Assignment 3: Data Exploration

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OVERVIEW

This exercise accompanies the lessons in Environmental Data Analytics on Data Exploration.

Directions

1. Rename this file `<FirstLast>_A03_DataExploration.Rmd` (replacing `<FirstLast>` with your first and last name).
2. Change "Student Name" on line 3 (above) with your name.
3. Work through the steps, **creating code and output** that fulfill each instruction.
4. Be sure to **answer the questions** in this assignment document.
5. When you have completed the assignment, **Knit** the text and code into a single PDF file.
6. After Knitting, submit the completed exercise (PDF file) to the dropbox in Sakai.

The completed exercise is due on Sept 30th.

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 include the subcommand to read strings in as factors.

```
getwd()
```

```
## [1] "/home/guest/ENV872/EDA-Fall2022"
```

```
library(tidyverse)
library(lubridate)
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 ecotoxicology of neonicotinoids on insects? Feel free to do a brief internet search if you feel you need more background information.

   Answer: Neonicotinoids selectively control pests. It can control pests that are resistant to other insecticides. While ensuring that beneficial insects are still present to ward off other potential pests. Knowing how neonicotinoid affects beneficial insects is significant, especially to bees.

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 influences the productivity of forests and the growth of trees by increasing the nutrients accumulated from the underlying soil and its biomass. Litter plays an important role in biogeochemical cycles. Woody debris serve as a habitat because they show variations in the forest's physical structure, which modify the type of light reflected into the tree canopy and create new habitat types on the forest floor.

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: 1. Quality control measures 2. All masses reported after processing are reported at a single trap's spatial resolution and a single collection event's temporal resolution. 3. The target sampling frequency for elevated traps varies depending on the vegetation at the site.

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: From those effect we can see in what way insects react to Neonicotinoids.

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: They are common insects that affect vegetation/crops. We want to understand how they respond to neonicotinoids to determine the benefits of using them.

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"
```

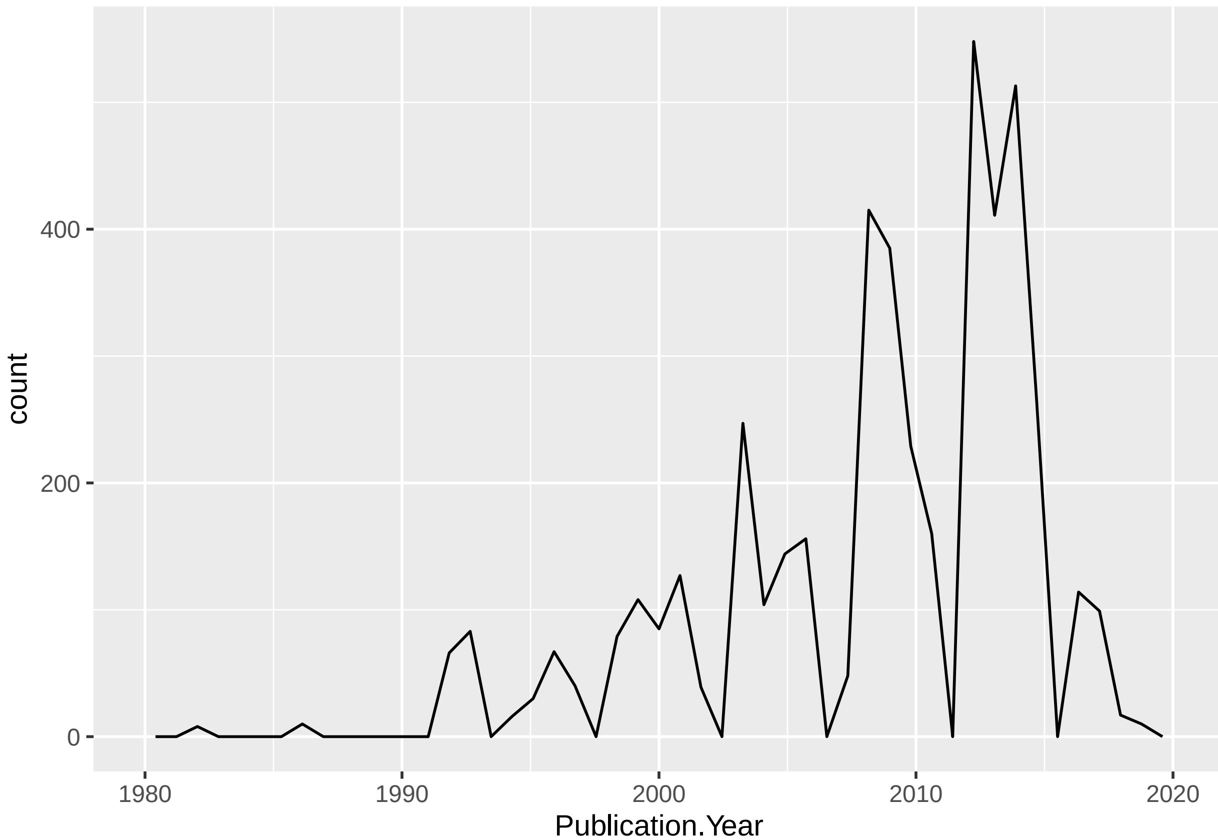
Answer: We have to set it as a numeric number manually.

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)+
  scale_x_continuous(limits = c(1980, 2020))
```

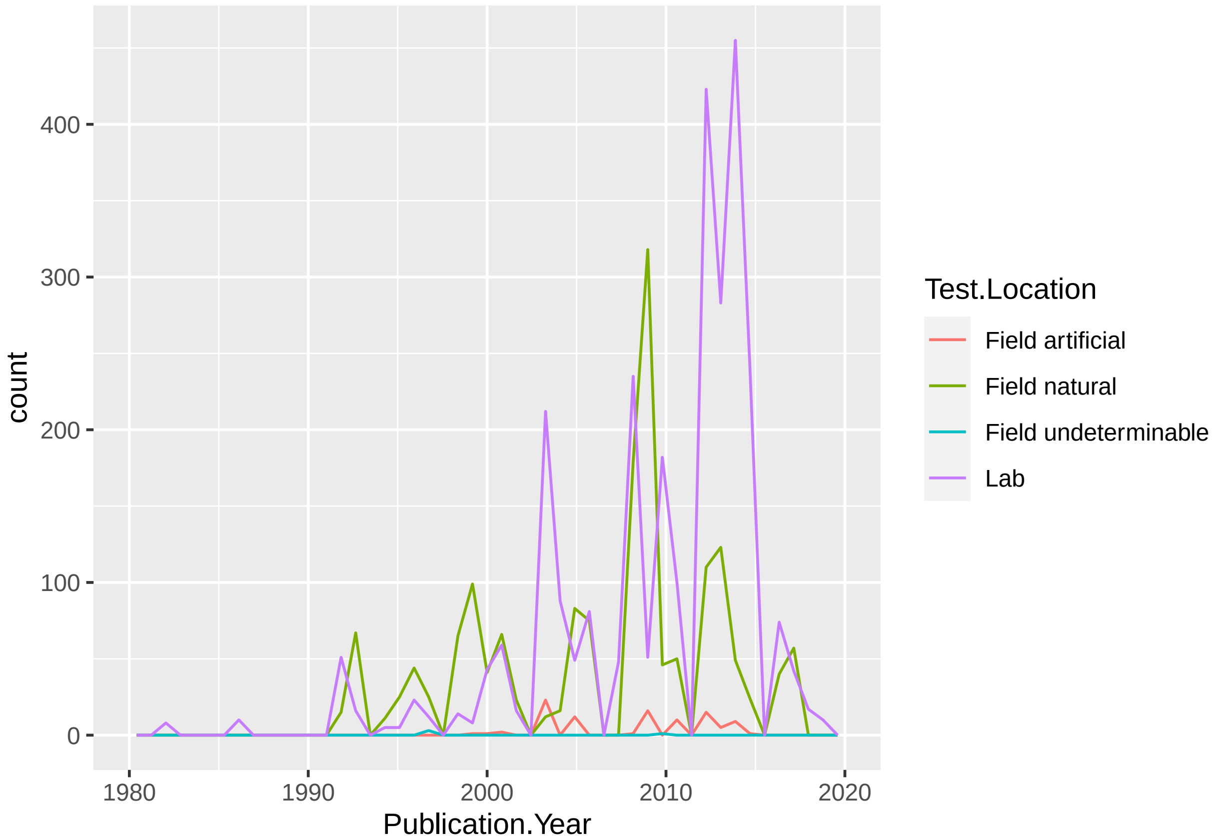
```
## Warning: Removed 2 row(s) containing missing values (geom_path).
```



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(1980, 2020))
```

```
## Warning: Removed 8 row(s) containing missing values (geom_path).
```

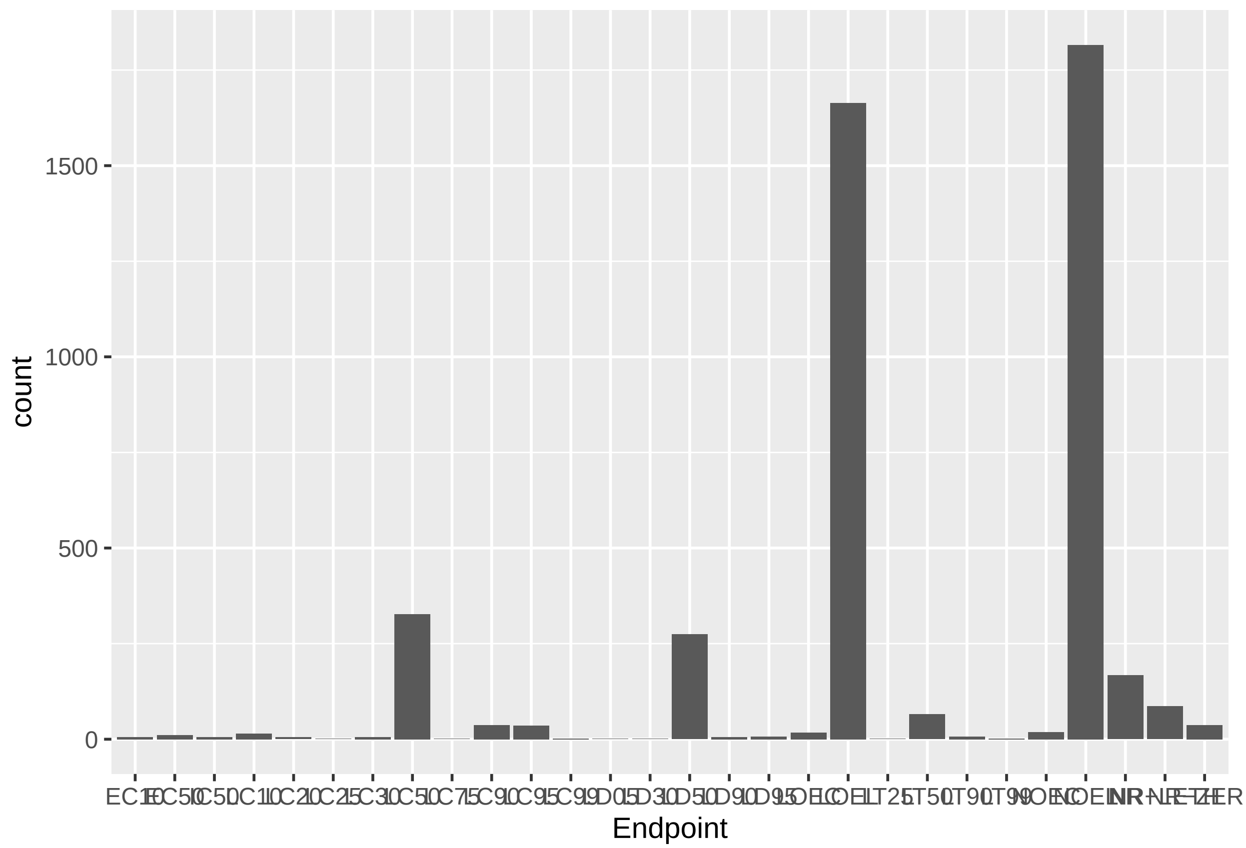


Interpret this graph. What are the most common test locations, and do they differ over time?

> Answer: The lab is the most common test location. Those test locations differ over time. Lab and field natural alternate between periods of time to become the most common test location. Field artificial is usually in third place, but it became the second most common test location roughly from 2003 to 2004. Field undeterminable is always the least, except in 1996.

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 end points are LOEL and NOEL. LOEL is terrestrial. It has lowest-observable-effect-level and lowest concentration. It producing effects that were significantly different from responses of controls. NOEL is also terrestrial, but with no-observable-effect-level and the highest concentration. It producing effects not significantly different from 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$collectDate <- ymd(Litter$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`?

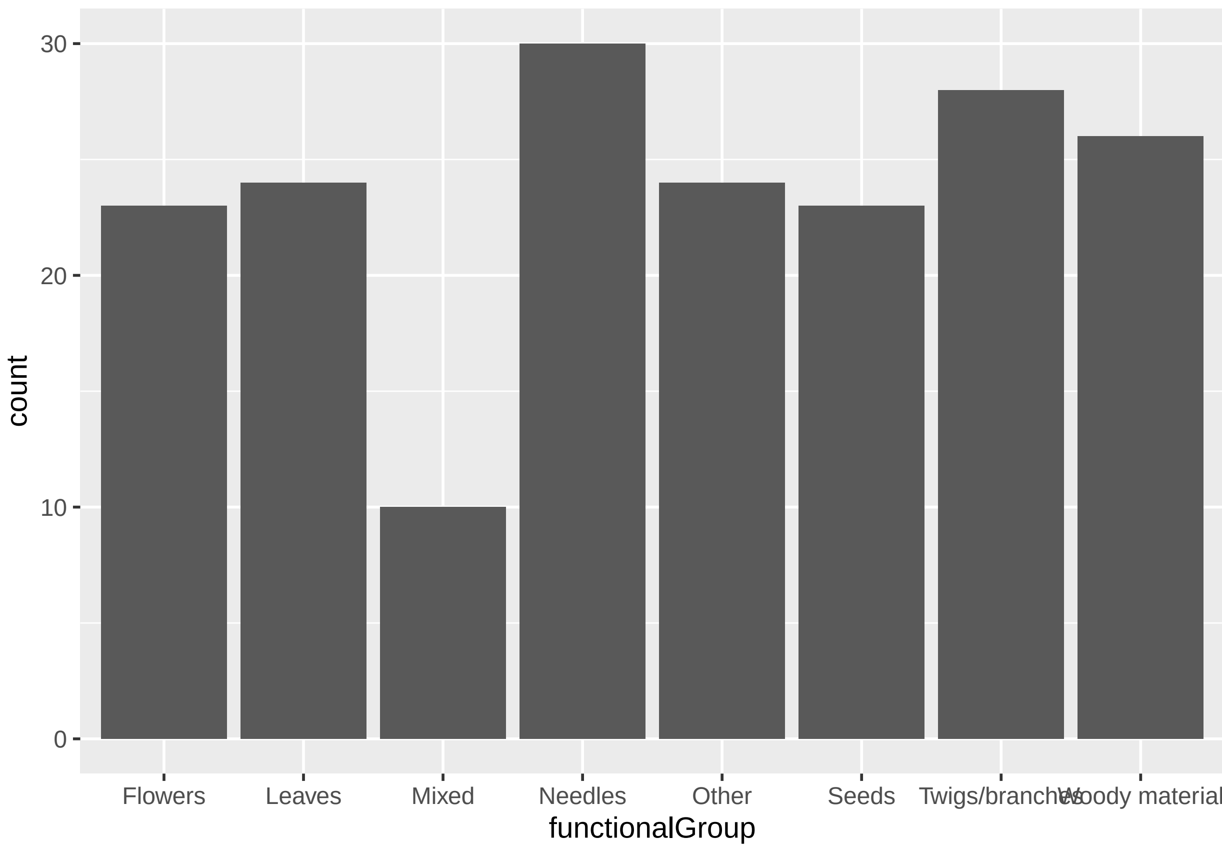
```
unique(Litter$plotID)
```

```
##  [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: The 'unique' function lists all the plots that were sampled at Niwot Ridge. But the 'summary' function not only lists all the plots but also shows how many samples are sampled at each plot.

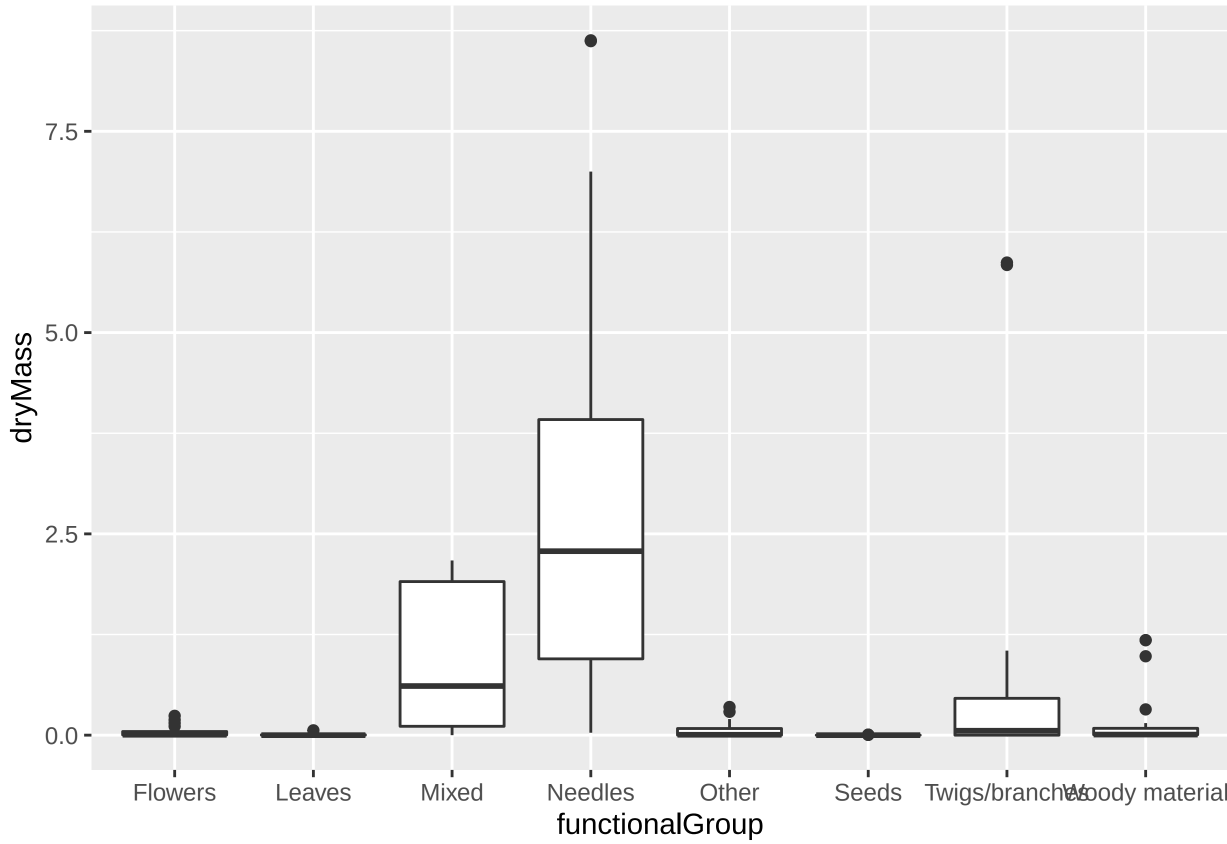
14. Create a bar graph of functionalGroup counts. This shows you what type of litter is collected at the Niwot Ridge sites. Notice that litter types are fairly equally distributed across the Niwot Ridge sites.

```
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))
```

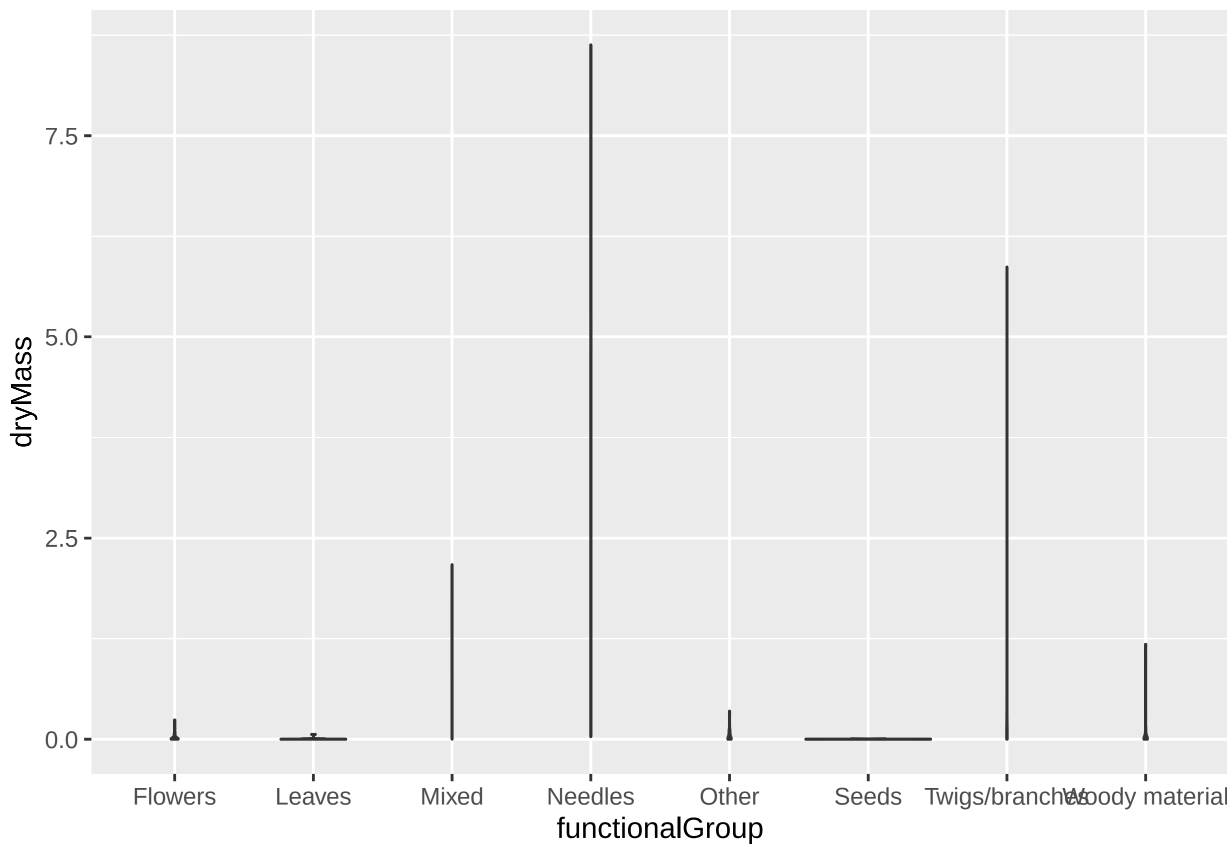



```
ggplot(Litter) +
  geom_violin(aes(x = functionalGroup, y = dryMass),
              draw_quantiles = c(0.25, 0.5, 0.75))
```

```
## 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: Boxplot is more effective because visually it is more clear. The violin plot doesn't work that well with unique values.

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

> Answer: Needles have the highest biomass at these site.