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. Assign a useful **name to each code chunk** and include ample **comments** with your code.
5. Be sure to **answer the questions** in this assignment document.
6. When you have completed the assignment, **Knit** the text and code into a single PDF file.
7. After Knitting, submit the completed exercise (PDF file) to the dropbox in Sakai.

TIP: If your code extends past the page when knit, tidy your code by manually inserting line breaks.

TIP: If your code fails to knit, check that no `install.packages()` or `View()` commands exist in your code.

Set up your R session

1. Check your working directory, load necessary packages (tidyverse, lubridate), 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.

```
library(tidyverse) #load tidyverse package
library(lubridate) #load lubridate package
Neonics <- read.csv("./Data/Raw/ECOTOX_Neonicotinoids_Insects_raw.csv",
  stringsAsFactors = TRUE)
#assigning the ECOTOX dataset to the variable "Neonics" and reading strings as factors

Litter <- read.csv("./Data/Raw/NEON_NIWO_Litter_massdata_2018-08_raw.csv",
    stringsAsFactors = TRUE)
#assigning the NEON_NIWO dataset to the variable "Litter" and reading strings as factors
```

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: It is important to research the exotoxicology of neonicotinoids on insects because some insects like bees are important for pollination of crops so we would want to make sure neonicotinoids don't harm them. The goal would be fore the neonicotinoids to only harm insects that are pests on crops and not other insects. Also, insecticides can lead to super resistance if some of the insects survive so it is important to know how effective the insectside is.

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: It is important to study leaf litter and woody debris because they are important indicators of forest health. Many organisms live in leaf litter or use leaf litter so it it has a vital function in the forest. Leaf litter also provides nutrients for soil and makes it viable to grow plants so it can indicate the quality of a forests soil.

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. Tower plots were used to sample litter and woody debris. 2. The tower plots were selected "within the 90% flux footprint of the primary and secondary airsheds" 3. Litterr was sampled in 20 40m x 40m plots for sites with forested tower airsheds.

Obtain basic summaries of your data (Neonics)

5. What are the dimensions of the dataset?

```
dim(Neonics) #dimensions of neonics dataset
```

```
## [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) #summary of the effects of neonicotinoids on insects
```

```
##     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: These effects are of interest because they show specifically how the neonicotinoids are affecting the insects. Particularly mortality and population are highest so it shows that the neonicotinoids have a high mortality rate.

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.[TIP: The `sort()` command can sort the output of the summary command…]

```
sort(summary(Neonics$Species.Common.Name))
```

```
##                         Ant Family                       Apple Maggot
##                                  9                                  9
##             Glasshouse Potato Wasp                           Lacewing
##                                 10                                 10
##            Southern House Mosquito           Two Spotted Lady Beetle
##                                 10                                 10
##           Spotless Ladybird Beetle                Braconid Parasitoid
##                                 11                                 12
##                       Common Thrip      Eastern Subterranean Termite
##                                 12                                 12
##                             Jassid                         Mite Order
##                                 12                                 12
##                          Pea Aphid                   Pond Wolf Spider
##                                 12                                 12
##              Armoured Scale Family                   Diamondback Moth
##                                 13                                 13
##                      Eulophid Wasp                  Monarch Butterfly
##                                 13                                 13
##                      Predatory Bug              Yellow Fever Mosquito
##                                 13                                 13
##                       Corn Earworm                  Green Peach Aphid
##                                 14                                 14
##                          House Fly                         Ox Beetle
##                                 14                                 14
##                  Red Scale Parasite                Spined Soldier Bug
##                                 14                                 14
##              Western Flower Thrips Hemlock Woolly Adelgid Lady Beetle
##                                 15                                 16
##              Hemlock Wooly Adelgid                               Mite
##                                 16                                 16
##                        Onion Thrip             Araneoid Spider Order
##                                 16                                 17
##                          Bee Order                    Egg Parasitoid
##                                 17                                 17
##                       Insect Class           Moth And Butterfly Order
```

```
##                            17                            17
##   Oystershell Scale Parasitoid     Black-spotted Lady Beetle
##                            17                            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
##                  Codling Moth   Flatheaded Appletree Borer
##                            19                            20
##           Horned Oak Gall Wasp            Leaf Beetle Family
##                            20                            20
##             Potato Leafhopper   Tooth-necked Fungus Beetle
##                            20                            20
##                 Argentine Ant                        Beetle
##                            21                            21
##                     Mason Bee                      Mosquito
##                            22                            22
##              Citrus Leafminer               Ladybird Beetle
##                            23                            23
##             Spider/Mite Class           Tobacco Flea Beetle
##                            24                            24
##                  Chalcid Wasp        Convergent Lady Beetle
##                            25                            25
##                 Stingless Bee          Ground Beetle Family
##                            25                            27
##            Rove Beetle Family                 Tobacco Aphid
##                            27                            27
##                 Scarab Beetle                 Spring Tiphia
##                            29                            29
##                   Thrip Order        Ladybird Beetle Family
##                            29                            30
##                    Parasitoid                  Braconid Wasp
##                            30                            33
##                  Cotton Aphid                Predatory Mite
##                            33                            33
##          Sweetpotato Whitefly                  Aphid Family
##                            37                            38
##                Cabbage Looper         Buff-tailed Bumblebee
##                            38                            39
##                True Bug Order      Sevenspotted Lady Beetle
##                            45                            46
##                  Beetle Order  Snout Beetle Family, Weevil
##                            47                            47
##             Erythrina Gall Wasp               Parasitoid Wasp
##                            49                            51
##         Colorado Potato Beetle                 Parastic Wasp
##                            57                            58
##           Asian Citrus Psyllid              Minute Pirate Bug
##                            60                            62
##             European Dark Bee                      Wireworm
```

```
##                         66                          69
##              Euonymus Scale           Asian Lady Beetle
##                         75                          76
##            Japanese Beetle           Italian Honeybee
##                         94                         113
##                 Bumble Bee        Carniolan Honey Bee
##                        140                         152
##      Buff Tailed Bumblebee             Parasitic Wasp
##                        183                         285
##                  Honey Bee                    (Other)
##                        667                         670
```

```
#summary of the most studied species in the dataset sorted by number of each species
```

> Answer: The 6 most commonly studied insects in the dataset are honey bees, parasitic wasps, buff tailed bumblebees, carniolan honey bees, bumble bees and italian honeybees. The species are all hymenopterans and pollinators so they are important because they pollinate crops which allows the crops to reproduce.

8. Concentrations are always a numeric value. What is the class of `Conc.1..Author.` column in the dataset, and why is it not numeric?

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

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

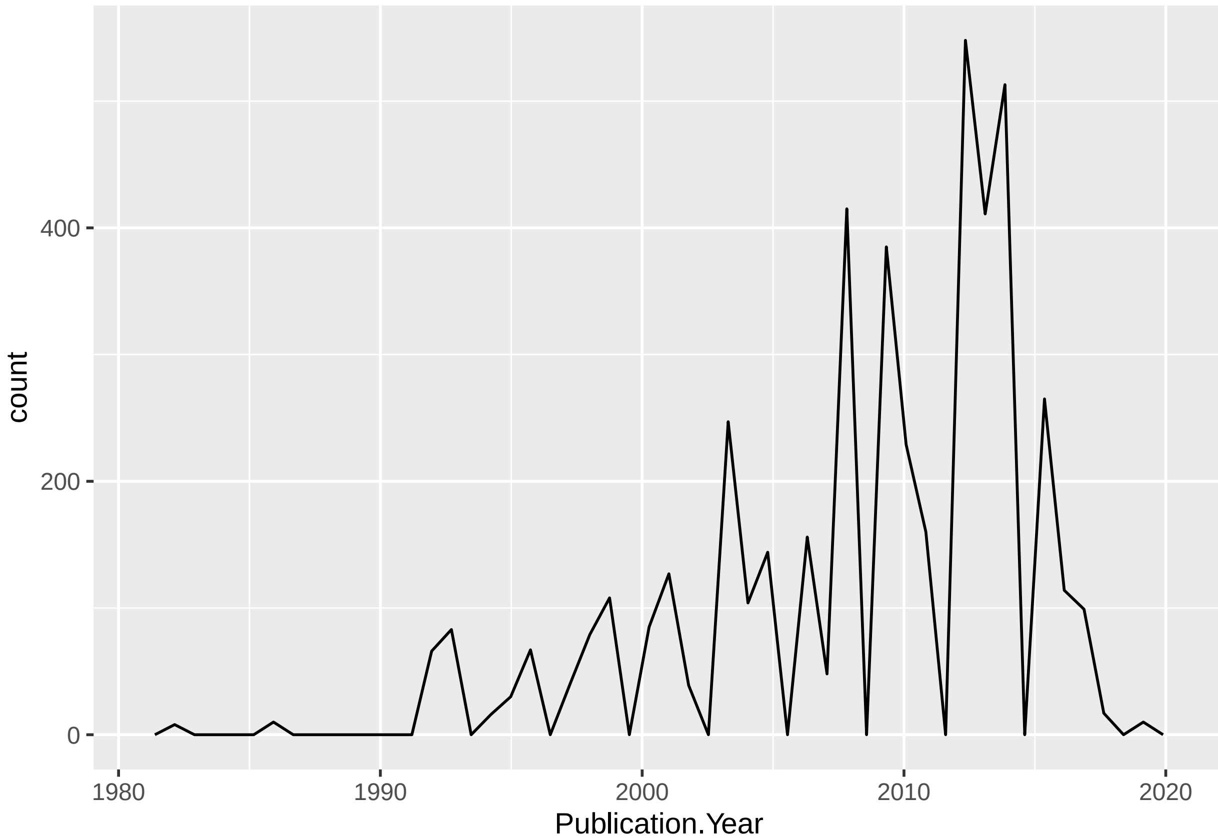
```
#determining the class of Conc.1..Author (concentration)
```

> Answer: The Conc.1..Author column is a factor. It is not numeric because earlier we set all strings as factors so it is reading the column as a factor.

Explore your data graphically (Neonics)

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

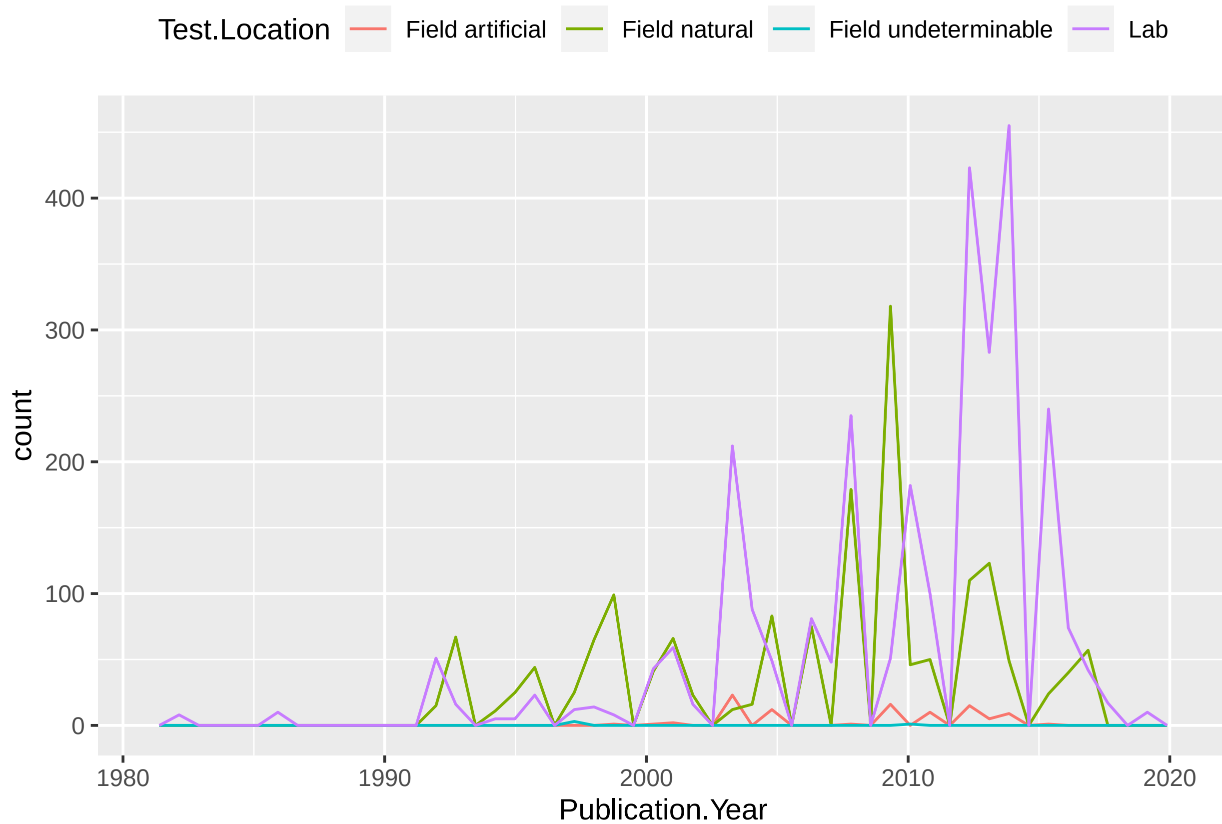
```
ggplot(Neonics) +
  geom_freqpoly(aes(x = Publication.Year), bins = 50)
```




```
#plot of the number of studies conducted by publication year in Neonics
```

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) +
  theme(legend.position = "top")
```




```
#plot of the number of studies conducted by publication year for each Test location.
```

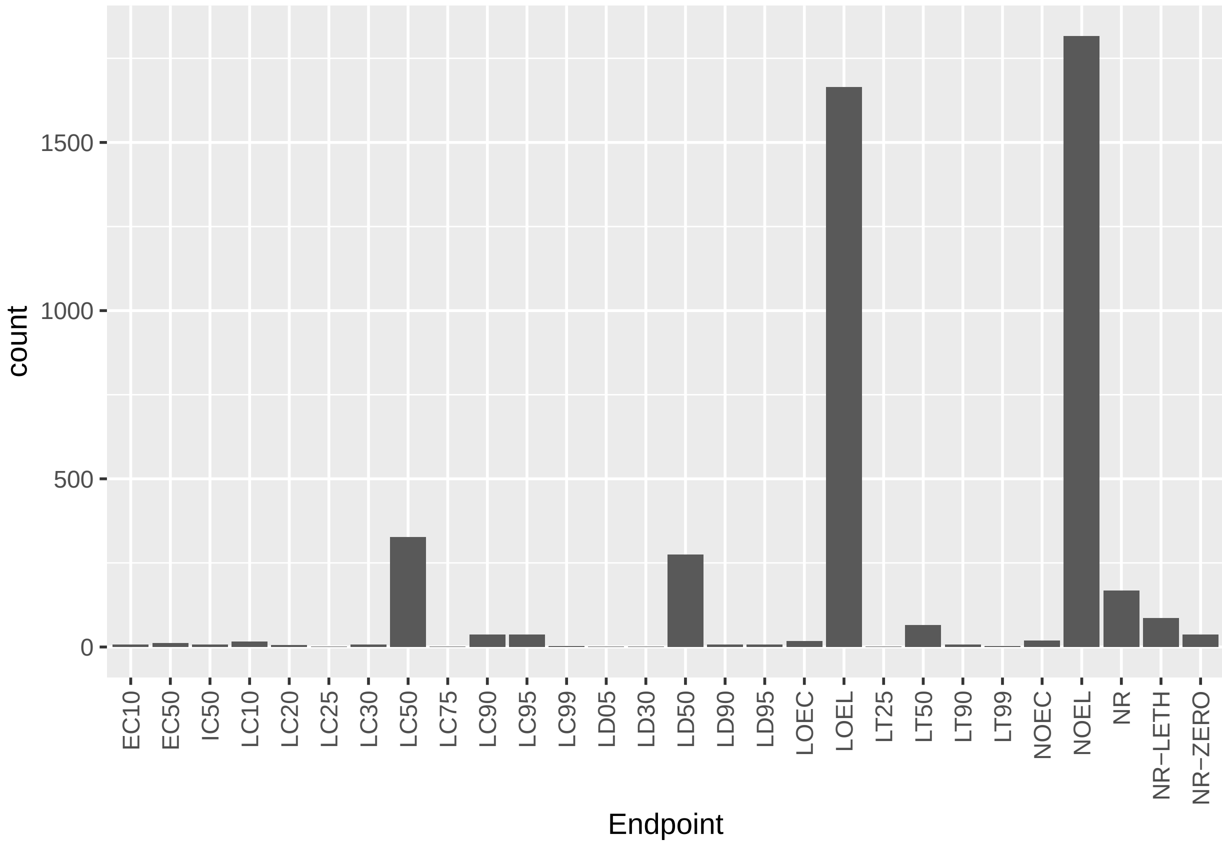
Interpret this graph. What are the most common test locations, and do they differ over time?

> Answer: The most common test locations are Lab and Field Natural. Lab starts low in the 1980s-2000 and then increases in the 2000s and spikes around 2015. Field Nautural follows a similar pattern but spikes at 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.

[**TIP**: Add `theme(axis.text.x = element_text(angle = 90, vjust = 0.5, hjust=1))` to the end of your plot command to rotate and align the X-axis labels…]

```
ggplot(Neonics, aes(x = Endpoint))+
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5, hjust=1)) +
  geom_bar() #plot of the endpoints and their frequencies
```



Answer: The two most common endpoints are NOEL ("No-observable-effect-level: highest dose (concentration) producing effects not significantly different from responses of controls according to author's reported statistical test") and LOEL ("Lowest-observable-effect-level: lowest dose (concentration) producing effects that were significantly different").

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) #checking class of collectDate
```

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

```
collection.date <- ymd(Litter$collectDate) #formating collectDate to be a date instead of factor
class(Litter$collectDate) #checking class of collectDate
```

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

```
unique(Litter$collectDate) #finding all the dates litter was sampled in August 2018
```

```
## [1] 2018-08-02 2018-08-30
## Levels: 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`?

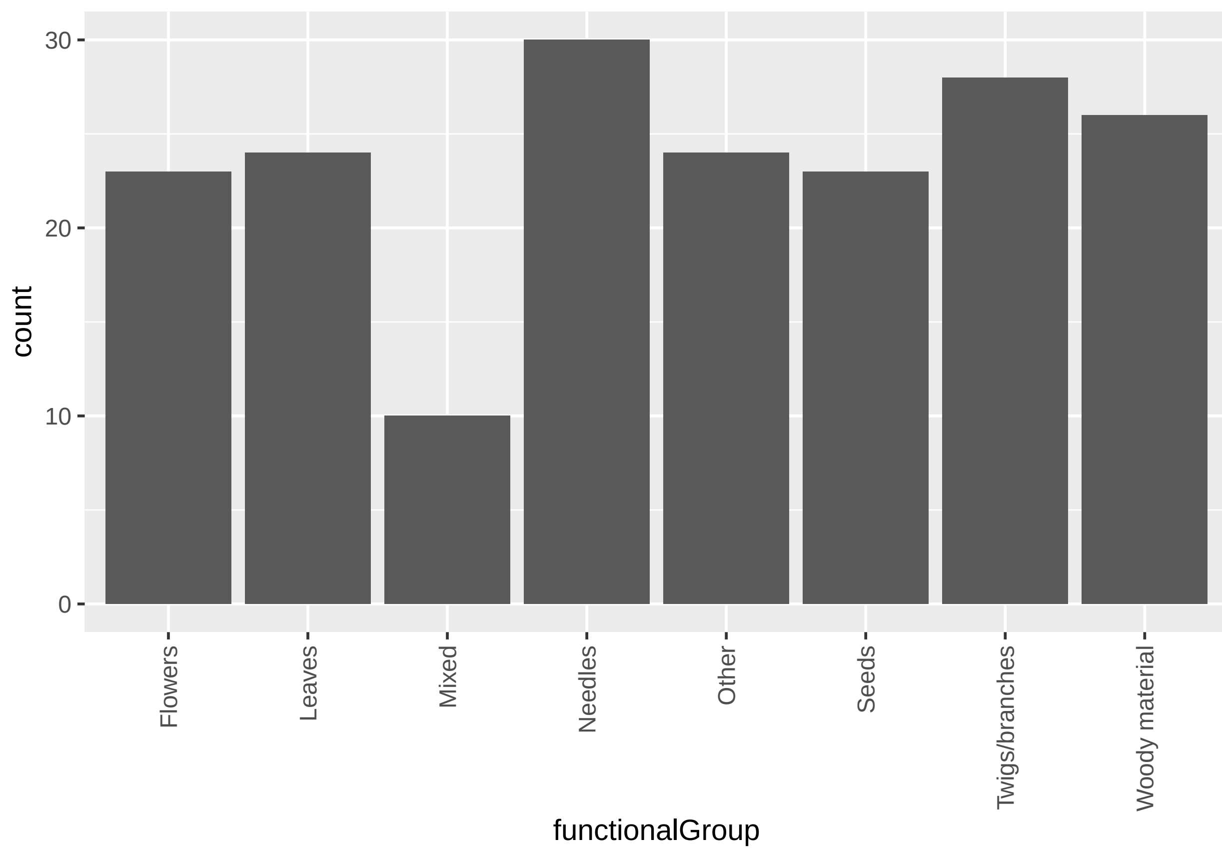
```
unique(Litter$namedLocation) #retrieving the number of plots that were sampled from Niwot Ridge
```

```
##  [1] NIWO_061.basePlot.ltr NIWO_064.basePlot.ltr NIWO_067.basePlot.ltr
##  [4] NIWO_040.basePlot.ltr NIWO_041.basePlot.ltr NIWO_063.basePlot.ltr
##  [7] NIWO_047.basePlot.ltr NIWO_051.basePlot.ltr NIWO_058.basePlot.ltr
## [10] NIWO_046.basePlot.ltr NIWO_062.basePlot.ltr NIWO_057.basePlot.ltr
## 12 Levels: NIWO_040.basePlot.ltr ... NIWO_067.basePlot.ltr
```

Answer: 12 plots. This information is different from summary because it is just showing the number of plots at Niwot Ridge not all of the different locations.

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.

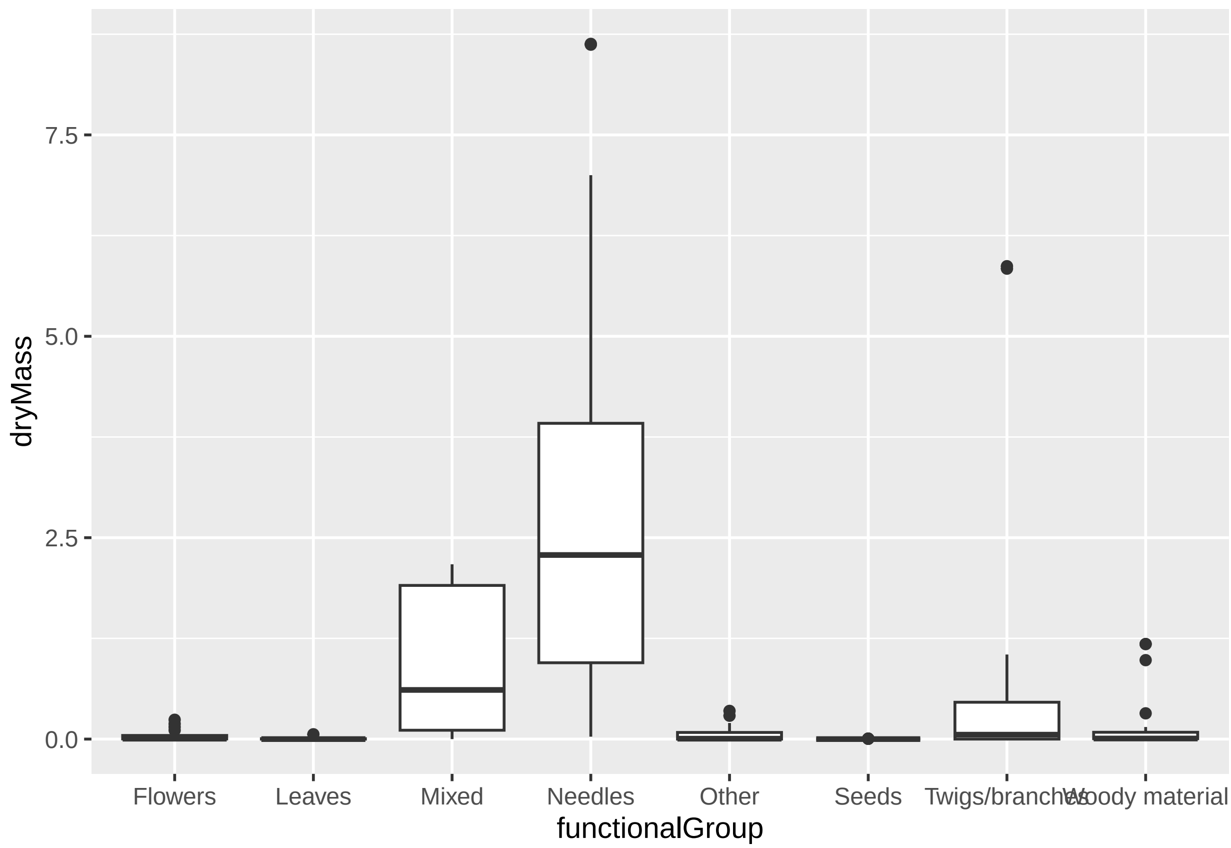
```
ggplot(Litter, aes(x = functionalGroup))+
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5, hjust=1)) +
  geom_bar()
```



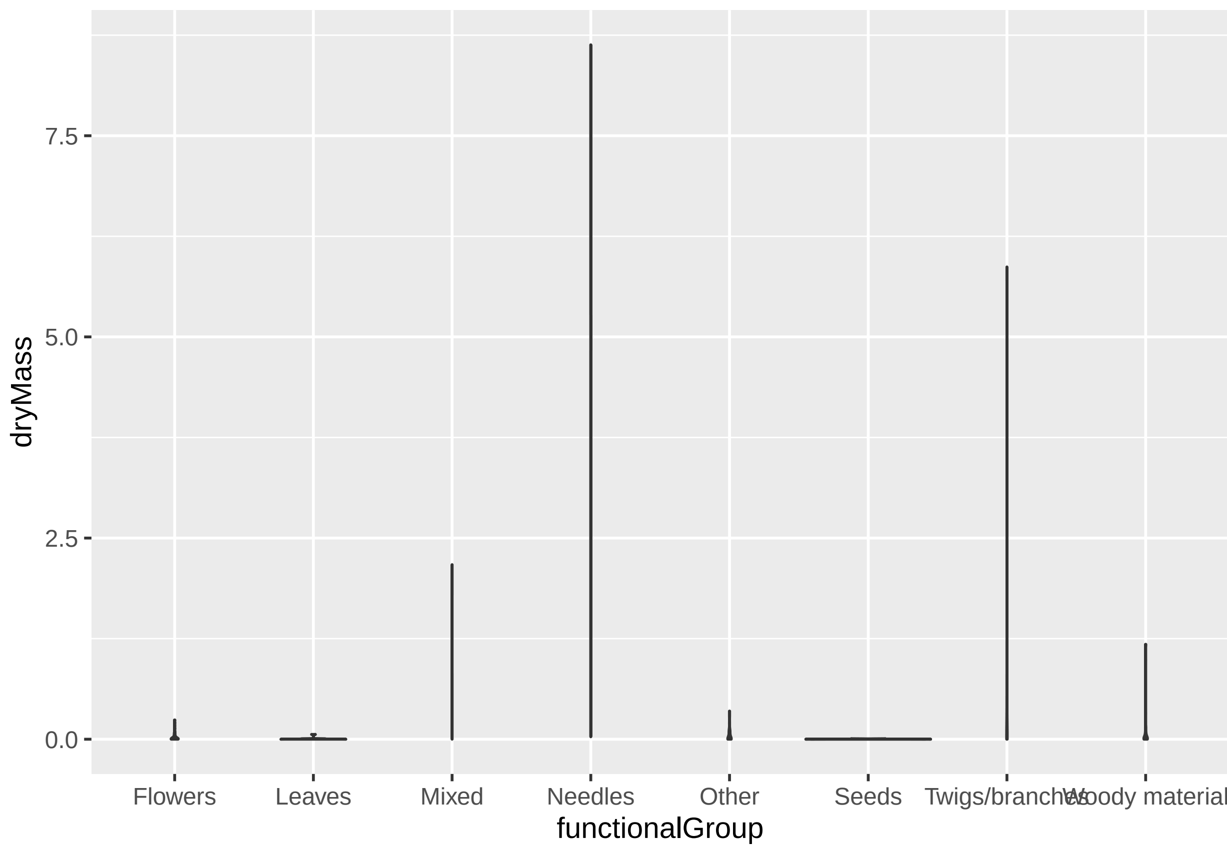

```
#bar graph of functionalGroup counts showing what type of litter is collected at the Niwot Ridge sites
```

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

```r
#boxplot of dryMass by functionalGroup
ggplot(Litter) +
  geom_boxplot(aes(x = functionalGroup, y = dryMass))
```




```r
#violin plot of dryMass by functionalGroup
ggplot(Litter) +
  geom_violin(aes(x = functionalGroup, y = dryMass),
              draw_quantiles = c(0.25, 0.5, 0.75))
```



“‘

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

> Answer: The boxplot was a better visualization option than the violin plot because the violin plot shows density as well and the density of all the litter types was very similar across sites.

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

> Answer: Needles and Twigs/branches