Assignment 3: Data Exploration

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OVERVIEW

This exercise accompanies the lessons in Environmental Data Analytics (ENV872L) on data exploration.

Directions

1. Change "Student Name" on line 3 (above) with your name.
2. Use the lesson as a guide. It contains code that can be modified to complete the assignment.
3. Work through the steps, **creating code and output** that fulfill each instruction.
4. Be sure to **answer the questions** in this assignment document. Space for your answers is provided in this document and is indicated by the ">" character. If you need a second paragraph be sure to start the first line with ">". You should notice that the answer is highlighted in green by RStudio.
5. When you have completed the assignment, **Knit** the text and code into a single PDF file. You will need to have the correct software installed to do this (see Software Installation Guide) Press the `Knit` button in the RStudio scripting panel. This will save the PDF output in your Assignments folder.
6. After Knitting, please submit the completed exercise (PDF file) to the dropbox in Sakai. Please add your last name into the file name (e.g., "Salk_A02_DataExploration.pdf") prior to submission.

The completed exercise is due on Thursday, 31 January, 2019 before class begins.

1) Set up your R session

Check your working directory, load necessary packages (tidyverse), and upload the North Temperate Lakes long term monitoring dataset for the light, temperature, and oxygen data for three lakes (file name: NTL-LTER_Lake_ChemistryPhysics_Raw.csv). Type your code into the R chunk below.

```
library(tidyverse)
```

```
## Warning: package 'tidyverse' was built under R version 3.5.2
```

```
## -- Attaching packages ---------------------------------------------------------------------
```

```
## v ggplot2 3.1.0     v purrr   0.2.5
## v tibble  1.4.2     v dplyr   0.7.8
## v tidyr   0.8.2     v stringr 1.3.1
## v readr   1.3.1     v forcats 0.3.0
```

```
## Warning: package 'ggplot2' was built under R version 3.5.2
```

```
## Warning: package 'tibble' was built under R version 3.5.2
```

```
## Warning: package 'tidyr' was built under R version 3.5.2
```

```
## Warning: package 'readr' was built under R version 3.5.2
```

```
## Warning: package 'purrr' was built under R version 3.5.2
```

```
## Warning: package 'dplyr' was built under R version 3.5.2
```

```
## Warning: package 'stringr' was built under R version 3.5.2
```

```
## Warning: package 'forcats' was built under R version 3.5.2
```

```
## -- Conflicts ------------------------------------------------------------------------------
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
getwd()
```

```
## [1] "V:/ENV_872_Project_Directory/Assignments"
```

```
temperate_lake_data_raw <- read.csv("V:/ENV_872_Project_Directory/Data/Raw/NTL-LTER_Lake_ChemistryPhysi
```

2) Learn about your system

Read about your dataset in the NTL-LTER README file. What are three salient pieces of information you gained from reading this file?

> ANSWER: The chemistry and physical data dates from 1984 to 2016. The data is from a study done in Wisconsin. I also learned about the data collection techniques for the data I have (as wel as for the other two data sets on nutrients and carbon, respectively)

3) Obtain basic summaries of your data

Write R commands to display the following information:

1. dimensions of the dataset
2. class of the dataset
3. first 8 rows of the dataset
4. class of the variables lakename, sampledate, depth, and temperature
5. summary of lakename, depth, and temperature

```
# 1
dim(temperate_lake_data_raw)
```

```
## [1] 38614    11
```

```
# 2
class(temperate_lake_data_raw)
```

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

```
# 3
head(temperate_lake_data_raw, 8)
```

```
##   lakeid  lakename year4 daynum sampledate depth temperature_C
## 1      L Paul Lake  1984    148    5/27/84  0.00          14.5
## 2      L Paul Lake  1984    148    5/27/84  0.25            NA
## 3      L Paul Lake  1984    148    5/27/84  0.50            NA
## 4      L Paul Lake  1984    148    5/27/84  0.75            NA
## 5      L Paul Lake  1984    148    5/27/84  1.00          14.5
## 6      L Paul Lake  1984    148    5/27/84  1.50            NA
## 7      L Paul Lake  1984    148    5/27/84  2.00          14.2
## 8      L Paul Lake  1984    148    5/27/84  3.00          11.0
##   dissolvedOxygen irradianceWater irradianceDeck comments
## 1             9.5            1750           1620     <NA>
## 2              NA            1550           1620     <NA>
## 3              NA            1150           1620     <NA>
## 4              NA             975           1620     <NA>
## 5             8.8             870           1620     <NA>
## 6              NA             610           1620     <NA>
## 7             8.6             420           1620     <NA>
## 8            11.5             220           1620     <NA>
```

```r
# 4
class(temperate_lake_data_raw$lakename)
```

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

```r
class(temperate_lake_data_raw$sampledate)
```

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

```r
class(temperate_lake_data_raw$depth)
```

```
## [1] "numeric"
```

```r
class(temperate_lake_data_raw$temperature_C)
```

```
## [1] "numeric"
```

```r
# 5
summary(temperate_lake_data_raw$lakename)
```

```
## Central Long Lake     Crampton Lake    East Long Lake  Hummingbird Lake
##               539              1234              3905               430
##         Paul Lake        Peter Lake      Tuesday Lake         Ward Lake
##             10325             11288              6107               598
##    West Long Lake
##              4188
```

```r
summary(temperate_lake_data_raw$depth)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    0.00    1.50    4.00    4.39    6.50   20.00
```

```r
summary(temperate_lake_data_raw$temperature_C)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##    0.30    5.30    9.30   11.81   18.70   34.10    3858
```

Change sampledate to class = date. After doing this, write an R command to display that the class of sammpledate is indeed date. Write another R command to show the first 10 rows of the date column.

```r
temperate_lake_data_raw$sampledate <- as.Date(temperate_lake_data_raw$sampledate, format = "%m/%d/%y")
class(temperate_lake_data_raw$sampledate)
```

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

```r
head(temperate_lake_data_raw, 10)
```

```
##    lakeid  lakename year4 daynum sampledate depth temperature_C
## 1       L Paul Lake  1984    148 1984-05-27  0.00          14.5
## 2       L Paul Lake  1984    148 1984-05-27  0.25            NA
## 3       L Paul Lake  1984    148 1984-05-27  0.50            NA
## 4       L Paul Lake  1984    148 1984-05-27  0.75            NA
## 5       L Paul Lake  1984    148 1984-05-27  1.00          14.5
## 6       L Paul Lake  1984    148 1984-05-27  1.50            NA
## 7       L Paul Lake  1984    148 1984-05-27  2.00          14.2
## 8       L Paul Lake  1984    148 1984-05-27  3.00          11.0
## 9       L Paul Lake  1984    148 1984-05-27  4.00           7.0
## 10      L Paul Lake  1984    148 1984-05-27  5.00           6.1
##    dissolvedOxygen irradianceWater irradianceDeck comments
## 1              9.5            1750           1620     <NA>
```

```
## 2                NA            1550            1620     <NA>
## 3                NA            1150            1620     <NA>
## 4                NA             975            1620     <NA>
## 5               8.8             870            1620     <NA>
## 6                NA             610            1620     <NA>
## 7               8.6             420            1620     <NA>
## 8              11.5             220            1620     <NA>
## 9              11.9             100            1620     <NA>
## 10              2.5              34            1620     <NA>
```

Question: Do you want to remove NAs from this dataset? Why or why not?

> ANSWER: No. Some of the NAs have scientific meaning and we want to keep them. For example, take irradiance. Irradiance is energy flux in W/mˆ2, and below a certain depth in each lake, it has a NA value. This tells us that sunlight is not penetrating to the bottom of the lake.

4) Explore your data graphically

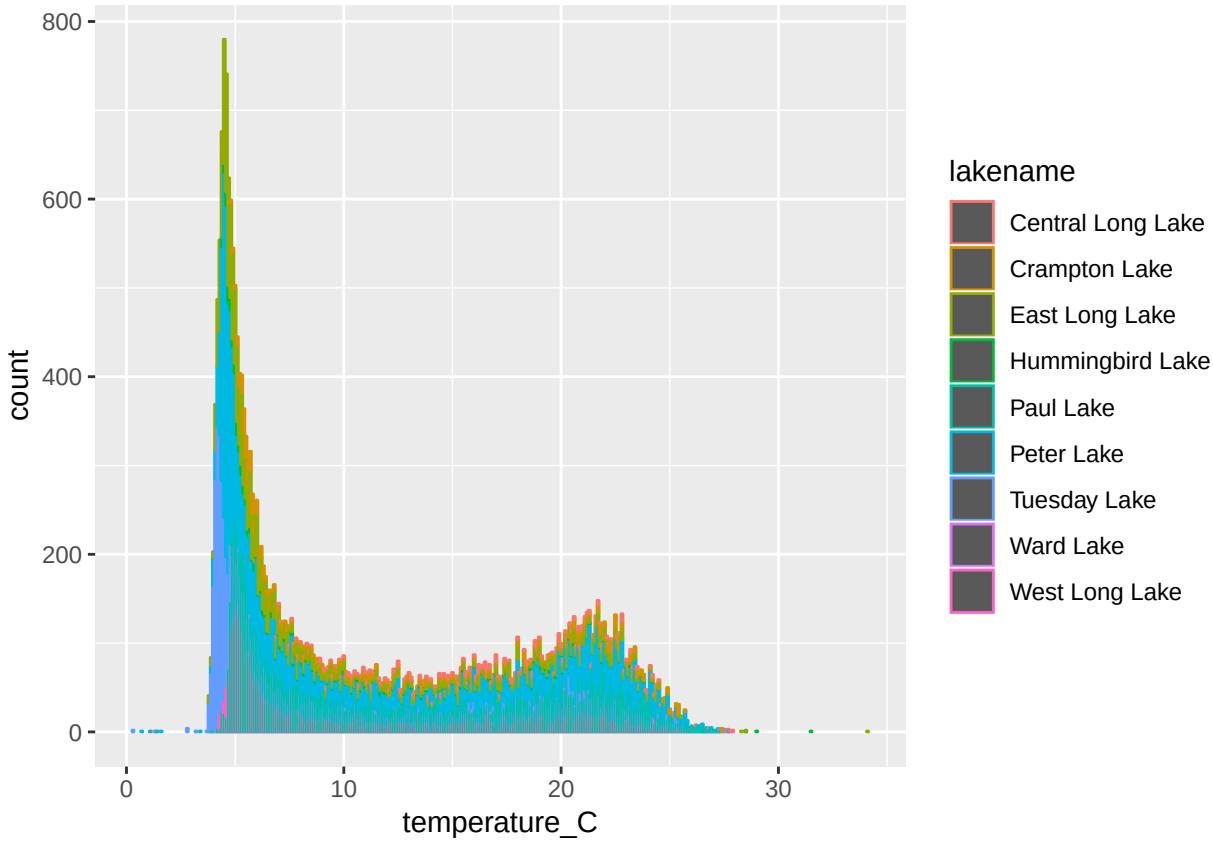
Write R commands to display graphs depicting:

1. Bar chart of temperature counts for each lake
2. Histogram of count distributions of temperature (all temp measurements together)
3. Change histogram from 2 to have a different number or width of bins
4. Frequency polygon of temperature for each lake. Choose different colors for each lake.
5. Boxplot of temperature for each lake
6. Boxplot of temperature based on depth, with depth divided into 0.25 m increments
7. Scatterplot of temperature by depth

```
# 1
ggplot(temperate_lake_data_raw, aes(x= temperature_C, color= lakename)) +
  geom_bar()
```

```
## Warning: Removed 3858 rows containing non-finite values (stat_count).
```

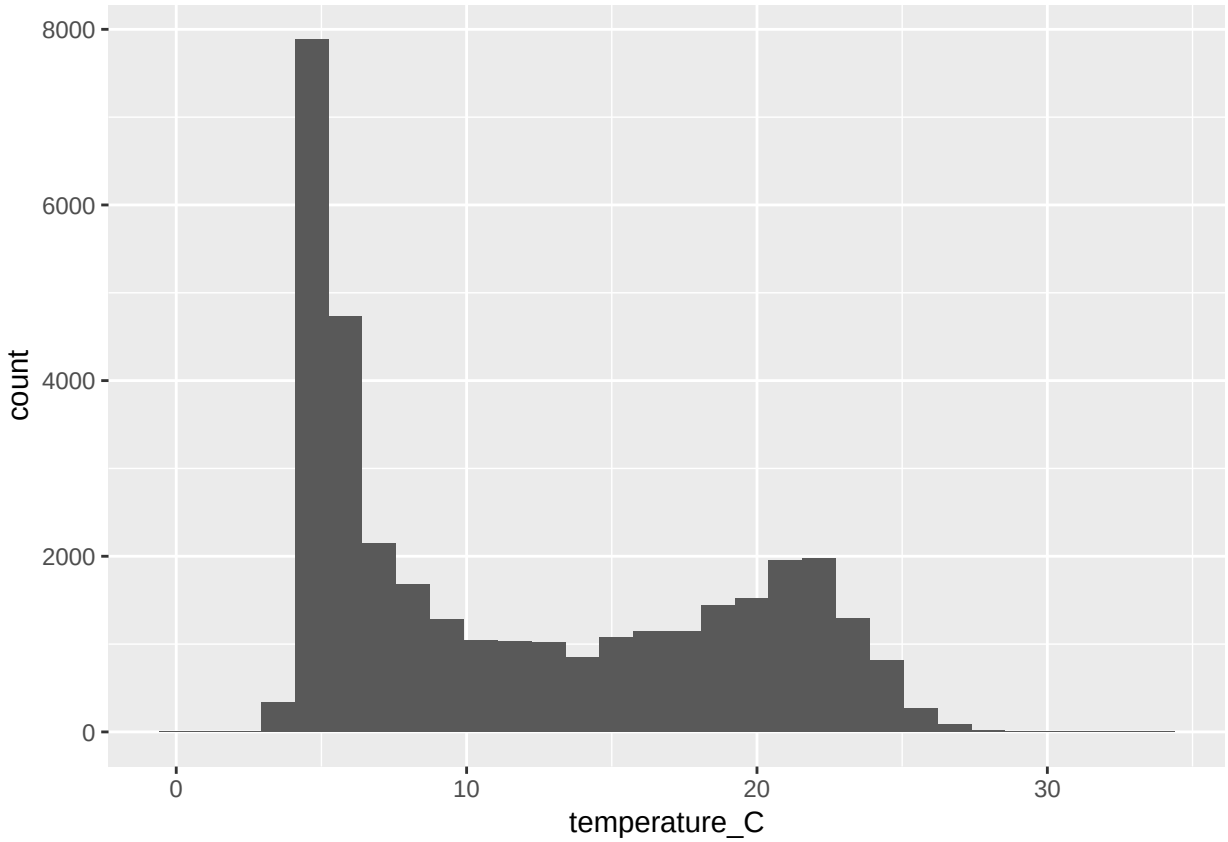
```
## Warning: position_stack requires non-overlapping x intervals
```




```
# 2
ggplot(temperate_lake_data_raw) +
  geom_histogram(aes(x= temperature_C))
```

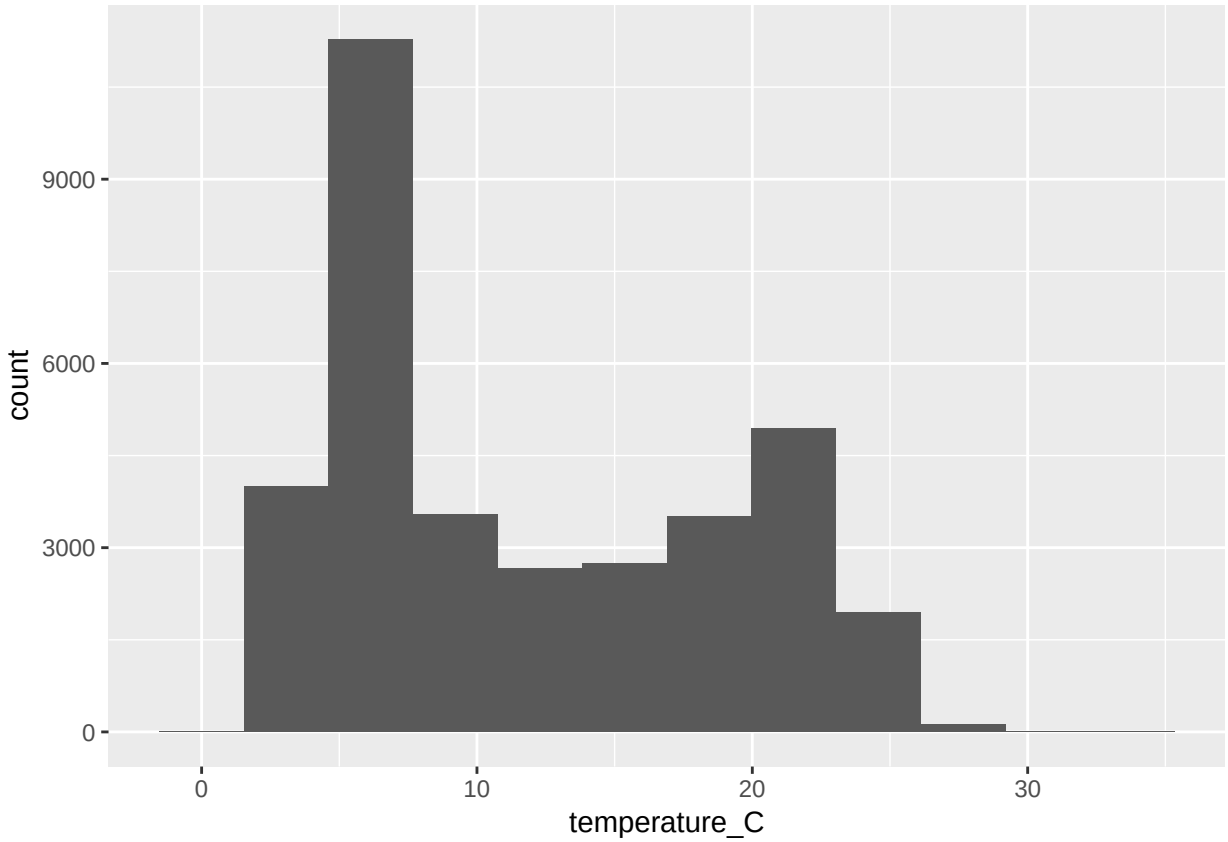
```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

```
## Warning: Removed 3858 rows containing non-finite values (stat_bin).
```



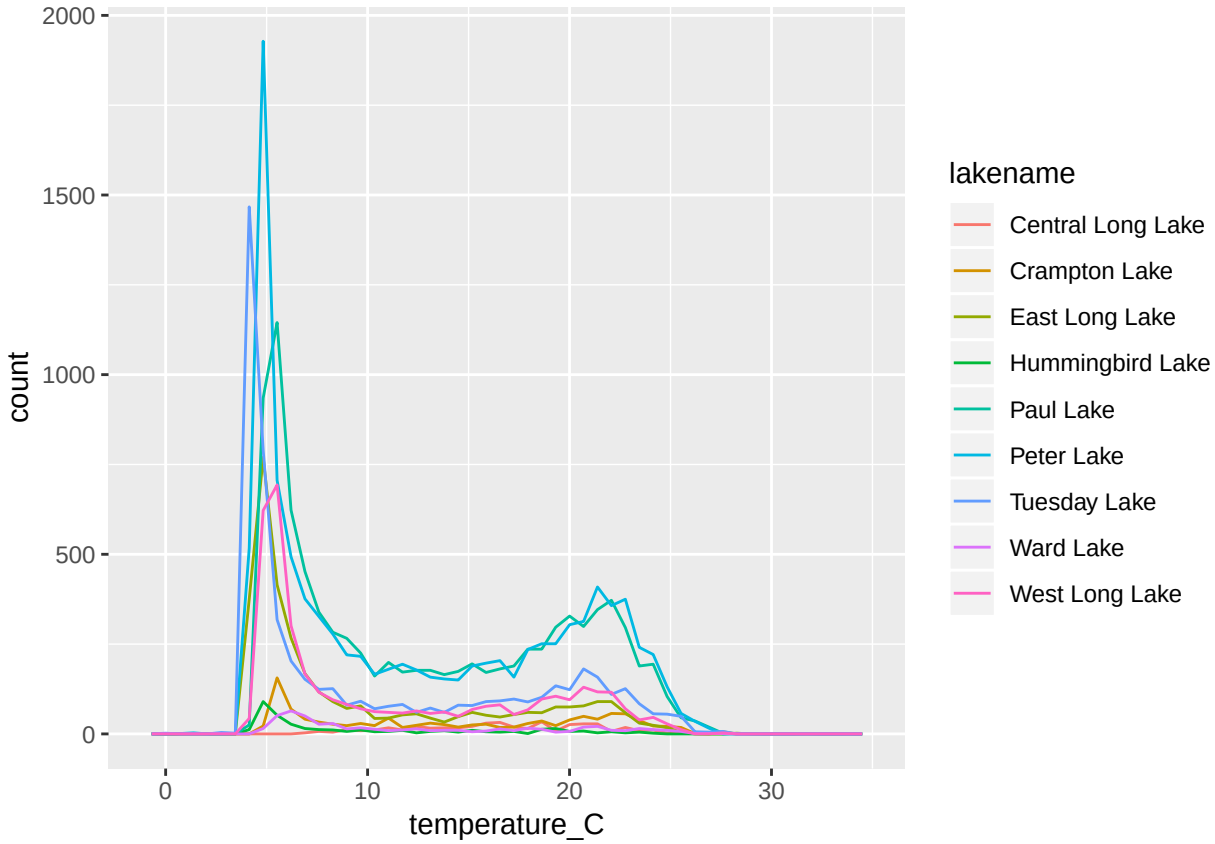

```
# 3
ggplot(temperate_lake_data_raw) +
  geom_histogram(aes(x= temperature_C), bins = 12)
```

```
## Warning: Removed 3858 rows containing non-finite values (stat_bin).
```



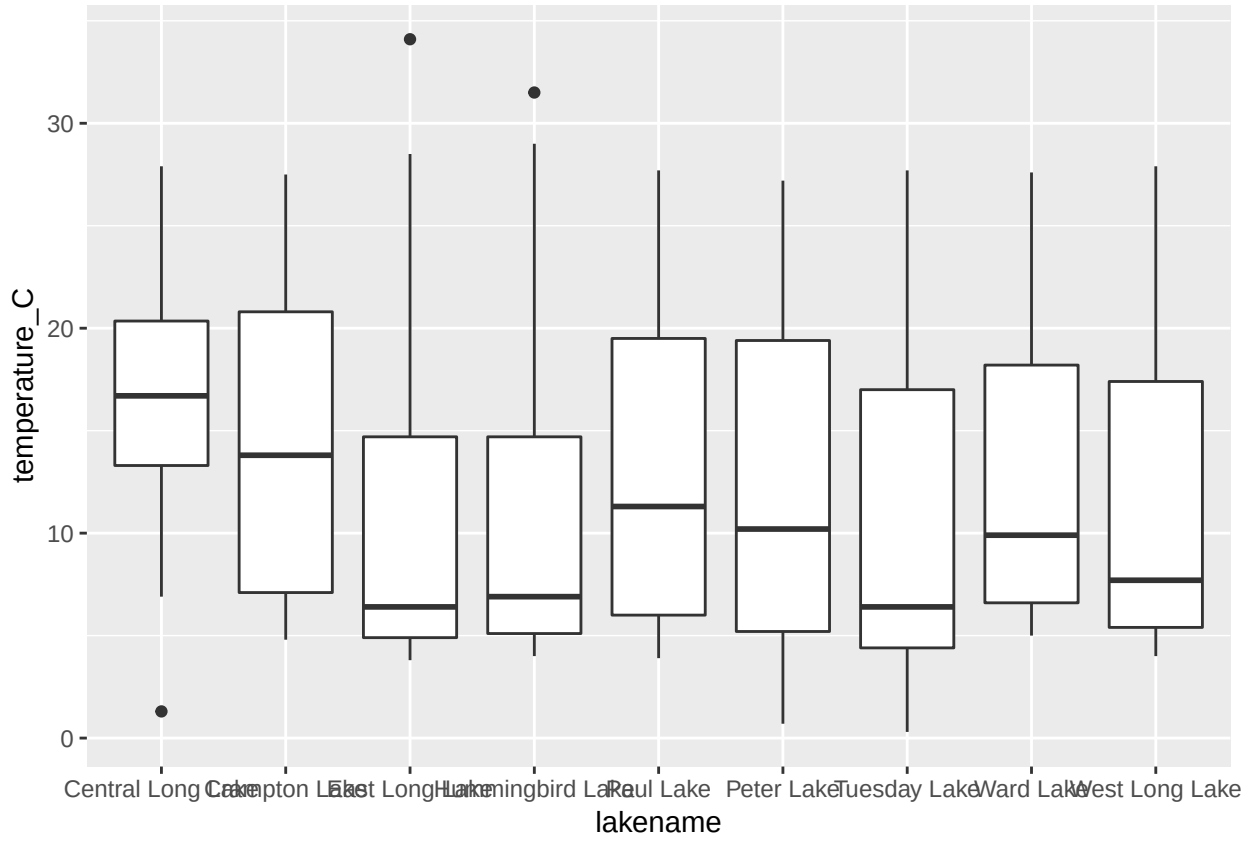

```
# 4
ggplot(temperate_lake_data_raw) +
  geom_freqpoly(aes(x = temperature_C, color = lakename), bins = 50)
```

```
## Warning: Removed 3858 rows containing non-finite values (stat_bin).
```



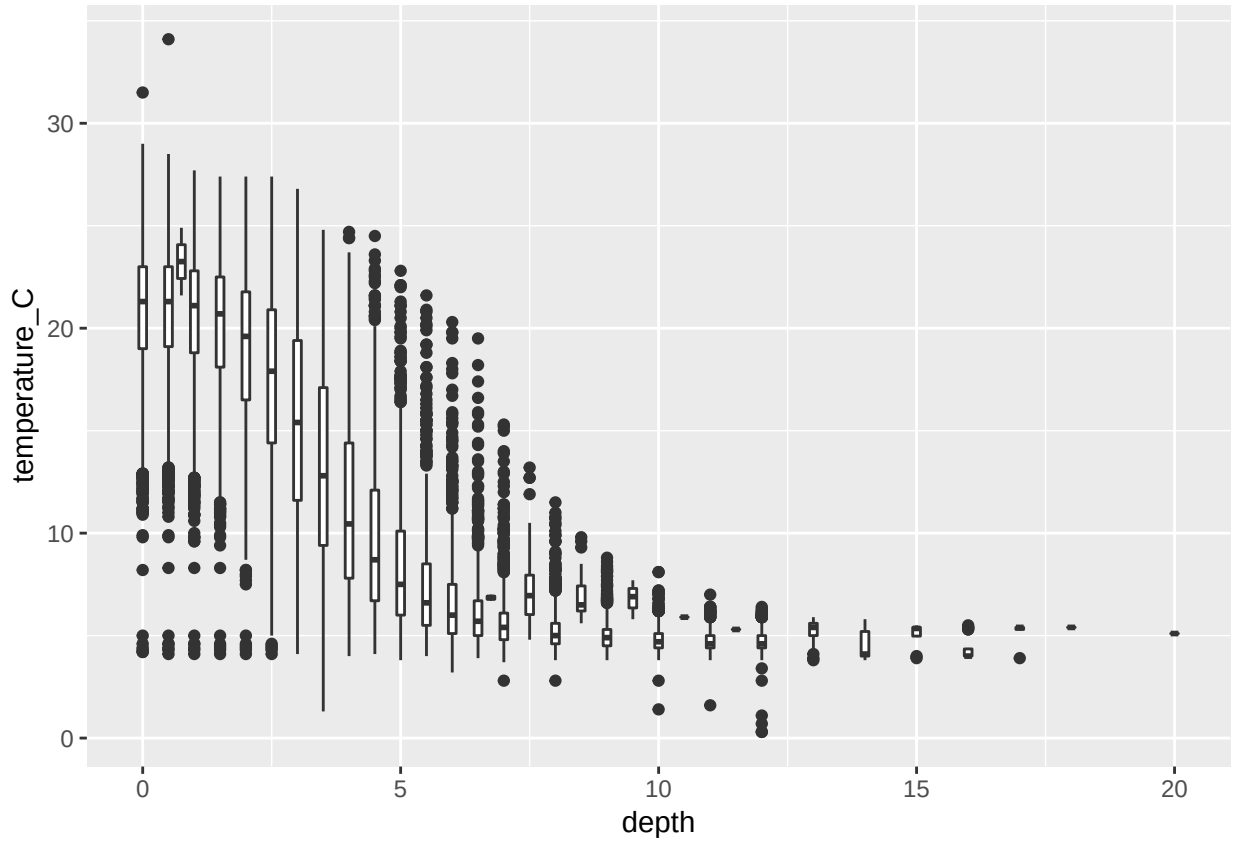

```
# 5
ggplot(temperate_lake_data_raw) +
  geom_boxplot(aes(x= lakename, y= temperature_C))
```

```
## Warning: Removed 3858 rows containing non-finite values (stat_boxplot).
```



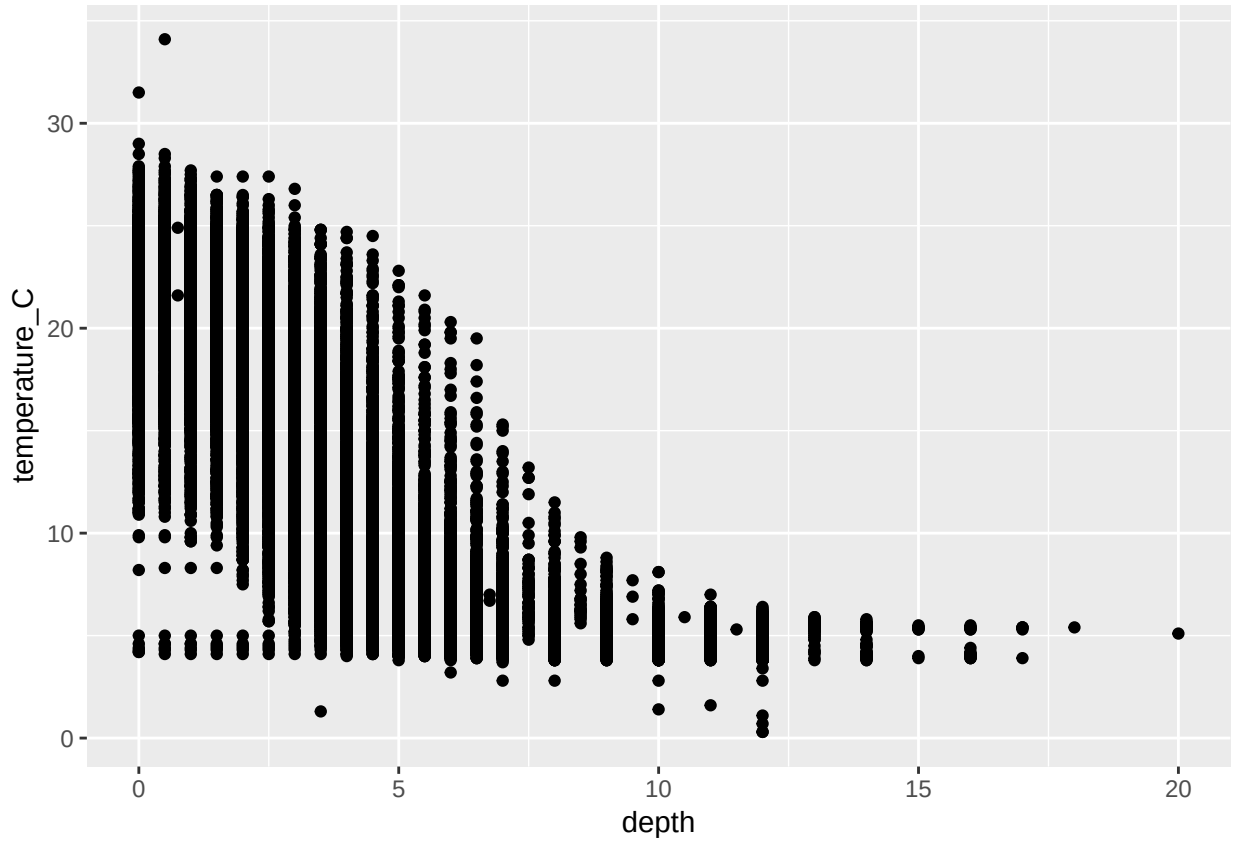

```
# 6
ggplot(temperate_lake_data_raw) +
  geom_boxplot(aes(x= depth, y= temperature_C, group = cut_width(depth, 0.25)))
```

```
## Warning: Removed 3858 rows containing non-finite values (stat_boxplot).
```




```
# 7
ggplot(temperate_lake_data_raw) +
  geom_point(aes(x= depth, y= temperature_C))
```

```
## Warning: Removed 3858 rows containing missing values (geom_point).
```



5) Form questions for further data analysis

What did you find out about your data from the basic summaries and graphs you made? Describe in 4-6 sentences.

> ANSWER: The lakes have several shared patterns and several unique characteristics. This makes sense because they are geographically and geomorphologically similar but not identical. The deeper you go in the lake, the colder the water gets. However, some lakes are warmer or colder than others. The sharp increase in frequency of 4 to 8 degree Celsius water in all lakes indicates the presense of a thermocline in these lakes. From the scatterplot, we see there was a systematic method of collecting the data.

What are 3 further questions you might ask as you move forward with analysis of this dataset?

> ANSWER 1: Where does the thermocline start on each lake?
>
> ANSWER 2: Are there correlations between temperature at a given depth and other information we might know about the lake, such as the presense of springs?
>
> ANSWER 3: How has lake temperature changed over time?