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.**

```
setwd("~/Desktop/Duke/Data Analytics/Environmental_Data_Analytics_2022")
getwd()
```

```
## [1] "/Users/devindomeyer/Desktop/Duke/Data Analytics/Environmental_Data_Analytics_2022"
```

```
#install.packages("tidyverse")
library(tidyverse)

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: Since neonicotinoids are a class of insecticides and are used widely, it would be beneficial to know how widespread its effects are. Although used in agriculture to control harmful insects, neonicotinoids are also effective at killing pollinators like bees which are already experiencing massive die-offs in the United States. There is also controversy surrouding exactly how dangerous neonicotinoids are to bees, with field-studies yielding different results than laboratory research.

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: Litter and woody debris in forests are shown to increase risk of forest fires, especially in the drier more arid regions of the western United States. It is common practice to preemptively burn or remove the woddy debris and litter to ensure incidental fires have less fodder.

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: * One litter trap pair (1 elevated trap & 1 ground trap) is deployed for every 400 m^2 plot area. * Ground traps are sampled once per year. * Trap pair placement within plots may be either targeted or randomized, depending on the vegetation.

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 studies are 1. Population and 2. Mortality, both with an order of magnitude more observations than the other effects. Across studies these are likely measured more because they give the best indication of how effective the insecticide is at killing insects, and potentially how dangerous it is to non-target species.

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: 1. Honey Bee, Parasitic Wasp, Buff Tailed Bumblebee, Carniolan Honey Bee, Bumble

Bee, Italian Honeybee. These species are all important pollinator species and very important in agriculture. Parasitic Wasps not only pollinate, they are also a common and effective pest controller. It would be important to know how neonicotinoids would impact these species.

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 in the dataset. It isn't numeric because many of the observations have a backward slash after the number. I'm sure there is an important reason for this but I'm not sure why.

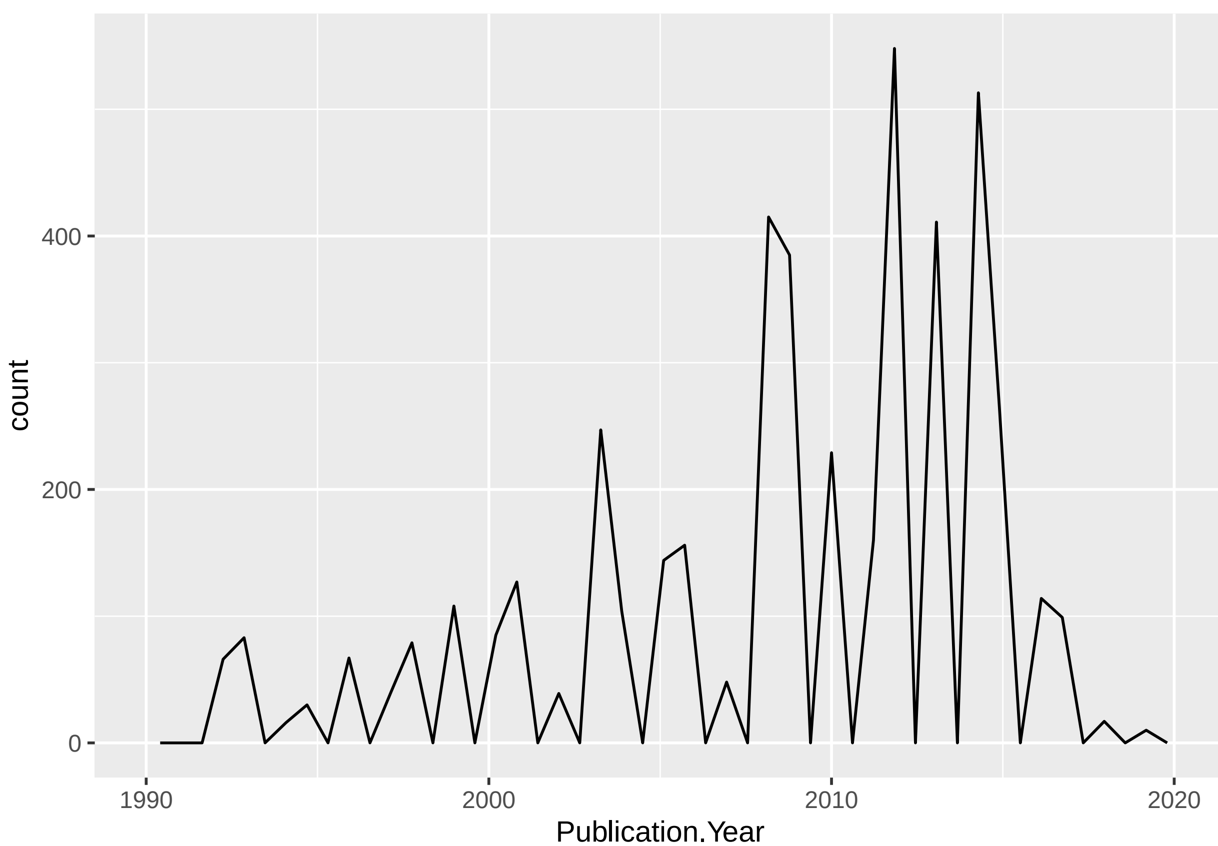
Explore your data graphically (Neonics)

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

```
ggplot(Neonics) +
  geom_freqpoly(aes(x = Publication.Year, color = Publication.Year), bins = 50) +
  scale_x_continuous(limits = c(1990, 2020)) +
  theme(legend.position = "top")
```

```
## Warning: Removed 18 rows containing non-finite values (stat_bin).

## Warning: Removed 3 row(s) containing missing values (geom_path).
```

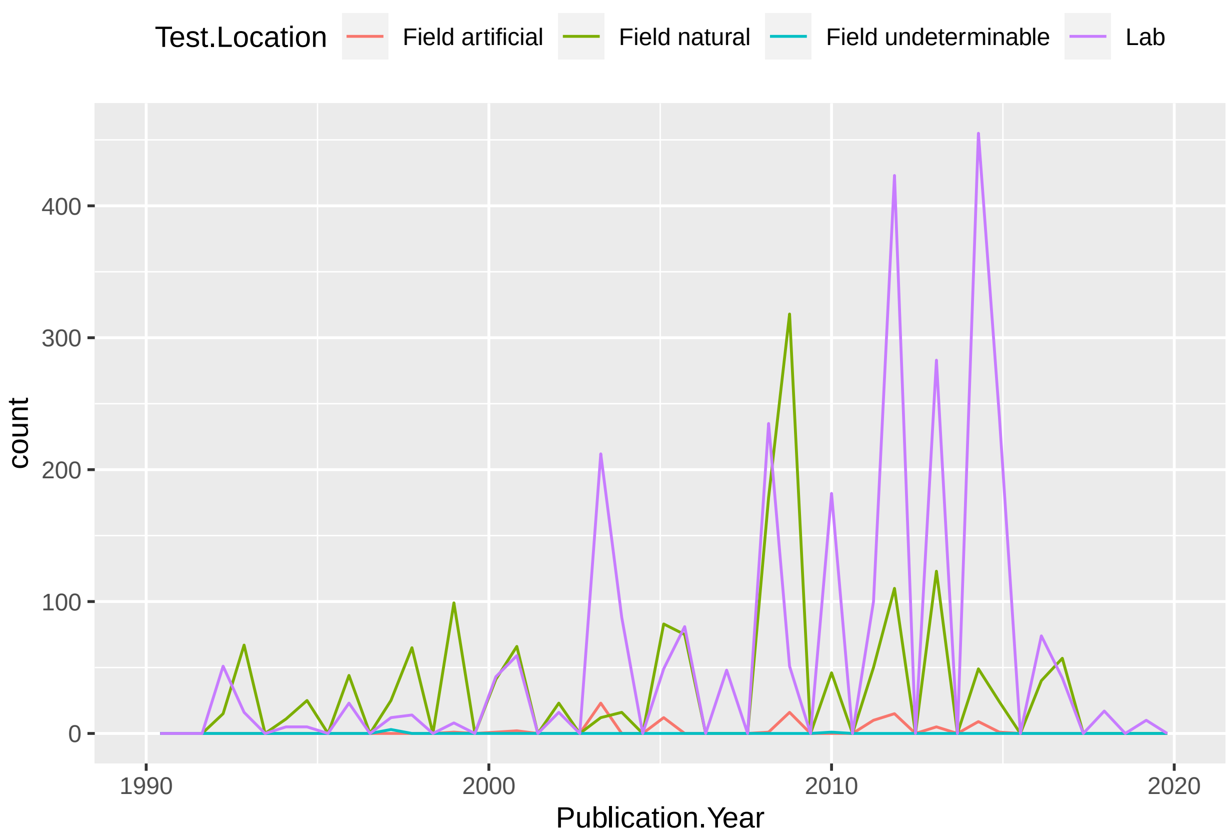


10. Reproduce the same graph but now add a color aesthetic so that different Test.Location are displayed as different colors.

```
ggplot(Neonics) +
  geom_freqpoly(aes(x = Publication.Year, color = Test.Location), bins = 50) +
  scale_x_continuous(limits = c(1990, 2020)) +
  theme(legend.position = "top")
```

```
## Warning: Removed 18 rows containing non-finite values (stat_bin).
```

```
## Warning: Removed 12 row(s) containing missing values (geom_path).
```

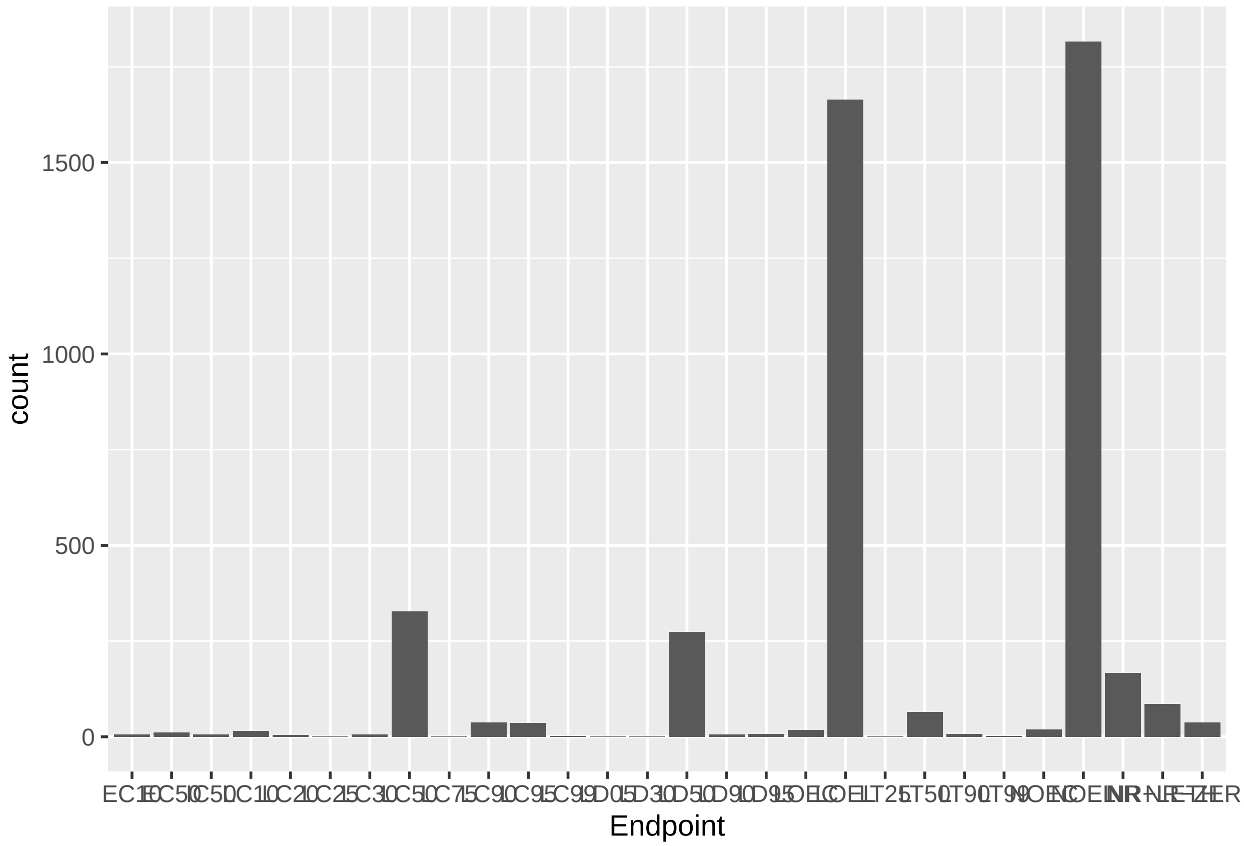


Interpret this graph. What are the most common test locations, and do they differ over time?

> Answer: The most common test locations are Lab and Field Natural. Overtime, the relative proportion of Lab to Field Natural locations increases.

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: NOEL and LOEL are the most common endpoints. NOEL means "no observable effect level", in which the highest dose produces effects not significantly different from responses of controls. LOEL means "lowest observable effect level", in which the lowest dose produces effects that were significantly different from the responses of controls.

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, format = "%Y-%m-%d")
class(Litter$collectDate)
```

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

```
unique(Litter$collectDate)
```

```
## [1] "2018-08-02" "2018-08-30"
```

Answer: The class of collectDate is "factor." On August 2 and August 30 litter was sampled in August 2018.

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`?

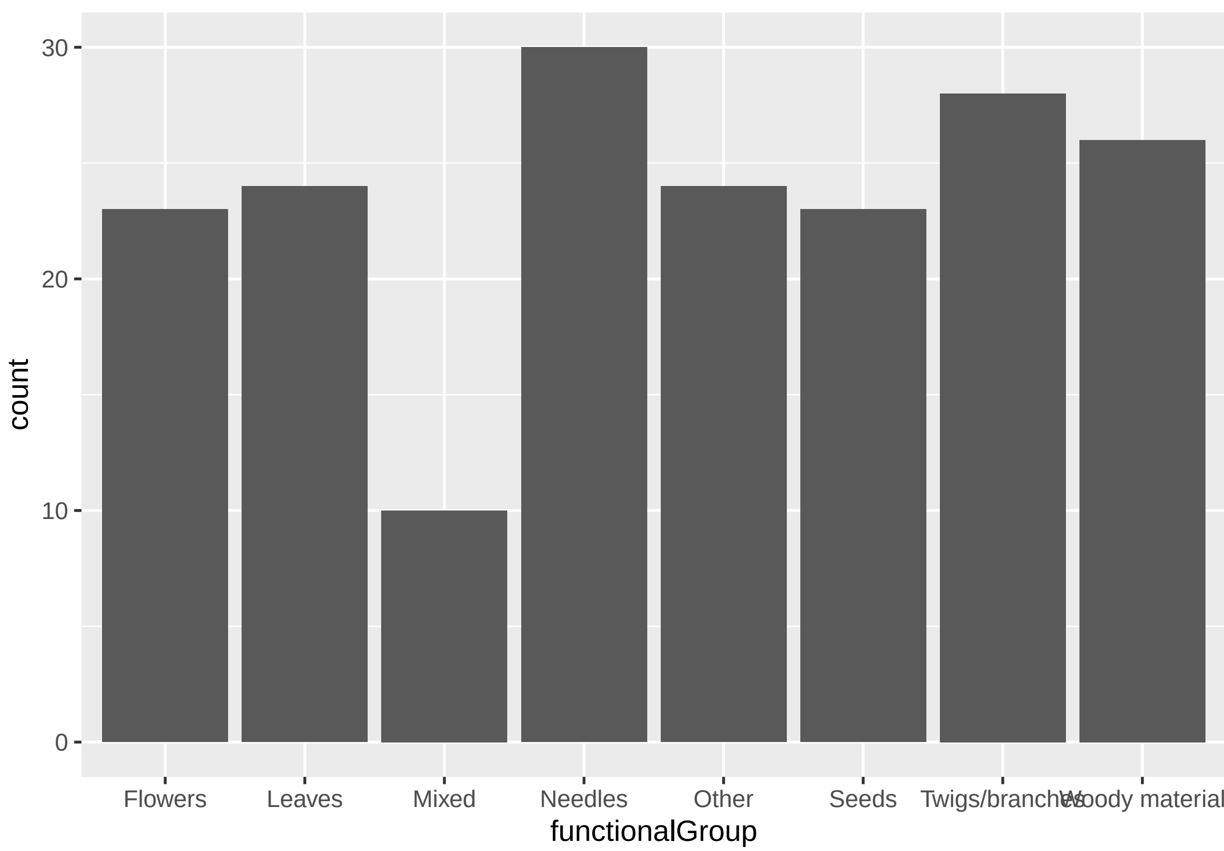
```
unique(Litter$plotID)
```

```
##  [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: 12 plots were sampled at Niwot Ridge. This information is different from summary because it can be defined to smaller subsets of the data frame.

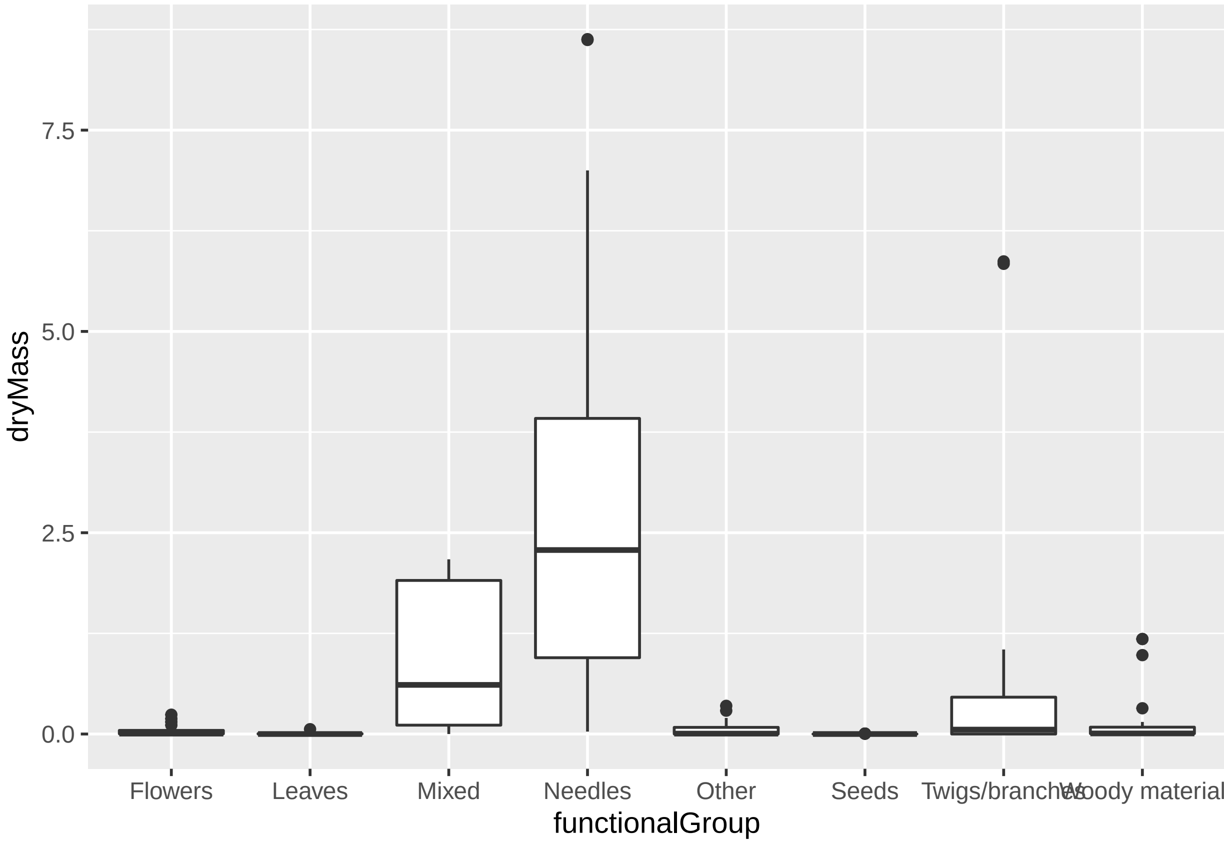
14. Create a bar graph of functionalGroup counts. This shows you what type of litter is collected at the Niwot Ridge sites. Notice that litter types are fairly equally distributed across the Niwot Ridge sites.

```
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))
```

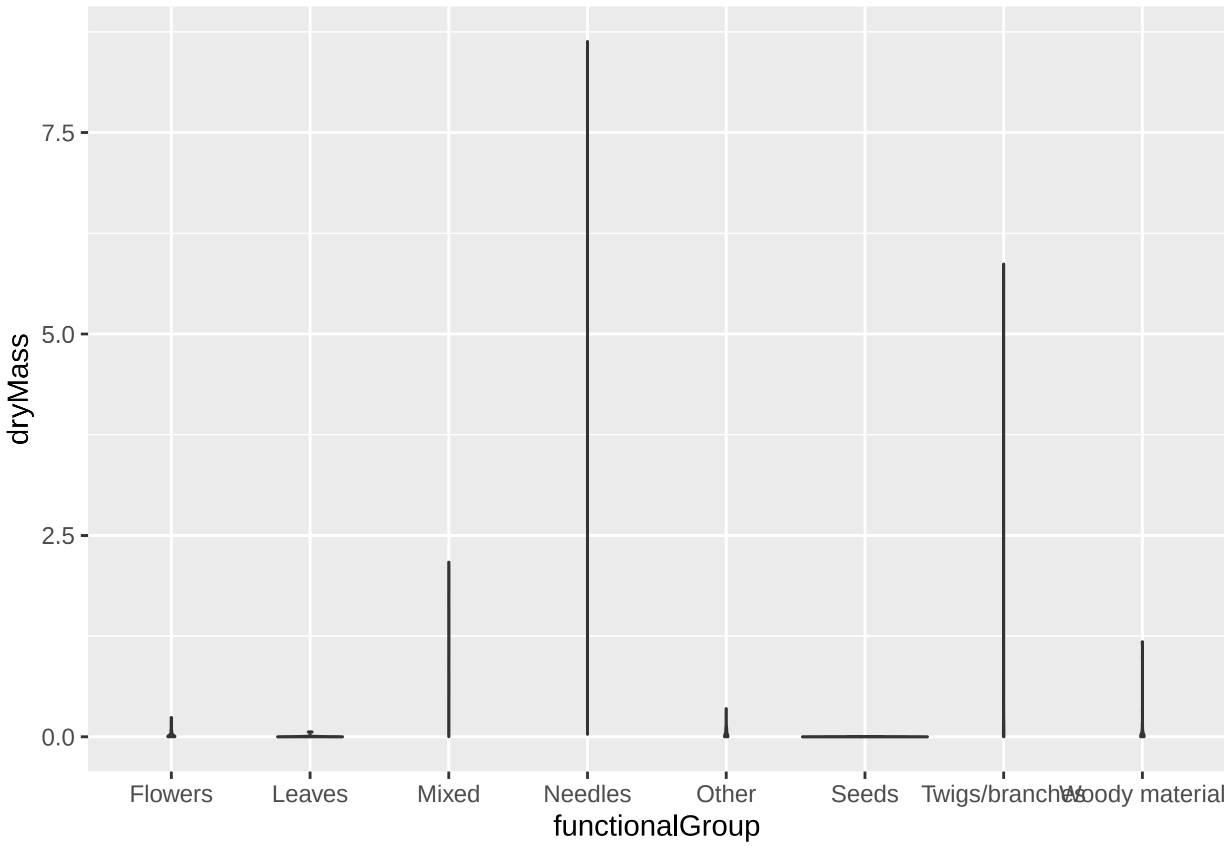



```
ggplot(Litter) +
  geom_violin(aes(x = functionalGroup, y = dryMass),
              draw_quantiles = c(0.25, 0.5, 0.75))
```

```
## 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: A boxplot is more effective in this case because across functional groups the data is fairly evenly distributed across drymass levels. There aren't any large data clusters that would demonstrate the violin effect.

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

> Answer: Needles tend to have the highest biomass at these sites.