

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.**

```
library(tidyverse)
```

```
## -- Attaching packages ----- tidyverse 1.3.1 --
```

```
## v ggplot2 3.3.5      v purrr  0.3.4
## v tibble  3.1.4      v dplyr  1.0.7
## v tidyr   1.1.3      v stringr 1.4.0
## v readr   2.0.1      v forcats 0.5.1
```

```
## -- Conflicts ----- tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()     masks stats::lag()
```

```
getwd()
```

```
## [1] "/Users/karenthornton/Documents/School/Grad School/Year 1/Semester 2/EDA/Environmental_Data_Anal
```

```
Neonics <- read.csv("//Users/karenthornton/Documents/School/Grad School/Year 1/Semester 2/EDA/Environment")
Litter <- read.csv("//Users/karenthornton/Documents/School/Grad School/Year 1/Semester 2/EDA/Environment")
```

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: Insects can be pollinators and have lots of other helpful ecosystem services. They are killing off the good insects as well as the bad ones. If neonicotinoids are toxic and are killing these insects then the plants/crops might start to die or are unable to reproduce.

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 in forests can often turn into fuel for fires. If we can see how much litter is being collected we can decide, based on dryness and temperature, what the chances of a big fire could be. There could be options to get rid of some litter to decrease the risk of fire.

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: There is a pair of litter traps (one higher and one lower) for every 400 m² plots. *ground samples are measured 1 time a year* elevated samples were sampled once every 2 weeks for deciduous forests and once every 1-2 months for evergreen *NEON sites have to have woody vegetation greater than 2m tall for selection.

Obtain basic summaries of your data (Neonics)

5. What are the dimensions of the dataset?

```
dim(Neonics)
```

```
## [1] 4623 30
```

```
#4623 rows and 30 columns
```

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: The most common effects that are measured are population and mortality. These are specifically of interest because the insecticides can kill pollinators as well, so scientists will want to see how the insecticide effects the population and mortality of these “good bugs” as well.

- 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 Woolly 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

#HoneyBee and Parasitic Wasp

Answer: Honeybee and Parasitic Wasp are the two most commonly studied. Both of these insects look similar to each other (both fly and have similar body structure). If the insecticide is meant to kill parasites then it is probably created for the exact body type of the parasitic wasp. Since honeybees have such a similar body type they are susceptible to the insecticide as well.

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"
```

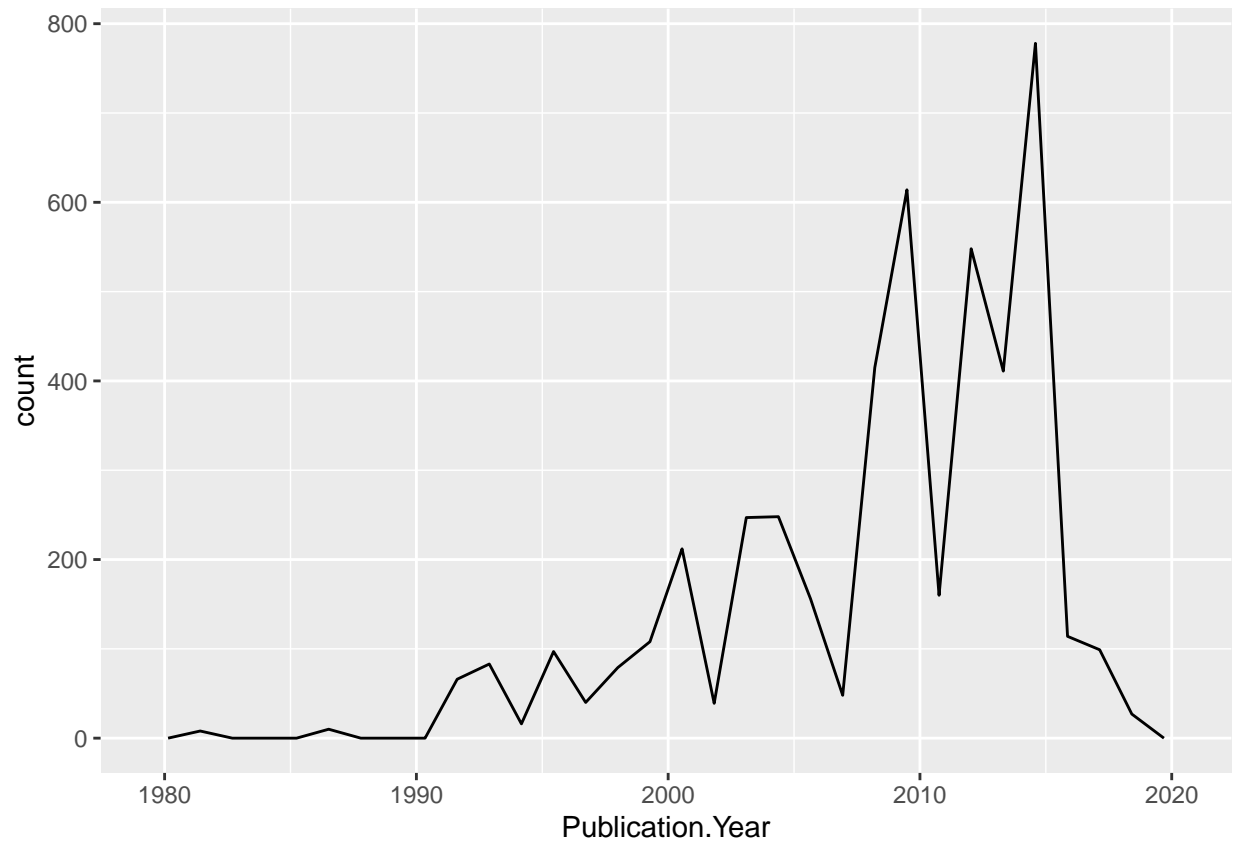
Answer: The class is factor. Factors are variables that have a limited number of different values. This column has 1006 factors, meaning there are 1006 different numbers that could appear in a given row.

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))
```

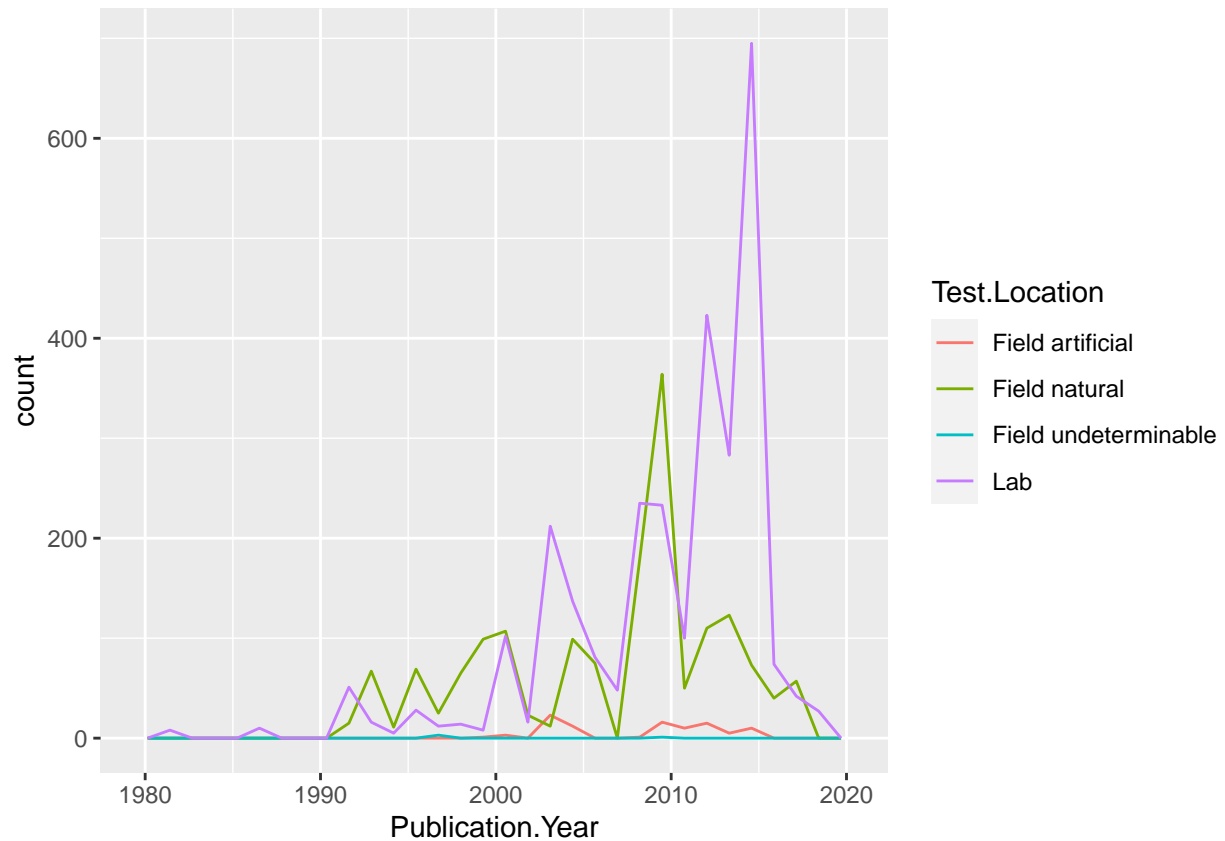
```
## 'stat_bin()' using 'bins = 30'. Pick better value with 'binwidth'.
```



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))
```

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

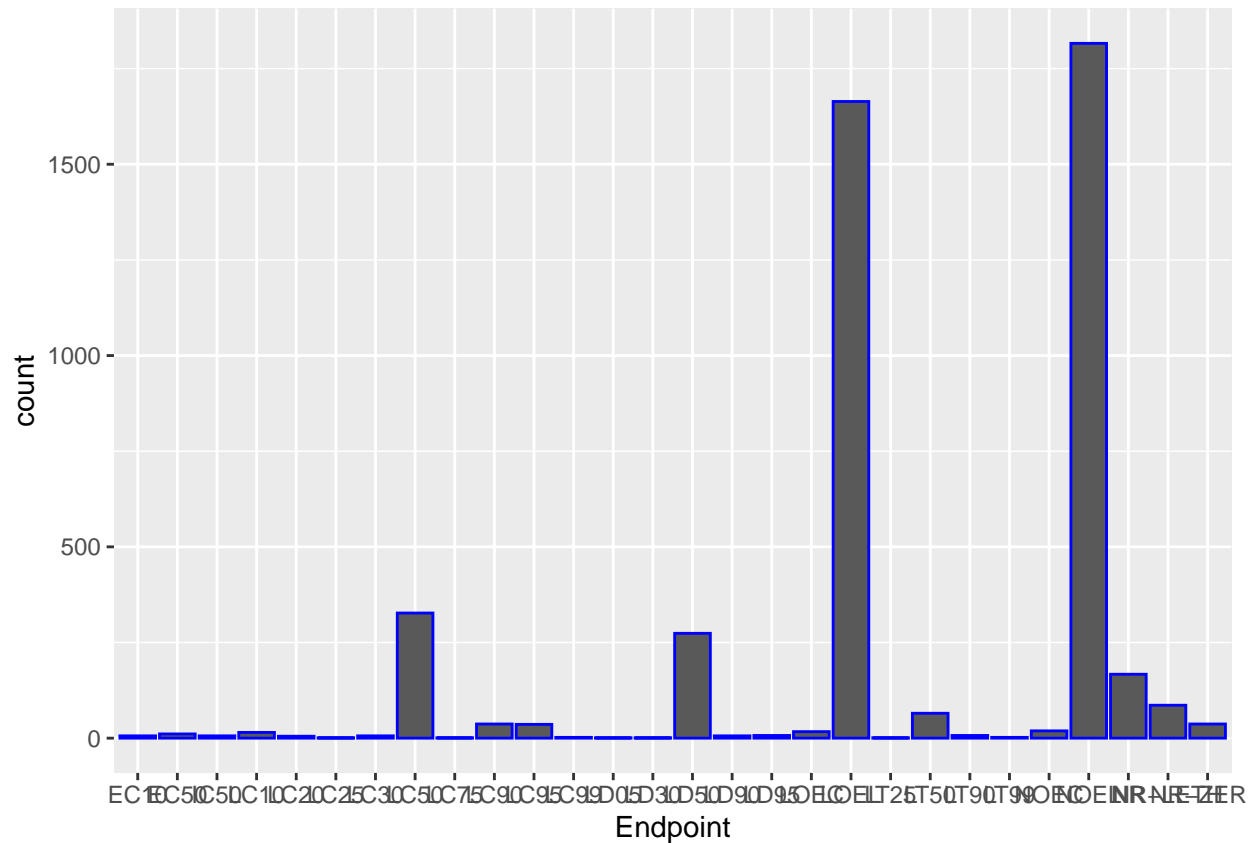


Interpret this graph. What are the most common test locations, and do they differ over time?

Answer: The most common test sites are Lab and Field natural. Over the years the most common test site switches from Field natural to Lab.

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)+
  geom_bar(aes(x=Endpoint), color = "blue")
```



Answer: NOEL and LOEL were the most common end points. NOEL is terrestrial and has no observable effect. LOEL is terrestrial and has the lowest observable effect.

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"
```

```
#factor, not date
```

```
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 NIWO_051  
## [9] NIWO_058 NIWO_046 NIWO_062 NIWO_057  
## 12 Levels: NIWO_040 NIWO_041 NIWO_046 NIWO_047 NIWO_051 NIWO_057 ... NIWO_067
```

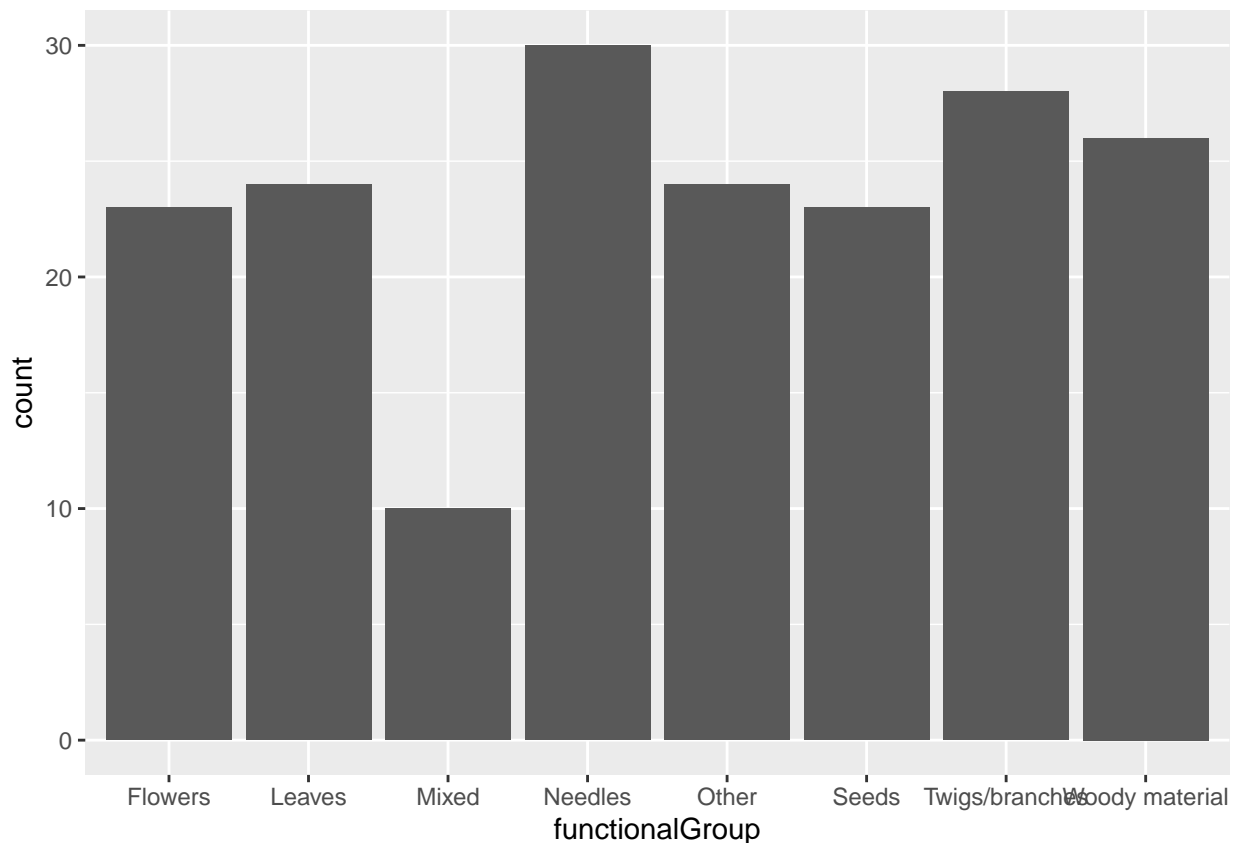
```
summary(Litter$plotID)
```

```
## 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: There were 12 plots sampled at Niwot Ridge. Unique gives you all the values that aren't duplicates. Summary gives you a count of all the values (event if they're the same value).

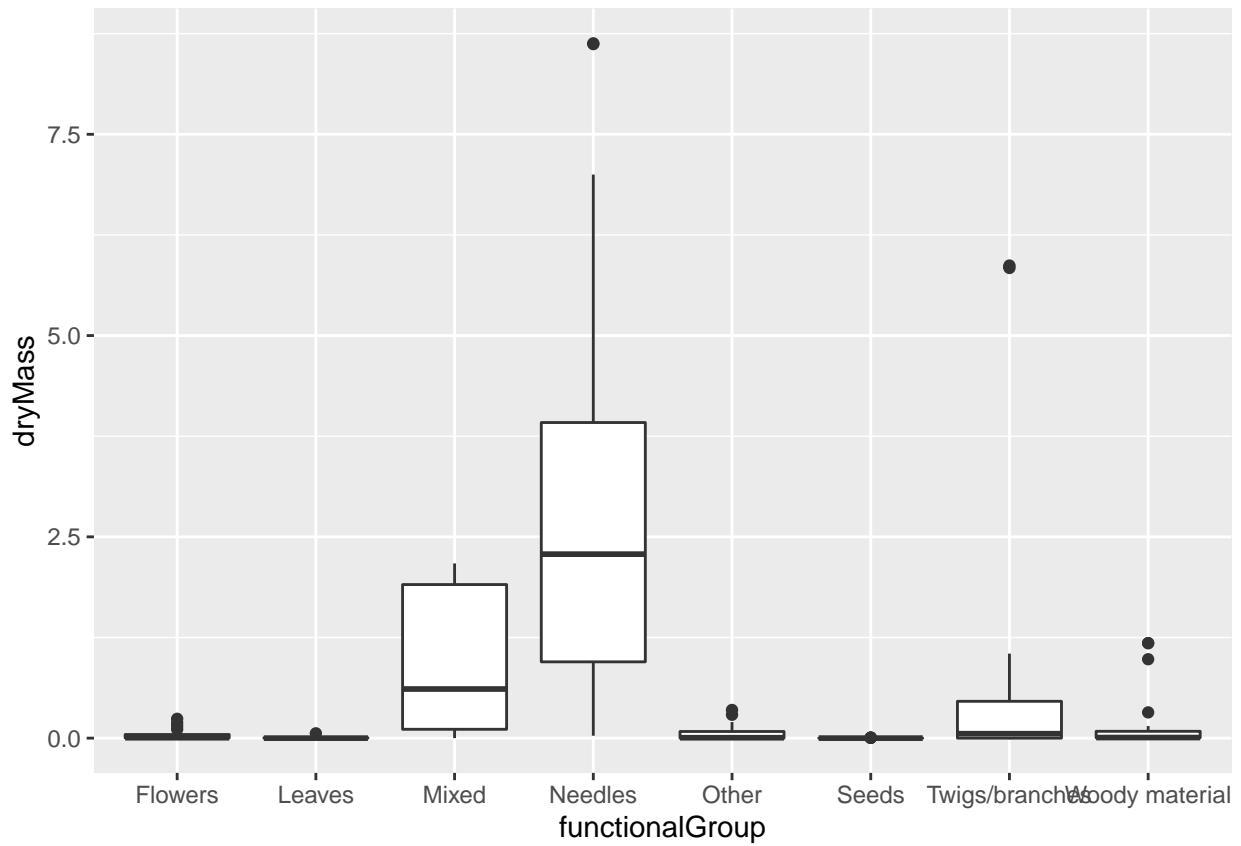
14. Create a bar graph of functionalGroup counts. This shows you what type of litter is collected at the Niwot Ridge sites. Notice that litter types are fairly equally distributed across the Niwot Ridge sites.

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

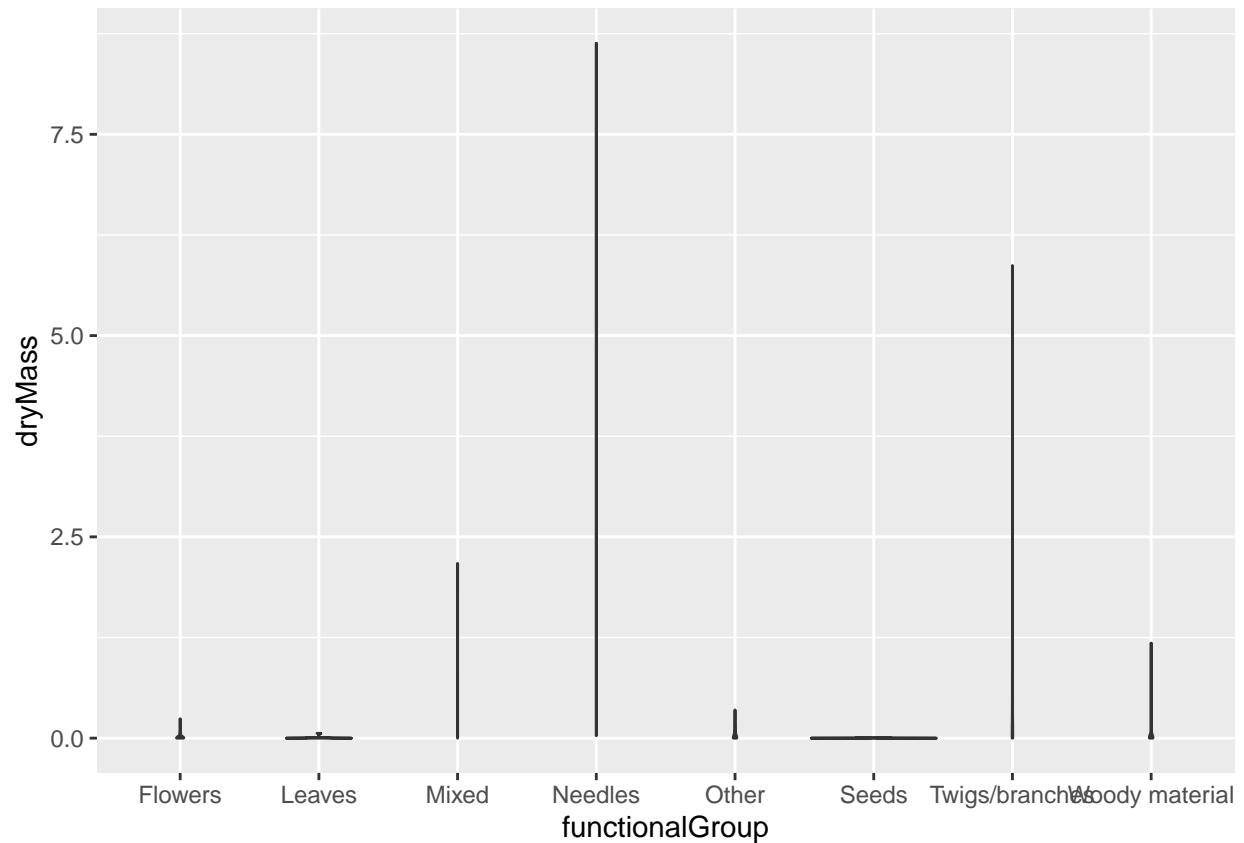


15. Using `geom_boxplot` and `geom_violin`, create a boxplot and a violin plot of `dryMass` by `functionalGroup`.

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



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



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 there are some extreme outliers that make the violin plot look like horizontal and vertical lines (not the normal pear-ish shape).

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

Answer: Needles have the highest biomass at these sites, with “mixed” coming in second.