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] "/Users/ethel/Desktop/Environ 872/Environmental_Data_Analytics_2020/Assignments"
```

```
setwd("/Users/ethel/Desktop/Environ 872/Environmental_Data_Analytics_2020")

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: Neonicotinoids have a relatively low risk for nontarget organisms and the environment and high-target specificity to insects. To reduce toxicity to mammals and increase toxicity to insects, neonicotinoid compounds have been selected that are highly specific for subtypes of nicotinic receptors that occur in 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 is an important factor in ecosystem dynamics, as it is indicative of ecological productivity and may be useful in predicting regional 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: *An elevated mesh litterfall trap (70.7 cm x 70.7 cm x 80 cm; 0.5 m2, 0.8 m tall) will be placed at a random location within each accepted plot/subplot, with trap locations selected from the herbaceous clip harvest list.* Ground traps for collecting large leaves, fronds, and fine woody debris with butt-end diameter < 2 cm and length > 50 cm, will be randomly located in plots at least 2 meters from elevated traps, consistent with Muller-Landau and Wright (2010). *Litter sampled from elevated traps will be sorted into functional groups following collection

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: The most common effects are mortality, population, behavior, feeding behaviour, and reproduction. These effects might specifically be of interest because these may be directly associated with species.

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: Six most commonly studied species: Honey Bee, Parasitic Wasp, Buff Tailed Bumblebee, Carniolan Honey Bee, Bumble Bee, Italian Honeybee. The common is that they all bees.The neonicotinoid class of insecticides represented a risk to bees, so the studies interested in bees.

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.)
```

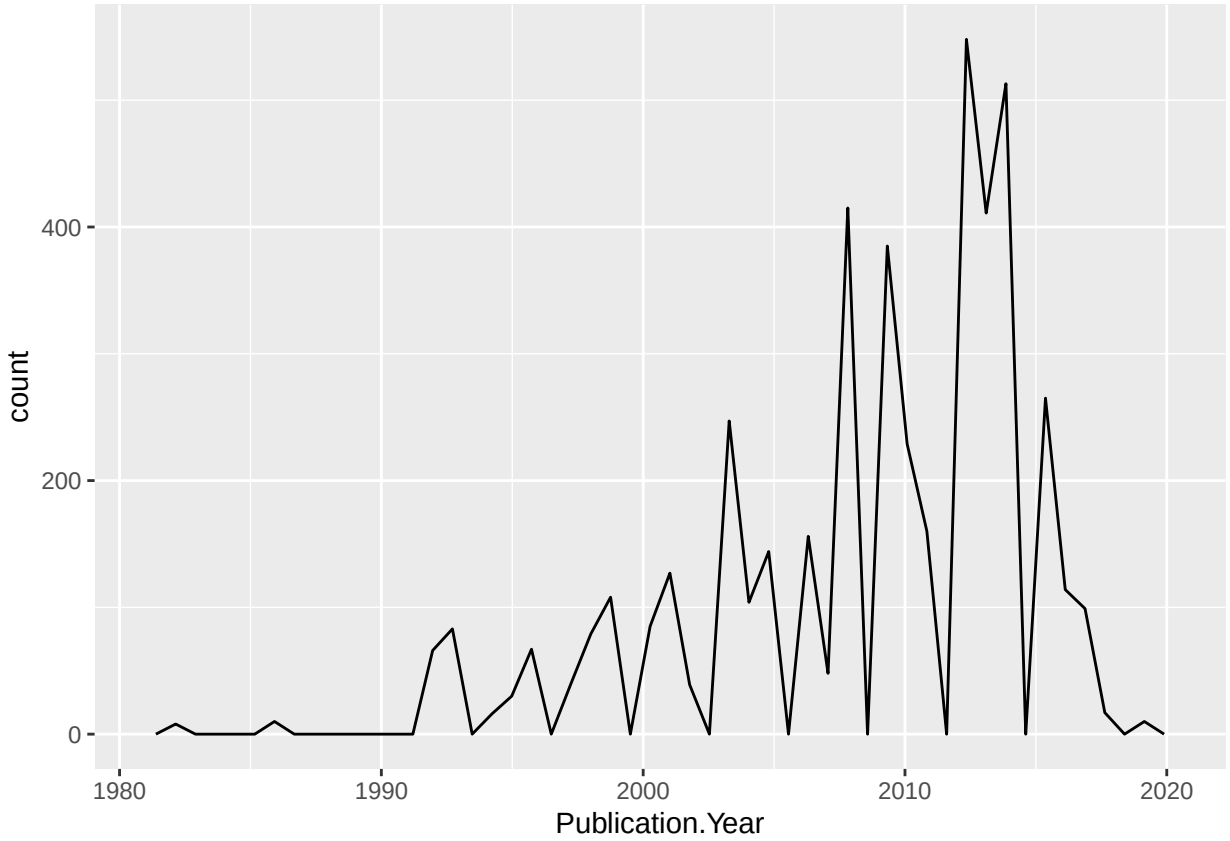
```
## [1] "factor"
```

Answer: The class of Conc.1..Author is factor. By default, read.csv checks the first few rows of your data to see whether to treat each variable as numeric. If it finds non-numeric values, it assumes the variable is character data, and character variables are converted to factors.

Explore your data graphically (Neonics)

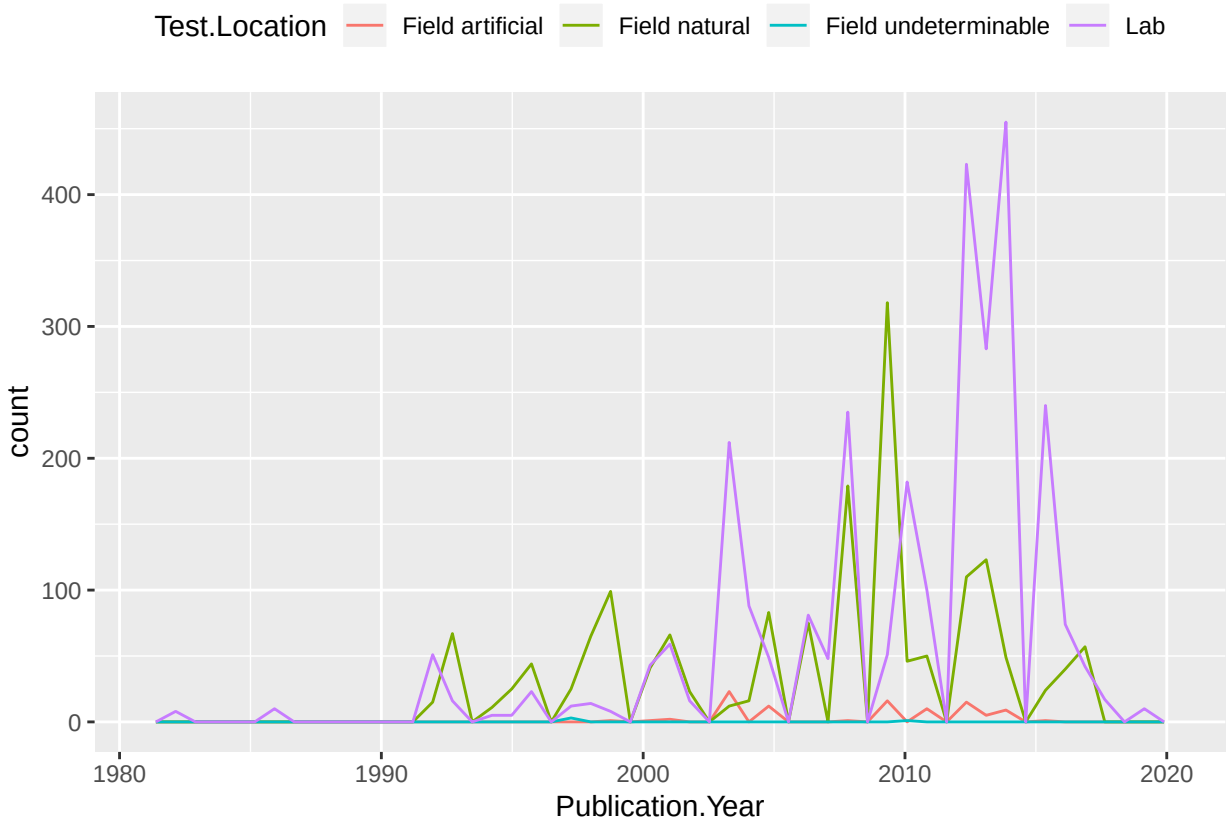
9. Using `geom_freqpoly`, generate a plot of the number of studies conducted by publication year.

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



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")
```

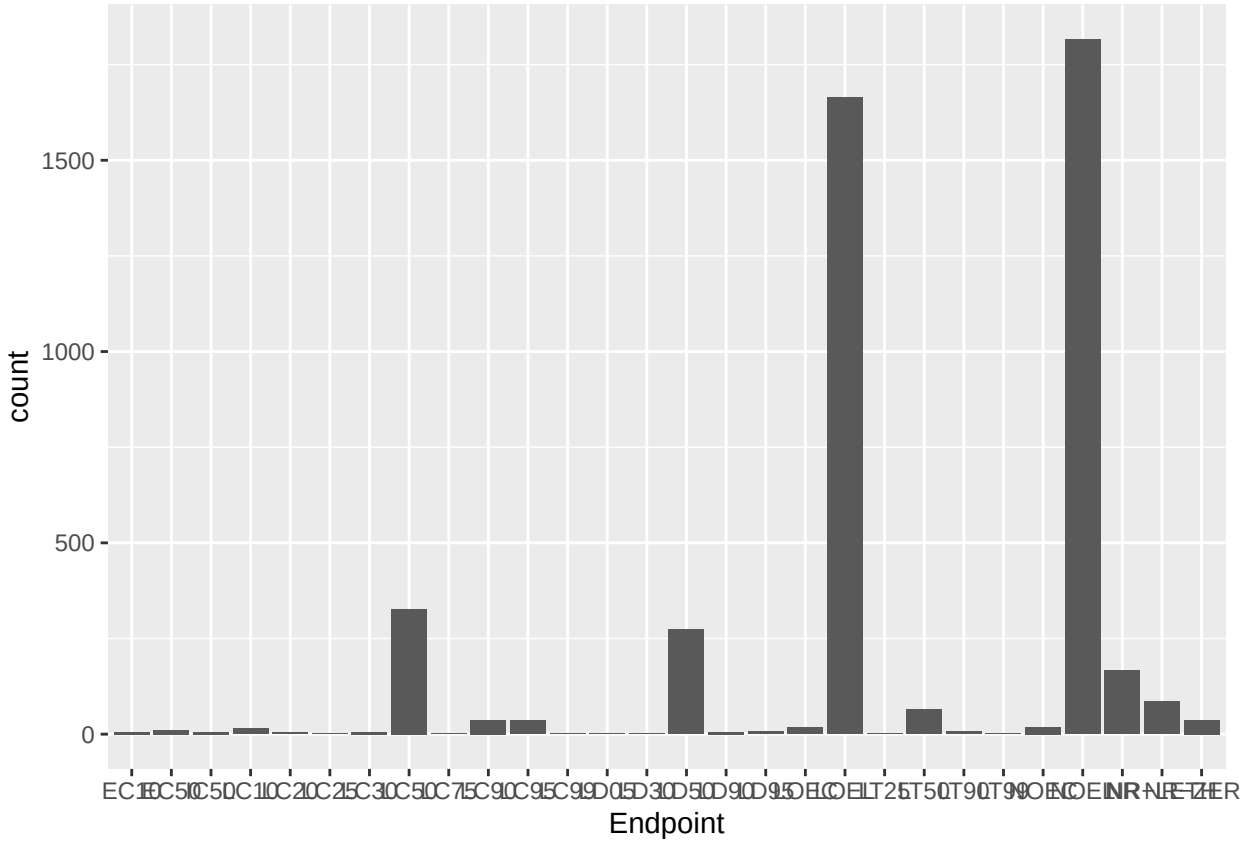


Interpret this graph. What are the most common test locations, and do they differ over time?

Answer: The most common test location are lab (2002-2016) and field nature (2008-2009).

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: The two common end points are LOEL and NOEL. LOEL: Lowest-observable-effect-level: lowest dose (concentration) producing effects that were significantly different (as reported by authors) from responses of controls (LOEAL/LOEC) NOEL: No-observable-effect-level: highest dose (concentration) producing effects not significantly different from responses of controls according to author's reported statistical test (NOEAL/NOEC)

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
```

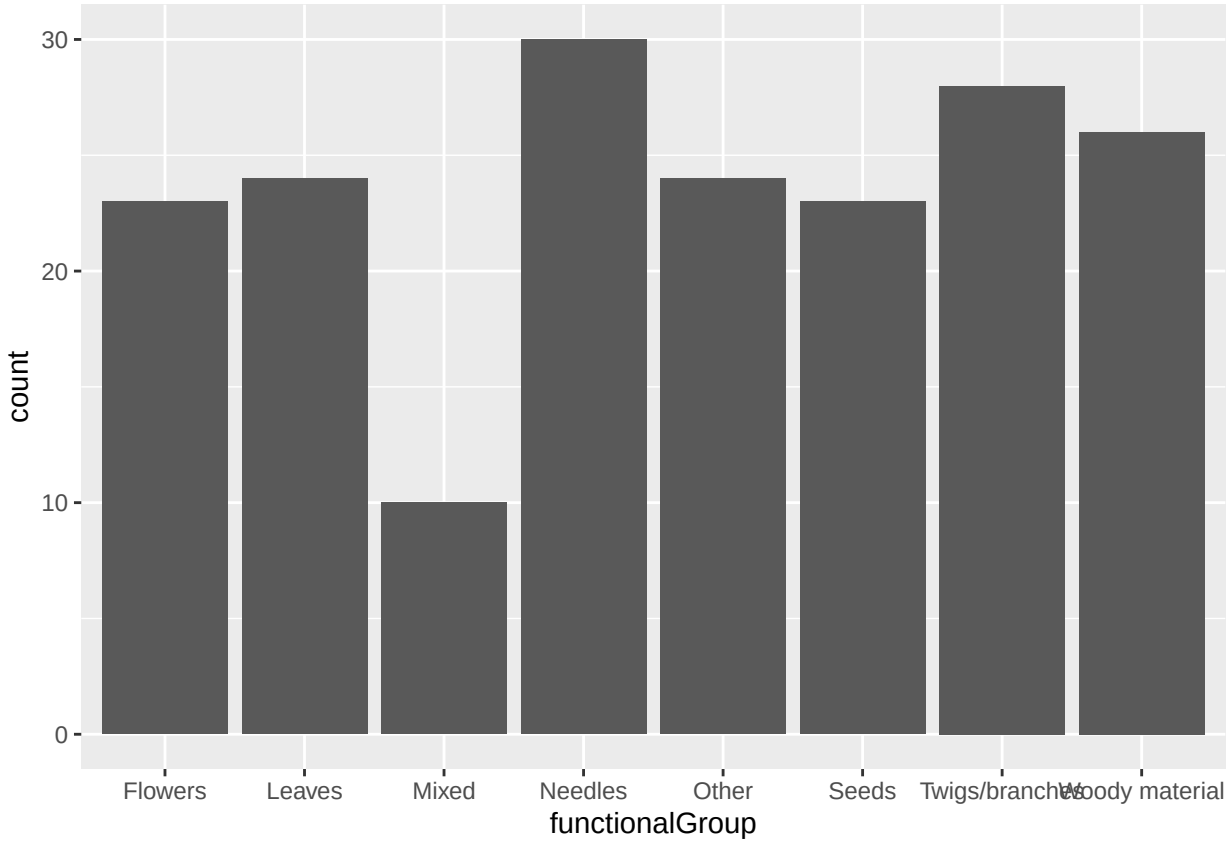
```
summary(Litter$plotID)
```

```
## 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: Unique tool can see which records are duplicated; Summary tool is to count how many records are duplicated.

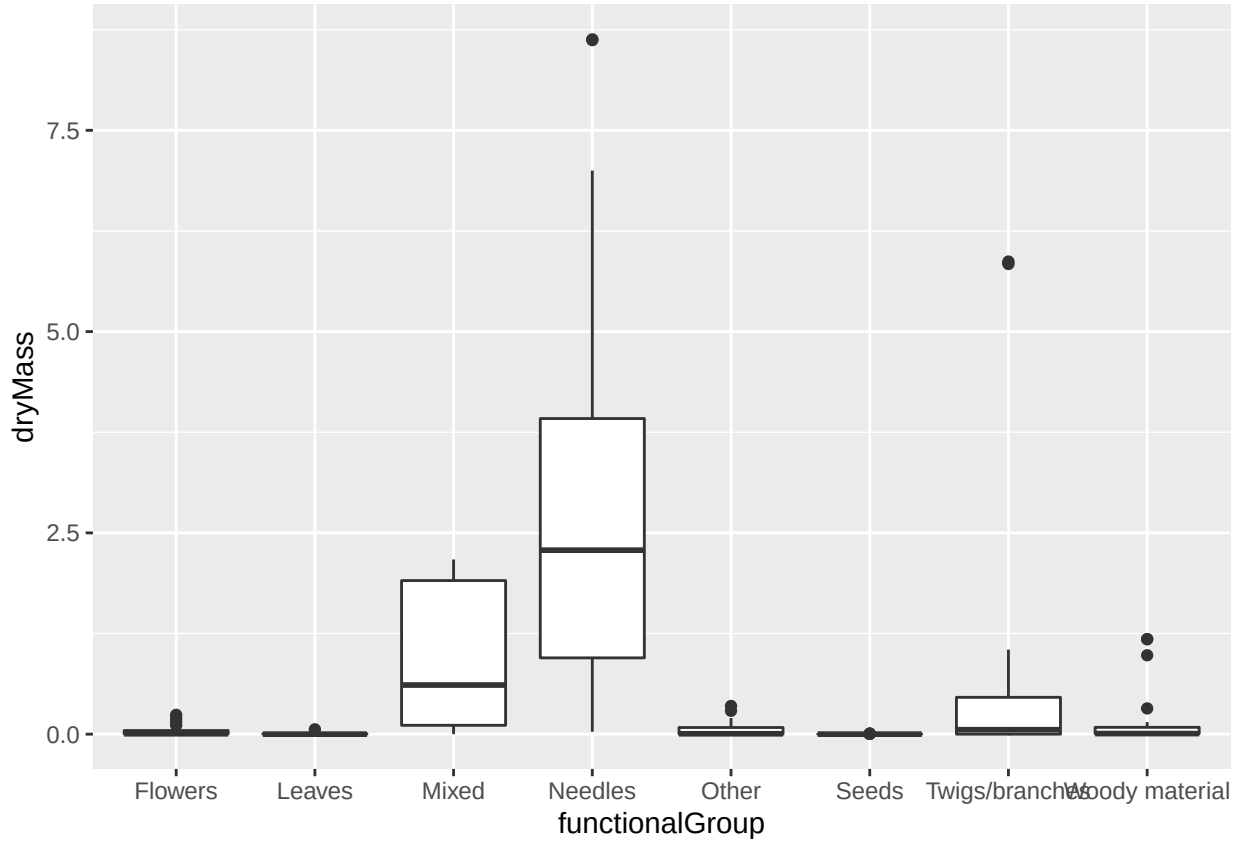
14. Create a bar graph of functionalGroup counts. This shows you what type of litter is collected at the Niwot Ridge sites. Notice that litter types are fairly equally distributed across the Niwot Ridge sites.

```
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))
```

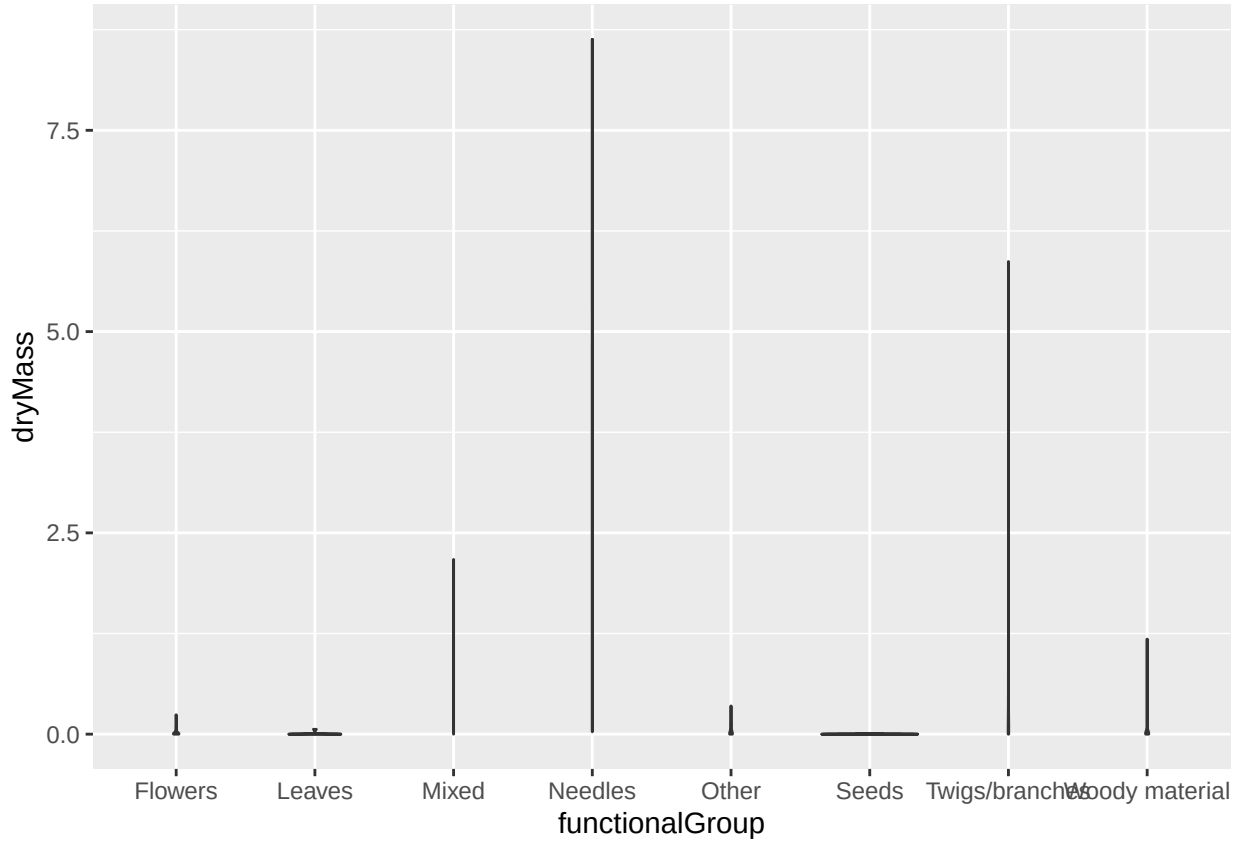



```
ggplot(Litter) +
  geom_violin(aes(x = functionalGroup, y = dryMass),
              draw_quantiles = c(0.25, 0.5, 0.75),
              scale="count")
```

```
## Warning in regularize.values(x, y, ties, missing(ties)): collapsing to
## unique 'x' values

## Warning in regularize.values(x, y, ties, missing(ties)): collapsing to
## unique 'x' values

## Warning in regularize.values(x, y, ties, missing(ties)): collapsing to
## unique 'x' values
```



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

> Answer: We can get more information from boxplot, such as the median, upper (max) and lower (min) adjacent values, but violin plot cannot, which only has a line in this case.

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.