Jiawei Liang Assignment 3: Data Exploration

Jiawei Liang

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. Be sure to **answer the questions** in this assignment document.
5. When you have completed the assignment, **Knit** the text and code into a single PDF file.
6. After Knitting, submit the completed exercise (PDF file) to the dropbox in Sakai.

The completed exercise is due on Sept 30th.

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 include the subcommand to read strings in as factors.

```
getwd()
```

```
## [1] "C:/Users/Jiawei Liang/Documents/EDA-Fall2022/Assignments"
```

```
Neonics <-read.csv('c:/Users/Jiawei Liang/Documents/EDA-Fall2022/Data/Raw/ECOTOX_Neonicotinoids_Insects_
Litter <-read.csv('c:/Users/Jiawei Liang/Documents/EDA-Fall2022/Data/Raw/NEON_NIWO_Litter_massdata_2018
```

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: Neonicotinoid insecticides are now the most widely used class of insecticides in the world. While they were initially introduced as less harmful than older insecticides, research has now shown their devastating ecological impacts. Neonicotinoids are very toxic to pollinators, beneficial insects, and aquatic invertebrates. Their widespread use, combined with their water solubility, means that they are now often found in water and soil samples throughout the country.

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: Coarse woody debris consists of fallen dead trees that are left during harvesting. Coarse woody debris increases the structural diversity at the forest floor and provides a valuable microhabitat for animals that are moisture and temperature sensitive such as amphibians. So, studying litter and woody debris could help us understand and study the animal groups and their environment.

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.Locatons of tower plots are selected randomly within the 90% flux footprint of the primary and secondary airsheds 2.In sites with forested tower airsheds, the liter sampling is targeted to take place in 20 40m x 40m plots. In sites with low-statured vegetaton over the tower airsheds, liter sampling is targeted to take place in 4 40m x 40m tower plots plus 26 20m x 20m plots. 3. One liter trap pair is deployed for every 400 m2 plot area, resultng in 1-4 trap pairs per plot. In some cases, available space, plot spacing requirements, and/or the tower airshed size restricts the number of plots that can be sampled for liter below 20 (forested) or 30 (low-stature).

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 are studied most. Maybe the population could affect whether the environment is good or bad.

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, Carniolan Honey Bee, Parastic Wasp, Buff Tailed Bumblebee, Bumble Bee, Italian Honeybee.The life of bees is also inseparable from the flow of fresh, pollution-free air. If the air is not circulated, the bee colony will appear uneasy, especially in a particularly hot environment, sudden exposure to the sun, etc. Bee colonies should be placed far away from factories, mining areas and cities with severe air pollution. Thus, the bee could reflect the environment.

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.)
```

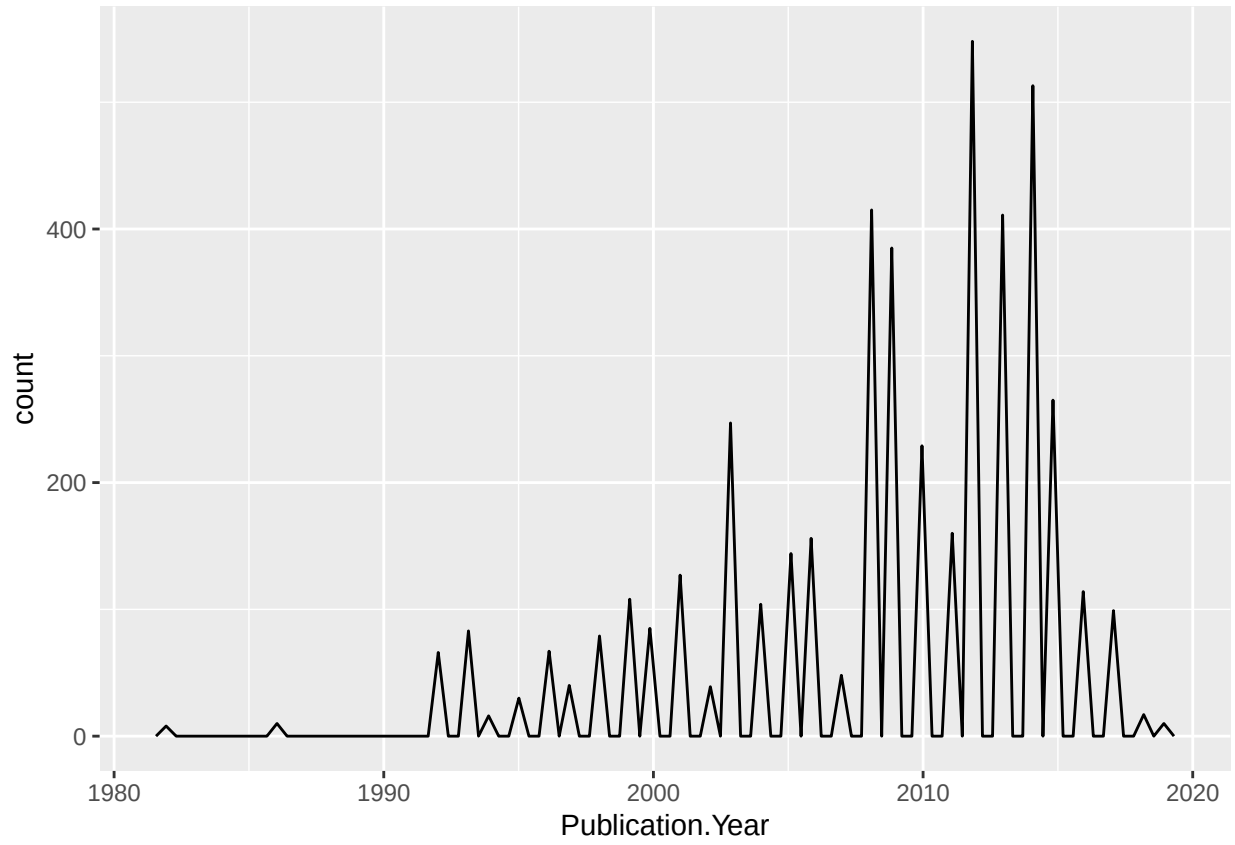
```
## [1] "factor"
```

Answer: Because there are N/A in the Conc.1..Author. So it is nor numeric, it is factor.

Explore your data graphically (Neonics)

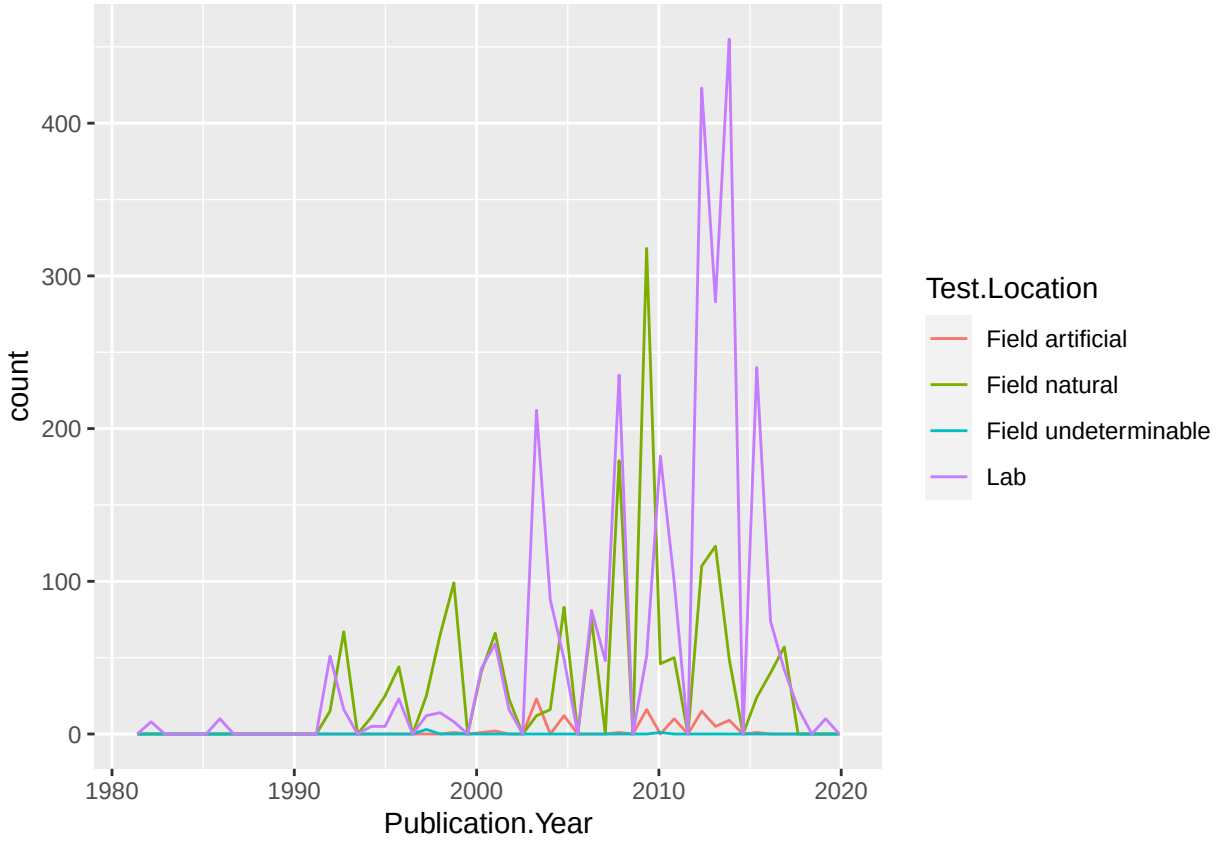
9. Using `geom_freqpoly`, generate a plot of the number of studies conducted by publication year.

```
library(ggplot2)
ggplot(Neonics) +
  geom_freqpoly(aes(x = Publication.Year), bins = 100)
```



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

```
library(ggplot2)
ggplot(Neonics) +
  geom_freqpoly(aes(x = Publication.Year,color = Test.Location), bins = 50)
```

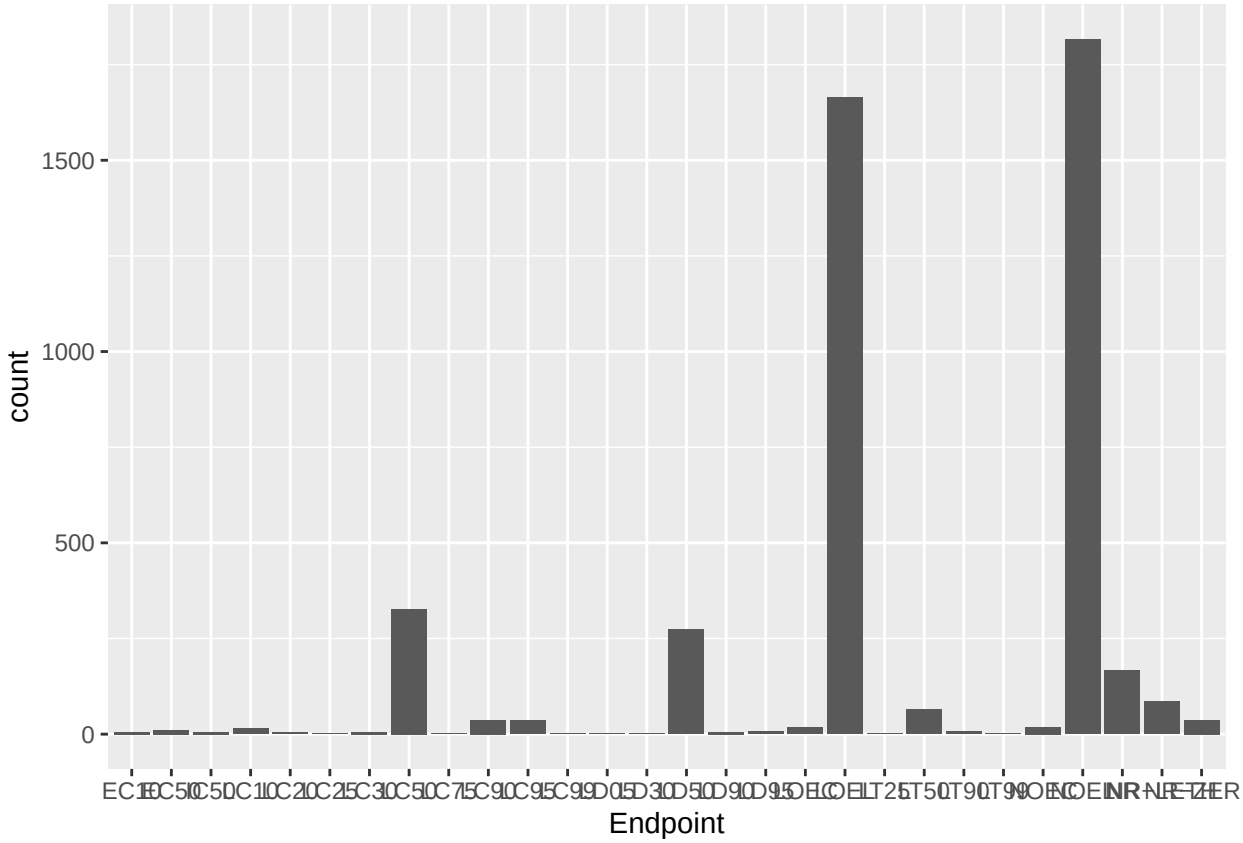


Interpret this graph. What are the most common test locations, and do they differ over time?

Answer:Lab and field natural. They do not differ onver time.

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.

```
library(ggplot2)
ggplot(Neonics, aes(x = Endpoint)) +
  geom_bar()
```



Answer:What are the two most common end points are LOEL and NOEL. LOEL:Lowest-observable-effect-level: lowest dose (concentration) producing effects that were significantly different (as reported by authors) from responses of controls (LOEAL/LOEC) 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)
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
```

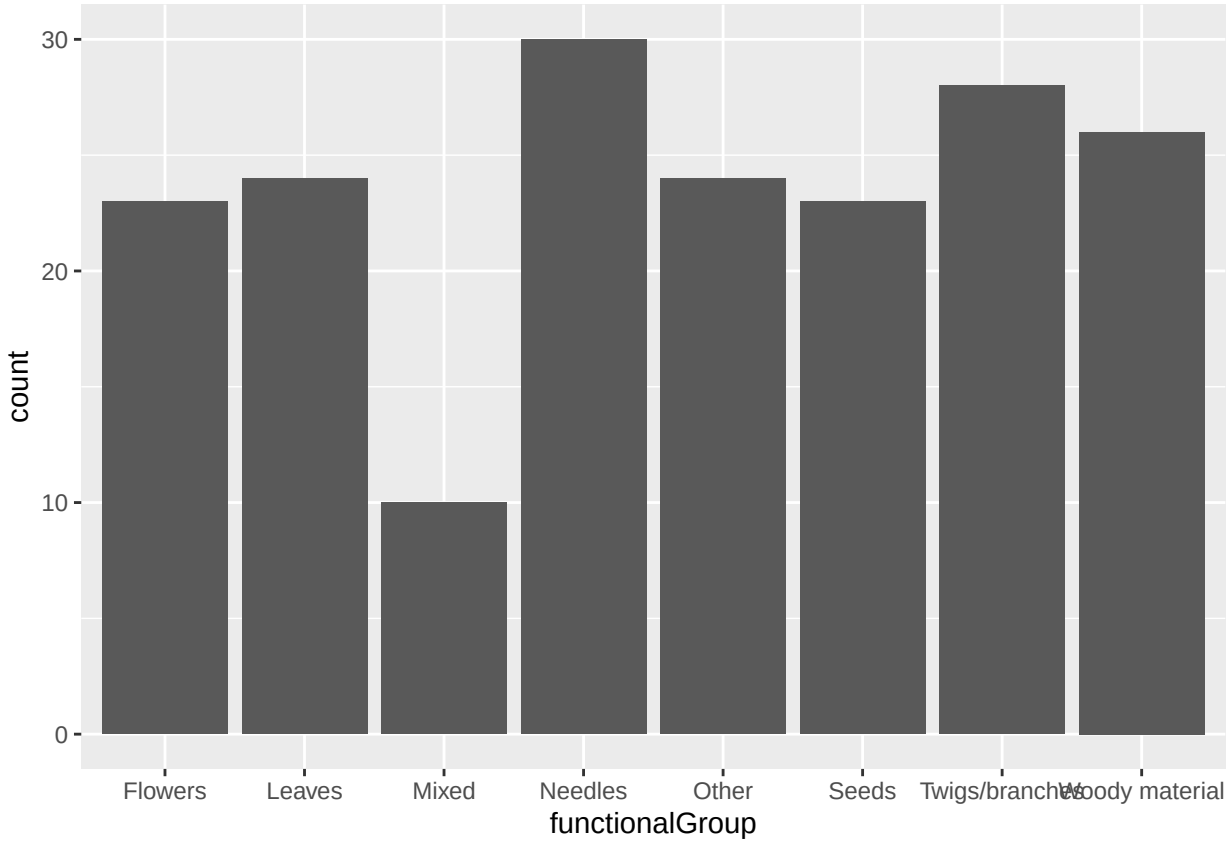
```
summary(Litter$plotID)
```

```
## 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: Unique could show the how many different kinds of contents in the information and list them. For summary, we conld konw the class of information and the length of the information.

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.

```
library(ggplot2)
ggplot(Litter, aes(x = functionalGroup)) +
  geom_bar()
```

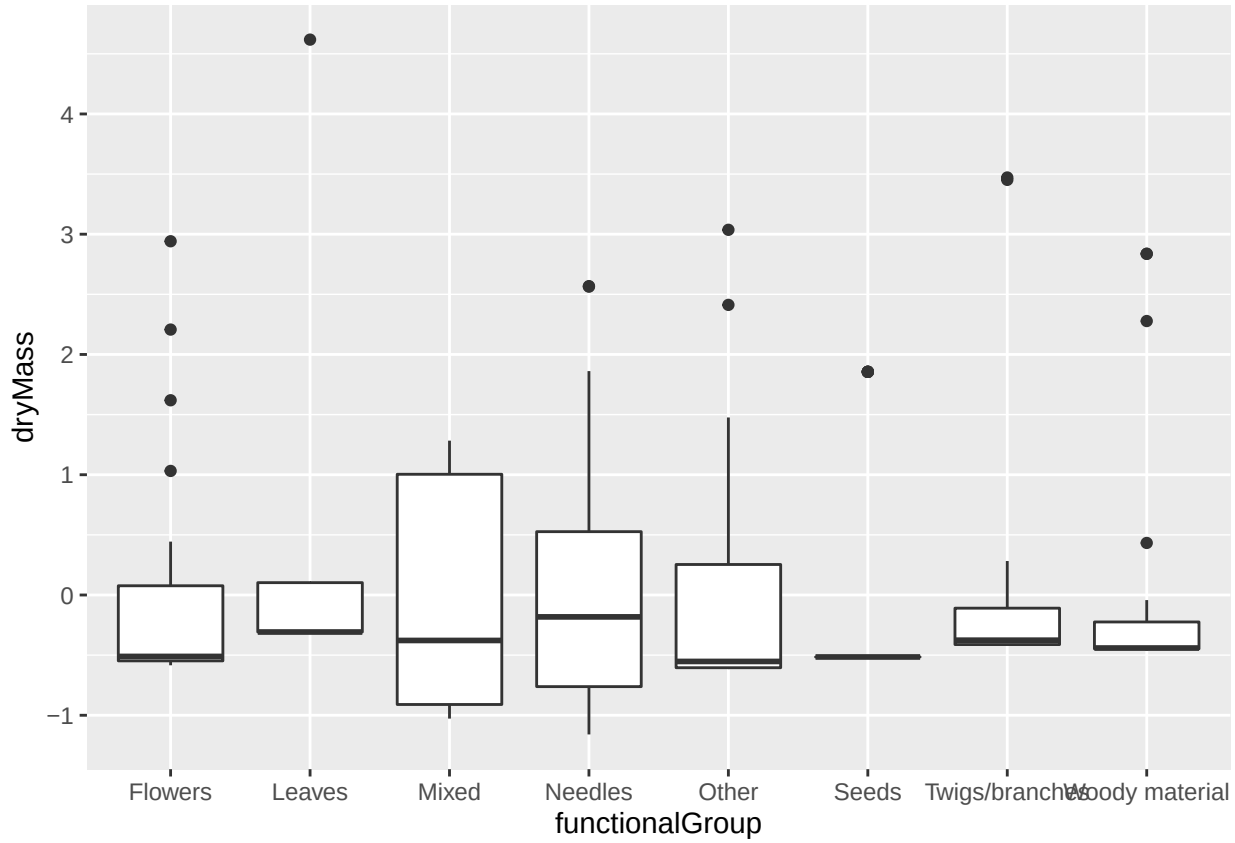


15. Using `geom_boxplot` and `geom_violin`, create a boxplot and a violin plot of dryMass by functionalGroup.

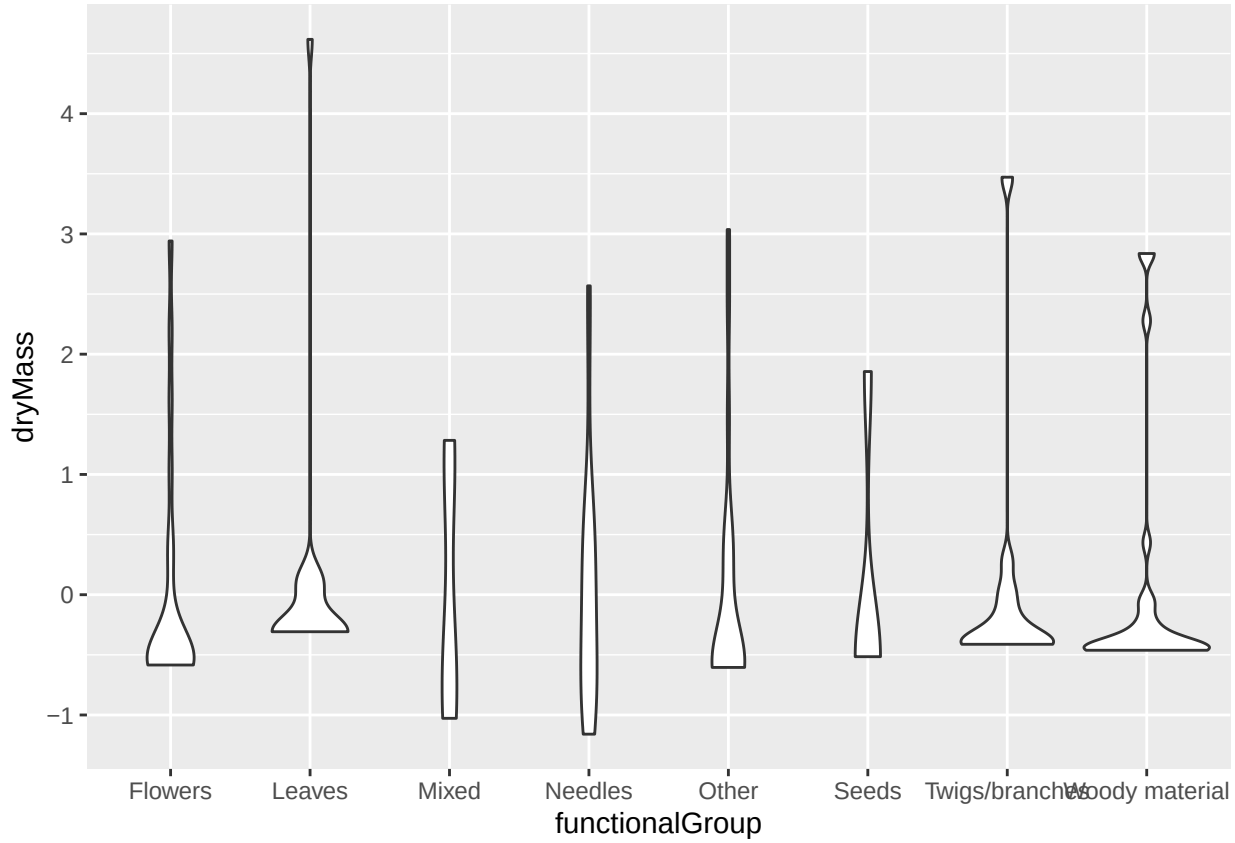
```
library(ggplot2)
for (func in unique(Litter$functionalGroup)){
  idx = Litter$functionalGroup == func
  data = Litter$dryMass[idx]
  m = mean(data)
  v = sd(data)
  nor_data = (data-m)/v
  Litter$dryMass[idx] = nor_data
}
m = mean(Litter)
```

```
## Warning in mean.default(Litter): argument is not numeric or logical: returning
## NA
```

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




```
library(ggplot2)
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:Box plots use common statistics and can provide key information about the location and dispersion of data, especially when comparing different parent data. It's more intuitive than a violin plot.

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

> Answer:Mixed