

# 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.

---

```
file.rename("A03_DataExploration.Rmd", "XuanchengGuo_A03_DataExploration.Rmd")
```

```
## Warning in file.rename("A03_DataExploration.Rmd",  
## "XuanchengGuo_A03_DataExploration.Rmd"): cannot rename file  
## 'A03_DataExploration.Rmd' to 'XuanchengGuo_A03_DataExploration.Rmd', reason 'No  
## such file or directory'  
  
## [1] FALSE
```

## 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.

```

# Loading datasets
getwd()

## [1] "/home/guest/EDA_Spring2024"

install.packages("tidyverse")

## Warning: package 'tidyverse' is not available for this version of R
##
## A version of this package for your version of R might be available elsewhere,
## see the ideas at
## https://cran.r-project.org/doc/manuals/r-patched/R-admin.html#Installing-packages

install.packages("lubridate")
install.packages("tinytex")
library(tidyverse)
library(lubridate)
library(tinytex)

# Naming datasets
Neonics <- read.csv("./Data/Raw/ECOTOX_Neonicotinoids_Insects_raw.csv", stringsAsFactors = TRUE)

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

```

## Learn about your system

2. The neonicotinoid dataset was collected from the Environmental Protection Agency's ECOTOX Knowledgebase, a database for ecotoxicology research. Neonicotinoids are a class of insecticides used widely in agriculture. The dataset that has been pulled includes all studies published on insects. Why might we be interested in the ecotoxicology of neonicotinoids on insects? Feel free to do a brief internet search if you feel you need more background information.

Answer: Because Neonicotinoids are widely used in agriculture, we might want to understand how that influence each type of crop and how these influence might transfer to human beings.

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: Forest litter and woody debris are a major source of nutrients for forest system. By focusing on LTER's data, we can further understand how these nutrients influence ecosystem in Colorado.

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. One pair of litter trap (one elevated and one grounded) is deployed every 400 m<sup>2</sup> plot area. Plot edge must be separated 150% of one edge to another. 2. Trap placement within plots may be either targeted or randomized, depending on the vegetation. 3. In sites with forested tower airsheds, the litter sampling is targeted to take place in 20 40m x 40m plots. In sites with low-statured vegetation over the tower airsheds, litter sampling is targeted to take place in 4 40m x 40m tower plots (to accommodate co-located soil sampling) plus 26 20m x 20m plots.

## Obtain basic summaries of your data (Neonics)

5. What are the dimensions of the dataset?

```
dimension_Neo <- dim(Neonics)
dimension_Neo
```

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

6. Using the `summary` function on the “Effect” column, determine the most common effects that are studied. Why might these effects specifically be of interest?

```
summary(Neonics$Effect)
```

```
##      Accumulation      Avoidance      Behavior      Biochemistry
##           12           102           360           11
##      Cell(s)      Development      Enzyme(s)      Feeding behavior
##           9           136           62           255
##      Genetics      Growth      Histology      Hormone(s)
##          82           38           5           1
##      Immunological      Intoxication      Morphology      Mortality
##          16           12           22           1493
##      Physiology      Population      Reproduction
##           7           1803           197
```

Answer: The most common effects studied is “Population”, followed by “Mortality”. These two are two major statistic result that can use to understand how effective is our design and treatment.

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...]

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

```
##      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 Woolly 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

```
common_species_studied[1:6]
```

##		Honey Bee		Parasitic Wasp		Buff Tailed Bumblebee
##		667		285		183
##		Carniolan Honey Bee		Bumble Bee		Italian Honeybee
##		152		140		113

Answer: The top six species studied are “Honey Bee”, “Parasitic Wasp”, “Buff Tailed Bumblebee”, “Carniolan Honey Bee”, “Bumble Bee”, and “Italian Honeybee”. They have multiple things in common that researchers might be interested in: They all pollinate flowers and produce honey. These species also share relatively similar diets.

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

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

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

Answer: The variable is a factor because they only represent qualitative result rather than numeric.

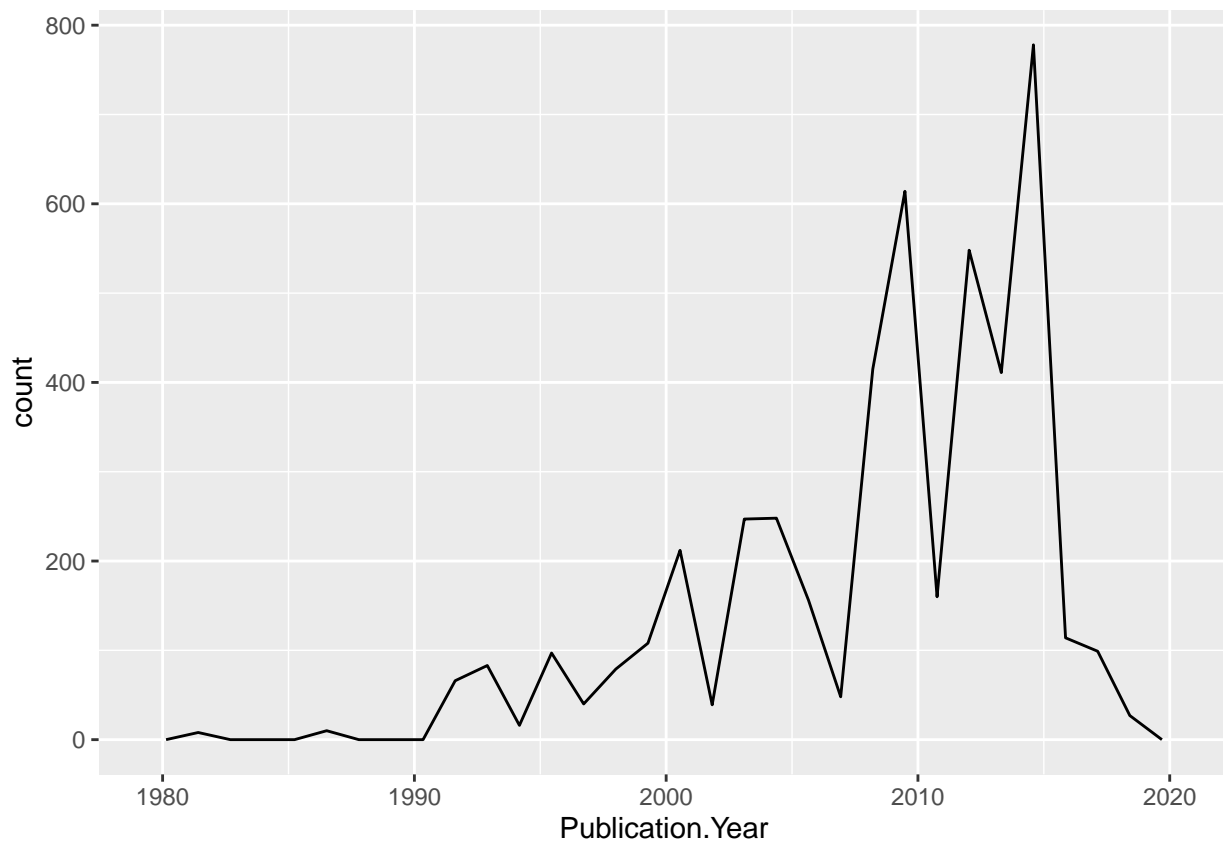
## Explore your data graphically (Neonics)

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

```
# Load tools
library(ggplot2)

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

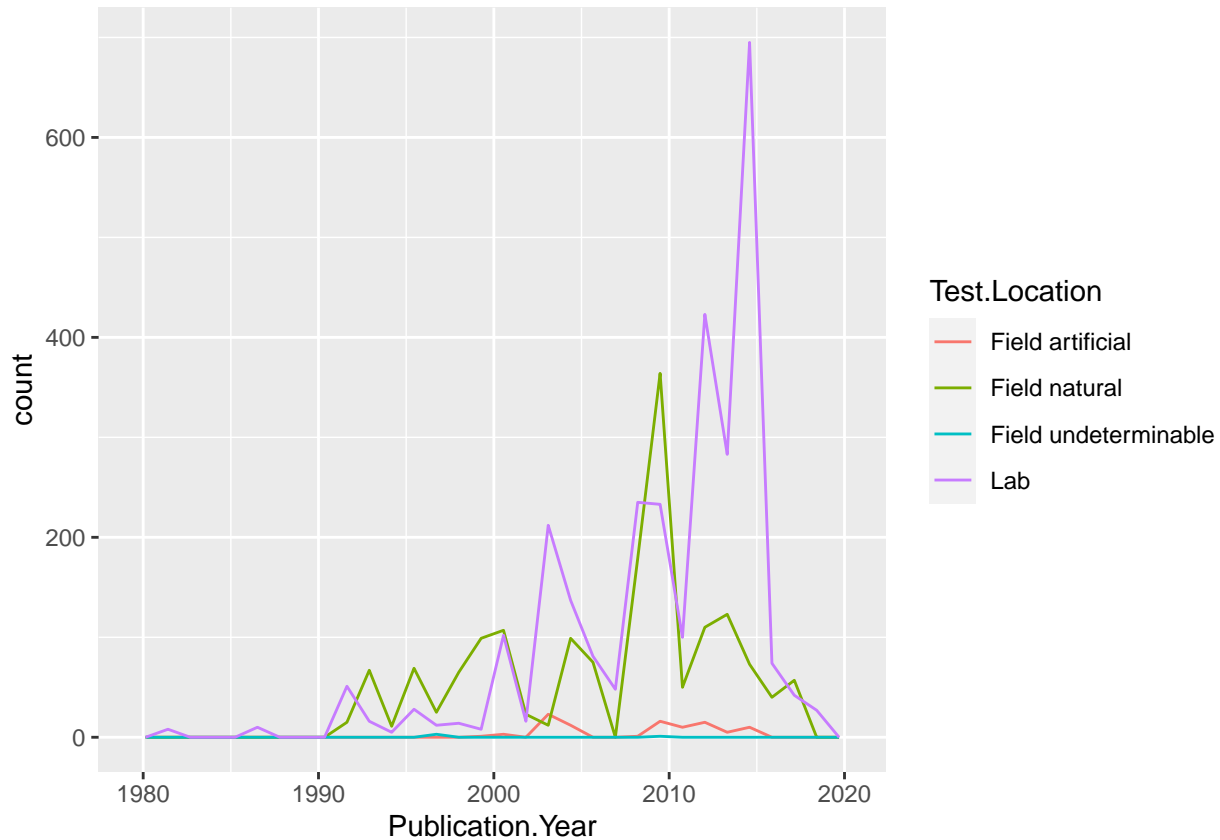
```
## 'stat_bin()' using 'bins = 30'. Pick better value with 'binwidth'.
```



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

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

## 'stat\_bin()' using 'bins = 30'. Pick better value with 'binwidth'.



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

Answer: Our data start from 1980 to 2020, and the most common test location is Lab which increase by year until 2015ish then drop and end at 2020. Researchers also do a lot of natual field studies around 2010 while they also do all other forms of researches.

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



Answer: The most common two endpoints are NOEL and LOEL. NOEL, stand for no observable effect level, and LOEL on the opposite, stand for lowest observable effect level. They stand for no or low concentration of producing effect.

## Explore your data (Litter)

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

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

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

```
view(Litter)
```

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

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

```
unique(Litter$collectDate)
```

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



13. Using the `unique` function, determine how many plots were sampled at Niwot Ridge. How is the information obtained from `unique` different from that obtained from `summary`?

```
unique(Litter)
```

##	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-b670-4f07-8040-6980d6cfd72	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-c827d529b55	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-fb04-480b-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	acf36093-4706-4dc3-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	a1afccb7-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	fbcb280eb-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
## 79	aa7ef4c5-da6d-4455-8761-730dd4135191	NIWO_046.basePlot.ltr	D13	NIWO
## 80	38e221c3-5011-4d73-aa99-8127154ddd0c	NIWO_046.basePlot.ltr	D13	NIWO
## 81	f8ef9082-9281-4c65-862c-f2696da58e2a	NIWO_046.basePlot.ltr	D13	NIWO
## 82	b6582d1e-b9c3-4a0d-bb37-aac749b1642e	NIWO_046.basePlot.ltr	D13	NIWO
## 83	3e567fbb-9616-444f-9d13-da894718ecf1	NIWO_046.basePlot.ltr	D13	NIWO
## 84	8c02f879-d03e-4903-9ca8-5d4dbcacac57	NIWO_062.basePlot.ltr	D13	NIWO
## 85	d1dc46e9-052d-4638-bdfd-840a9dc51f44	NIWO_062.basePlot.ltr	D13	NIWO
## 86	33aa6853-b3fd-4321-b8f0-9aa144867d6b	NIWO_062.basePlot.ltr	D13	NIWO
## 87	78c8dd41-483f-4f1d-9d35-0b775d0901f2	NIWO_062.basePlot.ltr	D13	NIWO
## 88	9a6bc315-d122-49a6-9817-8288703b1277	NIWO_062.basePlot.ltr	D13	NIWO
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## 94	89a7b052-f348-4967-b79b-bccfb428d44f	NIWO_041.basePlot.ltr	D13	NIWO
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## 5	NIWO_061	NIWO_061_169	2018-08-06	2018-07-05	2018-08-02	2018-08-02T21:00Z
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## 7	NIWO_061	NIWO_061_169	2018-08-06	2018-07-05	2018-08-02	2018-08-02T21:00Z
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## 16	NIWO_064	NIWO_064_103	2018-08-06	2018-07-05	2018-08-02	2018-08-02T21:00Z
## 17	NIWO_067	NIWO_067_017	2018-08-06	2018-07-05	2018-08-02	2018-08-02T21:00Z
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[illegible]

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## 184 2018-09-05T19:30Z NEON.LTR.NIW0040205.20180830
## 185 2018-09-05T19:30Z NEON.LTR.NIW0040205.20180830
## 186 2018-09-05T19:30Z NEON.LTR.NIW0040205.20180830
## 187 2018-09-05T19:30Z NEON.LTR.NIW0040205.20180830
## 188 2018-09-05T19:30Z NEON.LTR.NIW0040205.20180830
##
##          massSampleID samplingProtocolVersion functionalGroup
## 1  NEON.LTR.NIW0061169.20180802.TWI      NEON.DOC.001710vE  Twigs/branches
## 2  NEON.LTR.NIW0061169.20180802.SDS      NEON.DOC.001710vE      Seeds
## 3  NEON.LTR.NIW0061169.20180802.WDY      NEON.DOC.001710vE  Woody material
## 4  NEON.LTR.NIW0061169.20180802.FLR      NEON.DOC.001710vE    Flowers
## 5  NEON.LTR.NIW0061169.20180802.WDY      NEON.DOC.001710vE  Woody material
## 6  NEON.LTR.NIW0061169.20180802.NDL      NEON.DOC.001710vE    Needles
## 7  NEON.LTR.NIW0061169.20180802.OTH      NEON.DOC.001710vE    Other
## 8  NEON.LTR.NIW0061169.20180802.LVS      NEON.DOC.001710vE    Leaves
## 9  NEON.LTR.NIW0064103.20180802.FLR      NEON.DOC.001710vE    Flowers
## 10 NEON.LTR.NIW0064103.20180802.WDY      NEON.DOC.001710vE  Woody material
## 11 NEON.LTR.NIW0064103.20180802.WDY      NEON.DOC.001710vE  Woody material
## 12 NEON.LTR.NIW0064103.20180802.LVS      NEON.DOC.001710vE    Leaves
## 13 NEON.LTR.NIW0064103.20180802.TWI      NEON.DOC.001710vE  Twigs/branches
## 14 NEON.LTR.NIW0064103.20180802.OTH      NEON.DOC.001710vE    Other
## 15 NEON.LTR.NIW0064103.20180802.SDS      NEON.DOC.001710vE    Seeds
## 16 NEON.LTR.NIW0064103.20180802.NDL      NEON.DOC.001710vE    Needles
## 17 NEON.LTR.NIW0067017.20180802.LVS      NEON.DOC.001710vE    Leaves
## 18 NEON.LTR.NIW0067017.20180802.FLR      NEON.DOC.001710vE    Flowers
## 19 NEON.LTR.NIW0067017.20180802.OTH      NEON.DOC.001710vE    Other
## 20 NEON.LTR.NIW0067017.20180802.WDY      NEON.DOC.001710vE  Woody material
## 21 NEON.LTR.NIW0067017.20180802.TWI      NEON.DOC.001710vE  Twigs/branches

```

## 22	NEON.LTR.NIW0067017.20180802.NDL	NEON.DOC.001710vE	Needles
## 23	NEON.LTR.NIW0067017.20180802.MXT	NEON.DOC.001710vE	Mixed
## 24	NEON.LTR.NIW0067017.20180802.SDS	NEON.DOC.001710vE	Seeds
## 25	NEON.LTR.NIW0040205.20180802.OTH	NEON.DOC.001710vE	Other
## 26	NEON.LTR.NIW0040205.20180802.LVS	NEON.DOC.001710vE	Leaves
## 27	NEON.LTR.NIW0040205.20180802.TWI	NEON.DOC.001710vE	Twigs/branches
## 28	NEON.LTR.NIW0040205.20180802.MXT	NEON.DOC.001710vE	Mixed
## 29	NEON.LTR.NIW0040205.20180802.WDY	NEON.DOC.001710vE	Woody material
## 30	NEON.LTR.NIW0040205.20180802.NDL	NEON.DOC.001710vE	Needles
## 31	NEON.LTR.NIW0040205.20180802.FLR	NEON.DOC.001710vE	Flowers
## 32	NEON.LTR.NIW0040205.20180802.MXT	NEON.DOC.001710vE	Mixed
## 33	NEON.LTR.NIW0040205.20180802.NDL	NEON.DOC.001710vE	Needles
## 34	NEON.LTR.NIW0040205.20180802.SDS	NEON.DOC.001710vE	Seeds
## 35	NEON.LTR.NIW0041059.20180802.MXT	NEON.DOC.001710vE	Mixed
## 36	NEON.LTR.NIW0041059.20180802.SDS	NEON.DOC.001710vE	Seeds
## 37	NEON.LTR.NIW0063062.20180802.WDY	NEON.DOC.001710vE	Woody material
## 38	NEON.LTR.NIW0063062.20180802.NDL	NEON.DOC.001710vE	Needles
## 39	NEON.LTR.NIW0063062.20180802.TWI	NEON.DOC.001710vE	Twigs/branches
## 40	NEON.LTR.NIW0063062.20180802.LVS	NEON.DOC.001710vE	Leaves
## 41	NEON.LTR.NIW0063062.20180802.SDS	NEON.DOC.001710vE	Seeds
## 42	NEON.LTR.NIW0041059.20180802.FLR	NEON.DOC.001710vE	Flowers
## 43	NEON.LTR.NIW0041059.20180802.NDL	NEON.DOC.001710vE	Needles
## 44	NEON.LTR.NIW0041059.20180802.WDY	NEON.DOC.001710vE	Woody material
## 45	NEON.LTR.NIW0041059.20180802.OTH	NEON.DOC.001710vE	Other
## 46	NEON.LTR.NIW0041059.20180802.TWI	NEON.DOC.001710vE	Twigs/branches
## 47	NEON.LTR.NIW0041059.20180802.LVS	NEON.DOC.001710vE	Leaves
## 48	NEON.LTR.NIW0047197.20180802.LVS	NEON.DOC.001710vE	Leaves
## 49	NEON.LTR.NIW0047197.20180802.WDY	NEON.DOC.001710vE	Woody material
## 50	NEON.LTR.NIW0047197.20180802.NDL	NEON.DOC.001710vE	Needles
## 51	NEON.LTR.NIW0047197.20180802.FLR	NEON.DOC.001710vE	Flowers
## 52	NEON.LTR.NIW0047197.20180802.TWI	NEON.DOC.001710vE	Twigs/branches
## 53	NEON.LTR.NIW0047197.20180802.LVS	NEON.DOC.001710vE	Leaves
## 54	NEON.LTR.NIW0047197.20180802.OTH	NEON.DOC.001710vE	Other
## 55	NEON.LTR.NIW0047197.20180802.SDS	NEON.DOC.001710vE	Seeds
## 56	NEON.LTR.NIW0051045.20180802.LVS	NEON.DOC.001710vE	Leaves
## 57	NEON.LTR.NIW0051045.20180802.OTH	NEON.DOC.001710vE	Other
## 58	NEON.LTR.NIW0051045.20180802.TWI	NEON.DOC.001710vE	Twigs/branches
## 59	NEON.LTR.NIW0051045.20180802.NDL	NEON.DOC.001710vE	Needles
## 60	NEON.LTR.NIW0051045.20180802.WDY	NEON.DOC.001710vE	Woody material
## 61	NEON.LTR.NIW0051045.20180802.FLR	NEON.DOC.001710vE	Flowers
## 62	NEON.LTR.NIW0051045.20180802.SDS	NEON.DOC.001710vE	Seeds
## 63	NEON.LTR.NIW0058101.20180802.WDY	NEON.DOC.001710vE	Woody material
## 64	NEON.LTR.NIW0058101.20180802.NDL	NEON.DOC.001710vE	Needles
## 65	NEON.LTR.NIW0058101.20180802.TWI	NEON.DOC.001710vE	Twigs/branches
## 66	NEON.LTR.NIW0058101.20180802.NDL	NEON.DOC.001710vE	Needles
## 67	NEON.LTR.NIW0058101.20180802.OTH	NEON.DOC.001710vE	Other
## 68	NEON.LTR.NIW0058101.20180802.FLR	NEON.DOC.001710vE	Flowers
## 69	NEON.LTR.NIW0058101.20180802.LVS	NEON.DOC.001710vE	Leaves
## 70	NEON.LTR.NIW0058101.20180802.SDS	NEON.DOC.001710vE	Seeds
## 71	NEON.LTR.NIW0058101.20180802.OTH	NEON.DOC.001710vE	Other
## 72	NEON.LTR.NIW0063062.20180802.OTH	NEON.DOC.001710vE	Other
## 73	NEON.LTR.NIW0063062.20180802.FLR	NEON.DOC.001710vE	Flowers
## 74	NEON.LTR.NIW0046155.20180802.NDL	NEON.DOC.001710vE	Needles
## 75	NEON.LTR.NIW0046155.20180802.LVS	NEON.DOC.001710vE	Leaves

## 76	NEON.LTR.NIW0046155.20180802.TWI	NEON.DOC.001710vE	Twigs/branches
## 77	NEON.LTR.NIW0046155.20180802.TWI	NEON.DOC.001710vE	Twigs/branches
## 78	NEON.LTR.NIW0046155.20180802.MXT	NEON.DOC.001710vE	Mixed
## 79	NEON.LTR.NIW0046155.20180802.OTH	NEON.DOC.001710vE	Other
## 80	NEON.LTR.NIW0046155.20180802.NDL	NEON.DOC.001710vE	Needles
## 81	NEON.LTR.NIW0046155.20180802.WDY	NEON.DOC.001710vE	Woody material
## 82	NEON.LTR.NIW0046155.20180802.FLR	NEON.DOC.001710vE	Flowers
## 83	NEON.LTR.NIW0046155.20180802.SDS	NEON.DOC.001710vE	Seeds
## 84	NEON.LTR.NIW0062050.20180802.SDS	NEON.DOC.001710vE	Seeds
## 85	NEON.LTR.NIW0062050.20180802.TWI	NEON.DOC.001710vE	Twigs/branches
## 86	NEON.LTR.NIW0062050.20180802.FLR	NEON.DOC.001710vE	Flowers
## 87	NEON.LTR.NIW0062050.20180802.LVS	NEON.DOC.001710vE	Leaves
## 88	NEON.LTR.NIW0062050.20180802.OTH	NEON.DOC.001710vE	Other
## 89	NEON.LTR.NIW0062050.20180802.NDL	NEON.DOC.001710vE	Needles
## 90	NEON.LTR.NIW0062050.20180802.WDY	NEON.DOC.001710vE	Woody material
## 91	NEON.LTR.NIW0061169.20180802.NDL	NEON.DOC.001710vE	Needles
## 92	NEON.LTR.NIW0040205.20180830.MXT	NEON.DOC.001710vE	Mixed
## 93	NEON.LTR.NIW0041059.20180830.LVS	NEON.DOC.001710vE	Leaves
## 94	NEON.LTR.NIW0041059.20180830.NDL	NEON.DOC.001710vE	Needles
## 95	NEON.LTR.NIW0041059.20180830.FLR	NEON.DOC.001710vE	Flowers
## 96	NEON.LTR.NIW0041059.20180830.SDS	NEON.DOC.001710vE	Seeds
## 97	NEON.LTR.NIW0041059.20180830.MXT	NEON.DOC.001710vE	Mixed
## 98	NEON.LTR.NIW0041059.20180830.OTH	NEON.DOC.001710vE	Other
## 99	NEON.LTR.NIW0041059.20180830.MXT	NEON.DOC.001710vE	Mixed
## 100	NEON.LTR.NIW0041059.20180830.WDY	NEON.DOC.001710vE	Woody material
## 101	NEON.LTR.NIW0041059.20180830.TWI	NEON.DOC.001710vE	Twigs/branches
## 102	NEON.LTR.NIW0041059.20180830.NDL	NEON.DOC.001710vE	Needles
## 103	NEON.LTR.NIW0041059.20180830.TWI	NEON.DOC.001710vE	Twigs/branches
## 104	NEON.LTR.NIW0047197.20180830.OTH	NEON.DOC.001710vE	Other
## 105	NEON.LTR.NIW0047197.20180830.SDS	NEON.DOC.001710vE	Seeds
## 106	NEON.LTR.NIW0047197.20180830.LVS	NEON.DOC.001710vE	Leaves
## 107	NEON.LTR.NIW0047197.20180830.FLR	NEON.DOC.001710vE	Flowers
## 108	NEON.LTR.NIW0047197.20180830.NDL	NEON.DOC.001710vE	Needles
## 109	NEON.LTR.NIW0047197.20180830.TWI	NEON.DOC.001710vE	Twigs/branches
## 110	NEON.LTR.NIW0047197.20180830.WDY	NEON.DOC.001710vE	Woody material
## 111	NEON.LTR.NIW0051045.20180830.SDS	NEON.DOC.001710vE	Seeds
## 112	NEON.LTR.NIW0051045.20180830.OTH	NEON.DOC.001710vE	Other
## 113	NEON.LTR.NIW0051045.20180830.NDL	NEON.DOC.001710vE	Needles
## 114	NEON.LTR.NIW0051045.20180830.TWI	NEON.DOC.001710vE	Twigs/branches
## 115	NEON.LTR.NIW0051045.20180830.LVS	NEON.DOC.001710vE	Leaves
## 116	NEON.LTR.NIW0051045.20180830.WDY	NEON.DOC.001710vE	Woody material
## 117	NEON.LTR.NIW0051045.20180830.FLR	NEON.DOC.001710vE	Flowers
## 118	NEON.LTR.NIW0058101.20180830.WDY	NEON.DOC.001710vE	Woody material
## 119	NEON.LTR.NIW0058101.20180830.OTH	NEON.DOC.001710vE	Other
## 120	NEON.LTR.NIW0058101.20180830.SDS	NEON.DOC.001710vE	Seeds
## 121	NEON.LTR.NIW0058101.20180830.FLR	NEON.DOC.001710vE	Flowers
## 122	NEON.LTR.NIW0058101.20180830.NDL	NEON.DOC.001710vE	Needles
## 123	NEON.LTR.NIW0058101.20180830.LVS	NEON.DOC.001710vE	Leaves
## 124	NEON.LTR.NIW0058101.20180830.TWI	NEON.DOC.001710vE	Twigs/branches
## 125	NEON.LTR.NIW0063062.20180830.SDS	NEON.DOC.001710vE	Seeds
## 126	NEON.LTR.NIW0063062.20180830.NDL	NEON.DOC.001710vE	Needles
## 127	NEON.LTR.NIW0063062.20180830.LVS	NEON.DOC.001710vE	Leaves
## 128	NEON.LTR.NIW0063062.20180830.FLR	NEON.DOC.001710vE	Flowers
## 129	NEON.LTR.NIW0063062.20180830.WDY	NEON.DOC.001710vE	Woody material

## 130	NEON.LTR.NIW0063062.20180830.TWI	NEON.DOC.001710vE	Twigs/branches
## 131	NEON.LTR.NIW0063062.20180830.OTH	NEON.DOC.001710vE	Other
## 132	NEON.LTR.NIW0046155.20180830.LVS	NEON.DOC.001710vE	Leaves
## 133	NEON.LTR.NIW0046155.20180830.NDL	NEON.DOC.001710vE	Needles
## 134	NEON.LTR.NIW0046155.20180830.OTH	NEON.DOC.001710vE	Other
## 135	NEON.LTR.NIW0046155.20180830.WDY	NEON.DOC.001710vE	Woody material
## 136	NEON.LTR.NIW0046155.20180830.SDS	NEON.DOC.001710vE	Seeds
## 137	NEON.LTR.NIW0046155.20180830.TWI	NEON.DOC.001710vE	Twigs/branches
## 138	NEON.LTR.NIW0046155.20180830.FLR	NEON.DOC.001710vE	Flowers
## 139	NEON.LTR.NIW0046155.20180830.TWI	NEON.DOC.001710vE	Twigs/branches
## 140	NEON.LTR.NIW0062050.20180830.SDS	NEON.DOC.001710vE	Seeds
## 141	NEON.LTR.NIW0062050.20180830.FLR	NEON.DOC.001710vE	Flowers
## 142	NEON.LTR.NIW0062050.20180830.LVS	NEON.DOC.001710vE	Leaves
## 143	NEON.LTR.NIW0062050.20180830.WDY	NEON.DOC.001710vE	Woody material
## 144	NEON.LTR.NIW0062050.20180830.OTH	NEON.DOC.001710vE	Other
## 145	NEON.LTR.NIW0062050.20180830.TWI	NEON.DOC.001710vE	Twigs/branches
## 146	NEON.LTR.NIW0062050.20180830.NDL	NEON.DOC.001710vE	Needles
## 147	NEON.LTR.NIW0061169.20180830.OTH	NEON.DOC.001710vE	Other
## 148	NEON.LTR.NIW0061169.20180830.TWI	NEON.DOC.001710vE	Twigs/branches
## 149	NEON.LTR.NIW0061169.20180830.WDY	NEON.DOC.001710vE	Woody material
## 150	NEON.LTR.NIW0061169.20180830.FLR	NEON.DOC.001710vE	Flowers
## 151	NEON.LTR.NIW0061169.20180830.TWI	NEON.DOC.001710vE	Twigs/branches
## 152	NEON.LTR.NIW0061169.20180830.SDS	NEON.DOC.001710vE	Seeds
## 153	NEON.LTR.NIW0061169.20180830.LVS	NEON.DOC.001710vE	Leaves
## 154	NEON.LTR.NIW0061169.20180830.NDL	NEON.DOC.001710vE	Needles
## 155	NEON.LTR.NIW0064103.20180830.WDY	NEON.DOC.001710vE	Woody material
## 156	NEON.LTR.NIW0064103.20180830.WDY	NEON.DOC.001710vE	Woody material
## 157	NEON.LTR.NIW0064103.20180830.LVS	NEON.DOC.001710vE	Leaves
## 158	NEON.LTR.NIW0064103.20180830.FLR	NEON.DOC.001710vE	Flowers
## 159	NEON.LTR.NIW0064103.20180830.SDS	NEON.DOC.001710vE	Seeds
## 160	NEON.LTR.NIW0064103.20180830.OTH	NEON.DOC.001710vE	Other
## 161	NEON.LTR.NIW0064103.20180830.NDL	NEON.DOC.001710vE	Needles
## 162	NEON.LTR.NIW0064103.20180830.TWI	NEON.DOC.001710vE	Twigs/branches
## 163	NEON.LTR.NIW0057081.20180830.NDL	NEON.DOC.001710vE	Needles
## 164	NEON.LTR.NIW0057081.20180830.FLR	NEON.DOC.001710vE	Flowers
## 165	NEON.LTR.NIW0057081.20180830.SDS	NEON.DOC.001710vE	Seeds
## 166	NEON.LTR.NIW0057081.20180830.OTH	NEON.DOC.001710vE	Other
## 167	NEON.LTR.NIW0057081.20180830.LVS	NEON.DOC.001710vE	Leaves
## 168	NEON.LTR.NIW0057081.20180830.TWI	NEON.DOC.001710vE	Twigs/branches
## 169	NEON.LTR.NIW0057081.20180830.TWI	NEON.DOC.001710vE	Twigs/branches
## 170	NEON.LTR.NIW0057081.20180830.WDY	NEON.DOC.001710vE	Woody material
## 171	NEON.LTR.NIW0067017.20180830.NDL	NEON.DOC.001710vE	Needles
## 172	NEON.LTR.NIW0067017.20180830.OTH	NEON.DOC.001710vE	Other
## 173	NEON.LTR.NIW0067017.20180830.LVS	NEON.DOC.001710vE	Leaves
## 174	NEON.LTR.NIW0067017.20180830.WDY	NEON.DOC.001710vE	Woody material
## 175	NEON.LTR.NIW0067017.20180830.NDL	NEON.DOC.001710vE	Needles
## 176	NEON.LTR.NIW0067017.20180830.FLR	NEON.DOC.001710vE	Flowers
## 177	NEON.LTR.NIW0067017.20180830.SDS	NEON.DOC.001710vE	Seeds
## 178	NEON.LTR.NIW0067017.20180830.TWI	NEON.DOC.001710vE	Twigs/branches
## 179	NEON.LTR.NIW0067017.20180830.MXT	NEON.DOC.001710vE	Mixed
## 180	NEON.LTR.NIW0040205.20180830.SDS	NEON.DOC.001710vE	Seeds
## 181	NEON.LTR.NIW0040205.20180830.WDY	NEON.DOC.001710vE	Woody material
## 182	NEON.LTR.NIW0040205.20180830.OTH	NEON.DOC.001710vE	Other
## 183	NEON.LTR.NIW0040205.20180830.LVS	NEON.DOC.001710vE	Leaves

## 184	NEON.LTR.NIW0040205.20180830.NDL	NEON.DOC.001710vE	Needles
## 185	NEON.LTR.NIW0040205.20180830.TWI	NEON.DOC.001710vE	Twigs/branches
## 186	NEON.LTR.NIW0040205.20180830.MXT	NEON.DOC.001710vE	Mixed
## 187	NEON.LTR.NIW0040205.20180830.NDL	NEON.DOC.001710vE	Needles
## 188	NEON.LTR.NIW0040205.20180830.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



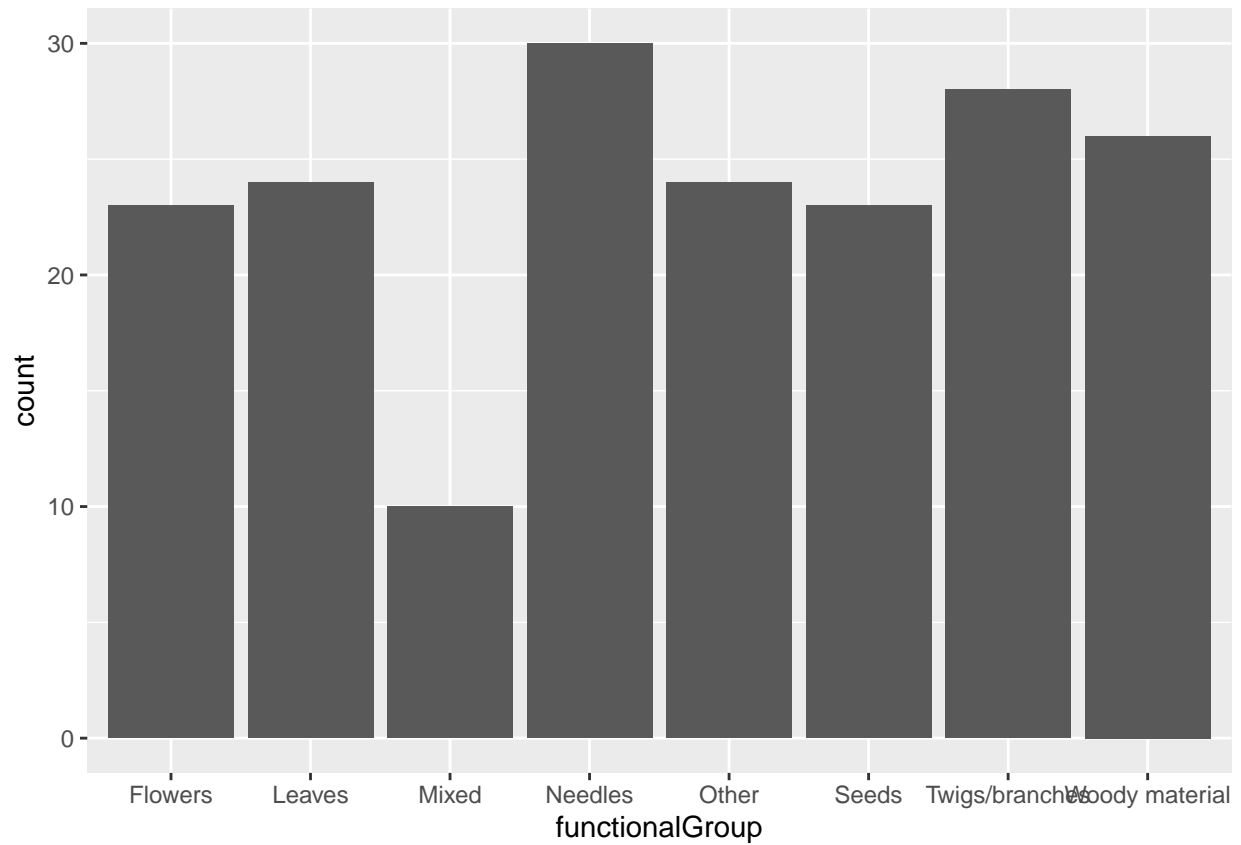
## 103	0.340	N	NA szrillo@battelleecology.org
## 104	0.005	N	NA szrillo@battelleecology.org
## 105	0.000	N	NA szrillo@battelleecology.org
## 106	0.000	N	NA szrillo@battelleecology.org
## 107	0.000	N	NA szrillo@battelleecology.org
## 108	0.420	N	NA szrillo@battelleecology.org
## 109	0.000	N	NA szrillo@battelleecology.org
## 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

Answer: There are 52 unique plots obtained by function unique and look at measuredBy column. Summary will provide unfavorable long result because it provide summary without omit duplicates.

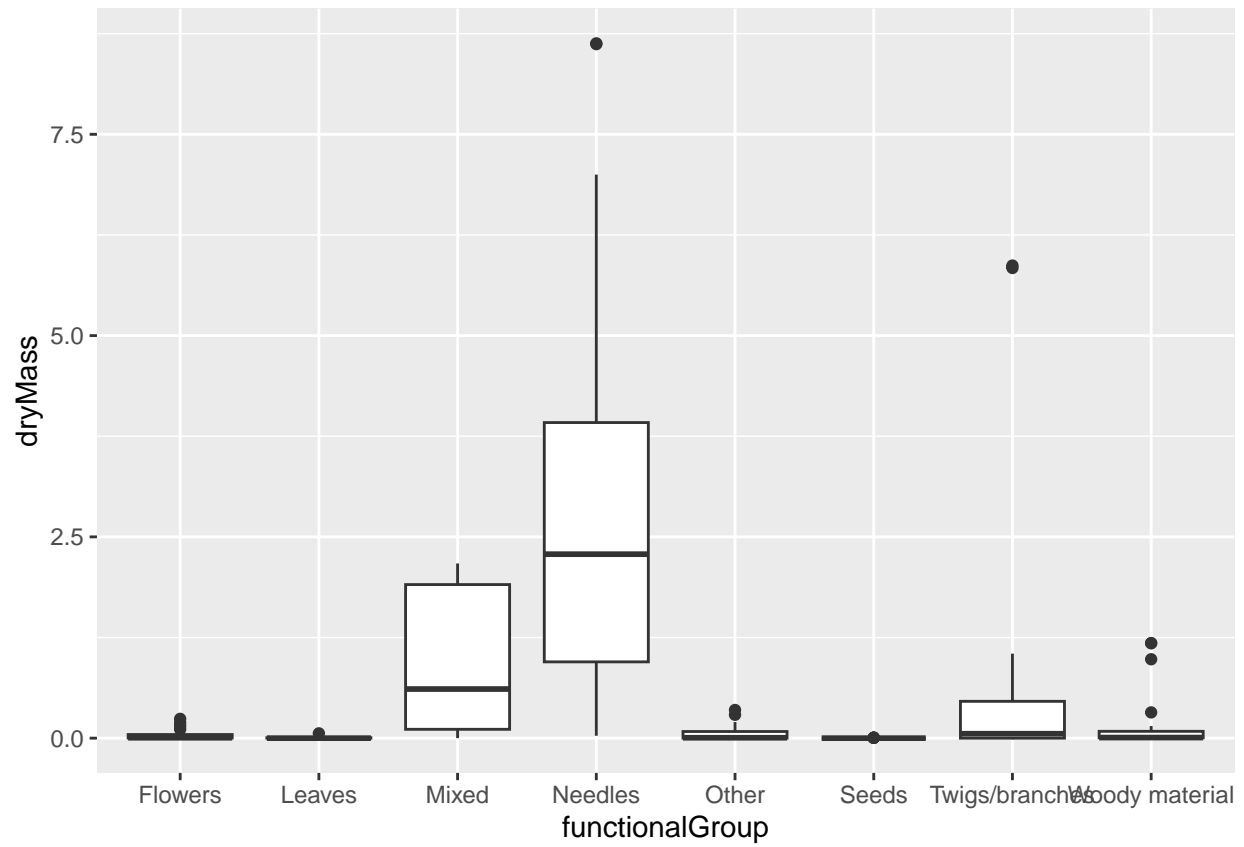
14. Create a bar graph of functionalGroup counts. This shows you what type of litter is collected at the Niwot Ridge sites. Notice that litter types are fairly equally distributed across the Niwot Ridge sites.

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

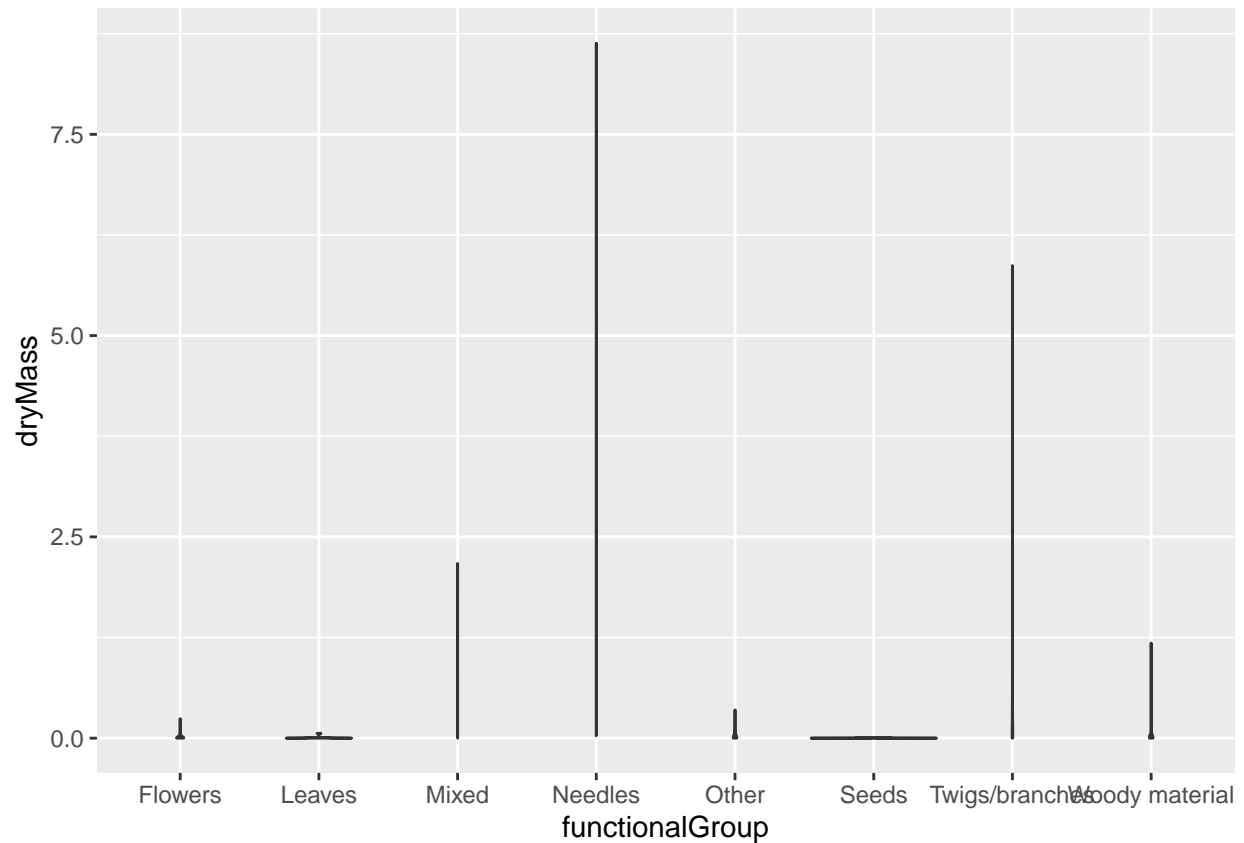


15. Using `geom_boxplot` and `geom_violin`, create a boxplot and a violin plot of `dryMass` by `functionalGroup`.

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



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



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

Answer: Because in this case, the data is nearly identical, so violin plot will be “squeezed” together and we cannot read any effective data. Whereas, box plot is drawn by defining inter quatile range, which almost gurantee we will have that “box” only by minor difference.

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

Answer: Needles tend to have the highest biomass, it has the largest range and largest inter quatile range and the longes tail.