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.**

```
library(tidyverse)
```

```
## Warning: package 'tidyverse' was built under R version 4.0.5

## Warning: package 'ggplot2' was built under R version 4.0.5

## Warning: package 'tibble' was built under R version 4.0.5

## Warning: package 'tidyr' was built under R version 4.0.5

## Warning: package 'readr' was built under R version 4.0.5

## Warning: package 'purrr' was built under R version 4.0.5

## Warning: package 'dplyr' was built under R version 4.0.5

## Warning: package 'stringr' was built under R version 4.0.5
```

```
## Warning: package 'forcats' was built under R version 4.0.5
```

```
library(ggplot2)

setwd("~/Environmental Data Analytics")
getwd()
```

```
## [1] "C:/Users/Emma DeAngeli/Documents/Environmental Data Analytics"
```

```
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: Neonicotinoids are harmful to insects. This is particularly concerning in terms of Colony Collapse Disorder, which has caused the number of bees to dwindle. Since bees are important pollinators, this is quite concerning.

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: The grounds of forests have important roles in the carbon cycle. I imagine that the amounts of litter and woody debris would have implications for this process.

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: NEON ascertained the weights of each litter trap and categorized them into different levels based upon these weights. * Trap placements within plots was both targeted and randomized. * Deciduous and evergreen sites had different frequencies of data collection, deciduous being more frequent. * The weights are categorized by groups at each site (pine needles, seeds, leaves, etc.).

Obtain basic summaries of your data (Neonics)

5. What are the dimensions of the dataset?

```r
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?

```r
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: Mortality, Population, and Behavior are the top three most common effects studied. These would all be important to understand Colony Collapse Disorder.

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.

```r
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 most commonly studied species are all different kinds of bees, the primary being the honeybee. They are important pollinators! Although beetles are cool too.

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.)
```

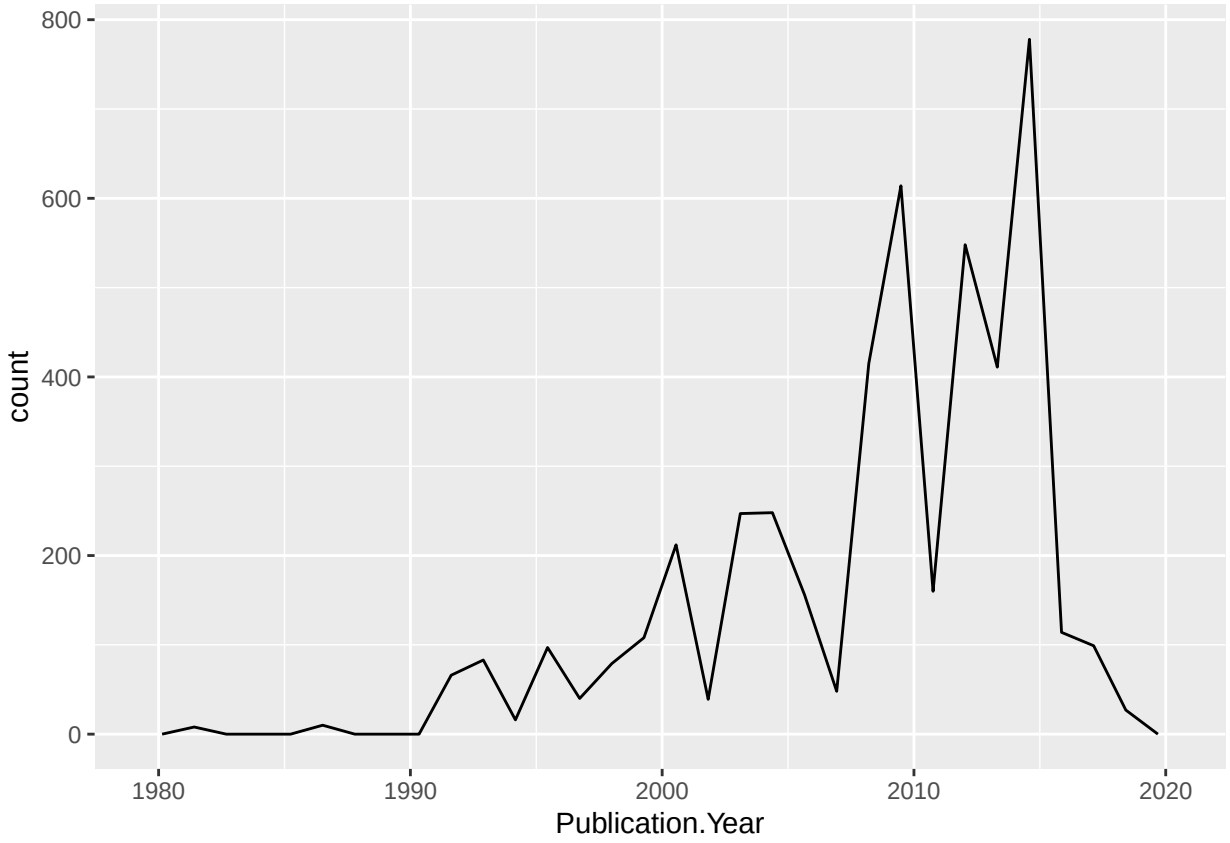
```
## [1] "factor"
```

Answer: It is a factor because there are values that include a "greater than" sign.

Explore your data graphically (Neonics)

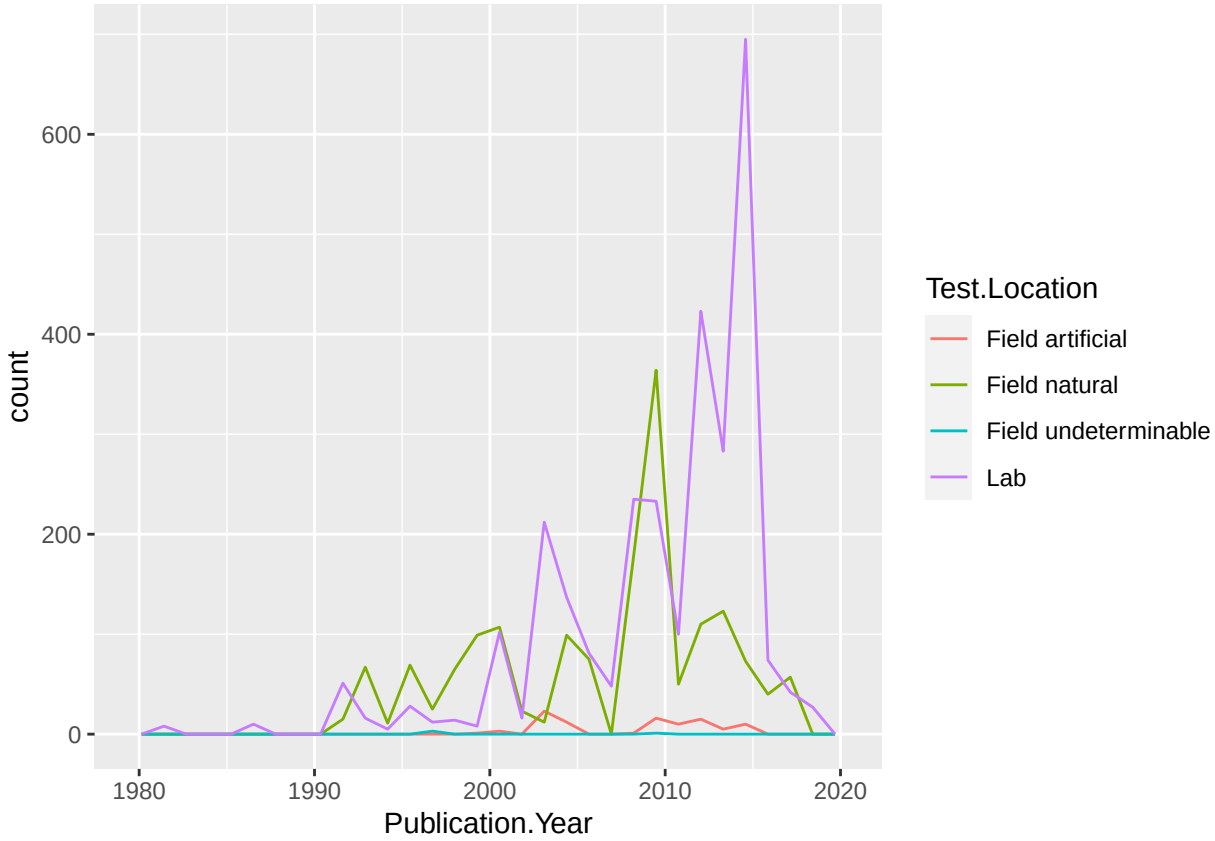
9. Using `geom_freqpoly`, generate a plot of the number of studies conducted by publication year.

```
ggplot(Neonics) +
  geom_freqpoly(aes(x = Publication.Year), bins = 30)
```



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 = 30)
```

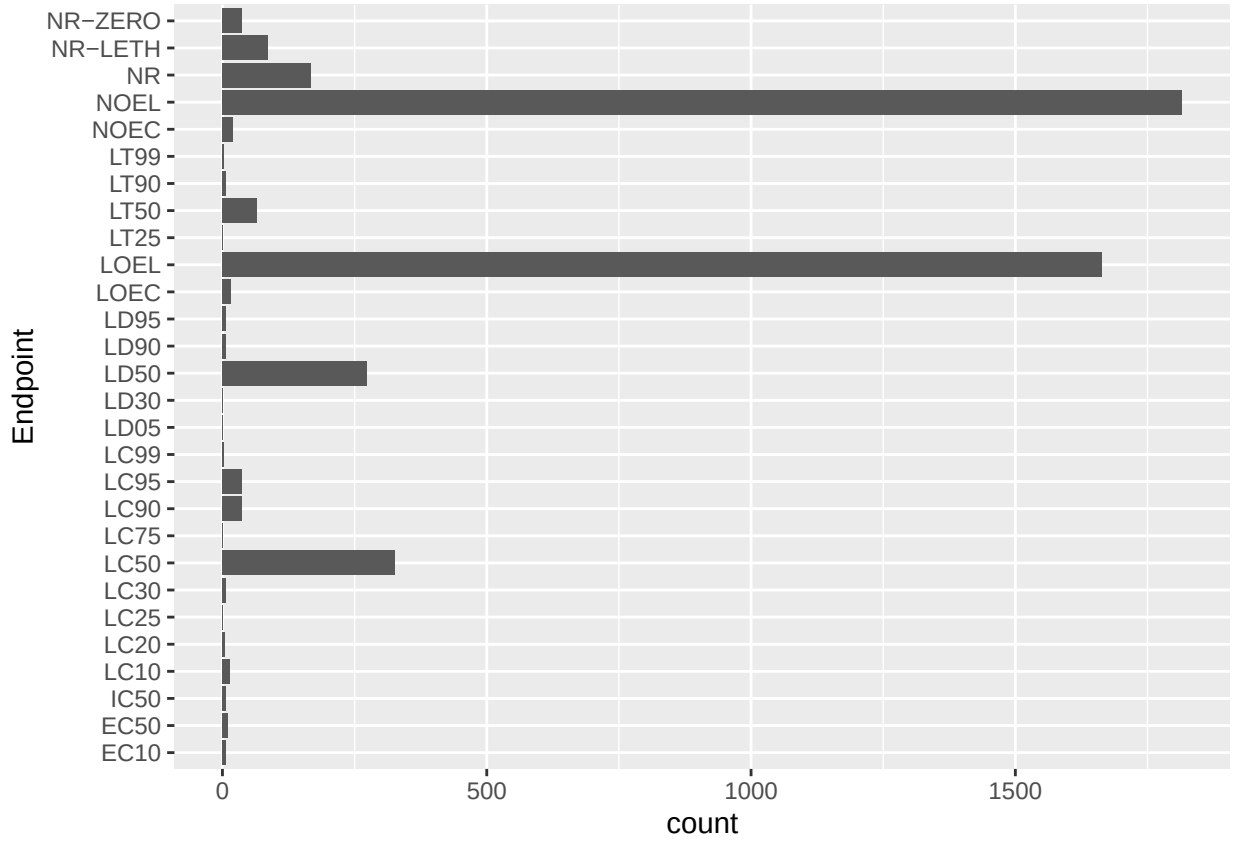


Interpret this graph. What are the most common test locations, and do they differ over time?

> Answer: The most common test locations are "Lab" and "Fireld natural." There are some years in which "Field natural" is most common (1995-2000, 2008-2010), but mostly "Lab" prevails.

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(y = Endpoint)) +
  geom_bar()
```



Answer: NOEL and LOEL are the two most common end points. LOEL is the "lowest-observable-effect-level" which means the lowest dose producing effects that were significantly different than the control responses. NOEL is "no-observable-effect-level" which was the highest does producing effects not significantly different from control responses.

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)

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"
```

Answer: The class was originally a factor. The dates litter was sampled were August 2nd and 30th.

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`?

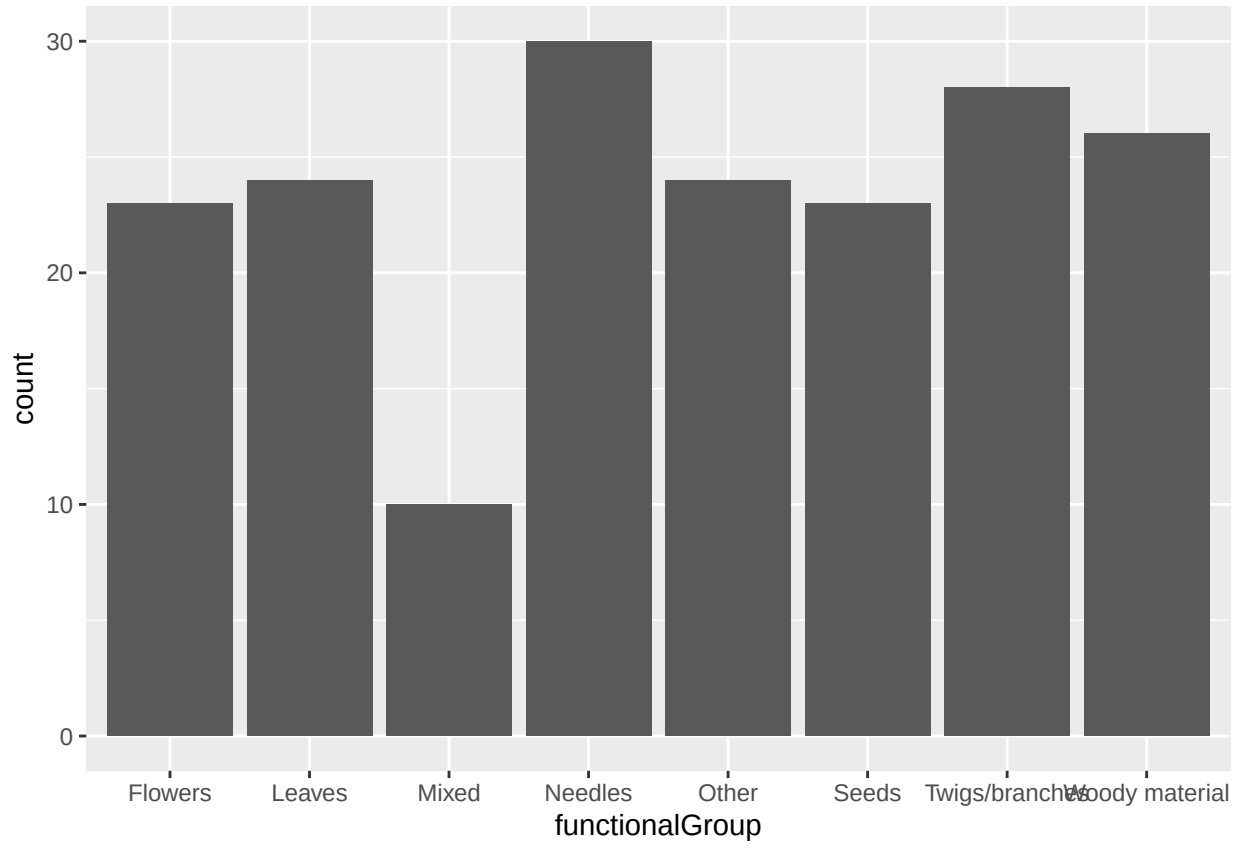
```
unique(Litter$plotID)
```

```
##  [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
```

Answer: 'summary' shows the counts of each variable whereas 'unique' shows only what unique variables exist.

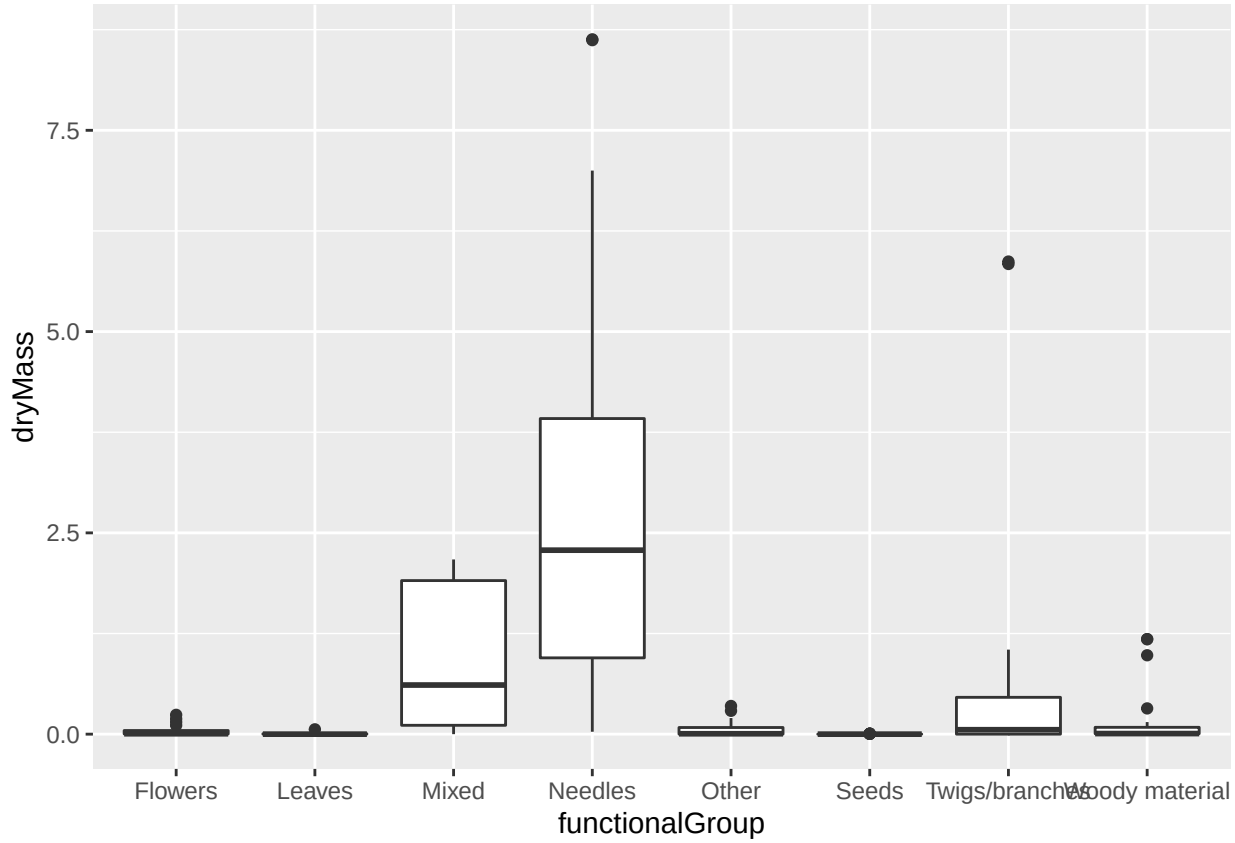
14. Create a bar graph of functionalGroup counts. This shows you what type of litter is collected at the Niwot Ridge sites. Notice that litter types are fairly equally distributed across the Niwot Ridge sites.

```
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))
```

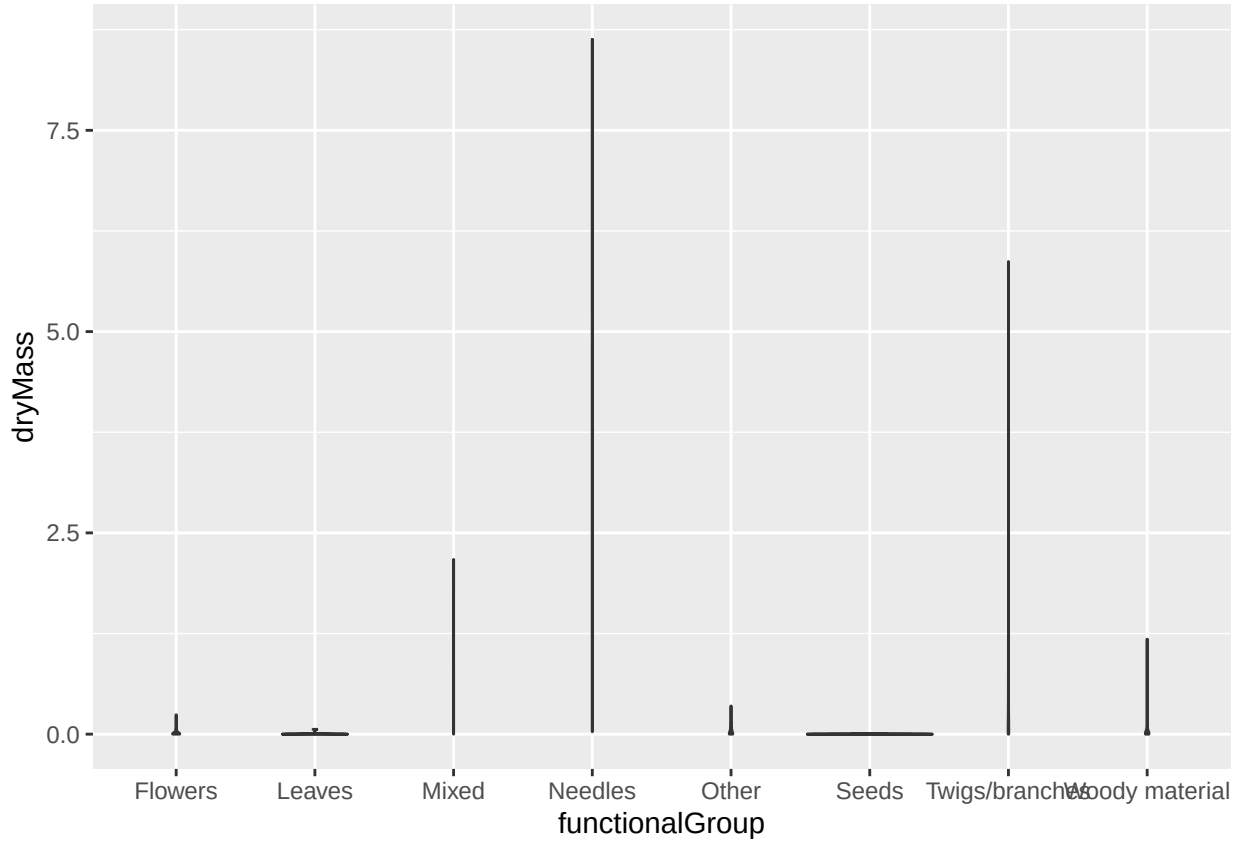



```
ggplot(Litter) +
  geom_violin(aes(x = functionalGroup, y = dryMass),
              draw_quantiles = c(0.25, 0.5, 0.75))
```

```
## 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: There seems to be pretty even distributions for the functionalGroups, so the violin plots pretty much just show straight lines.

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

> Answer: Needles, mixed litter, and twigs/branches are the top three highest biomass litters.