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/natalievonturkovich/Documents/DUKE/Courses/Spring 22/ENV_872_EDA/Environmental_Data_Analy
```

```
library(tidyverse)
Neonics<-read.csv(file="/Users/natalievonturkovich/Documents/DUKE/Courses/Spring 22/ENV_872_EDA/Environm
Litter<-read.csv(file="/Users/natalievonturkovich/Documents/DUKE/Courses/Spring 22/ENV_872_EDA/Environme
```

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: Neonicotinoids are insecticides that target sad feeding insects. They are very effective at managing pests in many agricultural systems, but there are also great negative effects of their use as well. Honey bees in particular are very effected by the used of neonicotinoids. Their use has been studied by its effect on declining honey bee populations, including honey bee colony collapse disorder (CCD). Other negative effects have been oberved in declining populations of insect eating birds.

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 critical to a healty forest ecosystem. Among it's services are carbon sequestration, soil nutrient replenishment and ersion control. Additinally it provide habitat and nutrients to ground dwelling invertebrates.

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: Litter and woody debris is sampled by observing what material has fallen from the woody vegetation onto elevated traps and ground tarps. *Liter is defined as material that is dropped from the forest canopy and has a butt end diameter <2cm and a length <50 cm. Litter material is collected in elevated 0.5m2 PVC traps.* Fine wood debris is defined as material that is dropped from the forest canopy and has a butt end diameter <2cm and a length >50 cm and is collected in ground traps. *Litter and fine woody debris sampling is executed at terrestrial NEON sites that contain woody vegetation >2m tall.

Obtain basic summaries of your data (Neonics)

5. What are the dimensions of the dataset?

4623 rows and 30 columns

```
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 population, and mortality. These effects are specifically of interest because we have the most data on them.

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, and the Italian Honeybee. These species are all bees. They might be of interest over other insects because they are important pollinators for many plant species. Additionally as we discussed above, there has been a decline in bee populations causing great alarm. Bees are essential to our agricultural practices and it is important that we preserve their existence.

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 Conc.1..Author is a factor. A factor is a not numeric, it is categorical. It can contain numbers or letter values, wheres as numeric data is just numbers. Conc.1..Author includes numbers, factors of numbers and letters.

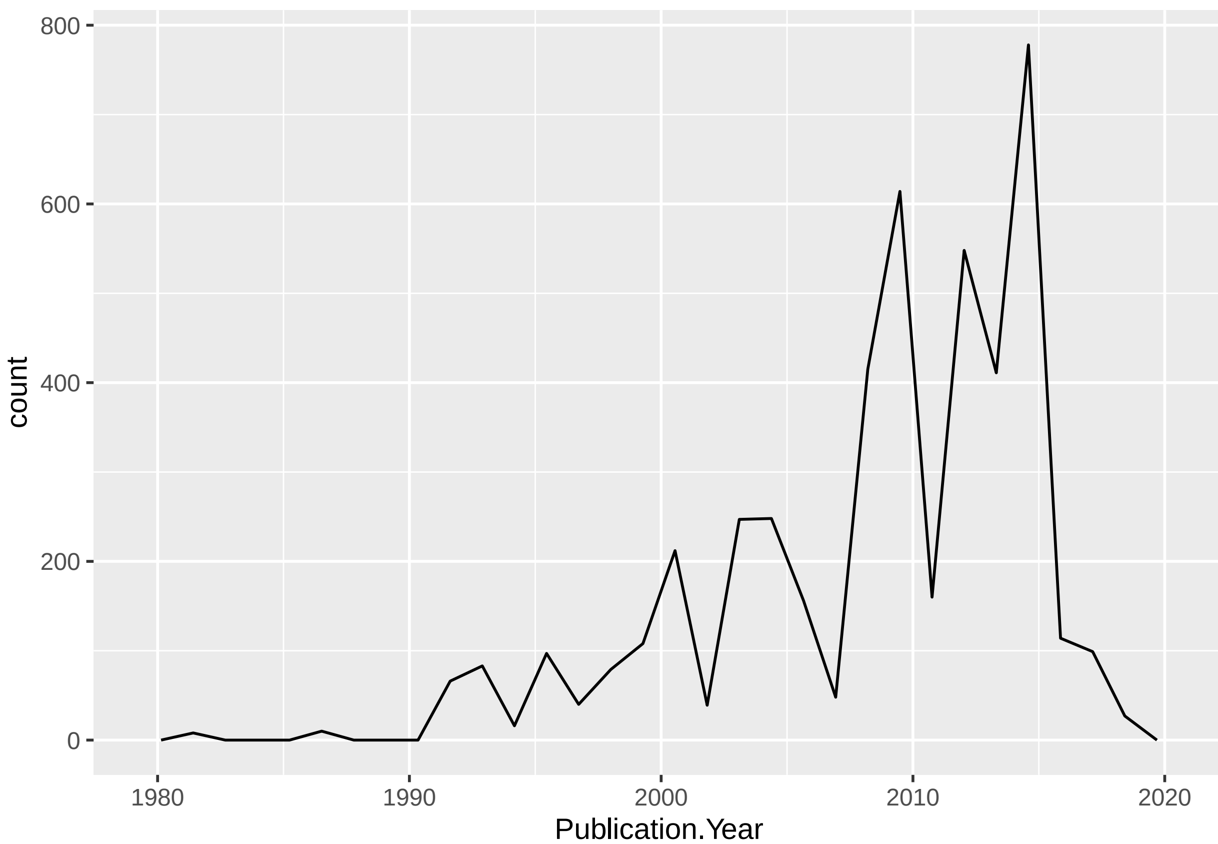
Explore your data graphically (Neonics)

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)
)
```

```
## Warning: Ignoring unknown aesthetics: bins
```

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

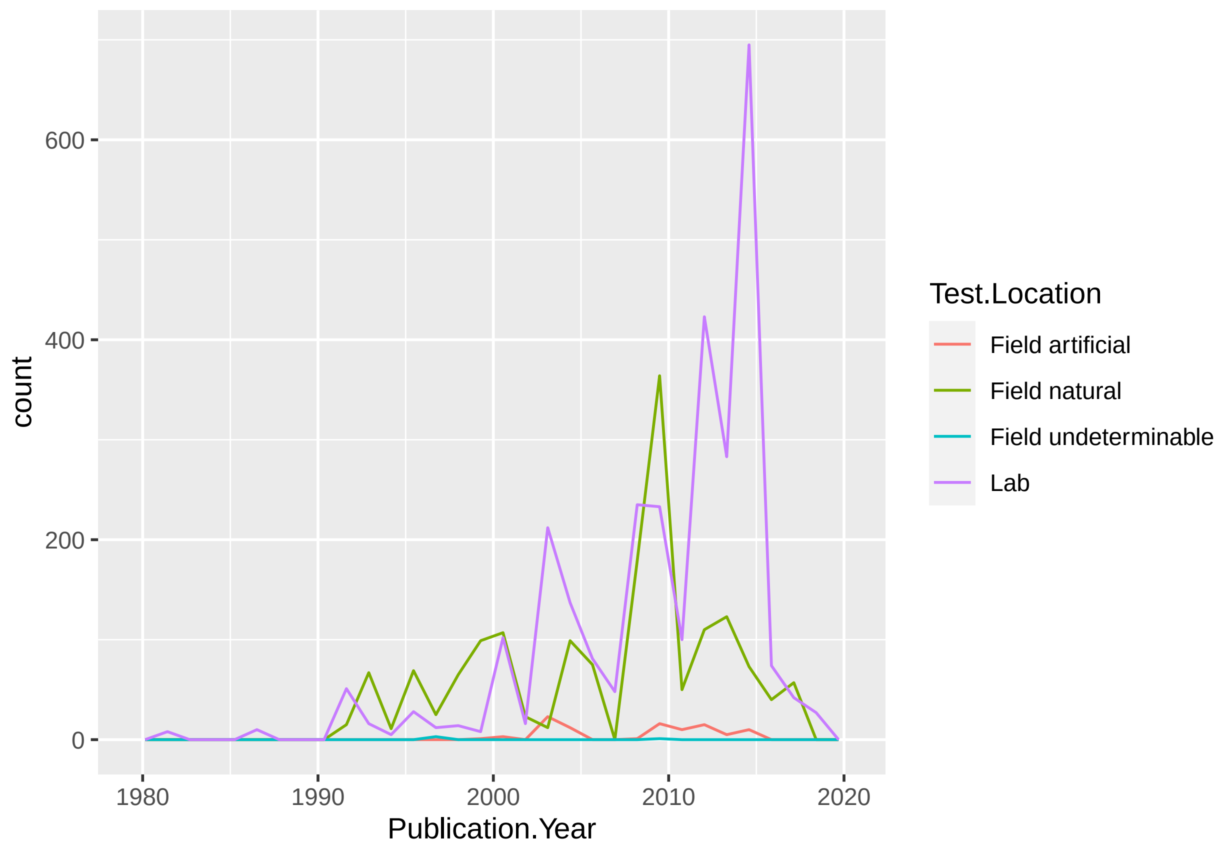


10. Reproduce the same graph but now add a color aesthetic so that different Test.Location are displayed as different colors.

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

```
## Warning: Ignoring unknown aesthetics: bins
```

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

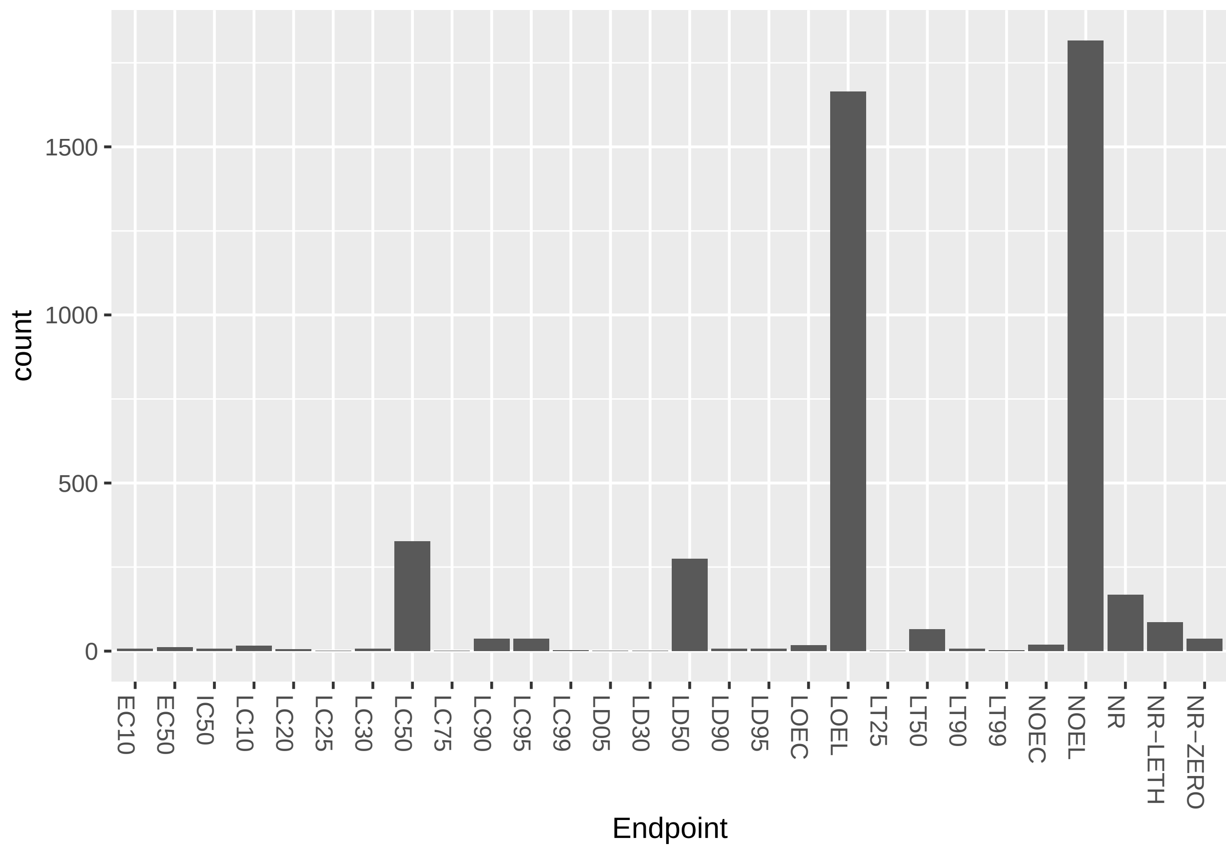


Interpret this graph. What are the most common test locations, and do they differ over time?

> Answer: The most common test locations are lab followed by field natural. Between 1990 and 2010 the most common test location flip flopped between lab and field natural. After 2010, lab test counts increased dramatically while field natural counts declined.

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, hjust = 0))
```



Answer: The two most common end points are NOEL and LOEL. NOEL means No-observable-effect-level, LOEL means Lowest-observable-effect-level.

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.

The unique dates sampled in August 2018 were 2018-08-02 and 2018-08-30.

```
class(Litter$collectDate)
```

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

```
library(lubridate)
```

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

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

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

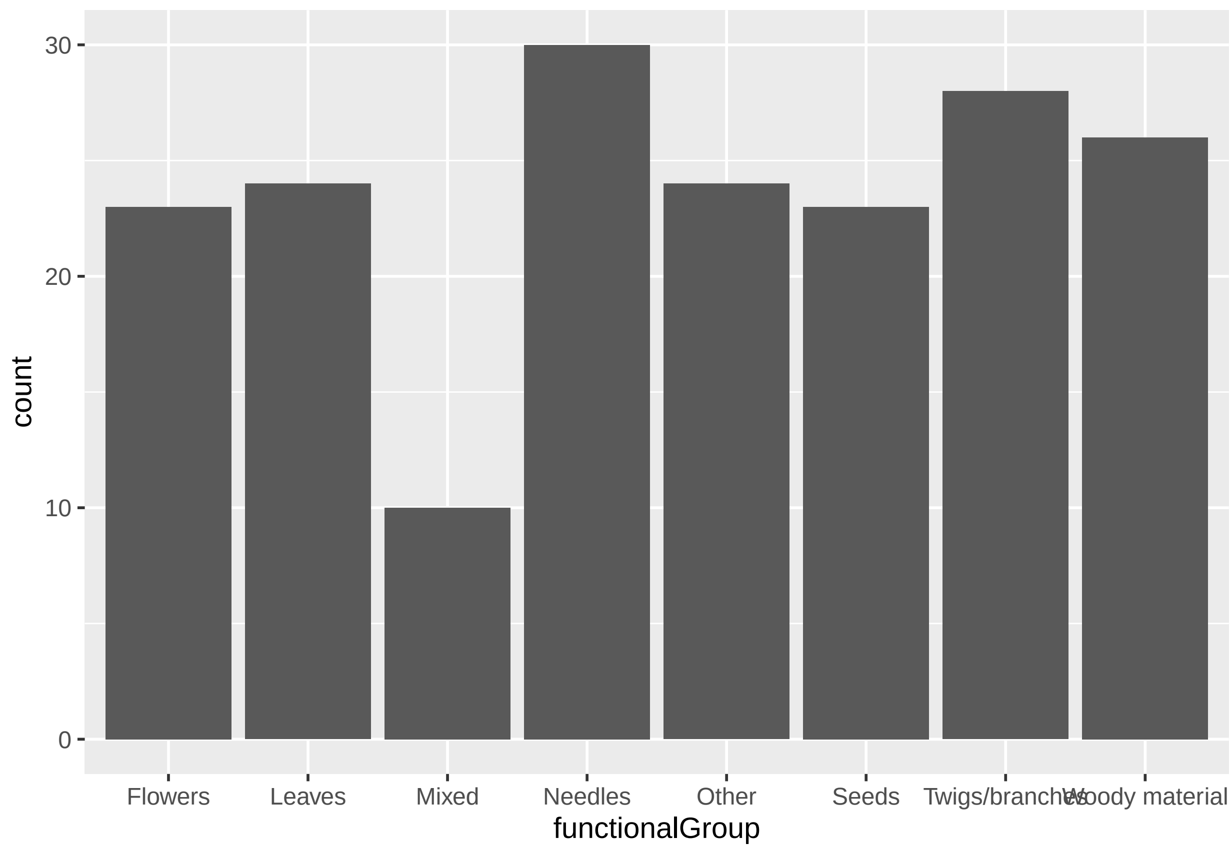
```
summary(Litter$plotID)
```

```
## 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: 12 ploits were sampled at Niwot Ridge. Summary shows how many samples were at each plot, while unique shows how many unique plots there were.

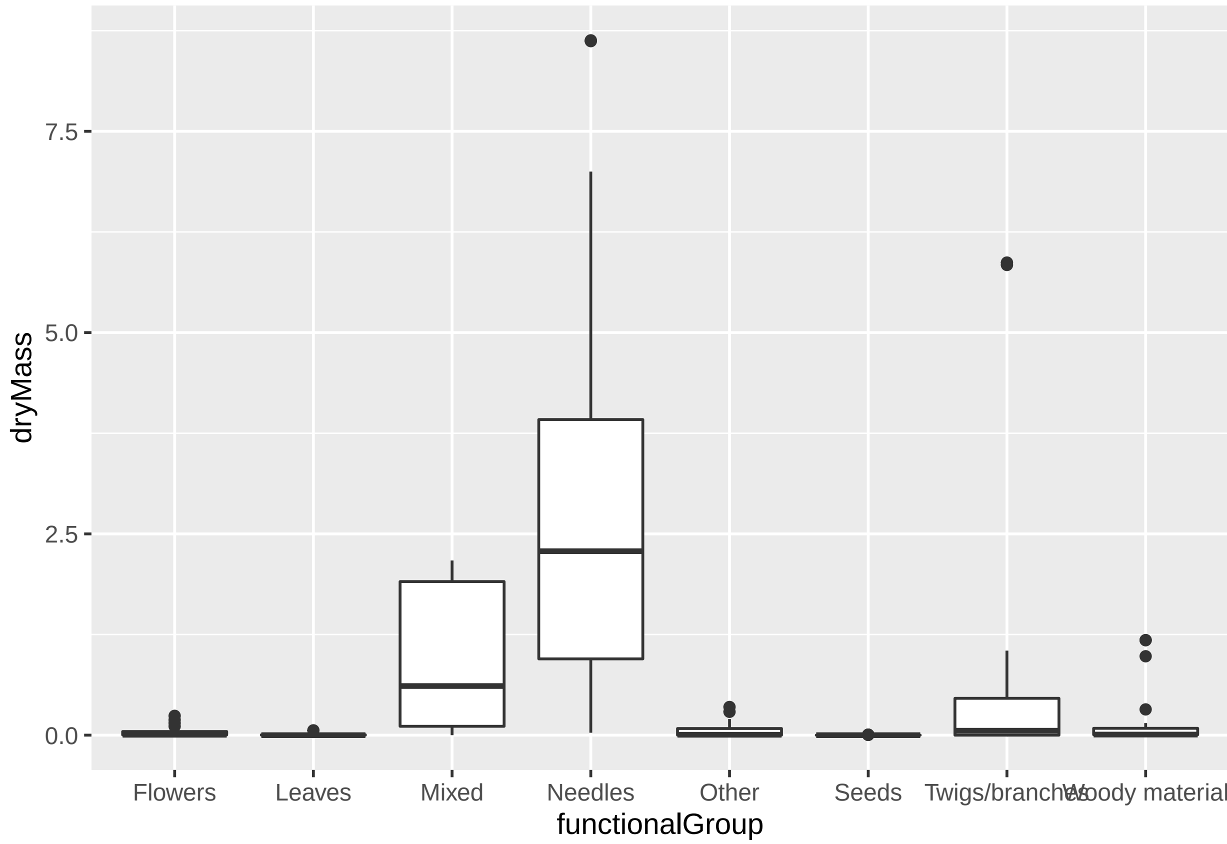
14. Create a bar graph of functionalGroup counts. This shows you what type of litter is collected at the Niwot Ridge sites. Notice that litter types are fairly equally distributed across the Niwot Ridge sites.

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

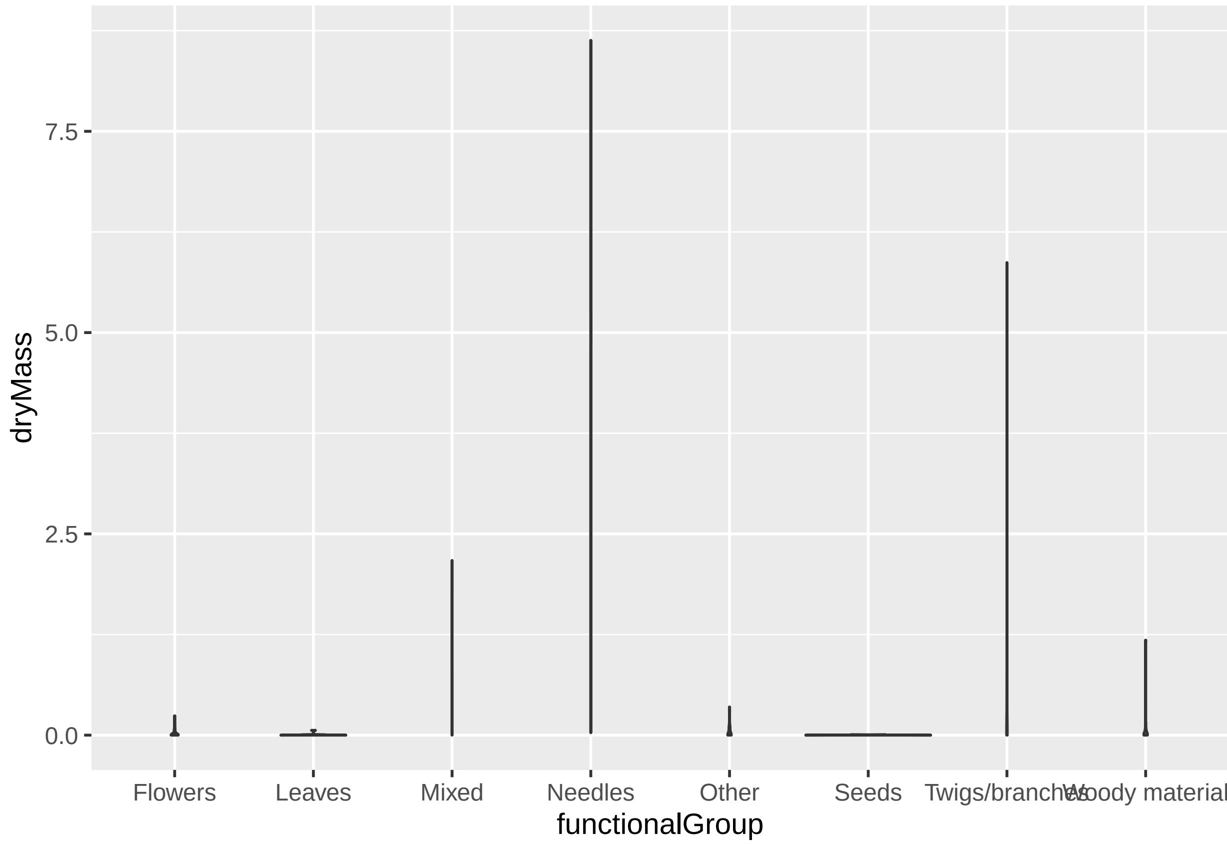


15. Using `geom_boxplot` and `geom_violin`, create a boxplot and a violin plot of dryMass by functionalGroup.

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




```r
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: The boxplot shows more dimensions of the data: outliers, quantiles and mean, while for the violin plot, there are not enough data points for each function group to show any meaningful statistics about the data.

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

> Answer: Needles tend to have the highest biomass.