Assignment 3: Data Exploration

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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. Assign a useful **name to each code chunk** and include ample **comments** with your code.
5. Be sure to **answer the questions** in this assignment document.
6. When you have completed the assignment, **Knit** the text and code into a single PDF file.
7. After Knitting, submit the completed exercise (PDF file) to the dropbox in Sakai.

TIP: If your code extends past the page when knit, tidy your code by manually inserting line breaks.

TIP: If your code fails to knit, check that no `install.packages()` or `View()` commands exist in your code.

Set up your R session

1. Check your working directory, load necessary packages (tidyverse, lubridate), 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] "C:/Users/asaje/OneDrive/Desktop/Data Analytics/EDA-Spring2023"
```

```
library(tidyverse)

library(lubridate)

library(readr)
```

```
Neonics <- read.csv("Data/Raw/ECOTOX_Neonicotinoids_Insects_raw.csv",
                    stringsAsFactors = T)

Litter <- read.csv("./Data/Raw/NEON_NIWO_Litter_massdata_2018-08_raw.csv",
                   stringsAsFactors = T)
```

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:Insecticides don't discriminate and neonicotinoids also harm pollinators which are important for continued agriculture and food production. Additionally the neonicotinoids could build up in larger animals that eat insects and harm them potentially leading to cascades in the food web.

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: Woody debris could serve as tinder during forest fires. It also serves as nutrient source for downstream aquatic ecosystems and as a habitat for insects and small animals on the forest floor.Leaf litter will protect the soil from drying out and eventually add more humus and nutrients to the soil for growing plants.

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.Ground traps are sampled once per year. Target sampling frequency for elevated traps varies by vegetation present at the site, with frequent sampling (1x every 2weeks) in deciduous forest sites during senescence, and infrequent year-round sampling (1x every 1-2 months) at evergreen sites. Ground traps and elevated traps are paired 2.A subset of collection bouts are chosen for chemistry and stable isotope measurements, once every five years. 3. Traps are placed within 4 40m x 40m tower plots and 26 20m x 20m plots.

Obtain basic summaries of your data (Neonics)

5. What are the dimensions of the dataset?

```
summary_neonics <- summary(Neonics)
summary_neonics
```

```
##    CAS.Number
##  Min.   : 58842209
##  1st Qu.:138261413
##  Median :138261413
##  Mean   :147651982
##  3rd Qu.:153719234
##  Max.   :210880925
##
##                                                                                 Chemical.Name
##  (2E)-1-[(6-Chloro-3-pyridinyl)methyl]-N-nitro-2-imidazolidinimine                      :2658
##  3-[(2-Chloro-5-thiazolyl)methyl]tetrahydro-5-methyl-N-nitro-4H-1,3,5-oxadiazin-4-imine: 686
##  [C(E)]-N-[(2-Chloro-5-thiazolyl)methyl]-N'-methyl-N''-nitroguanidine                   : 452
##  (1E)-N-[(6-Chloro-3-pyridinyl)methyl]-N'-cyano-N-methylethanimidamide                  : 420
##  N''-Methyl-N-nitro-N'-[(tetrahydro-3-furanyl)methyl]guanidine                          : 218
##  [N(Z)]-N-[3-[(6-Chloro-3-pyridinyl)methyl]-2-thiazolidinylidene]cyanamide              : 128
##  (Other)                                                                                :  61
##                                                          Chemical.Grade
##  Not reported                                                  :3989
##  Technical grade, technical product, technical formulation: 422
##  Pestanal grade                                                :  93
##  Not coded                                                     :  53
##  Commercial grade                                              :  27
##  Analytical grade                                              :  15
##  (Other)                                                       :  24
##                                                        Chemical.Analysis.Method
##  Measured                                                        : 230
##  Not coded                                                       :  51
##  Not reported                                                    :   5
##  Unmeasured                                                      :4321
##  Unmeasured values (some measured values reported in article):  16
##
##
##  Chemical.Purity                  Species.Scientific.Name
##  NR     :2502    Apis mellifera              : 667
##  25     : 244    Bombus terrestris           : 183
##  50     : 200    Apis mellifera ssp. carnica  : 152
##  20     : 189    Bombus impatiens            : 140
##  70     : 112    Apis mellifera ssp. ligustica: 113
##  75     :  89    Popillia japonica           :  94
##  (Other):1287    (Other)                     :3274
##            Species.Common.Name
##  Honey Bee            : 667
##  Parasitic Wasp       : 285
##  Buff Tailed Bumblebee: 183
##  Carniolan Honey Bee  : 152
##  Bumble Bee           : 140
##  Italian Honeybee     : 113
##  (Other)              :3083
##                                                               Species.Group
##  Insects/Spiders                                                    :3569
##  Insects/Spiders; Standard Test Species                             :  27
##  Insects/Spiders; Standard Test Species; U.S. Invasive Species: 667
##  Insects/Spiders; U.S. Invasive Species                             : 360
##
```

```
##
##
##    Organism.Lifestage  Organism.Age             Organism.Age.Units
##  Not reported:2271     NR     :3851   Not reported        :3515
##  Adult       :1222     2      : 111   Day(s)              : 327
##  Larva       : 437     3      : 105   Instar              : 255
##  Multiple    : 285     <24    :  81   Hour(s)             : 241
##  Egg         : 128     4      :  81   Hours post-emergence:  99
##  Pupa        :  69     1      :  59   Year(s)             :  64
##  (Other)     : 211     (Other): 335   (Other)             : 122
##                    Exposure.Type         Media.Type
##  Environmental, unspecified:1599   No substrate:2934
##  Food                      :1124   Not reported: 663
##  Spray                     : 393   Natural soil: 393
##  Topical, general          : 254   Litter      : 264
##  Ground granular           : 249   Filter paper: 230
##  Hand spray                : 210   Not coded   :  51
##  (Other)                   : 794   (Other)     :  88
##              Test.Location  Number.of.Doses        Conc.1.Type..Author.
##  Field artificial    :  96   2      :2441    Active ingredient:3161
##  Field natural       :1663   3      : 499    Formulation      :1420
##  Field undeterminable:   4   5      : 314    Not coded        :  42
##  Lab                 :2860   6      : 230
##                              4      : 221
##                              NR     : 217
##                              (Other): 701
##  Conc.1..Author. Conc.1.Units..Author.             Effect
##  0.37/  : 208    AI kg/ha  : 575       Population      :1803
##  10/    : 127    AI mg/L   : 298       Mortality       :1493
##  NR/    : 108    AI lb/acre: 277       Behavior        : 360
##  NR     :  94    AI g/ha   : 241       Feeding behavior: 255
##  1      :  82    ng/org    : 231       Reproduction    : 197
##  1023   :  80    ppm       : 180       Development     : 136
##  (Other):3924    (Other)   :2821       (Other)         : 379
##              Effect.Measurement    Endpoint                   Response.Site
##  Abundance             :1699     NOEL   :1816   Not reported         :4349
##  Mortality             :1294     LOEL   :1664   Midgut or midgut gland:  63
##  Survival              : 133     LC50   : 327   Not coded            :  51
##  Progeny counts/numbers: 120     LD50   : 274   Whole organism       :  41
##  Food consumption      : 103     NR     : 167   Hypopharyngeal gland :  27
##  Emergence             :  98     NR-LETH:  86   Head                 :  23
##  (Other)               :1176     (Other): 289   (Other)              :  69
##  Observed.Duration..Days.      Observed.Duration.Units..Days.
##  1      : 713             Day(s)              :4394
##  2      : 383             Emergence           :  70
##  NR     : 355             Growing season      :  48
##  7      : 207             Day(s) post-hatch   :  20
##  3      : 183             Day(s) post-emergence:  17
##  0.0417 : 133             Tiller stage        :  15
##  (Other):2649             (Other)             :  59
##                                                                        Author
##  Peck,D.C.                                                             : 208
##  Frank,S.D.                                                            : 100
##  El Hassani,A.K., M. Dacher, V. Gary, M. Lambin, M. Gauthier, and C. Armengaud:  96
```

```
##  Williamson,S.M., S.J. Willis, and G.A. Wright                                      :  93
##  Laurino,D., A. Manino, A. Patetta, and M. Porporato                                :  88
##  Scholer,J., and V. Krischik                                                        :  82
##  (Other)                                                                            :3956
##  Reference.Number
##  Min.   :   344
##  1st Qu.:108459
##  Median :165559
##  Mean   :142189
##  3rd Qu.:168998
##  Max.   :180410
##
##
##  Long-Term Effects of Imidacloprid on the Abundance of Surface- and Soil-Active Nontarget Fauna in Tu
##  Reduced Risk Insecticides to Control Scale Insects and Protect Natural Enemies in the Production and
##  Effects of Sublethal Doses of Acetamiprid and Thiamethoxam on the Behavior of the Honeybee (Apis mel
##  Exposure to Neonicotinoids Influences the Motor Function of Adult Worker Honeybees
##  Toxicity of Neonicotinoid Insecticides on Different Honey Bee Genotypes
##  Chronic Exposure of Imidacloprid and Clothianidin Reduce Queen Survival, Foraging, and Nectar Storin
##  (Other)
##                                            Source     Publication.Year
##  Agric. For. Entomol.11(4): 405-419           : 200   Min.   :1982
##  Environ. Entomol.41(2): 377-386              : 100   1st Qu.:2005
##  Arch. Environ. Contam. Toxicol.54(4): 653-661:  96   Median :2010
##  Ecotoxicology23:1409-1418                    :  93   Mean   :2008
##  Bull. Insectol.66(1): 119-126                :  88   3rd Qu.:2013
##  PLoS One9(3): 14 p.                          :  82   Max.   :2019
##  (Other)                                      :3964
##  Summary.of.Additional.Parameters
##  Purity: \xca NR - NR | Organism Age: \xca NR - NR Not reported | Conc 1 (Author): \xca Active ingred
##  Purity: \xca NR - NR | Organism Age: \xca NR - NR Not reported | Conc 1 (Author): \xca Active ingred
##  Purity: \xca NR - NR | Organism Age: \xca NR - NR Not reported | Conc 1 (Author): \xca Active ingred
##  Purity: \xca NR - NR | Organism Age: \xca NR - NR Not reported | Conc 1 (Author): \xca Active ingred
##  Purity: \xca NR - NR | Organism Age: \xca NR - NR Not reported | Conc 1 (Author): \xca Active ingred
##  Purity: \xca NR - NR | Organism Age: \xca NR - NR Not reported | Conc 1 (Author): \xca Formulation I
##  (Other)
```

```r
dim_neonics <- dim(Neonics)
dim_neonics
```

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

```r
ncol(Neonics)
```

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

```r
nrow(Neonics)
```

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

```
#These various commands return the basic dimensions of the Neonics dataset, how
 #many columns/rows are in the dataframe.
```

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?

```
Effect_Neo <- summary(Neonics$Effect)

Effect_Neo
```

```
##     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
```

```
#This commands allows us to see how many studies return results on the each
#effect of Neonics.
```

Answer:Population and Mortality. These 2 effects are of the greatest interest b/c they say the most about the lethality of neonicotinoids and their impact on insect populations. Population is a measure of abundance so if the abundance falls drastically the insect may be functionally extinct in the region.

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.[TIP: The `sort()` command can sort the output of the summary command...]

```
six_insects <- summary(Neonics$Species.Common.Name)
six_insects
```

```
##                         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
```

```
sort(six_insects,decreasing=FALSE)
```

```
##                          Ant Family                         Apple Maggot
##                                   9                                   9
##              Glasshouse Potato Wasp                             Lacewing
##                                  10                                  10
##             Southern House Mosquito              Two Spotted Lady Beetle
##                                  10                                  10
##            Spotless Ladybird Beetle                  Braconid Parasitoid
##                                  11                                  12
##                        Common Thrip        Eastern Subterranean Termite
##                                  12                                  12
##                              Jassid                           Mite Order
##                                  12                                  12
##                           Pea Aphid                     Pond Wolf Spider
##                                  12                                  12
##               Armoured Scale Family                     Diamondback Moth
##                                  13                                  13
##                       Eulophid Wasp                    Monarch Butterfly
##                                  13                                  13
##                       Predatory Bug                Yellow Fever Mosquito
```

```
##                          13                                13
##                 Corn Earworm                 Green Peach Aphid
##                          14                                14
##                    House Fly                         Ox Beetle
##                          14                                14
##            Red Scale Parasite               Spined Soldier Bug
##                          14                                14
##       Western Flower Thrips Hemlock Woolly Adelgid Lady Beetle
##                          15                                16
##       Hemlock Wooly Adelgid                              Mite
##                          16                                16
##                  Onion Thrip             Araneoid Spider Order
##                          16                                17
##                    Bee Order                   Egg Parasitoid
##                          17                                17
##                 Insect Class          Moth And Butterfly Order
##                          17                                17
## Oystershell Scale Parasitoid          Black-spotted Lady Beetle
##                          17                                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
##                 Codling Moth         Flatheaded Appletree Borer
##                          19                                20
##          Horned Oak Gall Wasp                Leaf Beetle Family
##                          20                                20
##            Potato Leafhopper        Tooth-necked Fungus Beetle
##                          20                                20
##               Argentine Ant                            Beetle
##                          21                                21
##                    Mason Bee                          Mosquito
##                          22                                22
##             Citrus Leafminer                   Ladybird Beetle
##                          23                                23
##            Spider/Mite Class               Tobacco Flea Beetle
##                          24                                24
##                 Chalcid Wasp           Convergent Lady Beetle
##                          25                                25
##                Stingless Bee              Ground Beetle Family
##                          25                                27
##            Rove Beetle Family                     Tobacco Aphid
##                          27                                27
##                Scarab Beetle                      Spring Tiphia
##                          29                                29
##                  Thrip Order            Ladybird Beetle Family
##                          29                                30
##                   Parasitoid                      Braconid Wasp
##                          30                                33
##                 Cotton Aphid                    Predatory Mite
```

```
##                         33                         33
##         Sweetpotato Whitefly               Aphid Family
##                         37                         38
##               Cabbage Looper       Buff-tailed Bumblebee
##                         38                         39
##                True Bug Order    Sevenspotted Lady Beetle
##                         45                         46
##                  Beetle Order  Snout Beetle Family, Weevil
##                         47                         47
##            Erythrina Gall Wasp            Parasitoid Wasp
##                         49                         51
##         Colorado Potato Beetle              Parastic Wasp
##                         57                         58
##           Asian Citrus Psyllid           Minute Pirate Bug
##                         60                         62
##             European Dark Bee                   Wireworm
##                         66                         69
##               Euonymus Scale           Asian Lady Beetle
##                         75                         76
##              Japanese Beetle            Italian Honeybee
##                         94                        113
##                   Bumble Bee         Carniolan Honey Bee
##                        140                        152
##          Buff Tailed Bumblebee            Parasitic Wasp
##                        183                        285
##                    Honey Bee                    (Other)
##                        667                        670
```

```
#As with the summary of effects, these commands let us see which insects are of
#most interest by returning how many studies include each insect.
```

Answer:Honey Bee, Parasitic Wasp, Buff Tailed Bumblebee, Carniolan Honey Bee, Bumble Bee, Italian Honeybee. Other than the parasitic wasp, all these insects have in common is that they're all bees and they're all important pollinators. They are important pollinators and the honey bees are very economically important for their pollinating and their honey.

8. Concentrations are always a numeric value. What is the class of `Conc.1..Author.` column in the dataset, and why is it not numeric?

```
lapply("Conc.1..Author",class)
```

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

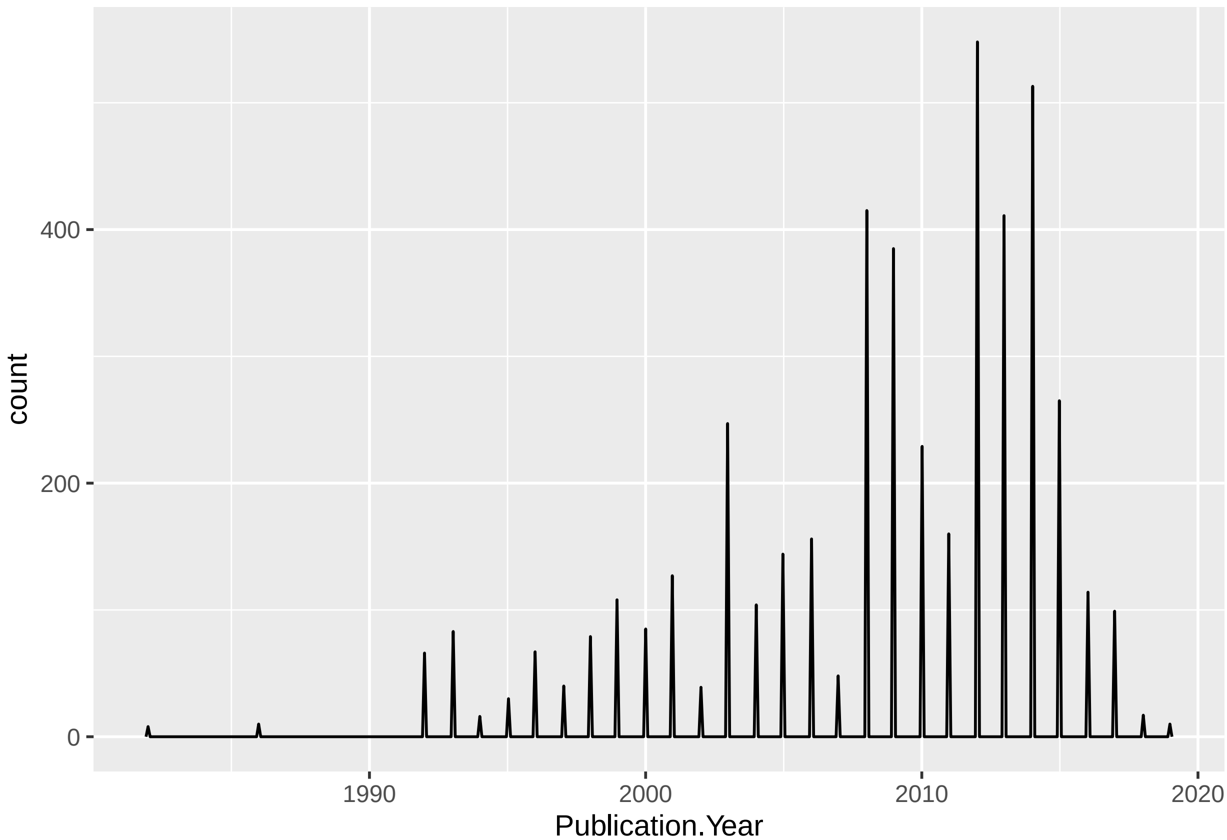
```
#It's useful to know which class of data you're dealing with because this
#informs the commands that can be used and what type of information it is
```

Answer: It's a character class. There are non-numeric characters in the column, like / and NR. Concentrations were not reported for all rows.

Explore your data graphically (Neonics)

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

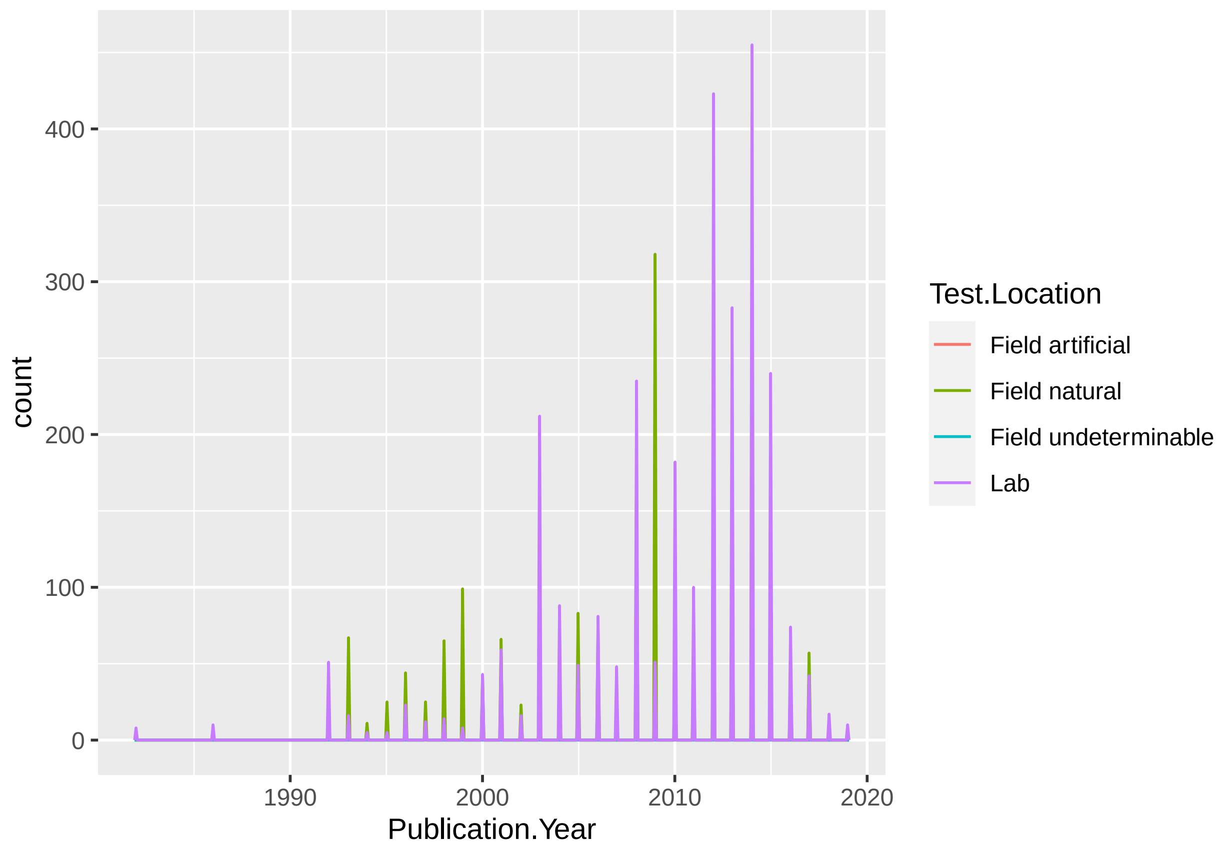
```
ggplot(Neonics,aes(Publication.Year))+
  geom_freqpoly(bins=500)
```




```
#Looking at frequency of each publication year in a frequency plot.
```

10. Reproduce the same graph but now add a color aesthetic so that different Test.Location are displayed as different colors.

```
ggplot(Neonics,aes(Publication.Year)) +
  geom_freqpoly(aes(color=Test.Location), bins=500)
```




```
#This allows us to look at multiple questions, in which years were most studies
#published and where were those studies conducted.
```

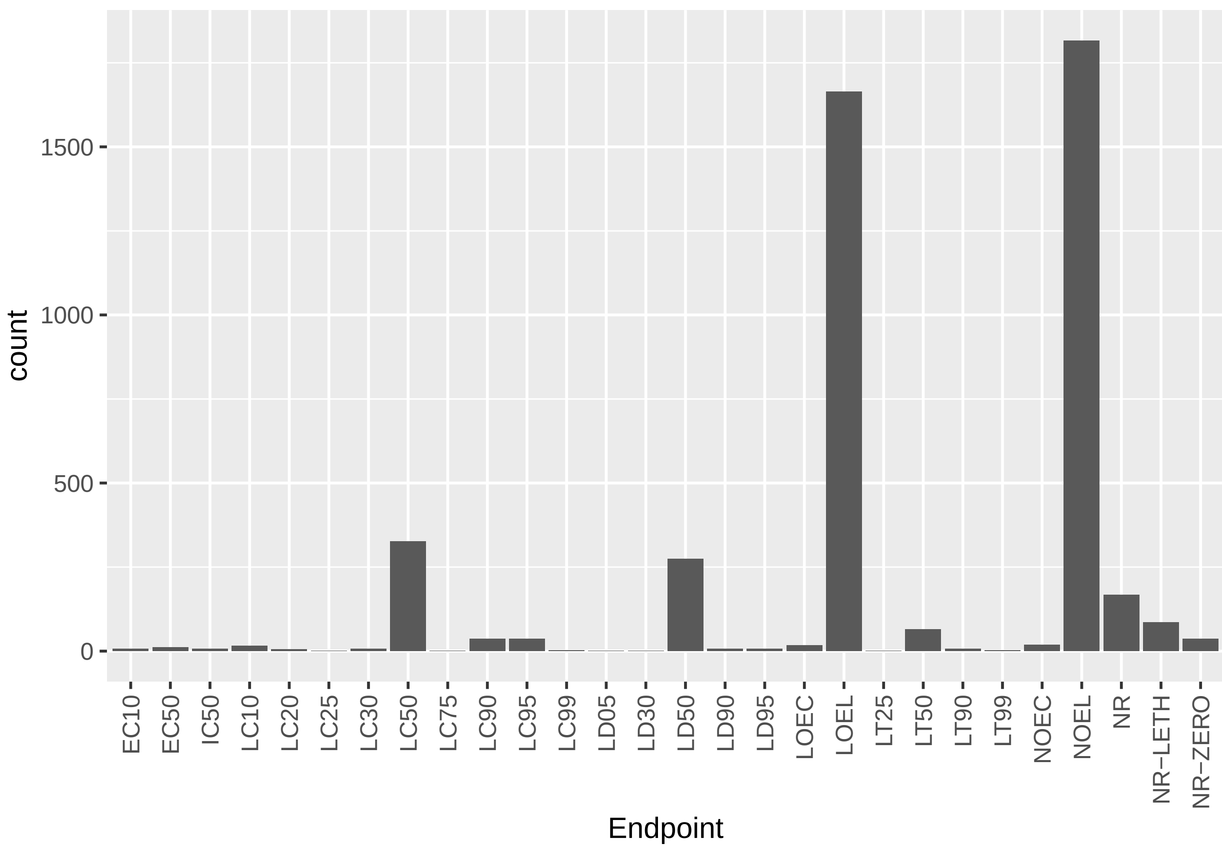
Interpret this graph. What are the most common test locations, and do they differ over time?

> Answer:Field natural and Lab are the most common test locations and after 2003 Test location is overwhelmingly in the lab whereas before 2000 it's mostly in field natural.

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.

[**TIP**: Add `theme(axis.text.x = element_text(angle = 90, vjust = , 0.5 hjust=1))` to the end of your plot command to rotate and align the X-axis labels…]

```
ggplot(Neonics, aes(x = Endpoint)) +
  geom_bar() +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5, hjust=1))
```




```
#This command simply makes the graph labels easier to read
```

> Answer:LOEL:Lowest-observable-effect-level: lowest dose (concentration) producing effects that were significantly different (as reported by authors) from responses of controls and NOEL:No-observable-effect-level: highest dose (concentration) producing effects not significantly different from responses of controls. So the most common endpoints were low doses producing effects and high doses producing no effects.

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.

```
lapply("collectDate",class)
```

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

```
Litter$collectDate <- "2018-08-02"
litter_dates <- ymd(Litter$collectDate)
litter_dates
```

```
##   [1] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
```

```
##   [6] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
##  [11] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
##  [16] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
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## [101] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
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## [121] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
## [126] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
## [131] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
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## [151] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
## [156] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
## [161] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
## [166] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
## [171] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
## [176] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
## [181] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
## [186] "2018-08-02" "2018-08-02" "2018-08-02"
```

```r
lapply("collectDate",class)
```

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

```r
collect_dates<- unique(Litter$collectDate,incomparables = FALSE)

#August 2, 2018 (and August 30, 2018 but I accidentally got rid of that)
#fixing the date columns b/c R is weird about dates
```

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`?

```
Niwot_Ridge_plots<- unique(Litter$plotID, incomparables=FALSE)
Niwot_Ridge_plots
```

```
##  [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
```

```
Niwot_test <- summary(Litter$plotID)
Niwot_test
```

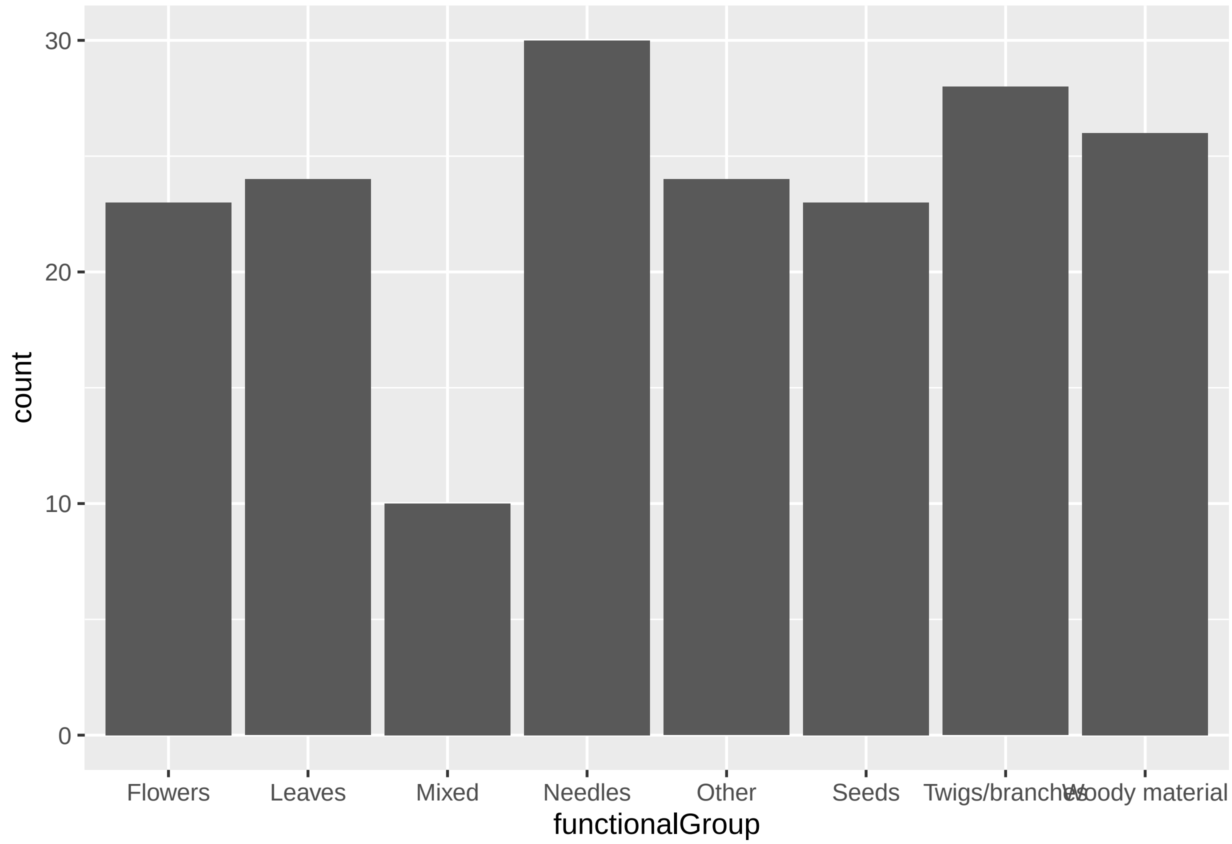
```
## NIWO_040 NIWO_041 NIWO_046 NIWO_047 NIWO_051 NIWO_057 NIWO_058 NIWO_061
##       20       19       18       15       14        8       16       17
## NIWO_062 NIWO_063 NIWO_064 NIWO_067
##       14       14       16       17
```

```
#Comparing unique and summary. As well as seeing how many plots were sampled.
```

> Answer: 12 plots were sampled at Niwot Ridge. Unique will return the same vector, dataframe, or array with duplicates removed so you can see how many exist in each row. Summary summarizes each unique plot, so returns how many subplots are in each plot, without returning the number of distinct plots.

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.

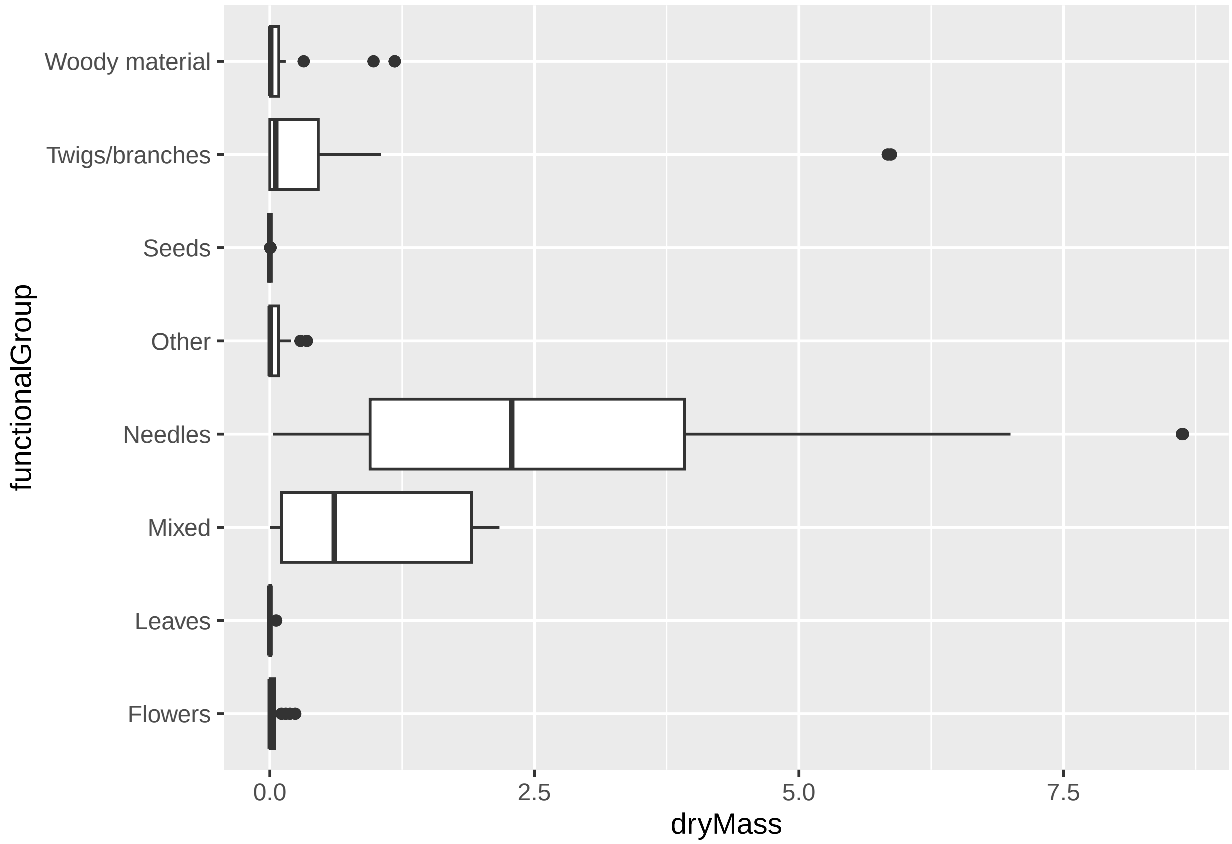
```
ggplot(Litter, aes(x = functionalGroup)) +
  geom_bar()
```



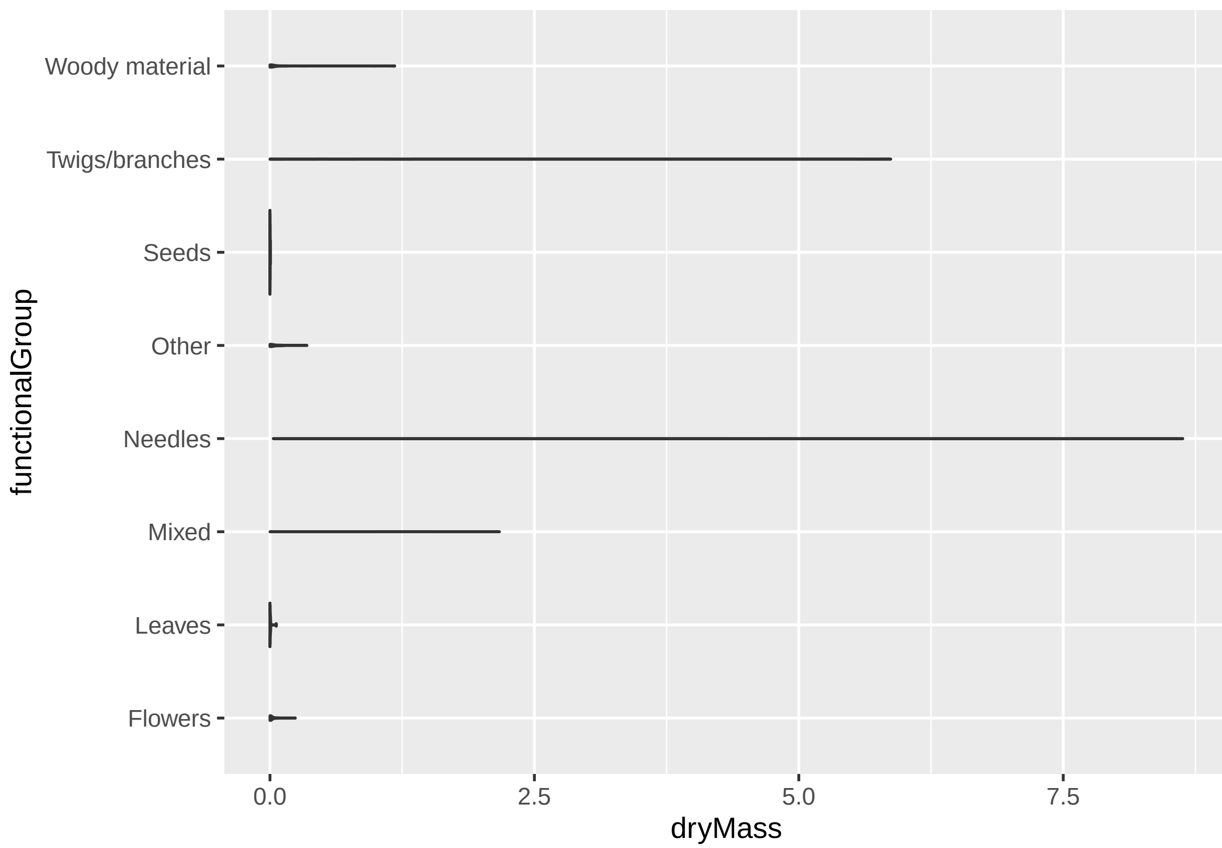

```r
#Looking at what types of litter were collected at each site.
```

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

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




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




```
#Comparing how a boxplot and a violin plot displayed the same data.
```

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

> Answer:Boxplot shows more of the summary statistics with mean and 1st and 2nd quartile and outliers distinct from the rest. The violin plot does not isolate the outliers so in this case it appears the Twigs/branches is much more dryMass than is the case.

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

> Answer:Needles made up the largest amount of biomass, followed by Mixed litter, with Twigs and branches in third.