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.**

```
getwd()
```

```
## [1] "C:/Users/nicho/OneDrive/Documents/ENV872/Environmental_Data_Analytics_2022"
```

```
library(tidyverse)
Neonics <- read.csv("./Data/Raw/ECOTOX_Neonicotinoids_Insects_raw.csv", stringsAsFactors = TRUE)
Litter <- read.csv("./Data/Raw/NEON_NIWO_Litter_massdata_2018-08_raw.csv", stringsAsFactors = TRUE)
```

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: Neonicotinoids are not only affecting targeted pest insects, but also nontarget organisms such as pollinators, thus posing a threat to biodiversity and the food web.

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: To determine organic matter decomposition rates and evaluate the health/productivity of forests.

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: *Ground traps are sampled once per year. Target sampling frequency for elevated traps varies by vegetation present at the site, with frequent sampling (1x every 2weeks) in deciduous forest sites during senescence, and infrequent year-round sampling (1x every 1-2 months) at evergreen sites.* The finest resolution at which spatial data are reported is a single trap *Mass data for each collection event are measured separately for the following functional groups, to an accuracy of 0.01 grams. (8 functional groups total: leaves, needles, twigs/branches, woody material, seeds, flowers, other, mixed)

Obtain basic summaries of your data (Neonics)

5. What are the dimensions of the 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?

```
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 and mortality are the most common effects. These effects might be of interest because they represent population changes of organisms exposed to Neonics.

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.

```
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: Honey Bee, Parasitic Wasp, Buff Tailed Bumblebee, Carniolan Honey Bee, Bumble Bee, Italian Honeybee. These species are pollinators. If they are negatively impacted by Neonics, there will be a systemic detrimental effect on ecosystems.

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

```
class(Neonics$Conc.1..Author.)
```

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

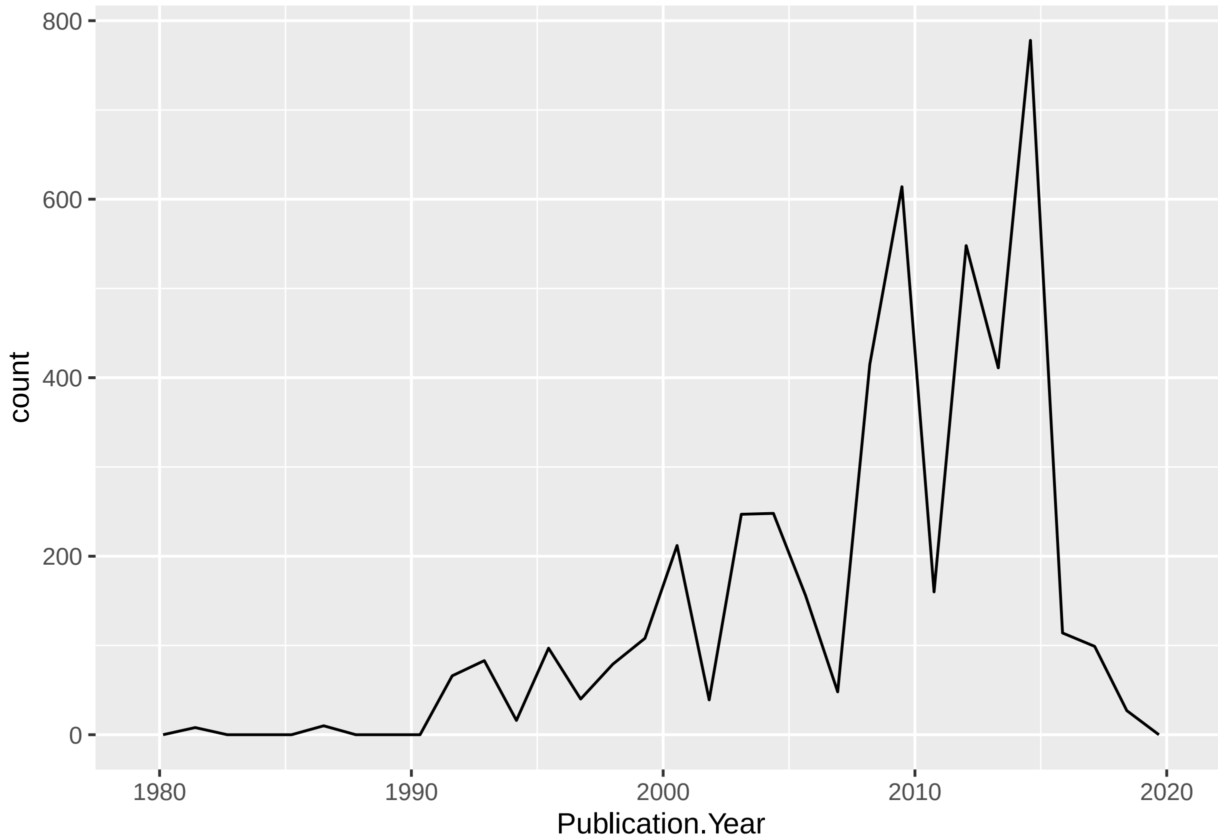
Answer: The Conc.1..Author column has other characters, such as backslashes, tildas, and "NR", that are not integers, causing the column to be read as a Factor.

Explore your data graphically (Neonics)

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

```r
library(ggplot2)
ggplot(Neonics, aes(x = Publication.Year))+
  geom_freqpoly()
```

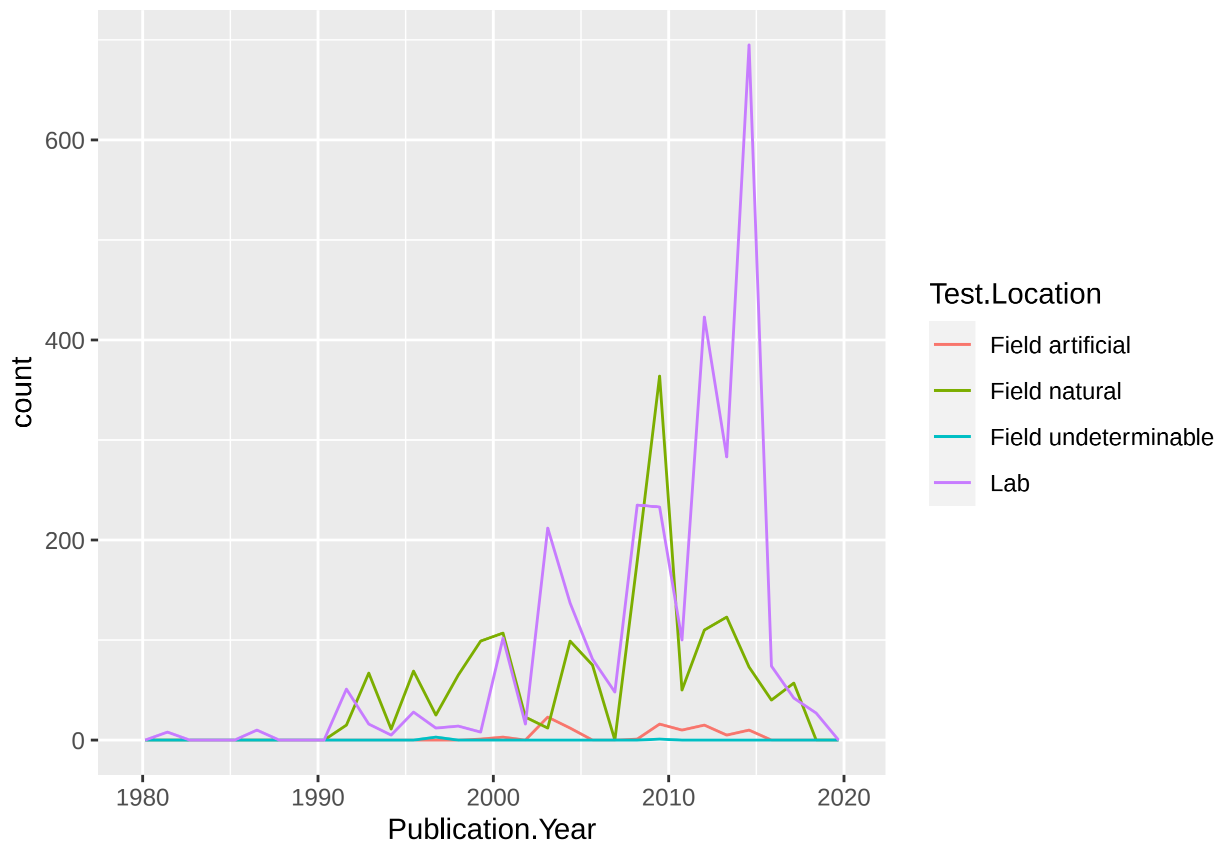
```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



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

```r
ggplot(Neonics, aes(x = Publication.Year, color = Test.Location))+
  geom_freqpoly()
```

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

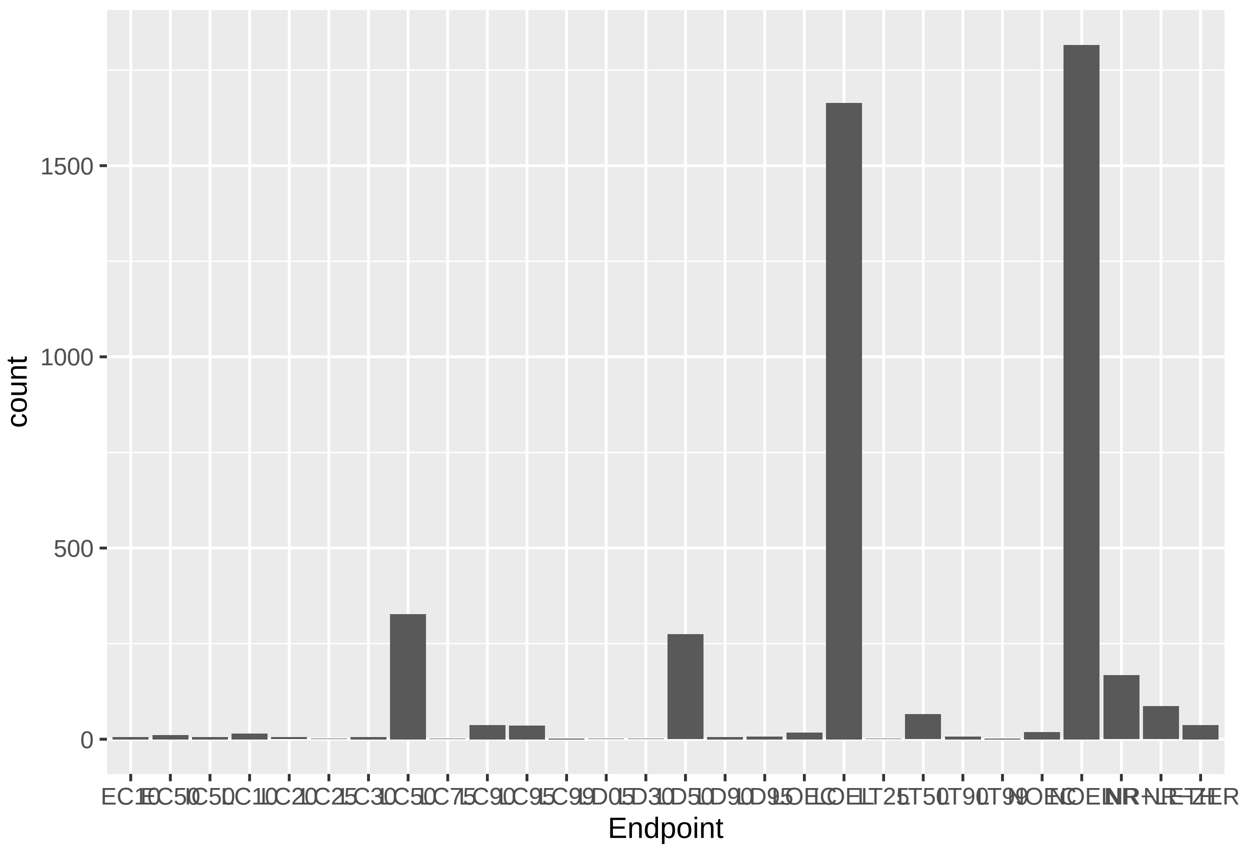


Interpret this graph. What are the most common test locations, and do they differ over time?

> Answer: Lab and field natural are the most common locations. In the 1990's, field natural was the most common test locations. However, after that the lab became the most common location, particularly in the 2010's.

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.

```
ggplot(Neonics, aes(x = Endpoint))+
  geom_bar()
```



Answer: NOEL & LOEL. NOEL indicates that there was no observable effect level, meaning the highest concentration producing effects were not significantly different than the control responses. LOEL stands for lowest observable effect level, indicating the lowest concentration producing effects that were significantly different than control responses.

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.

```
class(Litter$collectDate)
```

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

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

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

```
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`?

```
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
```

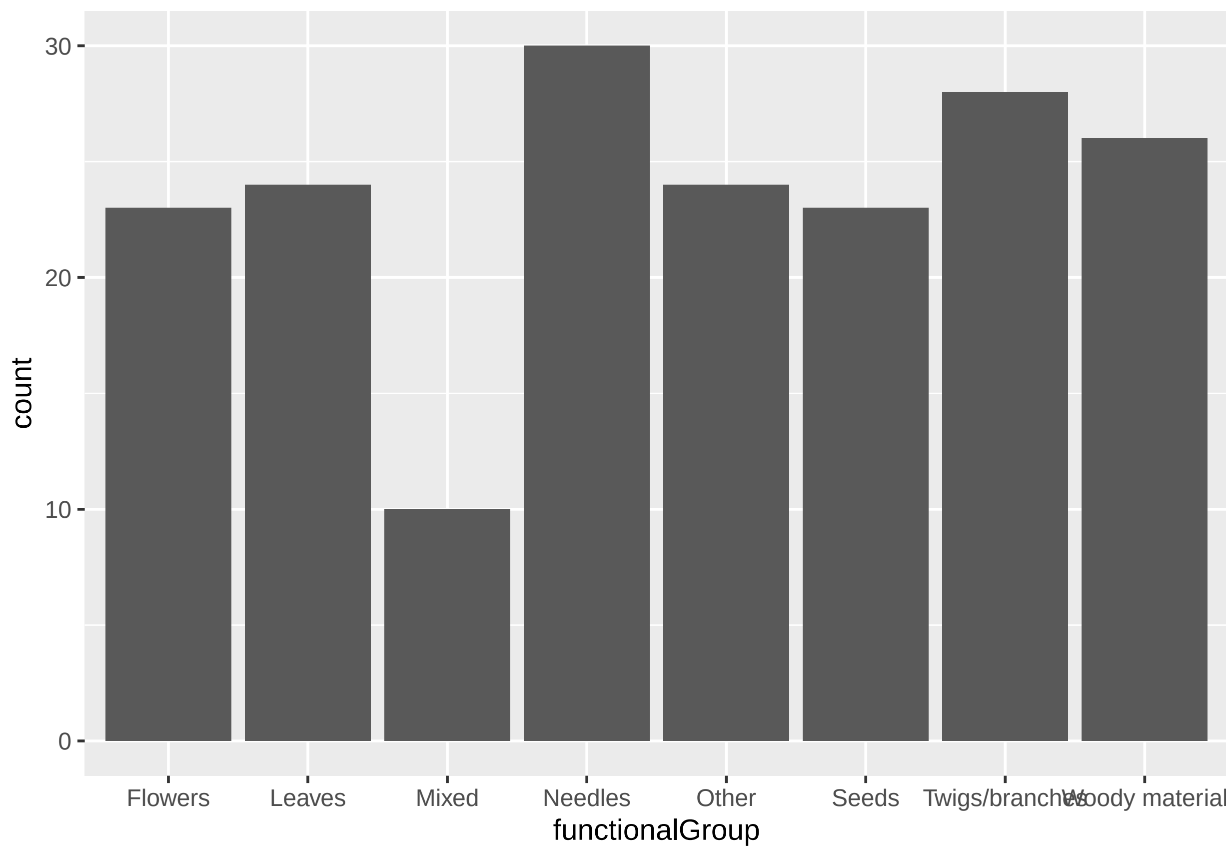
```
summary(Litter$plotID)
```

```
## NIWO_040 NIWO_041 NIWO_046 NIWO_047 NIWO_051 NIWO_057 NIWO_058 NIWO_061
##       20       19       18       15       14        8       16       17
## NIWO_062 NIWO_063 NIWO_064 NIWO_067
##       14       14       16       17
```

Answer: The unique function just shows that there are 12 different plots sampled. The summary function shows how many times each plot was sampled.

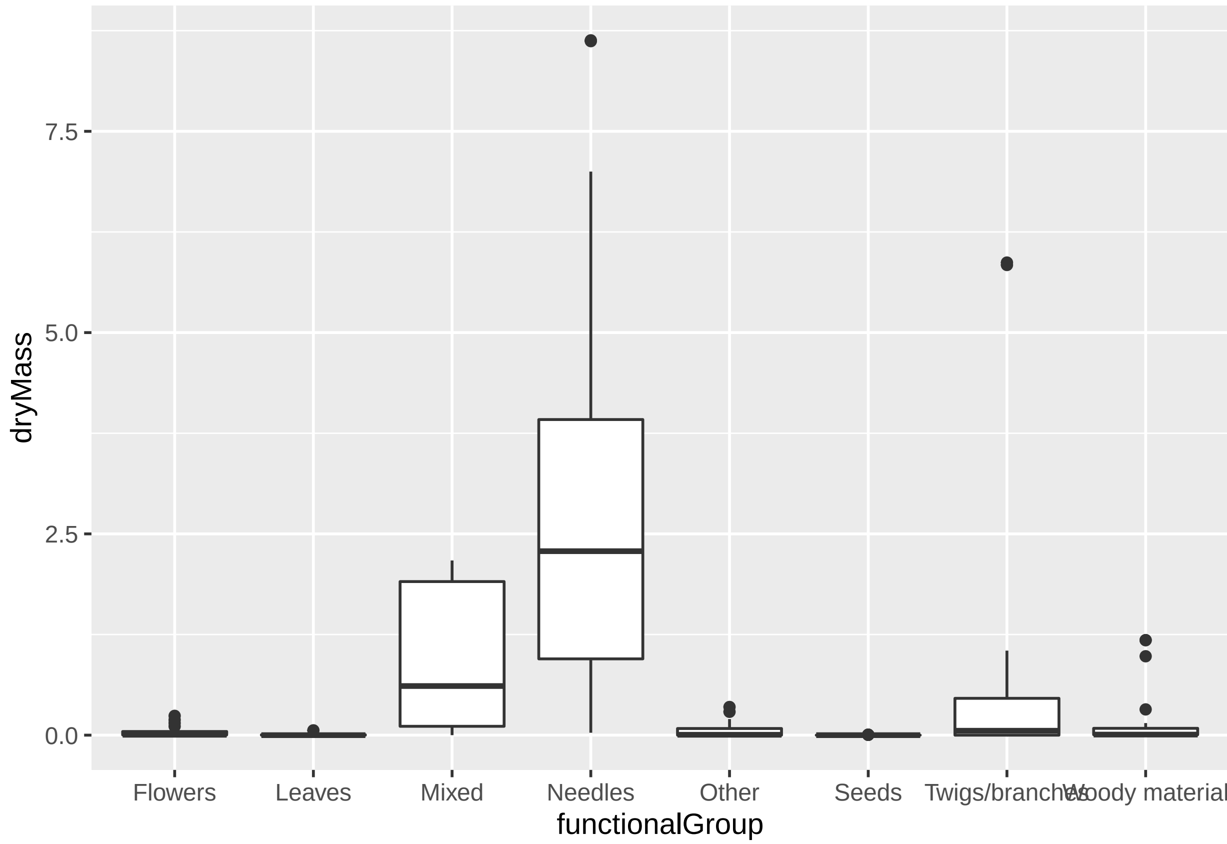
14. Create a bar graph of functionalGroup counts. This shows you what type of litter is collected at the Niwot Ridge sites. Notice that litter types are fairly equally distributed across the Niwot Ridge sites.

```
ggplot(Litter, aes(x=functionalGroup))+
  geom_bar()
```

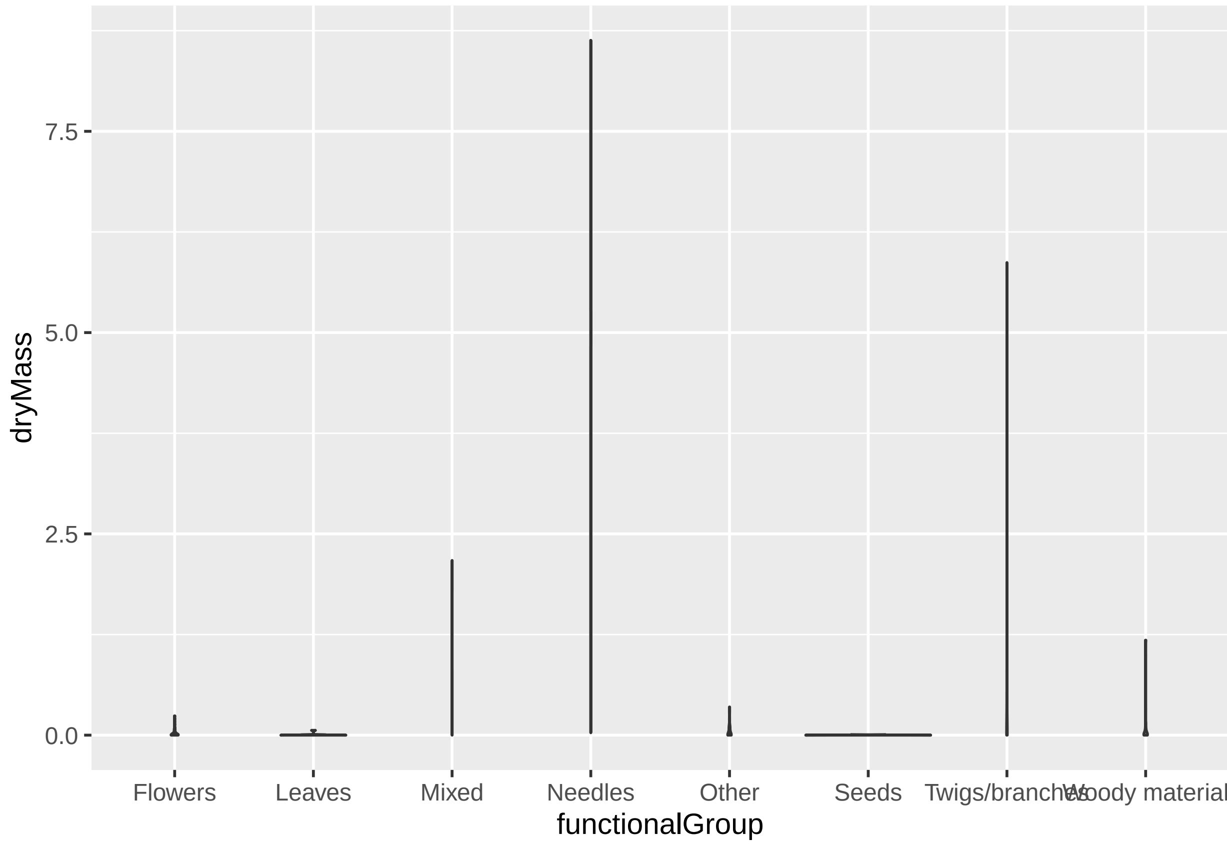


15. Using `geom_boxplot` and `geom_violin`, create a boxplot and a violin plot of dryMass by functionalGroup.

```
ggplot(Litter, aes(x = functionalGroup, y = dryMass))+
  geom_boxplot()
```




```
ggplot(Litter, aes(x = functionalGroup, y = dryMass))+
  geom_violin()
```



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

> Answer: The violin plot expands horizontally based on the distribution of points within a range. However, since certain functional groups have highly concentrated dry mass levels and others have a wide range of dry mass levels that are not concentrated around any given level, these functional groups present as either flat horizontal or vertical lines. In this case, the boxplot presents a clean view of the summary statistics since it is not factoring in the density of the points.

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

> Answer: Needles and mixed litter tend to have the highest biomass