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.**

```
getwd()
```

```
## [1] "\\\\homedir.oit.duke.edu/users/y/yw448/RforENV872/Environmental_Data_Analytics_2022/Assignments
```

```
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: Even though neonicotinoids are known for being low-toxic to many beneficial insects such as bees, new research shows that they still have potential toxicity to the beneficial insects.

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 are critical to forest and stream ecosystem because they play important roles in carbon budget and nutrient cycle.

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: The sampling of litter and woody debris is performed at terrestrial NEON sites that contain woody vegetation >2m tall, and then use litter trap pair in a selected tower plots to collect samples. *

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: Population and Mortality. As a insecticide, the impacts of neonicotinoids on insects' population and morality are essential.

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: Honey Bee, Parasitic Wasp, Buff Tailed Bumblebee, Carniolan Honey Bee, Bumble Bee, and Italian Honeybee. These species are all pollinators which are crucial to agriculture and ecosystem. Therefore, knowing the impact of neonicotinoids on these species is important.

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: Factor. Not all data of the Conc.1..Author are numeric, some numbers have '/' behind them.

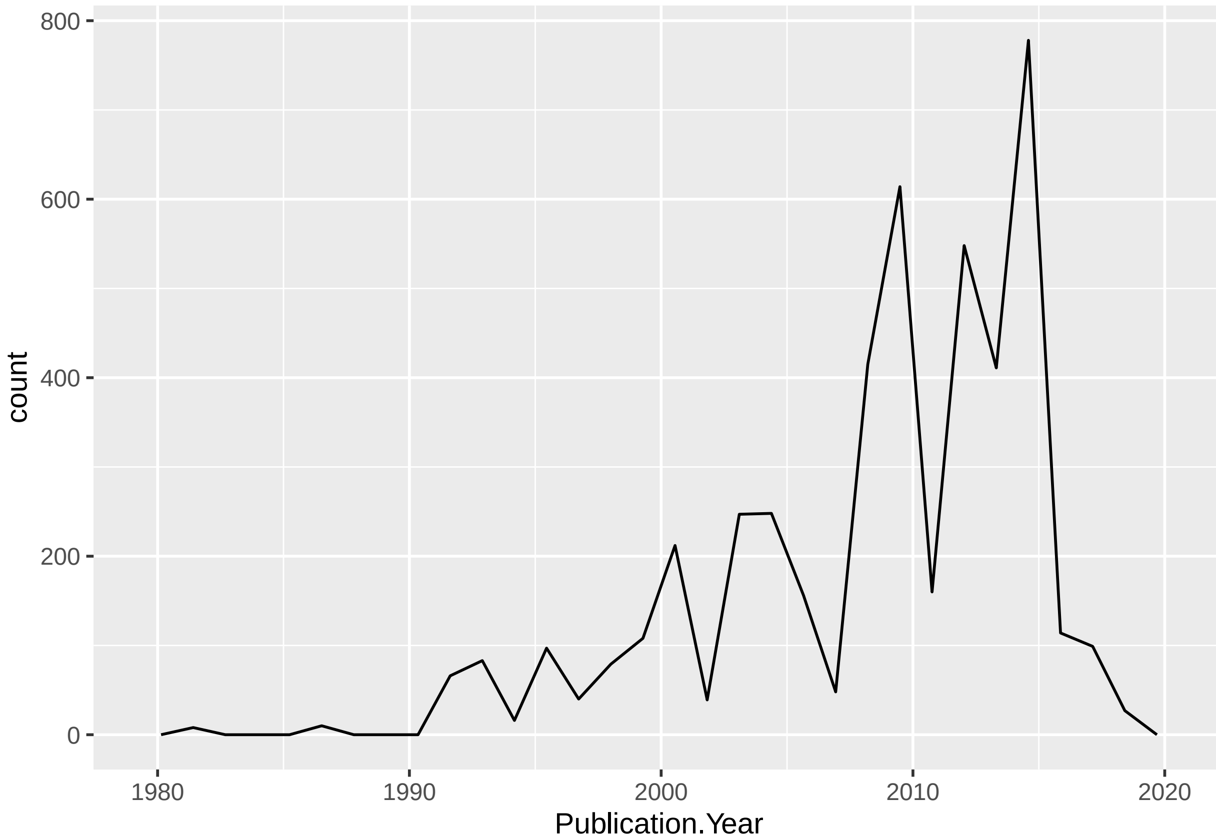
Explore your data graphically (Neonics)

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))
```

```
## Warning: Ignoring unknown aesthetics: bins
```

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

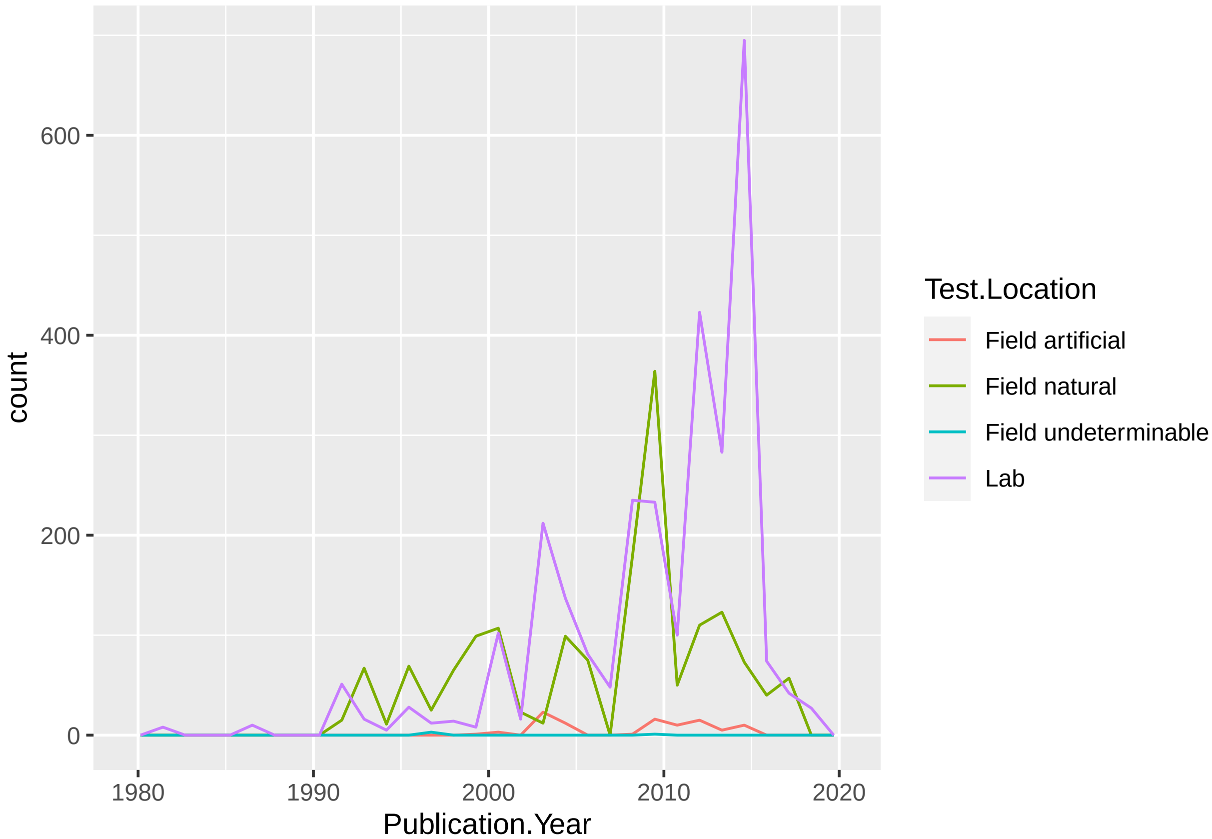


10. Reproduce the same graph but now add a color aesthetic so that different Test.Location are displayed as different colors.

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

```
## Warning: Ignoring unknown aesthetics: bins
```

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

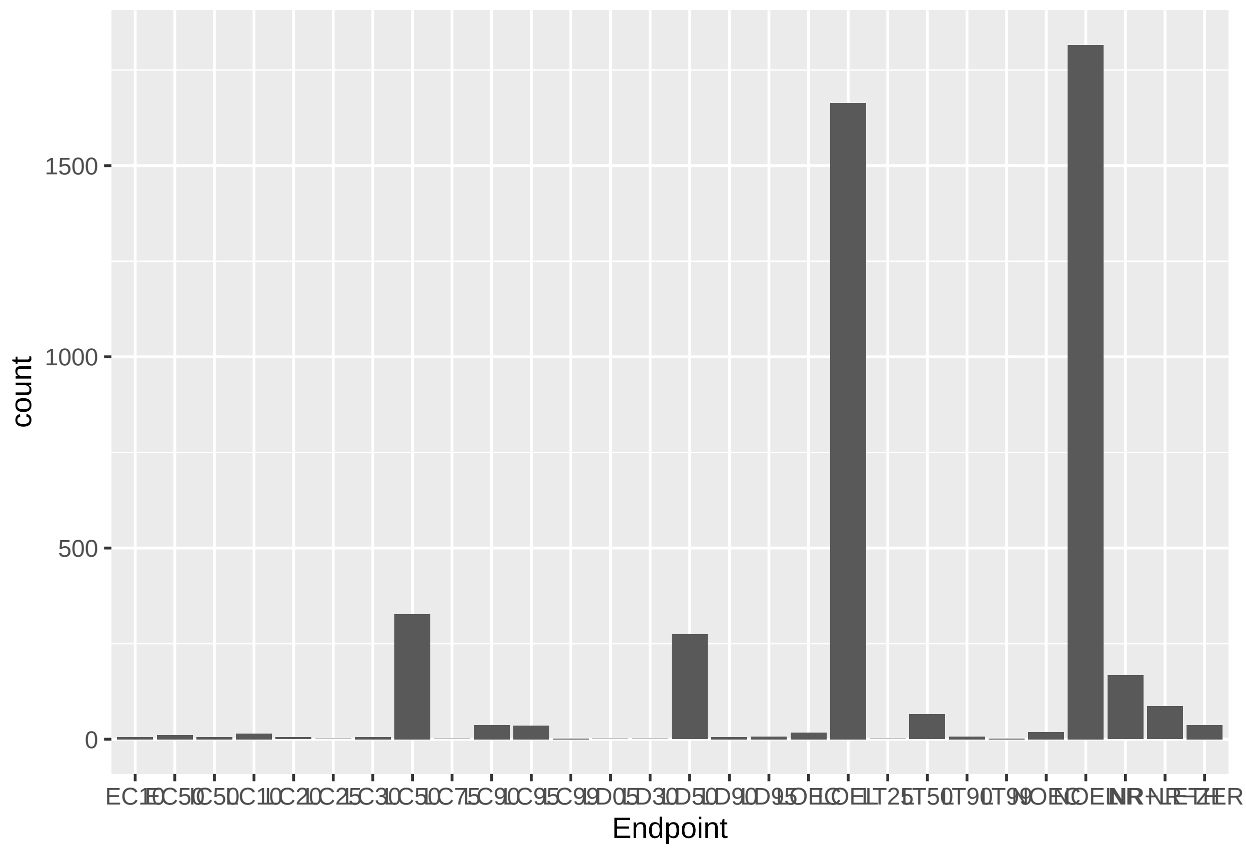


Interpret this graph. What are the most common test locations, and do they differ over time?

> Answer: The most common test locations is Lab. However, more tests were conducted in Field natural from 1990 to 2000 and around 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: NOEL & LOEL ; NOEL(No-observable-effect-level): highest dose (concentration) producing effects not significantly different from responses of controls according to author's reported statistical test. LOEL(Lowest-observable-effect-level): lowest dose (concentration) producing effects that were significantly different (as reported by authors) 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$collectDate=as.Date(Litter$collectDate, format= "%Y-%m-%d")
class(Litter$collectDate)
```

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

```
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`?

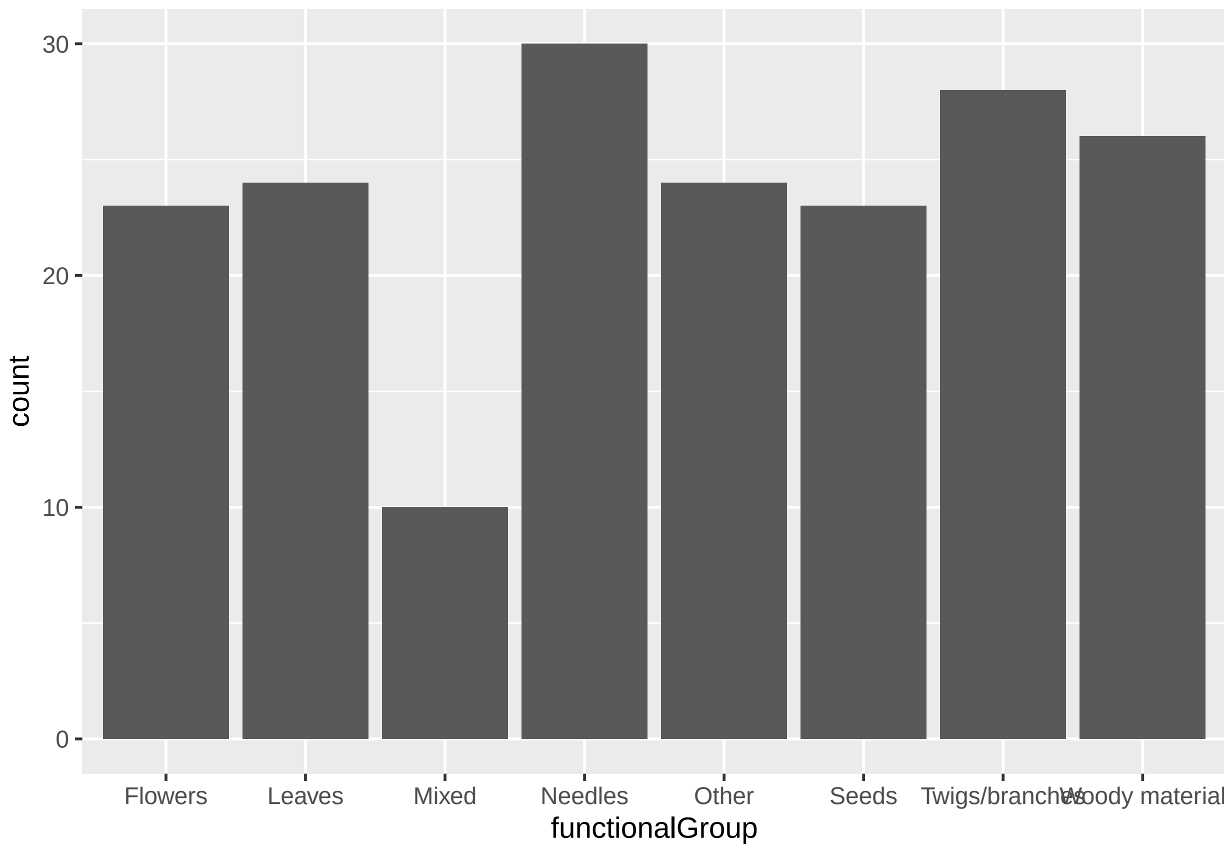
```
unique(Litter$siteID)
```

```
## [1] NIWO
## Levels: NIWO
```

Answer: All 188 plots were sampled at Niwot Ridge. > unique function returns the vector with duplicate elements removed; summary function shows the number of duplicate elements.

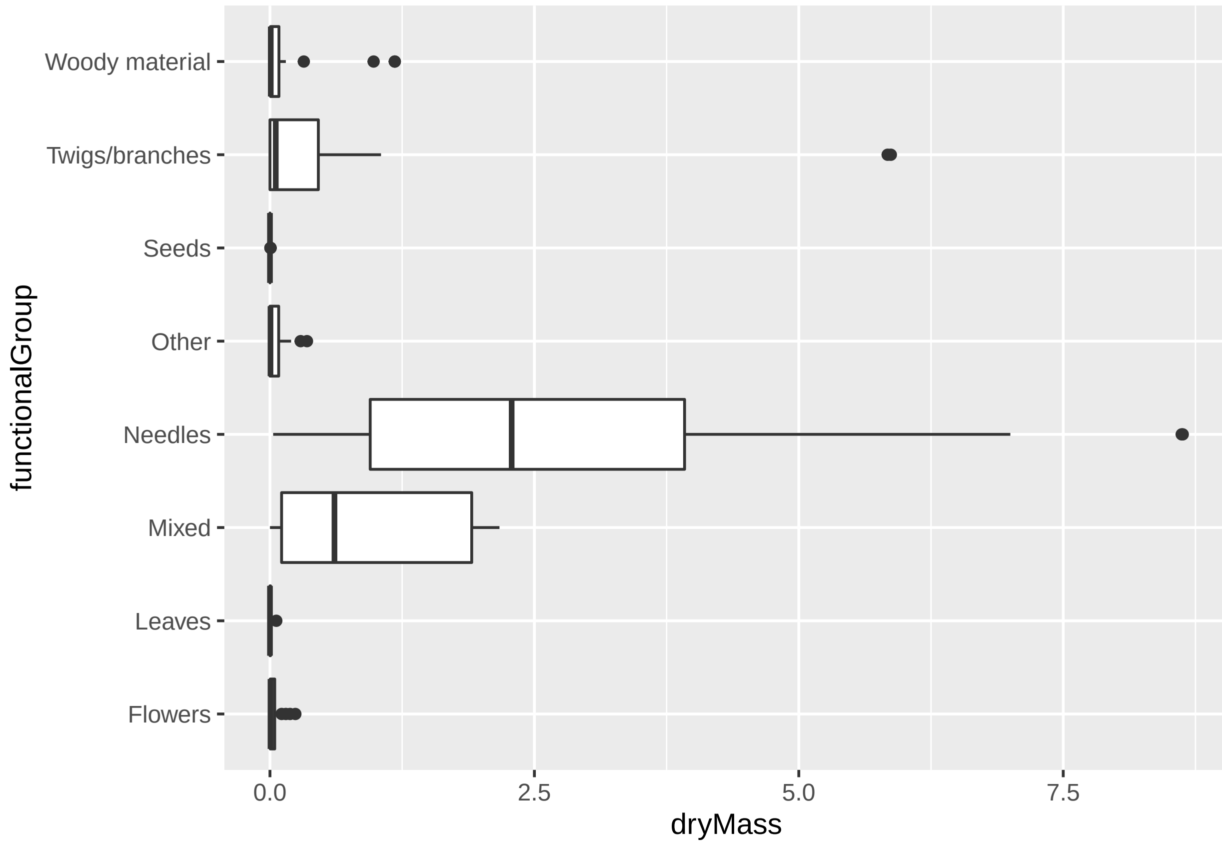
14. Create a bar graph of functionalGroup counts. This shows you what type of litter is collected at the Niwot Ridge sites. Notice that litter types are fairly equally distributed across the Niwot Ridge sites.

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

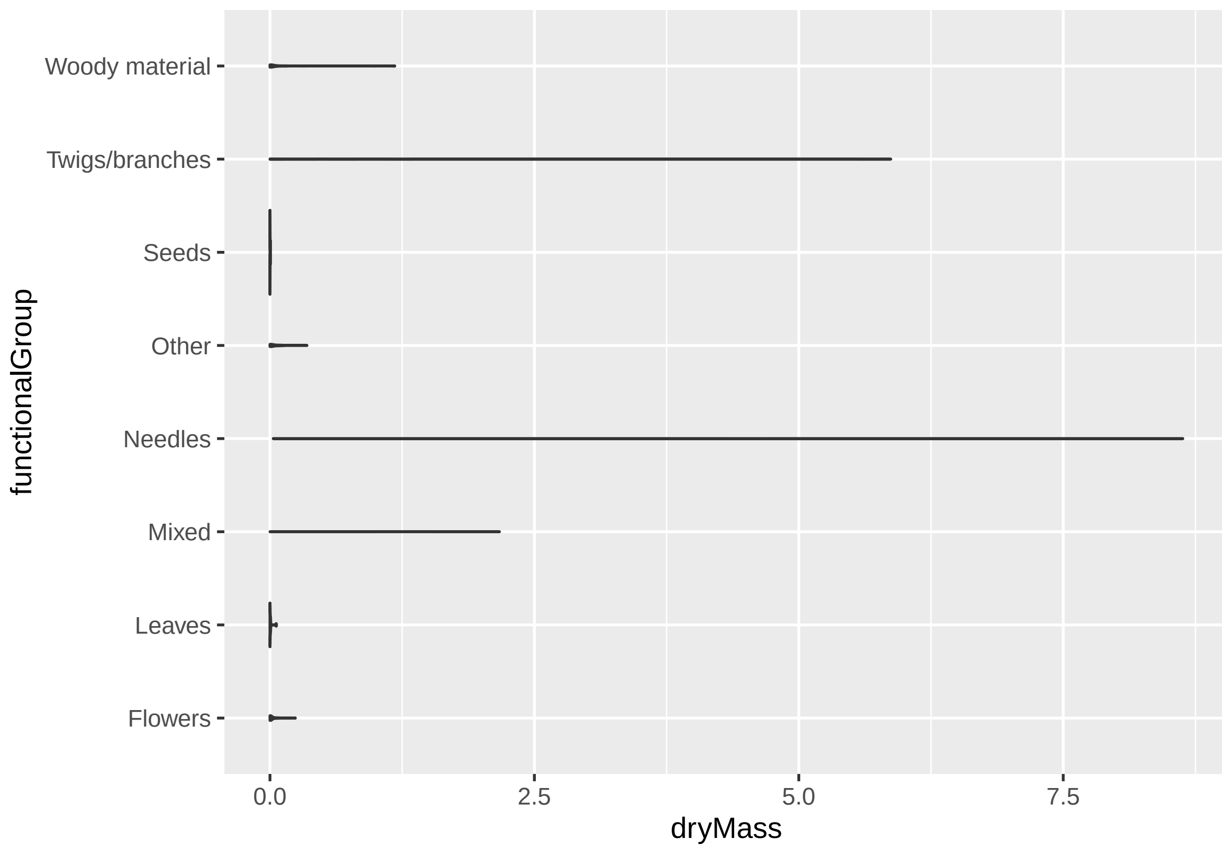


15. Using `geom_boxplot` and `geom_violin`, create a boxplot and a violin plot of dryMass by functionalGroup.

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




```
ggplot(Litter)+geom_violin(aes(x=dryMass, y=functionalGroup))
```



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

> Answer: The violin plot in this case doesn't show clear density distributions, and it's hard to identify median and IQR.

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

> Answer: Needles