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/wally/OneDrive/Documents/Environmental Data Anaytics/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: Because of uninteded insects also being killed by the insecticide, namely bees

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: Because of increased wildfire risk due to fire suppression. leaf litter is the main fuell source for wildfires

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: They are sampled using ground and elevated traps that collect all litter falling from the canopy. The collection nets were disepersed randomly across the forest that they were sampling. The mass for various litter classes were recorded to a precision of .01g. *

Obtain basic summaries of your data (Neonics)

5. What are the dimensions of the dataset?

```
dim(Neonics) #the dimentions are 4623 rows by 30 columns
```

```
## [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: The most common effect studied are population and mortality, followed by feeding behavior and reproduction. These are likely studied because the knowing the effects of an insecticide on the behavior and mortality for different species, including the target species and incidental species is imporatnt.

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: The six most common species are "Honey Bee, Parasitic Wasp, Buff Tailed Bumblebee, Carniolan Honey Bee, Bumble Bee, and Italian Honeybee". They are likely the interest of the study due to declining honeybee populations, and the widespread use of pesticides impacting honeybee populations.

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"
```

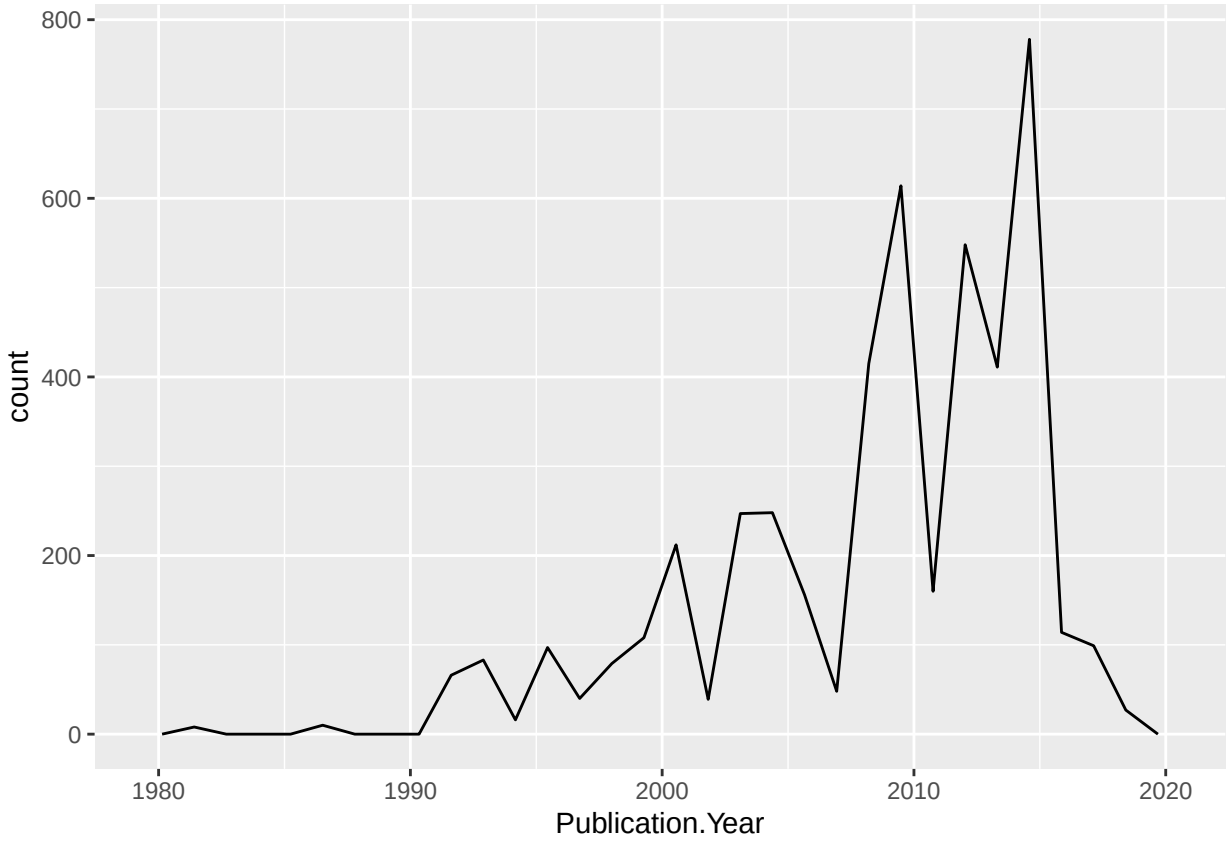
Answer: It is a factor. This is because we defined strings as factors to be true.

Explore your data graphically (Neonics)

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

```
ggplot(Neonics)+
  geom_freqpoly(aes(x = Publication.Year))
```

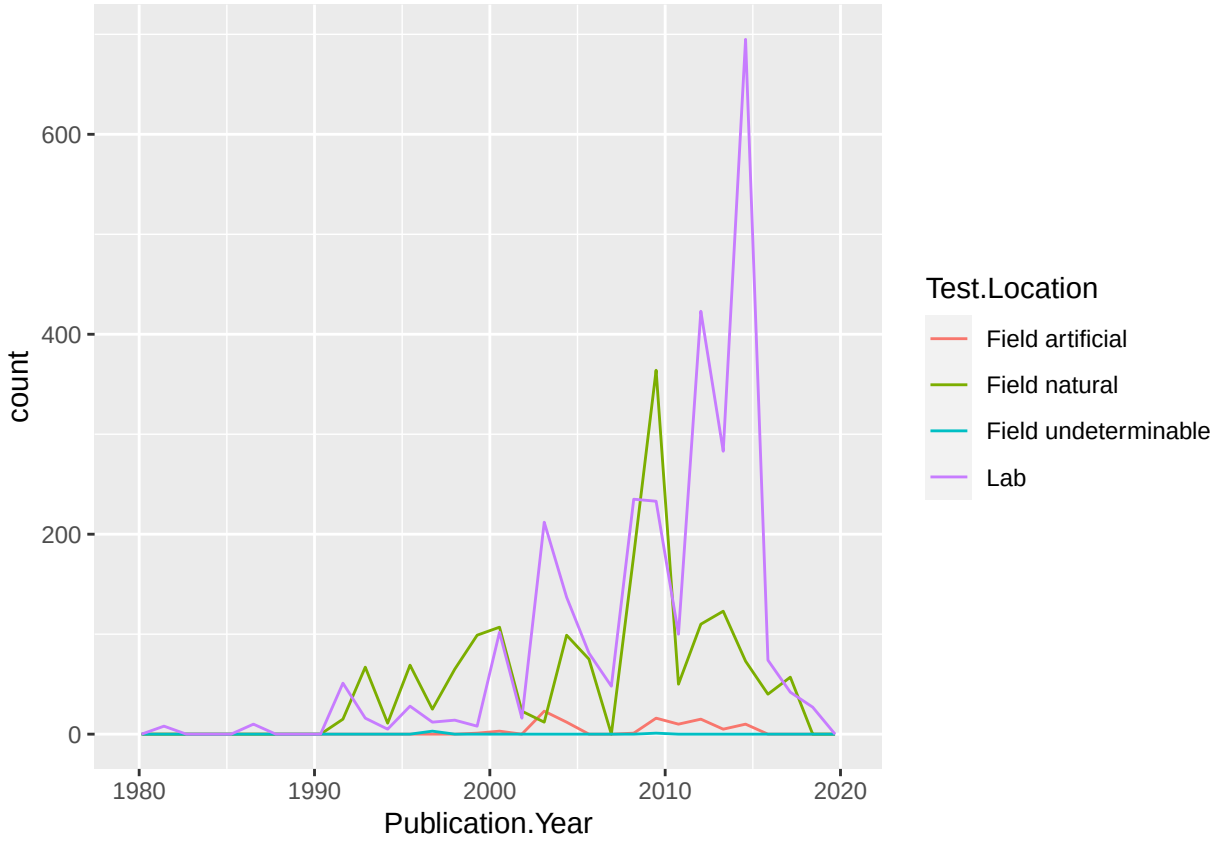
```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



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

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

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

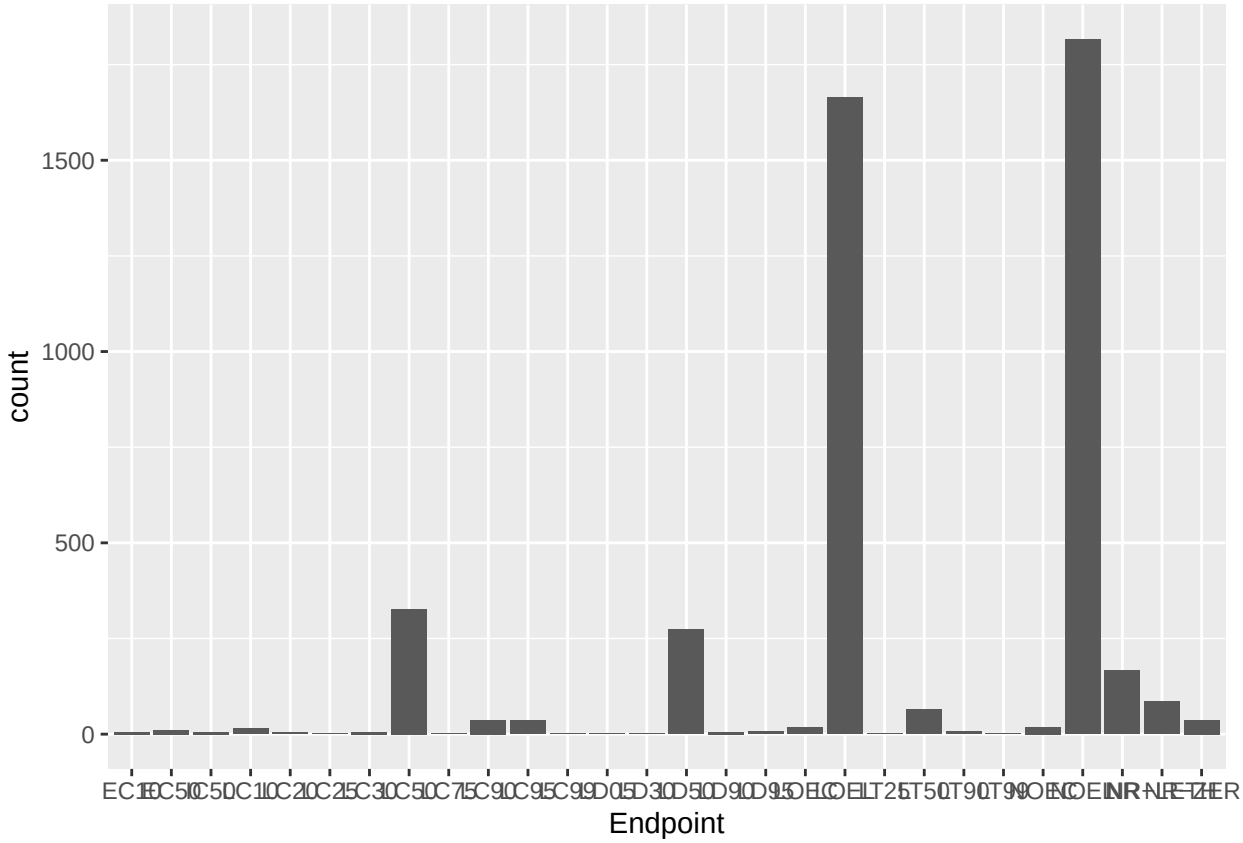


Interpret this graph. What are the most common test locations, and do they differ over time?

Answer: From 1990-2000, most studies were completed in a natural field setting. Since 2000, lab studies have become increasingly common and now are by far the most dominant setting.

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)+
  geom_bar(aes(x = Endpoint))
```



Answer: LOEL and NOEL are by far the most common endpoints. NOEL stands for No-observable-effect-level, which means the highest dose had no difference from the control group. LOEL stands for Lowest-observable-effect-level, where the lowest dose has a noticable difference from the 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.

```
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)
```

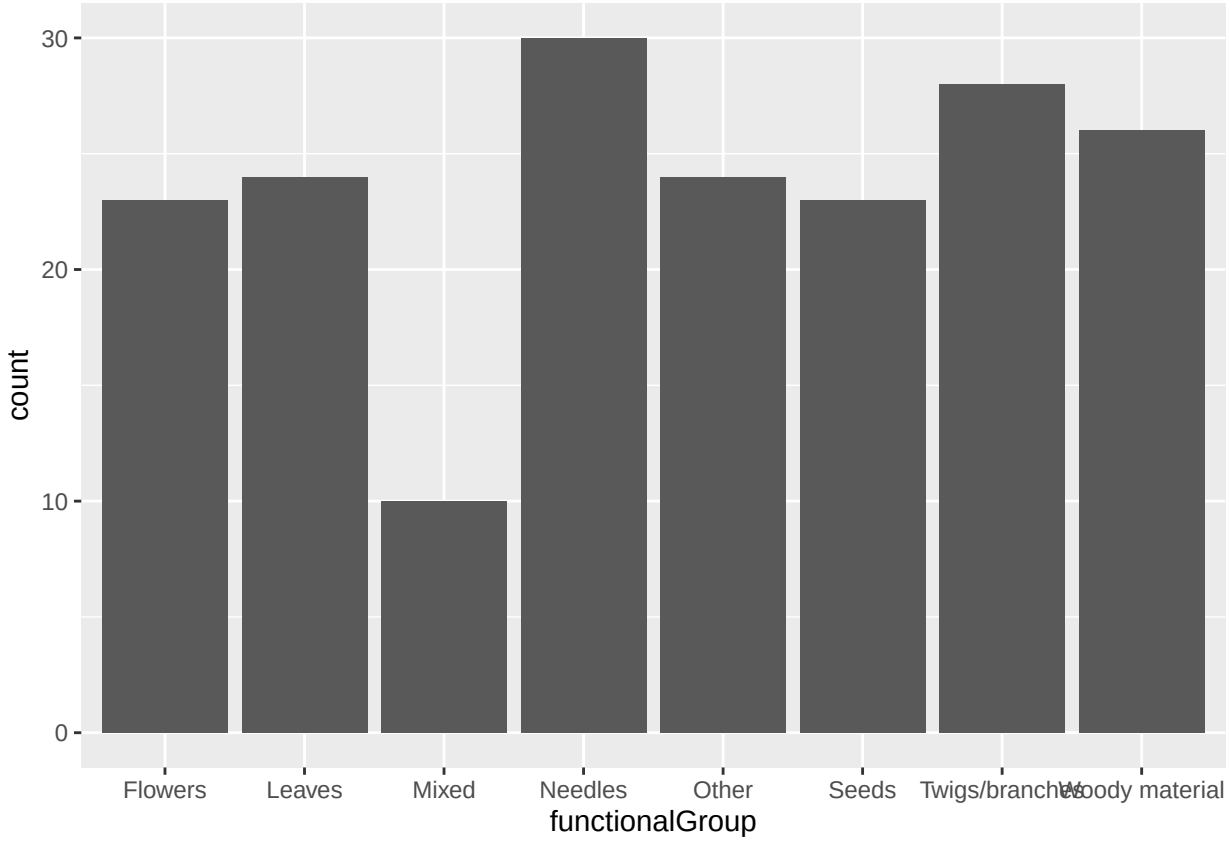
```
##  [1] NIWO_061 NIWO_064 NIWO_067 NIWO_040 NIWO_041 NIWO_063 NIWO_047 NIWO_051
##  [9] NIWO_058 NIWO_046 NIWO_062 NIWO_057
```

```
## 12 Levels: NIWO_040 NIWO_041 NIWO_046 NIWO_047 NIWO_051 NIWO_057 ... NIWO_067
```

Answer: There were 12 sites at Niwot Ridge that were sampled. The unique function lists out the names of the plotIDs. The summary function will report how many samples were actually taken at each of the plotIDs

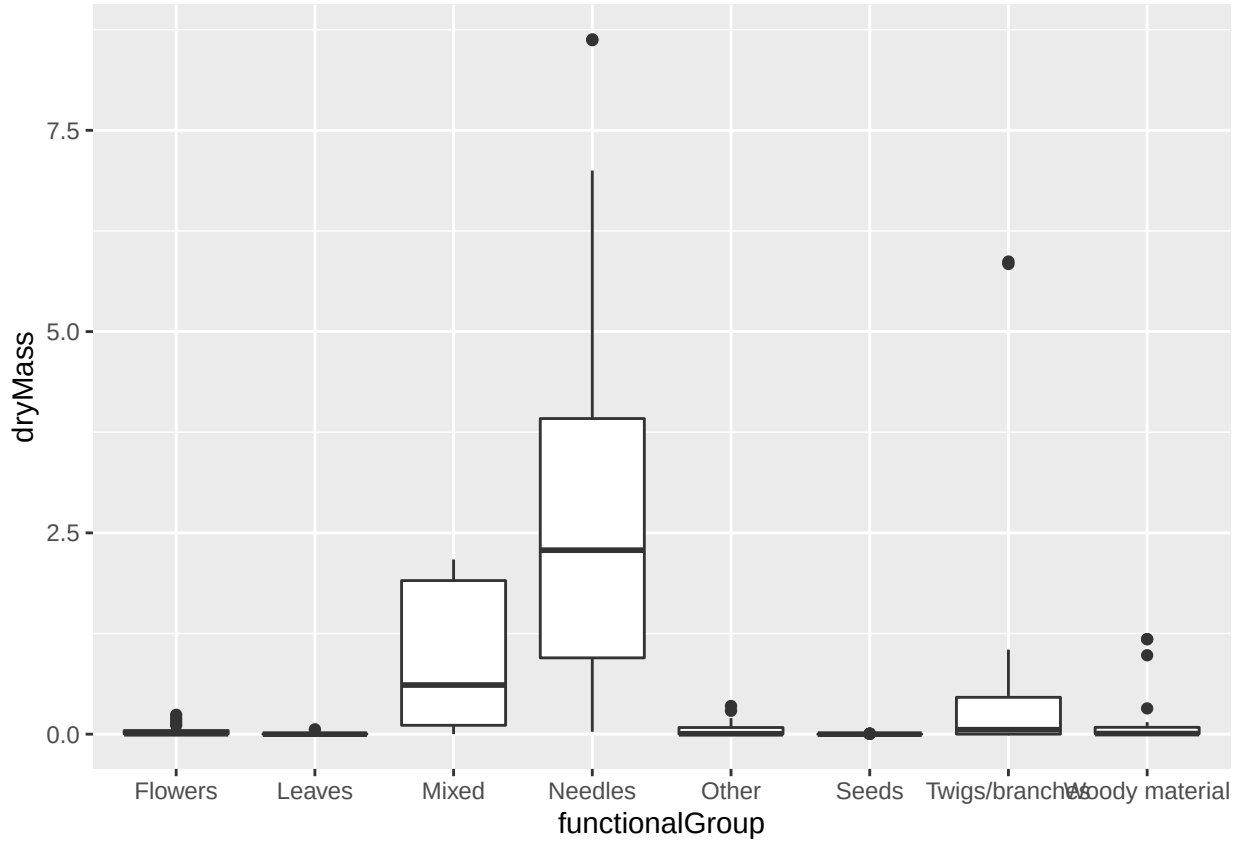
14. Create a bar graph of functionalGroup counts. This shows you what type of litter is collected at the Niwot Ridge sites. Notice that litter types are fairly equally distributed across the Niwot Ridge sites.

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

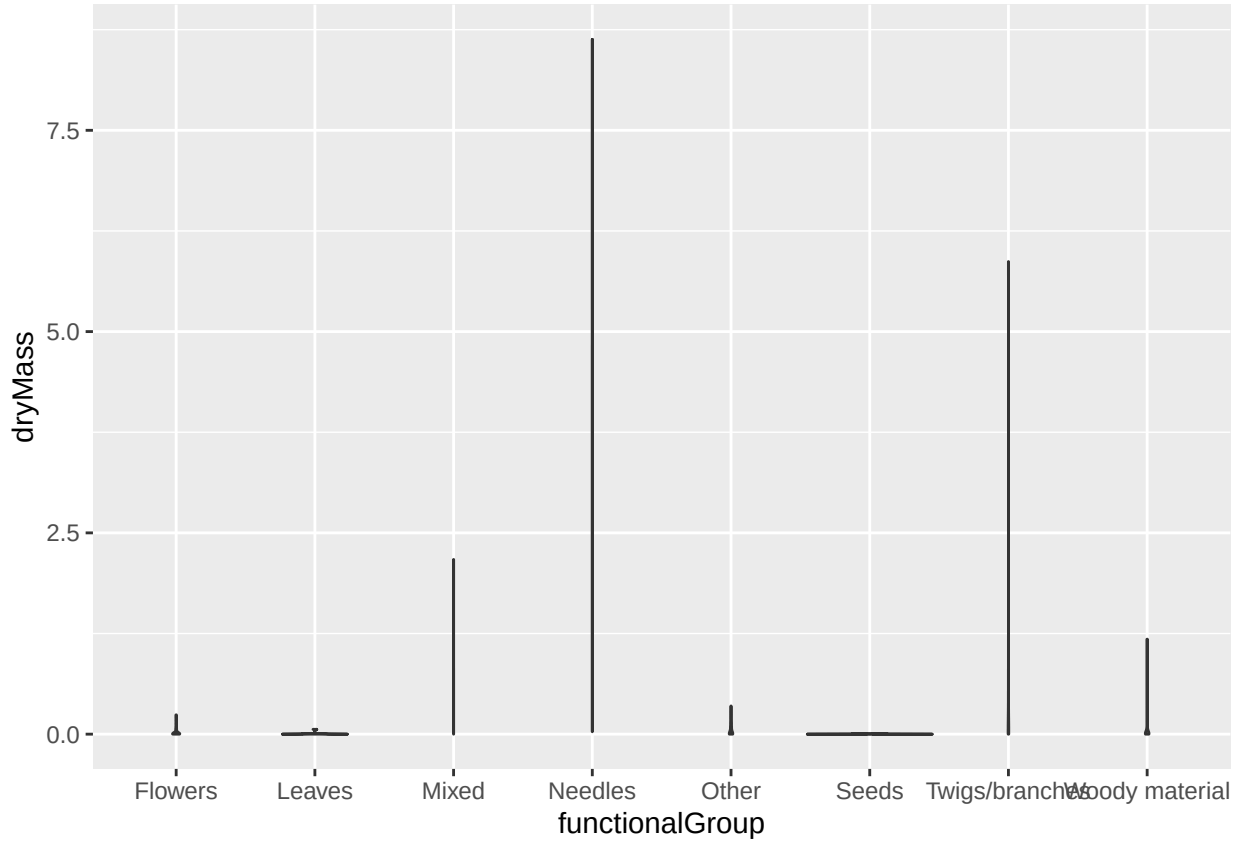


15. Using `geom_boxplot` and `geom_violin`, create a boxplot and a violin plot of dryMass by functionalGroup.

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




```
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: Because of the low number of samples, the violin plots are extremely thin, and do not show how the data is distributed. The box plot does a better job of showing the shape of the data distribution

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

> Answer: Needles and Twigs/Brances have the highest average values for biomass.