Assignment 3: Data Exploration

Katherine Owens, Section #01 Monday

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.**

```
getwd()
```

```
## [1] "C:/Users/Katherine/Documents/872-Data Analytics/Environmental_Data_Analytics_2022/Assignments"
```

```
#"C:/Users/Katherine/Documents/872-Data Analytics/Environmental_Data_Analytics_2022/Assignments"

library(dplyr)
```

```
##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
library(ggplot2)
library(tidyverse)
```

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

## v tibble  3.1.6     v purrr   0.3.4
## v tidyr   1.1.4     v stringr 1.4.0
```

```
## v readr   2.1.1     v forcats 0.5.1
```

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

```
#import data sets
Neonics_data <- read.csv('../Data/Raw/ECOTOX_Neonicotinoids_Insects_raw.csv')#, stringsAsFactors = TRUE

Litter_data<- read.csv('../Data/Raw/NEON_NIWO_Litter_massdata_2018-08_raw.csv')#, stringsAsFactors = TR
```

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 can be toxic to sap-feeding insects like aphids and bees and cause paralysis and death of 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: When leaves and debris fall to the ground and break down the CO2 absorbed by photosynthesis is in turn released back into the atmosphere as a part of global seasonal variations. Also, the more deforestation there is the more woody debris that is generated from the cuttings leading to more debris that can be transported and possibly inhibit growth in other ecosystems.

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: *Dry weight mass data of litterfall and woody debris was collected from litter traps (both elevsted and on the ground) around different plants depending on plant function such as leaves, twigs, flowers, etc.* Collection devices included 0.5m^2square mesh 'baskets' elevated ~80cm above the ground, and traps on the ground were 3m x 0.5 m rectangular areas. *Individual sampling bouts were executed one time per year on 20 ground sites 40mx40m in size. Elevated baskets were sampled every 1-2 weeks in deciduous sites, and once every 1-2 months at evergreen sites.

Obtain basic summaries of your data (Neonics)

5. What are the dimensions of the dataset?

```
dim(Neonics_data) #has 4623 rows and 30 columns
```

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

```
dim(Litter_data) #has 188 rows and 30 columns
```

```
## [1] 188  19
```

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? > Answer: The most common effects are

how the insecticide affected life or death reates, growth, population, behavior immunological, etc. What appeared the most though was an effect of mortality.

```
head(Neonics_data$Effect,100)
```

```
##   [1] "Mortality"     "Mortality"     "Mortality"     "Mortality"    
##   [5] "Mortality"     "Mortality"     "Mortality"     "Mortality"    
##   [9] "Mortality"     "Mortality"     "Mortality"     "Mortality"    
##  [13] "Growth"        "Growth"        "Growth"        "Growth"       
##  [17] "Mortality"     "Mortality"     "Mortality"     "Mortality"    
##  [21] "Mortality"     "Mortality"     "Mortality"     "Mortality"    
##  [25] "Mortality"     "Mortality"     "Mortality"     "Mortality"    
##  [29] "Population"    "Population"    "Mortality"     "Mortality"    
##  [33] "Mortality"     "Mortality"     "Population"    "Mortality"    
##  [37] "Mortality"     "Mortality"     "Mortality"     "Mortality"    
##  [41] "Mortality"     "Mortality"     "Mortality"     "Mortality"    
##  [45] "Mortality"     "Mortality"     "Mortality"     "Mortality"    
##  [49] "Mortality"     "Mortality"     "Mortality"     "Mortality"    
##  [53] "Mortality"     "Mortality"     "Mortality"     "Mortality"    
##  [57] "Mortality"     "Mortality"     "Mortality"     "Mortality"    
##  [61] "Immunological" "Cell(s)"       "Immunological" "Mortality"    
##  [65] "Mortality"     "Behavior"      "Behavior"      "Mortality"    
##  [69] "Behavior"      "Mortality"     "Population"    "Population"   
##  [73] "Population"    "Population"    "Reproduction"  "Mortality"    
##  [77] "Reproduction"  "Reproduction"  "Reproduction"  "Mortality"    
##  [81] "Mortality"     "Mortality"     "Population"    "Population"   
##  [85] "Population"    "Population"    "Population"    "Population"   
##  [89] "Population"    "Mortality"     "Mortality"     "Population"   
##  [93] "Population"    "Mortality"     "Mortality"     "Mortality"    
##  [97] "Mortality"     "Mortality"     "Mortality"     "Mortality"
```

```
summary(Neonics_data$Effect)
```

```
##    Length     Class      Mode 
##      4623 character character
```

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.

```
head(Neonics_data$Species.Common.Name,10)
```

```
##  [1] "Coffee Bean Weevil" "Coffee Bean Weevil" "House Fly"         
##  [4] "House Fly"          "House Fly"          "House Fly"         
##  [7] "House Fly"          "House Fly"          "House Fly"         
## [10] "House Fly"
```

```
summary(Neonics_data$Species.Common.Name)
```

```
##    Length     Class      Mode 
##      4623 character character
```

```
sort(table(Neonics_data$Species.Common.Name), decreasing = TRUE)
```

```
## 
##                          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                  Asiatic Honey Bee
##                                  9                                  9
##                Eulophid Parasitoid                    Lacewing Family
##                                  9                                  9
##                 Mealybug Destroyer             Alfalfa Leafcutter Bee
##                                  9                                  8
##                                Bee                          Bumblebee
##                                  8                                  8
##             Chilean Predatory Mite                    Dwarf Honey Bee
##                                  8                                  8
##          Neotropical Stingless Bee              Parasitic Wasp Family
##                                  8                                  8
##                Spiralling Whitefly                 Beetle Mite Family
```

```
##                              8                              7 
##                      Chinch Bug           Macedonian Honey Bee 
##                              7                              7 
##                           Moth                Potato Tuberworm 
##                              7                              7 
##             Russian Wheat Aphid                  Soldier Beetle 
##                              7                              7 
##       Southern One-Year Canegrub             Tarnished Plant Bug 
##                              7                              7 
##                 Ambrosia Beetle                      Aphid Wasp 
##                              6                              6 
##               Black Vine Weevil               Childers Canegrub 
##                              6                              6 
##             Coconut Leaf Beetle  Elevenspotted Ladybird Beetle 
##                              6                              6 
##                   Encyrtid Wasp               European Red Mite 
##                              6                              6 
##                   Fall Armyworm                      Fruit Fly 
##                              6                              6 
##                       Hover Fly     Oblique Banded Leaf Roller 
##                              6                              6 
##                Obscure Mealybug         Oribatid Mite Suborder 
##                              6                              6 
##               Pistachio Psyllid         Redbay Ambrosia Beetle 
##                              6                              6 
##             Silverleaf Whitefly                   Soybean Aphid 
##                              6                              6 
##            Subterranean Termite                           Thrip 
##                              6                              6 
##          Two-Spotted Spider Mite                    Apple Aphid 
##                              6                              5 
##               Brown Planthopper                         Earwig 
##                              5                              5 
##               Green June Beetle                   Hornfaced Bee 
##                              5                              5 
##       Long Horned Beetle Family                   Plum Curculio 
##                              5                              5 
##                     Rove Beetle                  San Jose Scale 
##                              5                              5 
##                  Scelionid Wasp            Speckled Cutworm Moth 
##                              5                              5 
##                    Thrip Family                             Ant 
##                              5                              4 
##           Cabbage Seedpod Weevil            Common Green Lacewing 
##                              4                              4 
##            Eucalyptus Gall Wasp            European Apple Sawfly 
##                              4                              4 
##              European Honey Bee    European Tarnished Plant Bug 
##                              4                              4 
##                Garden Symphylan                Linyphiid Spider 
##                              4                              4 
##                    Onion Maggot                 Oriental Beetle 
##                              4                              4 
##               Parsnip Seed Wasp              Pea And Bean Weevil 
```

```
##                              4                            4
##                    Pear Sucker         Red Imported Fire Ant
##                              4                            4
##        Striped Cucumber Beetle              Sugarcane Beetle
##                              4                            4
##                           Wasp            Wolf Spider Family
##                              4                            4
##         Yellow-faced Bumblebee          Ambrosia Bark Beetle
##                              4                            3
##         Asian Ambrosia Beetle                 Beetle Family
##                              3                            3
##               Birch Leafminer              Black Twig Borer
##                              3                            3
##      Braconid Parasitoid Wasp          California Red Scale
##                              3                            3
##          Crucifer Flea Beetle                       Cutworm
##                              3                            3
##         Delphacid Planthopper       Egyptian Cotton Leafworm
##                              3                            3
##           Encyrtid Parasitoid      Fly/Mosquito/Midge Order
##                              3                            3
##  Formosan Subterranean Termite      Fruit-tree Pinhole Borer
##                              3                            3
##         Green Rice Leafhopper                 Ground Beetle
##                              3                            3
##              Ichneumonid Wasp Large-Jawed Orb Weaver Family
##                              3                            3
##              Leaf Cutting Ant       Mediterranean Fruit Fly
##                              3                            3
##              Minute Flour Bug                   Mite Family
##                              3                            3
##                   Moth Family             Negatoria Canegrub
##                              3                            3
##              Sap Beetle Family            Scale Insect Order
##                              3                            3
##           Scarab Beetle Family       Sheet-Web Weaver Family
##                              3                            3
##                        Spider                Sugarcane Grub
##                              3                            3
##             Tenebrionid Beetle             Alfalfa Plant Bug
##                              3                            2
##                     Alkali Bee                        Aphid
##                              2                            2
##                   Assassin Bug               Azalea Lace Bug
##                              2                            2
##                   Banana Aphid                   Brown Scale
##                              2                            2
##                 Brown Stinkbug                       Budworm
##                              2                            2
##                  Cabbage Aphid                 Cabbage White
##                              2                            2
##                 Cardamom Thrip                 Carrot Weevil
##                              2                            2
##              Celer Crab Spider               Centipede Class
```

```
##                                2                                2
##                  Citricola Scale                Clouded Plant Bug
##                                2                                2
##                Coffee Bean Weevil               Cotton Fleahopper
##                                2                                2
##           Egyptian Alfalfa Weevil                  Engraver Beetle
##                                2                                2
##              Fig Longicorn Beetle    Glassy-winged Sharpshooter
##                                2                                2
##                 Hawthorn Lace Bug            Hister Beetle Family
##                                2                                2
##             Jumping Spider Family               Lined Click Beetle
##                                2                                2
##                 Maple Spider Mite                Meshweaver Spider
##                                2                                2
##           Minute Pirate Bug Family                  Predaceous Fly
##                                2                                2
##              Pygmy Mangold Beetle                      Rose Sawfly
##                                2                                2
##              Serpentine Leafminer           Spider Mite Destroyer
##                                2                                2
##        Spotted Tentiform Leafminer                       Stink Bug
##                                2                                2
##                Tawny Mole Cricket       Tick/Chigger/Mite Order
##                                2                                2
##               Turf Running-spider                     Turnip Aphid
##                                2                                2
##               Western Bigeyed Bug               Western Damsel Bug
##                                2                                2
##                 Western Plant Bug       White-backed Planthopper
##                                2                                2
##      White Apple Leafhopper Nymph          Whitemarked Fleahopper
##                                2                                2
##             Antlike Flower Beetle  Banded Soft-winged Flower Beetle
##                                1                                1
##             Banded Sunflower Moth                       Bee Family
##                                1                                1
##                     Beet Armyworm               Black Citrus Aphid
##                                1                                1
##                Blue Alfalfa Aphid                  Cabbage Root Fly
##                                1                                1
##                Cactus Lady Beetle                  Citrus Red Mite
##                                1                                1
##              Cottony Cushion Sale               Crapemyrtle Aphid
##                                1                                1
##                  Damselbug Family             Ectoparasitoid Wasp
##                                1                                1
##               English Grain Aphid                         Fairyfly
##                                1                                1
##                       Flea Beetle                       Gall Midge
##                                1                                1
##   Grasshopper/Cricket/Locust Order             Greenhouse Whitefly
##                                1                                1
##          Grey Sunflower Seed Weevil          Harvestman Spider Order
```

```
##                              1                                  1
##             Hawthorn Leaf Miner      Longtailed Fruit Fly Parasite
##                              1                                  1
##             Minute Lady Beetles                Painted Maple Aphid
##                              1                                  1
##                   Pepper Weevil                 Pine False Webworm
##                              1                                  1
##                       Plant Bug                      Pollen Beetle
##                              1                                  1
##                 Predacious Mite                       Predator Bug
##                              1                                  1
##           Pseudocentipede Class             Pteromalid Wasp Family
##                              1                                  1
##       Red Sunflower Seed Weevil             Rice Leaf Folder Moth
##                              1                                  1
##                Rose Grain Aphid                Scale Picnic Beetle
##                              1                                  1
##             Shiny Spider Beetle                  Southern Army Worm
##                              1                                  1
##                    Spirea Aphid      Spotted Sunflower Stem Weevil
##                              1                                  1
##       Strawberry Blossom Weevil                    Sunflower Midge
##                              1                                  1
##                  Sunflower Moth        Ten-spot Ladybird Beetle
##                              1                                  1
##                   Tobacco Thrip        Twicestabbed Lady Beetle
##                              1                                  1
##                     Wasp Family                             Weevil
##                              1                                  1
##          Yellow Mealworm Beetle
##                              1
```

Answer: Honey Bee=667,Parasitic Wasp=285, Buff Tailed Bumblebee=183, Carniolan Honey Bee=152, Bumble Bee=140, Italian Honeybee=113. All of these species fly and five out of six of them are types of bees, which are crucial for pollination of plants for agriculture. If all the bees start dying from insecticides, then farms won't be able to produce as much food and there will be shortages. We need safer insecticides for 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?

```r
class(Neonics_data$Conc.1..Author.)
```

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

```r
head (Neonics_data$Conc.1..Author.,20)
```

```
##  [1] "27.2"  "19.7"  "47"    "25"    "13"    "268"   "170"   "28"    "48"
## [10] "40"    "83"    "900"   "15.3"  "20.4"  "5"     "5"     "NR"    "~10"
## [19] "65.56" "635.4"
```

```r
attributes(Neonics_data$Conc.1..Author.)
```

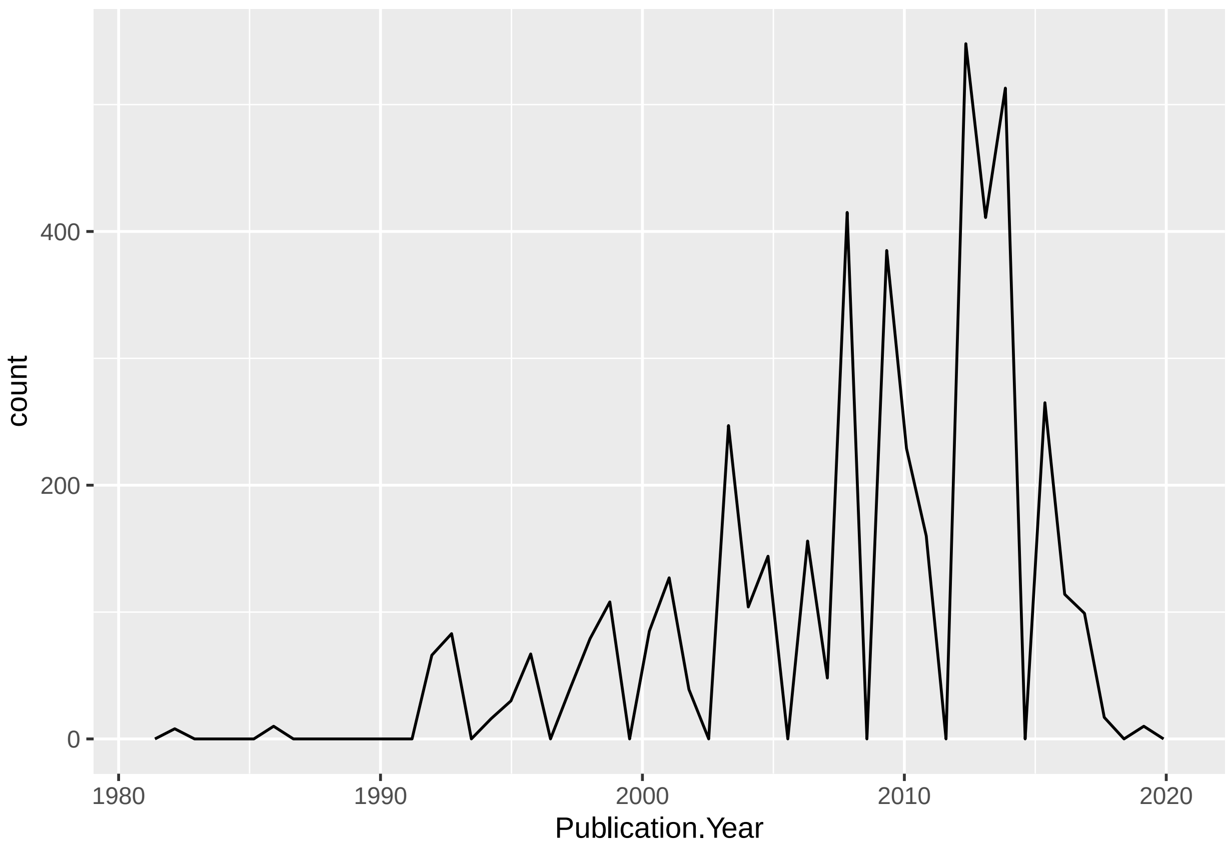
```
## NULL
```

Answer: In the dataset the Conc.1..Author. has character arguments because there is no set format and therefore defaults to the character class most likely because of the presence of special characters like slashes and tildas.

Explore your data graphically (Neonics)

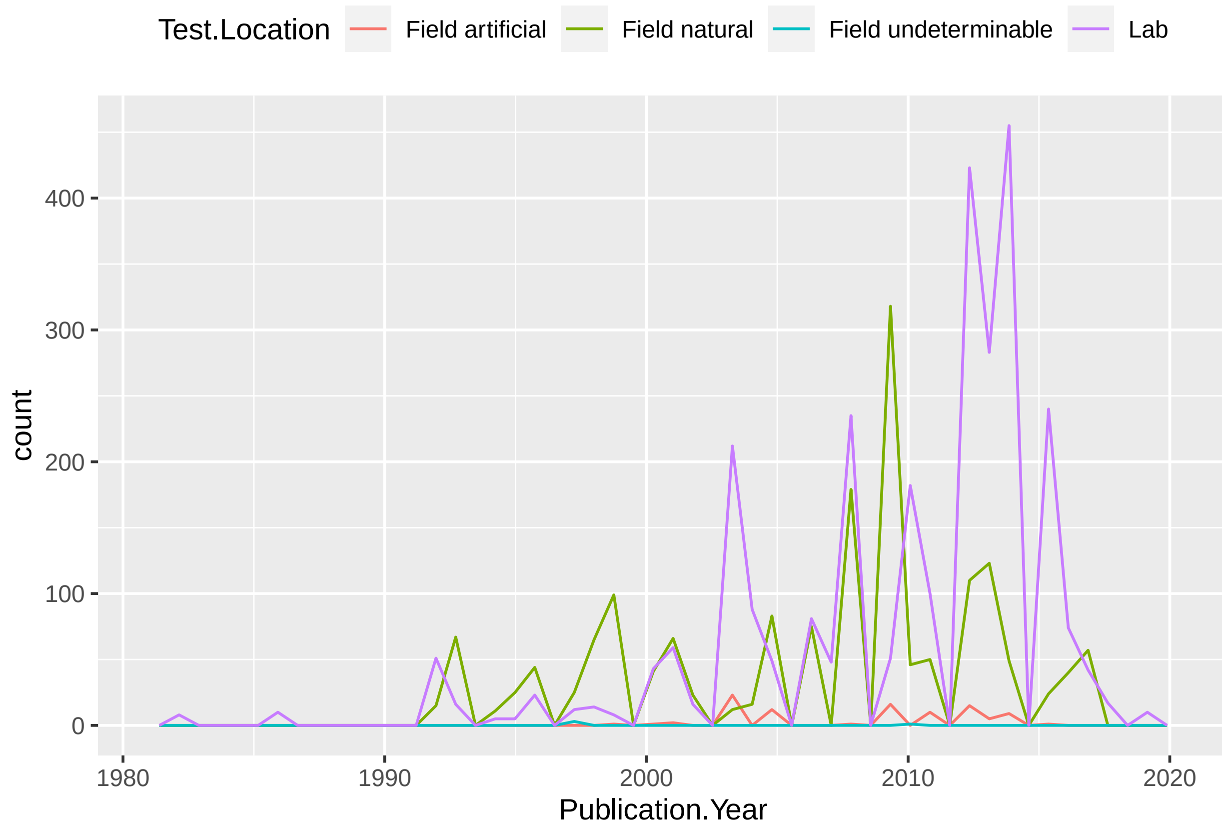
9. Using `geom_freqpoly`, generate a plot of the number of studies conducted by publication year.

```
#example used to make Pub Year Plot from DatExpl-pt2 lines 109-114
#ggplot(Neonics_data) +
 # geom_histogram(aes(x = gage.height.mean), bins = 50) +
#  geom_freqpoly(aes(x = Publication.Year, color =  Test.Location), bins =  #   50) +
#  geom_freqpoly(aes(x = Test.Location), bins = 50, color = "purple") +
 # geom_freqpoly(aes(x = gage.height.max), bins = 50,  lty = 2) +
# scale_x_continuous(limits = c(0, 10))

ggplot(Neonics_data) +
  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.

```
#correct plot above
#ggplot(Neonics_data) +
 # geom_freqpoly(aes(x = Publication.Year), bins = 50)

ggplot(Neonics_data) +
  geom_freqpoly(aes(x = Publication.Year, color = Test.Location), bins = 50) +
  #scale_x_continuous(limits = c(0, 10)) +
  theme(legend.position = "top")
```



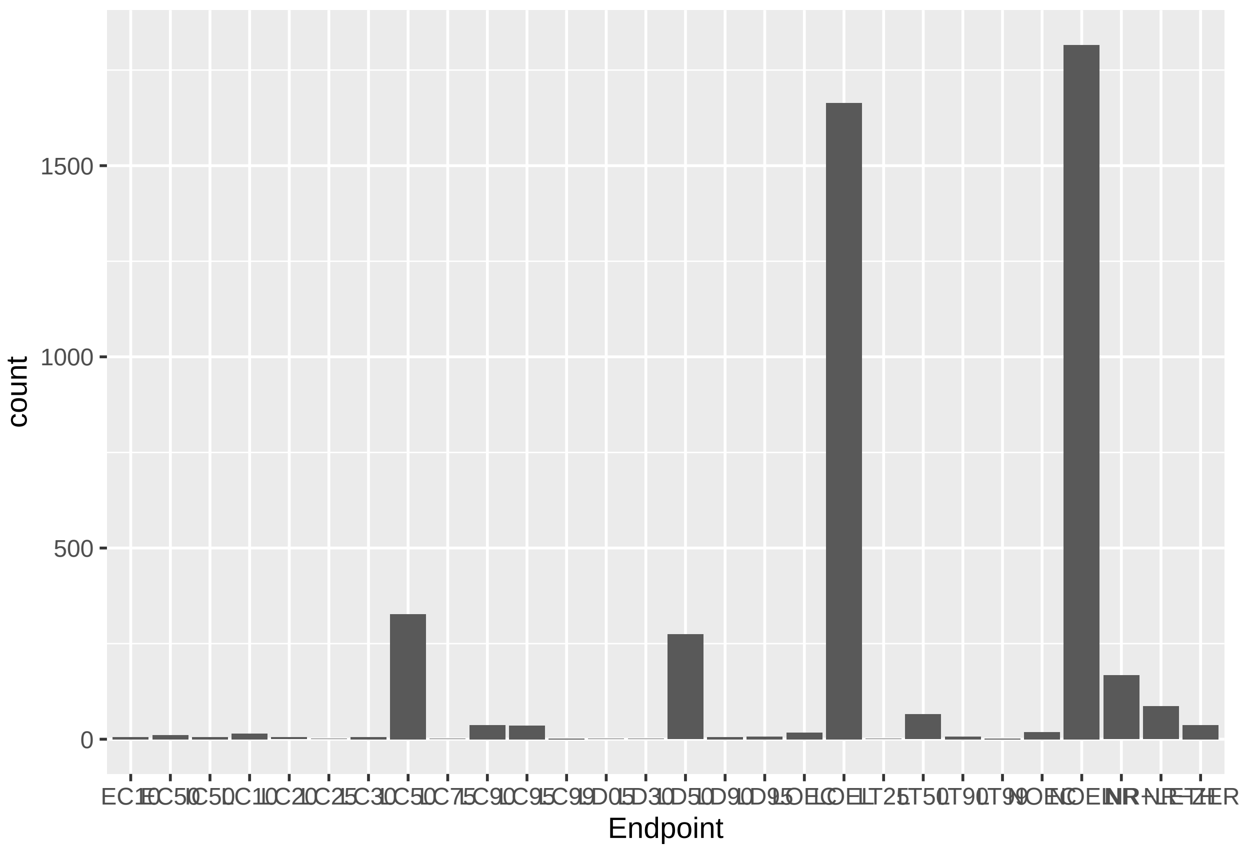

```
#example of colors from 03_DataExpl_pt2 under ###FreqLinGr lines 118-121
#ggplot(USGS.flow.data) +
 # geom_freqpoly(aes(x = gage.height.mean, color = gage.height.mean.approval), bins = 50) +

#  scale_x_continuous(limits = c(0, 10)) +
  #theme(legend.position = "top")
```

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

> Answer: Most common test locations are in the lab with over 1100 observations, and more lab tests were done after the year 2010, possibly reflecting a more efficient sample/test method rather that performing the tests in the field, which used to occur more frequently prior to 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.

```
#from 03_DatExpl lines 61-62 under Bar Chart
ggplot(Neonics_data, aes(x = Endpoint)) +
  geom_bar()
```




```
sort(table(Neonics_data$Endpoint), decreasing = TRUE)
```

```
##
##    NOEL    LOEL    LC50    LD50      NR NR-LETH    LT50    LC90 NR-ZERO    LC95
##    1816    1664     327     274     167      86      65      37      37      36
##    NOEC    LOEC    LC10    EC50    LD95    LT90    EC10    IC50    LC30    LD90
##      19      17      15      11       7       7       6       6       6       6
##    LC20    LC99    LT99    LC25    LC75    LD05    LD30    LT25
##       5       2       2       1       1       1       1       1
```

```
#Leads to NOEL=1816, and LOEL=1664
```

> Answer: Endpoints displayed with a code of letters combinations identify links between effecs for insecticides like accumulation of chemicals, cellular stuctural variations in bones and tissue in insects, etc. The two most common are NOEL and LOEL which are no to low observable effects.
>
> NOEL: No-observable-effect-level: highest dose (concentration) producing effects not significantly different from responses of controls according to author's reported statistical tes.
>
> LOEL: Lowest-observable-effect-level: lowest dose (concentration) producing effects that were significantly different (as reported by authors) from responses of controls.

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.

```
#example from 03_DatExpl lines 230-24
class(Litter_data$collectDate)#character
```

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

```
#puts in numercial date format with as.date fcn
Litter_data$collectDate <- as.Date(Litter_data$collectDate, format = "%Y-%m-%d")

class(Litter_data$collectDate)
```

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

```
view(Litter_data$collectDate)

unique(Litter_data$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`?

```
help(unique)
```

```
## starting httpd help server ... done
```

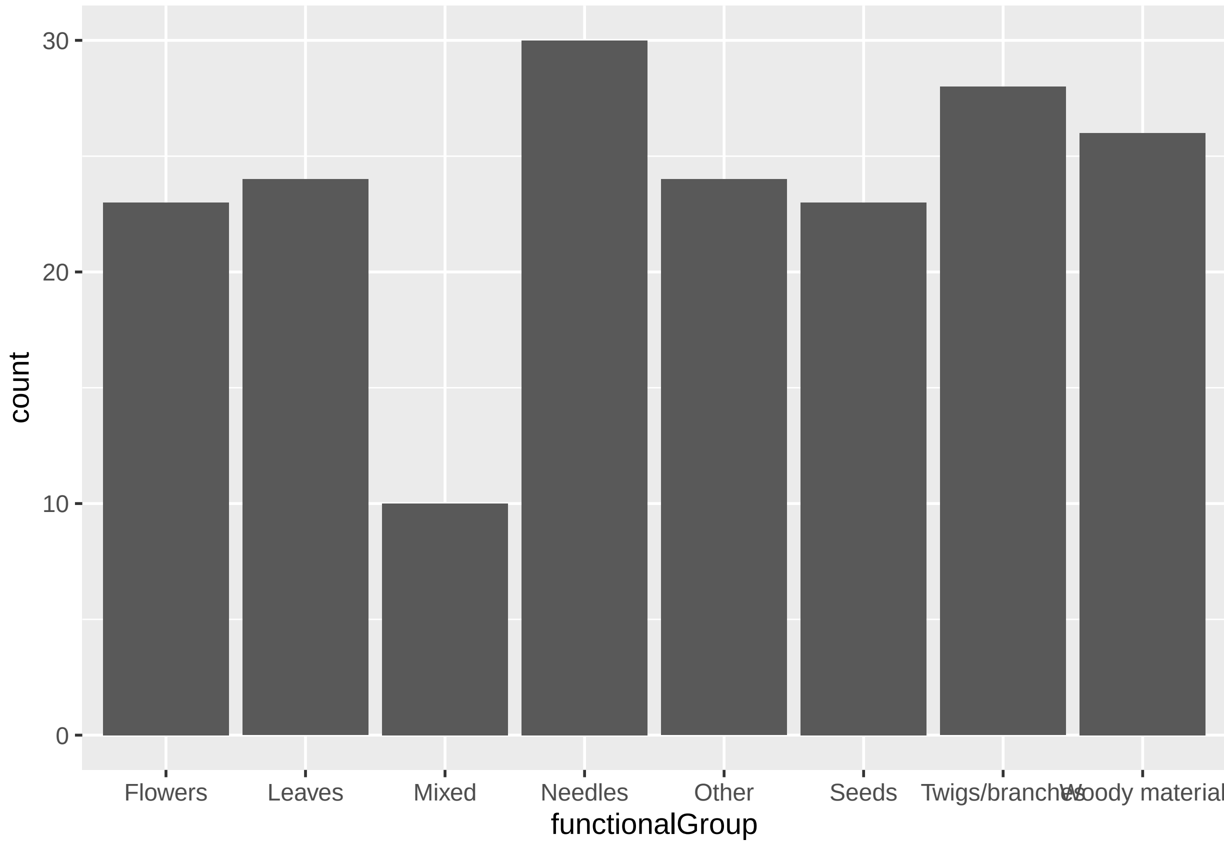
```
unique(Litter_data$plotID)
```

```
##  [1] "NIWO_061" "NIWO_064" "NIWO_067" "NIWO_040" "NIWO_041" "NIWO_063"
##  [7] "NIWO_047" "NIWO_051" "NIWO_058" "NIWO_046" "NIWO_062" "NIWO_057"
```

Answer: Summary treats the numbers as numbers to be added/subtracted etc., but unique treats them as IDs like zip codes. 12 plots were sampled.

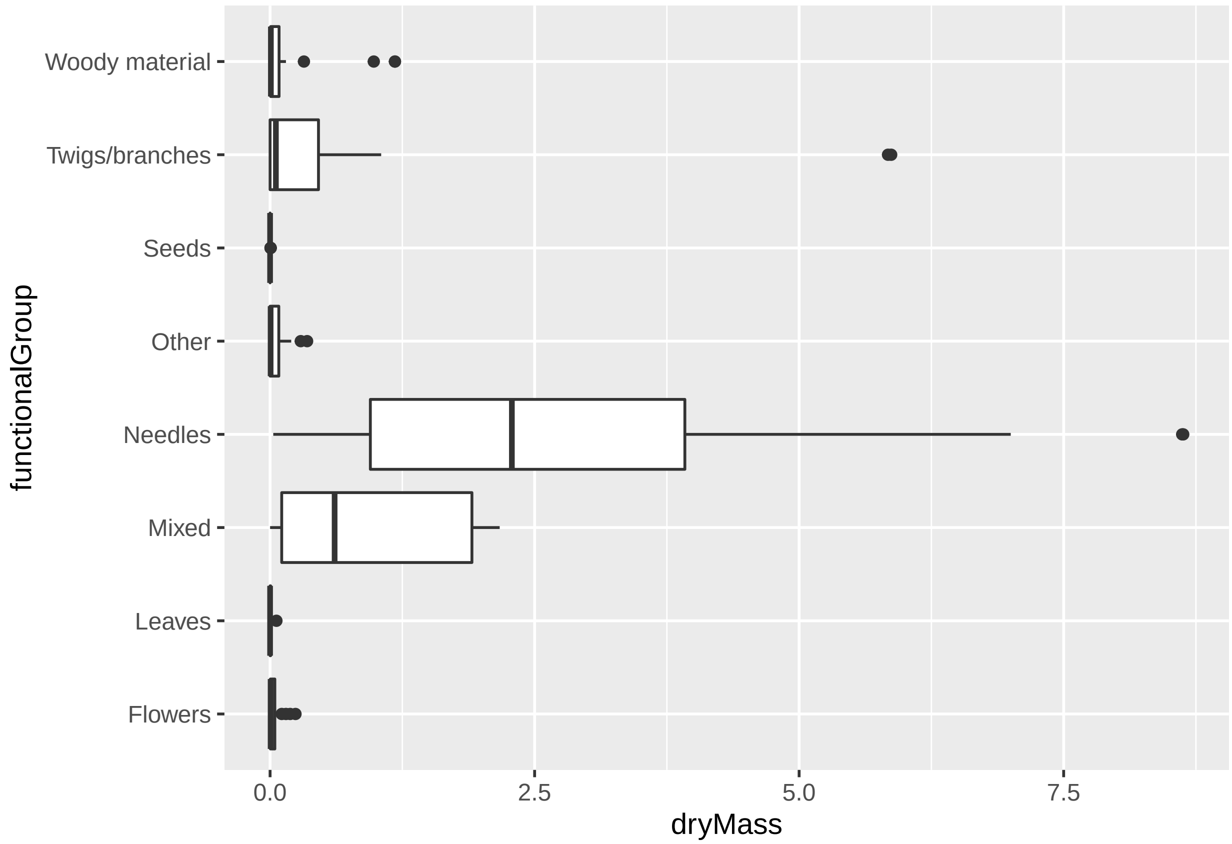
14. Create a bar graph of functionalGroup counts. This shows you what type of litter is collected at the Niwot Ridge sites. Notice that litter types are fairly equally distributed across the Niwot Ridge sites.

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




```r
ggplot(Litter_data) +
  geom_violin(aes(x = dryMass, y = functionalGroup),
              draw_quantiles = c(0.25, 0.5, 0.75))
```

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

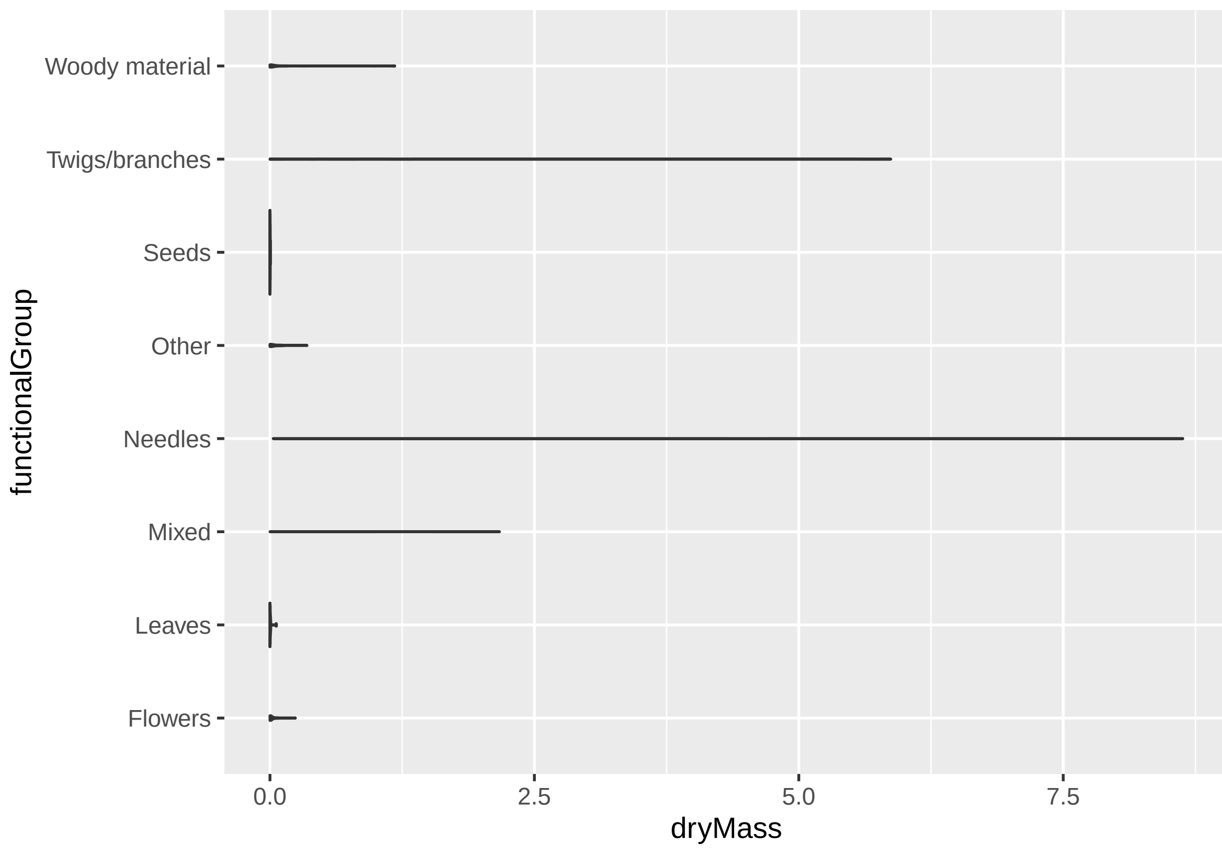

Why is the boxplot a more effective visualization option than the violin plot in this case?

> Answer: It works beter because it shows the mean and distribution of the data more effectively versus everything looking squished in the violin plot.

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

> Answer: Needles and mixed have the highest biomass at these sites.