Assignment 3: Data Exploration

Kristine Swann

OVERVIEW

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

Directions

1. Change "Student Name" on line 3 (above) with your name.
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., "Salk_A03_DataExploration.Rmd") prior to submission.

The completed exercise is due on Tuesday, January 28 at 1:00 pm.

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.

```
getwd()
```

```
## [1] "C:/Users/krist/Box Sync/Spring 2020/R/Environmental_Data_Analytics_2020"
```

```
neonic <- read.csv("./Data/Raw/ECOTOX_Neonicotinoids_Insects_raw.csv")
litter <- read.csv("./Data/Raw/NEON_NIWO_Litter_massdata_2018-08_raw.csv")
```

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: You don't want to kill the pollinators, just the "pests".

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: So many reasons. Decomposition rates, fuel loadings, nutrient loadings in the watershed, woody debris recruitment for habitat, GHG off-gassing, etc.

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: *Plots have specific dimensions with specific measurements at different locations within the plots for efficient measurement of multiple variables.* Sampling occurs at different temporal intervals based on plant community. *Measuring biomass of leaves, needles, twigs/branches, woody debris, seeds, etc.

Obtain basic summaries of your data (Neonics)

5. What are the dimensions of the dataset?

```
dim(neonic)
```

```
## [1] 4623   30
```

6. Using the `summary` function, determine the most common effects that are studied. Why might these effects specifically be of interest?

```
summary(neonic$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: Population, mortality, behavior, feeding behavior, reproduction, development; they encompass the entire life cycle of the insects and allows identification of impacts to these potentially sensitive periods/pathways.

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(neonic$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: honey bee, parasitic wasp, buff tailed bumblebee, carniolan honey bee, bumble bee, Italian honey bee; they're all pollinators and most are non-native species that are managed by apiarists for pollination. These guys are important for agricultural production and are part of a huge subsection of the agricultural economy.

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(neonic$Conc.1..Author.)
```

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

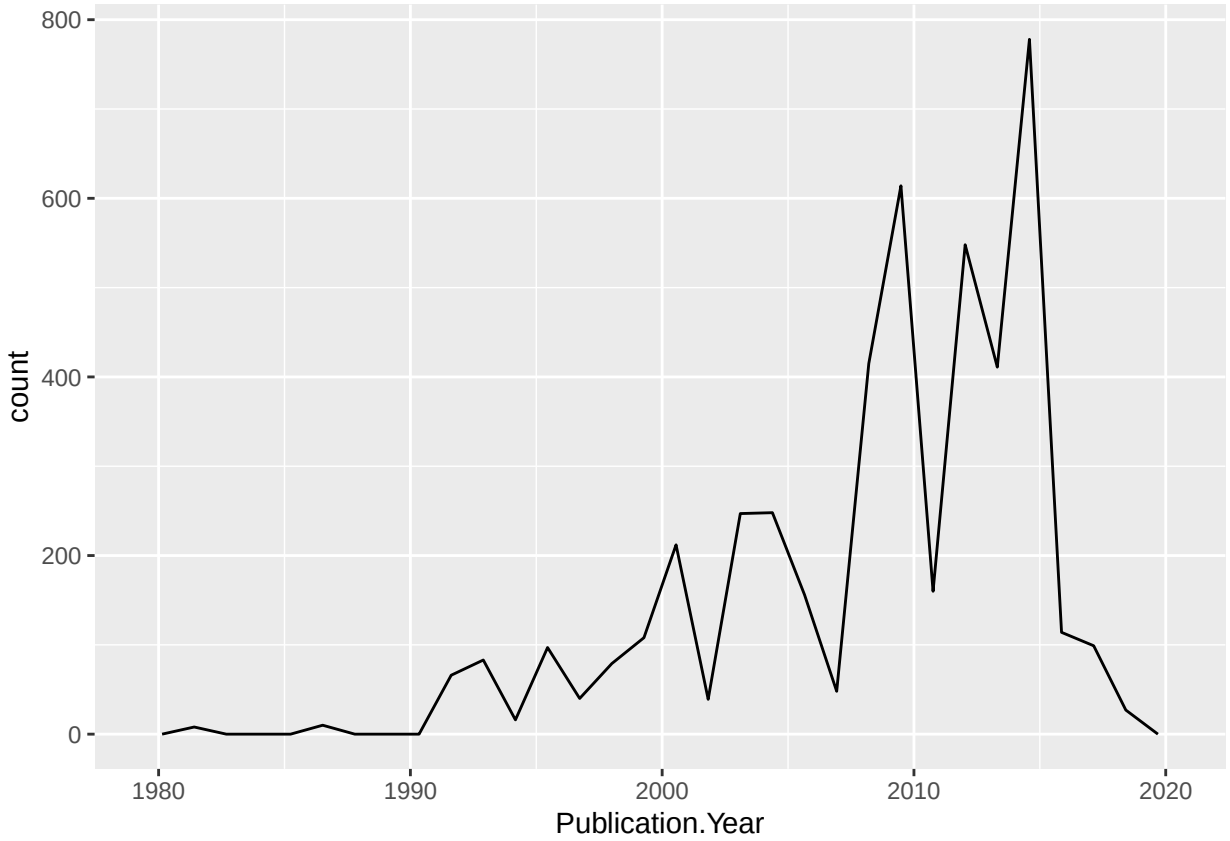
Answer: Factor; variable is character strings (names).

Explore your data graphically (Neonics)

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

```
library(ggplot2)
ggplot(neonic) +
  geom_freqpoly(aes(x = Publication.Year))
```

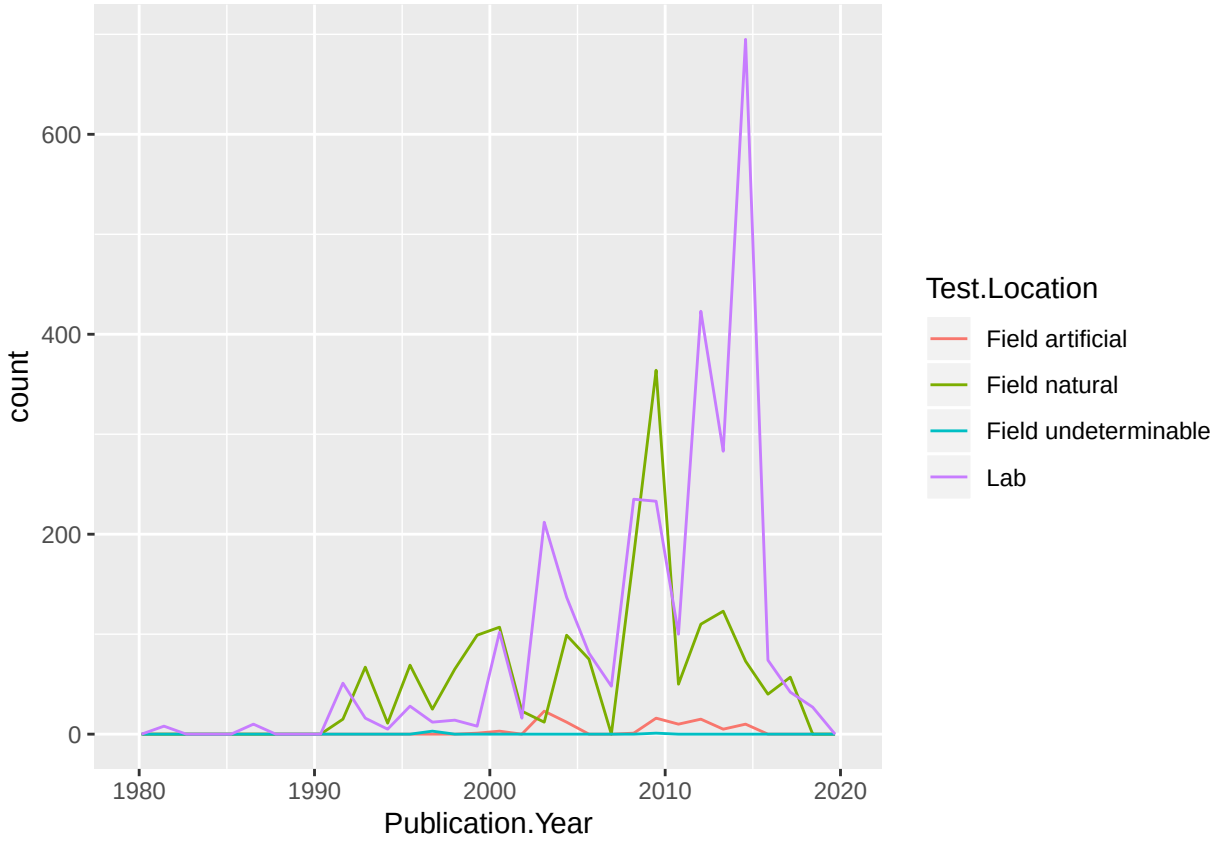
```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



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

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

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

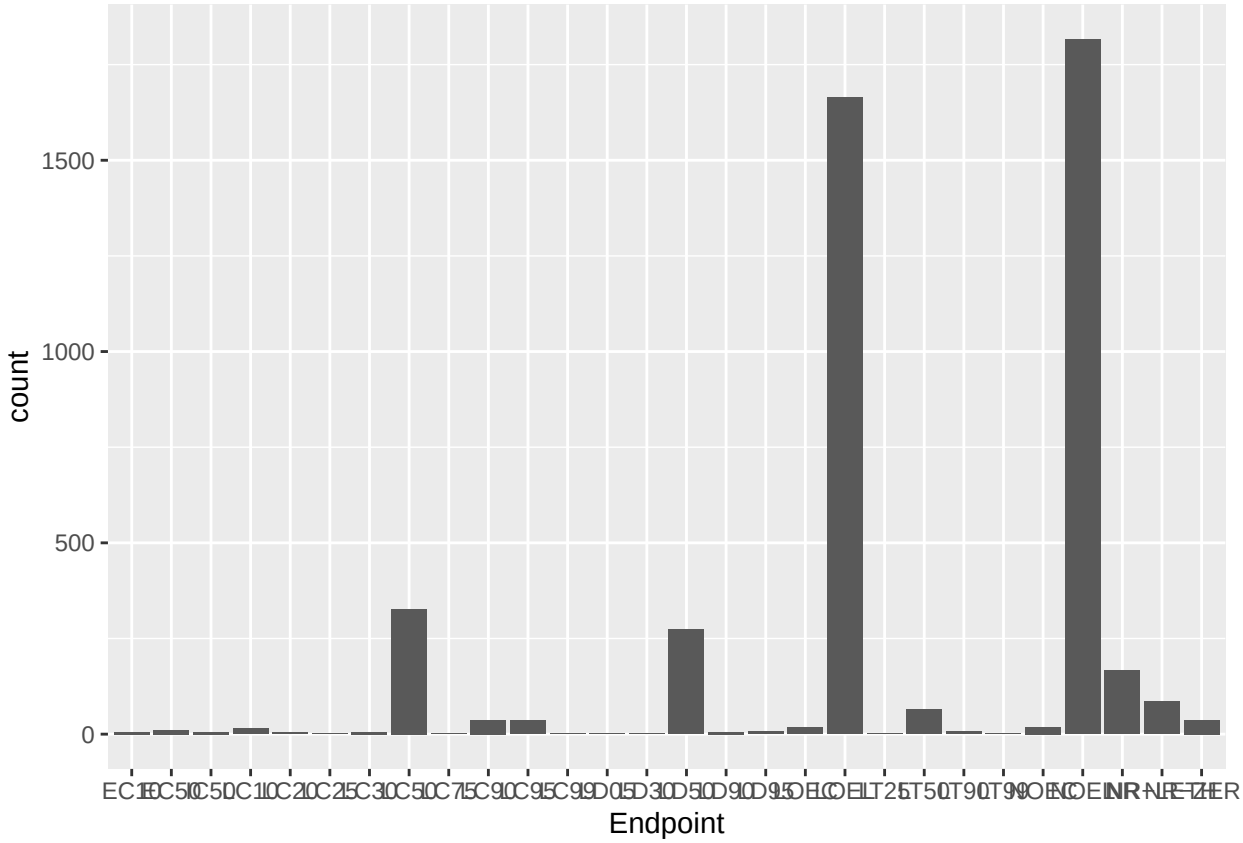


Interpret this graph. What are the most common test locations, and do they differ over time?

Answer: Most common are lab and field natural. They differ over time with lab becoming more common since approximately 2003 with a minor setback during the recession.

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(neonic, aes(x= Endpoint)) +
  geom_bar()
```



Answer: NOEL and LOELs: no observable effect level (conc with no sig effect) and lowest observed effect level (lowest conc with sig effect).

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 = "%m/%d/%y")
class(litter$collectDate)
```

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

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)
```

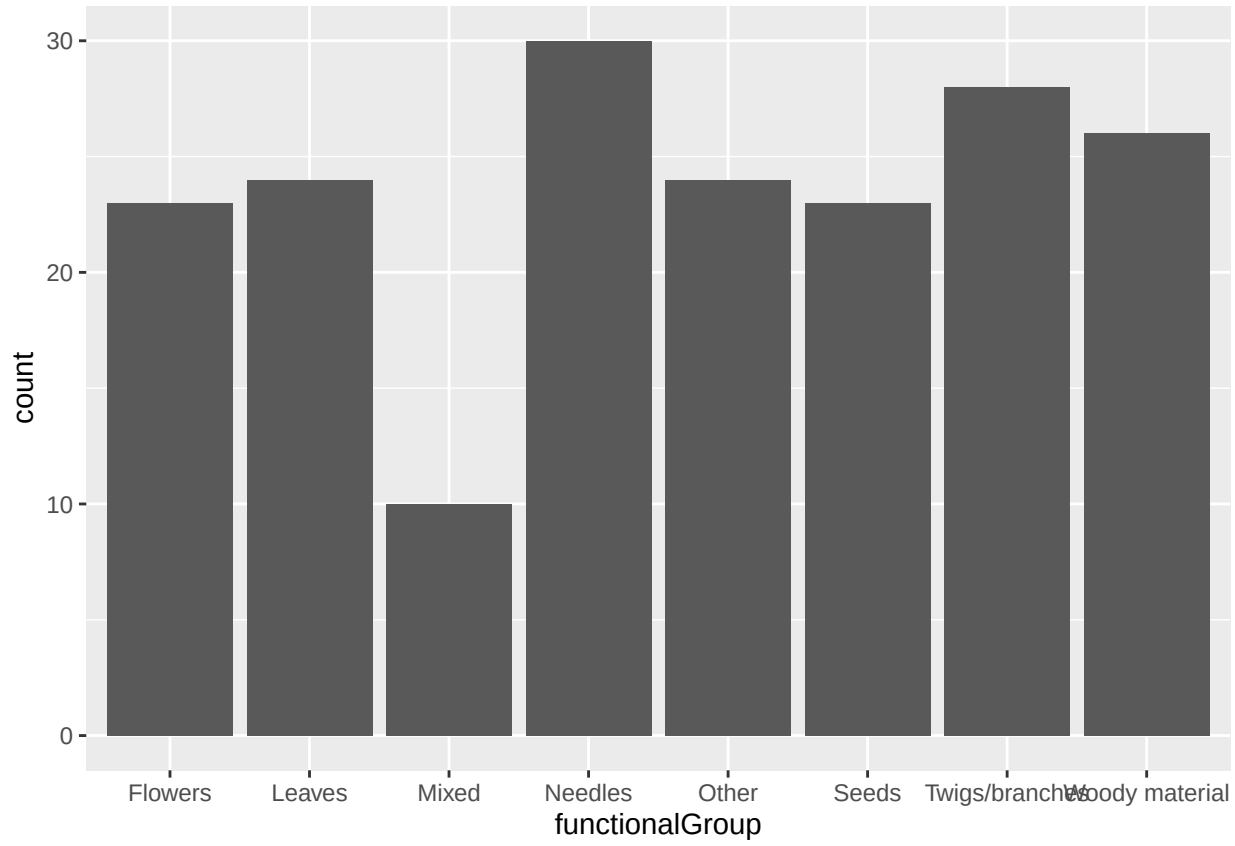
```
## NIWO_040 NIWO_041 NIWO_046 NIWO_047 NIWO_051 NIWO_057 NIWO_058 NIWO_061
##       20       19       18       15       14        8       16       17
```

```
## NIWO_062 NIWO_063 NIWO_064 NIWO_067
##       14       14       16       17
```

Answer: Unique lists out each unique plot id, then says how many 'levels' there are (ie how many plot ids there are. Summary just lists out the plot ids.

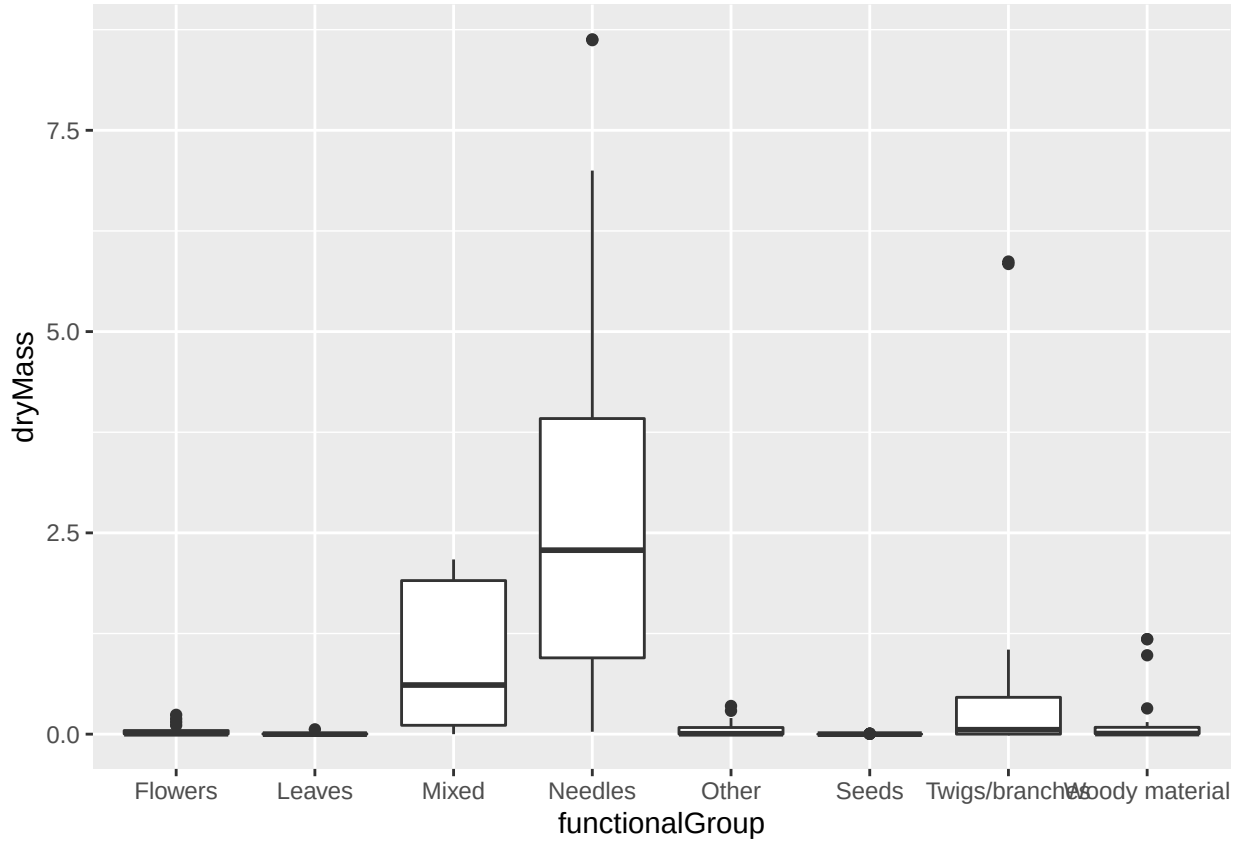
14. Create a bar graph of functionalGroup counts. This shows you what type of litter is collected at the Niwot Ridge sites. Notice that litter types are fairly equally distributed across the Niwot Ridge sites.

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

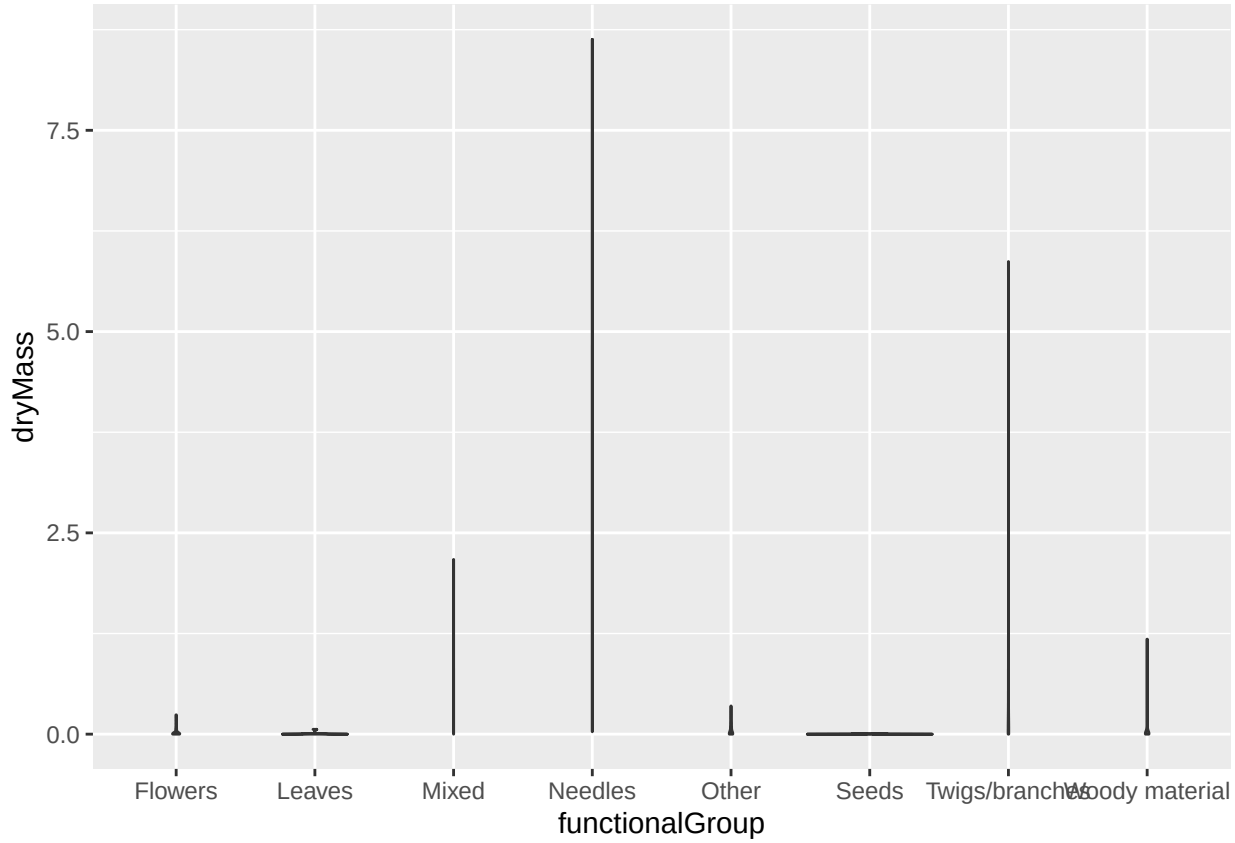


15. Using `geom_boxplot` and `geom_violin`, create a boxplot and a violin plot of dryMass by functionalGroup.

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




```
ggplot(litter)+
  geom_violin(aes(x=functionalGroup, y=dryMass),scale = "area" )
```



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

> Answer: The boxplot is way more effective; you can't see anything in the violin plot. I tried playing with scale in the violin plot, but that didn't change anything.

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

> Answer: Needles, mixed and twigs tend to have the highest biomass, which makes sense when you think about density.