Assignment 3: Data Exploration

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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. Assign a useful **name to each code chunk** and include ample **comments** with your code.
5. Be sure to **answer the questions** in this assignment document.
6. When you have completed the assignment, **Knit** the text and code into a single PDF file.
7. After Knitting, submit the completed exercise (PDF file) to the dropbox in Sakai.

TIP: If your code extends past the page when knit, tidy your code by manually inserting line breaks.

TIP: If your code fails to knit, check that no `install.packages()` or `View()` commands exist in your code.

Set up your R session

1. Check your working directory, load necessary packages (tidyverse, lubridate), 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.

```
library(tidyverse)
library(lubridate)
library(dplyr)
library(ggplot2)
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 ecotoxicology of neonicotinoids on insects? Feel free to do a brief internet search if you feel you need more background information.

   Answer: To understand the ecotoxicology of neonicotinoids on insects, it will help us to assess how effective this inseticide will be when applying to agricultural soils. Also, we could know dose of this insecticide needed to kill insects.

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: Litter and woody deris are important to forest ecosystems because they provide essential nutrients to soils and play roles in nutrient cycling.

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. Litter and fine woody debris are collected from elevated and ground traps, respectively; 2) Litter and fine woody debris sampling is executed at terrestrial NEON sites that contain woody vegetation >2m tall; 3) Ground traps are sampled once per year. Target sampling frequency for elevated traps varies by vegetation on 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.

Obtain basic summaries of your data (Neonics)

5. What are the dimensions of the dataset?

```
nrow(Neonics)
```

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

```
ncol(Neonics)
```

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

```
dim(Neonics)
```

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

```
length(Neonics)
```

```
## [1] 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 is Population. The studies on effects may help us understand the mechanism and the exposure risk of this insectide.

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.[TIP: The `sort()` command can sort the output of the summary command...]

```
sort(summary(Neonics$Species.Common.Name))
```

```
##                          Ant Family                         Apple Maggot
##                                   9                                    9
##              Glasshouse Potato Wasp                             Lacewing
##                                  10                                   10
##             Southern House Mosquito             Two Spotted Lady Beetle
##                                  10                                   10
##           Spotless Ladybird Beetle                 Braconid Parasitoid
##                                  11                                   12
##                        Common Thrip        Eastern Subterranean Termite
##                                  12                                   12
##                              Jassid                           Mite Order
##                                  12                                   12
##                           Pea Aphid                   Pond Wolf Spider
##                                  12                                   12
##               Armoured Scale Family                   Diamondback Moth
##                                  13                                   13
##                       Eulophid Wasp                   Monarch Butterfly
##                                  13                                   13
##                       Predatory Bug                Yellow Fever Mosquito
##                                  13                                   13
##                        Corn Earworm                   Green Peach Aphid
```

```
##                              14                                14
##                       House Fly                          Ox Beetle
##                              14                                14
##                 Red Scale Parasite                 Spined Soldier Bug
##                              14                                14
##             Western Flower Thrips Hemlock Woolly Adelgid Lady Beetle
##                              15                                16
##             Hemlock Wooly Adelgid                              Mite
##                              16                                16
##                      Onion Thrip              Araneoid Spider Order
##                              16                                17
##                        Bee Order                    Egg Parasitoid
##                              17                                17
##                     Insect Class           Moth And Butterfly Order
##                              17                                17
##       Oystershell Scale Parasitoid          Black-spotted Lady Beetle
##                              17                                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
##                     Codling Moth         Flatheaded Appletree Borer
##                              19                                20
##               Horned Oak Gall Wasp                Leaf Beetle Family
##                              20                                20
##                  Potato Leafhopper         Tooth-necked Fungus Beetle
##                              20                                20
##                     Argentine Ant                            Beetle
##                              21                                21
##                        Mason Bee                          Mosquito
##                              22                                22
##                  Citrus Leafminer                   Ladybird Beetle
##                              23                                23
##                 Spider/Mite Class                Tobacco Flea Beetle
##                              24                                24
##                      Chalcid Wasp             Convergent Lady Beetle
##                              25                                25
##                     Stingless Bee               Ground Beetle Family
##                              25                                27
##                 Rove Beetle Family                     Tobacco Aphid
##                              27                                27
##                     Scarab Beetle                     Spring Tiphia
##                              29                                29
##                       Thrip Order             Ladybird Beetle Family
##                              29                                30
##                        Parasitoid                     Braconid Wasp
##                              30                                33
##                      Cotton Aphid                    Predatory Mite
##                              33                                33
##                Sweetpotato Whitefly                      Aphid Family
```

```
##                              37                              38
##                  Cabbage Looper            Buff-tailed Bumblebee
##                              38                              39
##                  True Bug Order         Sevenspotted Lady Beetle
##                              45                              46
##                    Beetle Order      Snout Beetle Family, Weevil
##                              47                              47
##               Erythrina Gall Wasp                 Parasitoid Wasp
##                              49                              51
##            Colorado Potato Beetle                   Parastic Wasp
##                              57                              58
##              Asian Citrus Psyllid               Minute Pirate Bug
##                              60                              62
##                European Dark Bee                        Wireworm
##                              66                              69
##                   Euonymus Scale               Asian Lady Beetle
##                              75                              76
##                  Japanese Beetle                Italian Honeybee
##                              94                             113
##                       Bumble Bee              Carniolan Honey Bee
##                             140                             152
##             Buff Tailed Bumblebee                  Parasitic Wasp
##                             183                             285
##                       Honey Bee                         (Other)
##                             667                             670
```

Answer: They most six commonly studied species are honey bee, parasitic wasp, buff tailed bumblebee, Carniolan honey bee, bumble bee, and Italian Bee. They are all bees. They are of insters over other insects probably because bees were found most sensitive to this insecticide.

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

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

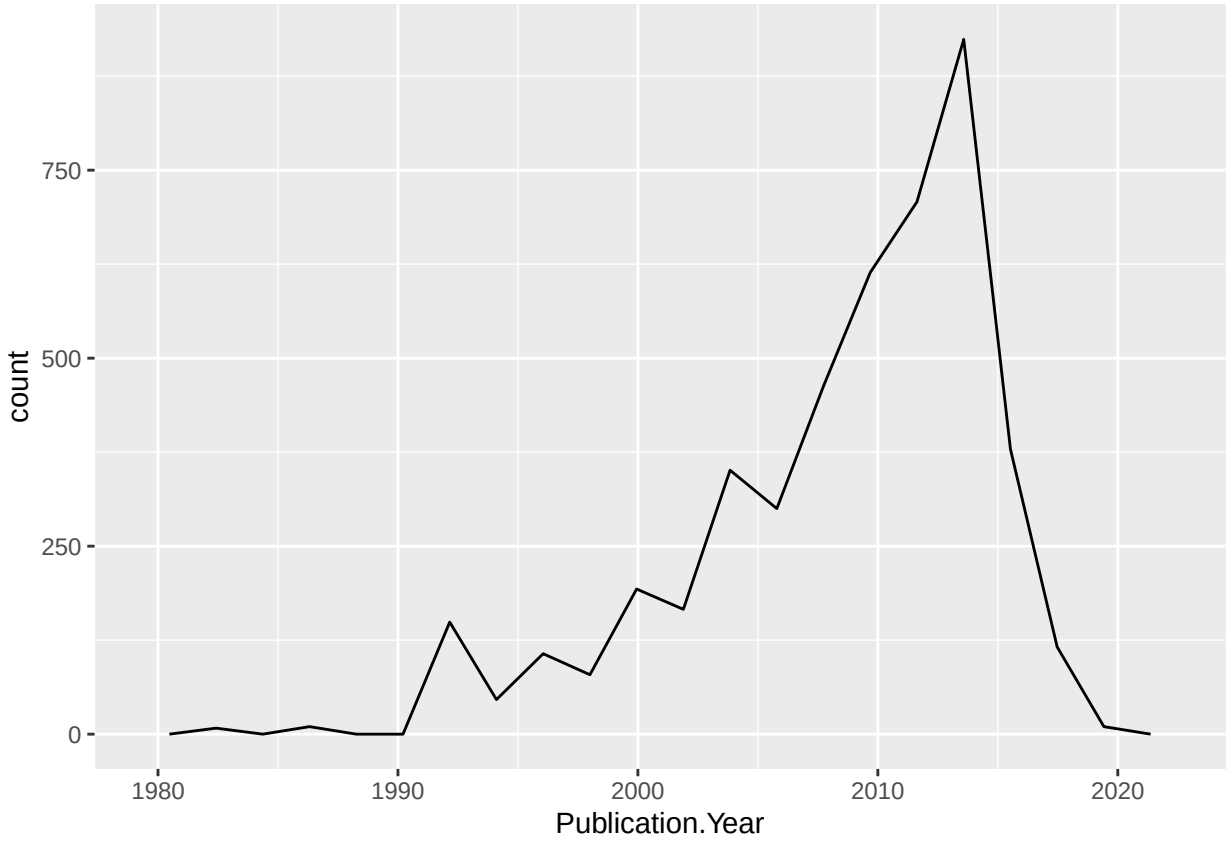
```
## [1] "factor"
```

Answer:It is factor because we import string as factor when imprting the data

Explore your data graphically (Neonics)

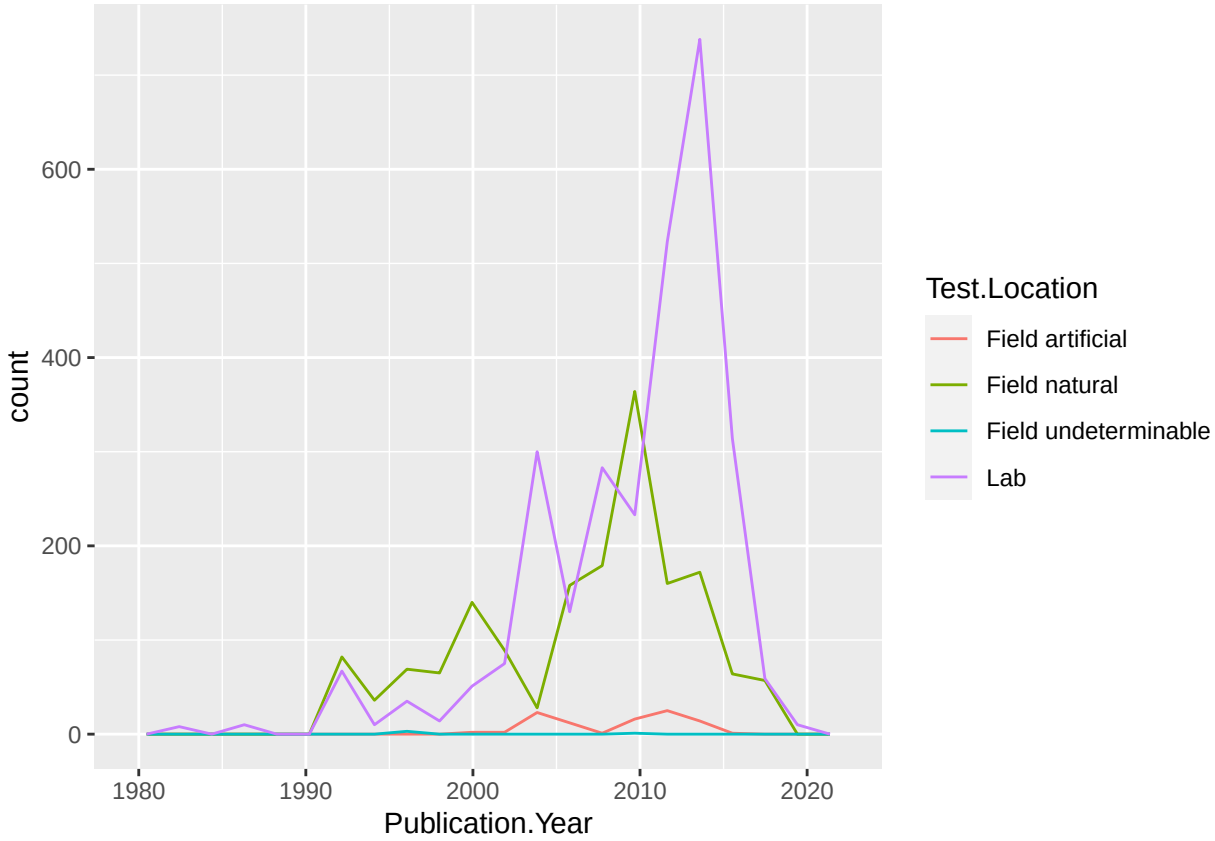
9. Using `geom_freqpoly`, generate a plot of the number of studies conducted by publication year.

```
ggplot(Neonics) +
  geom_freqpoly(aes(x = Publication.Year),bins = 20)
```



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

```
ggplot(Neonics, aes(Publication.Year, colour = Test.Location)) +
  geom_freqpoly(bins = 20)
```



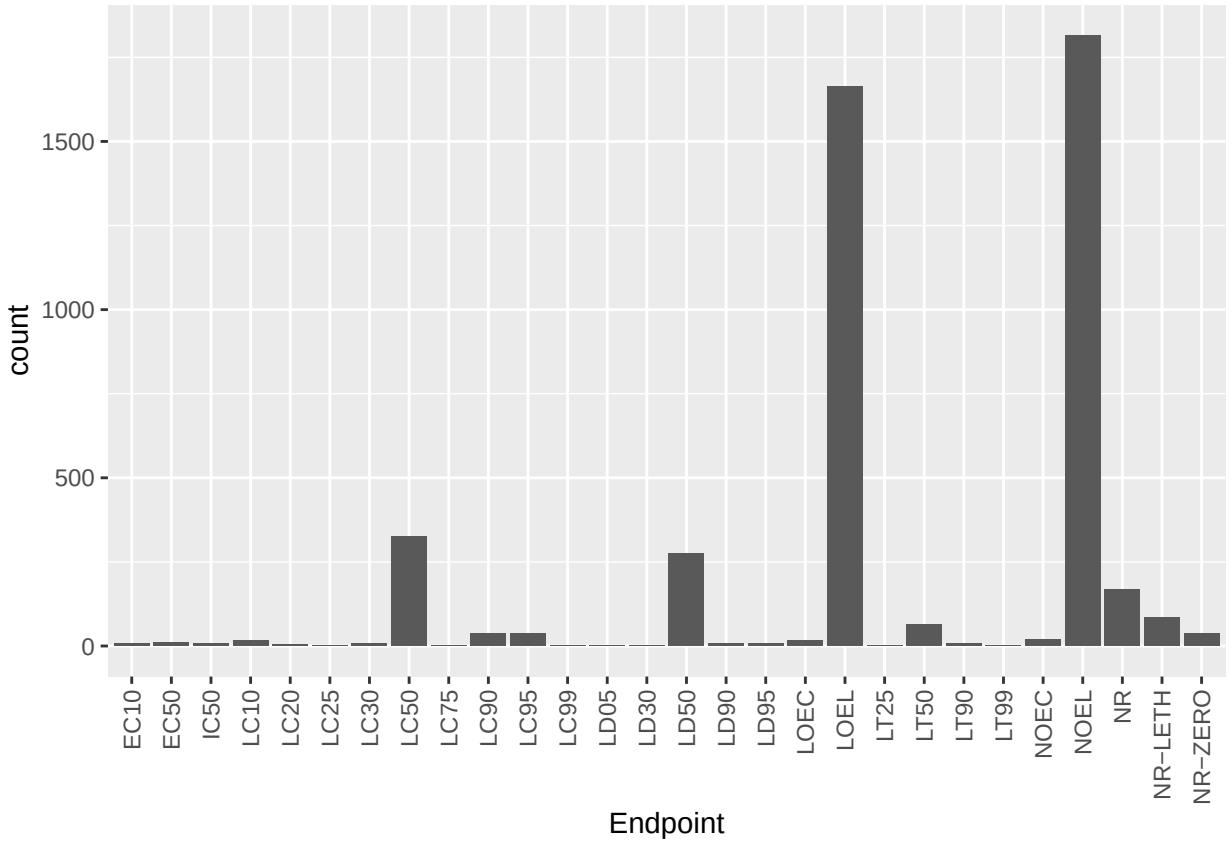
Interpret this graph. What are the most common test locations, and do they differ over time?

> Answer: Lab is the most common test locations. They differ over time as before 2000 the most common site was field natural.

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.

[**TIP**: Add `theme(axis.text.x = element_text(angle = 90, vjust = 0.5, hjust=1))` to the end of your plot command to rotate and align the X-axis labels...]

```
ggplot(Neonics, aes(x = Endpoint)) +
  geom_bar() +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5, hjust=1))
```



Answer:LOEL and NOEL; LOEL (Lowest Observed Effect Level) is the lowest dosage level at which chronic exposure to the substance shows adverse effects on tested animals; The NOEL (no observable effect level) is the highest dose or exposure level of a substance or material that produces no noticeable (observable) toxic effect on tested animals.

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")
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`?

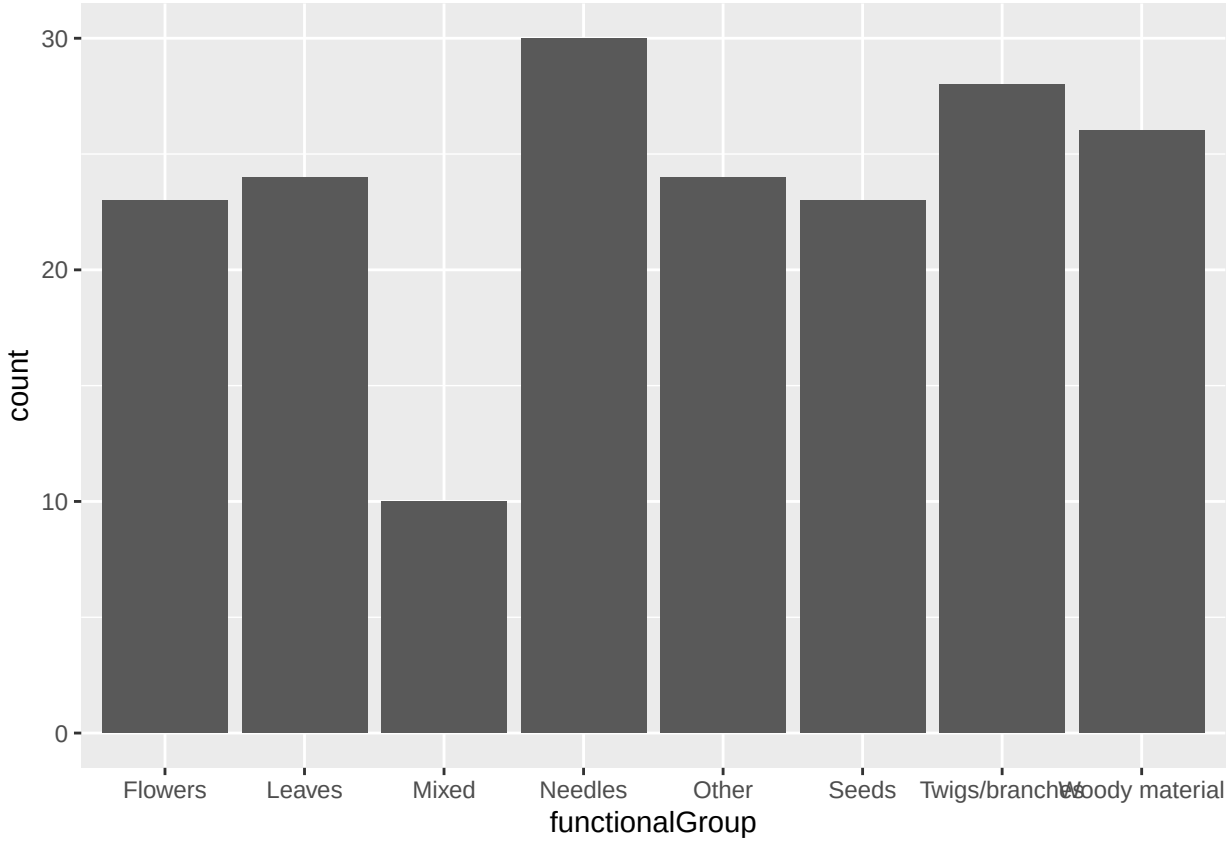
```
unique(Litter$plotID)
```

```
##  [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: 12 plots were sampled at Niwot Ridge.The unique function in R is used to eliminate or delete the duplicate values or the rows present in the vector, data frame, or matrix. Thus, dataframe with same value in one column will be only counted once, while the summary function will also count duplicated values.

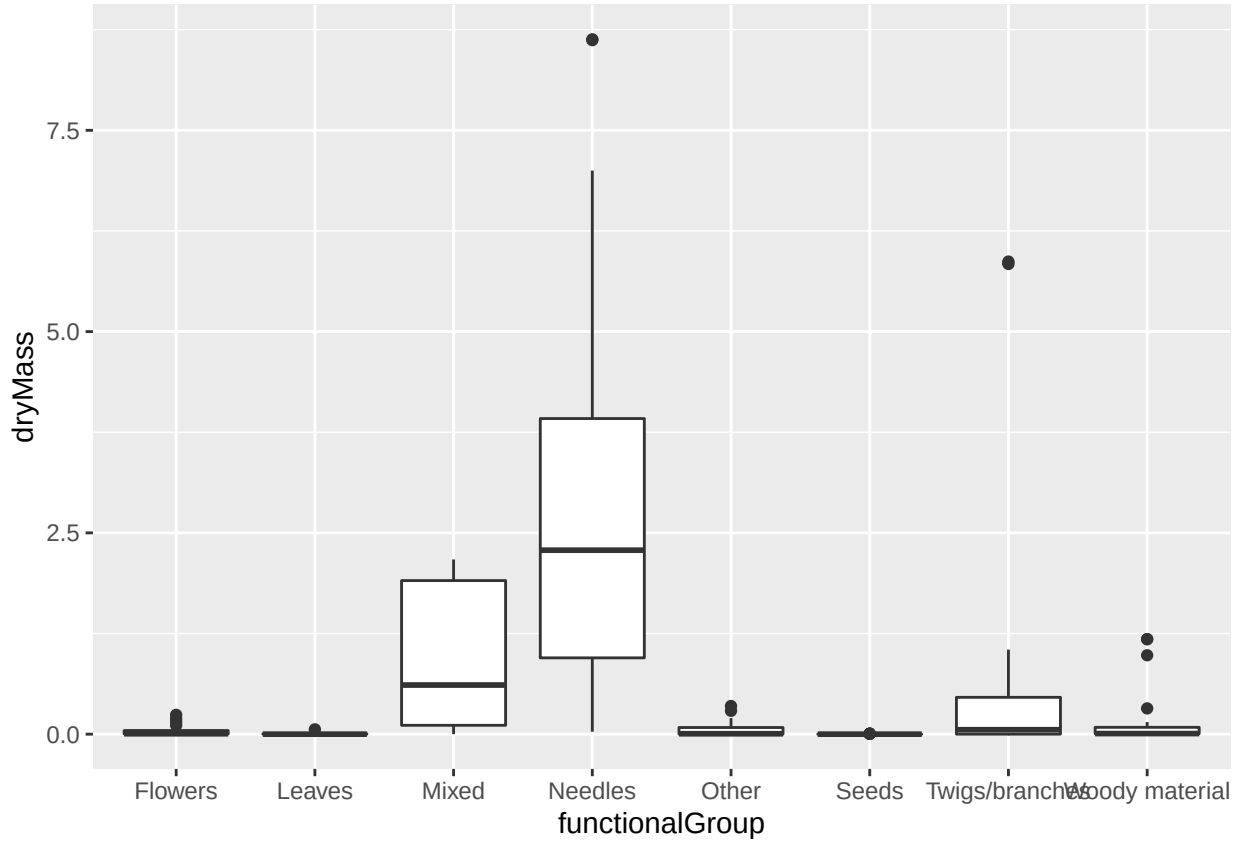
14. Create a bar graph of functionalGroup counts. This shows you what type of litter is collected at the Niwot Ridge sites. Notice that litter types are fairly equally distributed across the Niwot Ridge sites.

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

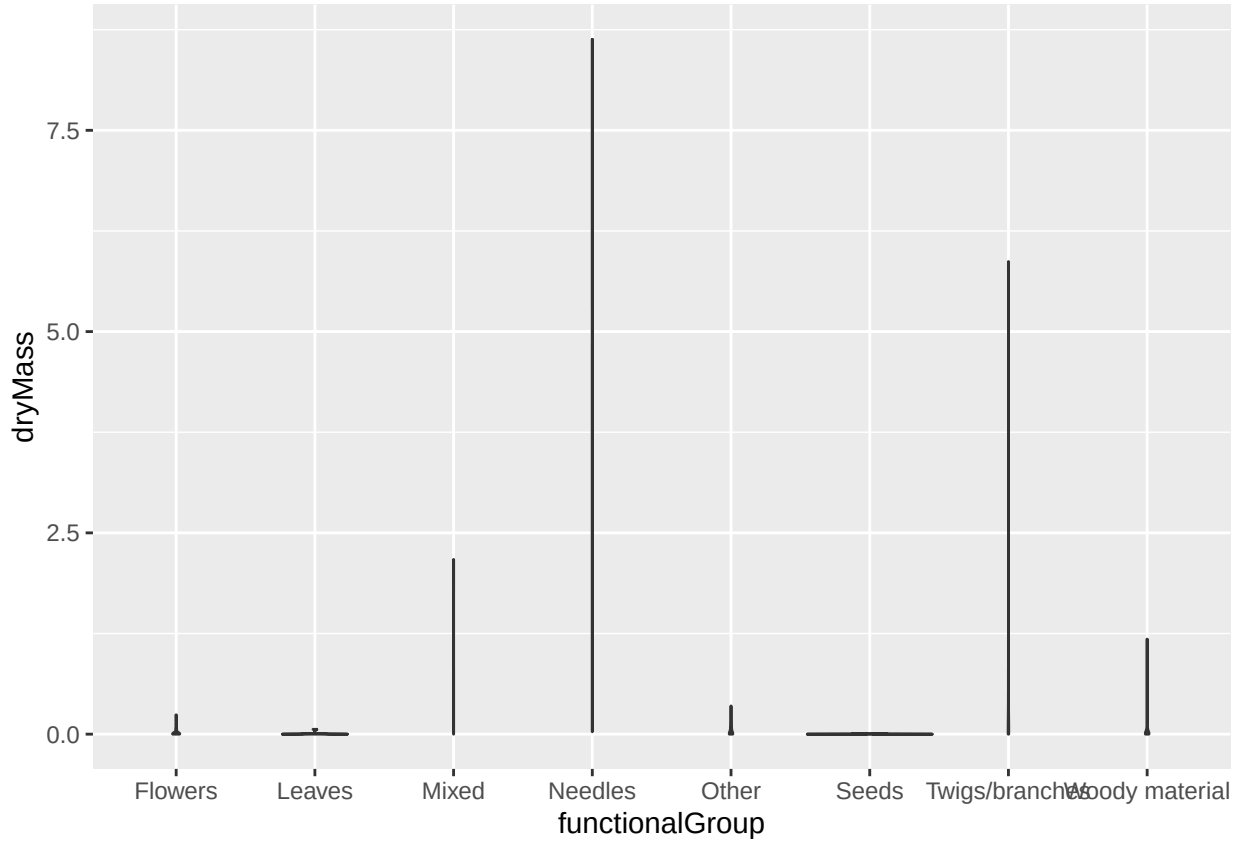


15. Using `geom_boxplot` and `geom_violin`, create a boxplot and a violin plot of dryMass by functionalGroup.

```
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: This may be because the size of the dataset is small, and we cannot predict the density from violin plot

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

> Answer: Needles is the highest biomass at these sites