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] "/home/guest/EDE_Fall2023"
```

```
#My working directory is in my class folder where my R project is located.
#I do not need to change it, but if I did I coulde use an absolute file path or go to the
#engine to set one.

#tidyverse and lubridate are already installed, so I will simply load them
```

```
library(tidyverse)
library(lubridate)

#Imported data and assigned names to the dataset. Assigned strings as
#factors to true to convert character/categorical values.

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)

#Checks to ensure data looks correct and that column header
#names are not taking the first line.

colnames(Neonics)
```

```
##  [1] "CAS.Number"                      "Chemical.Name"
##  [3] "Chemical.Grade"                  "Chemical.Analysis.Method"
##  [5] "Chemical.Purity"                 "Species.Scientific.Name"
##  [7] "Species.Common.Name"             "Species.Group"
##  [9] "Organism.Lifestage"              "Organism.Age"
## [11] "Organism.Age.Units"              "Exposure.Type"
## [13] "Media.Type"                      "Test.Location"
## [15] "Number.of.Doses"                 "Conc.1.Type..Author."
## [17] "Conc.1..Author."                 "Conc.1.Units..Author."
## [19] "Effect"                          "Effect.Measurement"
## [21] "Endpoint"                        "Response.Site"
## [23] "Observed.Duration..Days."        "Observed.Duration.Units..Days."
## [25] "Author"                          "Reference.Number"
## [27] "Title"                           "Source"
## [29] "Publication.Year"                "Summary.of.Additional.Parameters"
```

```
colnames(Litter)
```

```
##  [1] "uid"                    "namedLocation"
##  [3] "domainID"               "siteID"
##  [5] "plotID"                 "trapID"
##  [7] "weighDate"              "setDate"
##  [9] "collectDate"            "ovenStartDate"
## [11] "ovenEndDate"            "fieldSampleID"
## [13] "massSampleID"           "samplingProtocolVersion"
## [15] "functionalGroup"        "dryMass"
## [17] "qaDryMass"              "remarks"
## [19] "measuredBy"
```

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:There are environmental impacts of neonicotinoids that disrupt food webs. Some effects include impacts on reproduction and impairements to function for pollinating insects.

3. The Niwot Ridge litter and woody debris dataset was collected from the National Ecological Observatory Network, which collectively includes 81 aquatic and terrestrial sites across 20 ecoclimatic domains. 32 of these sites sample forest litter and woody debris, and we will focus on the Niwot Ridge long-term ecological research (LTER) station in Colorado. Why might we be interested in studying litter and woody debris that falls to the ground in forests? Feel free to do a brief internet search if you feel you need more background information.

   Answer:Litter and woody debris is important for carbon cycling in forests. These fallen trees that decay help restore nutrients to the forest environment and help it thrive. There is also importance of the role in providing habitat.

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. Sampling occurs at sites that have woody vegetation >2m tall. 2. There is one litter trap pair for every 400 m^2 plot area meaning overall there is 1-4 trap pairs per plot. 3. Tower plot locations are selected randomly within 90% flux footprint of primary and secondary airsheds.

Obtain basic summaries of your data (Neonics)

5. What are the dimensions of the dataset?

```
#Dimension tells me I have 4623 rows and 30 columns in the
#Neonics 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?

```
#By taking summary of the specific column 'Effect' able to see
#how many times each effect is by the summarized data.

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: Most common effects studied include population, mortality, behavior, feeding behavior, and development. These are probably particularly of interest because as state before neonicotinoids affect function and reproductability.

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. . .]

```
sort(summary(Neonics$Species.Common.Name))
```

```
##                          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
```

Answer: 1. Honey Bee, 2. Parasitic Wasp, 3. Buff Tailed Bumblebee, 4. Carniolan Honey Bee, 5. Bumble Bee, 6. Italian Honey Bee. These top commonly studied species are flying pollinators, most being bees. These might be of most interest because as said before neonicotinoids most commonly affect pollinaators when they come in contact with plants.

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?

```
class(Neonics$Conc.1..Author.)
```

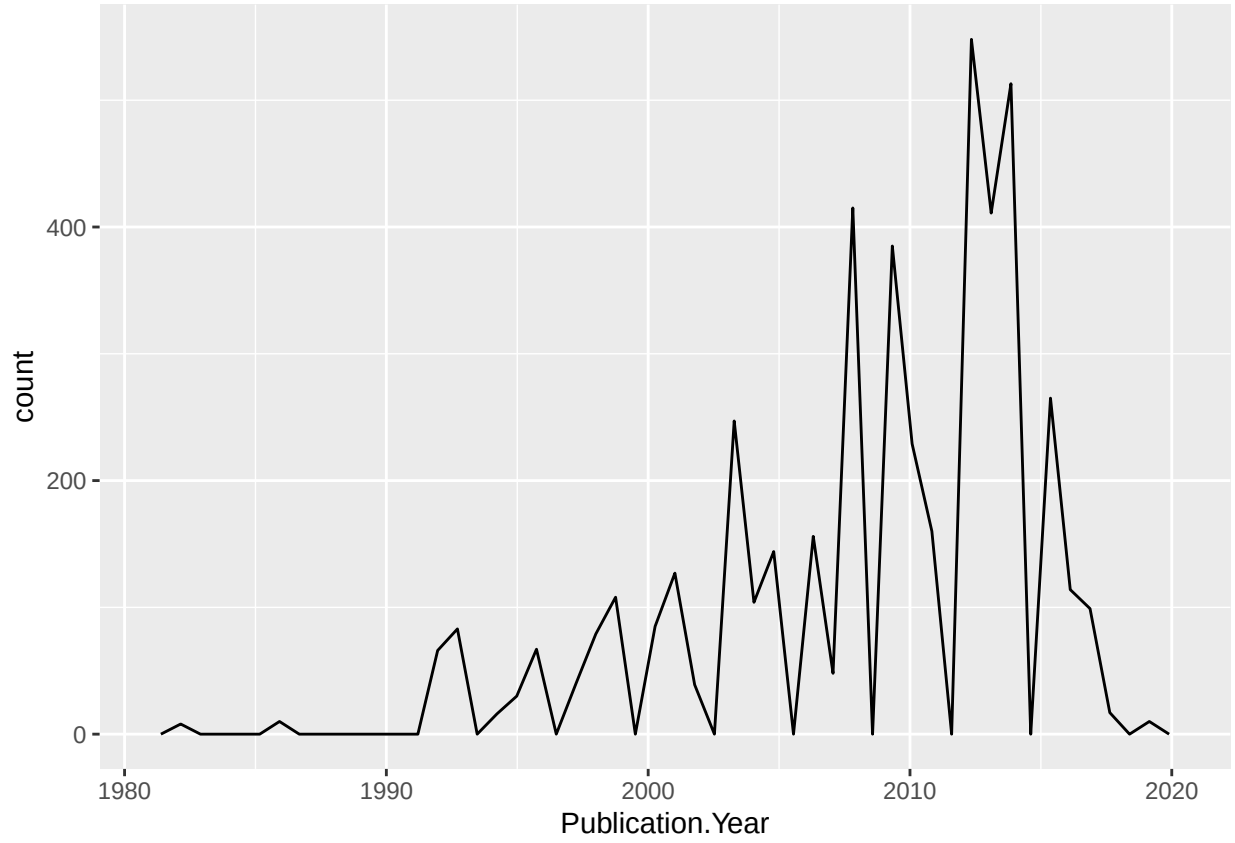
```
## [1] "factor"
```

Answer: It is a factor. This column tells how the concentration was prepared or what is included, such as an active ingredient or formulation.

Explore your data graphically (Neonics)

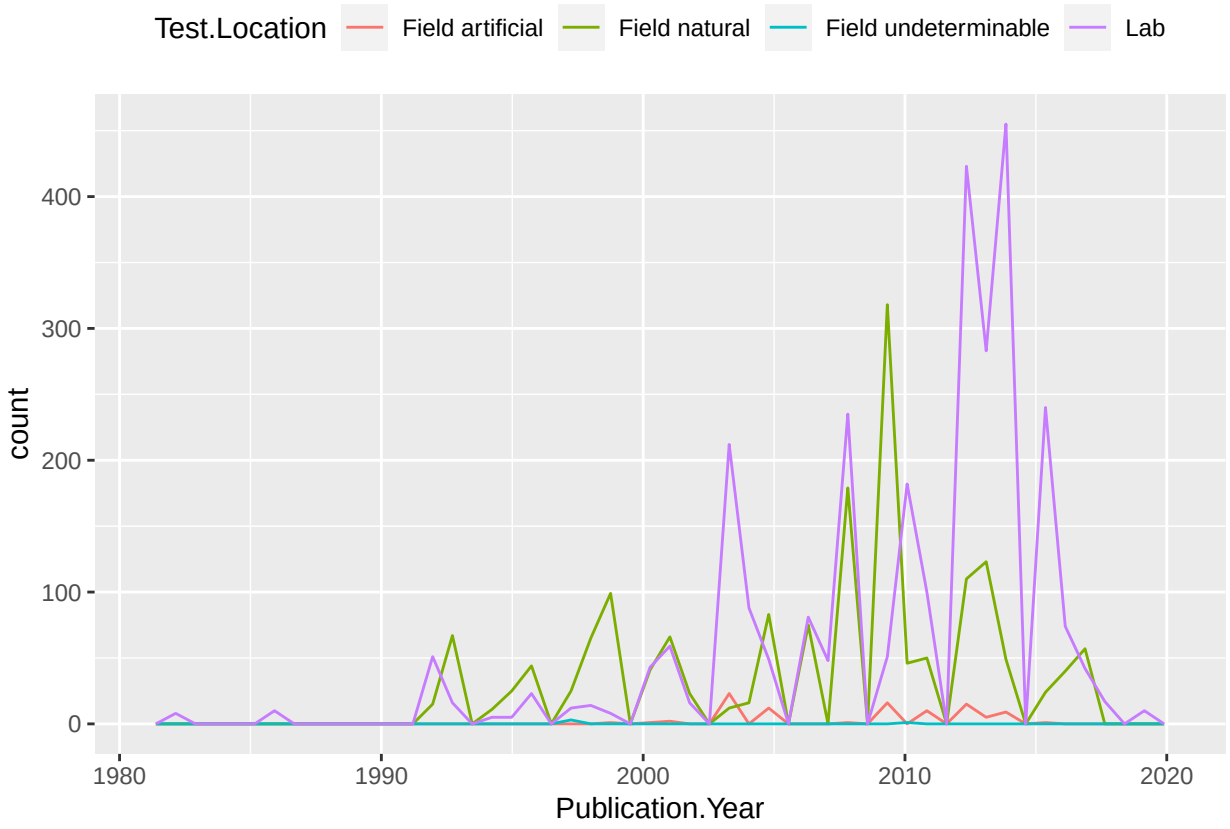
9. Using `geom_freqpoly`, generate a plot of the number of studies conducted by publication year.

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



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

```
ggplot(Neonics)+geom_freqpoly(aes(x= Publication.Year, color = Test.Location), bins=50) +
  theme(legend.position = "top")
```




```
#For aesthetic purposes, the legend was moved to the top. Each record for test location has
#been assigned a color.
```

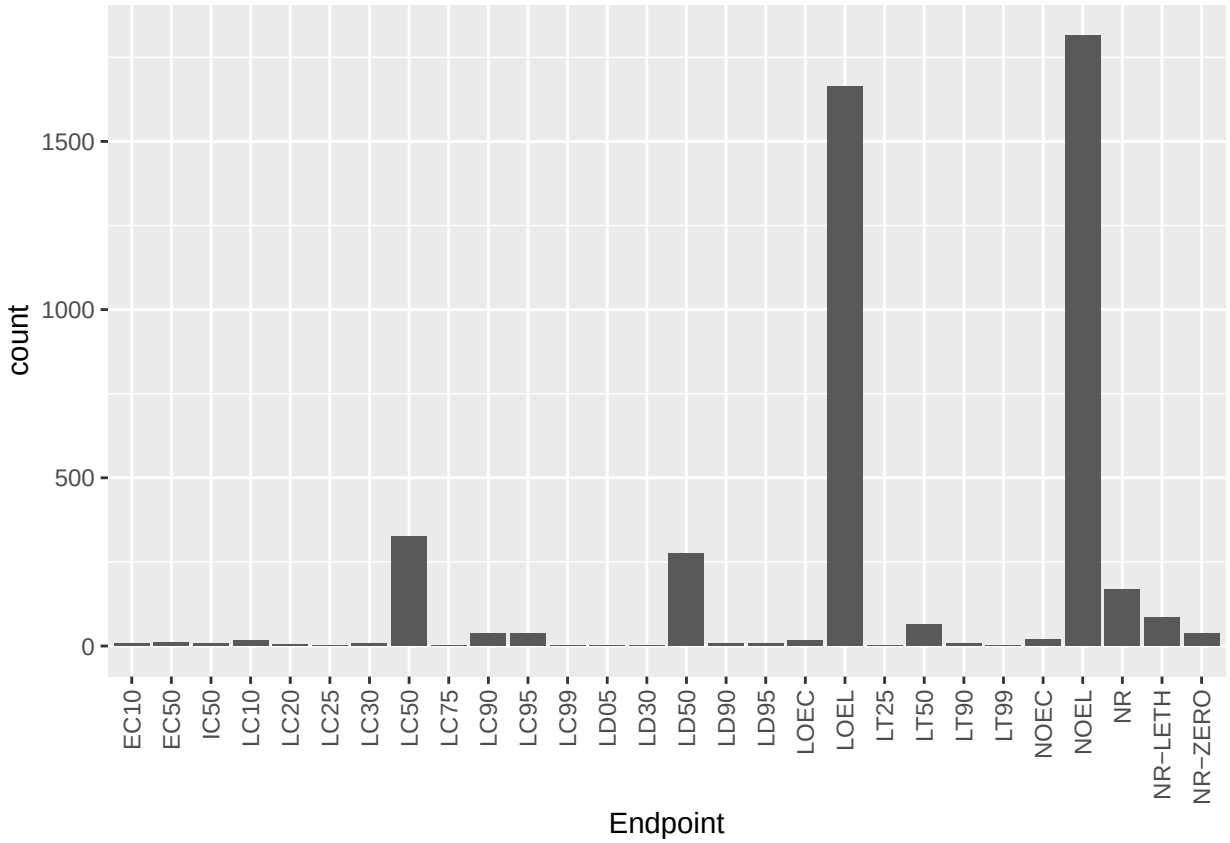
Interpret this graph. What are the most common test locations, and do they differ over time?

> Answer: Most common is the lab followed by natural field. Overtime both of these locations have increased in count, specially for the lab. For other variables, they have remained constant.

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))
```



Answer: The two most common endpoints are LOEL and NOEL. LOEL and NOEL are the database usage of terrestial. LOEL is the lowest-observable-effect-level where lowest dose (concentration) producing effects that were significantly different from responses of controls. NOEL is no-observable-effect-level where highest dose (concentration) producing effects not significantly different from responses of controls according to author's reported statistical test.

Explore your data (Litter)

12. Determine the class of collectDate. Is it a date? If not, change to a date and confirm the new class of the variable. Using the `unique` function, determine which dates litter was sampled in August 2018.

```
class(Litter$collectDate)
```

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

```
Litter$collectDate <- c('2018-08-02','2018-08-30')

Litter$collectDate <- as.Date(Litter$collectDate, format = '%Y-%m-%d')

unique(Litter$collectDate, 2018-08)
```

```
## [1] "2018-08-02" "2018-08-30"
```

```
#The class was a factor, not a date. Convert collect date to format year (four digit), month, day.
```

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)
```

```
##                                    uid         namedLocation domainID siteID
## 1   7f065fec-bcb2-4af9-b742-8e520fab7f6e NIWO_061.basePlot.ltr      D13   NIWO
## 2   88df210b-1445-4c3f-b19e-5dabd9305c6e NIWO_061.basePlot.ltr      D13   NIWO
## 3   7f3c549c-1dfa-43bf-a485-c7c2bcb31fd6 NIWO_061.basePlot.ltr      D13   NIWO
## 4   97806ab5-42d2-49c0-8463-db48cd5eab12 NIWO_061.basePlot.ltr      D13   NIWO
## 5   9d7c89f5-85f8-47b6-b415-1ae208580e6f NIWO_061.basePlot.ltr      D13   NIWO
## 6   6ca7a3e8-4d9e-4062-91a0-845f23b5b925 NIWO_061.basePlot.ltr      D13   NIWO
## 7   a0f02718-2a8e-4f02-beaa-edac27ab1b74 NIWO_061.basePlot.ltr      D13   NIWO
## 8   500eb7f8-1881-4a10-bd41-cce84f3b3c47 NIWO_061.basePlot.ltr      D13   NIWO
## 9   aa0ce5fb-6c8f-42cb-a325-f8c6ab214cff NIWO_064.basePlot.ltr      D13   NIWO
## 10  a588a308-b670-4f07-8040-6980d6cfdb72 NIWO_064.basePlot.ltr      D13   NIWO
## 11  9df0737f-67f3-4d29-a1ec-8eab4ebc2726 NIWO_064.basePlot.ltr      D13   NIWO
## 12  53ec9ef3-bd18-4712-9517-4132649cafe7 NIWO_064.basePlot.ltr      D13   NIWO
## 13  57f5c94c-1655-4ea8-a492-64a660c26803 NIWO_064.basePlot.ltr      D13   NIWO
## 14  65134dbe-0a9d-446c-a600-4740f396c201 NIWO_064.basePlot.ltr      D13   NIWO
## 15  be43eacf-16e0-4f2b-b928-2bbf0de2f3c1 NIWO_064.basePlot.ltr      D13   NIWO
## 16  836b268d-5e2f-4781-8457-b7b622d13ccd NIWO_064.basePlot.ltr      D13   NIWO
## 17  0fc3a175-47a1-4bd3-9158-96d0ec3815f9 NIWO_067.basePlot.ltr      D13   NIWO
## 18  c9bb4c46-d98f-45de-9f17-8a2c608dfe79 NIWO_067.basePlot.ltr      D13   NIWO
## 19  4e6bbdd4-3151-4a05-8b77-f5757b11531b NIWO_067.basePlot.ltr      D13   NIWO
## 20  ebf1432e-c43e-48c1-ad32-ae4ce423808b NIWO_067.basePlot.ltr      D13   NIWO
## 21  9feeb756-46f9-4bf0-8e94-f2e856728889 NIWO_067.basePlot.ltr      D13   NIWO
## 22  edbee742-9d18-4c23-a097-d695a23a4e30 NIWO_067.basePlot.ltr      D13   NIWO
## 23  1537c343-14f2-4a75-b91d-c827dd529b55 NIWO_067.basePlot.ltr      D13   NIWO
## 24  e101681f-57df-44ca-8d24-b14496813e8c NIWO_067.basePlot.ltr      D13   NIWO
## 25  07780a1e-8af9-4b8a-bb9b-be8add15a1e0 NIWO_040.basePlot.ltr      D13   NIWO
## 26  4bca72cc-6f04-480b-95c9-4f55345f32bd NIWO_040.basePlot.ltr      D13   NIWO
## 27  b0be64dc-fb65-41e6-b9fa-30201c94606b NIWO_040.basePlot.ltr      D13   NIWO
## 28  6856b517-6d05-403c-893a-3dd8a7b30bff NIWO_040.basePlot.ltr      D13   NIWO
## 29  ba9800b5-b01d-4ad3-87fb-1e512c8dc17d NIWO_040.basePlot.ltr      D13   NIWO
## 30  f1a1cf1e-1f74-4500-81e3-d179dabed35c NIWO_040.basePlot.ltr      D13   NIWO
## 31  acf36093-4706-4dcb-be8c-d4d3a845548f NIWO_040.basePlot.ltr      D13   NIWO
## 32  1475c9b3-a732-4617-bffa-406b072d382e NIWO_040.basePlot.ltr      D13   NIWO
## 33  0f34060c-fc8a-4c8c-bd71-5836e9bbfb05 NIWO_040.basePlot.ltr      D13   NIWO
## 34  c1b97ed7-ff4e-4982-9e61-a41d0ab8cbbd NIWO_040.basePlot.ltr      D13   NIWO
## 35  f7577092-93be-4a42-9157-f2ee2b12318f NIWO_041.basePlot.ltr      D13   NIWO
## 36  99709f0e-3989-412e-a80d-6987d2ac54e9 NIWO_041.basePlot.ltr      D13   NIWO
## 37  4920d35f-624a-45cc-9c75-dac8f9f1d9f8 NIWO_063.basePlot.ltr      D13   NIWO
## 38  a1afcbb7-add9-4dd5-8feb-1b0a5e295fed NIWO_063.basePlot.ltr      D13   NIWO
## 39  9cf0463e-c60b-4619-8658-2ed071ae3dcd NIWO_063.basePlot.ltr      D13   NIWO
## 40  73a932ba-e4c5-4ca7-9f19-8d34ef1dea5a NIWO_063.basePlot.ltr      D13   NIWO
## 41  a94addfa-17fc-47cb-8d69-4af3903c8bec NIWO_063.basePlot.ltr      D13   NIWO
## 42  51b709df-af0d-441c-8835-b4bf2251ac17 NIWO_041.basePlot.ltr      D13   NIWO
## 43  cb0eb445-e514-468e-bcad-b6b4ae52ccba NIWO_041.basePlot.ltr      D13   NIWO
## 44  f7188915-7307-4a91-b71c-7e3ff38f7d0b NIWO_041.basePlot.ltr      D13   NIWO
```

```
## 45  c5b62b0f-e753-40e0-8cf3-e78d8a2c6c8a NIWO_041.basePlot.ltr      D13   NIWO
## 46  85a503a8-6817-4513-8a64-d780842d6947 NIWO_041.basePlot.ltr      D13   NIWO
## 47  1b049f51-fbda-4b62-83fb-652da4308f5a NIWO_041.basePlot.ltr      D13   NIWO
## 48  3f0a9383-16f4-4197-808c-55ac449b952d NIWO_047.basePlot.ltr      D13   NIWO
## 49  25fff36f-f181-4f62-8529-b419227909d2 NIWO_047.basePlot.ltr      D13   NIWO
## 50  ce1f0639-26a8-4a90-9df5-39549bfa412b NIWO_047.basePlot.ltr      D13   NIWO
## 51  028eea3d-5c20-4afc-bb7e-a05bab305152 NIWO_047.basePlot.ltr      D13   NIWO
## 52  89f98b92-bbc5-4a43-a852-46db48f6b16f NIWO_047.basePlot.ltr      D13   NIWO
## 53  fc47bdf8-99aa-4289-9158-6ebe5b4ccb06 NIWO_047.basePlot.ltr      D13   NIWO
## 54  88ae9d88-44fd-4ef3-ba99-bd5c0590b507 NIWO_047.basePlot.ltr      D13   NIWO
## 55  7dd99eca-b6ef-42f7-8ce1-672c1d4626a5 NIWO_047.basePlot.ltr      D13   NIWO
## 56  0cbcd7ab-3995-49c8-8a36-6361dee82bc6 NIWO_051.basePlot.ltr      D13   NIWO
## 57  2a87c5aa-60ab-4ba1-afe5-24e0b52aa7d8 NIWO_051.basePlot.ltr      D13   NIWO
## 58  491fba9a-a682-4f7c-ac22-5b01b759f734 NIWO_051.basePlot.ltr      D13   NIWO
## 59  ba4d7a74-4570-4317-bea1-69a81b8083bf NIWO_051.basePlot.ltr      D13   NIWO
## 60  cbf183ba-6177-4afc-88d6-328f37fd57d4 NIWO_051.basePlot.ltr      D13   NIWO
## 61  77a0a09f-c819-4e54-b322-0529fa585d02 NIWO_051.basePlot.ltr      D13   NIWO
## 62  e5bbc4fc-92d5-4fab-b151-3e9655678e65 NIWO_051.basePlot.ltr      D13   NIWO
## 63  0a6cae78-ea42-4e68-98c6-9d929068a38a NIWO_058.basePlot.ltr      D13   NIWO
## 64  80263145-05ab-4b6c-93d3-b058fd56a044 NIWO_058.basePlot.ltr      D13   NIWO
## 65  fe503f47-15a6-497f-b7dc-b865099d0faa NIWO_058.basePlot.ltr      D13   NIWO
## 66  76676d6a-bdd4-4764-b56f-1e8abd242d62 NIWO_058.basePlot.ltr      D13   NIWO
## 67  3eb148f7-219b-43ba-9d39-7c9ea4c6f569 NIWO_058.basePlot.ltr      D13   NIWO
## 68  fbc280eb-cd64-41d6-bb82-616d9b11a8a5 NIWO_058.basePlot.ltr      D13   NIWO
## 69  63867744-5cd5-4c61-96f1-e6522ea3ef55 NIWO_058.basePlot.ltr      D13   NIWO
## 70  ea74be18-c9ce-4708-8ad6-513be0e66a22 NIWO_058.basePlot.ltr      D13   NIWO
## 71  3933adbb-6a03-4a7b-b87f-74af1fd92b50 NIWO_058.basePlot.ltr      D13   NIWO
## 72  c6a43776-e89f-463b-b27a-fa7b5de8a334 NIWO_063.basePlot.ltr      D13   NIWO
## 73  b209072a-dc98-480b-b41c-1da05d97a137 NIWO_063.basePlot.ltr      D13   NIWO
## 74  9812f8f1-25bf-4b29-8a51-5762e99b7578 NIWO_046.basePlot.ltr      D13   NIWO
## 75  d2c18392-2022-4984-86e1-290749d371bc NIWO_046.basePlot.ltr      D13   NIWO
## 76  324775a3-4799-4496-b545-8770724212ed NIWO_046.basePlot.ltr      D13   NIWO
## 77  47c666c6-577b-4de5-90d1-972eb7dd7820 NIWO_046.basePlot.ltr      D13   NIWO
## 78  3195d37b-860c-400e-ab26-3cf08f034563 NIWO_046.basePlot.ltr      D13   NIWO
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## 1   NEON.LTR.NIWO061169.20180802.TWI       NEON.DOC.001710vE  Twigs/branches
## 2   NEON.LTR.NIWO061169.20180802.SDS       NEON.DOC.001710vE           Seeds
## 3   NEON.LTR.NIWO061169.20180802.WDY       NEON.DOC.001710vE  Woody material
## 4   NEON.LTR.NIWO061169.20180802.FLR       NEON.DOC.001710vE         Flowers
## 5   NEON.LTR.NIWO061169.20180802.WDY       NEON.DOC.001710vE  Woody material
## 6   NEON.LTR.NIWO061169.20180802.NDL       NEON.DOC.001710vE         Needles
## 7   NEON.LTR.NIWO061169.20180802.OTH       NEON.DOC.001710vE           Other
## 8   NEON.LTR.NIWO061169.20180802.LVS       NEON.DOC.001710vE          Leaves
## 9   NEON.LTR.NIWO064103.20180802.FLR       NEON.DOC.001710vE         Flowers
## 10  NEON.LTR.NIWO064103.20180802.WDY       NEON.DOC.001710vE  Woody material
## 11  NEON.LTR.NIWO064103.20180802.WDY       NEON.DOC.001710vE  Woody material
## 12  NEON.LTR.NIWO064103.20180802.LVS       NEON.DOC.001710vE          Leaves
## 13  NEON.LTR.NIWO064103.20180802.TWI       NEON.DOC.001710vE  Twigs/branches
## 14  NEON.LTR.NIWO064103.20180802.OTH       NEON.DOC.001710vE           Other
## 15  NEON.LTR.NIWO064103.20180802.SDS       NEON.DOC.001710vE           Seeds
## 16  NEON.LTR.NIWO064103.20180802.NDL       NEON.DOC.001710vE         Needles
## 17  NEON.LTR.NIWO067017.20180802.LVS       NEON.DOC.001710vE          Leaves
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## 18  NEON.LTR.NIWO067017.20180802.FLR      NEON.DOC.001710vE         Flowers
## 19  NEON.LTR.NIWO067017.20180802.OTH      NEON.DOC.001710vE           Other
## 20  NEON.LTR.NIWO067017.20180802.WDY      NEON.DOC.001710vE  Woody material
## 21  NEON.LTR.NIWO067017.20180802.TWI      NEON.DOC.001710vE  Twigs/branches
## 22  NEON.LTR.NIWO067017.20180802.NDL      NEON.DOC.001710vE         Needles
## 23  NEON.LTR.NIWO067017.20180802.MXT      NEON.DOC.001710vE           Mixed
## 24  NEON.LTR.NIWO067017.20180802.SDS      NEON.DOC.001710vE           Seeds
## 25  NEON.LTR.NIWO040205.20180802.OTH      NEON.DOC.001710vE           Other
## 26  NEON.LTR.NIWO040205.20180802.LVS      NEON.DOC.001710vE          Leaves
## 27  NEON.LTR.NIWO040205.20180802.TWI      NEON.DOC.001710vE  Twigs/branches
## 28  NEON.LTR.NIWO040205.20180802.MXT      NEON.DOC.001710vE           Mixed
## 29  NEON.LTR.NIWO040205.20180802.WDY      NEON.DOC.001710vE  Woody material
## 30  NEON.LTR.NIWO040205.20180802.NDL      NEON.DOC.001710vE         Needles
## 31  NEON.LTR.NIWO040205.20180802.FLR      NEON.DOC.001710vE         Flowers
## 32  NEON.LTR.NIWO040205.20180802.MXT      NEON.DOC.001710vE           Mixed
## 33  NEON.LTR.NIWO040205.20180802.NDL      NEON.DOC.001710vE         Needles
## 34  NEON.LTR.NIWO040205.20180802.SDS      NEON.DOC.001710vE           Seeds
## 35  NEON.LTR.NIWO041059.20180802.MXT      NEON.DOC.001710vE           Mixed
## 36  NEON.LTR.NIWO041059.20180802.SDS      NEON.DOC.001710vE           Seeds
## 37  NEON.LTR.NIWO063062.20180802.WDY      NEON.DOC.001710vE  Woody material
## 38  NEON.LTR.NIWO063062.20180802.NDL      NEON.DOC.001710vE         Needles
## 39  NEON.LTR.NIWO063062.20180802.TWI      NEON.DOC.001710vE  Twigs/branches
## 40  NEON.LTR.NIWO063062.20180802.LVS      NEON.DOC.001710vE          Leaves
## 41  NEON.LTR.NIWO063062.20180802.SDS      NEON.DOC.001710vE           Seeds
## 42  NEON.LTR.NIWO041059.20180802.FLR      NEON.DOC.001710vE         Flowers
## 43  NEON.LTR.NIWO041059.20180802.NDL      NEON.DOC.001710vE         Needles
## 44  NEON.LTR.NIWO041059.20180802.WDY      NEON.DOC.001710vE  Woody material
## 45  NEON.LTR.NIWO041059.20180802.OTH      NEON.DOC.001710vE           Other
## 46  NEON.LTR.NIWO041059.20180802.TWI      NEON.DOC.001710vE  Twigs/branches
## 47  NEON.LTR.NIWO041059.20180802.LVS      NEON.DOC.001710vE          Leaves
## 48  NEON.LTR.NIWO047197.20180802.LVS      NEON.DOC.001710vE          Leaves
## 49  NEON.LTR.NIWO047197.20180802.WDY      NEON.DOC.001710vE  Woody material
## 50  NEON.LTR.NIWO047197.20180802.NDL      NEON.DOC.001710vE         Needles
## 51  NEON.LTR.NIWO047197.20180802.FLR      NEON.DOC.001710vE         Flowers
## 52  NEON.LTR.NIWO047197.20180802.TWI      NEON.DOC.001710vE  Twigs/branches
## 53  NEON.LTR.NIWO047197.20180802.LVS      NEON.DOC.001710vE          Leaves
## 54  NEON.LTR.NIWO047197.20180802.OTH      NEON.DOC.001710vE           Other
## 55  NEON.LTR.NIWO047197.20180802.SDS      NEON.DOC.001710vE           Seeds
## 56  NEON.LTR.NIWO051045.20180802.LVS      NEON.DOC.001710vE          Leaves
## 57  NEON.LTR.NIWO051045.20180802.OTH      NEON.DOC.001710vE           Other
## 58  NEON.LTR.NIWO051045.20180802.TWI      NEON.DOC.001710vE  Twigs/branches
## 59  NEON.LTR.NIWO051045.20180802.NDL      NEON.DOC.001710vE         Needles
## 60  NEON.LTR.NIWO051045.20180802.WDY      NEON.DOC.001710vE  Woody material
## 61  NEON.LTR.NIWO051045.20180802.FLR      NEON.DOC.001710vE         Flowers
## 62  NEON.LTR.NIWO051045.20180802.SDS      NEON.DOC.001710vE           Seeds
## 63  NEON.LTR.NIWO058101.20180802.WDY      NEON.DOC.001710vE  Woody material
## 64  NEON.LTR.NIWO058101.20180802.NDL      NEON.DOC.001710vE         Needles
## 65  NEON.LTR.NIWO058101.20180802.TWI      NEON.DOC.001710vE  Twigs/branches
## 66  NEON.LTR.NIWO058101.20180802.NDL      NEON.DOC.001710vE         Needles
## 67  NEON.LTR.NIWO058101.20180802.OTH      NEON.DOC.001710vE           Other
## 68  NEON.LTR.NIWO058101.20180802.FLR      NEON.DOC.001710vE         Flowers
## 69  NEON.LTR.NIWO058101.20180802.LVS      NEON.DOC.001710vE          Leaves
## 70  NEON.LTR.NIWO058101.20180802.SDS      NEON.DOC.001710vE           Seeds
## 71  NEON.LTR.NIWO058101.20180802.OTH      NEON.DOC.001710vE           Other
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## 72  NEON.LTR.NIWO063062.20180802.OTH      NEON.DOC.001710vE           Other
## 73  NEON.LTR.NIWO063062.20180802.FLR      NEON.DOC.001710vE         Flowers
## 74  NEON.LTR.NIWO046155.20180802.NDL      NEON.DOC.001710vE         Needles
## 75  NEON.LTR.NIWO046155.20180802.LVS      NEON.DOC.001710vE          Leaves
## 76  NEON.LTR.NIWO046155.20180802.TWI      NEON.DOC.001710vE  Twigs/branches
## 77  NEON.LTR.NIWO046155.20180802.TWI      NEON.DOC.001710vE  Twigs/branches
## 78  NEON.LTR.NIWO046155.20180802.MXT      NEON.DOC.001710vE           Mixed
## 79  NEON.LTR.NIWO046155.20180802.OTH      NEON.DOC.001710vE           Other
## 80  NEON.LTR.NIWO046155.20180802.NDL      NEON.DOC.001710vE         Needles
## 81  NEON.LTR.NIWO046155.20180802.WDY      NEON.DOC.001710vE  Woody material
## 82  NEON.LTR.NIWO046155.20180802.FLR      NEON.DOC.001710vE         Flowers
## 83  NEON.LTR.NIWO046155.20180802.SDS      NEON.DOC.001710vE           Seeds
## 84  NEON.LTR.NIWO062050.20180802.SDS      NEON.DOC.001710vE           Seeds
## 85  NEON.LTR.NIWO062050.20180802.TWI      NEON.DOC.001710vE  Twigs/branches
## 86  NEON.LTR.NIWO062050.20180802.FLR      NEON.DOC.001710vE         Flowers
## 87  NEON.LTR.NIWO062050.20180802.LVS      NEON.DOC.001710vE          Leaves
## 88  NEON.LTR.NIWO062050.20180802.OTH      NEON.DOC.001710vE           Other
## 89  NEON.LTR.NIWO062050.20180802.NDL      NEON.DOC.001710vE         Needles
## 90  NEON.LTR.NIWO062050.20180802.WDY      NEON.DOC.001710vE  Woody material
## 91  NEON.LTR.NIWO061169.20180802.NDL      NEON.DOC.001710vE         Needles
## 92  NEON.LTR.NIWO040205.20180830.MXT      NEON.DOC.001710vE           Mixed
## 93  NEON.LTR.NIWO041059.20180830.LVS      NEON.DOC.001710vE          Leaves
## 94  NEON.LTR.NIWO041059.20180830.NDL      NEON.DOC.001710vE         Needles
## 95  NEON.LTR.NIWO041059.20180830.FLR      NEON.DOC.001710vE         Flowers
## 96  NEON.LTR.NIWO041059.20180830.SDS      NEON.DOC.001710vE           Seeds
## 97  NEON.LTR.NIWO041059.20180830.MXT      NEON.DOC.001710vE           Mixed
## 98  NEON.LTR.NIWO041059.20180830.OTH      NEON.DOC.001710vE           Other
## 99  NEON.LTR.NIWO041059.20180830.MXT      NEON.DOC.001710vE           Mixed
## 100 NEON.LTR.NIWO041059.20180830.WDY      NEON.DOC.001710vE  Woody material
## 101 NEON.LTR.NIWO041059.20180830.TWI      NEON.DOC.001710vE  Twigs/branches
## 102 NEON.LTR.NIWO041059.20180830.NDL      NEON.DOC.001710vE         Needles
## 103 NEON.LTR.NIWO041059.20180830.TWI      NEON.DOC.001710vE  Twigs/branches
## 104 NEON.LTR.NIWO047197.20180830.OTH      NEON.DOC.001710vE           Other
## 105 NEON.LTR.NIWO047197.20180830.SDS      NEON.DOC.001710vE           Seeds
## 106 NEON.LTR.NIWO047197.20180830.LVS      NEON.DOC.001710vE          Leaves
## 107 NEON.LTR.NIWO047197.20180830.FLR      NEON.DOC.001710vE         Flowers
## 108 NEON.LTR.NIWO047197.20180830.NDL      NEON.DOC.001710vE         Needles
## 109 NEON.LTR.NIWO047197.20180830.TWI      NEON.DOC.001710vE  Twigs/branches
## 110 NEON.LTR.NIWO047197.20180830.WDY      NEON.DOC.001710vE  Woody material
## 111 NEON.LTR.NIWO051045.20180830.SDS      NEON.DOC.001710vE           Seeds
## 112 NEON.LTR.NIWO051045.20180830.OTH      NEON.DOC.001710vE           Other
## 113 NEON.LTR.NIWO051045.20180830.NDL      NEON.DOC.001710vE         Needles
## 114 NEON.LTR.NIWO051045.20180830.TWI      NEON.DOC.001710vE  Twigs/branches
## 115 NEON.LTR.NIWO051045.20180830.LVS      NEON.DOC.001710vE          Leaves
## 116 NEON.LTR.NIWO051045.20180830.WDY      NEON.DOC.001710vE  Woody material
## 117 NEON.LTR.NIWO051045.20180830.FLR      NEON.DOC.001710vE         Flowers
## 118 NEON.LTR.NIWO058101.20180830.WDY      NEON.DOC.001710vE  Woody material
## 119 NEON.LTR.NIWO058101.20180830.OTH      NEON.DOC.001710vE           Other
## 120 NEON.LTR.NIWO058101.20180830.SDS      NEON.DOC.001710vE           Seeds
## 121 NEON.LTR.NIWO058101.20180830.FLR      NEON.DOC.001710vE         Flowers
## 122 NEON.LTR.NIWO058101.20180830.NDL      NEON.DOC.001710vE         Needles
## 123 NEON.LTR.NIWO058101.20180830.LVS      NEON.DOC.001710vE          Leaves
## 124 NEON.LTR.NIWO058101.20180830.TWI      NEON.DOC.001710vE  Twigs/branches
## 125 NEON.LTR.NIWO063062.20180830.SDS      NEON.DOC.001710vE           Seeds
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## 126 NEON.LTR.NIWO063062.20180830.NDL      NEON.DOC.001710vE         Needles
## 127 NEON.LTR.NIWO063062.20180830.LVS      NEON.DOC.001710vE          Leaves
## 128 NEON.LTR.NIWO063062.20180830.FLR      NEON.DOC.001710vE         Flowers
## 129 NEON.LTR.NIWO063062.20180830.WDY      NEON.DOC.001710vE  Woody material
## 130 NEON.LTR.NIWO063062.20180830.TWI      NEON.DOC.001710vE  Twigs/branches
## 131 NEON.LTR.NIWO063062.20180830.OTH      NEON.DOC.001710vE           Other
## 132 NEON.LTR.NIWO046155.20180830.LVS      NEON.DOC.001710vE          Leaves
## 133 NEON.LTR.NIWO046155.20180830.NDL      NEON.DOC.001710vE         Needles
## 134 NEON.LTR.NIWO046155.20180830.OTH      NEON.DOC.001710vE           Other
## 135 NEON.LTR.NIWO046155.20180830.WDY      NEON.DOC.001710vE  Woody material
## 136 NEON.LTR.NIWO046155.20180830.SDS      NEON.DOC.001710vE           Seeds
## 137 NEON.LTR.NIWO046155.20180830.TWI      NEON.DOC.001710vE  Twigs/branches
## 138 NEON.LTR.NIWO046155.20180830.FLR      NEON.DOC.001710vE         Flowers
## 139 NEON.LTR.NIWO046155.20180830.TWI      NEON.DOC.001710vE  Twigs/branches
## 140 NEON.LTR.NIWO062050.20180830.SDS      NEON.DOC.001710vE           Seeds
## 141 NEON.LTR.NIWO062050.20180830.FLR      NEON.DOC.001710vE         Flowers
## 142 NEON.LTR.NIWO062050.20180830.LVS      NEON.DOC.001710vE          Leaves
## 143 NEON.LTR.NIWO062050.20180830.WDY      NEON.DOC.001710vE  Woody material
## 144 NEON.LTR.NIWO062050.20180830.OTH      NEON.DOC.001710vE           Other
## 145 NEON.LTR.NIWO062050.20180830.TWI      NEON.DOC.001710vE  Twigs/branches
## 146 NEON.LTR.NIWO062050.20180830.NDL      NEON.DOC.001710vE         Needles
## 147 NEON.LTR.NIWO061169.20180830.OTH      NEON.DOC.001710vE           Other
## 148 NEON.LTR.NIWO061169.20180830.TWI      NEON.DOC.001710vE  Twigs/branches
## 149 NEON.LTR.NIWO061169.20180830.WDY      NEON.DOC.001710vE  Woody material
## 150 NEON.LTR.NIWO061169.20180830.FLR      NEON.DOC.001710vE         Flowers
## 151 NEON.LTR.NIWO061169.20180830.TWI      NEON.DOC.001710vE  Twigs/branches
## 152 NEON.LTR.NIWO061169.20180830.SDS      NEON.DOC.001710vE           Seeds
## 153 NEON.LTR.NIWO061169.20180830.LVS      NEON.DOC.001710vE          Leaves
## 154 NEON.LTR.NIWO061169.20180830.NDL      NEON.DOC.001710vE         Needles
## 155 NEON.LTR.NIWO064103.20180830.WDY      NEON.DOC.001710vE  Woody material
## 156 NEON.LTR.NIWO064103.20180830.WDY      NEON.DOC.001710vE  Woody material
## 157 NEON.LTR.NIWO064103.20180830.LVS      NEON.DOC.001710vE          Leaves
## 158 NEON.LTR.NIWO064103.20180830.FLR      NEON.DOC.001710vE         Flowers
## 159 NEON.LTR.NIWO064103.20180830.SDS      NEON.DOC.001710vE           Seeds
## 160 NEON.LTR.NIWO064103.20180830.OTH      NEON.DOC.001710vE           Other
## 161 NEON.LTR.NIWO064103.20180830.NDL      NEON.DOC.001710vE         Needles
## 162 NEON.LTR.NIWO064103.20180830.TWI      NEON.DOC.001710vE  Twigs/branches
## 163 NEON.LTR.NIWO057081.20180830.NDL      NEON.DOC.001710vE         Needles
## 164 NEON.LTR.NIWO057081.20180830.FLR      NEON.DOC.001710vE         Flowers
## 165 NEON.LTR.NIWO057081.20180830.SDS      NEON.DOC.001710vE           Seeds
## 166 NEON.LTR.NIWO057081.20180830.OTH      NEON.DOC.001710vE           Other
## 167 NEON.LTR.NIWO057081.20180830.LVS      NEON.DOC.001710vE          Leaves
## 168 NEON.LTR.NIWO057081.20180830.TWI      NEON.DOC.001710vE  Twigs/branches
## 169 NEON.LTR.NIWO057081.20180830.TWI      NEON.DOC.001710vE  Twigs/branches
## 170 NEON.LTR.NIWO057081.20180830.WDY      NEON.DOC.001710vE  Woody material
## 171 NEON.LTR.NIWO067017.20180830.NDL      NEON.DOC.001710vE         Needles
## 172 NEON.LTR.NIWO067017.20180830.OTH      NEON.DOC.001710vE           Other
## 173 NEON.LTR.NIWO067017.20180830.LVS      NEON.DOC.001710vE          Leaves
## 174 NEON.LTR.NIWO067017.20180830.WDY      NEON.DOC.001710vE  Woody material
## 175 NEON.LTR.NIWO067017.20180830.NDL      NEON.DOC.001710vE         Needles
## 176 NEON.LTR.NIWO067017.20180830.FLR      NEON.DOC.001710vE         Flowers
## 177 NEON.LTR.NIWO067017.20180830.SDS      NEON.DOC.001710vE           Seeds
## 178 NEON.LTR.NIWO067017.20180830.TWI      NEON.DOC.001710vE  Twigs/branches
## 179 NEON.LTR.NIWO067017.20180830.MXT      NEON.DOC.001710vE           Mixed
```

```
## 180 NEON.LTR.NIWO040205.20180830.SDS       NEON.DOC.001710vE           Seeds
## 181 NEON.LTR.NIWO040205.20180830.WDY       NEON.DOC.001710vE  Woody material
## 182 NEON.LTR.NIWO040205.20180830.OTH       NEON.DOC.001710vE           Other
## 183 NEON.LTR.NIWO040205.20180830.LVS       NEON.DOC.001710vE          Leaves
## 184 NEON.LTR.NIWO040205.20180830.NDL       NEON.DOC.001710vE         Needles
## 185 NEON.LTR.NIWO040205.20180830.TWI       NEON.DOC.001710vE  Twigs/branches
## 186 NEON.LTR.NIWO040205.20180830.MXT       NEON.DOC.001710vE           Mixed
## 187 NEON.LTR.NIWO040205.20180830.NDL       NEON.DOC.001710vE         Needles
## 188 NEON.LTR.NIWO040205.20180830.FLR       NEON.DOC.001710vE         Flowers
##     dryMass qaDryMass remarks                  measuredBy
## 1     0.400         N      NA kstyers@battelleecology.org
## 2     0.005         N      NA kstyers@battelleecology.org
## 3     0.040         Y      NA kstyers@battelleecology.org
## 4     0.005         N      NA kstyers@battelleecology.org
## 5     0.070         N      NA kstyers@battelleecology.org
## 6     1.000         N      NA kstyers@battelleecology.org
## 7     0.200         N      NA kstyers@battelleecology.org
## 8     0.005         N      NA kstyers@battelleecology.org
## 9     0.190         N      NA kstyers@battelleecology.org
## 10    1.180         Y      NA kstyers@battelleecology.org
## 11    1.180         N      NA kstyers@battelleecology.org
## 12    0.000         N      NA kstyers@battelleecology.org
## 13    0.005         N      NA kstyers@battelleecology.org
## 14    0.350         N      NA kstyers@battelleecology.org
## 15    0.000         N      NA kstyers@battelleecology.org
## 16    3.060         N      NA kstyers@battelleecology.org
## 17    0.000         N      NA kstyers@battelleecology.org
## 18    0.005         N      NA kstyers@battelleecology.org
## 19    0.040         N      NA kstyers@battelleecology.org
## 20    0.005         N      NA kstyers@battelleecology.org
## 21    0.005         N      NA kstyers@battelleecology.org
## 22    0.930         N      NA kstyers@battelleecology.org
## 23    0.000         N      NA kstyers@battelleecology.org
## 24    0.005         N      NA kstyers@battelleecology.org
## 25    0.000         N      NA kstyers@battelleecology.org
## 26    0.000         N      NA kstyers@battelleecology.org
## 27    0.720         N      NA kstyers@battelleecology.org
## 28    2.120         Y      NA kstyers@battelleecology.org
## 29    0.000         N      NA kstyers@battelleecology.org
## 30    3.240         N      NA kstyers@battelleecology.org
## 31    0.240         N      NA kstyers@battelleecology.org
## 32    2.170         N      NA kstyers@battelleecology.org
## 33    3.160         Y      NA kstyers@battelleecology.org
## 34    0.000         N      NA kstyers@battelleecology.org
## 35    0.170         N      NA kstyers@battelleecology.org
## 36    0.000         N      NA kstyers@battelleecology.org
## 37    0.005         N      NA kstyers@battelleecology.org
## 38    0.240         N      NA kstyers@battelleecology.org
## 39    0.060         N      NA kstyers@battelleecology.org
## 40    0.000         N      NA kstyers@battelleecology.org
## 41    0.000         N      NA kstyers@battelleecology.org
## 42    0.005         N      NA kstyers@battelleecology.org
## 43    1.790         N      NA kstyers@battelleecology.org
## 44    0.005         N      NA kstyers@battelleecology.org
```

```
## 45    0.000         N      NA kstyers@battelleecology.org
## 46    0.005         N      NA kstyers@battelleecology.org
## 47    0.005         N      NA kstyers@battelleecology.org
## 48    0.005         Y      NA kstyers@battelleecology.org
## 49    0.000         N      NA kstyers@battelleecology.org
## 50    0.030         N      NA kstyers@battelleecology.org
## 51    0.000         N      NA kstyers@battelleecology.org
## 52    0.000         N      NA kstyers@battelleecology.org
## 53    0.005         N      NA kstyers@battelleecology.org
## 54    0.005         N      NA kstyers@battelleecology.org
## 55    0.000         N      NA kstyers@battelleecology.org
## 56    0.000         N      NA kstyers@battelleecology.org
## 57    0.005         N      NA kstyers@battelleecology.org
## 58    0.050         N      NA kstyers@battelleecology.org
## 59    0.470         N      NA kstyers@battelleecology.org
## 60    0.005         N      NA kstyers@battelleecology.org
## 61    0.005         N      NA kstyers@battelleecology.org
## 62    0.000         N      NA kstyers@battelleecology.org
## 63    0.005         N      NA kstyers@battelleecology.org
## 64    1.640         N      NA kstyers@battelleecology.org
## 65    0.000         N      NA kstyers@battelleecology.org
## 66    1.670         Y      NA kstyers@battelleecology.org
## 67    0.005         N      NA kstyers@battelleecology.org
## 68    0.000         N      NA kstyers@battelleecology.org
## 69    0.000         N      NA kstyers@battelleecology.org
## 70    0.000         N      NA kstyers@battelleecology.org
## 71    0.005         Y      NA kstyers@battelleecology.org
## 72    0.005         N      NA kstyers@battelleecology.org
## 73    0.000         N      NA kstyers@battelleecology.org
## 74    3.920         Y      NA kstyers@battelleecology.org
## 75    0.000         N      NA kstyers@battelleecology.org
## 76    0.630         N      NA kstyers@battelleecology.org
## 77    0.630         Y      NA kstyers@battelleecology.org
## 78    0.090         N      NA kstyers@battelleecology.org
## 79    0.000         N      NA kstyers@battelleecology.org
## 80    3.920         N      NA kstyers@battelleecology.org
## 81    0.030         N      NA kstyers@battelleecology.org
## 82    0.020         N      NA kstyers@battelleecology.org
## 83    0.000         N      NA kstyers@battelleecology.org
## 84    0.000         N      NA kstyers@battelleecology.org
## 85    0.000         N      NA kstyers@battelleecology.org
## 86    0.000         N      NA kstyers@battelleecology.org
## 87    0.000         N      NA kstyers@battelleecology.org
## 88    0.080         N      NA kstyers@battelleecology.org
## 89    0.320         N      NA kstyers@battelleecology.org
## 90    0.005         N      NA kstyers@battelleecology.org
## 91    1.000         Y      NA kstyers@battelleecology.org
## 92    0.610         Y      NA szrillo@battelleecology.org
## 93    0.000         N      NA szrillo@battelleecology.org
## 94    8.630         Y      NA szrillo@battelleecology.org
## 95    0.005         N      NA szrillo@battelleecology.org
## 96    0.005         N      NA szrillo@battelleecology.org
## 97    1.910         Y      NA szrillo@battelleecology.org
## 98    0.000         N      NA szrillo@battelleecology.org
```

```
## 99    1.900         N      NA szrillo@battelleecology.org
## 100   0.140         N      NA szrillo@battelleecology.org
## 101   0.340         Y      NA szrillo@battelleecology.org
## 102   8.620         N      NA szrillo@battelleecology.org
## 103   0.340         N      NA szrillo@battelleecology.org
## 104   0.005         N      NA szrillo@battelleecology.org
## 105   0.000         N      NA szrillo@battelleecology.org
## 106   0.000         N      NA szrillo@battelleecology.org
## 107   0.000         N      NA szrillo@battelleecology.org
## 108   0.420         N      NA szrillo@battelleecology.org
## 109   0.000         N      NA szrillo@battelleecology.org
## 110   0.005         N      NA szrillo@battelleecology.org
## 111   0.000         N      NA szrillo@battelleecology.org
## 112   0.010         N      NA szrillo@battelleecology.org
## 113   0.900         N      NA szrillo@battelleecology.org
## 114   0.020         N      NA szrillo@battelleecology.org
## 115   0.000         N      NA szrillo@battelleecology.org
## 116   0.005         N      NA szrillo@battelleecology.org
## 117   0.000         N      NA szrillo@battelleecology.org
## 118   0.000         N      NA szrillo@battelleecology.org
## 119   0.005         N      NA szrillo@battelleecology.org
## 120   0.000         N      NA szrillo@battelleecology.org
## 121   0.030         N      NA szrillo@battelleecology.org
## 122   2.820         N      NA szrillo@battelleecology.org
## 123   0.000         N      NA szrillo@battelleecology.org
## 124   0.000         N      NA szrillo@battelleecology.org
## 125   0.000         N      NA szrillo@battelleecology.org
## 126   0.300         N      NA szrillo@battelleecology.org
## 127   0.005         N      NA szrillo@battelleecology.org
## 128   0.005         N      NA szrillo@battelleecology.org
## 129   0.000         N      NA szrillo@battelleecology.org
## 130   0.200         N      NA szrillo@battelleecology.org
## 131   0.000         N      NA szrillo@battelleecology.org
## 132   0.000         N      NA szrillo@battelleecology.org
## 133   7.000         N      NA szrillo@battelleecology.org
## 134   0.110         N      NA szrillo@battelleecology.org
## 135   0.090         N      NA szrillo@battelleecology.org
## 136   0.000         N      NA szrillo@battelleecology.org
## 137   1.050         Y      NA szrillo@battelleecology.org
## 138   0.005         N      NA szrillo@battelleecology.org
## 139   1.050         N      NA szrillo@battelleecology.org
## 140   0.005         N      NA szrillo@battelleecology.org
## 141   0.005         N      NA szrillo@battelleecology.org
## 142   0.060         N      NA szrillo@battelleecology.org
## 143   0.050         N      NA szrillo@battelleecology.org
## 144   0.090         N      NA szrillo@battelleecology.org
## 145   0.000         N      NA szrillo@battelleecology.org
## 146   3.980         N      NA szrillo@battelleecology.org
## 147   0.110         N      NA szrillo@battelleecology.org
## 148   0.060         Y      NA szrillo@battelleecology.org
## 149   0.150         N      NA szrillo@battelleecology.org
## 150   0.060         N      NA szrillo@battelleecology.org
## 151   0.020         N      NA szrillo@battelleecology.org
## 152   0.000         N      NA szrillo@battelleecology.org
```

```
## 153   0.000         N      NA szrillo@battelleecology.org
## 154   1.530         N      NA szrillo@battelleecology.org
## 155   0.010         Y      NA szrillo@battelleecology.org
## 156   0.010         N      NA szrillo@battelleecology.org
## 157   0.005         N      NA szrillo@battelleecology.org
## 158   0.110         N      NA szrillo@battelleecology.org
## 159   0.000         N      NA szrillo@battelleecology.org
## 160   0.080         N      NA szrillo@battelleecology.org
## 161   2.820         N      NA szrillo@battelleecology.org
## 162   0.000         N      NA szrillo@battelleecology.org
## 163   4.090         N      NA szrillo@battelleecology.org
## 164   0.070         N      NA szrillo@battelleecology.org
## 165   0.000         N      NA szrillo@battelleecology.org
## 166   0.290         N      NA szrillo@battelleecology.org
## 167   0.000         N      NA szrillo@battelleecology.org
## 168   5.840         N      NA szrillo@battelleecology.org
## 169   5.870         Y      NA szrillo@battelleecology.org
## 170   0.320         N      NA szrillo@battelleecology.org
## 171   2.280         N      NA szrillo@battelleecology.org
## 172   0.000         N      NA szrillo@battelleecology.org
## 173   0.000         N      NA szrillo@battelleecology.org
## 174   0.005         N      NA szrillo@battelleecology.org
## 175   2.290         Y      NA szrillo@battelleecology.org
## 176   0.005         N      NA szrillo@battelleecology.org
## 177   0.000         N      NA szrillo@battelleecology.org
## 178   0.150         N      NA szrillo@battelleecology.org
## 179   0.070         N      NA szrillo@battelleecology.org
## 180   0.005         N      NA szrillo@battelleecology.org
## 181   0.980         N      NA szrillo@battelleecology.org
## 182   0.000         N      NA szrillo@battelleecology.org
## 183   0.000         N      NA szrillo@battelleecology.org
## 184   4.550         Y      NA szrillo@battelleecology.org
## 185   0.000         N      NA szrillo@battelleecology.org
## 186   0.610         N      NA szrillo@battelleecology.org
## 187   4.530         N      NA szrillo@battelleecology.org
## 188   0.150         N      NA szrillo@battelleecology.org
```

```
summary(Litter)
```

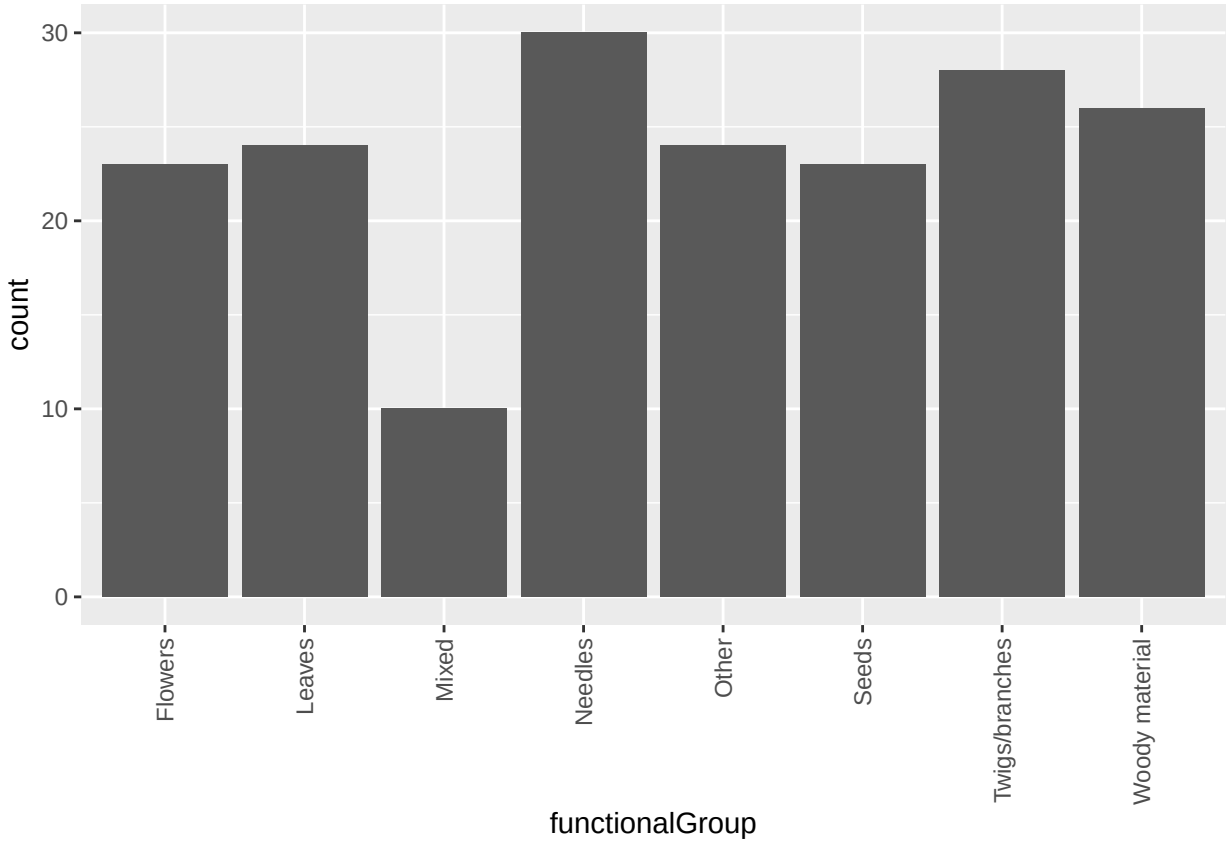
```
##                                     uid                    namedLocation
##  028eea3d-5c20-4afc-bb7e-a05bab305152:  1   NIWO_040.basePlot.ltr:20
##  06789d7b-b742-41d9-8556-79d23c193dc0:  1   NIWO_041.basePlot.ltr:19
##  07780a1e-8af9-4b8a-bb9b-be8add15a1e0:  1   NIWO_046.basePlot.ltr:18
##  0a6cae78-ea42-4e68-98c6-9d929068a38a:  1   NIWO_061.basePlot.ltr:17
##  0ae1c621-387e-42a9-bcf3-7ad1c9b97ab4:  1   NIWO_067.basePlot.ltr:17
##  0b274782-8e52-4f6a-bb17-36daa821f929:  1   NIWO_058.basePlot.ltr:16
##  (Other)                              :182   (Other)              :81
##  domainID   siteID         plotID            trapID        weighDate
##  D13:188   NIWO:188   NIWO_040:20   NIWO_040_205:20   2018-08-06:91
##                       NIWO_041:19   NIWO_041_059:19   2018-09-05:97
##                       NIWO_046:18   NIWO_046_155:18
##                       NIWO_061:17   NIWO_061_169:17
##                       NIWO_067:17   NIWO_067_017:17
##                       NIWO_058:16   NIWO_058_101:16
```

```
##                       (Other) :81   (Other)     :81
##        setDate    collectDate                   ovenStartDate
##  2018-07-05:91   Min.   :2018-08-02   2018-08-02T21:00Z:91
##  2018-08-02:97   1st Qu.:2018-08-02   2018-08-30T22:30Z:97
##                  Median :2018-08-16
##                  Mean   :2018-08-16
##                  3rd Qu.:2018-08-30
##                  Max.   :2018-08-30
##
##             ovenEndDate                       fieldSampleID
##  2018-08-06T18:02Z:91   NEON.LTR.NIWO041059.20180830: 11
##  2018-09-05T19:30Z:97   NEON.LTR.NIWO040205.20180802: 10
##                         NEON.LTR.NIWO040205.20180830: 10
##                         NEON.LTR.NIWO046155.20180802: 10
##                         NEON.LTR.NIWO058101.20180802:  9
##                         NEON.LTR.NIWO061169.20180802:  9
##                         (Other)                     :129
##                            massSampleID      samplingProtocolVersion
##  NEON.LTR.NIWO040205.20180802.MXT:  2   NEON.DOC.001710vE:188
##  NEON.LTR.NIWO040205.20180802.NDL:  2
##  NEON.LTR.NIWO040205.20180830.MXT:  2
##  NEON.LTR.NIWO040205.20180830.NDL:  2
##  NEON.LTR.NIWO041059.20180830.MXT:  2
##  NEON.LTR.NIWO041059.20180830.NDL:  2
##  (Other)                          :176
##        functionalGroup    dryMass       qaDryMass remarks
##  Needles       :30     Min.   :0.0000   N:168     Mode:logical
##  Twigs/branches:28     1st Qu.:0.0000   Y: 20     NA's:188
##  Woody material:26     Median :0.0050
##  Leaves        :24     Mean   :0.6115
##  Other         :24     3rd Qu.:0.3200
##  Flowers       :23     Max.   :8.6300
##  (Other)       :33
##                        measuredBy
##  kstyers@battelleecology.org:91
##  szrillo@battelleecology.org:97
##
##
##
##
##
```

Answer: 188 plots were sampled when looking at the data in the environment. 'unique' gets rid of duplicate counts in data to help get a clearer understanding of the data, there weren't any so there was no difference.

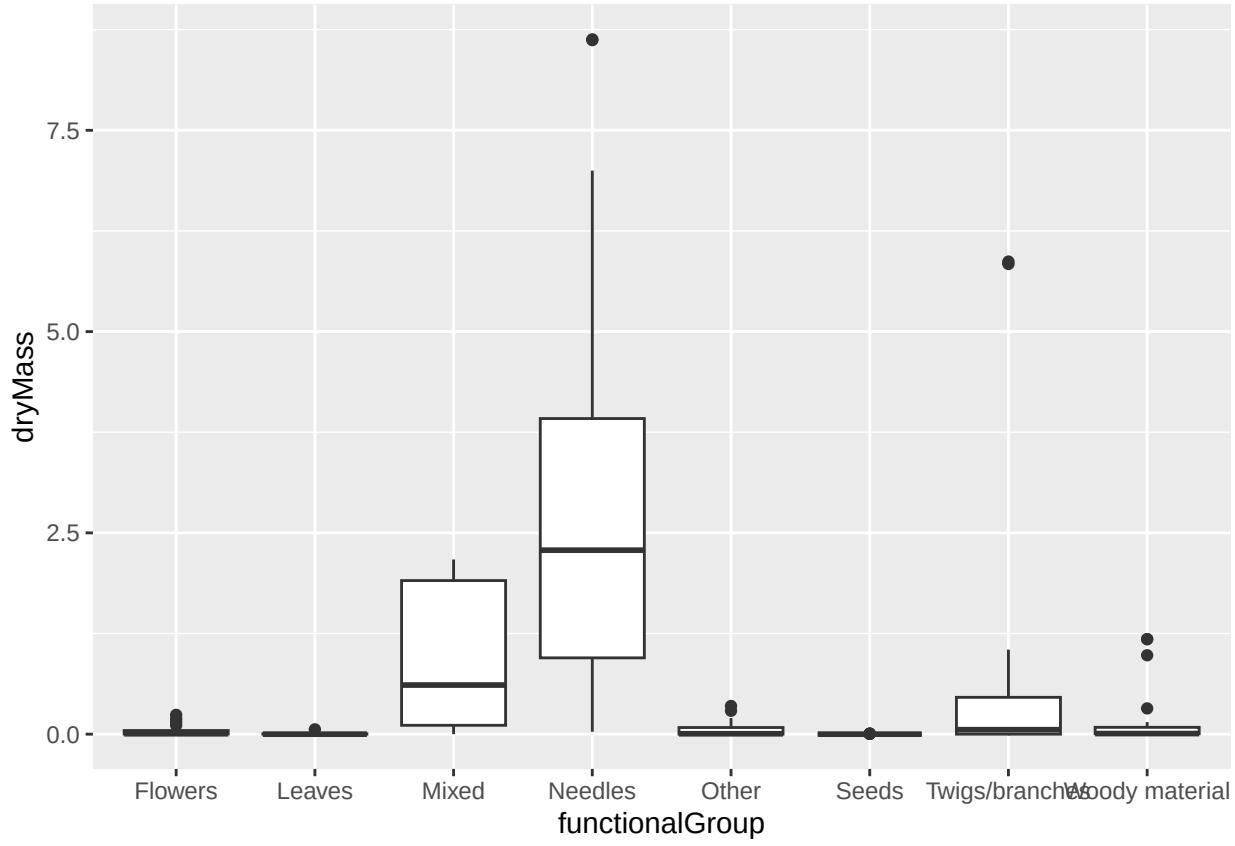
14. Create a bar graph of functionalGroup counts. This shows you what type of litter is collected at the Niwot Ridge sites. Notice that litter types are fairly equally distributed across the Niwot Ridge sites.

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

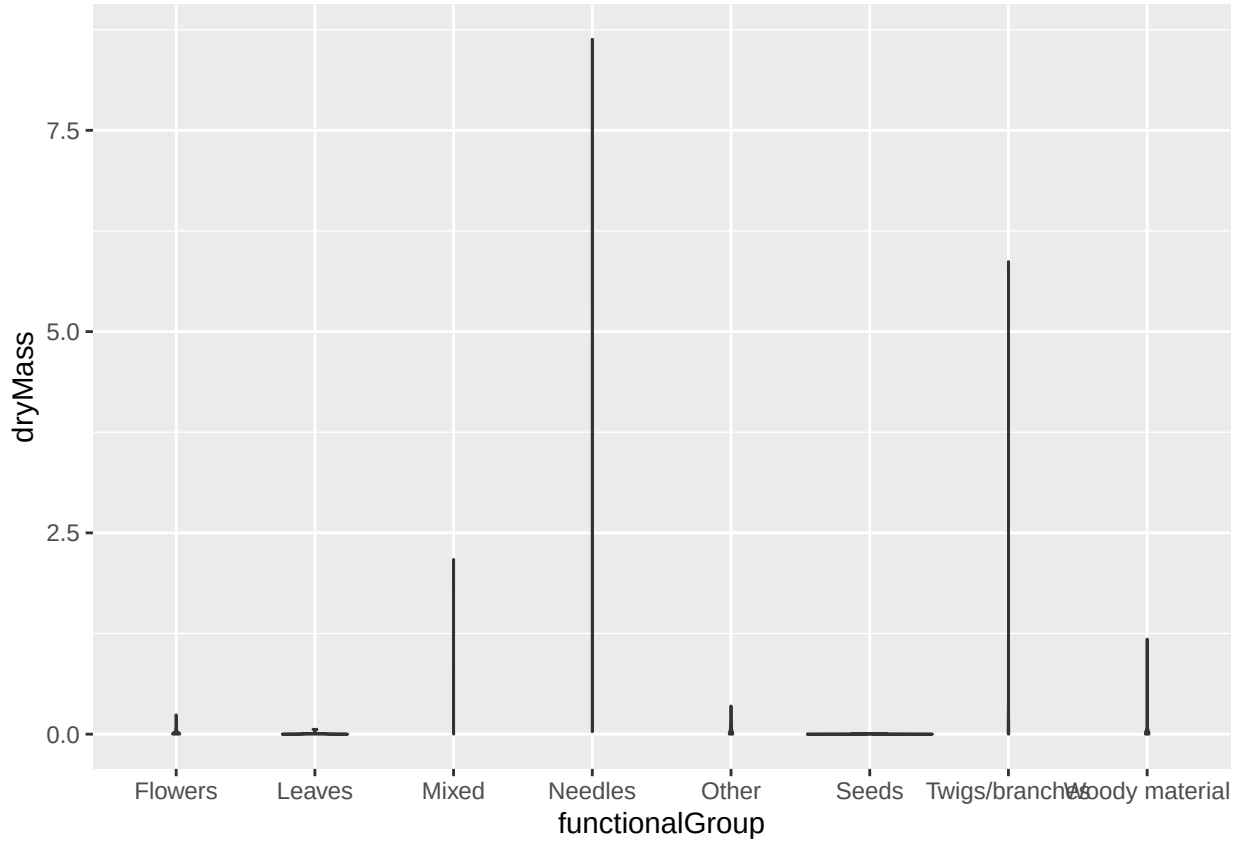


15. Using `geom_boxplot` and `geom_violin`, create a boxplot and a violin plot of dryMass by functionalGroup.

```
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 box plot is more effective at visualizing the data compared to the violin plot as it effectively shows the distribution of the range of the data vertically. The violin plot widths aren't very visual horizontally.

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

> Answer: Needles and somewhat mixed and twigs/branches.