps are important pollinators and some of these species may be endangered. Plus, species like non-native (i.e., European) honey bees have posed a threat to native bees because they outcompete them, even though they continue to be propped up by the honey industry.

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

```r
# Check class of "Conc.1..Author"
class(Neonics$Conc.1..Author.)
```

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

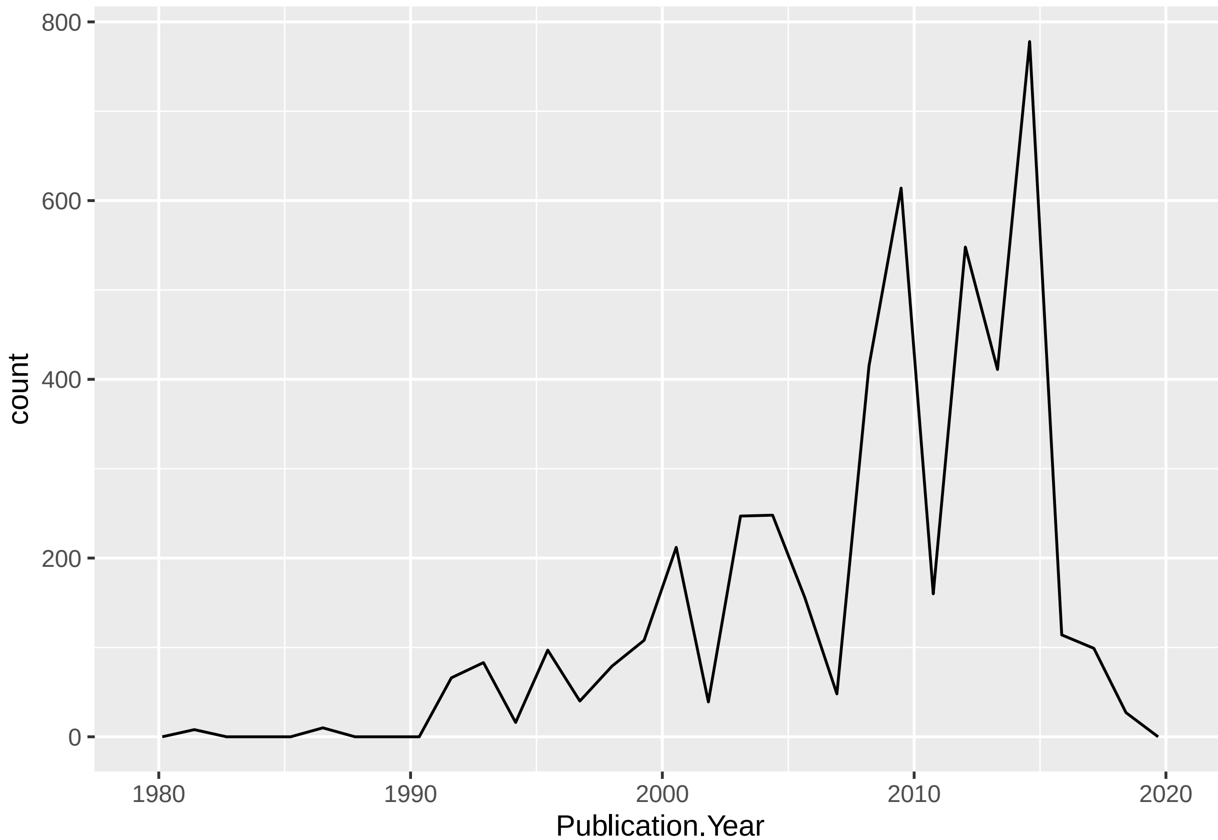
> Answer: It is a factor because some of the values are "NR" or end with a slash (e.g., "144.0/"), so R doesn't read it as numeric.

Explore your data graphically (Neonics)

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

```r
# Graph number of studies by publication year
ggplot(Neonics) +
  geom_freqpoly(aes(x=Publication.Year))
```

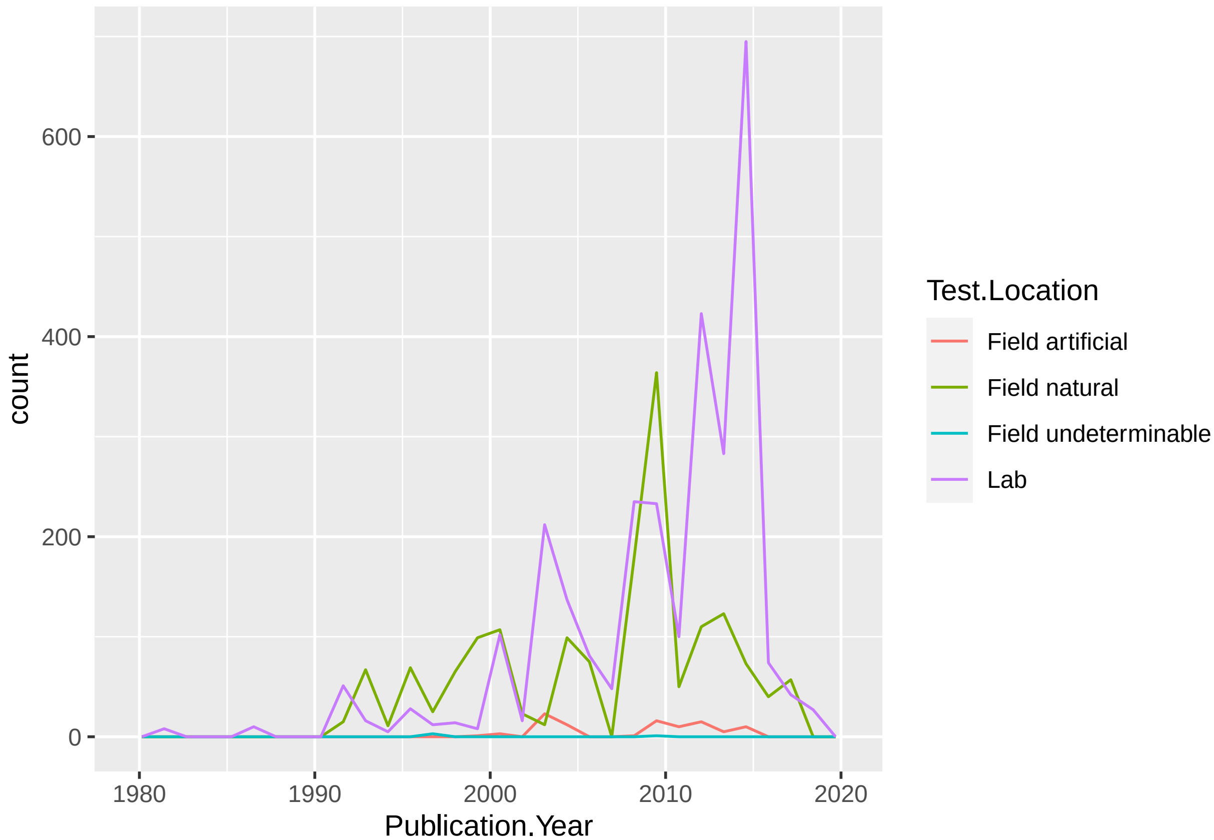
```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



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

```
# Graph  number of studies by publication year, colored by location
ggplot(Neonics) +
  geom_freqpoly(aes(x=Publication.Year, color = Test.Location))
```

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

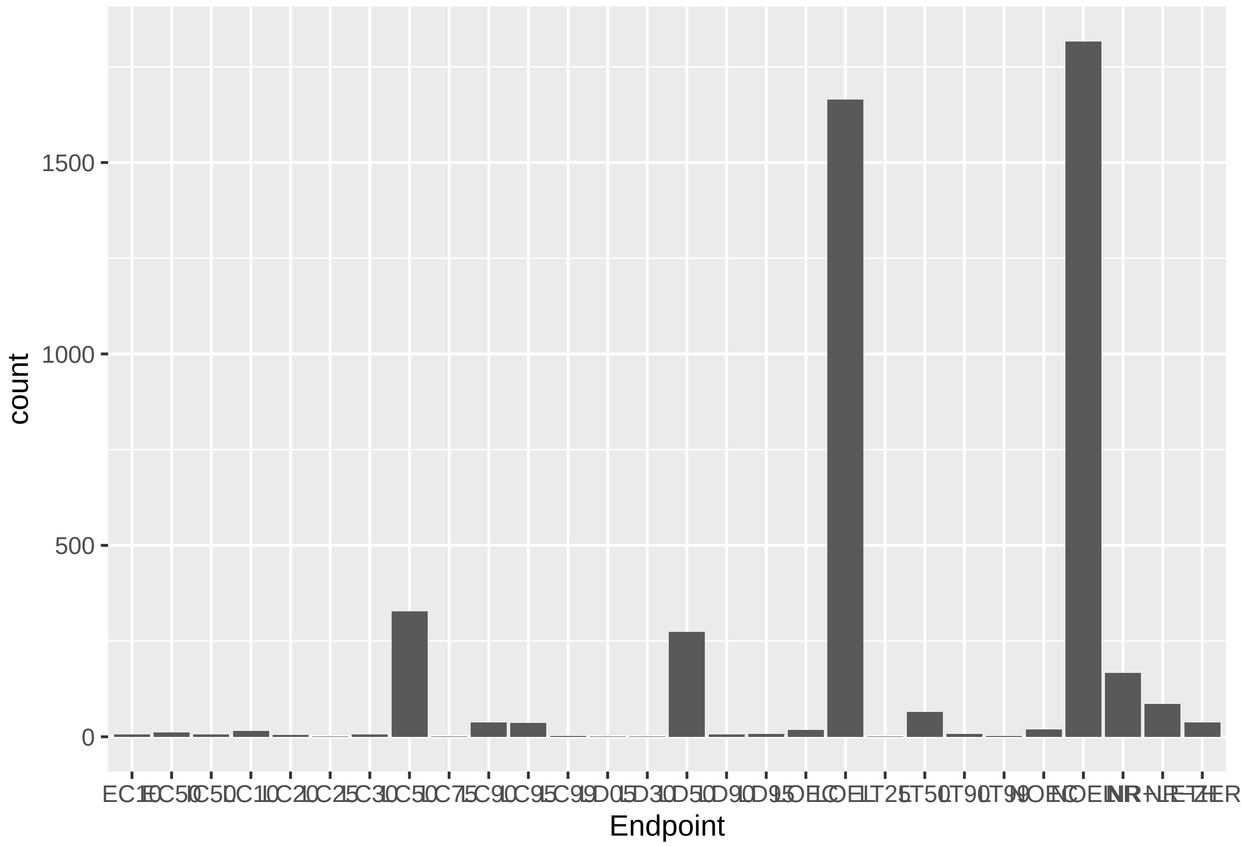


Interpret this graph. What are the most common test locations, and do they differ over time?

> Answer: The most common test locations are natural field and lab, and in the past decade, lab research has really taken over compared with other types.

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.

```
# Graph endpoint counts
ggplot(Neonics) +
  geom_bar(aes(x=Endpoint))
```



Answer: NOEL and LOEL are the two most common endpoints. NOEL: No Observable Effect Level - highest dose producing effects not significantly different from controls LOEL: Lowest Observable Effect Level - lowest dose producing effects significantly different from controls

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.

```
# Check "collectDate" class
class(Litter$collectDate)
```

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

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

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

```
# Check unique sample dates
unique(Litter$collectDate)
```

```
## [1] "2018-08-02" "2018-08-30"
```

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`?

```
# Check number of plots sampled
unique(Litter$plotID)
```

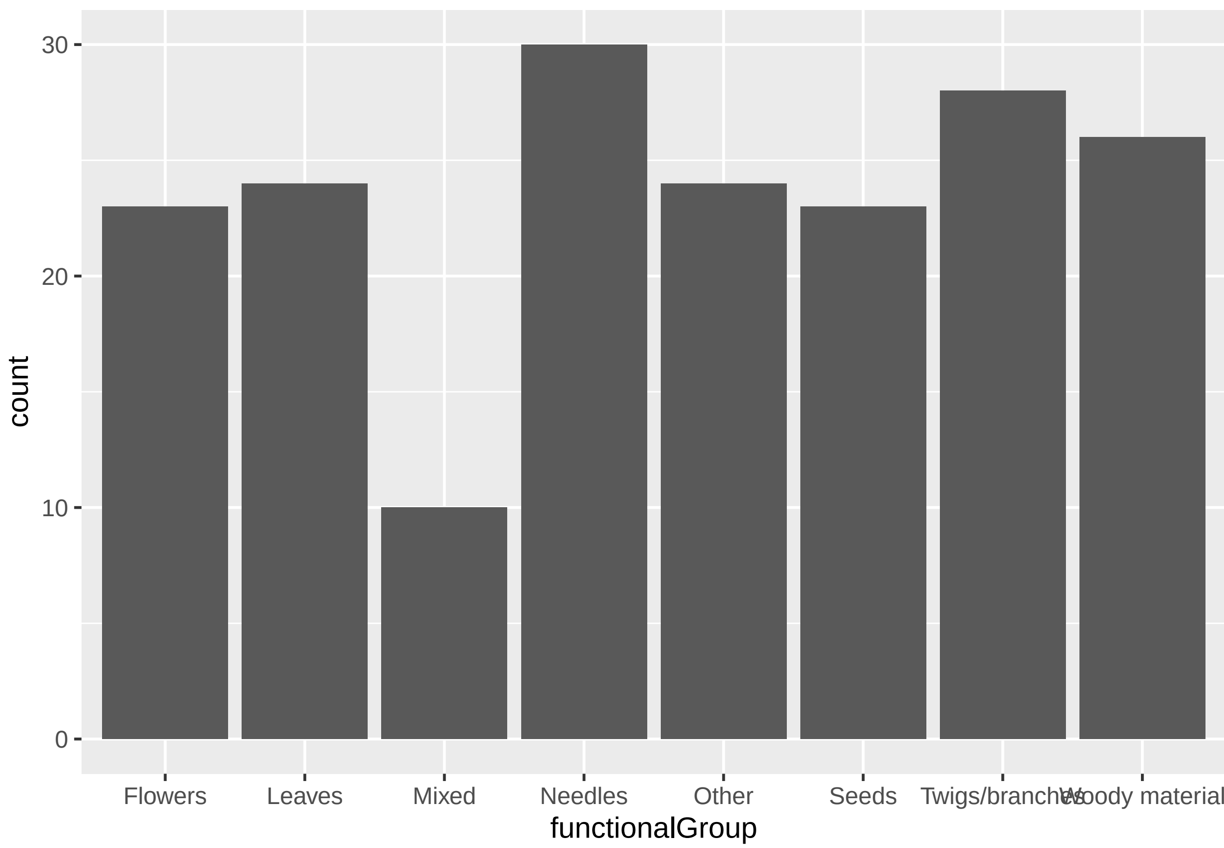
```
##  [1] NIWO_061 NIWO_064 NIWO_067 NIWO_040 NIWO_041 NIWO_063 NIWO_047 NIWO_051
##  [9] NIWO_058 NIWO_046 NIWO_062 NIWO_057
## 12 Levels: NIWO_040 NIWO_041 NIWO_046 NIWO_047 NIWO_051 NIWO_057 ... NIWO_067
```

```
# 12 plots
```

Answer:

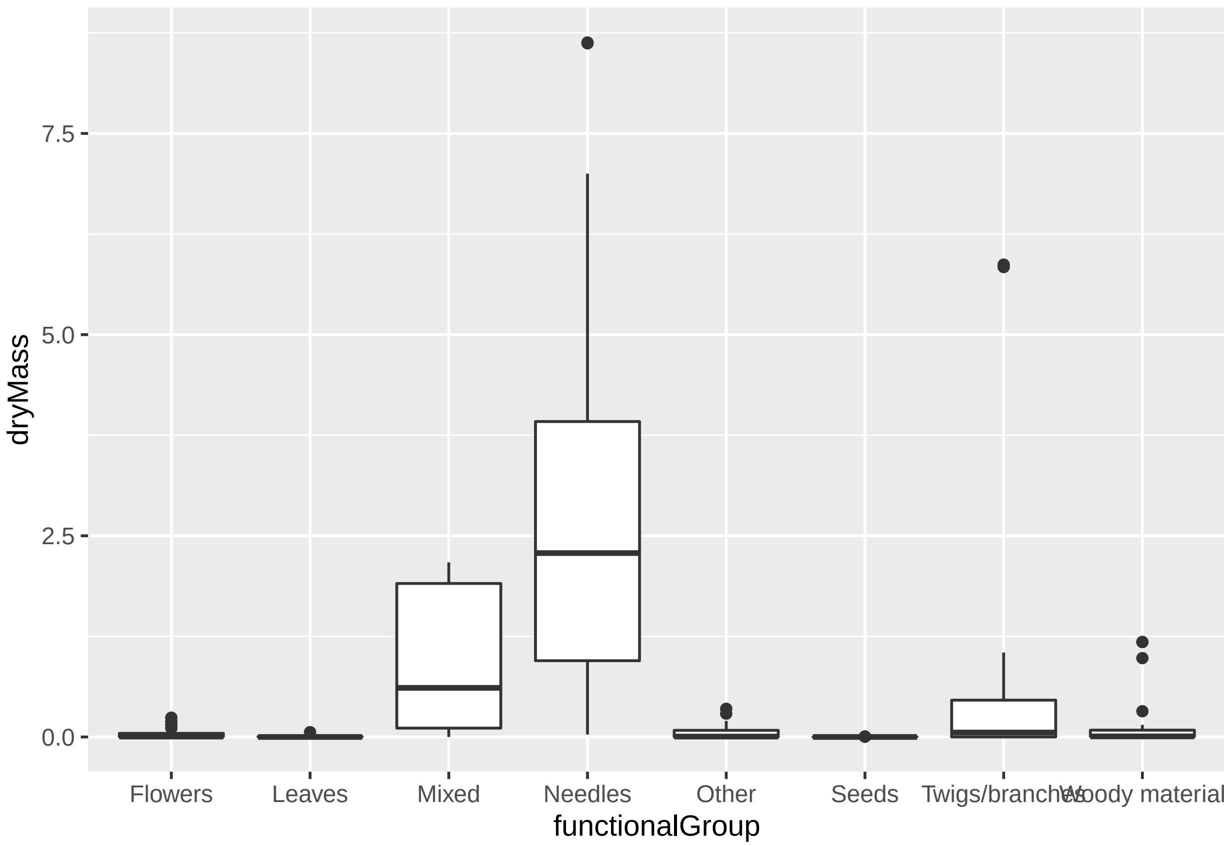
14. Create a bar graph of functionalGroup counts. This shows you what type of litter is collected at the Niwot Ridge sites. Notice that litter types are fairly equally distributed across the Niwot Ridge sites.

```
# Graph functional group counts
ggplot(Litter) +
  geom_bar(aes(x=functionalGroup))
```

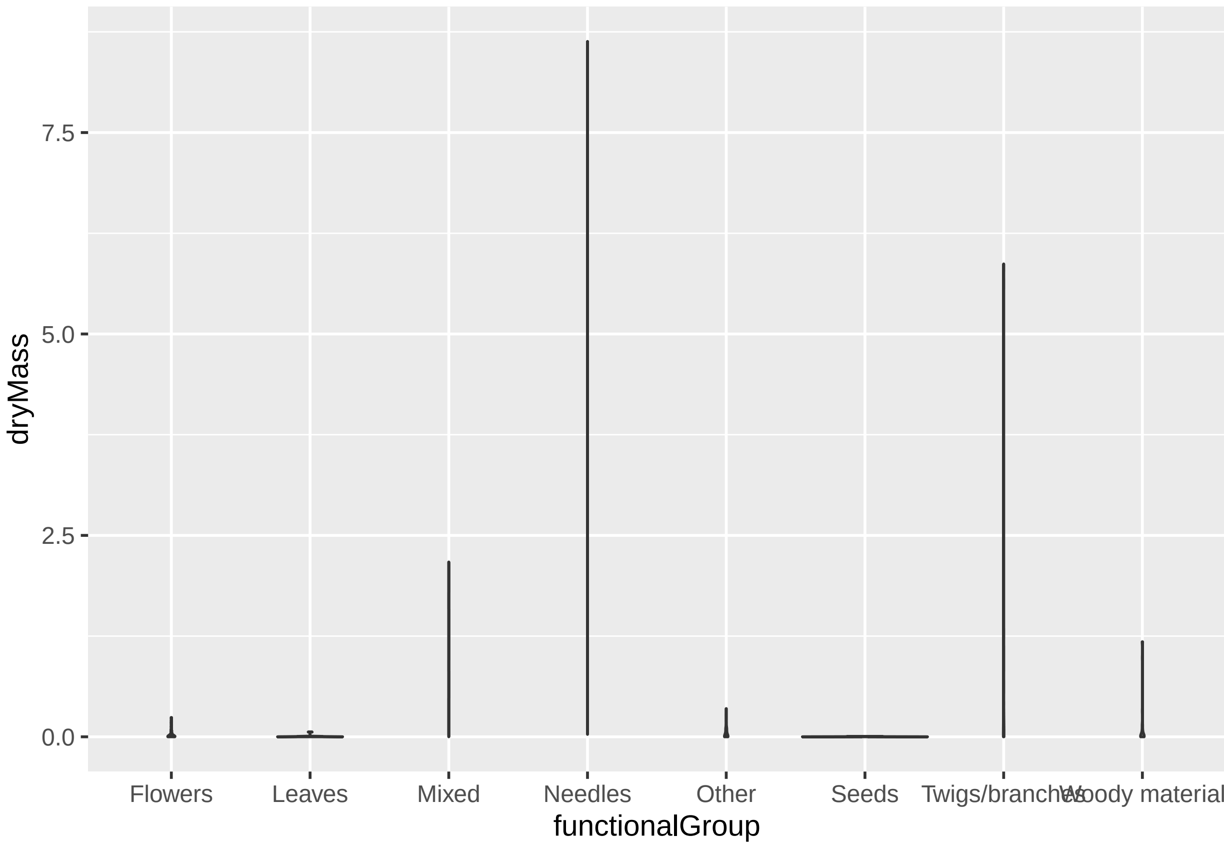


15. Using `geom_boxplot` and `geom_violin`, create a boxplot and a violin plot of dryMass by functionalGroup.

```r
# Graph dry mass by functional group (boxplot)
ggplot(Litter) +
  geom_boxplot(aes(x=functionalGroup, y=dryMass))
```




```r
# Graph dry mass by functional group (violin)
ggplot(Litter) +
  geom_violin(aes(x=functionalGroup, y=dryMass))
```



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

> Answer: The boxplot more effectively shows the spread and density of each distribution. In this case, the violin's shape is flattened into 2 dimensions, making it very difficult to interpret or compare. I'm not sure why this occurred, beyond that perhaps eight groups was too many for the violin visualization to display properly.

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

> Answer: Needles tend to have the highest amount of biomass, with "mixed" as a second. There appear to be a couple outliers with high amounts of trigs/branches.