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] "/Users/wangyinsu/Desktop/2022 Spring/Env872/Environmental_Data_Analytics_2022"
```

```
setwd("/Users/wangyinsu/Desktop/2022 Spring/Env872/Environmental_Data_Analytics_2022")
library(tidyverse)
Neonics<-read.csv("/Users/wangyinsu/Desktop/2022 Spring/Env872/Environmental_Data_Analytics_2022/Data/Ra
Litter<-read.csv("/Users/wangyinsu/Desktop/2022 Spring/Env872/Environmental_Data_Analytics_2022/Data/Raw
```

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: Probably because neonicotinoids have impacts not only on pests such as aphids, but also have negative impacts on insects such as bees, who are the most economically important group of pollinators worldwide; we thus need to find out ways to kill pests at same time to protect these good insects such as bees therefore we need to study the ecotoxicology of neonicotinoids.

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: this may be because some litter and trees that fall and decay in the forest add nutrients to the forest soil and retain moisture in the forest. Also they have a role in carbon budgets and 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: *Spatial Sampling: Litter and fine woody debris sampling is executed at terrestrial NEON sites that contain woody vegetation >2m tall. Along with most of NEON's plant productivity measurements, sampling for this product occurs only in tower plots. Locations of tower plots are selected randomly within the 90% flux footprint of the primary and secondary airsheds (and additional areas in close proximity to the airshed, as necessary to accommodate sufficient spacing between plots).* Spatial Sampling: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 vegetation 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. *Spatial Sampling:Trap placement within plots may be either targeted or randomized, depending on the vegetation. In sites with > 50% aerial cover of woody vegetation >2m in height, placement of litter traps is random and utilizes the randomized list of grid cell locations being utilized for herbaceous clip harvest and bryophyte sampling.

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 that are studied are mortality and population. The reason why these two effects might be of interest is because mortality and population are the most important parameters to a species; they will finally influence a species's survival on Earth.

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 are:Honey Bee, Parasitic Wasp,Buff Tailed Bumblebee, Carniolan Honey Bee, Bumble Bee, Italian Honeybee. they all belongs to the suborder Apocrita. why they might be of interest over other insects might be that they are the most economically important group of pollinators worldwide and sensitive to pesticides such as neonicotinoids.

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"
```

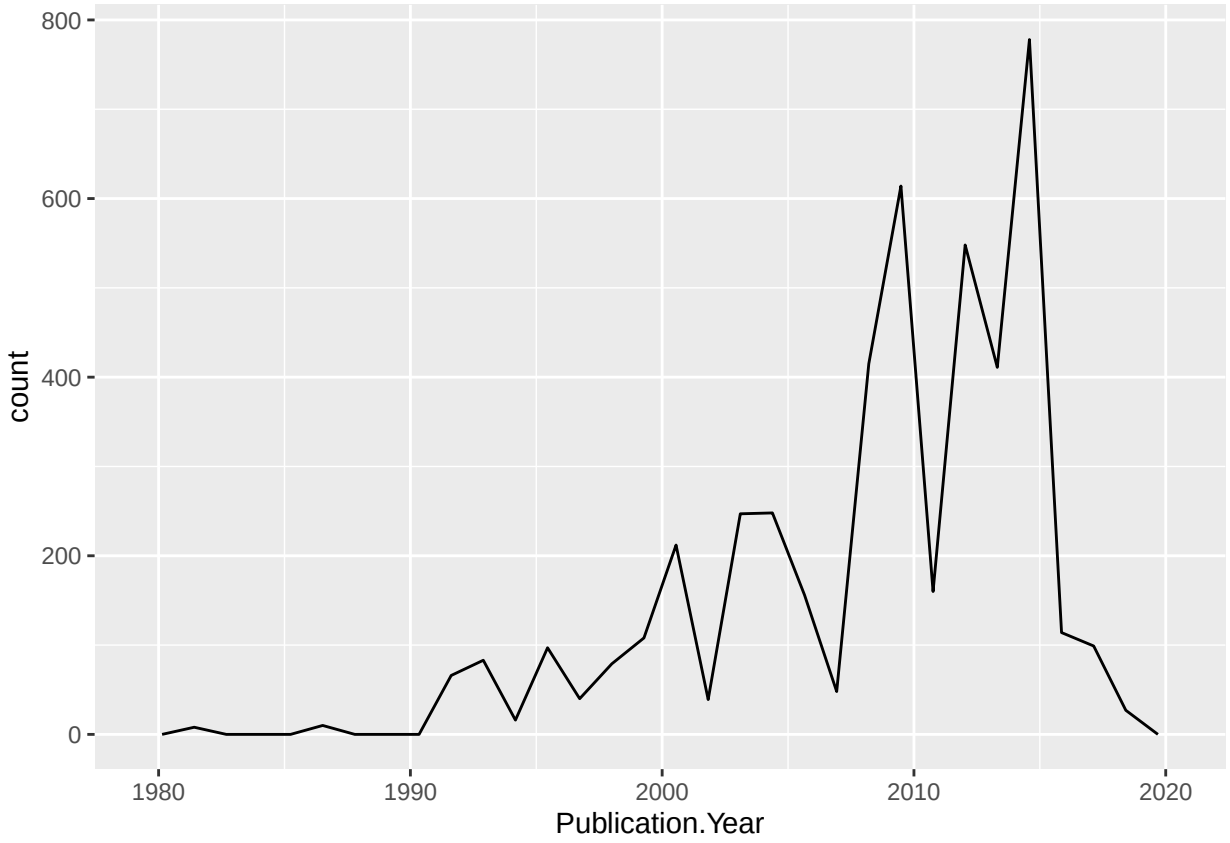
Answer:the class of this variable is "factor". The reason why it is not numeric is that this variable is used to categorize and store the data as integers, having a limited number of different values.

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))
```

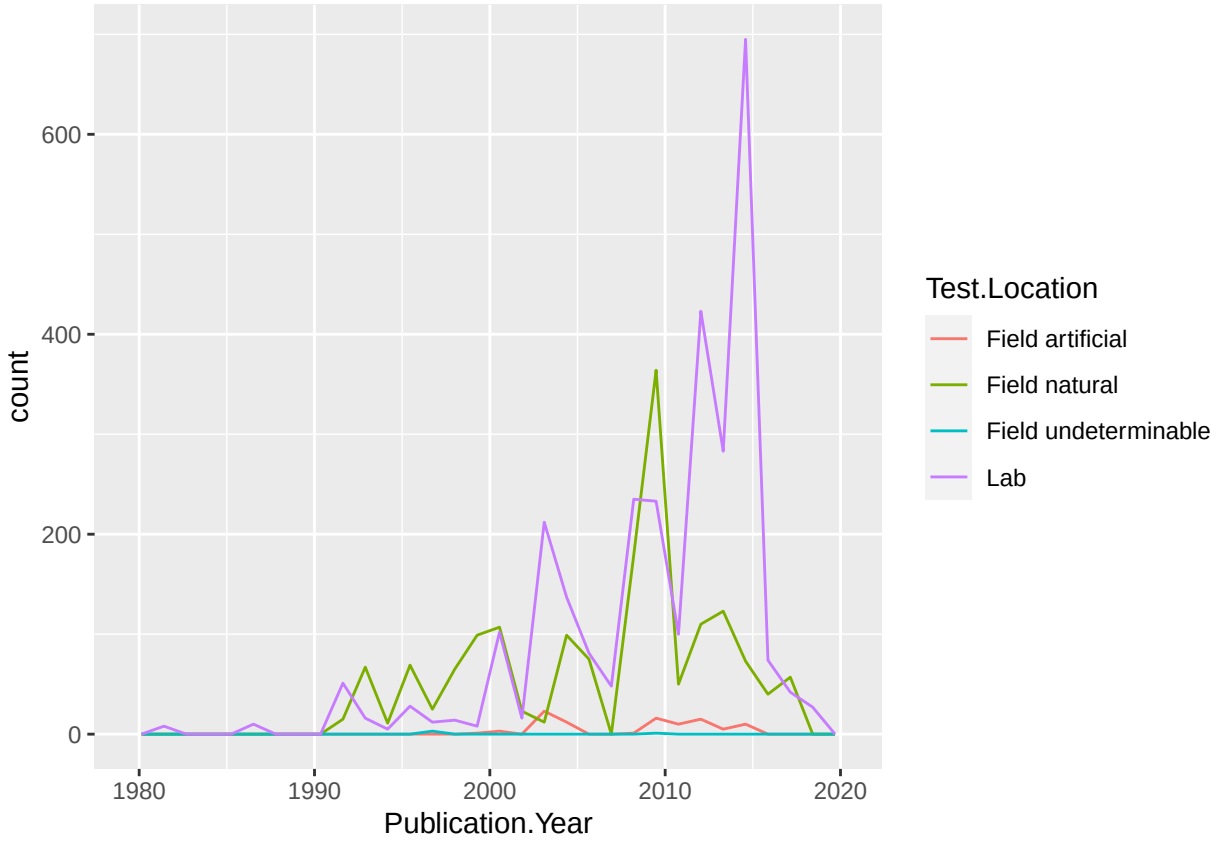
```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



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

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

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

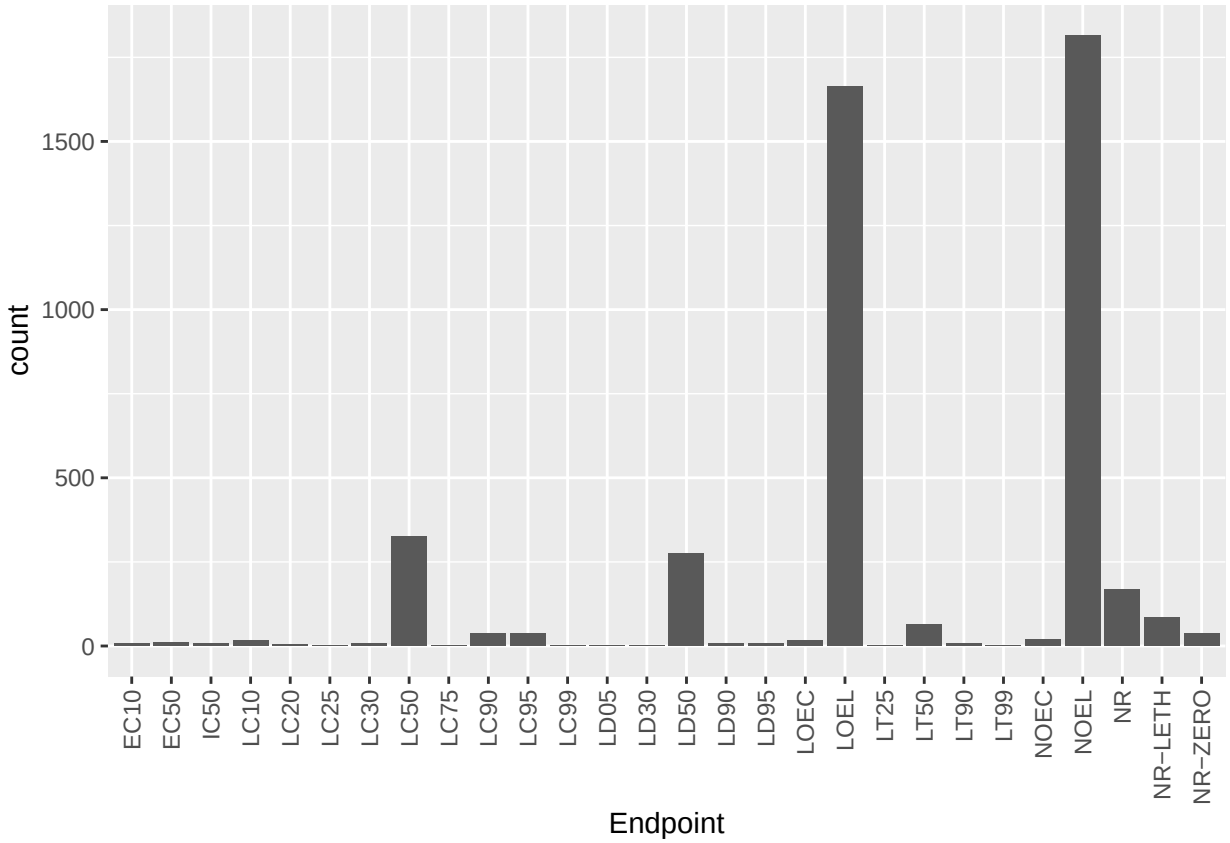


Interpret this graph. What are the most common test locations, and do they differ over time?

> Answer: As the publication year moves on, the number of studies increases first and then decreases. We also can conclude from this graph that the most common test location is lab, followed by field natural and field artifical; field underterminable is the least. As already said, all of these test locations differ over time, with firstly increase and then decrease.

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()+
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5, hjust=1))
```



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

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.

```
library(lubridate)
```

```
##
## Attaching package: 'lubridate'
```

```
## The following objects are masked from 'package:base':
##
##     date, intersect, setdiff, union
```

```
class(Litter$collectDate)#it is "factor", not date.
```

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

```
Litter$collectDate<-ymd(Litter$collectDate)
class(Litter$collectDate)
```

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

```
unique(Litter$collectDate)# litter was sampled on 2018-08-02 and 2018-08-30.
```

```
## [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
```

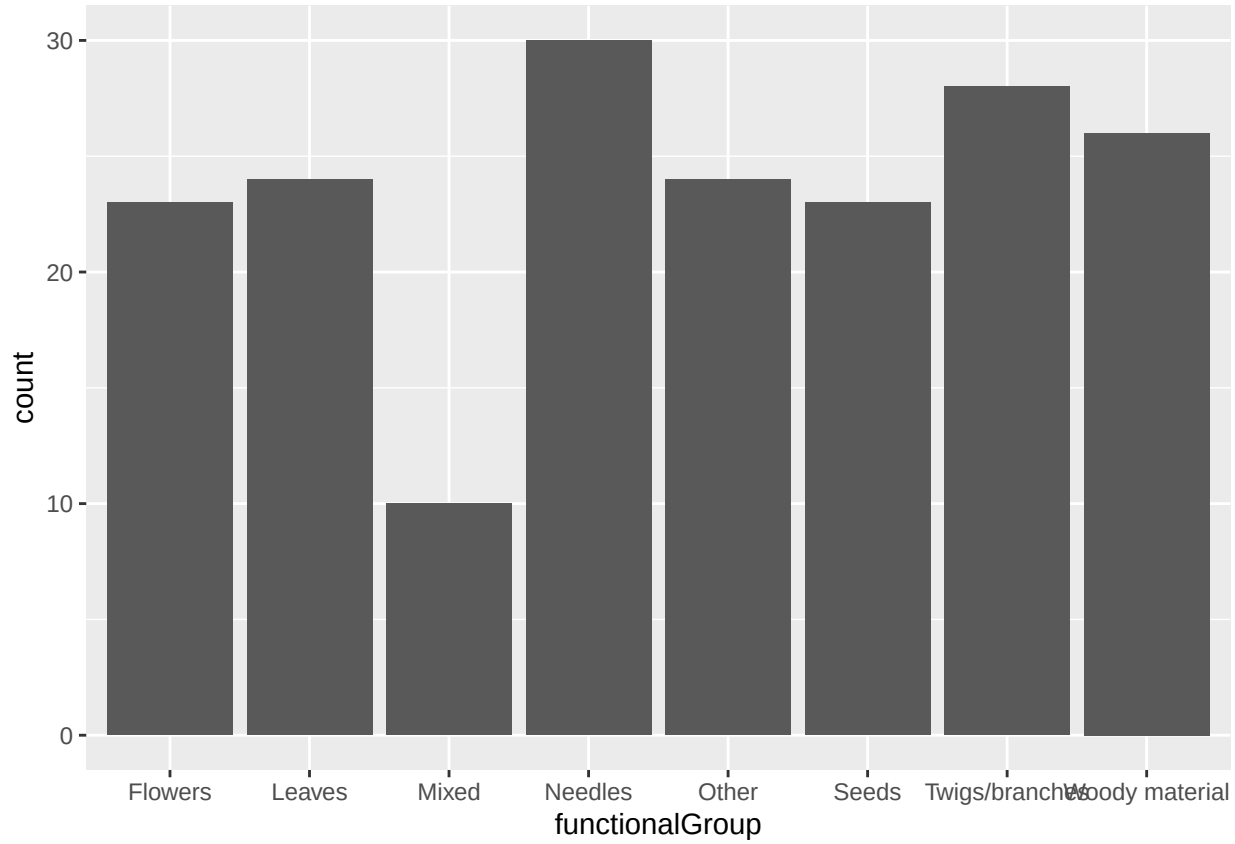
```
summary(Litter$plotID)
```

```
## 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: There are 12 plots sampled at Niwot Ridge. The information obtained from "summary" contains frequency of each variable but information from "unique" does not.

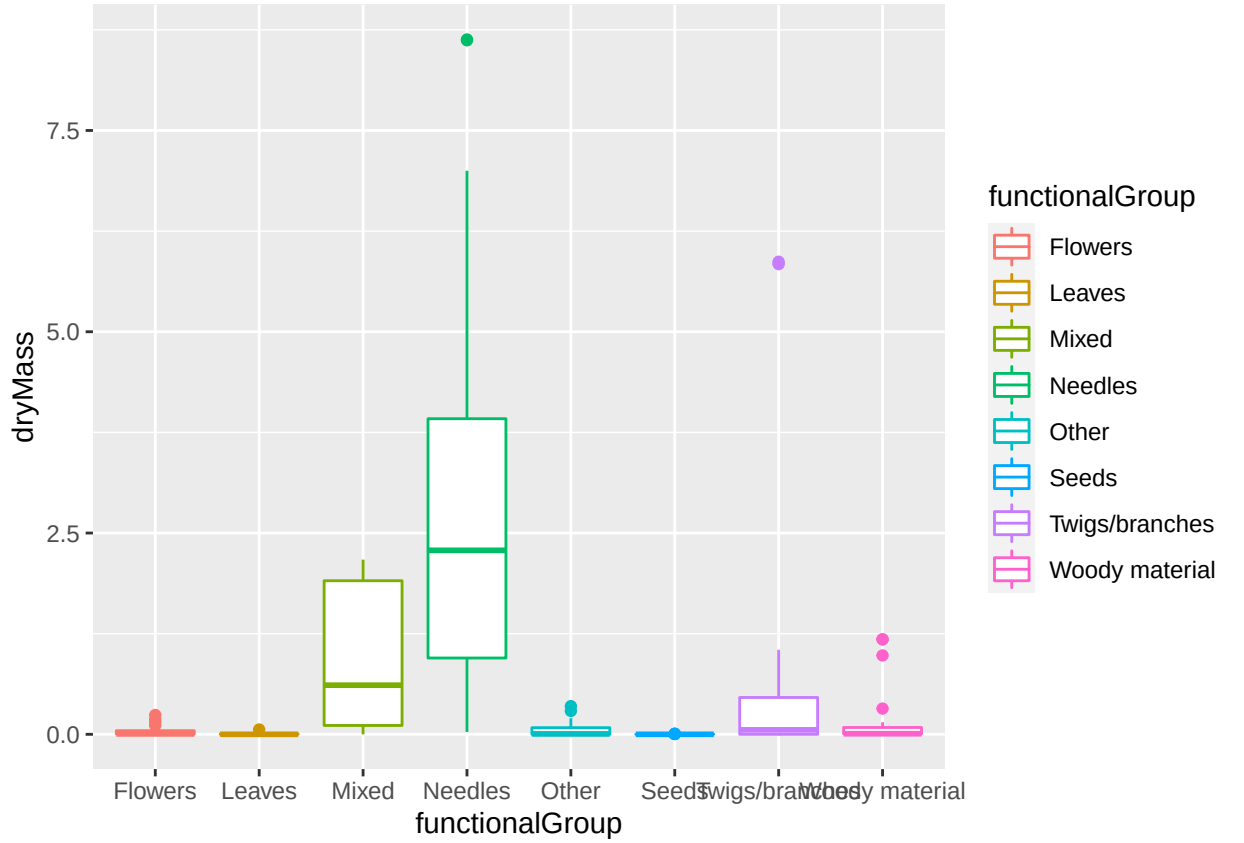
14. Create a bar graph of functionalGroup counts. This shows you what type of litter is collected at the Niwot Ridge sites. Notice that litter types are fairly equally distributed across the Niwot Ridge sites.

```
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(y = dryMass,x=functionalGroup,color=functionalGroup)) +
  geom_boxplot()
```

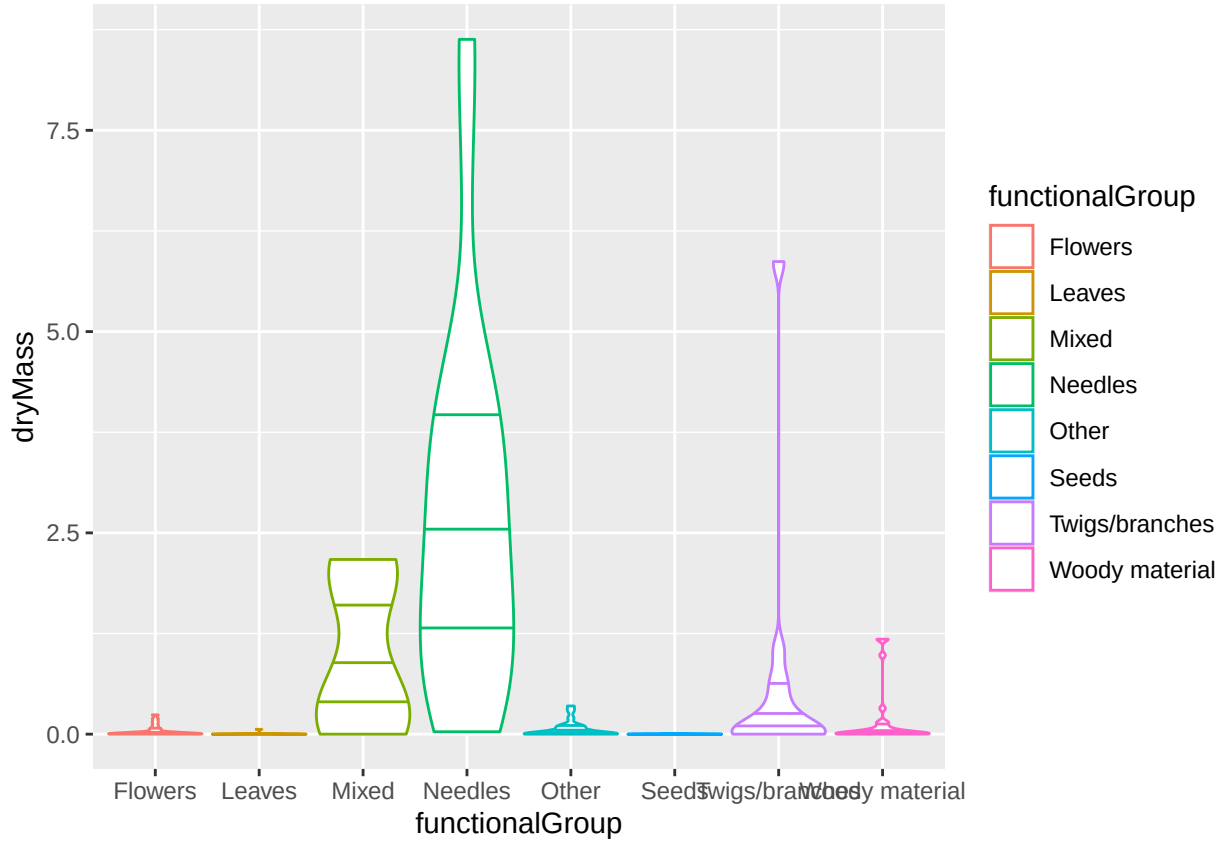



```
ggplot(Litter, aes(y = dryMass,x=functionalGroup,color=functionalGroup)) +
  geom_violin(draw_quantiles = c(0.25, 0.5, 0.75), scale = "width")
```

```
## Warning in regularize.values(x, y, ties, missing(ties), na.rm = na.rm):
## collapsing to unique 'x' values

## Warning in regularize.values(x, y, ties, missing(ties), na.rm = na.rm):
## collapsing to unique 'x' values

## Warning in regularize.values(x, y, ties, missing(ties), na.rm = na.rm):
## collapsing to unique 'x' values
```



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

> Answer: While a box plot only shows summary statistics such as median and interquartile ranges, the violin plot shows the full distribution of the data. In this case, boxplot can easily shows the quantiles of data and the outliers but in violin plot we can see the whole distribution of the variable, which makes it complicated.

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

> Answer: Needles.