

Assignment 5: Data Visualization

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OVERVIEW

This exercise accompanies the lessons in Environmental Data Analytics on Data Visualization

Directions

1. Rename this file `<FirstLast>_A02_CodingBasics.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. Be sure to **answer the questions** in this assignment document.
5. When you have completed the assignment, **Knit** the text and code into a single PDF file.

The completed exercise is due on Friday, Oct 21st @ 5:00pm.

Set up your session

1. Set up your session. Verify your working directory and load the tidyverse, lubridate, & cowplot packages.
2. Make sure R is reading dates as date format; if not change the format to date.

```
## 1. Verify working directory
```

```
getwd()
```

```
## [1] "C:/Users/sasho/Desktop/Environ Data Analytics/Env872 Workspace/EDA-Fall2022_SM/Assignments"
```

```
setwd("C:/Users/sasho/Desktop/Environ Data Analytics/Env872 Workspace/EDA-Fall2022_SM")
```

```
# b. Load packages
```

```
library(tidyverse)
```

```
## -- Attaching packages ----- tidyverse 1.3.2 --
```

```
## v ggplot2 3.3.6      v purrr   0.3.4
```

```
## v tibble  3.1.8      v dplyr  1.0.10
```

```
## v tidyr   1.2.1      v stringr 1.4.1
```

```
## v readr   2.1.2      v forcats 0.5.2
```

```
## -- Conflicts ----- tidyverse_conflicts() --
```

```
## x dplyr::filter() masks stats::filter()
```

```
## x dplyr::lag()    masks stats::lag()
```

```
library(lubridate)
```

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

```
library(cowplot)
```

```
##  
## Attaching package: 'cowplot'  
##  
## The following object is masked from 'package:lubridate':  
##  
##    stamp
```

```
# c. Load datasets
```

```
lake_chemistry <- read.csv("./Data/Processed/NTL-LTER_Lake_Chemistry_Nutrients_PeterPaul_Processed.csv",  
  stringsAsFactors = TRUE)
```

```
litter_dat <- read.csv("./Data/Processed/NEON_NIWO_Litter_mass_trap_Processed.csv",  
  stringsAsFactors = TRUE)
```

```
# 2. Check that date is in date format
```

```
### Lake Chemistry data set
```

```
class(lake_chemistry$sampdate)
```

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

```
lake_chemistry$sampdate <- ymd(lake_chemistry$sampdate)  
class(lake_chemistry$sampdate) # Recheck class of data
```

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

```
View(lake_chemistry) #View data to view variable
```

```
### Litter data set
```

```
class(litter_dat$collectDate)
```

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

```
litter_dat$collectDate <- ymd(litter_dat$collectDate)  
class(litter_dat$collectDate) #Recheck class of data
```

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

```
View(litter_dat)
```

Define your theme

3. Build a theme and set it as your default theme.

```
# 3. Building a theme

my_theme <- theme_bw(base_size = 12) + theme(axis.text = element_text(color = "black"),
  legend.position = "top", legend.justification = "center") +
  theme(plot.title = element_text(hjust = 0.5))
theme_set(my_theme)
```

Create graphs

For numbers 4-7, create ggplot graphs and adjust aesthetics to follow best practices for data visualization. Ensure your theme, color palettes, axes, and additional aesthetics are edited accordingly.

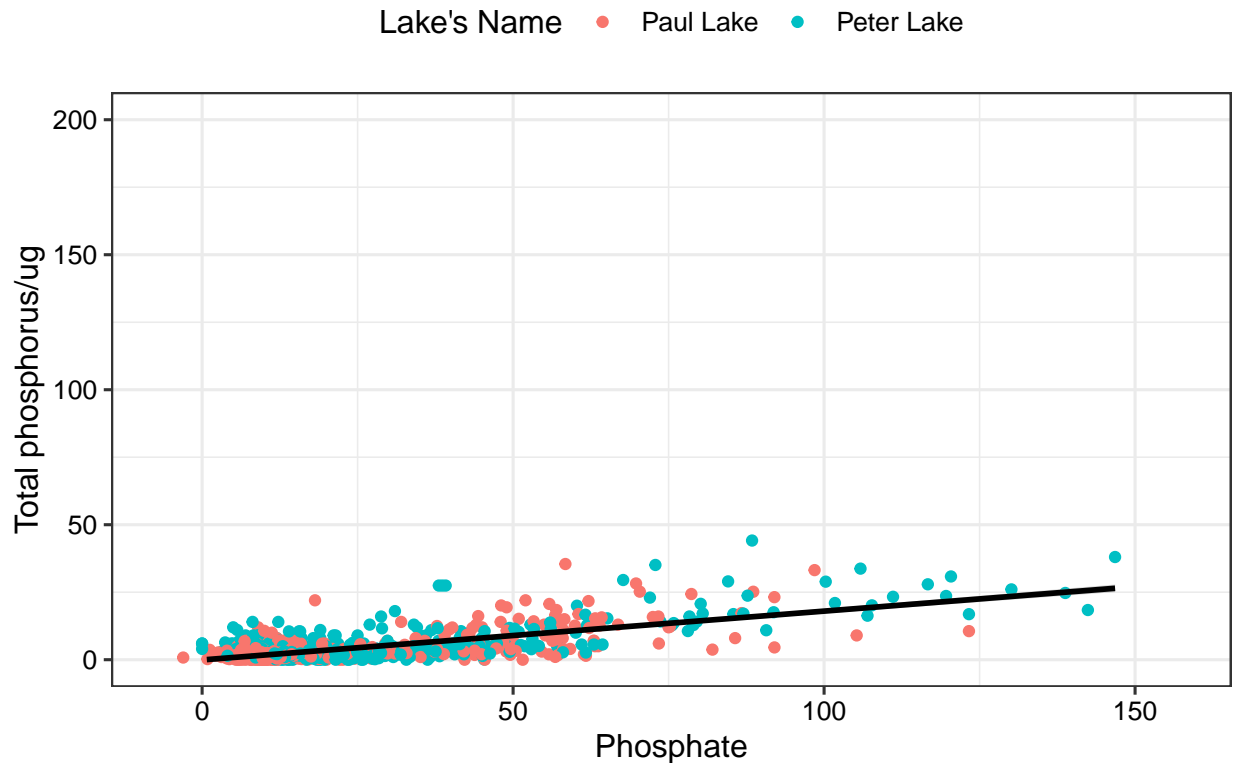
4. [NTL-LTER] Plot total phosphorus (tp_ug) by phosphate (po4), with separate aesthetics for Peter and Paul lakes. Add a line of best fit and color it black. Adjust your axes to hide extreme values (hint: change the limits using `xlim()` and/or `ylim()`).

```
# 4. Plot of total phosphorus by
# phosphate

ggplot(lake_chemistry, aes(x = tp_ug, y = po4,
  color = lakename)) + geom_point() + geom_smooth(method = lm,
  color = "black") + xlab("Phosphate") +
  ylab("Total phosphorus/ug") + ylim(0,
  200) + ggtitle("Total phosphorus by phosphate for Peter and Paul Lakes") +
  labs(color = "Lake's Name")
```

```
## 'geom_smooth()' using formula 'y ~ x'
```

Total phosphorus by phosphate for Peter and Paul Lakes



5. [NTL-LTER] Make three separate boxplots of (a) temperature, (b) TP, and (c) TN, with month as the x axis and lake as a color aesthetic. Then, create a cowplot that combines the three graphs. Make sure that only one legend is present and that graph axes are aligned.

Tip: R has a built-in variable called `month.abb` that returns a list of months; see <https://r-lang.com/month-abb-in-r-with-example>

```
# 5. Boxplots of Temperature, TP, and
# TN

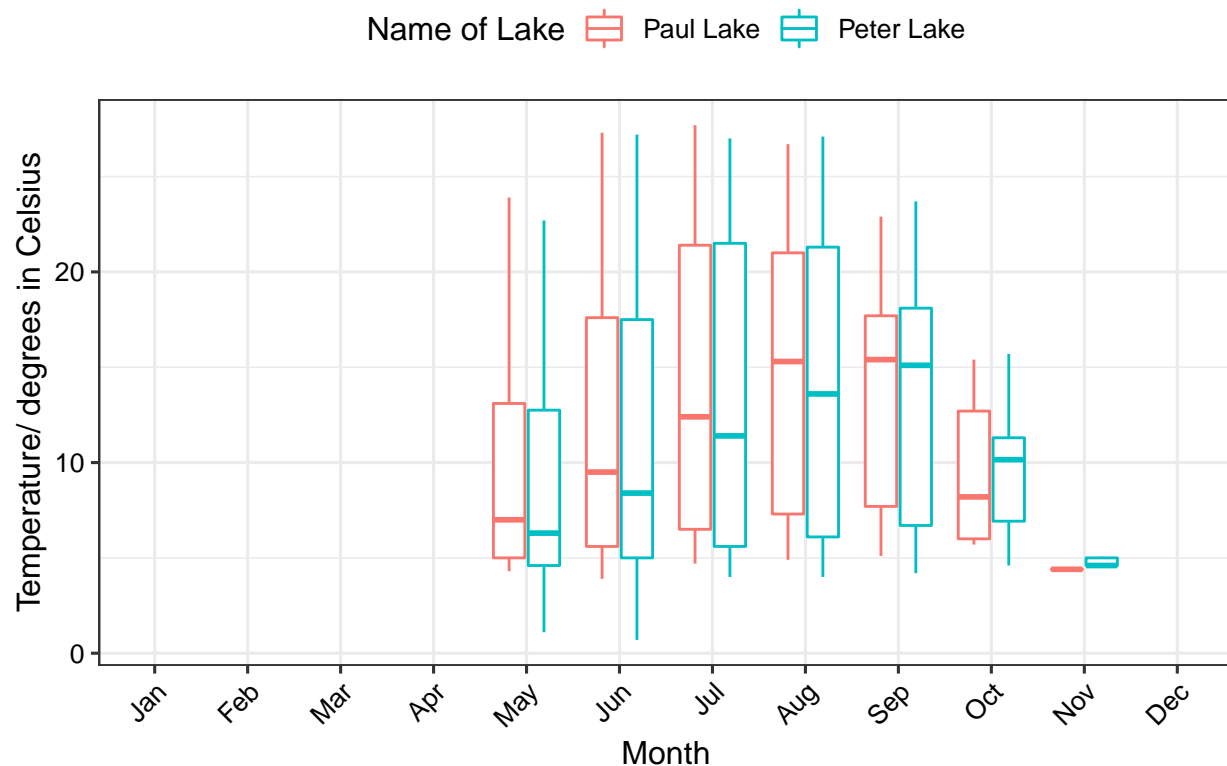
#### Separate boxplots

temp.plot <- ggplot(lake_chemistry, aes(x = factor(month,
  levels = c(1:12), labels = month.abb),
  y = temperature_C)) + geom_boxplot(aes(color = lakename)) +
  xlab("Month") + ylab("Temperature/ degrees in Celsius") +
  ggtitle(" Boxplot of Temperature of Peter and Paul Lake") +
  labs(color = "Name of Lake") + scale_x_discrete(drop = FALSE) +
  theme(axis.text.x = element_text(angle = 45,
    hjust = 1))

temp.plot #View graph
```

```
## Warning: Removed 3566 rows containing non-finite values (stat_boxplot).
```

Boxplot of Temperature of Peter and Paul Lake

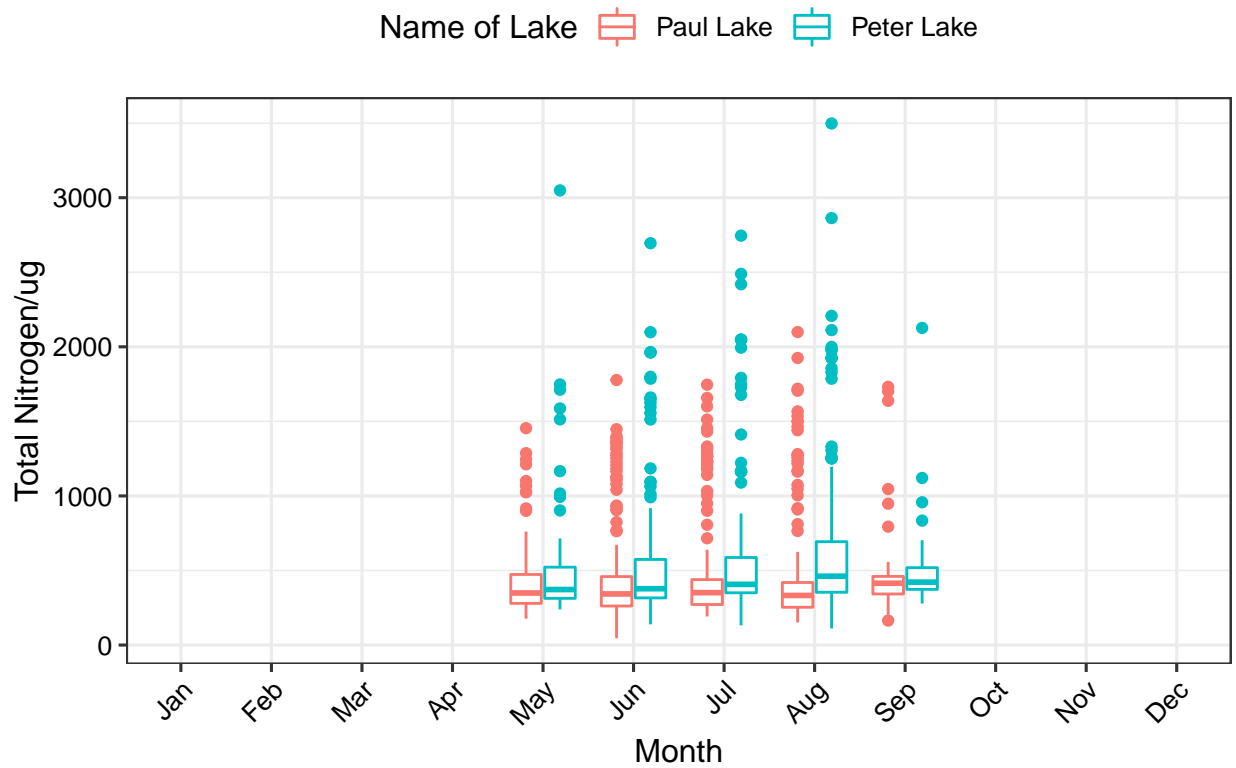


```
nitrogen.plot <- ggplot(lake_chemistry, aes(x = factor(month,
  levels = c(1:12), labels = month.abb),
  y = tn_ug)) + geom_boxplot(aes(color = lakename)) +
  xlab("Month") + ylab("Total Nitrogen/ug") +
  ggtitle(" Boxplot of Total Nitrogen of Peter and Paul Lake") +
  labs(color = "Name of Lake") + scale_x_discrete(drop = FALSE) +
  theme(axis.text.x = element_text(angle = 45,
    hjust = 1))
```

```
nitrogen.plot #View graph
```

```
## Warning: Removed 21583 rows containing non-finite values (stat_boxplot).
```

Boxplot of Total Nitrogen of Peter and Paul Lake

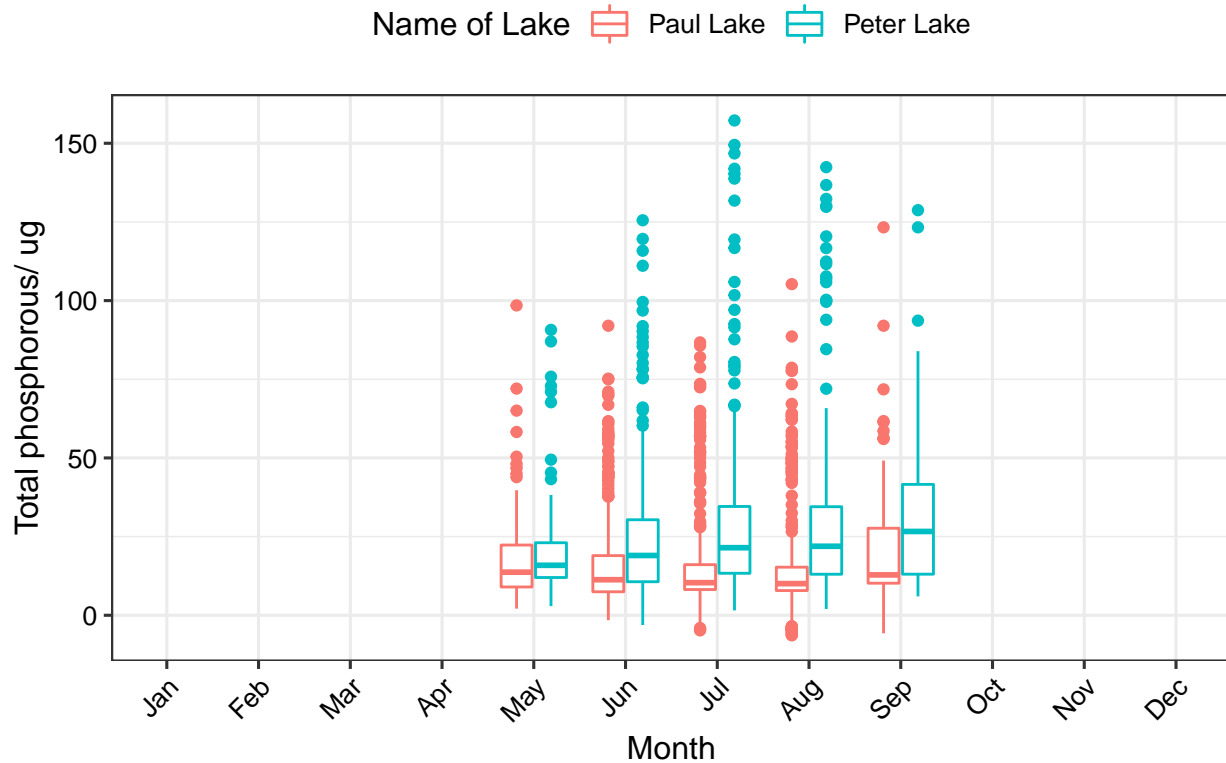


```
phosphorus.plot <- ggplot(lake_chemistry,
  aes(x = factor(month, levels = c(1:12),
    labels = month.abb), y = tp_ug)) +
  geom_boxplot(aes(color = lakename)) +
  xlab("Month") + ylab("Total phosphorous/ ug") +
  ggtitle(" Boxplot of Total Phosphorus of Peter and Paul Lake") +
  labs(color = "Name of Lake") + scale_x_discrete(drop = FALSE) +
  theme(axis.text.x = element_text(angle = 45,
    hjust = 1))
```

```
phosphorus.plot #View plot
```

```
## Warning: Removed 20729 rows containing non-finite values (stat_boxplot).
```

Boxplot of Total Phosphorus of Peter and Paul Lake



```
### Joint Plot
```

```
c.legend <- get_legend(temp.plot)
```

```
## Warning: Removed 3566 rows containing non-finite values (stat_boxplot).
```

```
title <- ggdraw() + draw_figure_label("Boxplots of Temperature, Total Phosphorus  
and Nitrogen of Peter and Paul Lake",  
  position = "top.left")
```

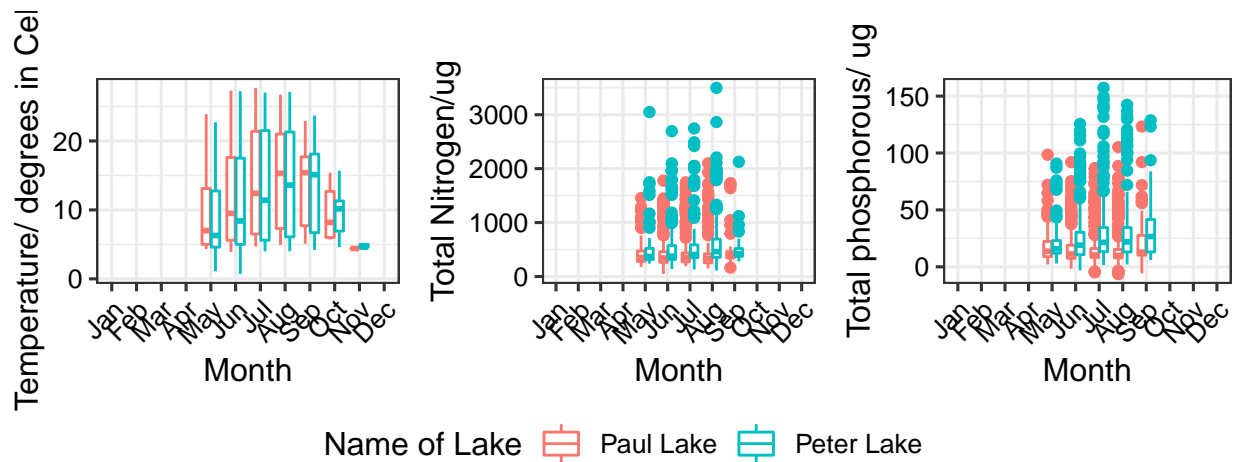
```
combined_plot <- plot_grid(temp.plot + theme(legend.position = "none") +  
  ggtitle(""), nitrogen.plot + theme(legend.position = "none") +  
  ggtitle(""), phosphorus.plot + theme(legend.position = "none") +  
  ggtitle(""), nrow = 1, align = "h")
```

```
## Warning: Removed 3566 rows containing non-finite values (stat_boxplot).
```

```
## Warning: Removed 21583 rows containing non-finite values (stat_boxplot).
```

```
## Warning: Removed 20729 rows containing non-finite values (stat_boxplot).
```

```
plot_grid(combined_plot, c.legend, title,
          nrow = 3, rel_heights = c(5, 1))
```



Boxplots of Temperature, Total Phosphorus
and Nitrogen of Peter and Paul Lake

Question: What do you observe about the variables of interest over seasons and between lakes?

Answer: I observe that as we move from spring to summer (August), there is a general increase in median temperature levels for both Peter and Paul Lake, with Paul Lake experiencing higher overall temperatures. Beginning in fall (September), there is an overall decrease in median temperatures across both lakes, with Peter Lake experiencing lower temperatures except in the month of October. Generally, Paul Lake had lower total median nitrogen levels when compared to Peter Lake over all seasons measured (end of spring - early fall). Noticeably, the levels of total nitrogen for most of the data points were fairly consistent for both lakes over the same period. For total phosphorus, the median levels observed at Peter Lake were generally greater than the levels observed at Paul Lake over the observed seasons (late spring to early fall). Further, there was a steady increase in total median phosphorus levels observed at Peter Lake over the same period. Conversely, total median phosphorus levels at Paul Lake from late spring to early fall remained fairly steady.

6. [Niwot Ridge] Plot a subset of the litter data-set by displaying only the “Needles” functional group. Plot the dry mass of needle litter by date and separate by NLCD class with a color aesthetic. (no need to adjust the name of each land use)
7. [Niwot Ridge] Now, plot the same plot but with NLCD classes separated into three facets rather than separated by color.

6.

```
subset_litter_dat <- litter_dat %>%  
  filter(functionalGroup == "Needles")
```

```
subset_litter_dat #View data
```

	plotID	trapID	collectDate	functionalGroup	dryMass	qaDryMass
## 1	NIWO_058	NIWO_058_101	2016-06-16	Needles	1.110	Y
## 2	NIWO_047	NIWO_047_197	2016-06-16	Needles	0.540	N
## 3	NIWO_057	NIWO_057_081	2016-06-16	Needles	20.960	N
## 4	NIWO_064	NIWO_064_103	2016-06-16	Needles	3.560	N
## 5	NIWO_061	NIWO_061_169	2016-06-16	Needles	15.540	Y
## 6	NIWO_062	NIWO_062_050	2016-06-16	Needles	2.490	N
## 7	NIWO_046	NIWO_046_155	2016-07-14	Needles	16.860	Y
## 8	NIWO_051	NIWO_051_045	2016-07-14	Needles	4.140	Y
## 9	NIWO_047	NIWO_047_197	2016-07-14	Needles	0.310	Y
## 10	NIWO_061	NIWO_061_169	2016-07-14	Needles	0.900	Y
## 11	NIWO_067	NIWO_067_017	2016-07-14	Needles	11.180	Y
## 12	NIWO_041	NIWO_041_059	2016-07-14	Needles	12.290	Y
## 13	NIWO_062	NIWO_062_050	2016-07-14	Needles	1.710	Y
## 14	NIWO_051	NIWO_051_045	2016-08-11	Needles	0.300	N
## 15	NIWO_063	NIWO_063_062	2016-08-11	Needles	0.610	N
## 16	NIWO_041	NIWO_041_059	2016-08-11	Needles	1.580	Y
## 17	NIWO_058	NIWO_058_101	2016-08-11	Needles	0.890	Y
## 18	NIWO_046	NIWO_046_155	2016-08-11	Needles	4.090	N
## 19	NIWO_062	NIWO_062_050	2016-08-11	Needles	0.470	N
## 20	NIWO_061	NIWO_061_169	2016-08-11	Needles	1.880	N
## 21	NIWO_057	NIWO_057_081	2016-08-11	Needles	1.320	N
## 22	NIWO_067	NIWO_067_017	2016-08-11	Needles	2.290	N
## 23	NIWO_040	NIWO_040_205	2016-08-11	Needles	1.580	Y
## 24	NIWO_047	NIWO_047_197	2016-08-11	Needles	0.060	N
## 25	NIWO_062	NIWO_062_050	2016-09-08	Needles	1.030	N
## 26	NIWO_057	NIWO_057_081	2016-09-08	Needles	9.430	N
## 27	NIWO_063	NIWO_063_062	2016-09-08	Needles	0.420	N
## 28	NIWO_046	NIWO_046_155	2016-09-08	Needles	12.300	Y
## 29	NIWO_064	NIWO_064_103	2016-09-08	Needles	3.290	Y
## 30	NIWO_067	NIWO_067_017	2016-09-08	Needles	9.060	Y
## 31	NIWO_041	NIWO_041_059	2016-09-08	Needles	2.520	N
## 32	NIWO_051	NIWO_051_045	2016-09-08	Needles	0.210	N
## 33	NIWO_058	NIWO_058_101	2016-09-08	Needles	0.840	Y
## 34	NIWO_061	NIWO_061_169	2016-09-08	Needles	3.370	Y
## 35	NIWO_040	NIWO_040_205	2016-09-08	Needles	4.370	Y
## 36	NIWO_046	NIWO_046_155	2016-10-07	Needles	14.790	Y
## 37	NIWO_057	NIWO_057_081	2016-10-07	Needles	42.840	Y
## 38	NIWO_047	NIWO_047_197	2016-10-07	Needles	54.230	Y
## 39	NIWO_062	NIWO_062_050	2016-10-07	Needles	3.830	N
## 40	NIWO_064	NIWO_064_103	2016-10-07	Needles	11.100	N
## 41	NIWO_041	NIWO_041_059	2016-10-07	Needles	9.950	Y
## 42	NIWO_051	NIWO_051_045	2016-10-07	Needles	7.400	Y
## 43	NIWO_063	NIWO_063_062	2016-10-07	Needles	2.190	N
## 44	NIWO_058	NIWO_058_101	2016-10-07	Needles	4.990	N
## 45	NIWO_067	NIWO_067_017	2016-10-07	Needles	23.320	N

## 46	NIWO_040	NIWO_040_205	2016-10-07	Needles	15.260	Y
## 47	NIWO_040	NIWO_040_205	2016-11-03	Needles	12.350	N
## 48	NIWO_051	NIWO_051_045	2016-11-03	Needles	1.860	N
## 49	NIWO_058	NIWO_058_101	2016-11-03	Needles	1.380	Y
## 50	NIWO_062	NIWO_062_050	2016-11-03	Needles	1.920	Y
## 51	NIWO_046	NIWO_046_155	2016-11-03	Needles	8.300	Y
## 52	NIWO_063	NIWO_063_062	2016-11-03	Needles	0.700	N
## 53	NIWO_061	NIWO_061_169	2016-11-03	Needles	21.670	N
## 54	NIWO_064	NIWO_064_103	2016-11-03	Needles	6.530	N
## 55	NIWO_057	NIWO_057_081	2016-11-03	Needles	26.750	N
## 56	NIWO_067	NIWO_067_017	2016-11-03	Needles	10.860	N
## 57	NIWO_041	NIWO_041_059	2016-11-03	Needles	6.400	N
## 58	NIWO_064	NIWO_064_103	2017-07-06	Needles	6.920	N
## 59	NIWO_040	NIWO_040_205	2017-07-06	Needles	39.370	N
## 60	NIWO_041	NIWO_041_059	2017-07-06	Needles	19.090	N
## 61	NIWO_062	NIWO_062_050	2017-07-06	Needles	4.490	N
## 62	NIWO_047	NIWO_047_197	2017-07-06	Needles	0.990	N
## 63	NIWO_046	NIWO_046_155	2017-07-07	Needles	8.910	N
## 64	NIWO_061	NIWO_061_169	2017-07-07	Needles	26.290	N
## 65	NIWO_057	NIWO_057_081	2017-07-07	Needles	33.300	Y
## 66	NIWO_067	NIWO_067_017	2017-07-07	Needles	49.240	N
## 67	NIWO_058	NIWO_058_101	2017-07-07	Needles	1.360	Y
## 68	NIWO_063	NIWO_063_062	2017-07-07	Needles	1.290	N
## 69	NIWO_051	NIWO_051_045	2017-07-07	Needles	2.840	Y
## 70	NIWO_040	NIWO_040_205	2017-08-03	Needles	2.550	Y
## 71	NIWO_064	NIWO_064_103	2017-08-03	Needles	0.820	Y
## 72	NIWO_062	NIWO_062_050	2017-08-03	Needles	0.040	N
## 73	NIWO_047	NIWO_047_197	2017-08-03	Needles	0.005	N
## 74	NIWO_041	NIWO_041_059	2017-08-03	Needles	0.970	Y
## 75	NIWO_057	NIWO_057_081	2017-08-03	Needles	2.690	Y
## 76	NIWO_067	NIWO_067_017	2017-08-03	Needles	14.070	Y
## 77	NIWO_063	NIWO_063_062	2017-08-03	Needles	0.480	Y
## 78	NIWO_058	NIWO_058_101	2017-08-03	Needles	0.370	N
## 79	NIWO_051	NIWO_051_045	2017-08-03	Needles	0.190	N
## 80	NIWO_061	NIWO_061_169	2017-08-03	Needles	0.920	Y
## 81	NIWO_046	NIWO_046_155	2017-08-03	Needles	0.430	N
## 82	NIWO_057	NIWO_057_081	2017-08-31	Needles	10.670	N
## 83	NIWO_051	NIWO_051_045	2017-08-31	Needles	0.005	N
## 84	NIWO_063	NIWO_063_062	2017-08-31	Needles	1.090	Y
## 85	NIWO_062	NIWO_062_050	2017-08-31	Needles	0.610	Y
## 86	NIWO_046	NIWO_046_155	2017-08-31	Needles	3.260	Y
## 87	NIWO_058	NIWO_058_101	2017-08-31	Needles	2.710	N
## 88	NIWO_040	NIWO_040_205	2017-08-31	Needles	3.780	N
## 89	NIWO_064	NIWO_064_103	2017-08-31	Needles	1.800	N
## 90	NIWO_041	NIWO_041_059	2017-10-12	Needles	21.570	Y
## 91	NIWO_051	NIWO_051_045	2017-10-12	Needles	1.290	N
## 92	NIWO_063	NIWO_063_062	2017-10-12	Needles	7.010	N
## 93	NIWO_062	NIWO_062_050	2017-10-12	Needles	3.250	N
## 94	NIWO_057	NIWO_057_081	2017-10-12	Needles	34.580	Y
## 95	NIWO_067	NIWO_067_017	2017-10-12	Needles	4.150	N
## 96	NIWO_040	NIWO_040_205	2017-10-12	Needles	14.510	Y
## 97	NIWO_058	NIWO_058_101	2017-10-12	Needles	6.810	N
## 98	NIWO_046	NIWO_046_155	2017-10-12	Needles	11.790	Y
## 99	NIWO_061	NIWO_061_169	2017-10-12	Needles	7.170	N

## 100	NIWO_064	NIWO_064_103	2017-10-12	Needles	5.250	N
## 101	NIWO_063	NIWO_063_062	2017-11-20	Needles	4.670	N
## 102	NIWO_063	NIWO_063_062	2018-06-07	Needles	1.810	N
## 103	NIWO_062	NIWO_062_050	2018-06-07	Needles	4.510	N
## 104	NIWO_061	NIWO_061_169	2018-06-07	Needles	3.900	Y
## 105	NIWO_061	NIWO_061_169	2018-06-07	Needles	3.910	N
## 106	NIWO_057	NIWO_057_081	2018-06-07	Needles	11.390	N
## 107	NIWO_040	NIWO_040_205	2018-06-07	Needles	5.620	Y
## 108	NIWO_040	NIWO_040_205	2018-06-07	Needles	5.620	N
## 109	NIWO_047	NIWO_047_197	2018-06-07	Needles	1.890	Y
## 110	NIWO_047	NIWO_047_197	2018-06-07	Needles	1.900	N
## 111	NIWO_058	NIWO_058_101	2018-06-07	Needles	1.180	N
## 112	NIWO_064	NIWO_064_103	2018-06-07	Needles	2.860	N
## 113	NIWO_063	NIWO_063_062	2018-07-05	Needles	7.340	N
## 114	NIWO_046	NIWO_046_155	2018-07-05	Needles	15.100	N
## 115	NIWO_062	NIWO_062_050	2018-07-05	Needles	1.060	Y
## 116	NIWO_062	NIWO_062_050	2018-07-05	Needles	1.050	N
## 117	NIWO_061	NIWO_061_169	2018-07-05	Needles	2.440	N
## 118	NIWO_061	NIWO_061_169	2018-07-05	Needles	2.460	Y
## 119	NIWO_057	NIWO_057_081	2018-07-05	Needles	2.970	Y
## 120	NIWO_057	NIWO_057_081	2018-07-05	Needles	2.960	N
## 121	NIWO_067	NIWO_067_017	2018-07-05	Needles	8.880	N
## 122	NIWO_040	NIWO_040_205	2018-07-05	Needles	1.810	N
## 123	NIWO_041	NIWO_041_059	2018-07-05	Needles	25.320	N
## 124	NIWO_047	NIWO_047_197	2018-07-05	Needles	0.350	N
## 125	NIWO_051	NIWO_051_045	2018-07-05	Needles	22.860	N
## 126	NIWO_058	NIWO_058_101	2018-07-05	Needles	1.520	N
## 127	NIWO_061	NIWO_061_169	2018-08-02	Needles	1.000	N
## 128	NIWO_064	NIWO_064_103	2018-08-02	Needles	3.060	N
## 129	NIWO_067	NIWO_067_017	2018-08-02	Needles	0.930	N
## 130	NIWO_040	NIWO_040_205	2018-08-02	Needles	3.240	N
## 131	NIWO_040	NIWO_040_205	2018-08-02	Needles	3.160	Y
## 132	NIWO_063	NIWO_063_062	2018-08-02	Needles	0.240	N
## 133	NIWO_041	NIWO_041_059	2018-08-02	Needles	1.790	N
## 134	NIWO_047	NIWO_047_197	2018-08-02	Needles	0.030	N
## 135	NIWO_051	NIWO_051_045	2018-08-02	Needles	0.470	N
## 136	NIWO_058	NIWO_058_101	2018-08-02	Needles	1.640	N
## 137	NIWO_058	NIWO_058_101	2018-08-02	Needles	1.670	Y
## 138	NIWO_046	NIWO_046_155	2018-08-02	Needles	3.920	Y
## 139	NIWO_046	NIWO_046_155	2018-08-02	Needles	3.920	N
## 140	NIWO_062	NIWO_062_050	2018-08-02	Needles	0.320	N
## 141	NIWO_061	NIWO_061_169	2018-08-02	Needles	1.000	Y
## 142	NIWO_041	NIWO_041_059	2018-08-30	Needles	8.630	Y
## 143	NIWO_041	NIWO_041_059	2018-08-30	Needles	8.620	N
## 144	NIWO_047	NIWO_047_197	2018-08-30	Needles	0.420	N
## 145	NIWO_051	NIWO_051_045	2018-08-30	Needles	0.900	N
## 146	NIWO_058	NIWO_058_101	2018-08-30	Needles	2.820	N
## 147	NIWO_063	NIWO_063_062	2018-08-30	Needles	0.300	N
## 148	NIWO_046	NIWO_046_155	2018-08-30	Needles	7.000	N
## 149	NIWO_062	NIWO_062_050	2018-08-30	Needles	3.980	N
## 150	NIWO_061	NIWO_061_169	2018-08-30	Needles	1.530	N
## 151	NIWO_064	NIWO_064_103	2018-08-30	Needles	2.820	N
## 152	NIWO_057	NIWO_057_081	2018-08-30	Needles	4.090	N
## 153	NIWO_067	NIWO_067_017	2018-08-30	Needles	2.280	N

## 154	NIWO_067	NIWO_067_017	2018-08-30	Needles	2.290	Y
## 155	NIWO_040	NIWO_040_205	2018-08-30	Needles	4.550	Y
## 156	NIWO_040	NIWO_040_205	2018-08-30	Needles	4.530	N
## 157	NIWO_046	NIWO_046_155	2018-09-27	Needles	10.040	N
## 158	NIWO_062	NIWO_062_050	2018-09-27	Needles	1.130	N
## 159	NIWO_061	NIWO_061_169	2018-09-27	Needles	26.310	N
## 160	NIWO_064	NIWO_064_103	2018-09-27	Needles	5.320	N
## 161	NIWO_057	NIWO_057_081	2018-09-27	Needles	14.400	N
## 162	NIWO_067	NIWO_067_017	2018-09-27	Needles	4.040	N
## 163	NIWO_040	NIWO_040_205	2018-09-27	Needles	11.190	Y
## 164	NIWO_047	NIWO_047_197	2018-09-27	Needles	0.150	N
## 165	NIWO_051	NIWO_051_045	2018-09-27	Needles	4.920	Y
## 166	NIWO_063	NIWO_063_062	2018-09-27	Needles	0.380	N
## 167	NIWO_067	NIWO_067_017	2018-09-27	Needles	4.050	Y
## 168	NIWO_040	NIWO_040_205	2018-09-27	Needles	11.190	N
## 169	NIWO_051	NIWO_051_045	2018-09-27	Needles	4.920	N
## 170	NIWO_058	NIWO_058_101	2018-09-27	Needles	1.870	N
## 171	NIWO_041	NIWO_041_059	2018-09-27	Needles	7.950	N
## 172	NIWO_046	NIWO_046_155	2018-10-25	Needles	4.900	N
## 173	NIWO_061	NIWO_061_169	2018-10-25	Needles	8.990	N
## 174	NIWO_064	NIWO_064_103	2018-10-25	Needles	2.990	N
## 175	NIWO_057	NIWO_057_081	2018-10-25	Needles	8.810	N
## 176	NIWO_067	NIWO_067_017	2018-10-25	Needles	2.780	N
## 177	NIWO_040	NIWO_040_205	2018-10-25	Needles	6.390	N
## 178	NIWO_051	NIWO_051_045	2018-10-25	Needles	2.760	Y
## 179	NIWO_061	NIWO_061_169	2018-10-25	Needles	9.000	Y
## 180	NIWO_041	NIWO_041_059	2018-10-25	Needles	9.190	N
## 181	NIWO_041	NIWO_041_059	2018-10-25	Needles	9.200	Y
## 182	NIWO_051	NIWO_051_045	2018-10-25	Needles	2.750	N
## 183	NIWO_058	NIWO_058_101	2018-10-25	Needles	1.590	N
## 184	NIWO_058	NIWO_058_101	2018-10-25	Needles	1.590	Y
## 185	NIWO_064	NIWO_064_103	2018-11-21	Needles	1.130	Y
## 186	NIWO_040	NIWO_040_205	2018-11-21	Needles	3.110	Y
## 187	NIWO_040	NIWO_040_205	2018-11-21	Needles	3.110	N
## 188	NIWO_064	NIWO_064_103	2018-11-21	Needles	1.130	N
## 189	NIWO_064	NIWO_064_103	2019-06-05	Needles	3.690	Y
## 190	NIWO_064	NIWO_064_103	2019-06-05	Needles	3.680	N
## 191	NIWO_062	NIWO_062_050	2019-07-02	Needles	6.080	N
## 192	NIWO_047	NIWO_047_197	2019-07-02	Needles	0.630	Y
## 193	NIWO_047	NIWO_047_197	2019-07-02	Needles	0.640	N
## 194	NIWO_057	NIWO_057_081	2019-07-02	Needles	8.060	N
## 195	NIWO_063	NIWO_063_062	2019-07-02	Needles	0.470	N
## 196	NIWO_061	NIWO_061_169	2019-07-02	Needles	8.860	N
## 197	NIWO_058	NIWO_058_101	2019-07-02	Needles	1.450	N
## 198	NIWO_057	NIWO_057_081	2019-07-02	Needles	8.060	Y
## 199	NIWO_046	NIWO_046_155	2019-07-31	Needles	8.560	N
## 200	NIWO_067	NIWO_067_017	2019-07-31	Needles	3.910	N
## 201	NIWO_041	NIWO_041_059	2019-07-31	Needles	14.750	N
## 202	NIWO_040	NIWO_040_205	2019-07-02	Needles	5.870	N
## 203	NIWO_064	NIWO_064_103	2019-07-02	Needles	1.770	Y
## 204	NIWO_064	NIWO_064_103	2019-07-02	Needles	1.780	N
## 205	NIWO_061	NIWO_061_169	2019-07-31	Needles	2.360	N
## 206	NIWO_062	NIWO_062_050	2019-07-31	Needles	1.380	N
## 207	NIWO_064	NIWO_064_103	2019-07-31	Needles	2.240	N

##	208	NIWO_058	NIWO_058_101	2019-07-31	Needles	1.400	N
##	209	NIWO_040	NIWO_040_205	2019-07-31	Needles	2.370	N
##	210	NIWO_047	NIWO_047_197	2019-07-31	Needles	0.090	N
##	211	NIWO_057	NIWO_057_081	2019-07-31	Needles	7.440	Y
##	212	NIWO_057	NIWO_057_081	2019-07-31	Needles	7.410	N
##	213	NIWO_063	NIWO_063_062	2019-07-31	Needles	0.890	N
##	214	NIWO_041	NIWO_041_059	2019-08-28	Needles	3.420	N
##	215	NIWO_063	NIWO_063_062	2019-08-28	Needles	0.350	N
##	216	NIWO_041	NIWO_041_059	2019-08-28	Needles	3.430	Y
##	217	NIWO_061	NIWO_061_169	2019-08-28	Needles	1.730	N
##	218	NIWO_062	NIWO_062_050	2019-08-28	Needles	1.440	N
##	219	NIWO_064	NIWO_064_103	2019-08-28	Needles	1.510	N
##	220	NIWO_067	NIWO_067_017	2019-08-28	Needles	2.030	N
##	221	NIWO_046	NIWO_046_155	2019-08-28	Needles	2.530	N
##	222	NIWO_058	NIWO_058_101	2019-08-28	Needles	1.020	Y
##	223	NIWO_067	NIWO_067_017	2019-08-28	Needles	2.030	Y
##	224	NIWO_058	NIWO_058_101	2019-08-28	Needles	1.010	N
##	225	NIWO_040	NIWO_040_205	2019-08-28	Needles	1.880	N
##	226	NIWO_047	NIWO_047_197	2019-08-28	Needles	0.020	N
##	227	NIWO_051	NIWO_051_045	2019-08-28	Needles	0.200	N
##	228	NIWO_057	NIWO_057_081	2019-08-28	Needles	2.400	N
##	229	NIWO_051	NIWO_051_045	2019-09-25	Needles	0.310	N
##	230	NIWO_064	NIWO_064_103	2019-09-25	Needles	3.210	N
##	231	NIWO_040	NIWO_040_205	2019-09-25	Needles	3.580	Y
##	232	NIWO_046	NIWO_046_155	2019-09-25	Needles	3.960	N
##	233	NIWO_058	NIWO_058_101	2019-09-25	Needles	3.040	N
##	234	NIWO_063	NIWO_063_062	2019-09-25	Needles	0.180	N
##	235	NIWO_062	NIWO_062_050	2019-09-25	Needles	1.850	N
##	236	NIWO_041	NIWO_041_059	2019-09-25	Needles	4.760	N
##	237	NIWO_067	NIWO_067_017	2019-09-25	Needles	1.540	N
##	238	NIWO_061	NIWO_061_169	2019-09-25	Needles	1.840	N
##	239	NIWO_047	NIWO_047_197	2019-09-25	Needles	0.150	N
##	240	NIWO_057	NIWO_057_081	2019-09-25	Needles	4.220	N
##	241	NIWO_040	NIWO_040_205	2019-09-25	Needles	3.600	N
##		subplotID	decimalLatitude	decimalLongitude	elevation		nlcdClass
##	1	32	40.04872	-105.5872	3446.4		shrubScrub
##	2	40	40.05466	-105.5844	3509.8	grasslandHerbaceous	
##	3	31	40.04708	-105.5851	3382.5	evergreenForest	
##	4	32	40.04737	-105.5840	3373.2	evergreenForest	
##	5	41	40.04762	-105.5861	3413.4	evergreenForest	
##	6	31	40.05114	-105.5858	3477.0	shrubScrub	
##	7	40	40.04816	-105.5861	3426.9	shrubScrub	
##	8	31	40.04844	-105.5854	3427.4	grasslandHerbaceous	
##	9	40	40.05466	-105.5844	3509.8	grasslandHerbaceous	
##	10	41	40.04762	-105.5861	3413.4	evergreenForest	
##	11	31	40.04979	-105.5850	3443.5	grasslandHerbaceous	
##	12	32	40.05035	-105.5830	3425.6	shrubScrub	
##	13	31	40.05114	-105.5858	3477.0	shrubScrub	
##	14	31	40.04844	-105.5854	3427.4	grasslandHerbaceous	
##	15	32	40.04898	-105.5851	3432.7	shrubScrub	
##	16	32	40.05035	-105.5830	3425.6	shrubScrub	
##	17	32	40.04872	-105.5872	3446.4	shrubScrub	
##	18	40	40.04816	-105.5861	3426.9	shrubScrub	
##	19	31	40.05114	-105.5858	3477.0	shrubScrub	

## 20	41	40.04762	-105.5861	3413.4	evergreenForest
## 21	31	40.04708	-105.5851	3382.5	evergreenForest
## 22	31	40.04979	-105.5850	3443.5	grasslandHerbaceous
## 23	41	40.04655	-105.5847	3364.0	evergreenForest
## 24	40	40.05466	-105.5844	3509.8	grasslandHerbaceous
## 25	31	40.05114	-105.5858	3477.0	shrubScrub
## 26	31	40.04708	-105.5851	3382.5	evergreenForest
## 27	32	40.04898	-105.5851	3432.7	shrubScrub
## 28	40	40.04816	-105.5861	3426.9	shrubScrub
## 29	32	40.04737	-105.5840	3373.2	evergreenForest
## 30	31	40.04979	-105.5850	3443.5	grasslandHerbaceous
## 31	32	40.05035	-105.5830	3425.6	shrubScrub
## 32	31	40.04844	-105.5854	3427.4	grasslandHerbaceous
## 33	32	40.04872	-105.5872	3446.4	shrubScrub
## 34	41	40.04762	-105.5861	3413.4	evergreenForest
## 35	41	40.04655	-105.5847	3364.0	evergreenForest
## 36	40	40.04816	-105.5861	3426.9	shrubScrub
## 37	31	40.04708	-105.5851	3382.5	evergreenForest
## 38	40	40.05466	-105.5844	3509.8	grasslandHerbaceous
## 39	31	40.05114	-105.5858	3477.0	shrubScrub
## 40	32	40.04737	-105.5840	3373.2	evergreenForest
## 41	32	40.05035	-105.5830	3425.6	shrubScrub
## 42	31	40.04844	-105.5854	3427.4	grasslandHerbaceous
## 43	32	40.04898	-105.5851	3432.7	shrubScrub
## 44	32	40.04872	-105.5872	3446.4	shrubScrub
## 45	31	40.04979	-105.5850	3443.5	grasslandHerbaceous
## 46	41	40.04655	-105.5847	3364.0	evergreenForest
## 47	41	40.04655	-105.5847	3364.0	evergreenForest
## 48	31	40.04844	-105.5854	3427.4	grasslandHerbaceous
## 49	32	40.04872	-105.5872	3446.4	shrubScrub
## 50	31	40.05114	-105.5858	3477.0	shrubScrub
## 51	40	40.04816	-105.5861	3426.9	shrubScrub
## 52	32	40.04898	-105.5851	3432.7	shrubScrub
## 53	41	40.04762	-105.5861	3413.4	evergreenForest
## 54	32	40.04737	-105.5840	3373.2	evergreenForest
## 55	31	40.04708	-105.5851	3382.5	evergreenForest
## 56	31	40.04979	-105.5850	3443.5	grasslandHerbaceous
## 57	32	40.05035	-105.5830	3425.6	shrubScrub
## 58	32	40.04737	-105.5840	3373.2	evergreenForest
## 59	41	40.04655	-105.5847	3364.0	evergreenForest
## 60	32	40.05035	-105.5830	3425.6	shrubScrub
## 61	31	40.05114	-105.5858	3477.0	shrubScrub
## 62	40	40.05466	-105.5844	3509.8	grasslandHerbaceous
## 63	40	40.04816	-105.5861	3426.9	shrubScrub
## 64	41	40.04762	-105.5861	3413.4	evergreenForest
## 65	31	40.04708	-105.5851	3382.5	evergreenForest
## 66	31	40.04979	-105.5850	3443.5	grasslandHerbaceous
## 67	32	40.04872	-105.5872	3446.4	shrubScrub
## 68	32	40.04898	-105.5851	3432.7	shrubScrub
## 69	31	40.04844	-105.5854	3427.4	grasslandHerbaceous
## 70	41	40.04655	-105.5847	3364.0	evergreenForest
## 71	32	40.04737	-105.5840	3373.2	evergreenForest
## 72	31	40.05114	-105.5858	3477.0	shrubScrub
## 73	40	40.05466	-105.5844	3509.8	grasslandHerbaceous

## 74	32	40.05035	-105.5830	3425.6	shrubScrub
## 75	31	40.04708	-105.5851	3382.5	evergreenForest
## 76	31	40.04979	-105.5850	3443.5	grasslandHerbaceous
## 77	32	40.04898	-105.5851	3432.7	shrubScrub
## 78	32	40.04872	-105.5872	3446.4	shrubScrub
## 79	31	40.04844	-105.5854	3427.4	grasslandHerbaceous
## 80	41	40.04762	-105.5861	3413.4	evergreenForest
## 81	40	40.04816	-105.5861	3426.9	shrubScrub
## 82	31	40.04708	-105.5851	3382.5	evergreenForest
## 83	31	40.04844	-105.5854	3427.4	grasslandHerbaceous
## 84	32	40.04898	-105.5851	3432.7	shrubScrub
## 85	31	40.05114	-105.5858	3477.0	shrubScrub
## 86	40	40.04816	-105.5861	3426.9	shrubScrub
## 87	32	40.04872	-105.5872	3446.4	shrubScrub
## 88	41	40.04655	-105.5847	3364.0	evergreenForest
## 89	32	40.04737	-105.5840	3373.2	evergreenForest
## 90	32	40.05035	-105.5830	3425.6	shrubScrub
## 91	31	40.04844	-105.5854	3427.4	grasslandHerbaceous
## 92	32	40.04898	-105.5851	3432.7	shrubScrub
## 93	31	40.05114	-105.5858	3477.0	shrubScrub
## 94	31	40.04708	-105.5851	3382.5	evergreenForest
## 95	31	40.04979	-105.5850	3443.5	grasslandHerbaceous
## 96	41	40.04655	-105.5847	3364.0	evergreenForest
## 97	32	40.04872	-105.5872	3446.4	shrubScrub
## 98	40	40.04816	-105.5861	3426.9	shrubScrub
## 99	41	40.04762	-105.5861	3413.4	evergreenForest
## 100	32	40.04737	-105.5840	3373.2	evergreenForest
## 101	32	40.04898	-105.5851	3432.7	shrubScrub
## 102	32	40.04898	-105.5851	3432.7	shrubScrub
## 103	31	40.05114	-105.5858	3477.0	shrubScrub
## 104	41	40.04762	-105.5861	3413.4	evergreenForest
## 105	41	40.04762	-105.5861	3413.4	evergreenForest
## 106	31	40.04708	-105.5851	3382.5	evergreenForest
## 107	41	40.04655	-105.5847	3364.0	evergreenForest
## 108	41	40.04655	-105.5847	3364.0	evergreenForest
## 109	40	40.05466	-105.5844	3509.8	grasslandHerbaceous
## 110	40	40.05466	-105.5844	3509.8	grasslandHerbaceous
## 111	32	40.04872	-105.5872	3446.4	shrubScrub
## 112	32	40.04737	-105.5840	3373.2	evergreenForest
## 113	32	40.04898	-105.5851	3432.7	shrubScrub
## 114	40	40.04816	-105.5861	3426.9	shrubScrub
## 115	31	40.05114	-105.5858	3477.0	shrubScrub
## 116	31	40.05114	-105.5858	3477.0	shrubScrub
## 117	41	40.04762	-105.5861	3413.4	evergreenForest
## 118	41	40.04762	-105.5861	3413.4	evergreenForest
## 119	31	40.04708	-105.5851	3382.5	evergreenForest
## 120	31	40.04708	-105.5851	3382.5	evergreenForest
## 121	31	40.04979	-105.5850	3443.5	grasslandHerbaceous
## 122	41	40.04655	-105.5847	3364.0	evergreenForest
## 123	32	40.05035	-105.5830	3425.6	shrubScrub
## 124	40	40.05466	-105.5844	3509.8	grasslandHerbaceous
## 125	31	40.04844	-105.5854	3427.4	grasslandHerbaceous
## 126	32	40.04872	-105.5872	3446.4	shrubScrub
## 127	41	40.04762	-105.5861	3413.4	evergreenForest

## 128	32	40.04737	-105.5840	3373.2	evergreenForest
## 129	31	40.04979	-105.5850	3443.5	grasslandHerbaceous
## 130	41	40.04655	-105.5847	3364.0	evergreenForest
## 131	41	40.04655	-105.5847	3364.0	evergreenForest
## 132	32	40.04898	-105.5851	3432.7	shrubScrub
## 133	32	40.05035	-105.5830	3425.6	shrubScrub
## 134	40	40.05466	-105.5844	3509.8	grasslandHerbaceous
## 135	31	40.04844	-105.5854	3427.4	grasslandHerbaceous
## 136	32	40.04872	-105.5872	3446.4	shrubScrub
## 137	32	40.04872	-105.5872	3446.4	shrubScrub
## 138	40	40.04816	-105.5861	3426.9	shrubScrub
## 139	40	40.04816	-105.5861	3426.9	shrubScrub
## 140	31	40.05114	-105.5858	3477.0	shrubScrub
## 141	41	40.04762	-105.5861	3413.4	evergreenForest
## 142	32	40.05035	-105.5830	3425.6	shrubScrub
## 143	32	40.05035	-105.5830	3425.6	shrubScrub
## 144	40	40.05466	-105.5844	3509.8	grasslandHerbaceous
## 145	31	40.04844	-105.5854	3427.4	grasslandHerbaceous
## 146	32	40.04872	-105.5872	3446.4	shrubScrub
## 147	32	40.04898	-105.5851	3432.7	shrubScrub
## 148	40	40.04816	-105.5861	3426.9	shrubScrub
## 149	31	40.05114	-105.5858	3477.0	shrubScrub
## 150	41	40.04762	-105.5861	3413.4	evergreenForest
## 151	32	40.04737	-105.5840	3373.2	evergreenForest
## 152	31	40.04708	-105.5851	3382.5	evergreenForest
## 153	31	40.04979	-105.5850	3443.5	grasslandHerbaceous
## 154	31	40.04979	-105.5850	3443.5	grasslandHerbaceous
## 155	41	40.04655	-105.5847	3364.0	evergreenForest
## 156	41	40.04655	-105.5847	3364.0	evergreenForest
## 157	40	40.04816	-105.5861	3426.9	shrubScrub
## 158	31	40.05114	-105.5858	3477.0	shrubScrub
## 159	41	40.04762	-105.5861	3413.4	evergreenForest
## 160	32	40.04737	-105.5840	3373.2	evergreenForest
## 161	31	40.04708	-105.5851	3382.5	evergreenForest
## 162	31	40.04979	-105.5850	3443.5	grasslandHerbaceous
## 163	41	40.04655	-105.5847	3364.0	evergreenForest
## 164	40	40.05466	-105.5844	3509.8	grasslandHerbaceous
## 165	31	40.04844	-105.5854	3427.4	grasslandHerbaceous
## 166	32	40.04898	-105.5851	3432.7	shrubScrub
## 167	31	40.04979	-105.5850	3443.5	grasslandHerbaceous
## 168	41	40.04655	-105.5847	3364.0	evergreenForest
## 169	31	40.04844	-105.5854	3427.4	grasslandHerbaceous
## 170	32	40.04872	-105.5872	3446.4	shrubScrub
## 171	32	40.05035	-105.5830	3425.6	shrubScrub
## 172	40	40.04816	-105.5861	3426.9	shrubScrub
## 173	41	40.04762	-105.5861	3413.4	evergreenForest
## 174	32	40.04737	-105.5840	3373.2	evergreenForest
## 175	31	40.04708	-105.5851	3382.5	evergreenForest
## 176	31	40.04979	-105.5850	3443.5	grasslandHerbaceous
## 177	41	40.04655	-105.5847	3364.0	evergreenForest
## 178	31	40.04844	-105.5854	3427.4	grasslandHerbaceous
## 179	41	40.04762	-105.5861	3413.4	evergreenForest
## 180	32	40.05035	-105.5830	3425.6	shrubScrub
## 181	32	40.05035	-105.5830	3425.6	shrubScrub

## 182	31	40.04844	-105.5854	3427.4	grasslandHerbaceous
## 183	32	40.04872	-105.5872	3446.4	shrubScrub
## 184	32	40.04872	-105.5872	3446.4	shrubScrub
## 185	32	40.04737	-105.5840	3373.2	evergreenForest
## 186	41	40.04655	-105.5847	3364.0	evergreenForest
## 187	41	40.04655	-105.5847	3364.0	evergreenForest
## 188	32	40.04737	-105.5840	3373.2	evergreenForest
## 189	32	40.04737	-105.5840	3373.2	evergreenForest
## 190	32	40.04737	-105.5840	3373.2	evergreenForest
## 191	31	40.05114	-105.5858	3477.0	shrubScrub
## 192	40	40.05466	-105.5844	3509.8	grasslandHerbaceous
## 193	40	40.05466	-105.5844	3509.8	grasslandHerbaceous
## 194	31	40.04708	-105.5851	3382.5	evergreenForest
## 195	32	40.04898	-105.5851	3432.7	shrubScrub
## 196	41	40.04762	-105.5861	3413.4	evergreenForest
## 197	32	40.04872	-105.5872	3446.4	shrubScrub
## 198	31	40.04708	-105.5851	3382.5	evergreenForest
## 199	40	40.04816	-105.5861	3426.9	shrubScrub
## 200	31	40.04979	-105.5850	3443.5	grasslandHerbaceous
## 201	32	40.05035	-105.5830	3425.6	shrubScrub
## 202	41	40.04655	-105.5847	3364.0	evergreenForest
## 203	32	40.04737	-105.5840	3373.2	evergreenForest
## 204	32	40.04737	-105.5840	3373.2	evergreenForest
## 205	41	40.04762	-105.5861	3413.4	evergreenForest
## 206	31	40.05114	-105.5858	3477.0	shrubScrub
## 207	32	40.04737	-105.5840	3373.2	evergreenForest
## 208	32	40.04872	-105.5872	3446.4	shrubScrub
## 209	41	40.04655	-105.5847	3364.0	evergreenForest
## 210	40	40.05466	-105.5844	3509.8	grasslandHerbaceous
## 211	31	40.04708	-105.5851	3382.5	evergreenForest
## 212	31	40.04708	-105.5851	3382.5	evergreenForest
## 213	32	40.04898	-105.5851	3432.7	shrubScrub
## 214	32	40.05035	-105.5830	3425.6	shrubScrub
## 215	32	40.04898	-105.5851	3432.7	shrubScrub
## 216	32	40.05035	-105.5830	3425.6	shrubScrub
## 217	41	40.04762	-105.5861	3413.4	evergreenForest
## 218	31	40.05114	-105.5858	3477.0	shrubScrub
## 219	32	40.04737	-105.5840	3373.2	evergreenForest
## 220	31	40.04979	-105.5850	3443.5	grasslandHerbaceous
## 221	40	40.04816	-105.5861	3426.9	shrubScrub
## 222	32	40.04872	-105.5872	3446.4	shrubScrub
## 223	31	40.04979	-105.5850	3443.5	grasslandHerbaceous
## 224	32	40.04872	-105.5872	3446.4	shrubScrub
## 225	41	40.04655	-105.5847	3364.0	evergreenForest
## 226	40	40.05466	-105.5844	3509.8	grasslandHerbaceous
## 227	31	40.04844	-105.5854	3427.4	grasslandHerbaceous
## 228	31	40.04708	-105.5851	3382.5	evergreenForest
## 229	31	40.04844	-105.5854	3427.4	grasslandHerbaceous
## 230	32	40.04737	-105.5840	3373.2	evergreenForest
## 231	41	40.04655	-105.5847	3364.0	evergreenForest
## 232	40	40.04816	-105.5861	3426.9	shrubScrub
## 233	32	40.04872	-105.5872	3446.4	shrubScrub
## 234	32	40.04898	-105.5851	3432.7	shrubScrub
## 235	31	40.05114	-105.5858	3477.0	shrubScrub

## 236	32	40.05035	-105.5830	3425.6	shrubScrub
## 237	31	40.04979	-105.5850	3443.5	grasslandHerbaceous
## 238	41	40.04762	-105.5861	3413.4	evergreenForest
## 239	40	40.05466	-105.5844	3509.8	grasslandHerbaceous
## 240	31	40.04708	-105.5851	3382.5	evergreenForest
## 241	41	40.04655	-105.5847	3364.0	evergreenForest
##	plotType	geodeticDatum			
## 1	tower	WGS84			
## 2	tower	WGS84			
## 3	tower	WGS84			
## 4	tower	WGS84			
## 5	tower	WGS84			
## 6	tower	WGS84			
## 7	tower	WGS84			
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## 10	tower	WGS84			
## 11	tower	WGS84			
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## 13	tower	WGS84			
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## 16	tower	WGS84			
## 17	tower	WGS84			
## 18	tower	WGS84			
## 19	tower	WGS84			
## 20	tower	WGS84			
## 21	tower	WGS84			
## 22	tower	WGS84			
## 23	tower	WGS84			
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## 25	tower	WGS84			
## 26	tower	WGS84			
## 27	tower	WGS84			
## 28	tower	WGS84			
## 29	tower	WGS84			
## 30	tower	WGS84			
## 31	tower	WGS84			
## 32	tower	WGS84			
## 33	tower	WGS84			
## 34	tower	WGS84			
## 35	tower	WGS84			
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## 90	tower	WGS84
## 91	tower	WGS84
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## 93	tower	WGS84
## 94	tower	WGS84
## 95	tower	WGS84
## 96	tower	WGS84
## 97	tower	WGS84
## 98	tower	WGS84
## 99	tower	WGS84
## 100	tower	WGS84
## 101	tower	WGS84

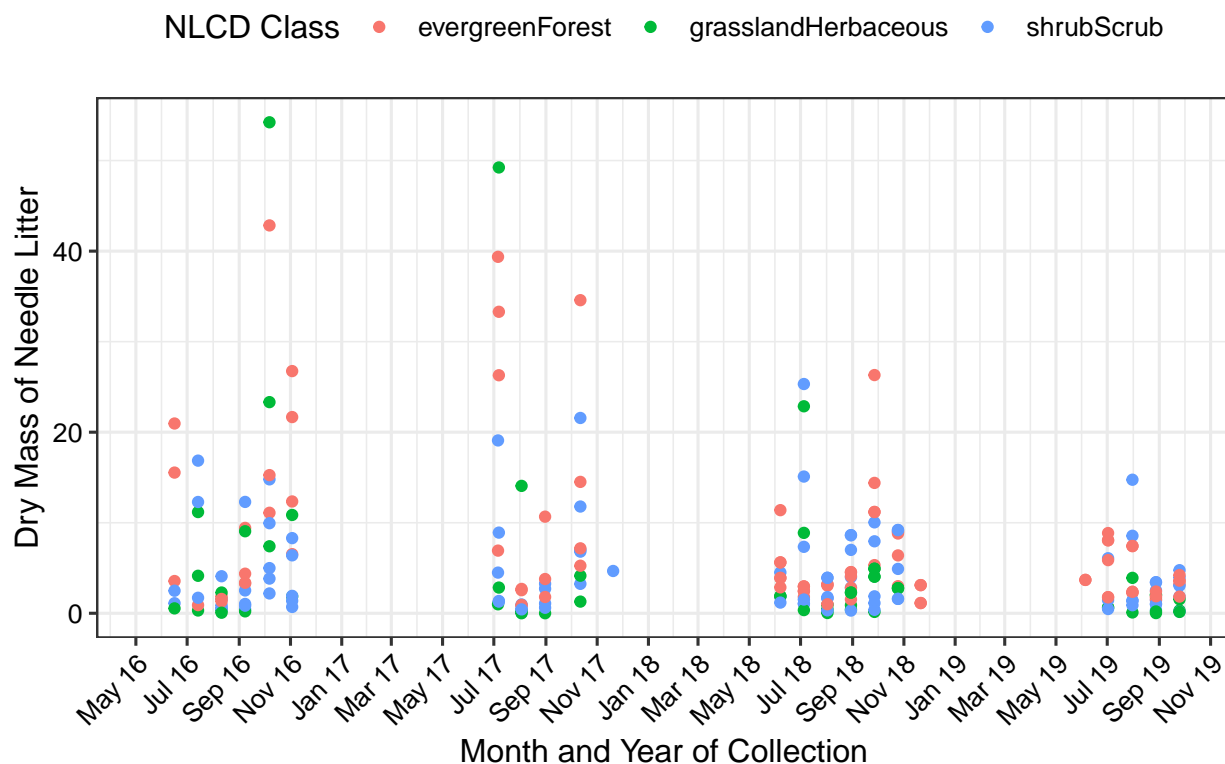
## 102	tower	WGS84
## 103	tower	WGS84
## 104	tower	WGS84
## 105	tower	WGS84
## 106	tower	WGS84
## 107	tower	WGS84
## 108	tower	WGS84
## 109	tower	WGS84
## 110	tower	WGS84
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## 112	tower	WGS84
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## 116	tower	WGS84
## 117	tower	WGS84
## 118	tower	WGS84
## 119	tower	WGS84
## 120	tower	WGS84
## 121	tower	WGS84
## 122	tower	WGS84
## 123	tower	WGS84
## 124	tower	WGS84
## 125	tower	WGS84
## 126	tower	WGS84
## 127	tower	WGS84
## 128	tower	WGS84
## 129	tower	WGS84
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## 132	tower	WGS84
## 133	tower	WGS84
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## 136	tower	WGS84
## 137	tower	WGS84
## 138	tower	WGS84
## 139	tower	WGS84
## 140	tower	WGS84
## 141	tower	WGS84
## 142	tower	WGS84
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## 144	tower	WGS84
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## 209	tower	WGS84

```
## 210    tower    WGS84
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## 237    tower    WGS84
## 238    tower    WGS84
## 239    tower    WGS84
## 240    tower    WGS84
## 241    tower    WGS84
```

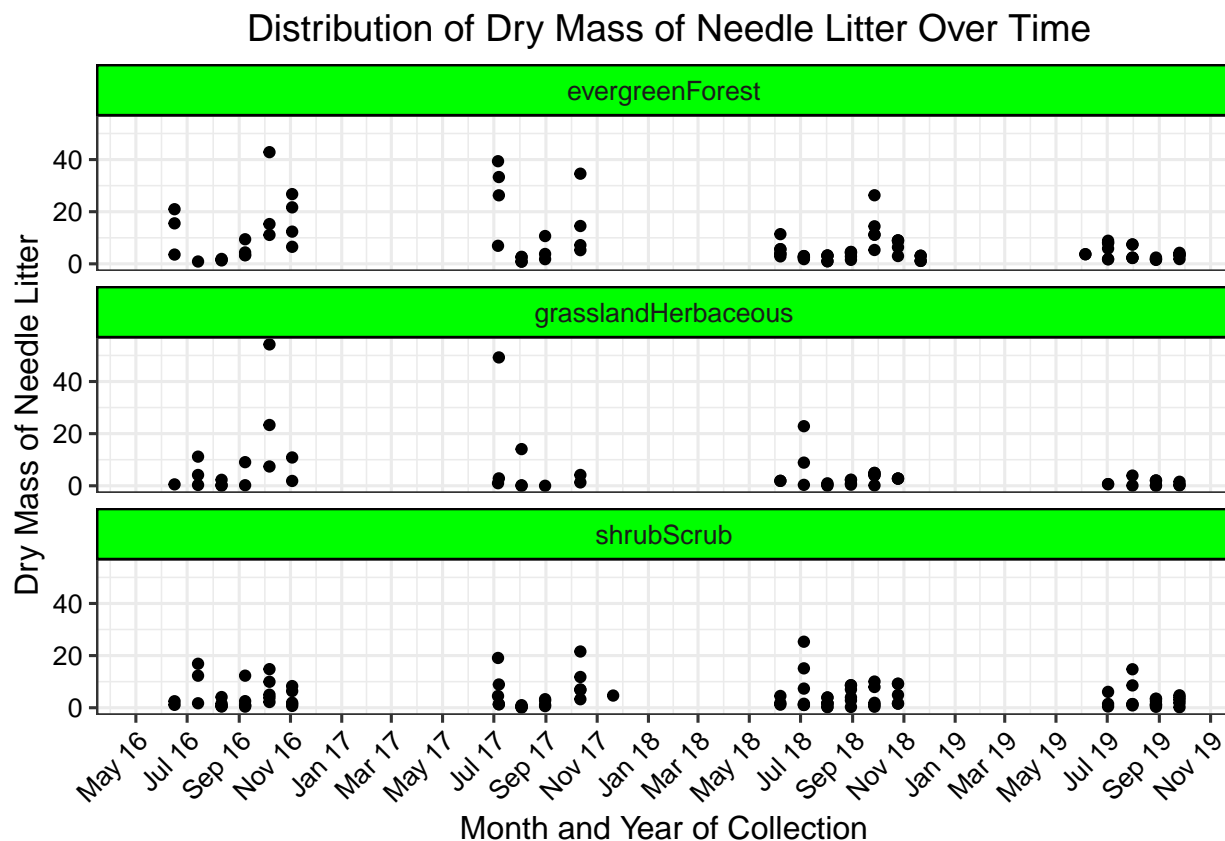
```
ggplot(subset_litter_dat, aes(x = collectDate,
  y = dryMass, color = nlcdClass)) + geom_point() +
  xlab("Month and Year of Collection") +
  ylab("Dry Mass of Needle Litter") + ggtitle(" Distribution of Dry Mass of Needle Litter Over Time")
  labs(color = "NLCD Class") + scale_x_date(limits = as.Date(c("2016-05-16",
    "2019-09-25")), date_breaks = "2 months",
  date_labels = "%b %y") + theme(axis.text.x = element_text(angle = 45,
    hjust = 1))
```

Distribution of Dry Mass of Needle Litter Over Time



7

```
ggplot(subset_litter_dat, aes(collectDate,
  y = dryMass)) + geom_point() + facet_wrap(vars(nlcdClass),
  nrow = 3) + ylab("Dry Mass of Needle Litter") +
  xlab("Month and Year of Collection") +
  theme(strip.background = element_rect(color = "black",
    fill = "green")) + ggtitle(" Distribution of Dry Mass of Needle Litter Over Time") +
  scale_x_date(limits = as.Date(c("2016-05-16",
    "2019-09-25")), date_breaks = "2 months",
    date_labels = "%b %y") + theme(axis.text.x = element_text(angle = 45,
    hjust = 1))
```



Question: Which of these plots (6 vs. 7) do you think is more effective, and why?

Answer: The plot with the NCLD classes separated into three facets rather than separated by color is more effective. This is as it is easier to decipher the differences in dry mass of needle litter for each of the NCLD classes over the observed period when they were separated into their own panel. When separated by color, it was difficult to interpret not only the variation observed at each time point for each NCLD class but to determine the differences in between each class.