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" 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/26059/OneDrive/Desktop/ENV 872 R/Yang_ENV872"
```

```
library(tidyverse)
Neonics <- 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: Neonicotinoid pesticides are widely applied to agriculture land. The residue of neonicotinoid may post risk to non-target beneficial insects.Insects are one of important parts of a healthy ecosystem. Therefore, we might interested in the ecotoxicology of this chemical for ecosystem health and balance.

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: Insects constantly contact with litter and woody debris. Knowing the concentration of chemical in litter and woody debris can help to identify the chemical exposure of insects.

4. How is litter and woody debr is 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: *spatial sampling design* ramdom for the tower plots, and target for the forest tower airshed *temporal sampling design

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, 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 are the most common effects that are studied. Because both of them can reflect the acute effect of the chemical, while other endpoints are reflecting chronic effect.

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: The most common is honey bee, parasitic wasp, buff tailed bumblebee, carniolan honey bee, bumble bee and Italian honeybee. The six most commonly species are all pollinators. They got more attention than other species because they are important pollinators for agriculture crops.

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"
```

```
str(Neonics$Conc.1..Author.)
```

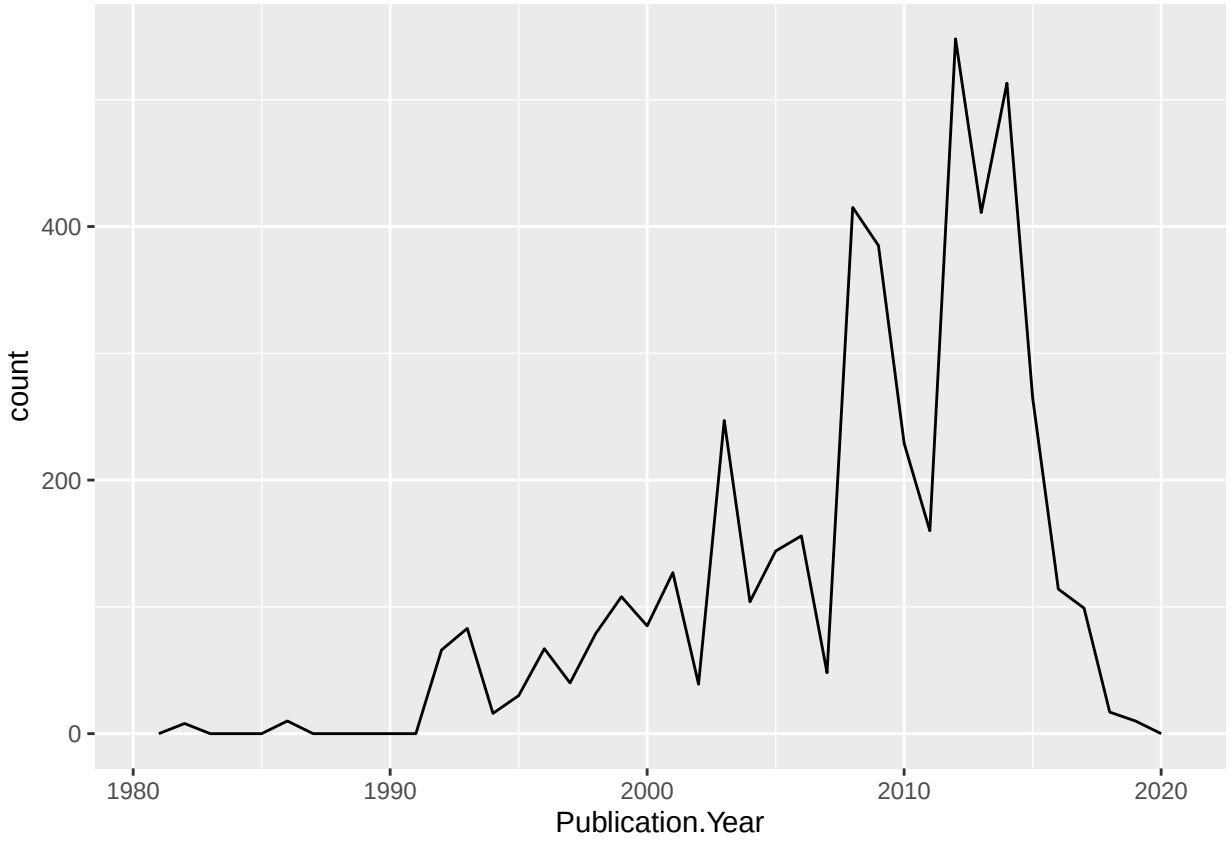
```
##  Factor w/ 1006 levels "~10","~30/","~40/",..: 639 510 813 622 442 637 500 642 814 784 ...
```

Answer: It is factor. Because it has non-numeric subjects and symbol like slash..

Explore your data graphically (Neonics)

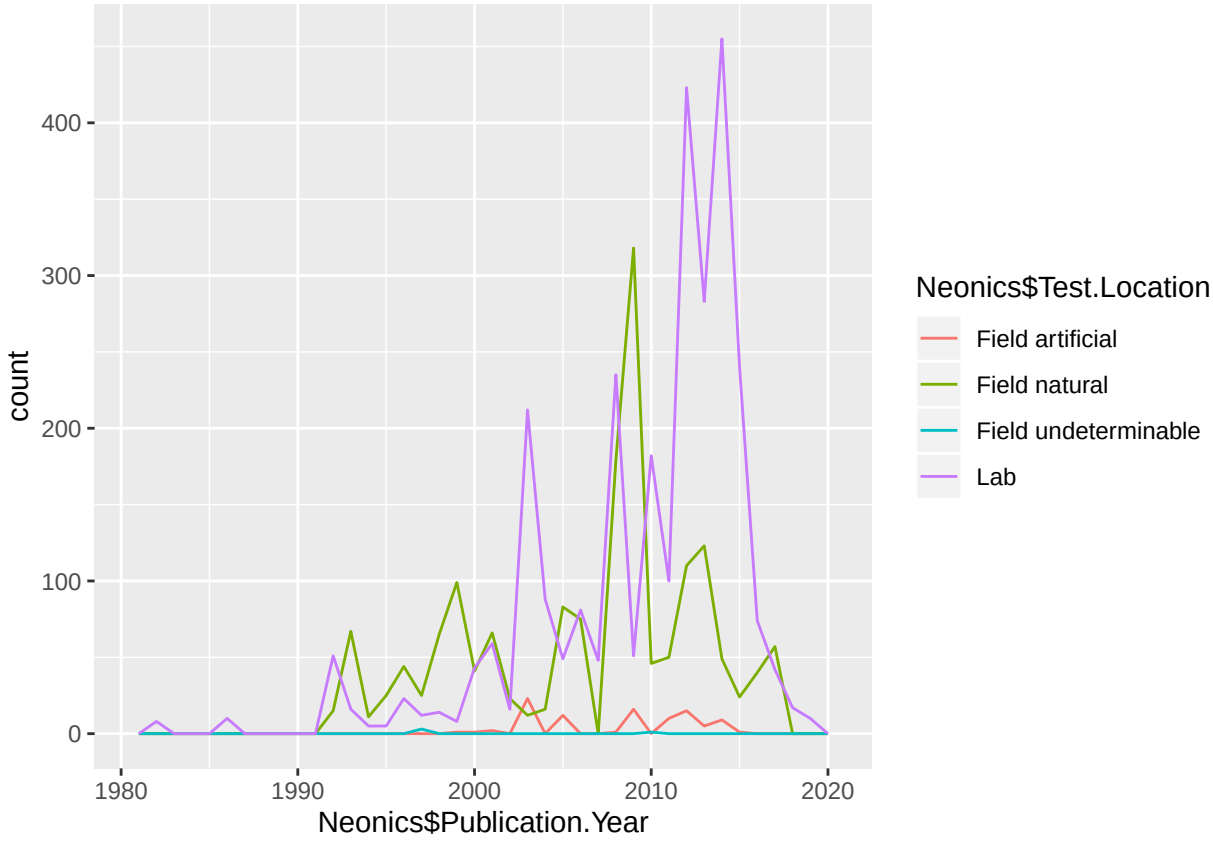
9. Using `geom_freqpoly`, generate a plot of the number of studies conducted by publication year.

```
ggplot(Neonics) +
  geom_freqpoly(aes(x = Publication.Year),binwidth = 1)
```



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 = Neonics$Publication.Year, color = Neonics$Test.Location ),binwidth = 1)
```

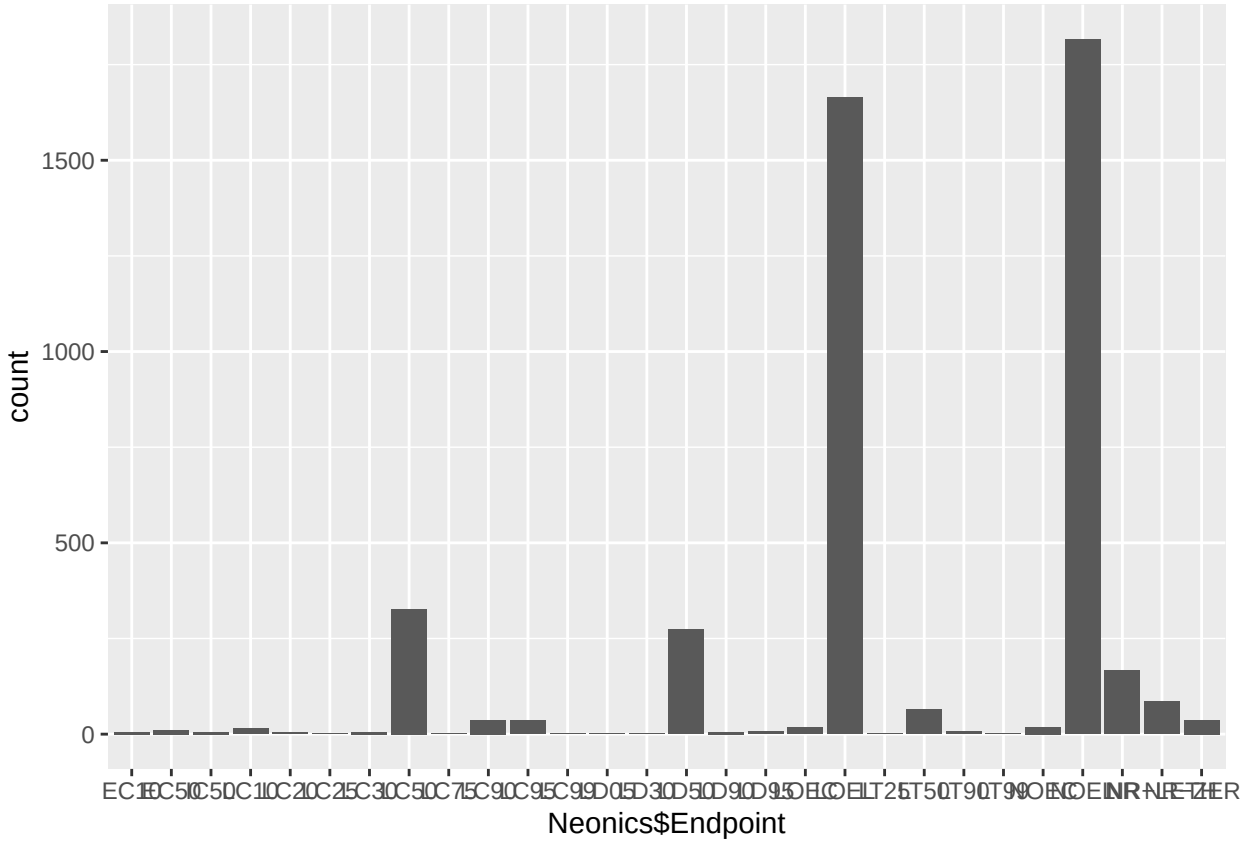


Interpret this graph. What are the most common test locations, and do they differ over time?

Answer:

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 = Neonics$Endpoint)) +
  geom_bar()
```



Answer: The most common end points are LOEL and NOEL.LOEL is the lowest observed adverse effect level. NOEL is the highest no observable effect level.

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$plotID)
```

```
##  [1] NIWO_061 NIWO_064 NIWO_067 NIWO_040 NIWO_041 NIWO_063 NIWO_047
##  [8] NIWO_051 NIWO_058 NIWO_046 NIWO_062 NIWO_057
## 12 Levels: NIWO_040 NIWO_041 NIWO_046 NIWO_047 NIWO_051 ... NIWO_067
```

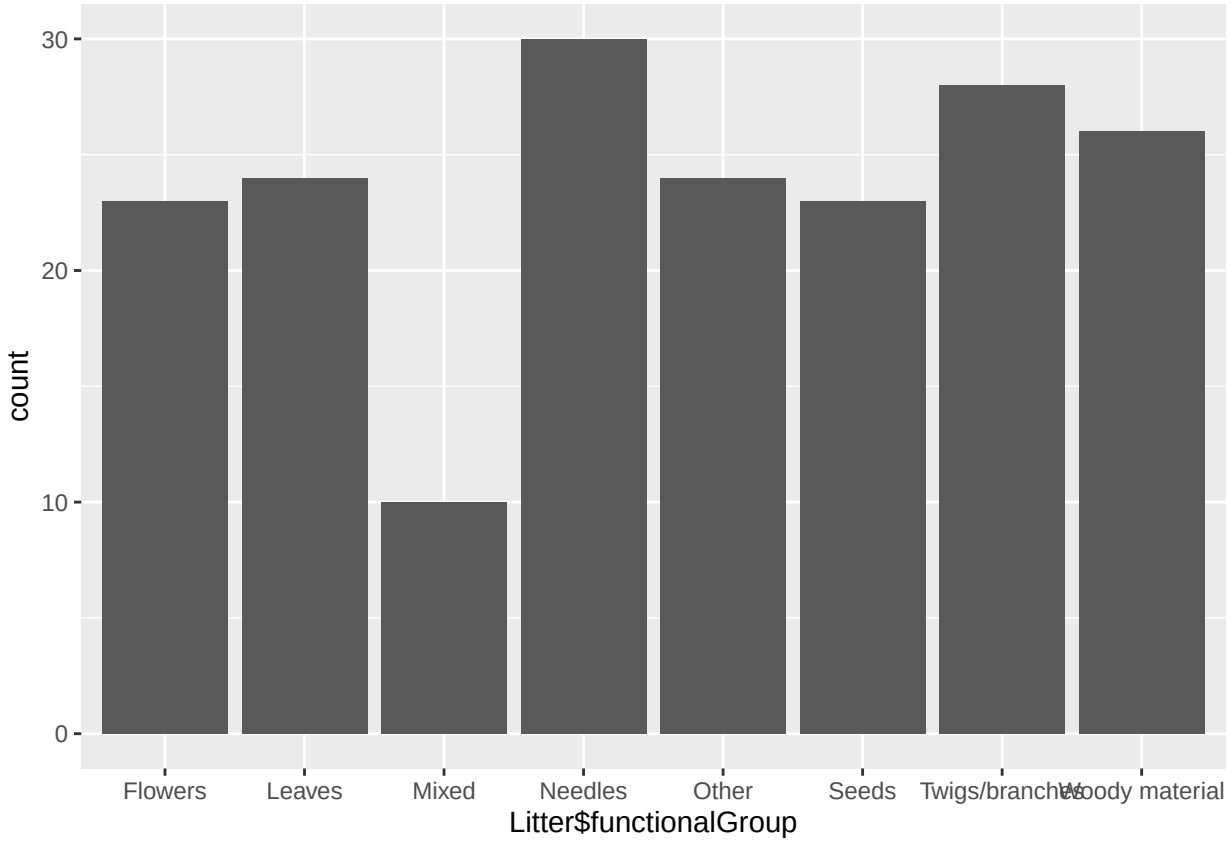
```
summary(Litter$plotID)
```

```
## 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: 12 plots. The information obtained from unique function does not include the count of the same plot. However, It gives the number of the unique plots and has a rank of the plot code.

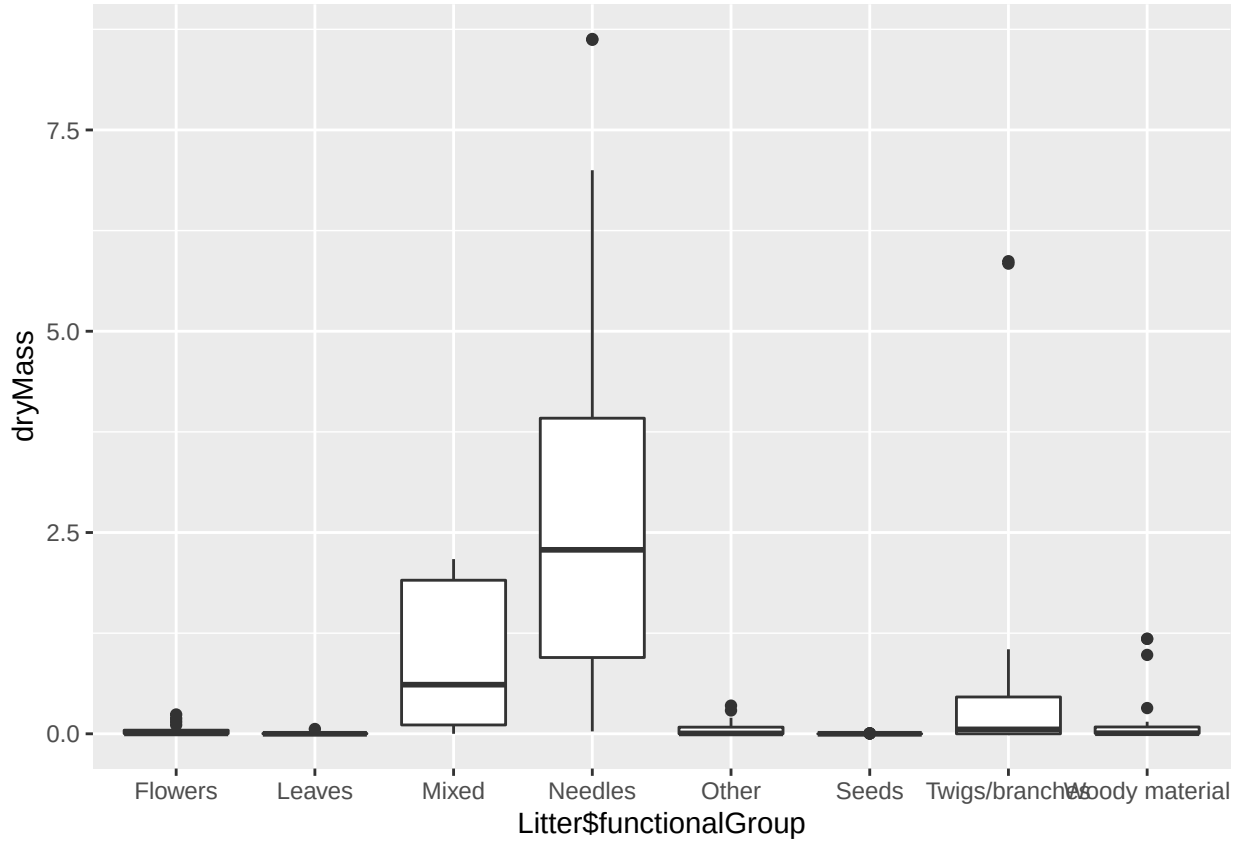
14. Create a bar graph of functionalGroup counts. This shows you what type of litter is collected at the Niwot Ridge sites. Notice that litter types are fairly equally distributed across the Niwot Ridge sites.

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

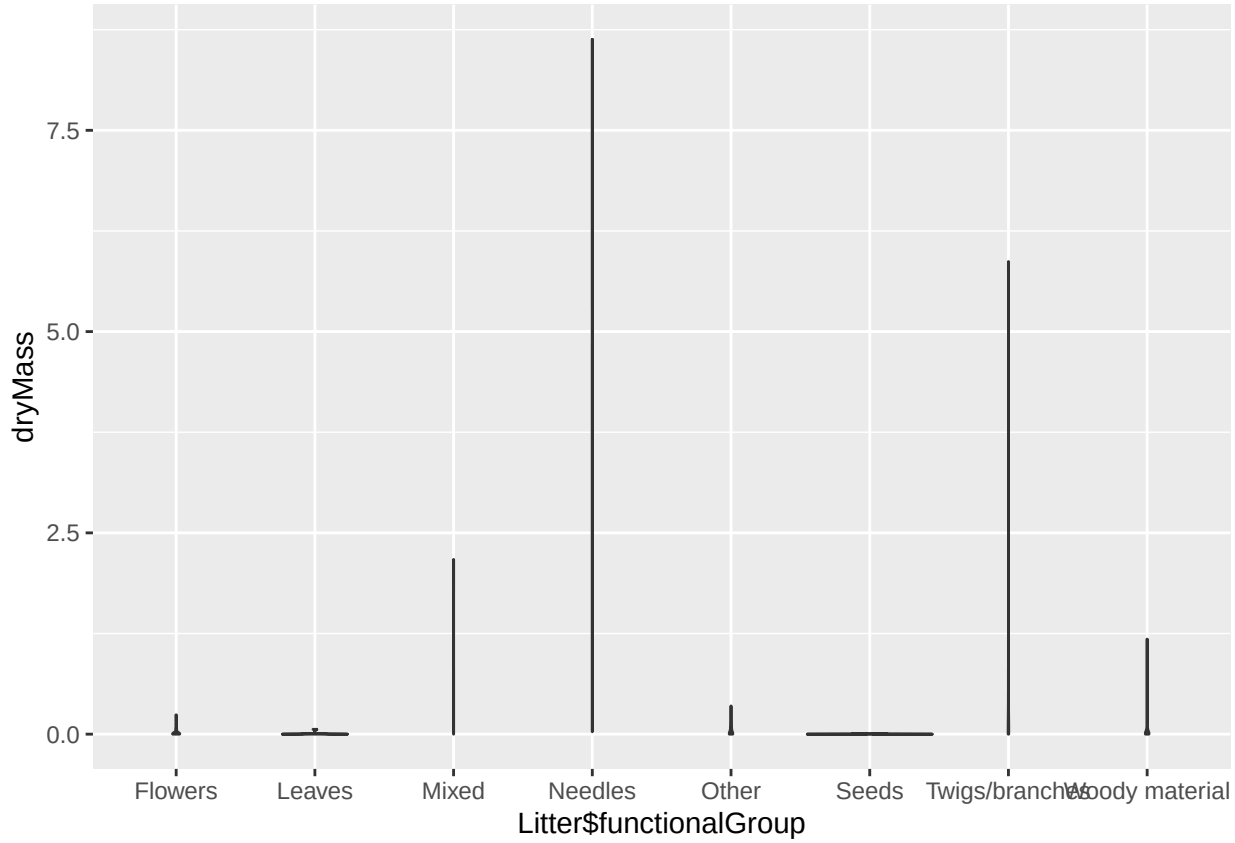


15. Using `geom_boxplot` and `geom_violin`, create a boxplot and a violin plot of dryMass by functionalGroup.

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




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



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

Answer: The dry mass between different functional groups vary too much.

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

Answer: Needles