Assignment 3: Data Exploration

Karly Nocera

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 <>.

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] "Z:/Environmental_Data_Analytics_2021/Assignments"
```

```
#Note: Every time I try to setwd() it reverts back to Assignment folder so had to use absolute path for

library(tidyverse)

neonics <- read.csv("Z:/Environmental_Data_Analytics_2021/Data/Raw/ECOTOX_Neonicotinoids_Insects_raw.cs
litter <- read.csv("Z:/Environmental_Data_Analytics_2021/Data/Raw/NEON_NIWO_Litter_massdata_2018-08_raw
```

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: This insecticide is chemically related to nicotine and are much more toxic to invertebrates than mammals. Additionally, its water solubility facilitates plant absorption and can result in potential harm to bees feeding on nectar.

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: Forest litter (non-living organic debris) and woody debris can inform researchers about the forest's characteristics, habitat, and ecology. This is important to understanding ecosystem dynamics, including productivity, and predicting nutrient cycling and soil fertility.

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) Only sites that had woody vegetation greater than 2 meters tall were sampled. 2) Tower lot locations are selected at random within the 90% flux footprint of the airsheds. 3) Trap placements can be targeted or randomized, depending on vegetation composition. *

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 "Effects" column, determine the most common effects that are studied. Why might these effects specifically be of interest?

```
neonics$Effect <- as.factor(neonics$Effect)

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: The population and mortality are the most common effects studied, which are particularly of interest when analyzing life cycle and strain on forest resources.

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.

```
neonics$Species.Common.Name <- as.factor(neonics$Species.Common.Name)

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 six most commonly studied insects in this dataset are the honey bee, parasitic wasp, buff tailed bumblebee, carniloan honey bee, bumble bee, and Italian honeybee. All six are members of the Hymenoptera order of insects, five of which are bees. As noted about the concern of toxic ingestion via nectar, that is why these six are likely a research interest over other species.

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.)
```

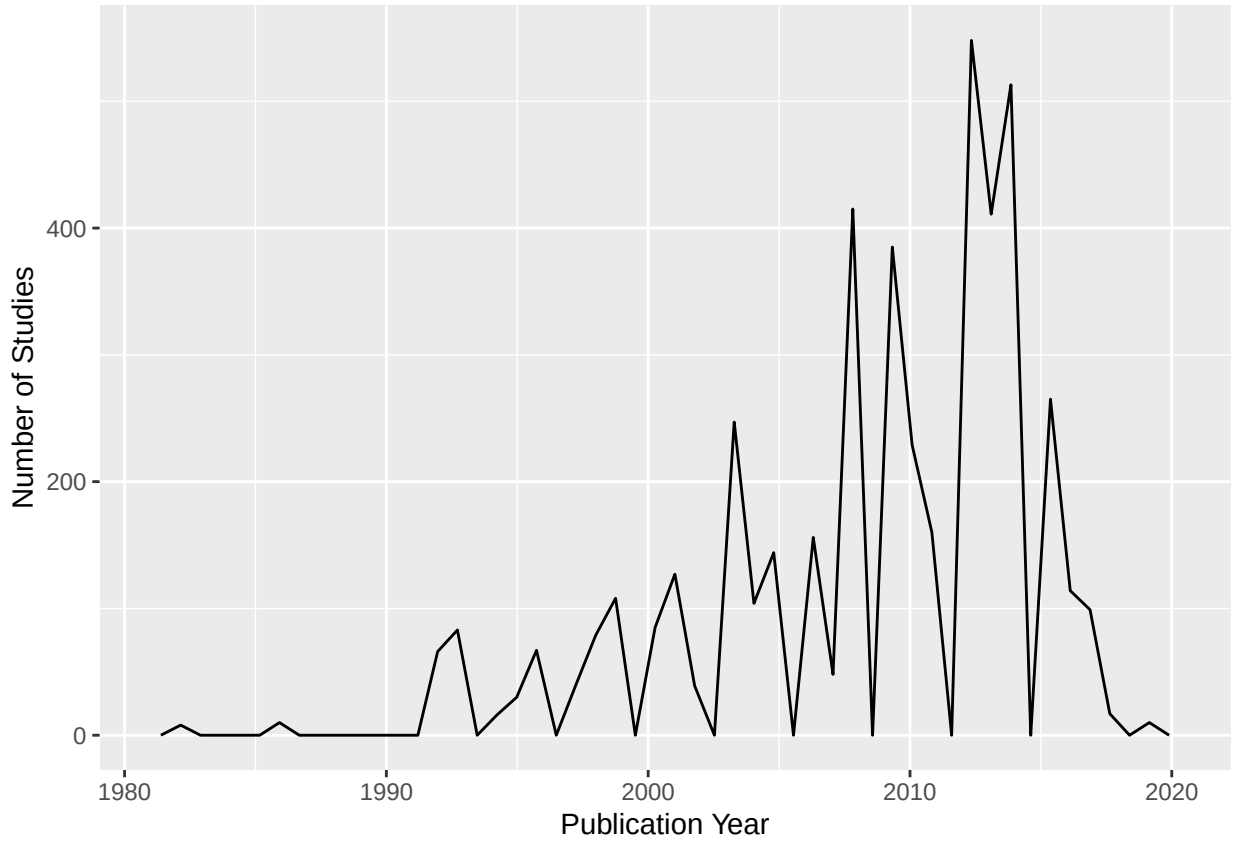
```
## [1] "character"
```

Answer: The class of Conc.1..Author. is a character rather than numeric because not all entries are numeric. For example, there are aproximations (ex: ~10) and no readings (NR).

Explore your data graphically (Neonics)

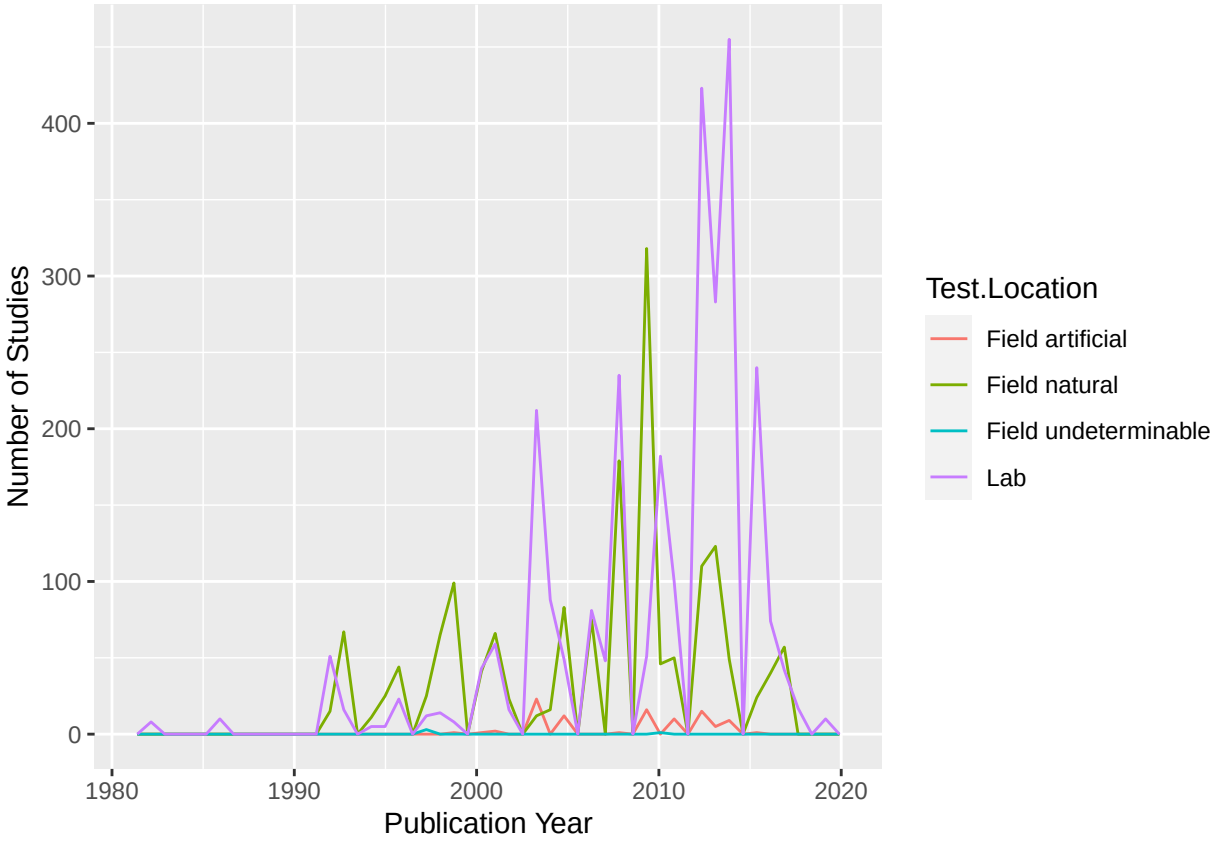
9. Using `geom_freqpoly`, generate a plot of the number of studies conducted by publication year.

```
ggplot(neonics) +
  geom_freqpoly(aes(x = Publication.Year), bins = 50) +
  scale_x_continuous() +
  labs(x = "Publication Year", y = "Number of Studies")
```



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) +
  labs(x = "Publication Year", y = "Number of Studies")
```

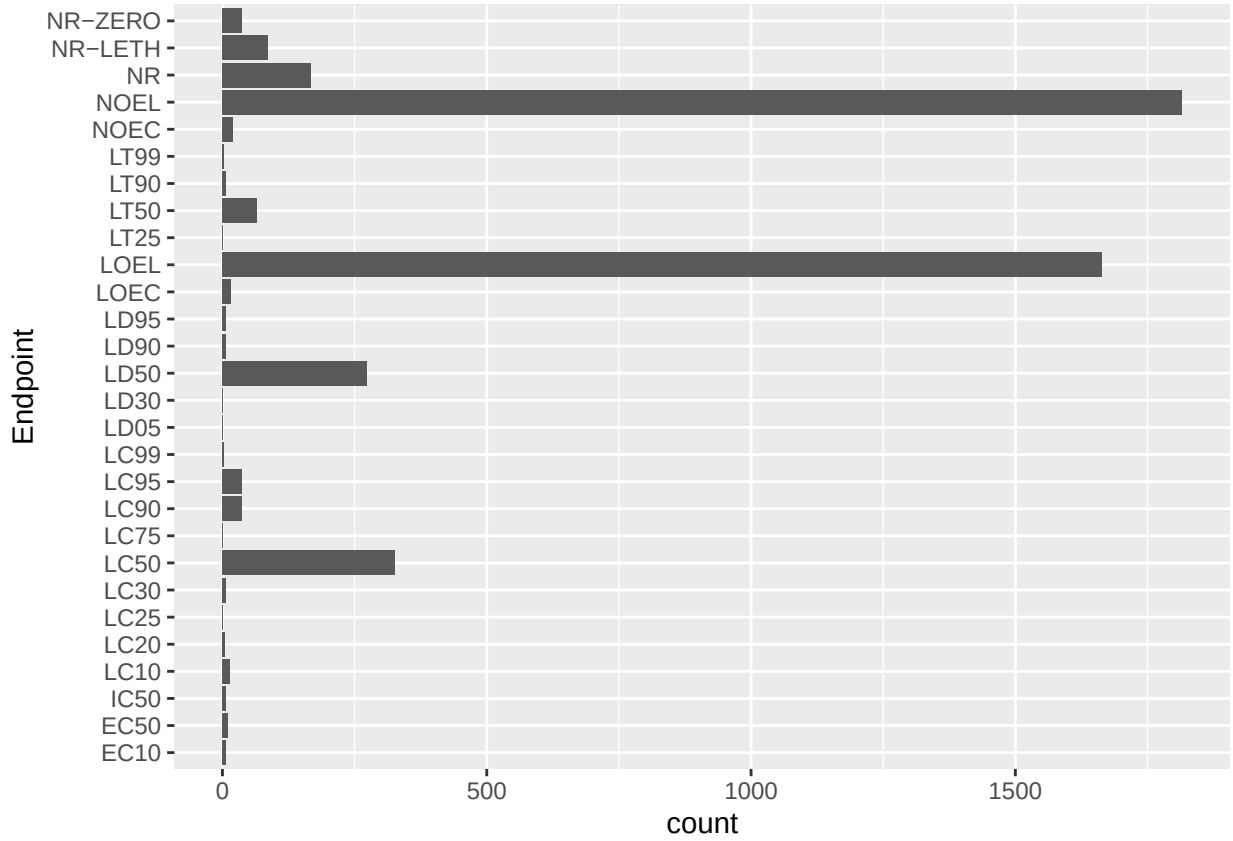


Interpret this graph. What are the most common test locations, and do they differ over time?

> Answer: The two most common test locations are lab and field natural. Generally, lab test locations are more common, but there are points in time (particularly before 2000 and around 2008) where there are more field natural than lab. Additionally, both test locations vary in number of studies over time, with cyclical peaks and troughs.

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() +
  coord_flip() # for label viability
```



Answer: Most common endpoint is NOEL, no observable effect level (highest concentration producing effects not significantly different from control responses) and second most common is LOEL, lowest observable effect level (lowest concentration producing significantly different effects from control responses).

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.

```
# is it date class?
class(litter$collectDate)
```

```
## [1] "character"
```

```
# convert to date
litter$collectDate <- as.Date(litter$collectDate, format = "%Y-%m-%d")

# confirm new class
class(litter$collectDate)
```

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

```
# determine which dates litter was sampled in August 2018
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"
```

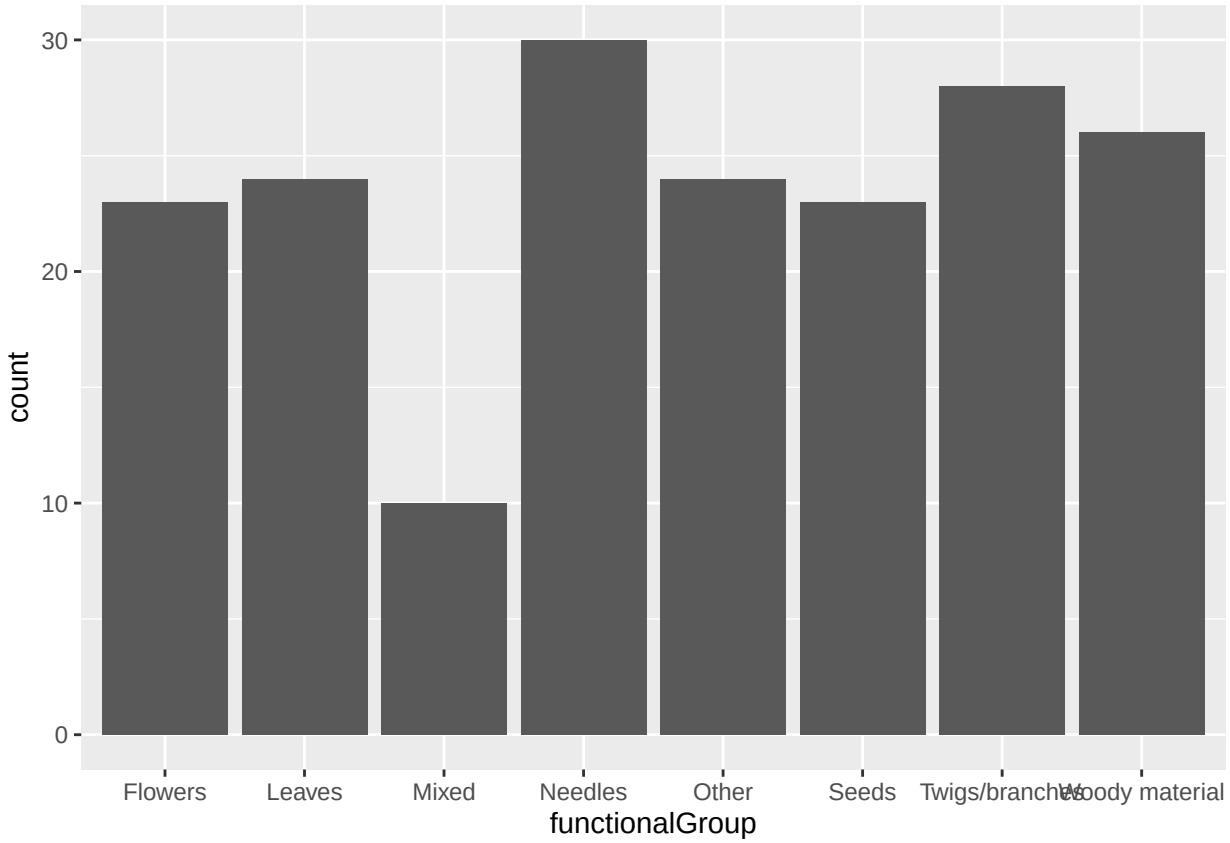
```
summary(litter$siteID)
```

```
##    Length     Class      Mode
##       188 character character
```

Answer: All plots were sampled at Niwot Ridge because there is only one unique result (NIWO). This is different from summary because summary tells how many samples (188) were at a siteID but unique will only output how many different siteIDs there are.

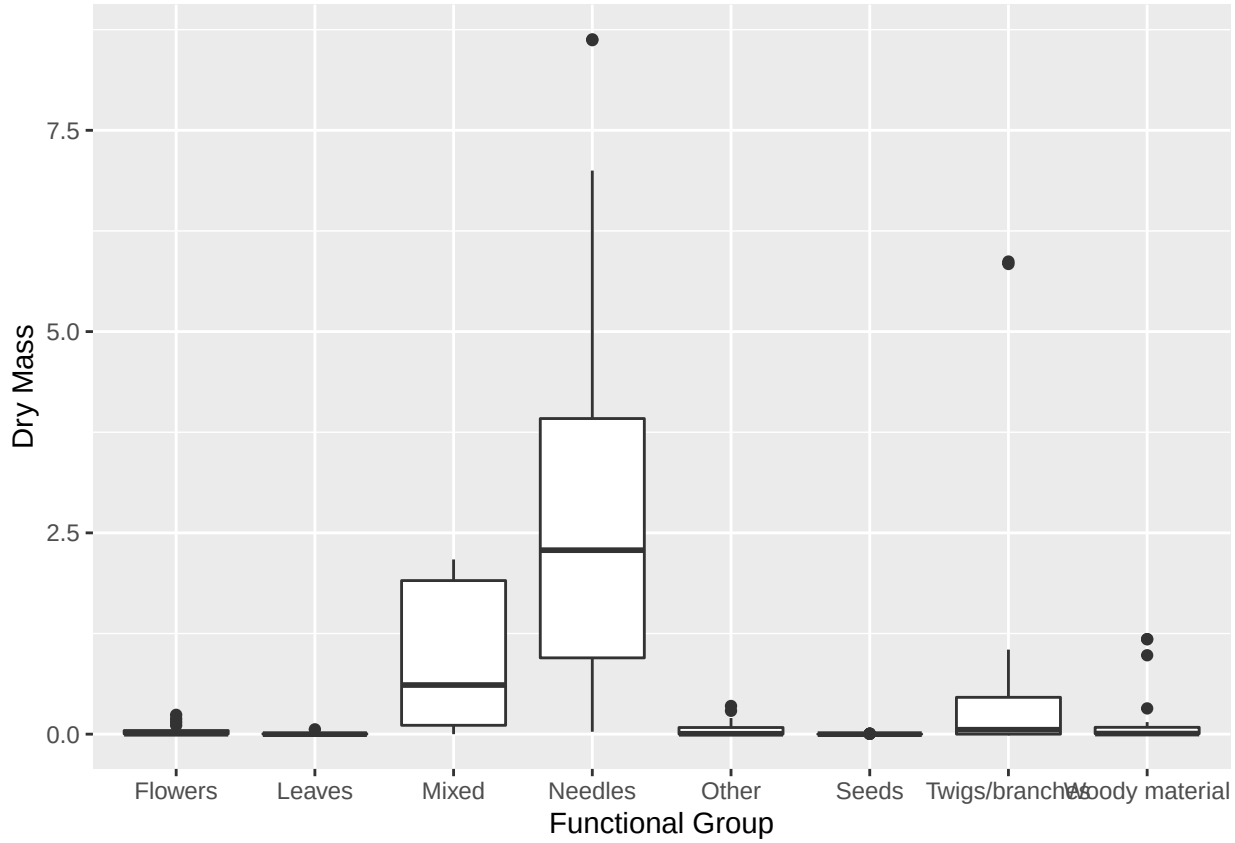
14. Create a bar graph of functionalGroup counts. This shows you what type of litter is collected at the Niwot Ridge sites. Notice that litter types are fairly equally distributed across the Niwot Ridge sites.

```
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)) +
  labs(x = "Functional Group", y = "Dry Mass")
```

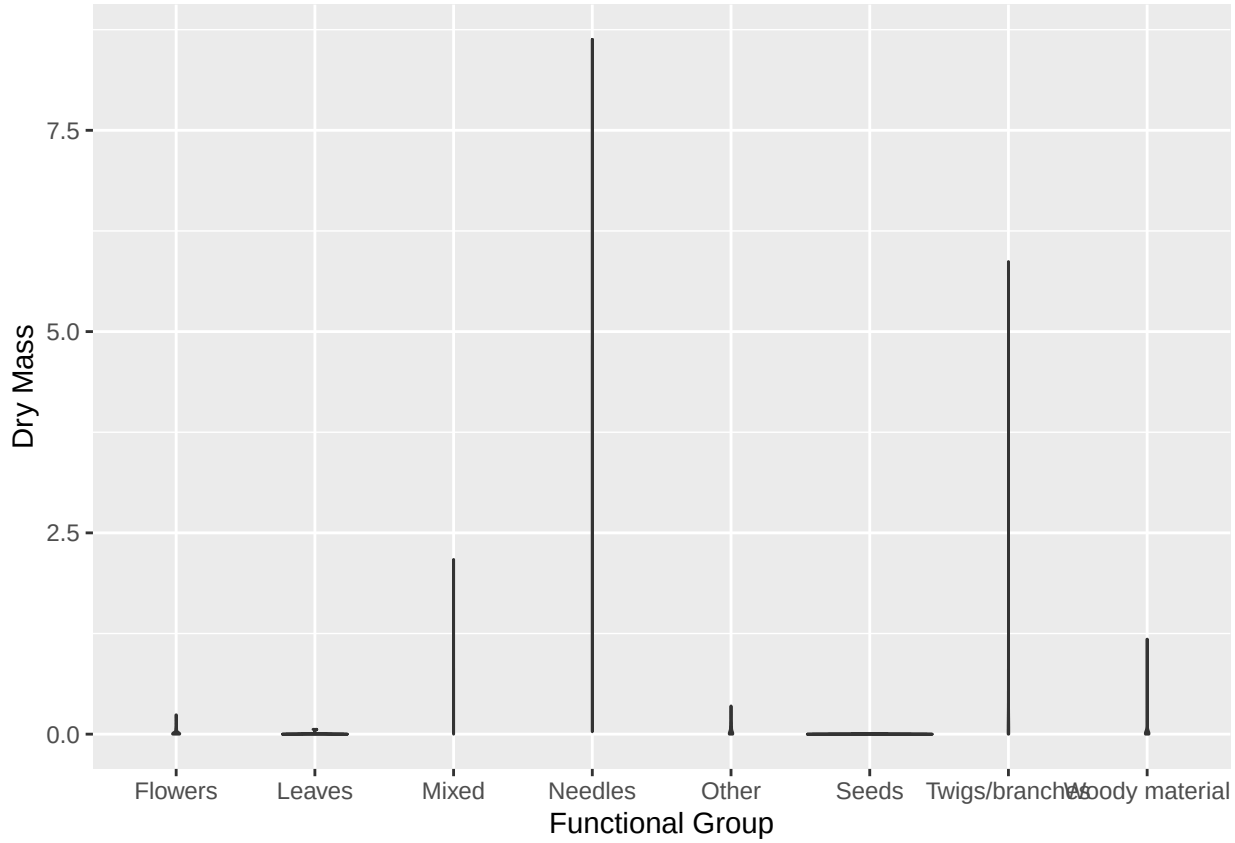



```
ggplot(litter) +
  geom_violin(aes(x = functionalGroup, y = dryMass),
              draw_quantiles = c(0.25, 0.5, 0.75)) +
  labs(x = "Functional Group", y = "Dry Mass")
```

```
## 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: The boxplot is a more effective visualization option because it is able to more clearly display the variance and percentiles of data whereas the violin plot collapses the figures to an illegible size/shape.

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

> Answer: Needles tend to have the highest biomass at these sites.