

# Assignment 3: Data Exploration

Megan McClaugherty

## 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. Be sure to **answer the questions** in this assignment document.
5. When you have completed the assignment, **Knit** the text and code into a single PDF file.
6. After Knitting, submit the completed exercise (PDF file) to the dropbox in Sakai.

The completed exercise is due on Sept 30th.

## 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 include the subcommand to read strings in as factors.

```
getwd()

## [1] "/home/guest/EDA-Fall2022/Assignments"

library(tidyverse)
library(ggplot2)
knitr::opts_chunk$set(tidy.opts=list(width.cutoff=80), tidy=TRUE)
Neonics<-read.csv("/home/guest/EDA-Fall2022/Data/Raw/ECOTOX_Neonicotinoids_Insects_raw.csv", stringsAsFactors=TRUE)
Litter<-read.csv("/home/guest/EDA-Fall2022/Data/Raw/NEON_NIWO_Litter_massdata_2018-08_raw.csv", stringsAsFactors=TRUE)
```

## 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 perform a wide variety of ecosystem services that directly benefit humans, particularly pollination and decomposition. They are also an integral part of food webs acting as both consumers and prey of other species. Unforeseen impacts of neonicotinoids on insects could therefore have severe consequences for resources that humans rely on.

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: Leaf litter and woody debris in forests provide nutrients for soils as they decompose, help retain soil moisture, and also serve as important habitat for a variety of forest organisms. Changes in leaf litter and woody debris in an area could have far-reaching impacts and potentially provide information about the overall health of standing vegetation.

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. Samples are taken from sites with woody vegetation greater than 2m tall 2. The number and size of plots depends on the stature of the vegetation around the tower airshed. One litter trap pair (one ground trap and one elevated trap) is deployed for every 400m<sup>2</sup> plot area, however, the number and location of the litter traps within each plot depends on the type of vegetation in that plot, available space, spacing requirements, and tower airshed size. 3. Ground traps are checked annually. Elevated traps in deciduous sites are checked once every two weeks but this sampling ceases during dormant months. Elevated traps in evergreen sites once every one or two months year-round.

## 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 “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: These effects are of interest because it is useful to see how the insects responded to exposure to the chemicals and to see how many experienced each type of 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 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

Answer: The six most commonly used species were Honey Bees, Parasitic Wasps, Buff Tailed BumbleBee, Carniolan Honey Bees, Bumble Bees, and Italian Honey Bees. Many of these species are pollinators that provide valuable agricultural services for humans. If we use insecticides to target crop pests, we would want to understand the impacts on these pollinator species. Parasitic wasps target species that may be considered agricultural pests, so similarly we would want to understand how insecticides affect these species.

- 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.)
```

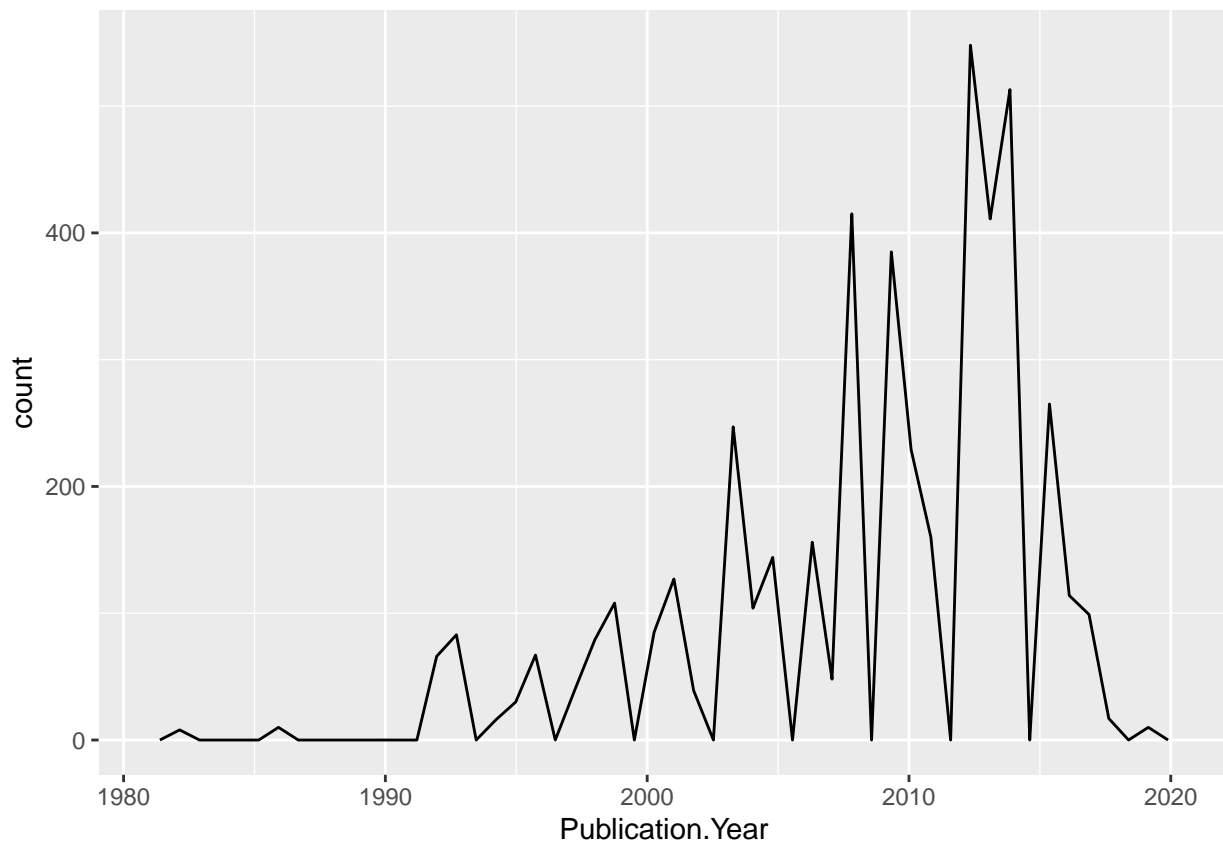
```
## [1] "factor"
```

Answer: Conc.1..Author is a factor. They represent different categories of concentrations because these concentrations depend on several other factors, like the chemical type and concentration type, so they aren't universal concentrations.

## Explore your data graphically (Neonics)

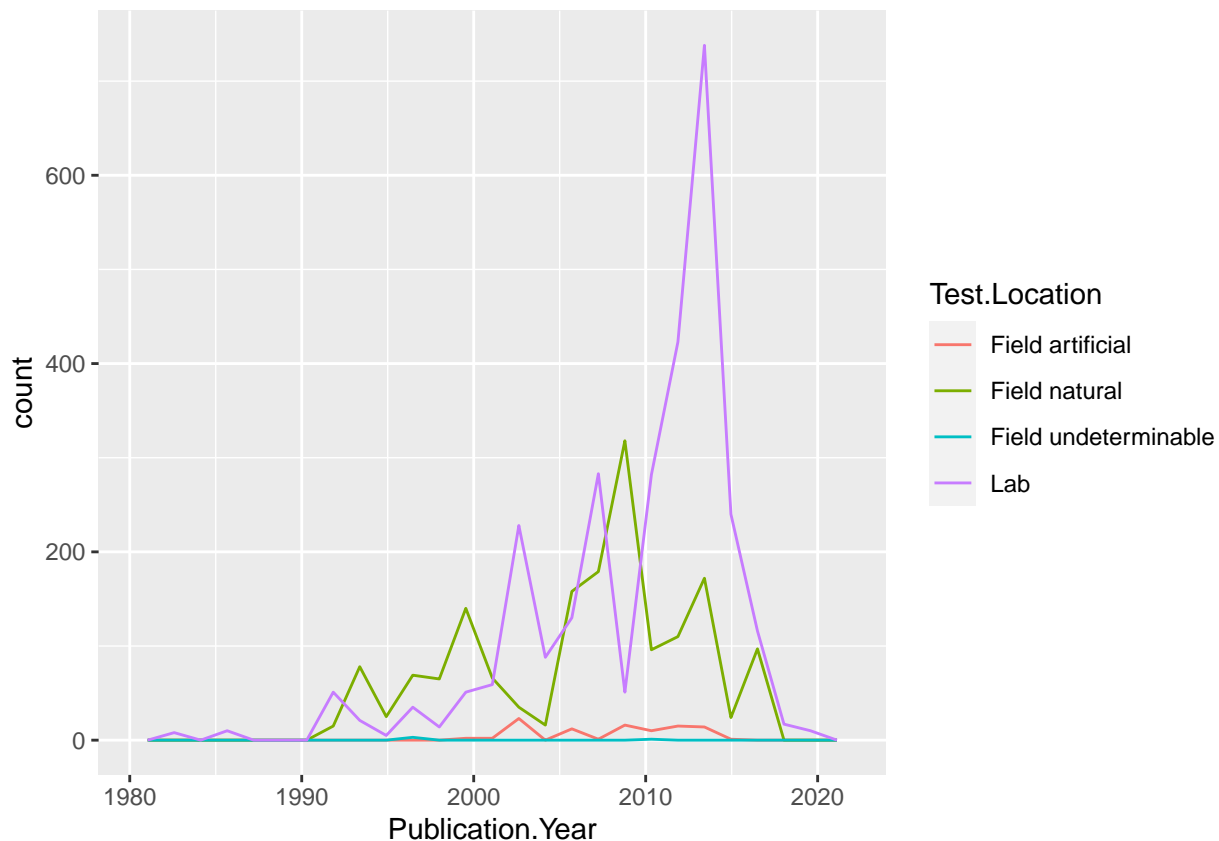
9. Using `geom_freqpoly`, generate a plot of the number of studies conducted by publication year.

```
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 = 25)
```

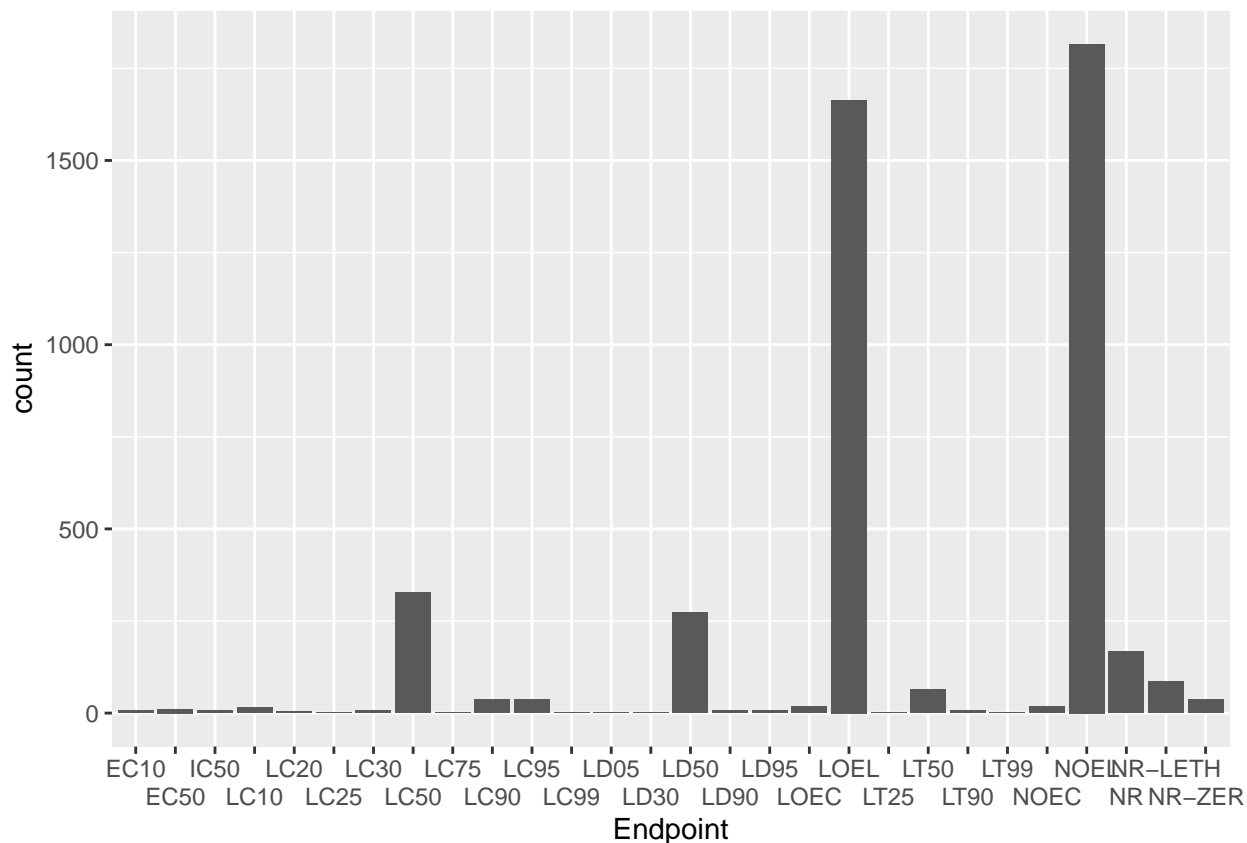


Interpret this graph. What are the most common test locations, and do they differ over time?

Answer: The Lab and Field Natural are the most common test locations. This changes slightly over time. From the early 1990s into 2000, Field Natural was slightly more common but from that time forward, Lab test locations were relatively as common until about 2010 when Lab tests far exceeded all other test locations.

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)) + scale_x_discrete(guide = guide_axis(n.dodge = 2))
```



Answer: The two most common endpoints are LOEL (Lowest Observable Effects Level), or the lowest concentration producing effects that were significantly different from the controls, and the NOEL (No Observable Effect Level), the highest concentration that produced effects that were not significantly different than those observed in controls.

## Explore your data (Litter)

- 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"
```

```
library(lubridate)
```

```
##
```

```
## Attaching package: 'lubridate'
```

```
## The following objects are masked from 'package:base':
```

```
##
```

```
## date, intersect, setdiff, union
```

```
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
```

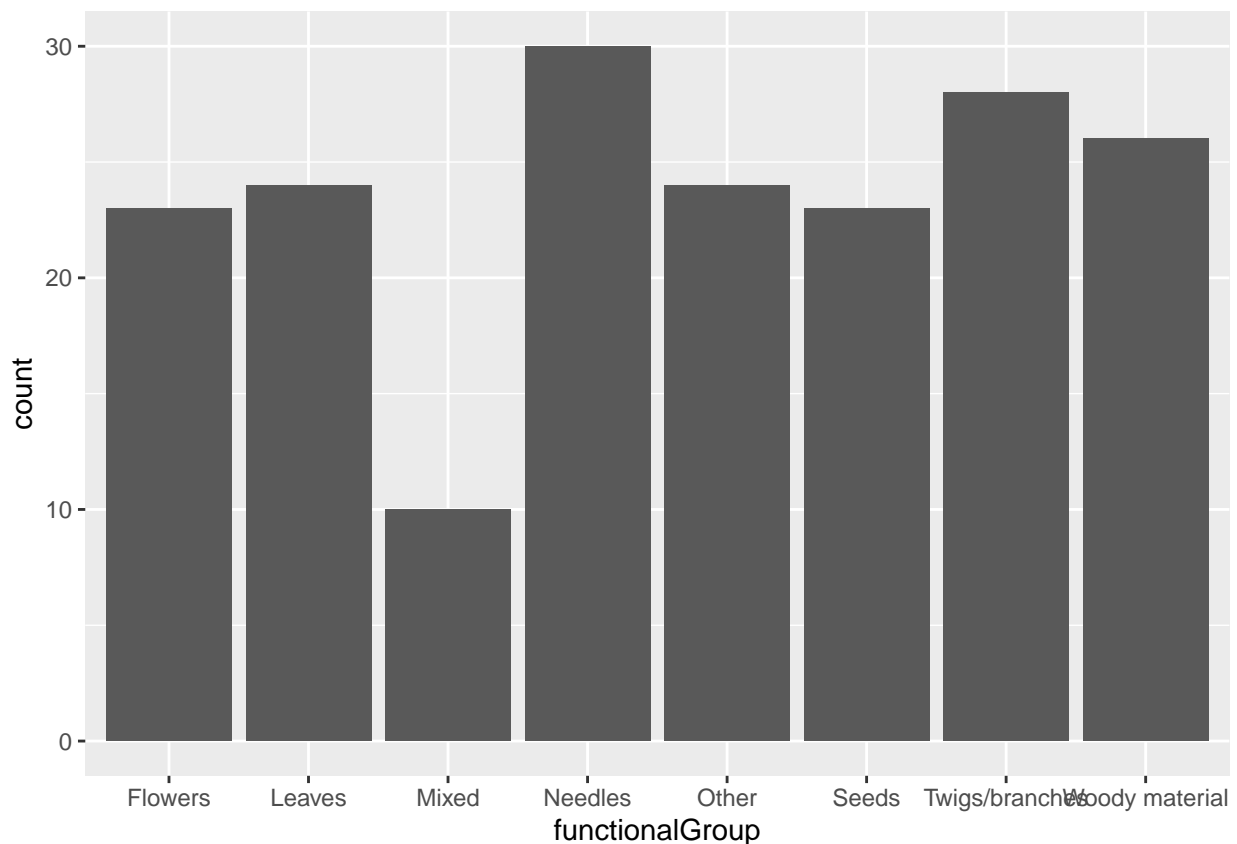
```
summary(Litter$plotID)
```

```
## 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: 12 plots were sampled at Niwot Ridge. Unique only returns a list of values that don't have duplicates based on your selection criteria. Summary will give a count of how many entries there are for each of your selections.

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.

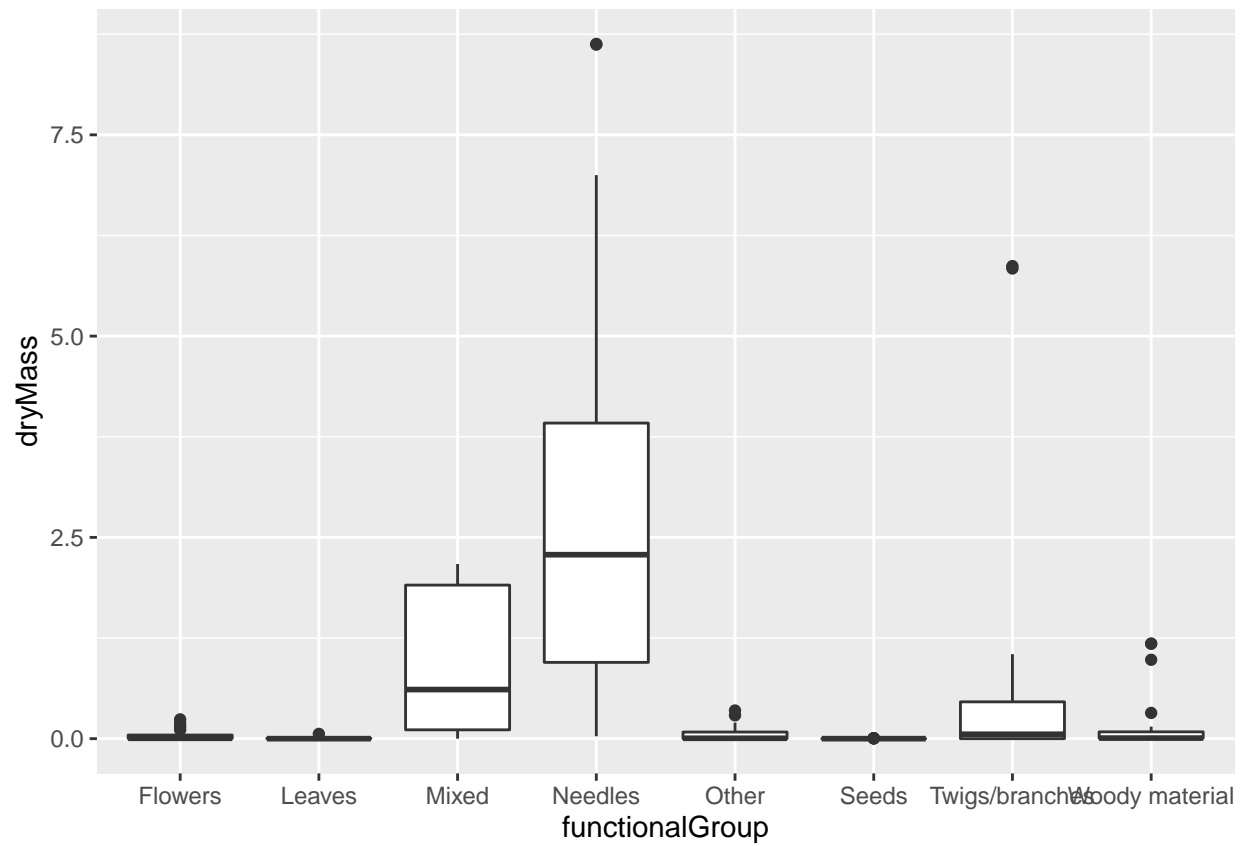
```
ggplot(Litter) + geom_bar(aes(x = functionalGroup))
```



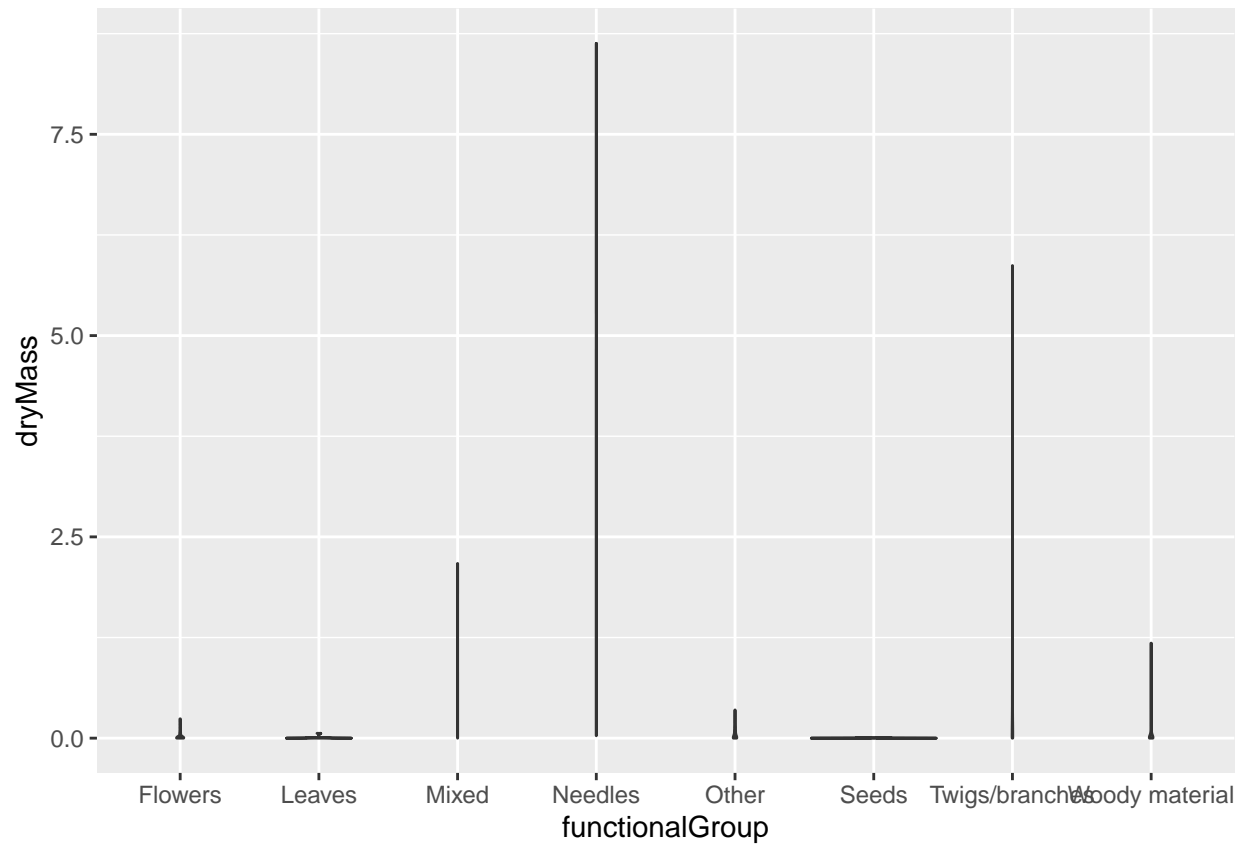
15. Using `geom_boxplot` and `geom_violin`, create a boxplot and a violin plot of `dryMass` by `functionalGroup`.



```
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: In this case the boxplot is a more effective visualization option because without further manipulation, the violin plot is too compressed to reveal anything about the data.

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

Answer: Needles, mixed, and twigs/branches have the highest biomass at these sites.