

## 5: Part 2 - Data Visualization Advanced

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### LESSON OBJECTIVES

1. Perform advanced edits on ggplot objects to follow best practices for data visualization
2. Troubleshoot visualization challenges

### SET UP YOUR DATA ANALYSIS SESSION

```
getwd()

## [1] "/Users/ataliefischer/Desktop/EDA/Environmental_Data_Analytics_2022/Lessons"

library(tidyverse)

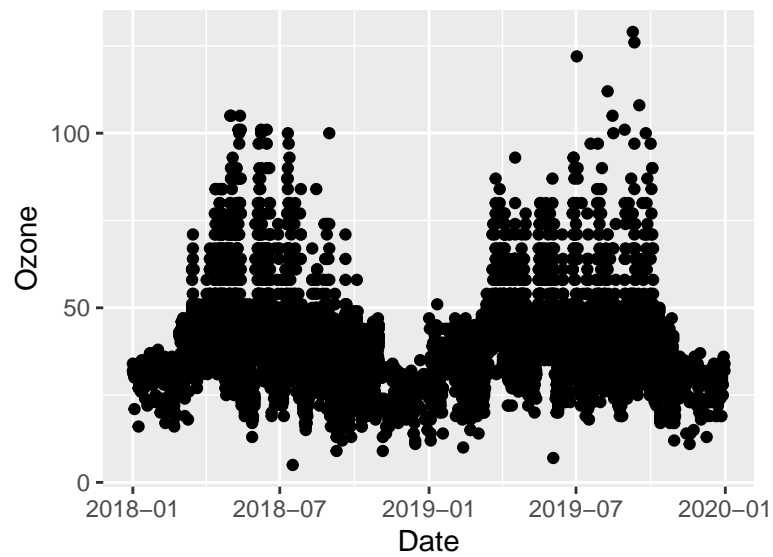
PeterPaul.chem.nutrients <-
  read.csv("../Data/Processed/NTL-LTER_Lake_Chemistry_Nutrients_PeterPaul_Processed.csv")
PeterPaul.chem.nutrients.gathered <-
  read.csv("../Data/Processed/NTL-LTER_Lake_Nutrients_PeterPaulGathered_Processed.csv")
EPAair <- read.csv("../Data/Processed/EPAair_O3_PM25_NC2021_Processed.csv")

EPAair$Date <- as.Date(EPAair$Date, format = "%Y-%m-%d")
PeterPaul.chem.nutrients$sampldate <- as.Date(
  PeterPaul.chem.nutrients$sampldate, format = "%Y-%m-%d")
PeterPaul.chem.nutrients.gathered$sampldate <- as.Date(
  PeterPaul.chem.nutrients.gathered$sampldate, format = "%Y-%m-%d")
```

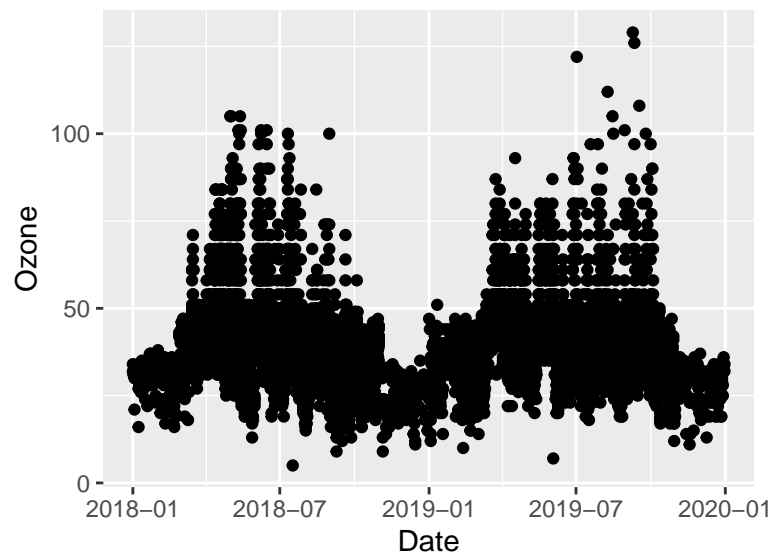
### Themes

Often, we will want to change multiple visual aspects of a plot. Ggplot comes with pre-built themes that will adjust components of plots if you call that theme.

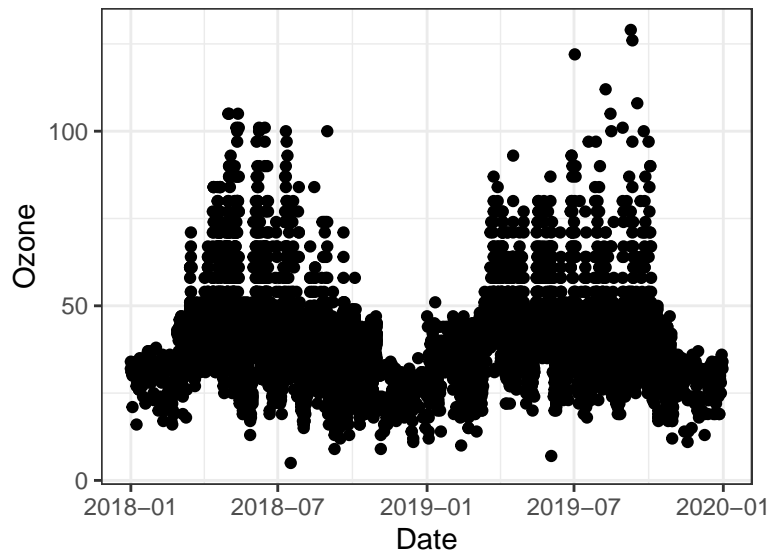
```
O3plot <- ggplot(EPAair) +
  geom_point(aes(x = Date, y = Ozone))
print(O3plot)
```



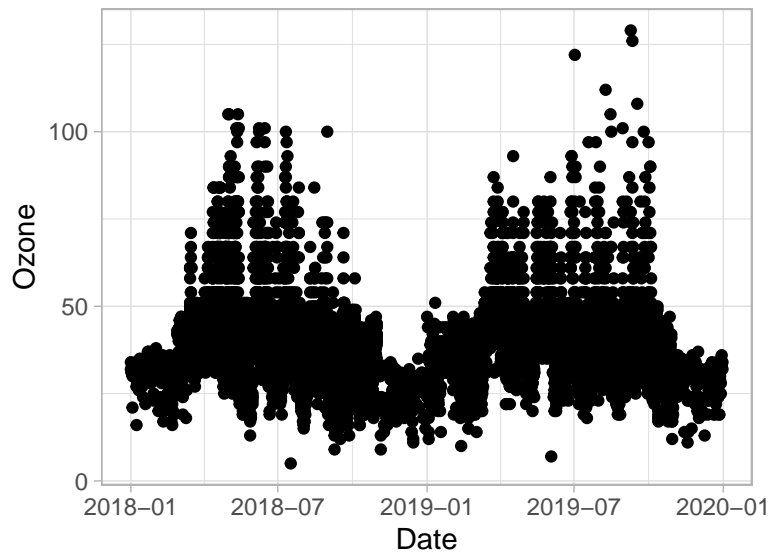
```
O3plot1 <- ggplot(EPAair) +  
  geom_point(aes(x = Date, y = Ozone)) +  
  theme_gray()  
print(O3plot1)
```



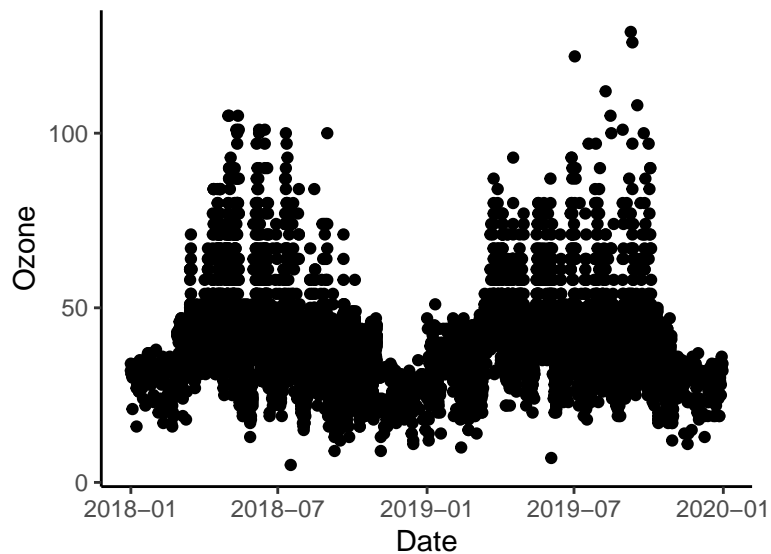
```
O3plot2 <- ggplot(EPAair) +  
  geom_point(aes(x = Date, y = Ozone)) +  
  theme_bw()  
print(O3plot2)
```



```
O3plot3 <- ggplot(EPAair) +
  geom_point(aes(x = Date, y = Ozone)) +
  theme_light()
print(O3plot3)
```



```
O3plot4 <- ggplot(EPAair) +
  geom_point(aes(x = Date, y = Ozone)) +
  theme_classic()
print(O3plot4)
```



Notice that some aspects of your graph have not been adjusted, including:

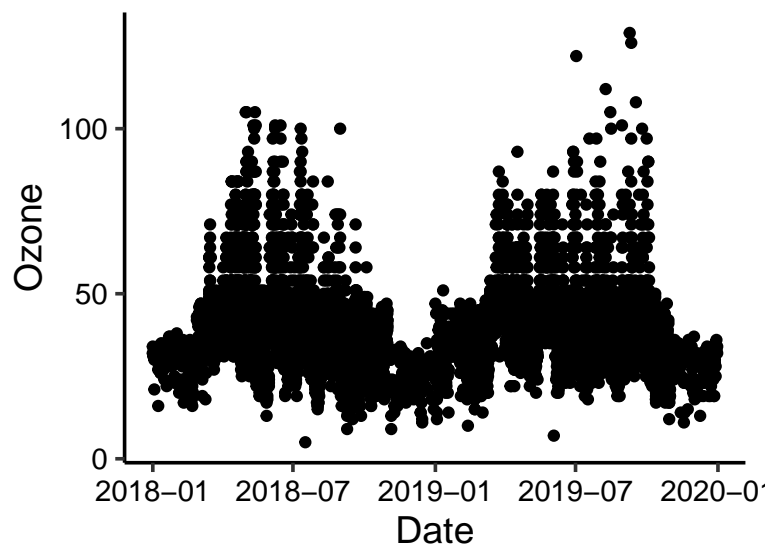
- text size
- axis label colors
- legend position and justification

If you would like to set a common theme across all plots in your analysis session, you may define a theme and call up that theme for each graph. This eliminates the need to add multiple lines of code in each plot.

```
mytheme <- theme_classic(base_size = 14) +
  theme(axis.text = element_text(color = "black"),
        legend.position = "top") #alternative: legend.position + legend.justification

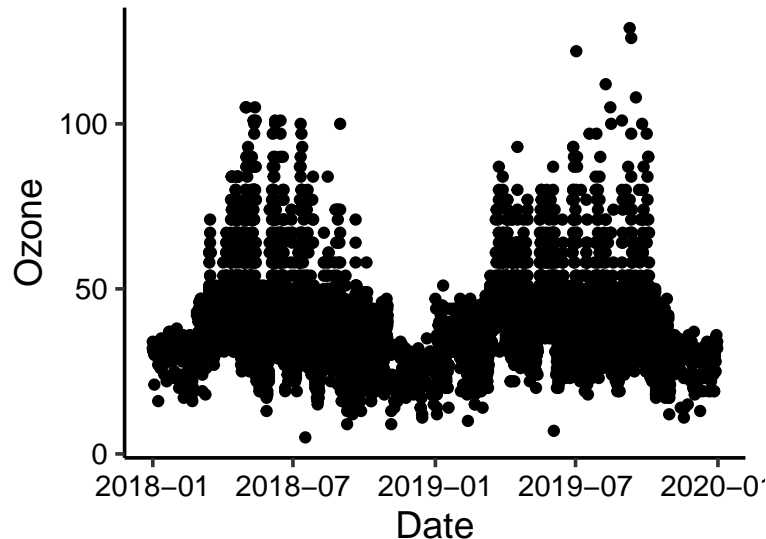
# options: call the theme in each plot or set the theme at the start.

O3plot5 <- ggplot(EPAair) +
  geom_point(aes(x = Date, y = Ozone)) +
  mytheme #setting theme within the plot environment
print(O3plot5)
```



```
theme_set(mytheme) #set theme for all subsequent plots

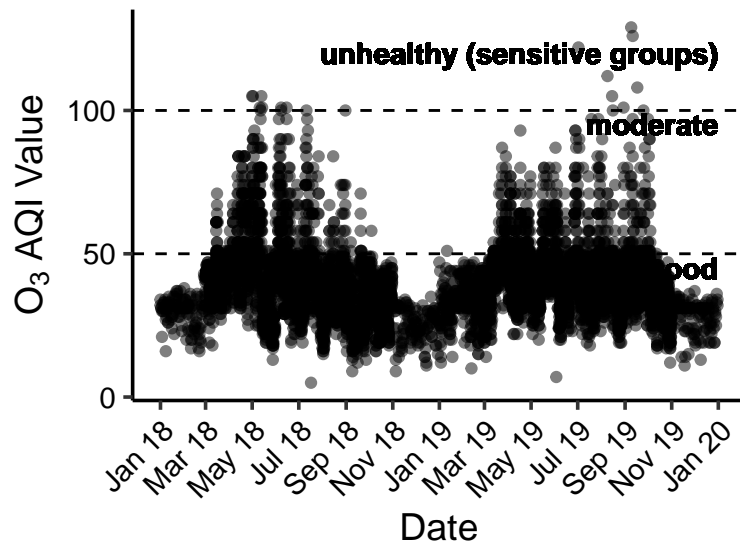
O3plot6 <- ggplot(EPAair) +
  geom_point(aes(x = Date, y = Ozone))
print(O3plot6)
```



### Adjusting multiple components of your plots

While the theme allows us to set multiple aspects of plots, ggplot allows us to adjust other parts of plots outside of the theme.

```
#geom_hline --> horizontal line. lty = 2 --> dashed line. geom_text --> specify location of text. label
O3plot7 <- ggplot(EPAair, aes(x = Date, y = Ozone)) +
  geom_hline(yintercept = 50, lty = 2) +
  geom_hline(yintercept = 100, lty = 2) +
  geom_point(alpha = 0.5, size = 1.5) +
  geom_text(x = as.Date("2020-01-01"), y = 45, label = "good", hjust = 1, fontface = "bold") + # hjust
  geom_text(x = as.Date("2020-01-01"), y = 95, label = "moderate", hjust = 1, fontface = "bold") +
  geom_text(x = as.Date("2020-01-01"), y = 120, label = "unhealthy (sensitive groups)", hjust = 1, fontface = "bold") +
  scale_x_date(limits = as.Date(c("2018-01-01", "2019-12-31")),
    date_breaks = "2 months", date_labels = "%b %y") +
  ylab(expression("O" [3] * " AQI Value")) +
  theme(axis.text.x = element_text(angle = 45, hjust = 1))
print(O3plot7)
```



### Color palettes

Color palettes are an effective way to communicate additional aspects of our data, often illustrating a third categorical or continuous variable in addition to the variables on the x and y axes. A few rules for choosing colors:

- Consider if your plot needs to be viewed in black and white. If so, choose a sequential palette with varying color intensity.
- Choose a palette that is color-blind friendly
- Maximize contrast (e.g., no pale colors on a white background)
- Diverging color palettes should be used for diverging values (e.g., warm-to-cool works well for values on a scale encompassing negative and positive values)

Does your color palette communicate additional and necessary information? If the answer is no, then you might consider removing it and going with a single color. Common instances of superfluous or redundant color palettes include:

- Color that duplicates an axis
- Color that distinguishes categories when labels already exist (exception: if category colors repeat throughout a series of interrelated visualizations and help the reader build a frame of reference across a report)
- Color that reduces the conciseness of a plot

Perception is key! Choose palettes that are visually pleasing and will communicate what you are hoping your audience to perceive.

RColorBrewer (package)

- <http://colorbrewer2.org>
- <https://moderndata.plot.ly/create-colorful-graphs-in-r-with-rcolorbrewer-and-plotly/>

viridis and viridisLite (packages)

- <https://cran.r-project.org/web/packages/viridis/vignettes/intro-to-viridis.html>
- [https://ggplot2.tidyverse.org/reference/scale\\_viridis.html](https://ggplot2.tidyverse.org/reference/scale_viridis.html)

colorRamp (function; comes with base R as part of the grDevices package)

- <https://bookdown.org/rdpeng/exdata/plotting-and-color-in-r.html#colorramp>

LaCroixColor (package)

- <https://github.com/johannesbjork/LaCroixColor>

wesanderson (package)

- <https://github.com/karthik/wesanderson>

nationalparkcolors (package)

- <https://github.com/katiejolly/nationalparkcolors>

```
# install.packages("viridis")
# install.packages("RColorBrewer")
# install.packages("colormap")
library(viridis)
```

```
## Loading required package: viridisLite
```

```
library(RColorBrewer)
library(colormap)
```

```
scales::show_col(colormap(colormap = colormaps$viridis, nshades = 16))
```

#440154ff	#461868ff	#472d7bff	#404284ff
#39558bff	#31668dff	#2a768eff	#24888dff
#23978aff	#26a784ff	#37b578ff	#55c467ff
#79d051ff	#a3da37ff	#cee12cff	#fde725ff

```
scales::show_col(colormap(colormap = colormaps$inferno, nshades = 16))
```

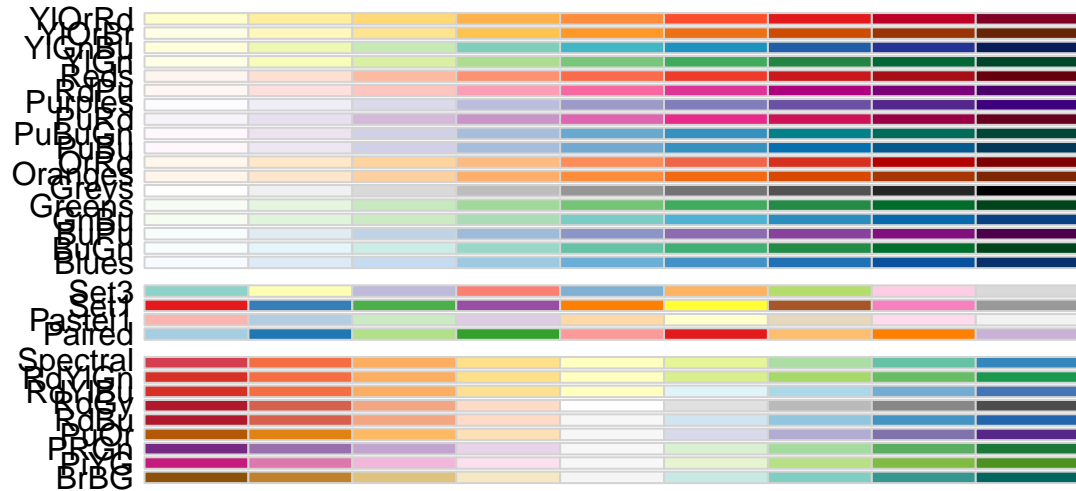
#000004ff	#100628ff	#210c49ff	#3f0e5eff
#5b116dff	#761b6bff	#902567ff	#ad315bff
#c43f4dff	#da513aff	#ea6827ff	#f6850fff
#f9a319ff	#f9c32eff	#fae063ff	#fcffa4ff

```
scales::show_col(colormap(colormap = colormaps$magma, nshades = 16))
```

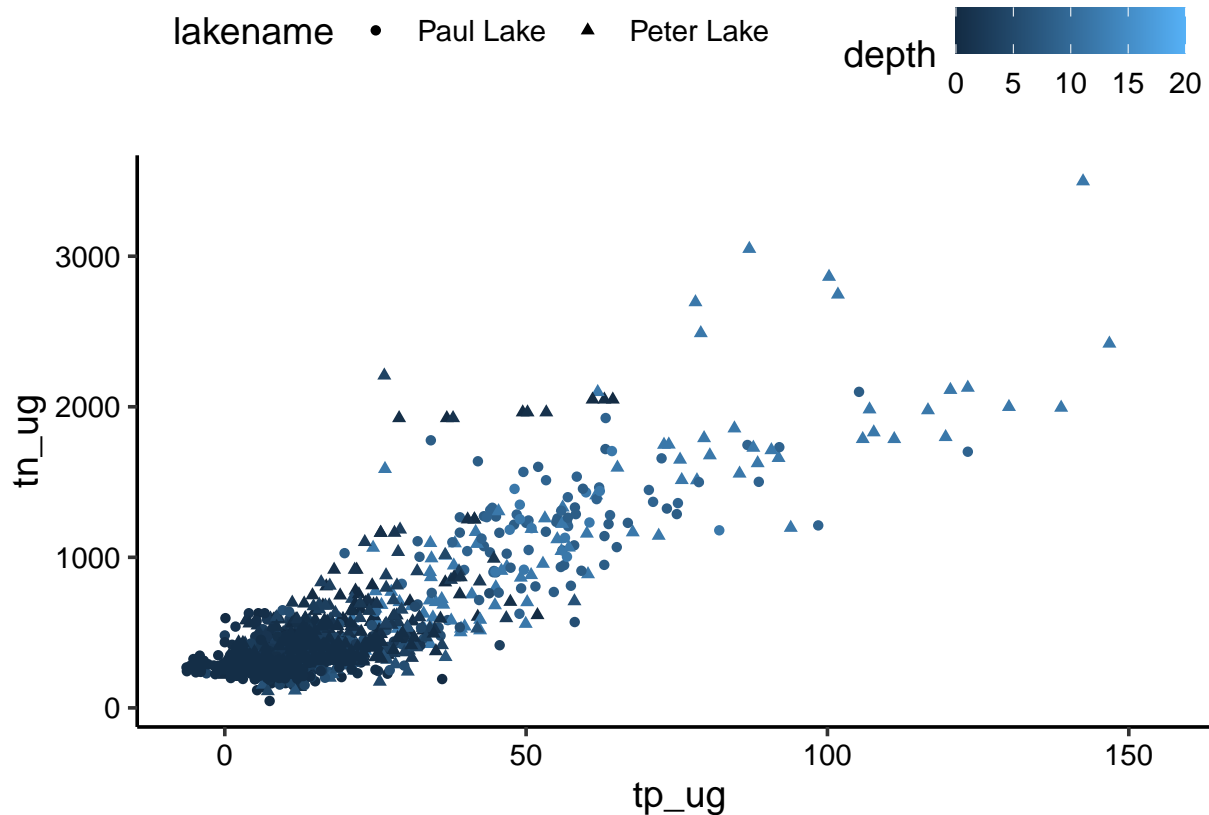
#000004ff	#0f0926ff	#1e1046ff	#3b1165ff
#55147cff	#701e7fff	#8a2880ff	#a7317cff
#c13d75ff	#db4a69ff	#ec6163ff	#f88061ff
#fc9d6fff	#febc83ff	#fddc9fff	#fcfdbfff



```
display.brewer.all(n = 9)
```



```
NvsP <-  
  ggplot(PeterPaul.chem.nutrients, aes(x = tp_ug, y = tn_ug, color = depth, shape = lakena  
  geom_point()  
print(NvsP)
```

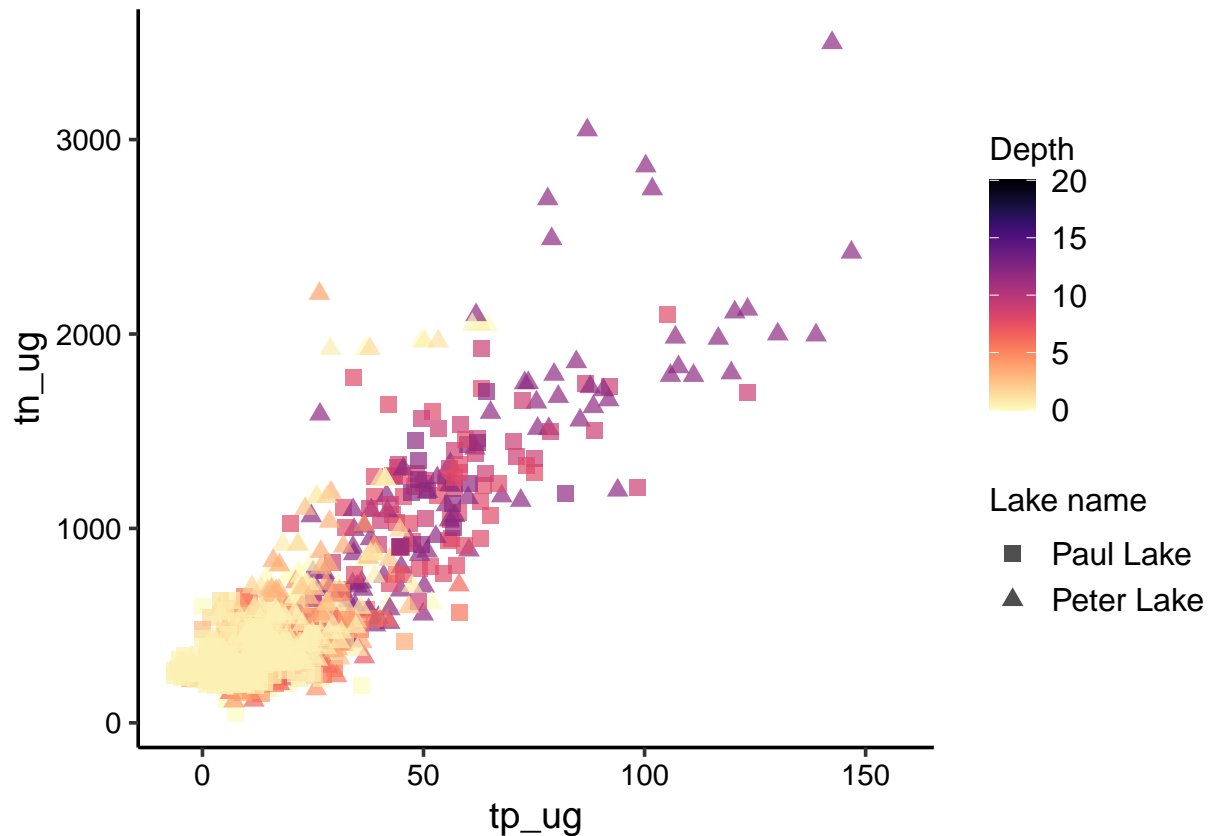


```
# let's first make the plot look better. alpha --> transparency
# change your axis labels to reflect TN and TP in micrograms per liter.
# change your legend labels
NvsP2 <-
  ggplot(PeterPaul.chem.nutrients, aes(x = tp_ug, y = tn_ug, color = depth, shape = lakena
```

```

geom_point(alpha = 0.7, size = 2.5) +
labs(color = "Depth", shape = "Lake name") + # change your legend labels here
scale_shape_manual(values = c(15, 17)) +
#scale_color_distiller(palette = "Blues", direction = 1) + # use scale_color_brewer for discrete vari
scale_color_viridis(option = "magma", direction = -1) +
theme(legend.position = "right",
      legend.text = element_text(size = 12), legend.title = element_text(size = 12))
print(NvSP2)

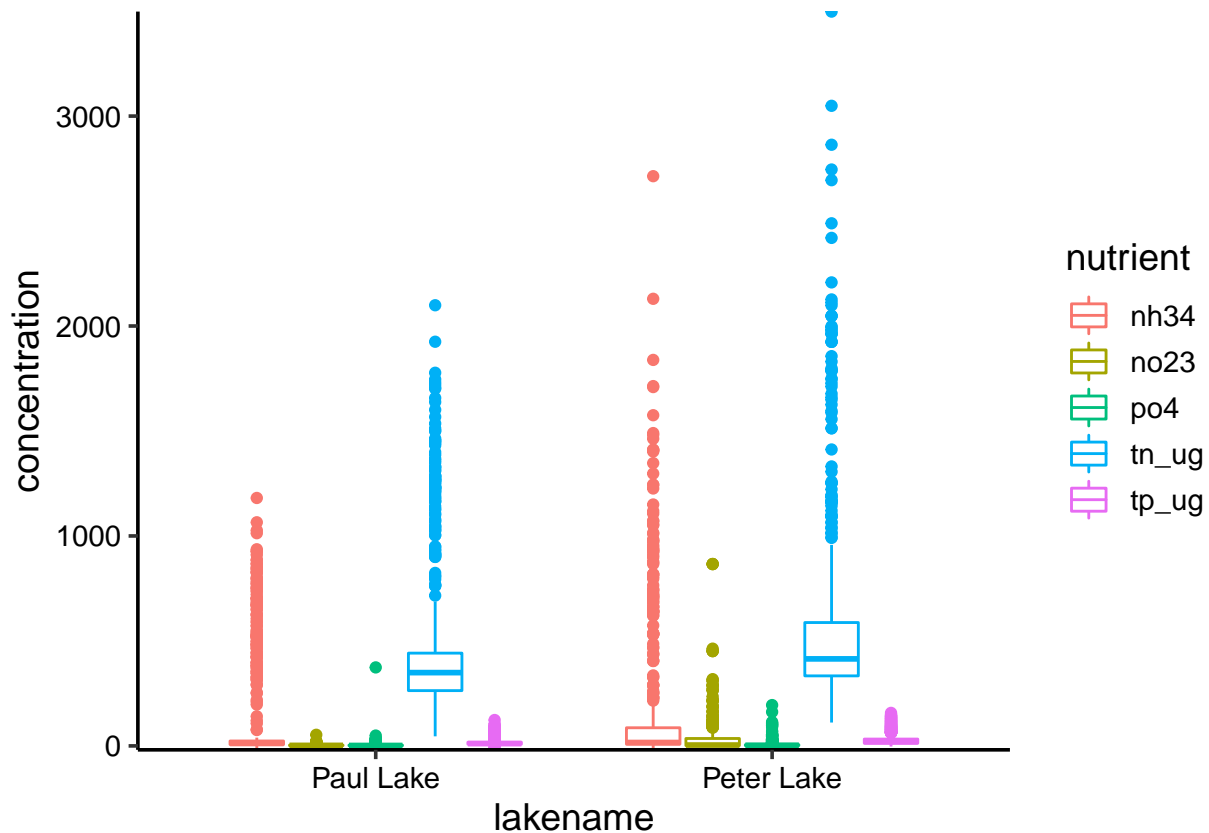
```



```

# change your y axis label to list concentration in micrograms per liter
# remove your x axis label
# change labels for nutrients in the legend
# try out the different color palette options and choose one (or edit)
Nutrientplot <-
  ggplot(PeterPaul.chem.nutrients.gathered, aes(x = lakename, y = concentration, color = nutrient)) +
  geom_boxplot() +
  # place your additional edits here
  scale_y_continuous(expand = c(0, 0)) +
  #scale_color_brewer(palette = "YlGnBu") +
  #scale_color_manual(values = c("#7fcdbb", "#41b6c4", "#1d91c0", "#225ea8", "#0c2c84")) +
  #scale_color_viridis(discrete = TRUE, end = 0.8) +
  theme(legend.position = "right")
print(Nutrientplot)

```



### Multiple plots on a page

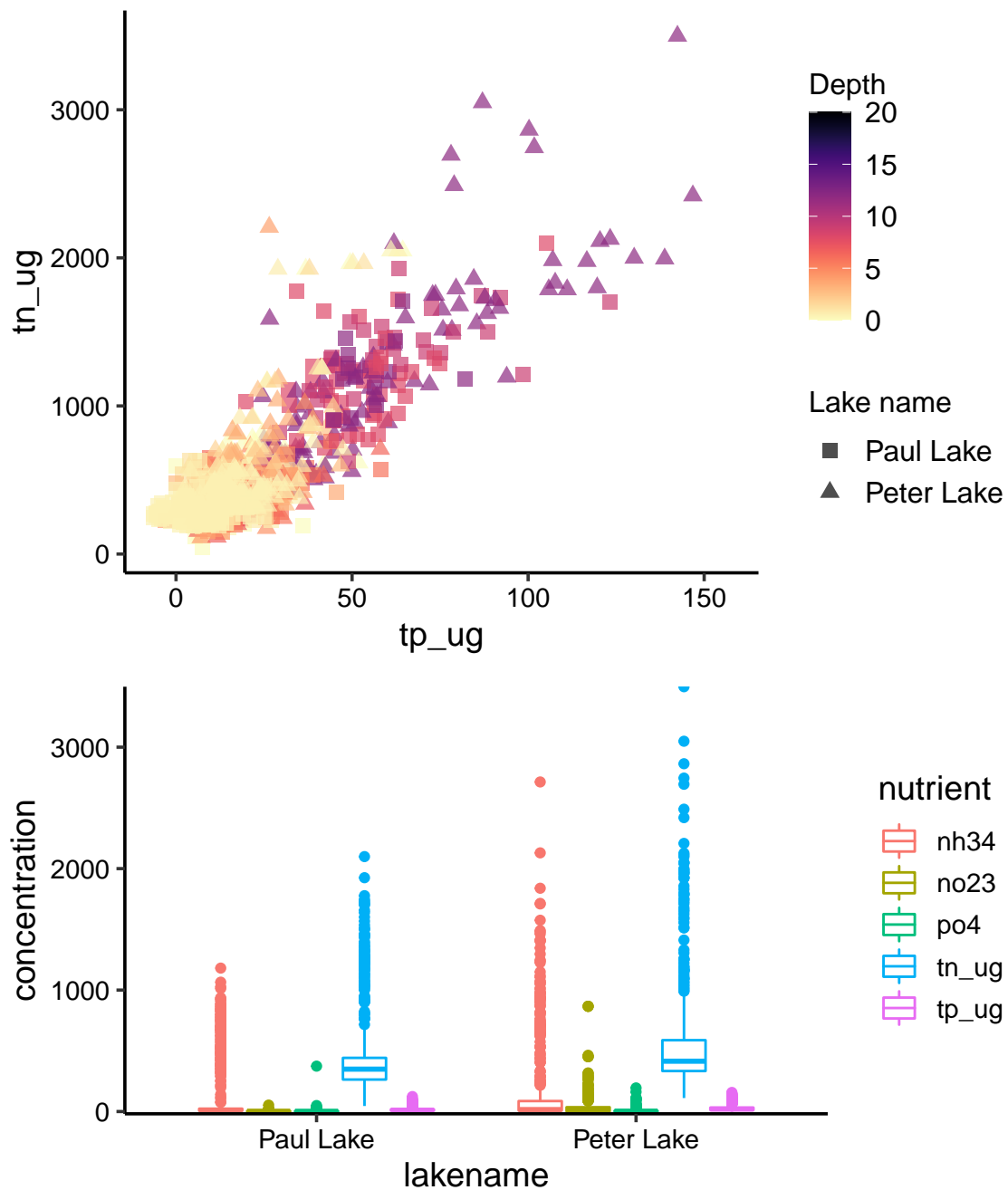
In situations where facets don't fill our needs to place multiple plots on a page, we can use the package `cowplot` to arrange plots. The `plot_grid` function is extremely flexible in its ability to arrange plots in specific configurations. A useful guide can be found here: <https://cran.r-project.org/web/packages/cowplot/vignettes/introduction.html>.

A useful guide for aligning plots by axis can be found here: [https://wilkelab.org/cowplot/articles/aligning\\_plots.html](https://wilkelab.org/cowplot/articles/aligning_plots.html)

```
#install.packages("cowplot")
library(cowplot)

#multiple plots in a grid, specify dimensions. rel_heights --> plots of different sizes
plot_grid(NvsP2, Nutrientplot, nrow = 2, align = 'h', rel_heights = c(1.25, 1))
```

```
## Warning: Removed 21587 rows containing missing values (geom_point).
```



### Saving plots

The `ggsave` function allows you to save plots in jpg, png, eps, pdf, tiff, and other formats. The following information can be supplied:

- filename and relative path, with file extension and in quotes (required)
- plot object (required)
- width, height, units
- resolution (dpi)

For example: `ggsave("../Output/PMplot.jpg", PMplot.faceted, height = 4, width = 6, units = "in", dpi = 300)`

## Visualization challenge

The following graph displays the counts of specific endpoints measured in neonicotinoid ecotoxicology studies. The way it is visualized, however, is not effective. Make the following coding changes to improve the graph:

1. Change the ordering of the “Endpoint” factor (function: `reorder`) so that the highest counts are listed first (hint: `FUN = length`)
2. Plot the barplot with the reordered factor levels. Add this line of code to make the bars show up left to right: `scale_x_discrete(limits = rev(levels(Neonics$Endpoint)))`
3. Adjust the x axis labels so they appear at a 45 degree angle.
4. Change the color and/or border on the bars. Should you have a consistent color across all bars, or a different color for each bar?

```
#Neonics <- read.csv("../Data/Raw/ECOTOX_Neonicotinoids_Insects_raw.csv")
#ggplot(Neonics) +
#  geom_bar(aes(x = Endpoint))
```