

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.

```
#setwd("C:/Users/eon3/Documents/EDE_Fall2023")
#setwd("/EDE_Fall2023/Data/raw/ECOTOX_Neonicotinoids_Insects_raw")
#install.packages("Rtools")
#install.packages("lubridate")
#install.packages("tidyverse")
library("lubridate")
library("tidyverse")
#install.packages("dplyr")
#install.packages("ggplot2")
#library("dplyr")
#library("ggplot2")
library("here")
```

```
#getwd(ECOTOX_Neonicotinoids_Insects_raw)
neonics <- read.csv(here("Data/Raw/ECOTOX_Neonicotinoids_Insects_raw.csv"), stringsAsFactors = TRUE)
litter <- read.csv(here("Data/Raw/NEON_NIWO_Litter_massdata_2018-08_raw.csv"), stringsAsFactors = TRUE)
#neonics
#litter
#getwd(NEON_NIWO_Litter_massdata_2018_08_raw)
```

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: We may be interested in learning more about this class of insecticides because they are the deadliest pesticide ever created, and target both “pest” species and nontarget ones including vital pollinators. Because of its broad, deadly effects on insects, it is important to study how this class of insecticide moves through the environment and cause wider trophic level effects.

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: We may be interested in studying woody debris and leaf litter because of the important effects of water storage, carbon sequestration, and habitats they provide. Fallen logs and woody debris help water distribute into the soil at slower rates, allowing plants more time to take in water as gravity pulls it down. Leaf litter also provides valuable habitat for many smaller insects, amphibians, worms, and other animals to live. Decaying plant matter on the forest floor also helps return nutrients to the soil and back to the plants. All of these reasons mean that this dataset is a valuable tool to study these interactions.

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 only occurs at sites with woody vegetation that is more than 2 meters tall
 2. One litter trap pair is deployed for every 400 square meters of plot area
 3. Ground traps are sampled once per year

Obtain basic summaries of your data (Neonics)

5. What are the dimensions of the dataset? > The dimensions are 4623 by 30 #used the dim function and the Na.omit to retrieve the dimensions of dataset and remove any potential “N/As” or missing data in the dataset.

```
#View(neonics)
neonics_dim <- dim(na.omit(neonics))
neonics_dim
```

```
## [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?

```
class(neonics)
```

```
## [1] "data.frame"
```

```
#colnames(neonics) <- c("CAS.Number", "Chemical.Name", "Chemical.Grade", "Chemical.Analysis.Method", "Chemical.Analysis.Result")
#str(neonics)
#neonics$Effect
#neonics_summary <- summary(neonics)
N_summary <- summary(neonics$Effect)
N_summary
```

```
##      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
```

```
effectsdata <- data.frame(neonics$Effect)
effectcount <- table(neonics$Effect)
effectcount
```

```
##
##      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
```

```
#tried to rename column names, but issue had to do with reading the csv because data was not showing up
```

Answer: These effects may be particularly interesting because we can see how the insecticide is most affecting the species, and how to potentially mitigate the mortality risk and improve pollinator populations. Population and Mortality are some of the most common effects being studied

- 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...]

```
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
```

```
six_species <- summary(neonics$Species.Common.Name)
print(six_species)
```

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

##	Cotton Aphid	Predatory Mite
##	33	33
##	Ladybird Beetle Family	Parasitoid
##	30	30
##	Scarab Beetle	Spring Tiphia
##	29	29
##	Thrip Order	Ground Beetle Family
##	29	27
##	Rove Beetle Family	Tobacco Aphid
##	27	27
##	Chalcid Wasp	Convergent Lady Beetle
##	25	25
##	Stingless Bee	Spider/Mite Class
##	25	24
##	Tobacco Flea Beetle	Citrus Leafminer
##	24	23
##	Ladybird Beetle	Mason Bee
##	23	22
##	Mosquito	Argentine Ant
##	22	21
##	Beetle	Flatheaded Appletree Borer
##	21	20
##	Horned Oak Gall Wasp	Leaf Beetle Family
##	20	20
##	Potato Leafhopper	Tooth-necked Fungus Beetle
##	20	20
##	Codling Moth	Black-spotted Lady Beetle
##	19	18
##	Calico Scale	Fairyfly Parasitoid
##	18	18
##	Lady Beetle	Minute Parasitic Wasps
##	18	18
##	Mirid Bug	Mulberry Pyralid
##	18	18
##	Silkworm	Vedalia Beetle
##	18	18
##	Araneoid Spider Order	Bee Order
##	17	17
##	Egg Parasitoid	Insect Class
##	17	17
##	Moth And Butterfly Order	Oystershell Scale Parasitoid
##	17	17
##	Hemlock Woolly Adelgid Lady Beetle	Hemlock Woolly Adelgid
##	16	16
##	Mite	Onion Thrip
##	16	16
##	Western Flower Thrips	Corn Earworm
##	15	14
##	Green Peach Aphid	House Fly
##	14	14
##	Ox Beetle	Red Scale Parasite
##	14	14
##	Spined Soldier Bug	Armoured Scale Family
##	14	13

##	Diamondback Moth	Eulophid Wasp
##	13	13
##	Monarch Butterfly	Predatory Bug
##	13	13
##	Yellow Fever Mosquito	Braconid Parasitoid
##	13	12
##	Common Thrip	Eastern Subterranean Termite
##	12	12
##	Jassid	Mite Order
##	12	12
##	Pea Aphid	Pond Wolf Spider
##	12	12
##	Spotless Ladybird Beetle	Glasshouse Potato Wasp
##	11	10
##	Lacewing	Southern House Mosquito
##	10	10
##	Two Spotted Lady Beetle	Ant Family
##	10	9
##	Apple Maggot	(Other)
##	9	670

```
Species_summary <- summary(neonics$Species.Common.Name)
Species_summary
```

##	Honey Bee	Parasitic Wasp
##	667	285
##	Buff Tailed Bumblebee	Carniolan Honey Bee
##	183	152
##	Bumble Bee	Italian Honeybee
##	140	113
##	Japanese Beetle	Asian Lady Beetle
##	94	76
##	Euonymus Scale	Wireworm
##	75	69
##	European Dark Bee	Minute Pirate Bug
##	66	62
##	Asian Citrus Psyllid	Parastic Wasp
##	60	58
##	Colorado Potato Beetle	Parasitoid Wasp
##	57	51
##	Erythrina Gall Wasp	Beetle Order
##	49	47
##	Snout Beetle Family, Weevil	Sevenspotted Lady Beetle
##	47	46
##	True Bug Order	Buff-tailed Bumblebee
##	45	39
##	Aphid Family	Cabbage Looper
##	38	38
##	Sweetpotato Whitefly	Braconid Wasp
##	37	33
##	Cotton Aphid	Predatory Mite
##	33	33
##	Ladybird Beetle Family	Parasitoid
##	30	30

##	Scarab Beetle	Spring Tiphia
##	29	29
##	Thrip Order	Ground Beetle Family
##	29	27
##	Rove Beetle Family	Tobacco Aphid
##	27	27
##	Chalcid Wasp	Convergent Lady Beetle
##	25	25
##	Stingless Bee	Spider/Mite Class
##	25	24
##	Tobacco Flea Beetle	Citrus Leafminer
##	24	23
##	Ladybird Beetle	Mason Bee
##	23	22
##	Mosquito	Argentine Ant
##	22	21
##	Beetle	Flatheaded Appletree Borer
##	21	20
##	Horned Oak Gall Wasp	Leaf Beetle Family
##	20	20
##	Potato Leafhopper	Tooth-necked Fungus Beetle
##	20	20
##	Codling Moth	Black-spotted Lady Beetle
##	19	18
##	Calico Scale	Fairyfly Parasitoid
##	18	18
##	Lady Beetle	Minute Parasitic Wasps
##	18	18
##	Mirid Bug	Mulberry Pyralid
##	18	18
##	Silkworm	Vedalia Beetle
##	18	18
##	Araneoid Spider Order	Bee Order
##	17	17
##	Egg Parasitoid	Insect Class
##	17	17
##	Moth And Butterfly Order	Oystershell Scale Parasitoid
##	17	17
##	Hemlock Woolly Adelgid Lady Beetle	Hemlock Wooly Adelgid
##	16	16
##	Mite	Onion Thrip
##	16	16
##	Western Flower Thrips	Corn Earworm
##	15	14
##	Green Peach Aphid	House Fly
##	14	14
##	Ox Beetle	Red Scale Parasite
##	14	14
##	Spined Soldier Bug	Armoured Scale Family
##	14	13
##	Diamondback Moth	Eulophid Wasp
##	13	13
##	Monarch Butterfly	Predatory Bug
##	13	13

##	Yellow Fever Mosquito	Braconid Parasitoid
##	13	12
##	Common Thrip	Eastern Subterranean Termite
##	12	12
##	Jassid	Mite Order
##	12	12
##	Pea Aphid	Pond Wolf Spider
##	12	12
##	Spotless Ladybird Beetle	Glasshouse Potato Wasp
##	11	10
##	Lacewing	Southern House Mosquito
##	10	10
##	Two Spotted Lady Beetle	Ant Family
##	10	9
##	Apple Maggot	(Other)
##	9	670

```

Speciesdata <- data.frame(neonics$Species.Common.Name)
Speciescount <- table(neonics$Species.Common.Name)
Speciescount

```

##	Alfalfa Leafcutter Bee	Alfalfa Plant Bug
##	8	2
##	Alkali Bee	Ambrosia Bark Beetle
##	2	3
##	Ambrosia Beetle	Ant
##	6	4
##	Ant Family	Antlike Flower Beetle
##	9	1
##	Aphid	Aphid Family
##	2	38
##	Aphid Wasp	Apple Aphid
##	6	5
##	Apple Maggot	Araneoid Spider Order
##	9	17
##	Argentine Ant	Armoured Scale Family
##	21	13
##	Asian Ambrosia Beetle	Asian Citrus Psyllid
##	3	60
##	Asian Lady Beetle	Asiatic Honey Bee
##	76	9
##	Assassin Bug	Azalea Lace Bug
##	2	2
##	Banana Aphid	Banded Soft-winged Flower Beetle
##	2	1
##	Banded Sunflower Moth	Bee
##	1	8
##	Bee Family	Bee Order
##	1	17
##	Beet Armyworm	Beetle
##	1	21
##	Beetle Family	Beetle Mite Family
##	3	7

##	Beetle Order	Birch Leafminer
##	47	3
##	Black-spotted Lady Beetle	Black Citrus Aphid
##	18	1
##	Black Twig Borer	Black Vine Weevil
##	3	6
##	Blue Alfalfa Aphid	Braconid Parasitoid
##	1	12
##	Braconid Parasitoid Wasp	Braconid Wasp
##	3	33
##	Brown Planthopper	Brown Scale
##	5	2
##	Brown Stinkbug	Budworm
##	2	2
##	Buff-tailed Bumblebee	Buff Tailed Bumblebee
##	39	183
##	Bumble Bee	Bumblebee
##	140	8
##	Cabbage Aphid	Cabbage Looper
##	2	38
##	Cabbage Root Fly	Cabbage Seedpod Weevil
##	1	4
##	Cabbage White	Cactus Lady Beetle
##	2	1
##	Calico Scale	California Red Scale
##	18	3
##	Cardamom Thrip	Carniolan Honey Bee
##	2	152
##	Carrot Weevil	Celer Crab Spider
##	2	2
##	Centipede Class	Chalcid Wasp
##	2	25
##	Childers Canegrub	Chilean Predatory Mite
##	6	8
##	Chinch Bug	Citricola Scale
##	7	2
##	Citrus Leafminer	Citrus Red Mite
##	23	1
##	Clouded Plant Bug	Coconut Leaf Beetle
##	2	6
##	Codling Moth	Coffee Bean Weevil
##	19	2
##	Colorado Potato Beetle	Common Green Lacewing
##	57	4
##	Common Thrip	Convergent Lady Beetle
##	12	25
##	Corn Earworm	Cotton Aphid
##	14	33
##	Cotton Fleahopper	Cottony Cushion Sale
##	2	1
##	Crapemyrtle Aphid	Crucifer Flea Beetle
##	1	3
##	Cutworm	Damselbug Family
##	3	1

##	Delphacid Planthopper	Diamondback Moth
##	3	13
##	Dwarf Honey Bee	Earwig
##	8	5
##	Eastern Subterranean Termite	Ectoparasitoid Wasp
##	12	1
##	Egg Parasitoid	Egyptian Alfalfa Weevil
##	17	2
##	Egyptian Cotton Leafworm	Eleven-spotted Ladybird Beetle
##	3	6
##	Encyrtid Parasitoid	Encyrtid Wasp
##	3	6
##	English Grain Aphid	Engraver Beetle
##	1	2
##	Erythrina Gall Wasp	Eucalyptus Gall Wasp
##	49	4
##	Eulophid Parasitoid	Eulophid Wasp
##	9	13
##	Euonymus Scale	European Apple Sawfly
##	75	4
##	European Dark Bee	European Honey Bee
##	66	4
##	European Red Mite	European Tarnished Plant Bug
##	6	4
##	Fairyfly	Fairyfly Parasitoid
##	1	18
##	Fall Armyworm	Fig Longicorn Beetle
##	6	2
##	Flatheaded Appletree Borer	Flea Beetle
##	20	1
##	Fly/Mosquito/Midge Order	Formosan Subterranean Termite
##	3	3
##	Fruit-tree Pinhole Borer	Fruit Fly
##	3	6
##	Gall Midge	Garden Symphylan
##	1	4
##	Glasshouse Potato Wasp	Glassy-winged Sharpshooter
##	10	2
##	Grasshopper/Cricket/Locust Order	Green June Beetle
##	1	5
##	Green Peach Aphid	Green Rice Leafhopper
##	14	3
##	Greenhouse Whitefly	Grey Sunflower Seed Weevil
##	1	1
##	Ground Beetle	Ground Beetle Family
##	3	27
##	Harvestman Spider Order	Hawthorn Lace Bug
##	1	2
##	Hawthorn Leaf Miner	Hemlock Woolly Adelgid Lady Beetle
##	1	16
##	Hemlock Woolly Adelgid	Hister Beetle Family
##	16	2
##	Honey Bee	Horned Oak Gall Wasp
##	667	20

##	Hornfaced Bee	House Fly
##	5	14
##	Hover Fly	Ichneumonid Wasp
##	6	3
##	Insect Class	Italian Honeybee
##	17	113
##	Japanese Beetle	Jassid
##	94	12
##	Jumping Spider Family	Lacewing
##	2	10
##	Lacewing Family	Lady Beetle
##	9	18
##	Ladybird Beetle	Ladybird Beetle Family
##	23	30
##	Large-Jawed Orb Weaver Family	Leaf Beetle Family
##	3	20
##	Leaf Cutting Ant	Lined Click Beetle
##	3	2
##	Linyphiid Spider	Long Horned Beetle Family
##	4	5
##	Longtailed Fruit Fly Parasite	Macedonian Honey Bee
##	1	7
##	Maple Spider Mite	Mason Bee
##	2	22
##	Mealybug Destroyer	Mediterranean Fruit Fly
##	9	3
##	Meshweaver Spider	Minute Flour Bug
##	2	3
##	Minute Lady Beetles	Minute Parasitic Wasps
##	1	18
##	Minute Pirate Bug	Minute Pirate Bug Family
##	62	2
##	Mirid Bug	Mite
##	18	16
##	Mite Family	Mite Order
##	3	12
##	Monarch Butterfly	Mosquito
##	13	22
##	Moth	Moth And Butterfly Order
##	7	17
##	Moth Family	Mulberry Pyralid
##	3	18
##	Negatoria Canegrub	Neotropical Stingless Bee
##	3	8
##	Oblique Banded Leaf Roller	Obscure Mealybug
##	6	6
##	Onion Maggot	Onion Thrip
##	4	16
##	Oribatid Mite Suborder	Oriental Beetle
##	6	4
##	Ox Beetle	Oystershell Scale Parasitoid
##	14	17
##	Painted Maple Aphid	Parasitic Wasp
##	1	285

##	Parasitic Wasp Family	Parasitoid
##	8	30
##	Parasitoid Wasp	Parastic Wasp
##	51	58
##	Parsnip Seed Wasp	Pea And Bean Weevil
##	4	4
##	Pea Aphid	Pear Sucker
##	12	4
##	Pepper Weevil	Pine False Webworm
##	1	1
##	Pistachio Psyllid	Plant Bug
##	6	1
##	Plum Curculio	Pollen Beetle
##	5	1
##	Pond Wolf Spider	Potato Leafhopper
##	12	20
##	Potato Tuberworm	Predaceous Fly
##	7	2
##	Predacious Mite	Predator Bug
##	1	1
##	Predatory Bug	Predatory Mite
##	13	33
##	Pseudocentipede Class	Pteromalid Wasp Family
##	1	1
##	Pygmy Mangold Beetle	Red Imported Fire Ant
##	2	4
##	Red Scale Parasite	Red Sunflower Seed Weevil
##	14	1
##	Redbay Ambrosia Beetle	Rice Leaf Folder Moth
##	6	1
##	Rose Grain Aphid	Rose Sawfly
##	1	2
##	Rove Beetle	Rove Beetle Family
##	5	27
##	Russian Wheat Aphid	San Jose Scale
##	7	5
##	Sap Beetle Family	Scale Insect Order
##	3	3
##	Scale Picnic Beetle	Scarab Beetle
##	1	29
##	Scarab Beetle Family	Scelionid Wasp
##	3	5
##	Serpentine Leafminer	Sevenspotted Lady Beetle
##	2	46
##	Sheet-Web Weaver Family	Shiny Spider Beetle
##	3	1
##	Silkworm	Silverleaf Whitefly
##	18	6
##	Snout Beetle Family, Weevil	Soldier Beetle
##	47	7
##	Southern Army Worm	Southern House Mosquito
##	1	10
##	Southern One-Year Canegrub	Soybean Aphid
##	7	6

##	Speckled Cutworm Moth	Spider
##	5	3
##	Spider Mite Destroyer	Spider/Mite Class
##	2	24
##	Spined Soldier Bug	Spiralling Whitefly
##	14	8
##	Spirea Aphid	Spotless Ladybird Beetle
##	1	11
##	Spotted Sunflower Stem Weevil	Spotted Tentiform Leafminer
##	1	2
##	Spring Tiphia	Stingless Bee
##	29	25
##	Stink Bug	Strawberry Blossom Weevil
##	2	1
##	Striped Cucumber Beetle	Subterranean Termite
##	4	6
##	Sugarcane Beetle	Sugarcane Grub
##	4	3
##	Sunflower Midge	Sunflower Moth
##	1	1
##	Sweetpotato Whitefly	Tarnished Plant Bug
##	37	7
##	Tawny Mole Cricket	Ten-spot Ladybird Beetle
##	2	1
##	Tenebrionid Beetle	Thrip
##	3	6
##	Thrip Family	Thrip Order
##	5	29
##	Tick/Chigger/Mite Order	Tobacco Aphid
##	2	27
##	Tobacco Flea Beetle	Tobacco Thrip
##	24	1
##	Tooth-necked Fungus Beetle	True Bug Order
##	20	45
##	Turf Running-spider	Turnip Aphid
##	2	2
##	Twicestabbed Lady Beetle	Two-Spotted Spider Mite
##	1	6
##	Two Spotted Lady Beetle	Vedalia Beetle
##	10	18
##	Wasp	Wasp Family
##	4	1
##	Weevil	Western Bigeyed Bug
##	1	2
##	Western Damsel Bug	Western Flower Thrips
##	2	15
##	Western Plant Bug	White-backed Planthopper
##	2	2
##	White Apple Leafhopper Nymph	Whitemarked Fleahopper
##	2	2
##	Wireworm	Wolf Spider Family
##	69	4
##	Yellow-faced Bumblebee	Yellow Fever Mosquito
##	4	13

```
##          Yellow Mealworm Beetle
##                                     1
```

```
sort(Speciescount)
```

```
##
##          Antlike Flower Beetle    Banded Soft-winged Flower Beetle
##                                     1                                     1
##          Banded Sunflower Moth    Bee Family
##                                     1                                     1
##          Beet Armyworm            Black Citrus Aphid
##                                     1                                     1
##          Blue Alfalfa Aphid        Cabbage Root Fly
##                                     1                                     1
##          Cactus Lady Beetle        Citrus Red Mite
##                                     1                                     1
##          Cottony Cushion Sale      Crapemyrtle Aphid
##                                     1                                     1
##          Damselbug Family          Ectoparasitoid Wasp
##                                     1                                     1
##          English Grain Aphid        Fairyfly
##                                     1                                     1
##          Flea Beetle               Gall Midge
##                                     1                                     1
##          Grasshopper/Cricket/Locust Order    Greenhouse Whitefly
##                                     1                                     1
##          Grey Sunflower Seed Weevil    Harvestman Spider Order
##                                     1                                     1
##          Hawthorn Leaf Miner          Longtailed Fruit Fly Parasite
##                                     1                                     1
##          Minute Lady Beetles          Painted Maple Aphid
##                                     1                                     1
##          Pepper Weevil               Pine False Webworm
##                                     1                                     1
##          Plant Bug                  Pollen Beetle
##                                     1                                     1
##          Predacious Mite             Predator Bug
##                                     1                                     1
##          Pseudocentipede Class        Pteromalid Wasp Family
##                                     1                                     1
##          Red Sunflower Seed Weevil    Rice Leaf Folder Moth
##                                     1                                     1
##          Rose Grain Aphid            Scale Picnic Beetle
##                                     1                                     1
##          Shiny Spider Beetle          Southern Army Worm
##                                     1                                     1
##          Spirea Aphid                Spotted Sunflower Stem Weevil
##                                     1                                     1
##          Strawberry Blossom Weevil    Sunflower Midge
##                                     1                                     1
##          Sunflower Moth              Ten-spot Ladybird Beetle
##                                     1                                     1
##          Tobacco Thrip               Twicestabbed Lady Beetle
##                                     1                                     1
```

##	Wasp Family	Weevil
##	1	1
##	Yellow Mealworm Beetle	Alfalfa Plant Bug
##	1	2
##	Alkali Bee	Aphid
##	2	2
##	Assassin Bug	Azalea Lace Bug
##	2	2
##	Banana Aphid	Brown Scale
##	2	2
##	Brown Stinkbug	Budworm
##	2	2
##	Cabbage Aphid	Cabbage White
##	2	2
##	Cardamom Thrip	Carrot Weevil
##	2	2
##	Celer Crab Spider	Centipede Class
##	2	2
##	Citricola Scale	Clouded Plant Bug
##	2	2
##	Coffee Bean Weevil	Cotton Fleahopper
##	2	2
##	Egyptian Alfalfa Weevil	Engraver Beetle
##	2	2
##	Fig Longicorn Beetle	Glassy-winged Sharpshooter
##	2	2
##	Hawthorn Lace Bug	Hister Beetle Family
##	2	2
##	Jumping Spider Family	Lined Click Beetle
##	2	2
##	Maple Spider Mite	Meshweaver Spider
##	2	2
##	Minute Pirate Bug Family	Predaceous Fly
##	2	2
##	Pygmy Mangold Beetle	Rose Sawfly
##	2	2
##	Serpentine Leafminer	Spider Mite Destroyer
##	2	2
##	Spotted Tentiform Leafminer	Stink Bug
##	2	2
##	Tawny Mole Cricket	Tick/Chigger/Mite Order
##	2	2
##	Turf Running-spider	Turnip Aphid
##	2	2
##	Western Bigeyed Bug	Western Damsel Bug
##	2	2
##	Western Plant Bug	White-backed Planthopper
##	2	2
##	White Apple Leafhopper Nymph	Whitemarked Fleahopper
##	2	2
##	Ambrosia Bark Beetle	Asian Ambrosia Beetle
##	3	3
##	Beetle Family	Birch Leafminer
##	3	3

##	Black Twig Borer	Braconid Parasitoid Wasp
##	3	3
##	California Red Scale	Crucifer Flea Beetle
##	3	3
##	Cutworm	Delphacid Planthopper
##	3	3
##	Egyptian Cotton Leafworm	Encyrtid Parasitoid
##	3	3
##	Fly/Mosquito/Midge Order	Formosan Subterranean Termite
##	3	3
##	Fruit-tree Pinhole Borer	Green Rice Leafhopper
##	3	3
##	Ground Beetle	Ichneumonid Wasp
##	3	3
##	Large-Jawed Orb Weaver Family	Leaf Cutting Ant
##	3	3
##	Mediterranean Fruit Fly	Minute Flour Bug
##	3	3
##	Mite Family	Moth Family
##	3	3
##	Negatoria Canegrub	Sap Beetle Family
##	3	3
##	Scale Insect Order	Scarab Beetle Family
##	3	3
##	Sheet-Web Weaver Family	Spider
##	3	3
##	Sugarcane Grub	Tenebrionid Beetle
##	3	3
##	Ant	Cabbage Seedpod Weevil
##	4	4
##	Common Green Lacewing	Eucalyptus Gall Wasp
##	4	4
##	European Apple Sawfly	European Honey Bee
##	4	4
##	European Tarnished Plant Bug	Garden Symphytan
##	4	4
##	Linyphiid Spider	Onion Maggot
##	4	4
##	Oriental Beetle	Parsnip Seed Wasp
##	4	4
##	Pea And Bean Weevil	Pear Sucker
##	4	4
##	Red Imported Fire Ant	Striped Cucumber Beetle
##	4	4
##	Sugarcane Beetle	Wasp
##	4	4
##	Wolf Spider Family	Yellow-faced Bumblebee
##	4	4
##	Apple Aphid	Brown Planthopper
##	5	5
##	Earwig	Green June Beetle
##	5	5
##	Hornfaced Bee	Long Horned Beetle Family
##	5	5

##	Plum Curculio	Rove Beetle
##	5	5
##	San Jose Scale	Scelionid Wasp
##	5	5
##	Speckled Cutworm Moth	Thrip Family
##	5	5
##	Ambrosia Beetle	Aphid Wasp
##	6	6
##	Black Vine Weevil	Childers Canegrub
##	6	6
##	Coconut Leaf Beetle	Eleven-spotted Ladybird Beetle
##	6	6
##	Encyrtid Wasp	European Red Mite
##	6	6
##	Fall Armyworm	Fruit Fly
##	6	6
##	Hover Fly	Oblique Banded Leaf Roller
##	6	6
##	Obscure Mealybug	Oribatid Mite Suborder
##	6	6
##	Pistachio Psyllid	Redbay Ambrosia Beetle
##	6	6
##	Silverleaf Whitefly	Soybean Aphid
##	6	6
##	Subterranean Termite	Thrip
##	6	6
##	Two-Spotted Spider Mite	Beetle Mite Family
##	6	7
##	Chinch Bug	Macedonian Honey Bee
##	7	7
##	Moth	Potato Tuberworm
##	7	7
##	Russian Wheat Aphid	Soldier Beetle
##	7	7
##	Southern One-Year Canegrub	Tarnished Plant Bug
##	7	7
##	Alfalfa Leafcutter Bee	Bee
##	8	8
##	Bumblebee	Chilean Predatory Mite
##	8	8
##	Dwarf Honey Bee	Neotropical Stingless Bee
##	8	8
##	Parasitic Wasp Family	Spiralling Whitefly
##	8	8
##	Ant Family	Apple Maggot
##	9	9
##	Asiatic Honey Bee	Eulophid Parasitoid
##	9	9
##	Lacewing Family	Mealybug Destroyer
##	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	
##	667	

Answer: The six most commonly studied species in the dataset are the Italian Honeybee Bumble Bee Carniolan Honey Bee 113 140 152 Buff Tailed Bumblebee Parasitic Wasp Honey Bee 183 285 667 There are mostly bee species that are affected, and these are pollinators, which could cause pollinator declines and hurt crop production and species biodiversity. 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: The class is not an integer because not all of the values may be numbers, so Rstudio converts the whole thing to a string

Explore your data graphically (Neonics)

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

```
summary(neonics$Publication.Year)
```

```
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      1982   2005   2010   2008   2013   2019
```

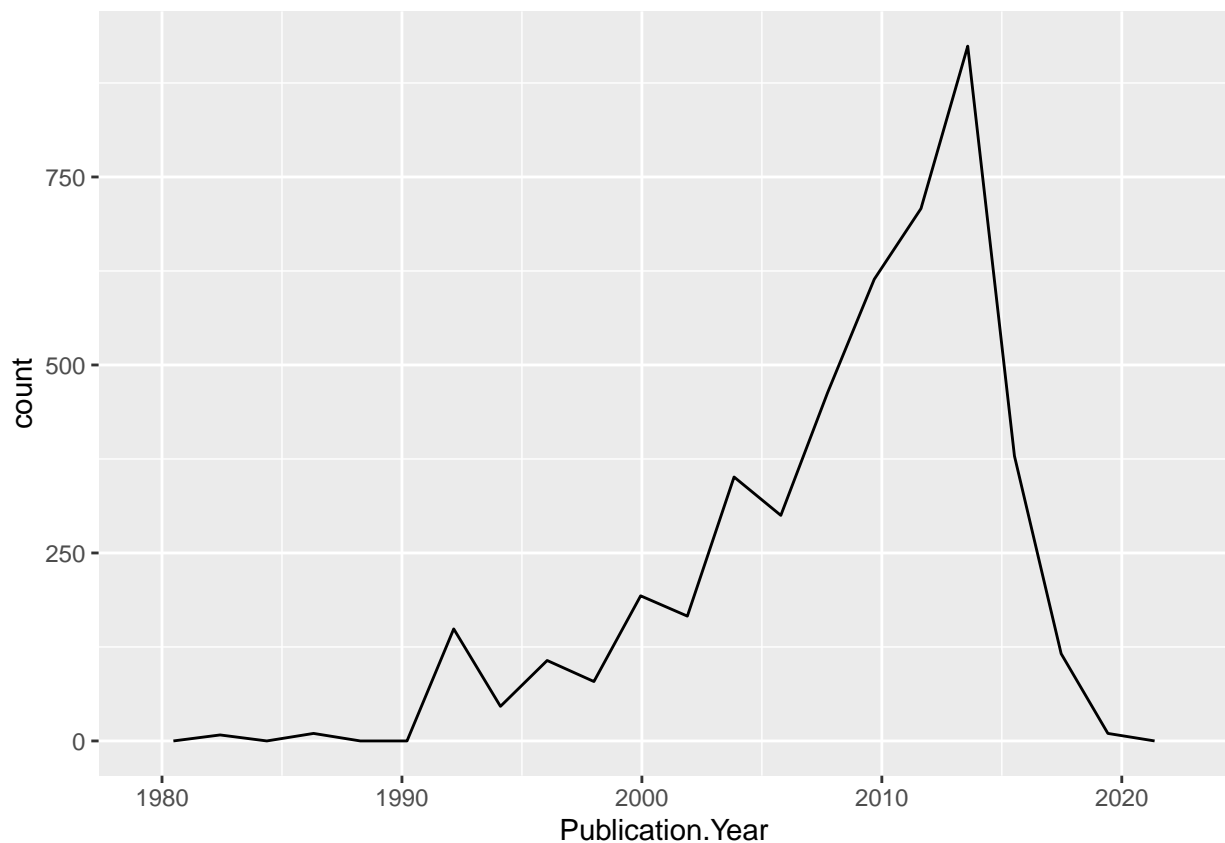
```
class(neonics$Publication.Year)
```

```
## [1] "integer"
```

```
neonics_plot <- ggplot(neonics) + geom_freqpoly(aes(x = Publication.Year), bins=20)
publication_year <- geom_freqpoly()
publication_year
```

```
## geom_path: na.rm = FALSE
## stat_bin: na.rm = FALSE, pad = TRUE
## position_identity
```

```
neonics_plot
```



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

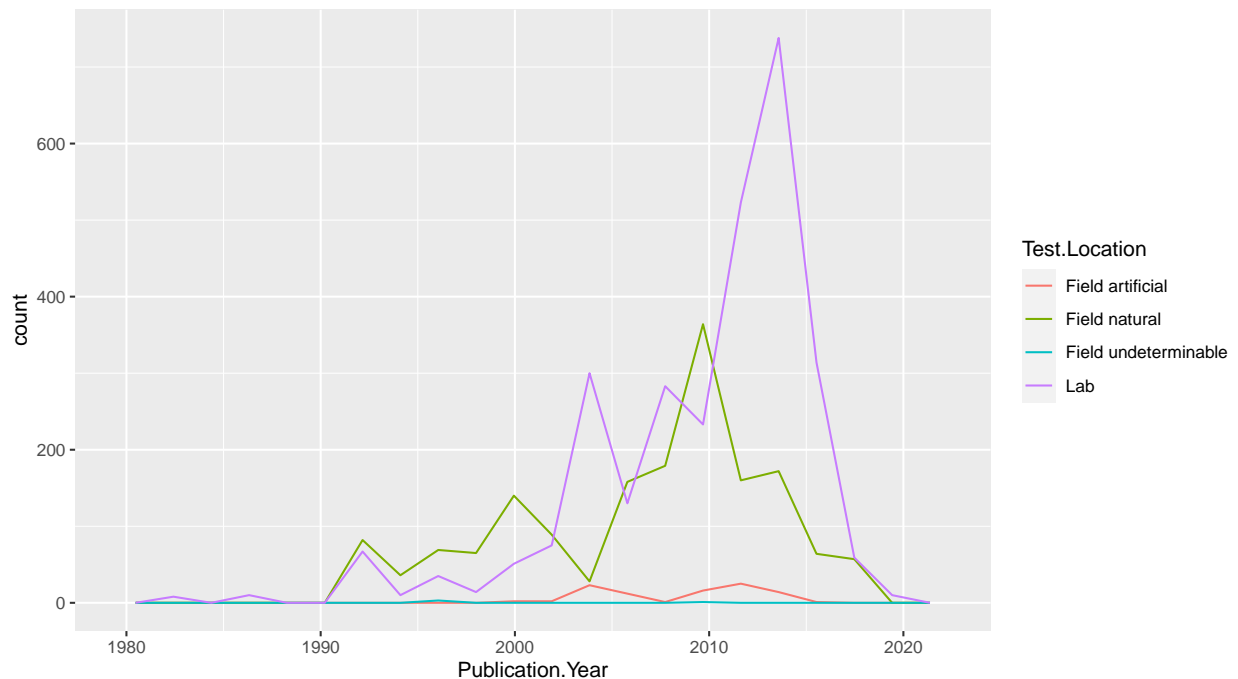
```
summary(neonics$Test.Location)
```

```
##      Field artificial      Field natural Field undeterminable
##              96              1663              4
##              Lab
##              2860
```

```
class(neonics$Test.Location)
```

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

```
color_graph <- ggplot(neonics) + geom_freqpoly(aes(x= Publication.Year, color = Test.Location), bins=20)
color_graph
```



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

Answer: The most common test locations occur in a lab setting, and this drastically increases between 2010 and 2020.

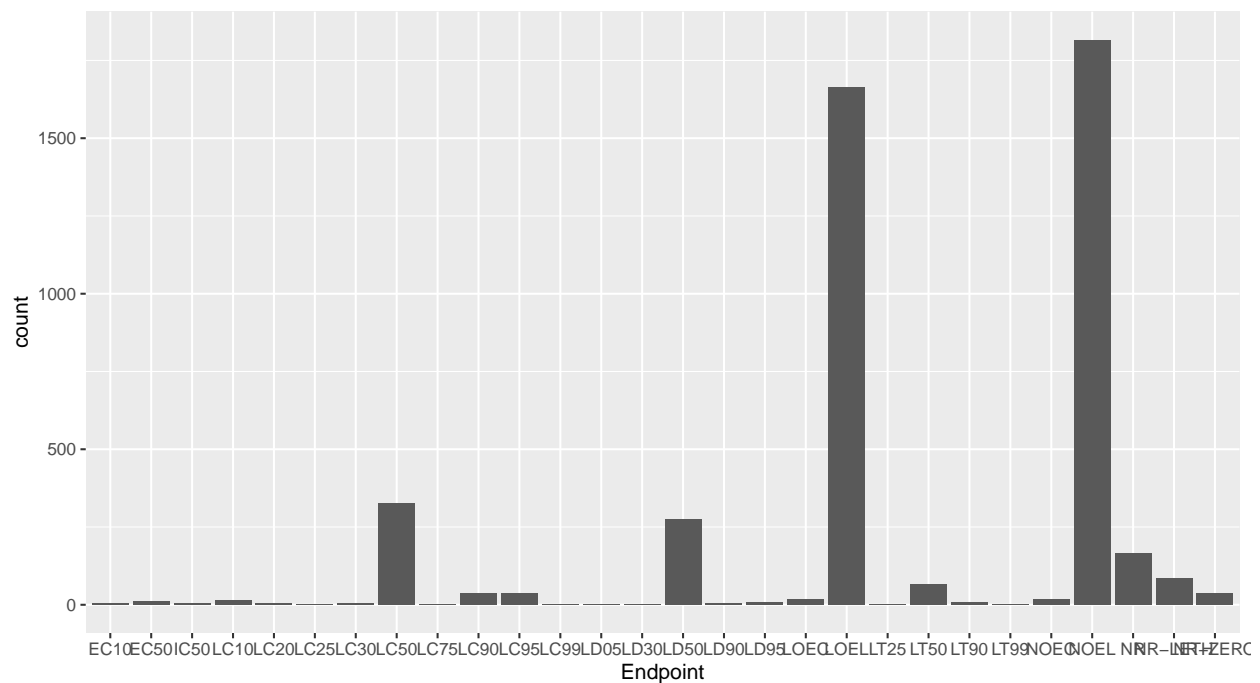
11. Create a bar graph of Endpoint counts. What are the two most common end points, and how are they defined? Consult the ECOTOX_CodeAppendix for more information.

[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...]

```
summary(neonics$Endpoint)
```

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

```
#ggplot(neonics) + geom_histogram(aes(x= Endpoint, color = 'red'))
endpoint_graph<- ggplot(neonics)+geom_bar(aes(x=Endpoint))
endpoint_graph
```



Answer:

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.

The two dates that were sampled in 2018 are 2018-08-02 2018-08-30

```
litterclass <- class(litter$collectDate)
litterclass
```

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

```
litterymd<- ymd(litter$collectDate)
litterymd
```

```
## [1] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
## [6] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
## [11] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
## [16] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
## [21] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
## [26] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
## [31] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
## [36] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
## [41] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
## [46] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
## [51] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
## [56] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
## [61] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
## [66] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
## [71] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
## [76] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
## [81] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
## [86] "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02" "2018-08-02"
## [91] "2018-08-02" "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30"
## [96] "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30"
## [101] "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30"
## [106] "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30"
## [111] "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30"
## [116] "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30"
## [121] "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30"
## [126] "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30"
## [131] "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30"
## [136] "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30"
## [141] "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30"
## [146] "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30"
## [151] "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30"
## [156] "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30"
## [161] "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30"
## [166] "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30"
## [171] "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30"
## [176] "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30"
## [181] "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30"
## [186] "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30" "2018-08-30"
```

```
litterunique<- unique(litter$collectDate)
litterunique
```

```
## [1] 2018-08-02 2018-08-30
## Levels: 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$namedLocation)
```

```
## [1] NIWO_061.basePlot.ltr NIWO_064.basePlot.ltr NIWO_067.basePlot.ltr
## [4] NIWO_040.basePlot.ltr NIWO_041.basePlot.ltr NIWO_063.basePlot.ltr
## [7] NIWO_047.basePlot.ltr NIWO_051.basePlot.ltr NIWO_058.basePlot.ltr
## [10] NIWO_046.basePlot.ltr NIWO_062.basePlot.ltr NIWO_057.basePlot.ltr
## 12 Levels: NIWO_040.basePlot.ltr ... NIWO_067.basePlot.ltr
```

```
summary(litter$namedLocation)
```

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

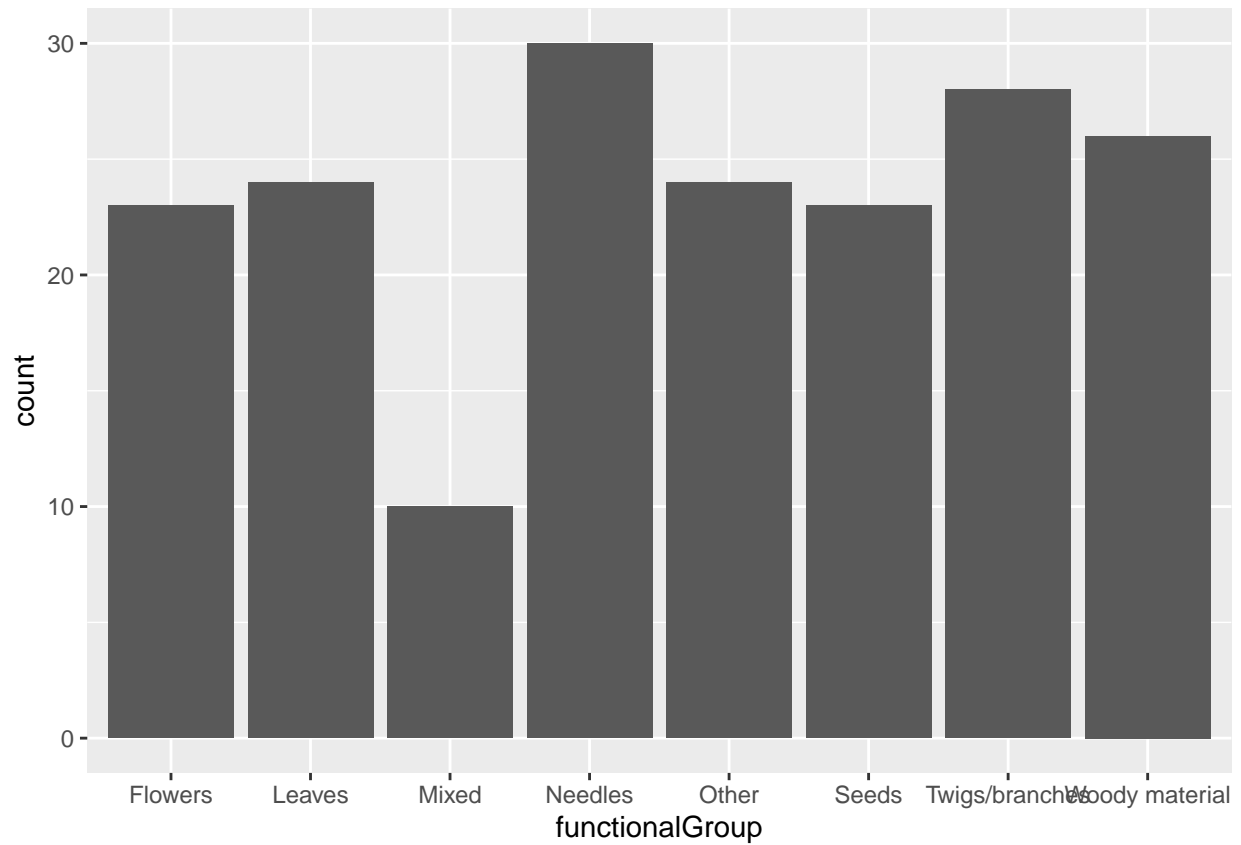
Answer: When you use summary, it provides a count for how many times each unique plot was sampled. While unique sends back a list of the unique location plots, but not how many times they were sampled. It returned 12 samples

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.

```
summary(litter$functionalGroup)
```

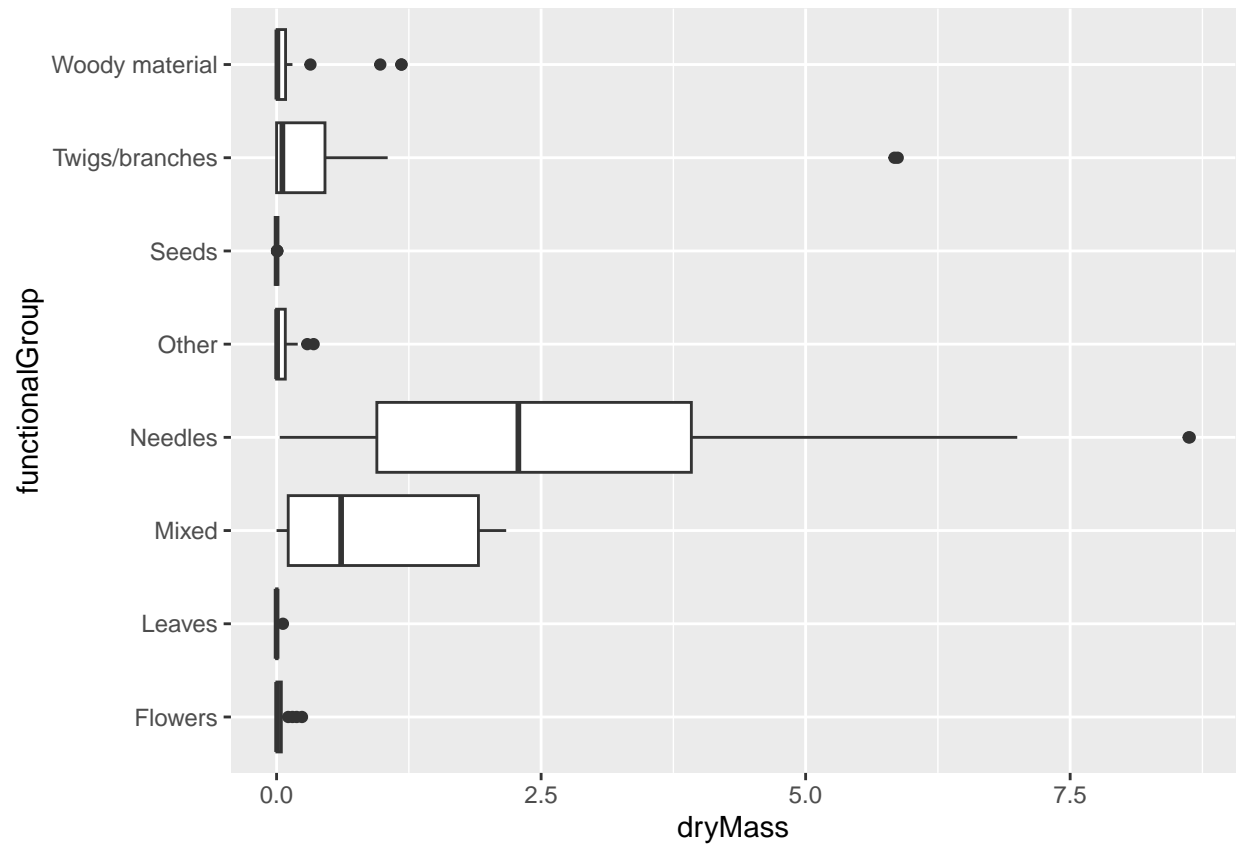
```
##      Flowers      Leaves      Mixed      Needles      Other
##         23         24         10         30         24
##      Seeds Twigs/branches Woody material
##         23         28         26
```

```
functionalgroup_graph <- ggplot(litter) + geom_bar(aes(x= functionalGroup))
functionalgroup_graph
```

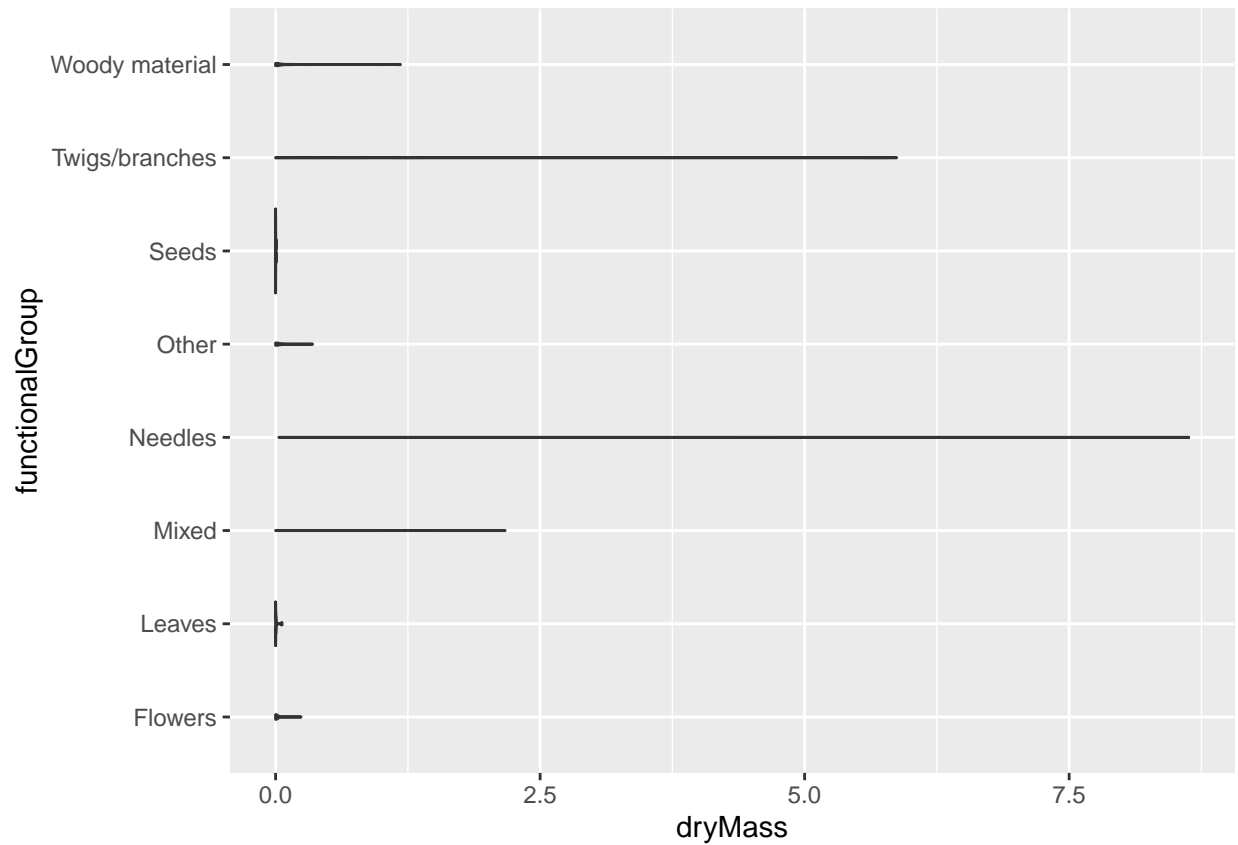



15. Using `geom_boxplot` and `geom_violin`, create a boxplot and a violin plot of `dryMass` by `functionalGroup`.

```
#summary(litter$functionalGroup)
ggplot(litter) + geom_boxplot(aes(x= dryMass, y= functionalGroup))
```



```
litter_boxplot<- ggplot(litter) + geom_violin(aes(x= dryMass, y= functionalGroup))  
litter_boxplot
```



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

Answer: The boxplot is a more efficient visualization because it shows outliers in the data rather than implying that the drymass continues to the endpoints

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

Answer: twigs, branches, and needles