Assignment 3: Data Exploration

Aurora McCollum, Section #1.001 Th 8:30

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 <1/31/22>.

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.**

```
library(tidyverse)
library(ggplot2)
library(dplyr)
library(readr)

getwd()
```

```
## [1] "/Users/rorymccollum/Desktop/Rdata/Environmental_Data_Analytics_2022"
```

```
Neonics <- read.csv('/Users/rorymccollum/Desktop/Rdata/Environmental_Data_Analytics_2022/Data/Raw/ECOTO
View(Neonics)

Litter <- read.csv('/Users/rorymccollum/Desktop/Rdata/Environmental_Data_Analytics_2022/Data/Raw/NEON_N
View(Litter)
```

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: It's interesting to note what effects are seen in insects because some effects might also occur in humans.

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: Forest litter and woody debris are important factors 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: Litter and woody debris are sampled in tower plots. *There is different litter trap placement (randomized or targeted) depending on vegetation* Plots must be specific distances from man made structures * Streams must not intersect plots.

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: It looks like population and mortality are the two most studied effects. Population might indicate that there is a population level effect, which is good to know that it's widespread. Mortality is good to know because death is a pretty strong effect.

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 top six species are all bees (except for the one wasp). These are likely of particular interest as important pollinators.

```
Honey Bee                      Parasitic Wasp
                        667                                285
         Buff Tailed Bumblebee                Carniolan Honey Bee
                        183                                152
                  Bumble Bee                   Italian Honeybee
                        140                                113
```

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.)
```

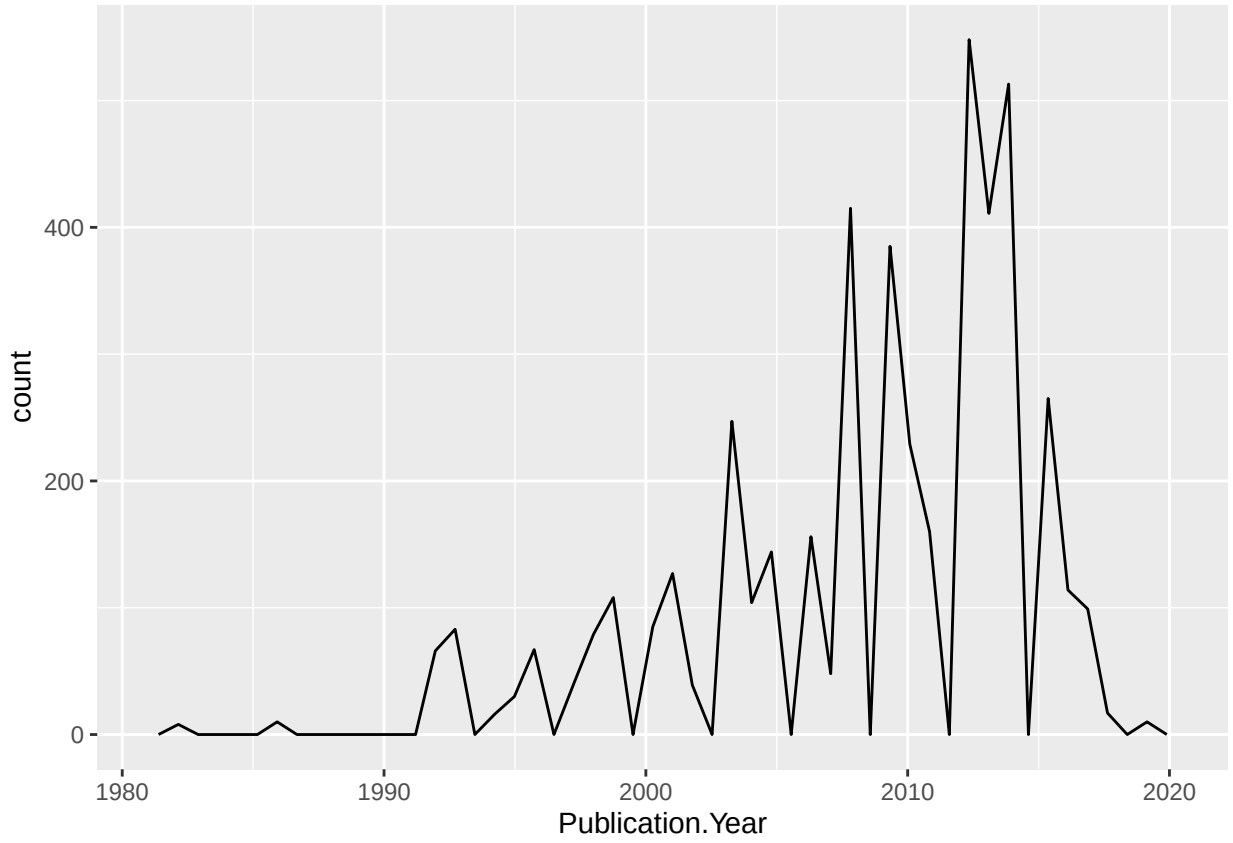
```
## [1] "factor"
```

Answer: Conc.1..Author is a factor because it uses only a certain set of values.

Explore your data graphically (Neonics)

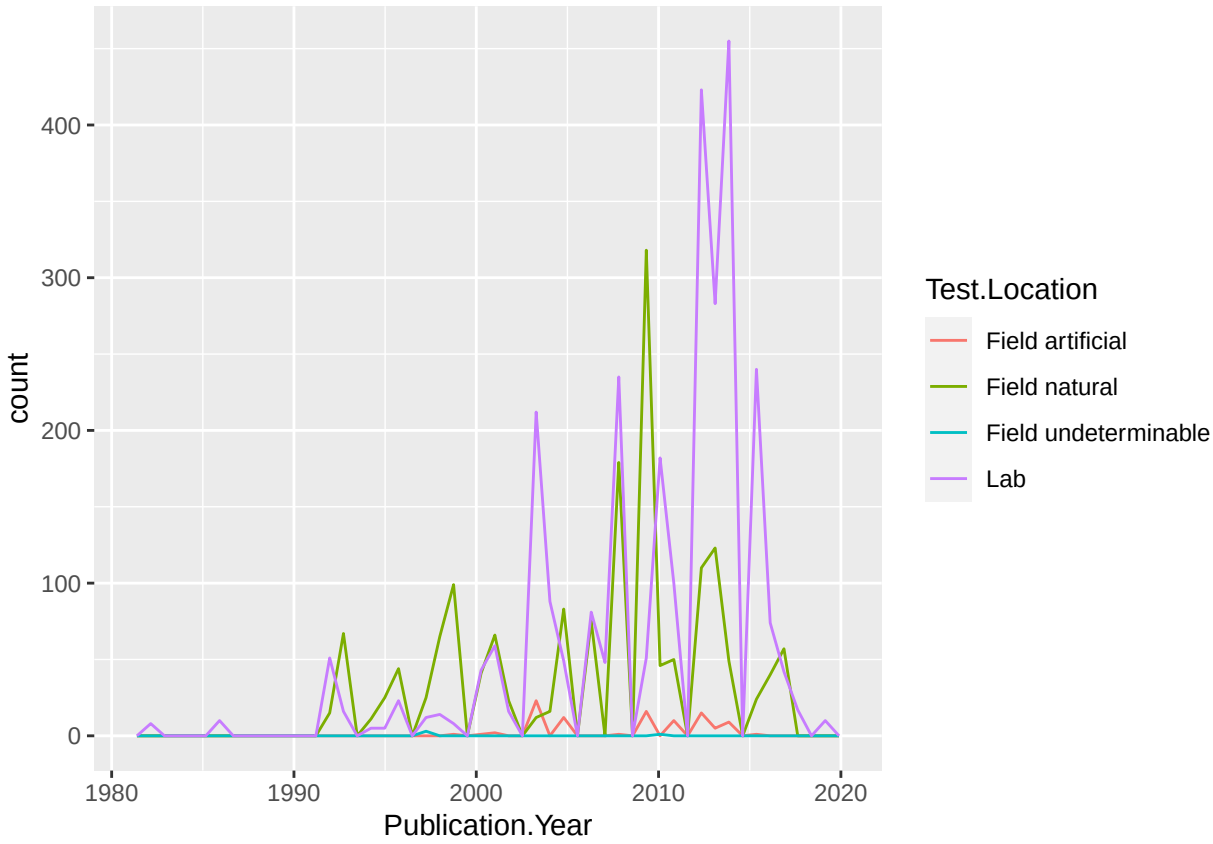
9. Using `geom_freqpoly`, generate a plot of the number of studies conducted by publication year.

```
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)
```

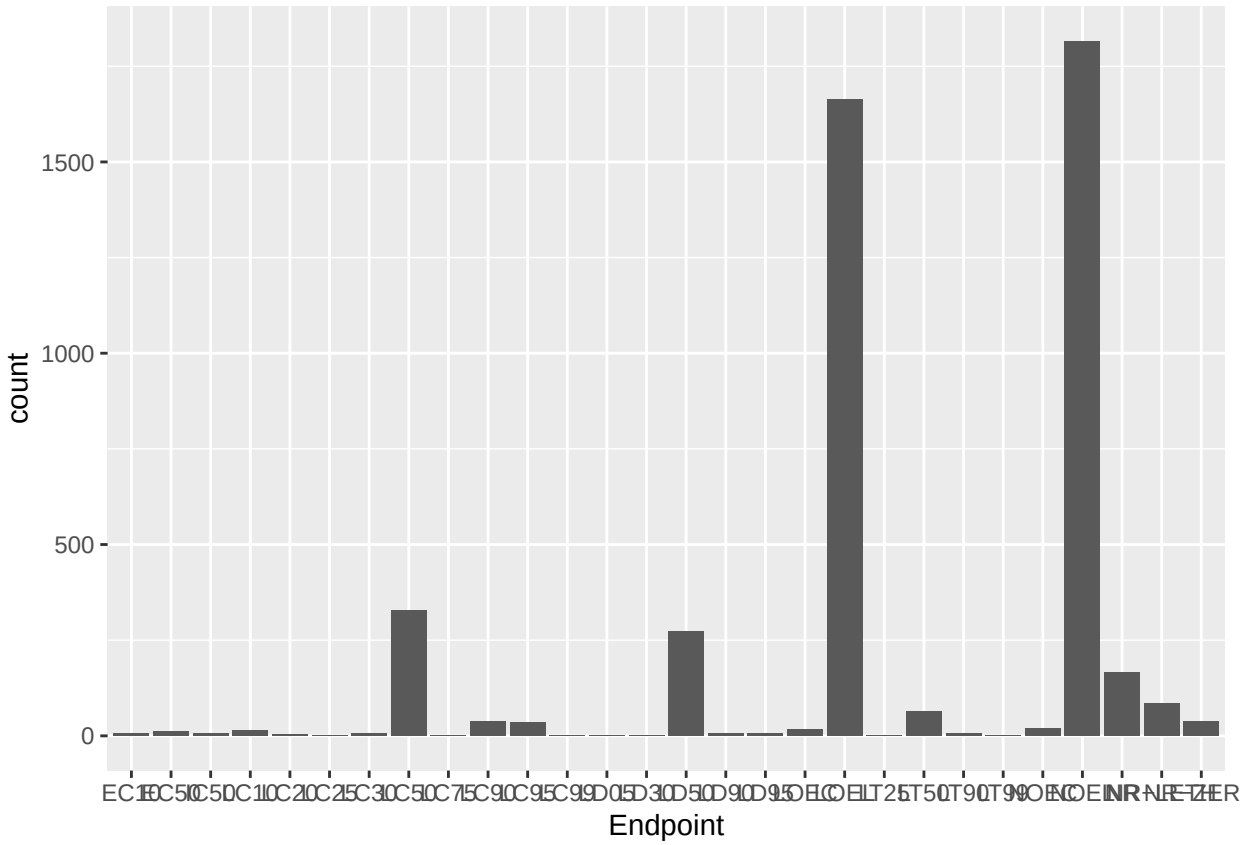


Interpret this graph. What are the most common test locations, and do they differ over time?

> Answer: The most common test location is the lab, and it has slowly been gaining traction over time. The second most common test location is "field natural" and it varied over time, the most popular time being just before 2010.

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: The two most common endpoints and LOEL= Lowest observed effect level and NOEL= no observed effect level. These describe the lowest dose of a toxin where you see a statistically significant effect and the highest does of a toxin where you see no effect, respectively.

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)
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$namedLocation)
```

```
##  [1] NIWO_061.basePlot.ltr NIWO_064.basePlot.ltr NIWO_067.basePlot.ltr
##  [4] NIWO_040.basePlot.ltr NIWO_041.basePlot.ltr NIWO_063.basePlot.ltr
##  [7] NIWO_047.basePlot.ltr NIWO_051.basePlot.ltr NIWO_058.basePlot.ltr
## [10] NIWO_046.basePlot.ltr NIWO_062.basePlot.ltr NIWO_057.basePlot.ltr
## 12 Levels: NIWO_040.basePlot.ltr ... NIWO_067.basePlot.ltr
```

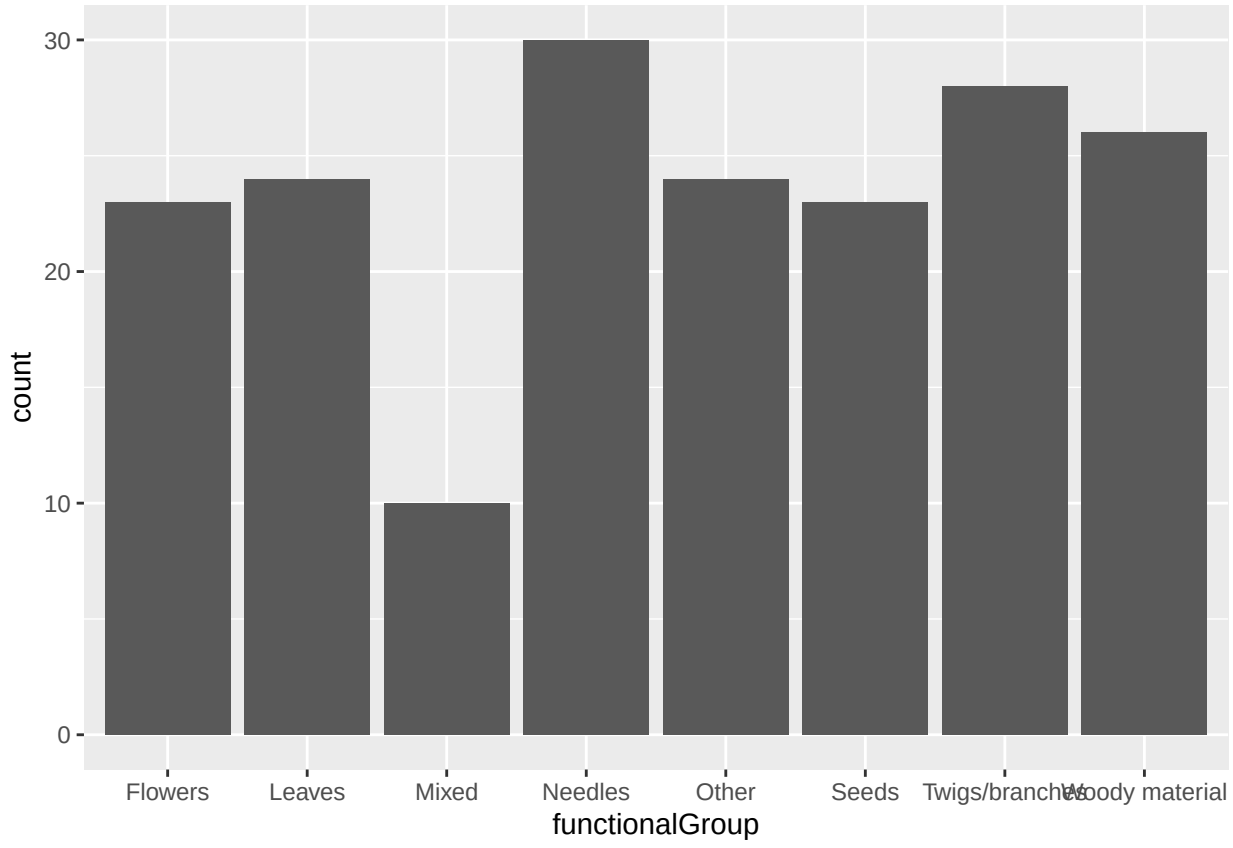
```
summary(Litter$namedLocation)
```

```
## NIWO_040.basePlot.ltr NIWO_041.basePlot.ltr NIWO_046.basePlot.ltr
##                    20                    19                    18
## NIWO_047.basePlot.ltr NIWO_051.basePlot.ltr NIWO_057.basePlot.ltr
##                    15                    14                     8
## NIWO_058.basePlot.ltr NIWO_061.basePlot.ltr NIWO_062.basePlot.ltr
##                    16                    17                    14
## NIWO_063.basePlot.ltr NIWO_064.basePlot.ltr NIWO_067.basePlot.ltr
##                    14                    16                    17
```

Answer: There were 12 different plot locations. Summary shows the name of the plot with the nuber of times it was sampled underneath while unique shows the names of the plots in rows and at the end tells you the number of levels.

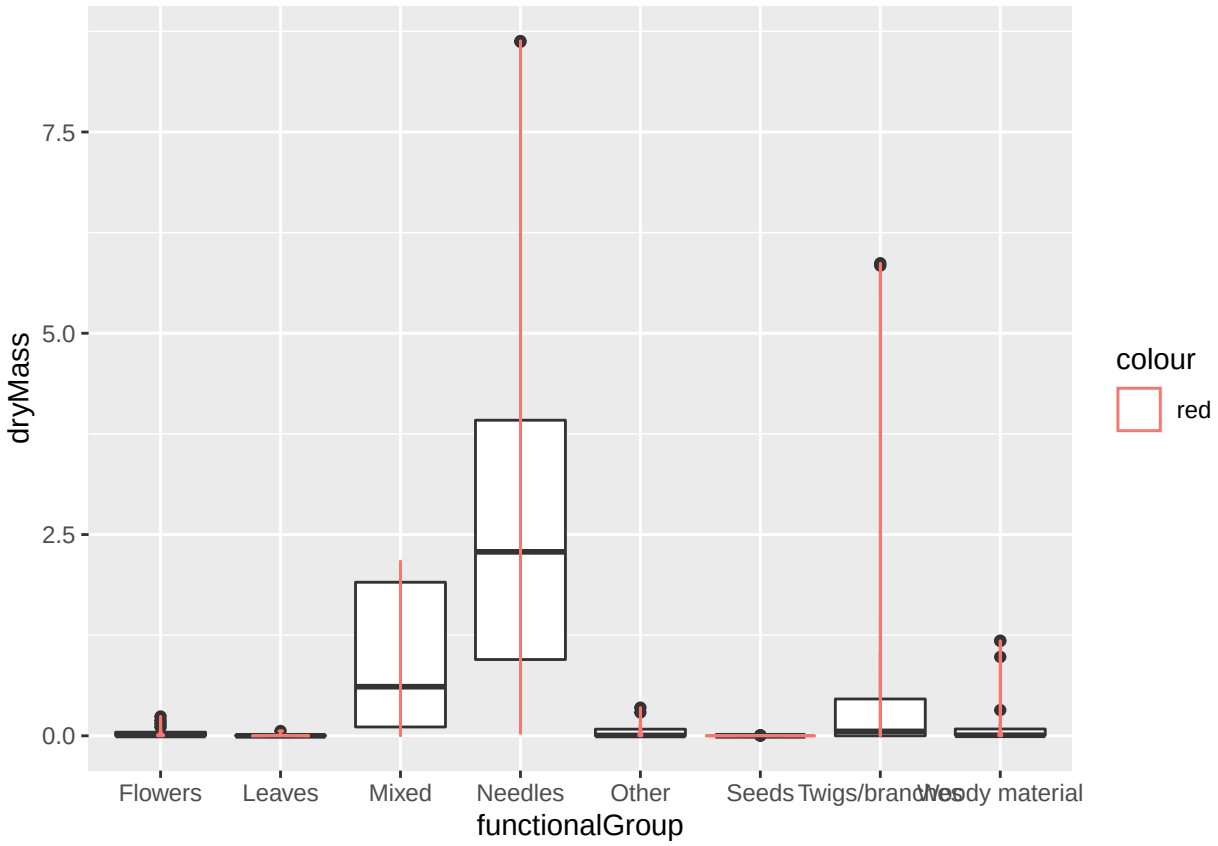
14. Create a bar graph of functionalGroup counts. This shows you what type of litter is collected at the Niwot Ridge sites. Notice that litter types are fairly equally distributed across the Niwot Ridge sites.

```
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)) +
  geom_violin(aes(x=functionalGroup, y=dryMass, color="red"))
```



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

Answer: A boxplot tells you more information than the violin plot. Vioin only shows a line up to the uppermost bound for each group, while boxplots show you where the data is concentrated.

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

Answer: Needles tend to have the highest biomass, followed by mixed.