Assignment 3: Data Exploration

LeheXu, Section #3

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.**

```
#install.packages("tidyverse")
#install.packages("dplyr")
#install.packages("ggplot2")
library(tidyverse)
```

```
## Warning: package 'tidyverse' was built under R version 3.6.3
```

```
## Warning: package 'tibble' was built under R version 3.6.3
```

```
## Warning: package 'tidyr' was built under R version 3.6.3
```

```
## Warning: package 'readr' was built under R version 3.6.3
```

```
## Warning: package 'purrr' was built under R version 3.6.3
```

```
## Warning: package 'dplyr' was built under R version 3.6.3
```

```
## Warning: package 'forcats' was built under R version 3.6.3
```

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

Answer: Neonicotinoid is a new kind of nicotine-like insecticide. It is toxical too many pests. It has a bright future of application because it has water solubility, whcih enables it to be applied to soil. This advantage makes it less harmful to beneficial insects on plants and reduces the risk for insecticide drift from the target site. Though it is low-toxical to many beneficial insects including bees, new studies found that it may impact some bees' ability to foraging for nectar, learn and remember where flowers are located, and possibly impair their ability to find their way home to the nest or hive. Therefore, studying the exotoxicology of neonicotinoids is important to help us use it more environmental-friendly and scientifically.

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: Woody debris is an important part of forest and stream ecosystems because it has a role in carbon budgets and nutrient cycling, is a source of energy for aquatic ecosystems, provides habitat for terrestrial and aquatic organisms, and contributes to structure and roughness, thereby influencing water flows and sediment transport. Few studies of woody debris in forested wetlands have been done in the Southeastern United States.

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: * The sampling of litter and woody debris only takes place in tower plots. Locations of tower plots are selected randomly within the 90% flux footprint of the primary and secondary airsheds.In sites with forested tower airsheds, the litter sampling is targeted to take place in 20 40m x 40m plots. In sites with low-statured wegetation over the tower airsheds, litter sampling is targeted to take place in 4 40m x 40m tower plots (to accommodate co-located soil sampling) plus 26 20m x 20m plots. * One litter trap pair (one elevated trap and one ground trap) is deployed for every 400 m2 plot area, resulting in 1-4 trap pairs per plot. * In sites with >50% aerial cover of woody vegetation >2m in height, placement of litter traps is random; In sites with < 50% cover of woody vegetation, sites with heterogeneously distributed, patchy, vegetation, trap placement is targeted such that only areas beneath qualifying vegetation are considered for trap placement.

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: The most common effects are "mortality" and "population". These effects are impotant because they are the critical parameters to measure the effectiveness of pesticides and also the environemntal impacts of pesticides.

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 commonly studied species: honey bee, parasitic wasp, buff tailed bumblebee, carbiolan honey bee, bumble bee, italian honeybee. They are studied becasue some studies found that Neonicotinoid may impact some bees' ability to foraging for nectar, learn and remember where flowers are located, and possibly impair their ability to find their way home to the nest or hive. And, bees are crucial to the peace of the world for its important role in maintain biodiverity and yield. So, we should closely look at Neonicotinoid's bad impacts on bees.

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.)
```

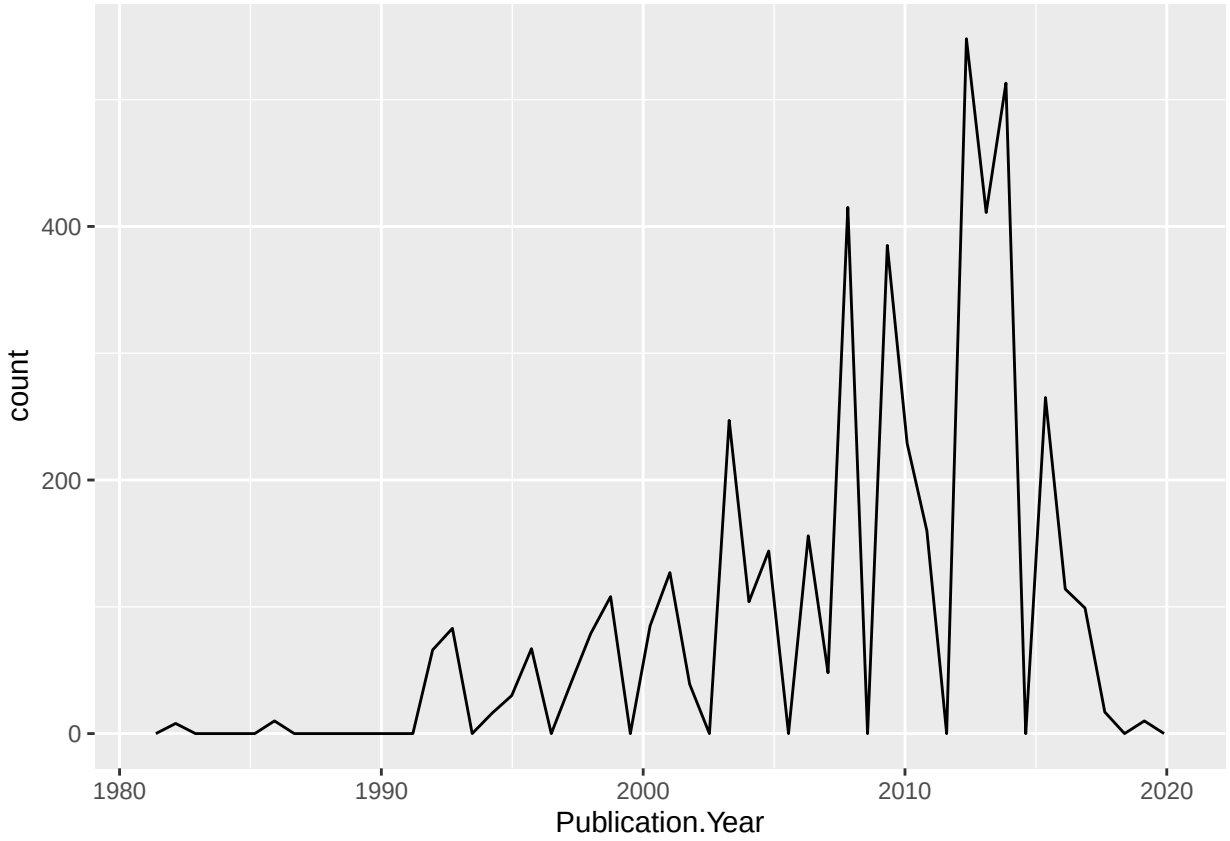
```
## [1] "factor"
```

Answer: Because the data are not numerical data, but data with other punctuations. Numerical data should be pure numbers. The concentrations in the dataset are only ranges, instead of specific numbers so it is factor.

Explore your data graphically (Neonics)

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

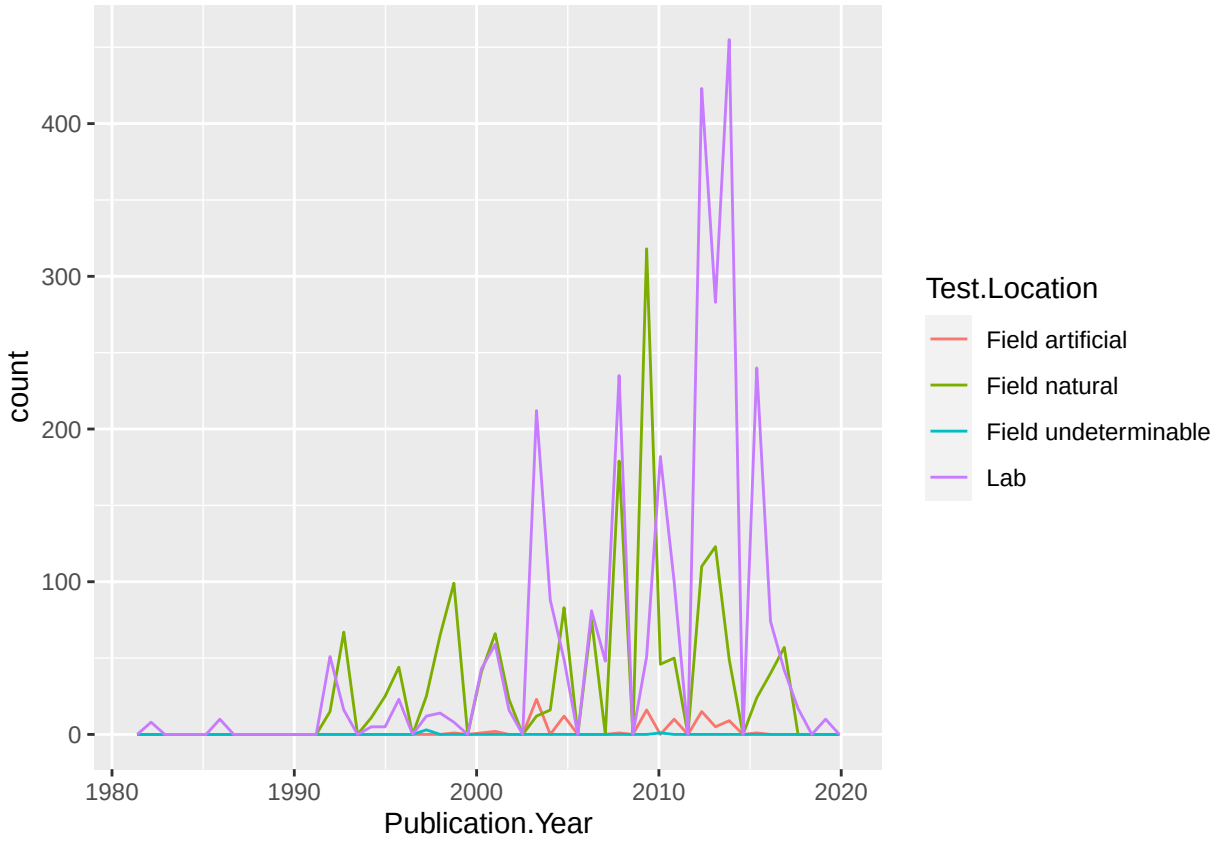
```
ggplot(Neonics) +
  geom_freqpoly(aes(x = Publication.Year), bins = 50)
```



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), bins = 50)
```

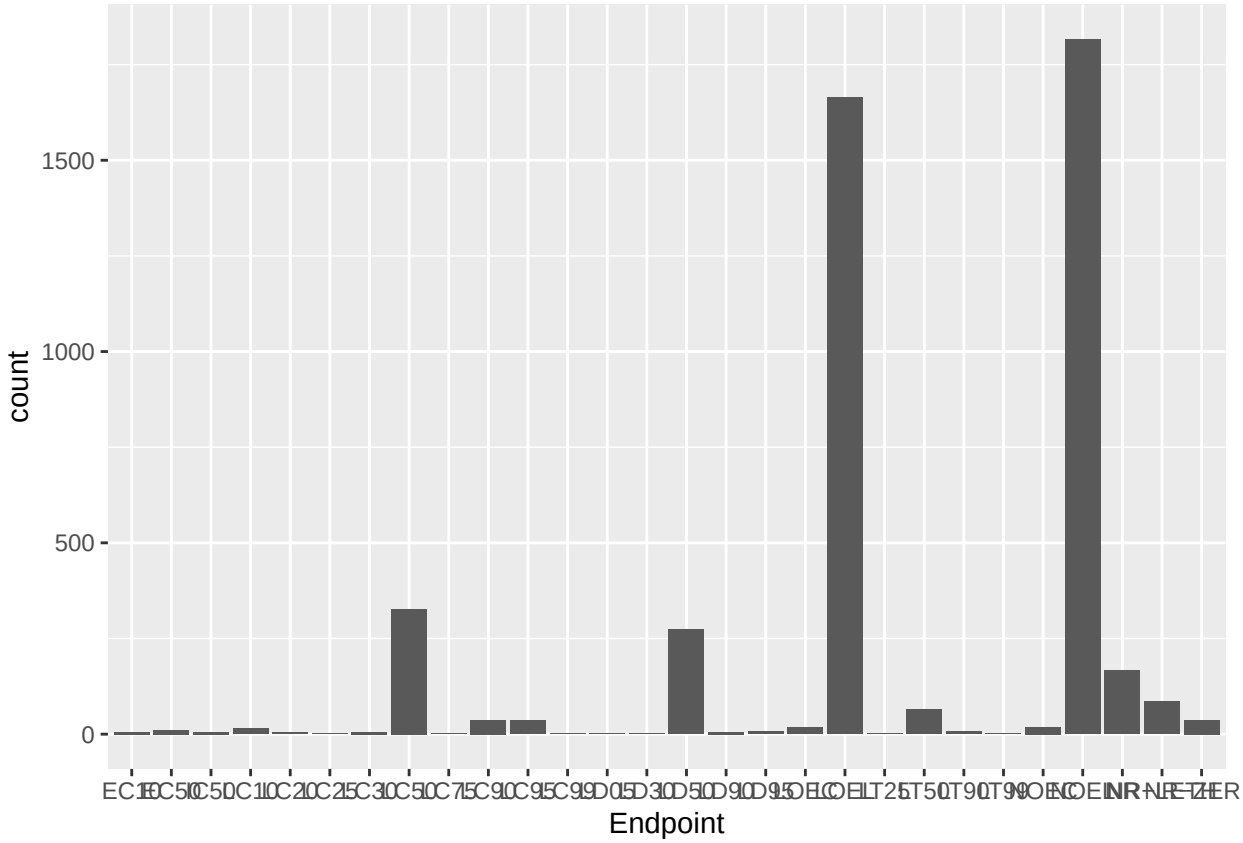


Interpret this graph. What are the most common test locations, and do they differ over time?

Answer: Lab and Field Natural are the most common test locations. Yes, they do. In the past field natural was more frequently used than lab. Then, lab was more frequently used.

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: LOEL:Lowest-observable-effect-level: lowest dose (concentration) producing effects that were significantly different (as reported by authors) from responses of controls (LOEAL/LOEC) and
NOEL: No-observable-effect-level: highest dose (concentration) producing effects not significantly different from responses of controls according to author's reported statistical test (NOEAL/NOEC)

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
```

```
##  [8] NIWO_051 NIWO_058 NIWO_046 NIWO_062 NIWO_057
## 12 Levels: NIWO_040 NIWO_041 NIWO_046 NIWO_047 NIWO_051 ... NIWO_067
```

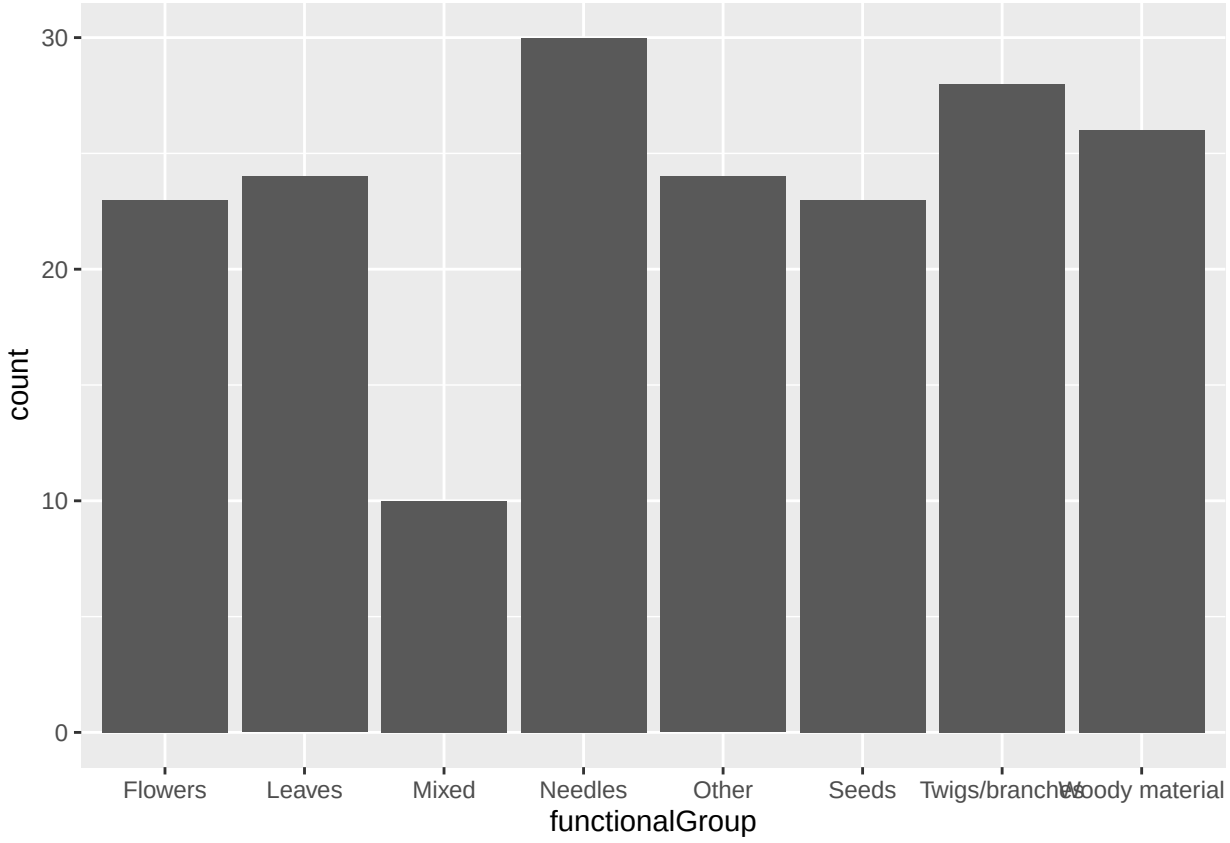
```
summary(Litter$plotID)
```

```
## 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: Summary has more detailed information of frequency. Unique ranks the data without frequency.

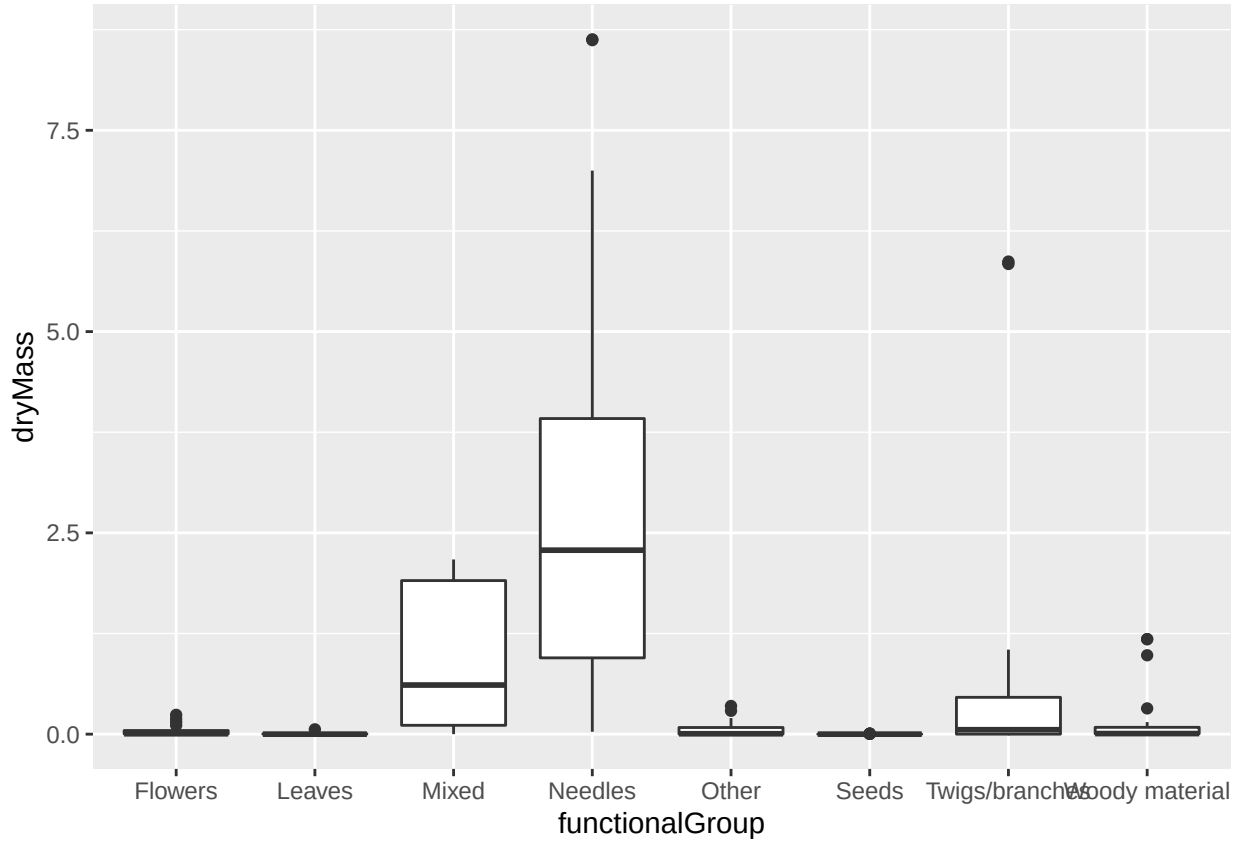
14. Create a bar graph of functionalGroup counts. This shows you what type of litter is collected at the Niwot Ridge sites. Notice that litter types are fairly equally distributed across the Niwot Ridge sites.

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

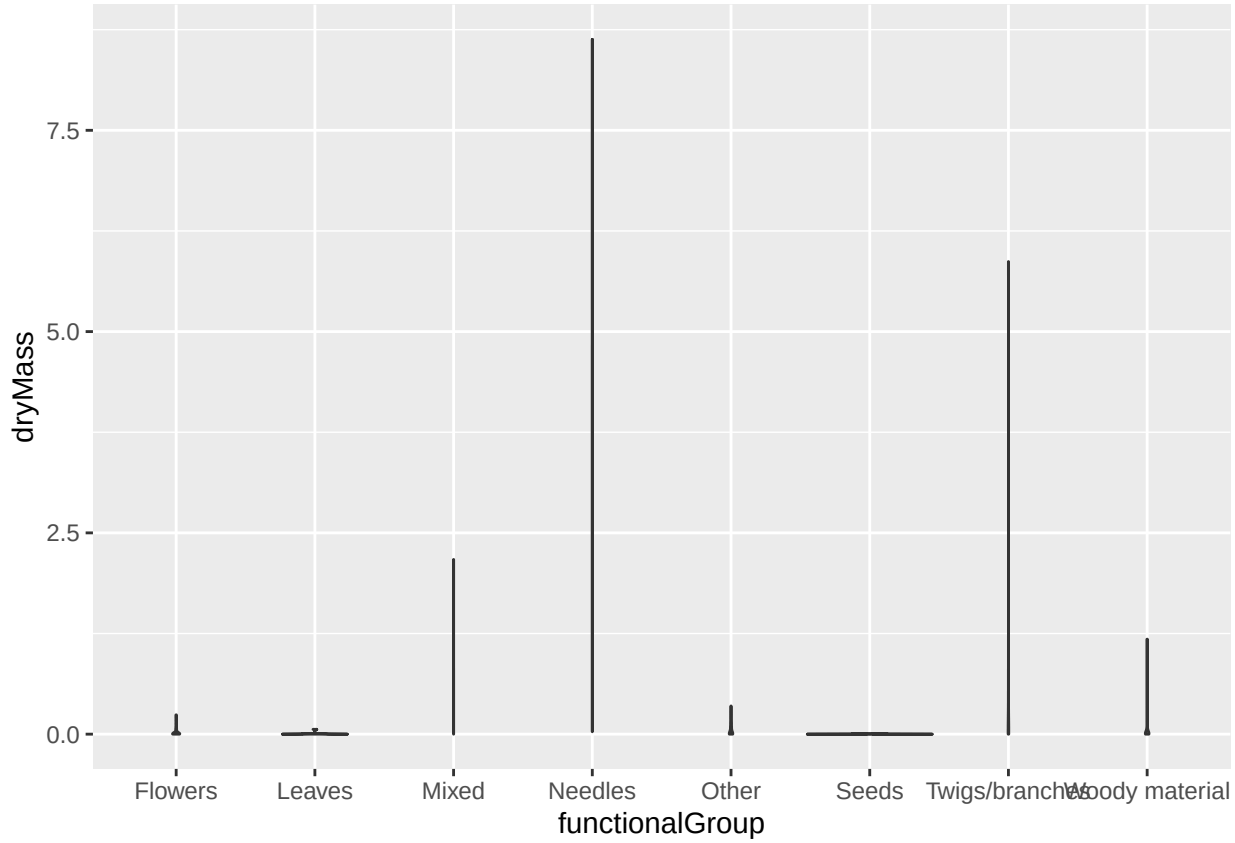


15. Using `geom_boxplot` and `geom_violin`, create a boxplot and a violin plot of dryMass by functionalGroup.

```
ggplot(Litter) +
  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 the sample size is too small to draw a violin plot. But boxplot is less sensitive to sample size.

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

> Answer: Needles