

# Assignment 09: Data Scraping

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## Total points:

## OVERVIEW

This exercise accompanies the lessons in Environmental Data Analytics on data scraping.

## Directions

1. Change “Student Name” on line 3 (above) with your name.
2. Work through the steps, **creating code and output** that fulfill each instruction.
3. Be sure to **answer the questions** in this assignment document.
4. When you have completed the assignment, **Knit** the text and code into a single PDF file.
5. After Knitting, submit the completed exercise (PDF file) to the dropbox in Sakai. Add your last name into the file name (e.g., “Fay\_\_09\_\_Data\_\_Scraping.Rmd”) prior to submission.

## Set up

1. Set up your session:
  - Check your working directory
  - Load the packages **tidyverse**, **rvest**, and any others you end up using.
  - Set your ggplot theme

```
#1  
getwd()
```

```
## [1] "/Users/karenthornton/Documents/School/Grad School/Year 1/Semester 2/EDA/Environmental_Data_Anal,
```

```
library(tidyverse)  
library(rvest)  
  
mytheme <- theme_light(base_size = 16)+  
  theme(legend.position = "top",  
        legend.justification = "right",  
        axis.text = element_text(color= "black"))  
  
theme_set(mytheme)
```

2. We will be scraping data from the NC DEQs Local Water Supply Planning website, specifically the Durham’s 2020 Municipal Local Water Supply Plan (LWSP):

- Navigate to <https://www.ncwater.org/WUDC/app/LWSP/search.php>
- Change the date from 2021 to 2020 in the upper right corner.
- Scroll down and select the LWSP link next to Durham Municipality.
- Note the web address: <https://www.ncwater.org/WUDC/app/LWSP/report.php?psid=03-32-010&year=2020>

Indicate this website as the as the URL to be scraped. (In other words, read the contents into an `rvest` webpage object.)

```
#2
webpage <- read_html('https://www.ncwater.org/WUDC/app/LWSP/report.php?psid=03-32-010&year=2020')
webpage
```

```
## {html_document}
## <html xmlns="http://www.w3.org/1999/xhtml" lang="en" xml:lang="en">
## [1] <head>\n<title>DWR :: Local Water Supply Planning</title>\n<meta http-equ ...
## [2] <body id="plan">\r\n<!--<div id="division-header">\r\n<a name="top" href= ...
```

3. The data we want to collect are listed below:

- From the “1. System Information” section:
  - Water system name
  - PSWID
  - Ownership
- From the “3. Water Supply Sources” section:
  - Max Daily Use (MGD)

In the code chunk below scrape these values, assigning them to three separate variables.

HINT: The first value should be “Durham”, the second “03-32-010”, the third “Municipality”, and the last should be a vector of 12 numeric values, with the first value being 36.0100.

```
#3
water.system.name <- webpage %>%
  html_nodes("div+ table tr:nth-child(1) td:nth-child(2)") %>%
  html_text()
water.system.name
```

```
## [1] "Durham"
```

```
pswid <- webpage %>%
  html_nodes("td tr:nth-child(1) td:nth-child(5)") %>%
  html_text()
pswid
```

```
## [1] "03-32-010"
```

```
ownership <- webpage %>%
  html_nodes("div+ table tr:nth-child(2) td:nth-child(4)") %>%
  html_text()
ownership
```

```
## [1] "Municipality"
```

```
max.withdrawals.mgd <- webpage %>%
  html_nodes("th~ td+ td") %>%
  html_text()
max.withdrawals.mgd
```

```
## [1] "36.0100" "36.9800" "41.6900" "32.0500" "40.6100" "40.5600" "37.2900"
## [8] "43.6300" "33.3200" "32.3700" "41.9300" "28.0600"
```

4. Convert your scraped data into a dataframe. This dataframe should have a column for each of the 4 variables scraped and a row for the month corresponding to the withdrawal data. Also add a Date column that includes your month and year in data format. (Feel free to add a Year column too, if you wish.)

TIP: Use `rep()` to repeat a value when creating a dataframe.

NOTE: It's likely you won't be able to scrape the monthly withdrawal data in order. You can overcome this by creating a month column in the same order the data are scraped: Jan, May, Sept, Feb, etc...

5. Plot the max daily withdrawals across the months for 2020

```
#4
df_WaterSupply <- data.frame("Month" = c("Jan", "May", "Sep",
                                           "Feb", "Jun", "Oct",
                                           "Mar", "Jul", "Nov",
                                           "Apr", "Aug", "Dec"),
                             "Year" = rep(2020,12),
                             "Max-Withdrawals_mgd" =
                               as.numeric(max.withdrawals.mgd))

library(lubridate)
```

```
##
## Attaching package: 'lubridate'

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

```
df_WaterSupply <- df_WaterSupply %>%
  mutate(Water_System_Name = !!water.system.name,
         PSWID = !!pswid,
         Ownership = !!ownership,
```

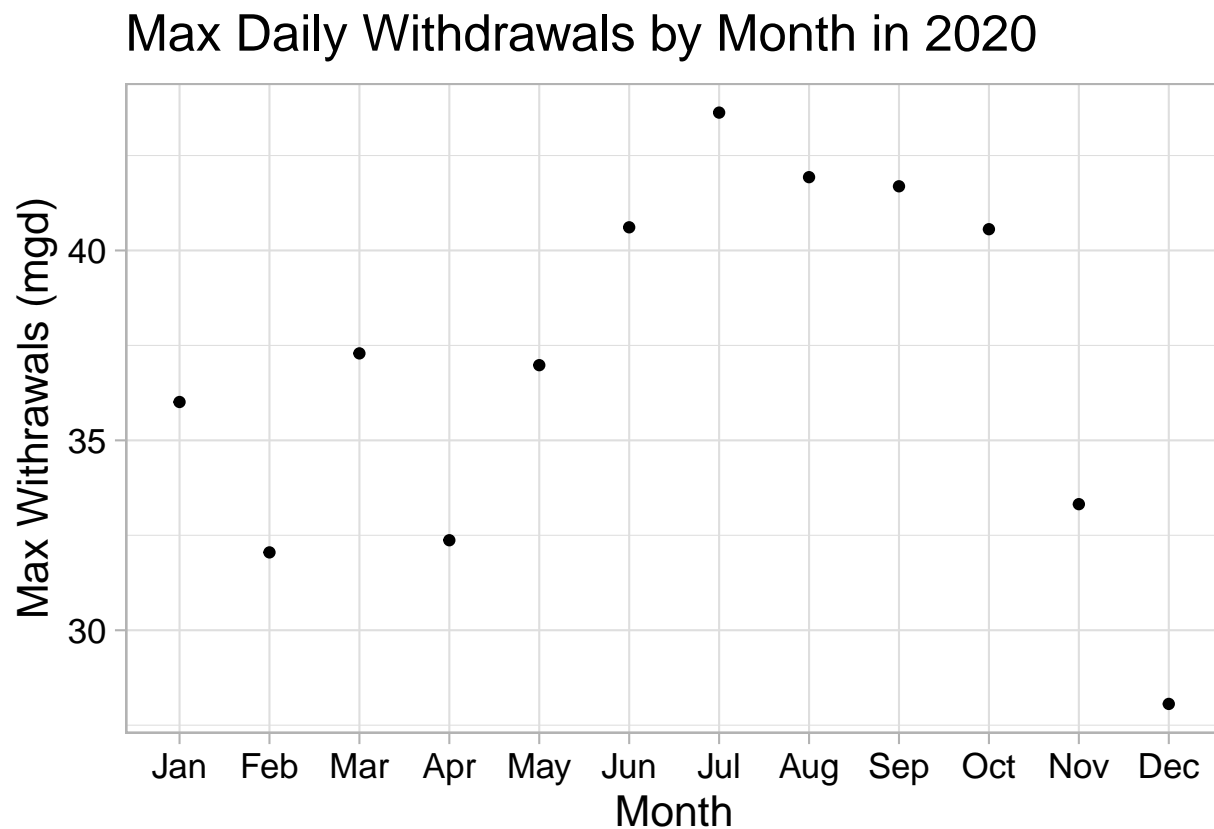
```

Date = my(paste(Month,"-",Year)))

#5
df_WaterSupply$Month <- as.factor(df_WaterSupply$Month)
df_WaterSupply$Month <- factor(df_WaterSupply$Month,
                              levels = c ("Jan", "Feb", "Mar",
                                           "Apr", "May", "Jun",
                                           "Jul", "Aug", "Sep",
                                           "Oct", "Nov", "Dec"))

ggplot(df_WaterSupply, aes(y=Max-Withdrawals_mgd, x= Month))+
  geom_point()+
  labs(title = "Max Daily Withdrawals by Month in 2020",
       x="Month",
       y="Max Withdrawals (mgd)")

```



6. Note that the PWSID and the year appear in the web address for the page we scraped. Construct a function using your code above that can scrape data for any PWSID and year for which the NC DEQ has data. **Be sure to modify the code to reflect the year and site scraped.**

```

#6.
the_function <- function(the_year, the_pwsid){
  the_base_url <- 'https://www.ncwater.org/WUDC/app/LWSP/report.php?'

```

```

the_scrape_url <- paste0(the_base_url, 'pwsid=', the_pwsid,
                        '&year=', the_year)
print(the_scrape_url)

webpage <- read_html(the_scrape_url)

water.system.name.tag <- "div+ table tr:nth-child(1) td:nth-child(2)"
pwsid.tag <- "td tr:nth-child(1) td:nth-child(5)"
ownership.tag <- "div+ table tr:nth-child(2) td:nth-child(4)"
max.withdrawals.mgd.tag <- "th~ td+ td"

water.system.name <- webpage %>%
  html_nodes(water.system.name.tag) %>%
  html_text()
water.system.name
pwsid <- webpage %>%
  html_nodes(pwsid.tag) %>%
  html_text()
pwsid
ownership <- webpage %>%
  html_nodes(ownership.tag) %>%
  html_text()
ownership
max.withdrawals.mgd <- webpage %>%
  html_nodes(max.withdrawals.mgd.tag) %>%
  html_text()
max.withdrawals.mgd

df_WaterSupply <- data.frame("Month" = c("Jan", "May", "Sep",
                                         "Feb", "Jun", "Oct",
                                         "Mar", "Jul", "Nov",
                                         "Apr", "Aug", "Dec"),
                             "Year" = rep(the_year, 12),
                             "Max-Withdrawals_mgd" =
                               as.numeric(max.withdrawals.mgd))

df_WaterSupply <- df_WaterSupply %>%
  mutate(Water_System_Name = !!water.system.name,
         PSWID = !!pwsid,
         Ownership = !!ownership,
         Date = my(paste(Month, "-", Year)))

df_WaterSupply$Month <- as.factor(df_WaterSupply$Month)
df_WaterSupply$Month <- factor(df_WaterSupply$Month,
                              levels = c("Jan", "Feb", "Mar",
                                           "Apr", "May", "Jun",
                                           "Jul", "Aug", "Sep",
                                           "Oct", "Nov", "Dec"))

return(df_WaterSupply)
}

```

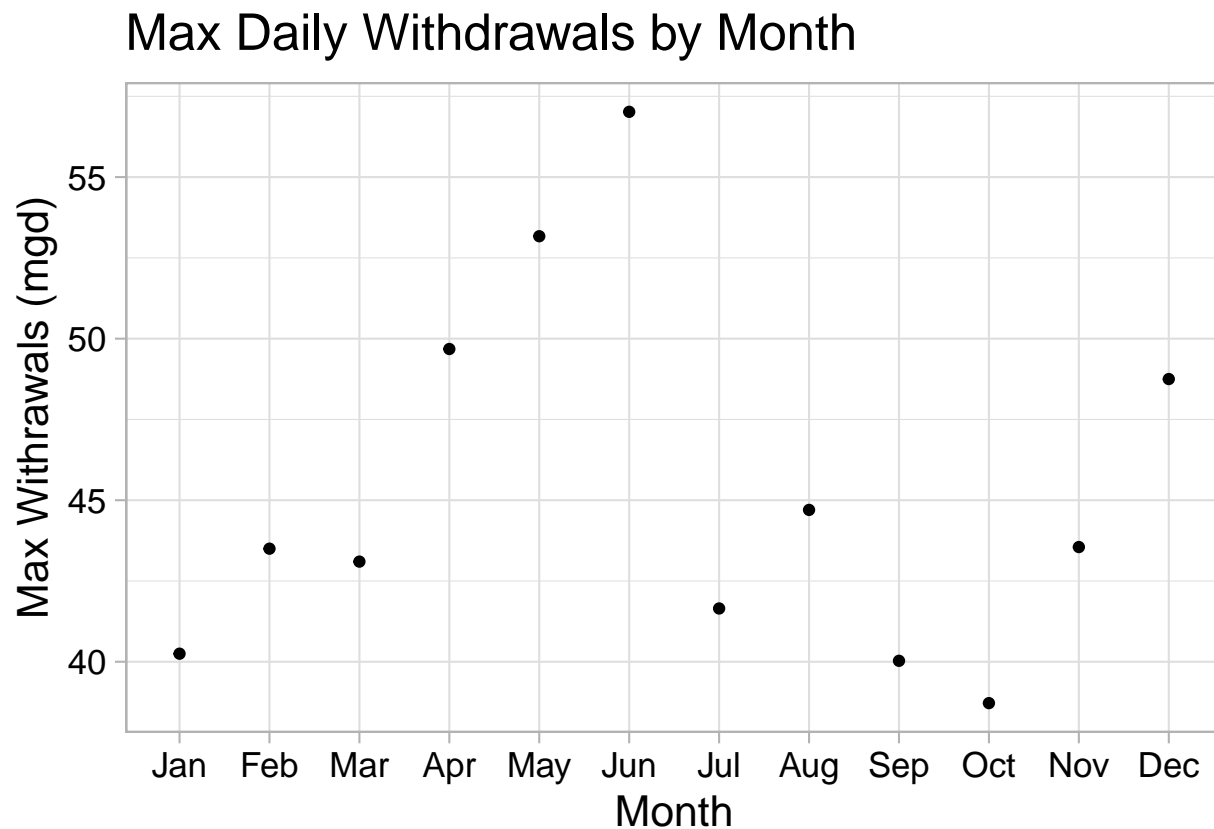
7. Use the function above to extract and plot max daily withdrawals for Durham (PWSID='03-32-010') for each month in 2015

#7

```
Dur2015 <- the_function(2015, '03-32-010')
```

```
## [1] "https://www.ncwater.org/WUDC/app/LWSP/report.php?pwsid=03-32-010&year=2015"
```

```
ggplot(Dur2015, aes(y=Max-Withdrawals_mgd, x= Month))+  
  geom_point()+  
  labs(title = "Max Daily Withdrawals by Month",  
        x="Month",  
        y="Max Withdrawals (mgd)")
```



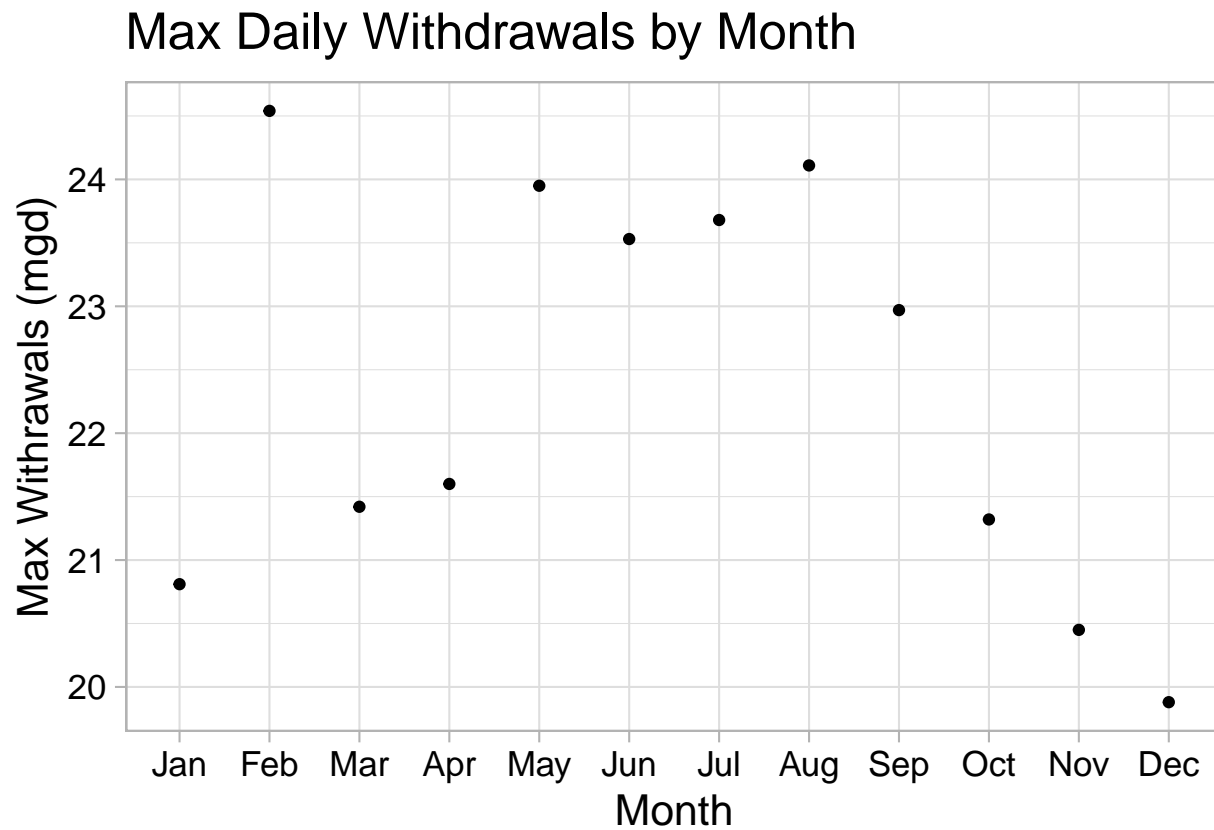
8. Use the function above to extract data for Asheville (PWSID = 01-11-010) in 2015. Combine this data with the Durham data collected above and create a plot that compares the Asheville to Durham's water withdrawals.

#8

```
Ash2015 <- the_function(2015, '01-11-010')
```

```
## [1] "https://www.ncwater.org/WUDC/app/LWSP/report.php?pwsid=01-11-010&year=2015"
```

```
ggplot(Ash2015, aes(y=Max-Withdrawals_mgd, x= Month))+
  geom_point()+
  labs(title = "Max Daily Withdrawals by Month",
        x="Month",
        y="Max Withdrawals (mgd)")
```



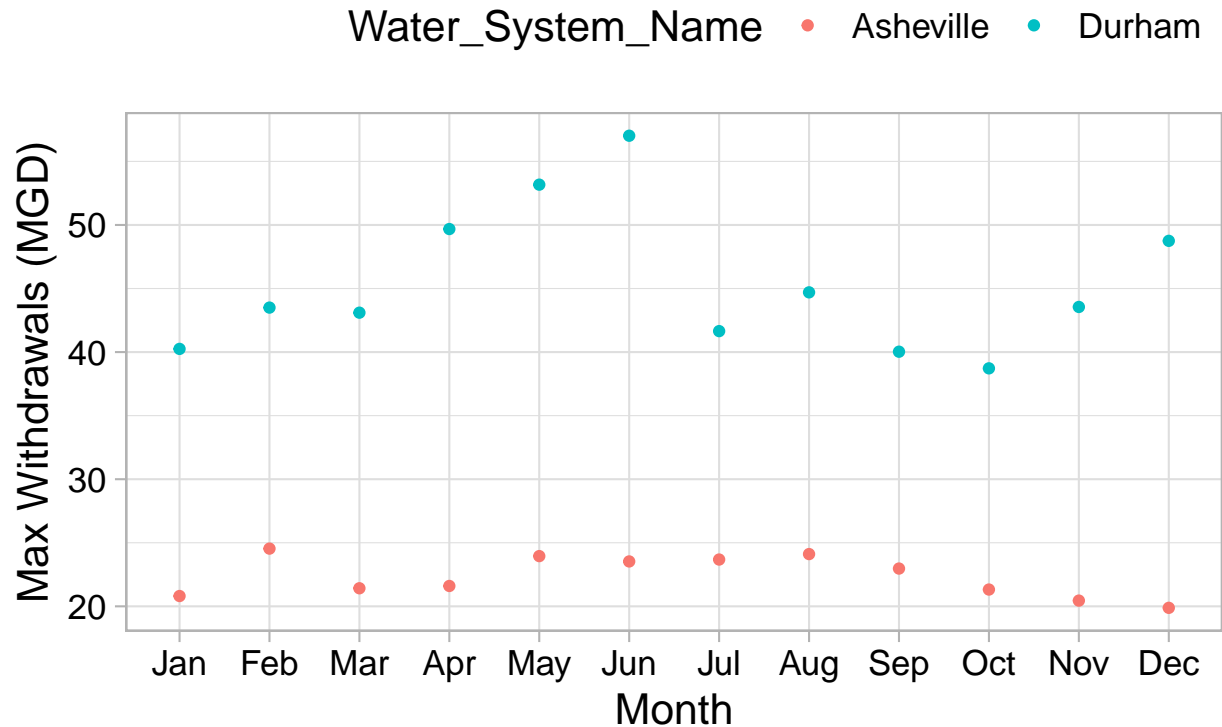
```
#combine

Combined <- rbind(Ash2015, Dur2015)

#plot
Combined$Water_System_Name <- as.factor(Combined$Water_System_Name)

ggplot(Combined, aes(y=Max-Withdrawals_mgd, x=Month,
                    col= Water_System_Name))+
  geom_point()+
  labs(title = "Water Withdrawals",
        y="Max Withdrawals (MGD)", x= "Month")
```

# Water Withdrawals



9. Use the code & function you created above to plot Asheville's max daily withdrawal by months for the years 2010 thru 2019. Add a smoothed line to the plot.

```
#9
the_years = rep(2010:2019)
my_pwsid = '01-11-010'
Ash2010to1019 <- lapply(X = the_years,
                        FUN = the_function,
                        the_pwsid=my_pwsid)

## [1] "https://www.ncwater.org/WUDC/app/LWSP/report.php?pwsid=01-11-010&year=2010"
## [1] "https://www.ncwater.org/WUDC/app/LWSP/report.php?pwsid=01-11-010&year=2011"
## [1] "https://www.ncwater.org/WUDC/app/LWSP/report.php?pwsid=01-11-010&year=2012"
## [1] "https://www.ncwater.org/WUDC/app/LWSP/report.php?pwsid=01-11-010&year=2013"
## [1] "https://www.ncwater.org/WUDC/app/LWSP/report.php?pwsid=01-11-010&year=2014"
## [1] "https://www.ncwater.org/WUDC/app/LWSP/report.php?pwsid=01-11-010&year=2015"
## [1] "https://www.ncwater.org/WUDC/app/LWSP/report.php?pwsid=01-11-010&year=2016"
## [1] "https://www.ncwater.org/WUDC/app/LWSP/report.php?pwsid=01-11-010&year=2017"
## [1] "https://www.ncwater.org/WUDC/app/LWSP/report.php?pwsid=01-11-010&year=2018"
## [1] "https://www.ncwater.org/WUDC/app/LWSP/report.php?pwsid=01-11-010&year=2019"

CombAshDates <- bind_rows(Ash2010to1019)

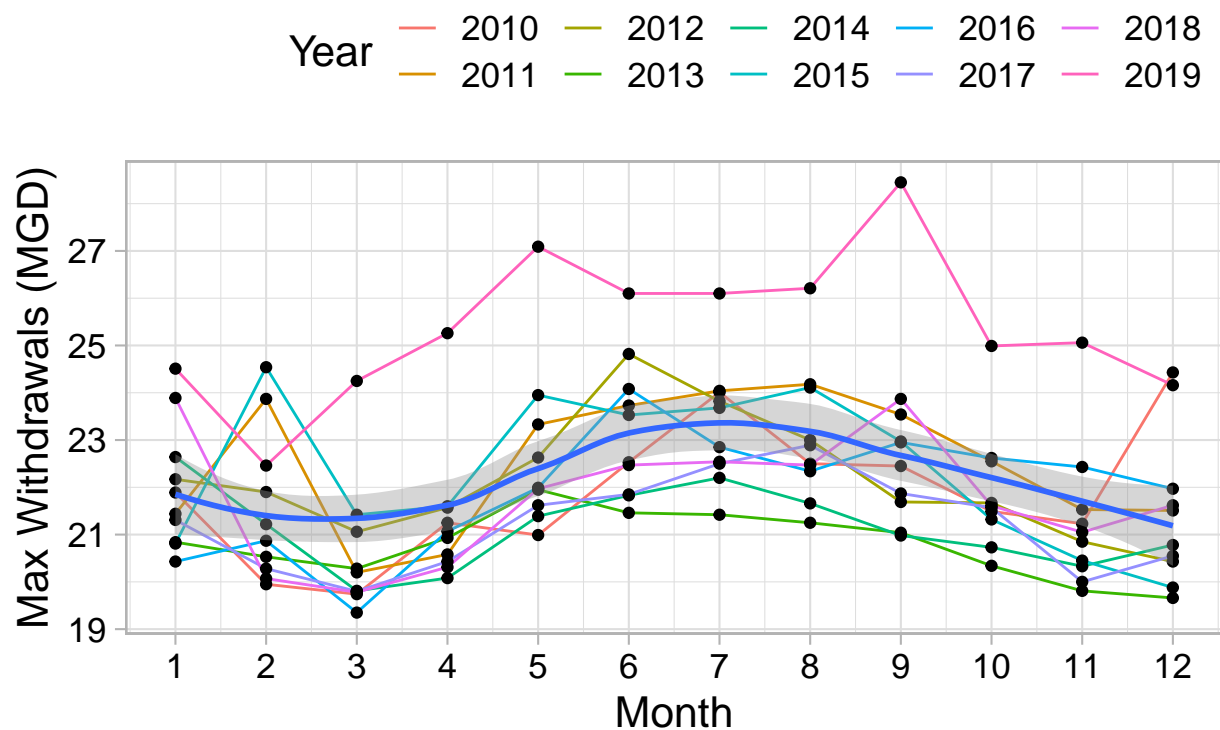
CombAshDates$Year <- as.factor(CombAshDates$Year)
```



```
ggplot(CombAshDates, aes(y= Max-Withdrawals_mgd, x= month(Date)))+
  geom_line(aes(col = Year))+
  geom_point()+
  geom_smooth()+
  scale_x_continuous(breaks = seq(1, 12, by = 1))+
  labs(title = "Asheville Max Withdrawals 2010 to 2019",
       y = "Max Withdrawals (MGD)", x = "Month")
```

## 'geom\_smooth()' using method = 'loess' and formula 'y ~ x'

## Asheville Max Withdrawals 2010 to 2019



Question: Just by looking at the plot (i.e. not running statistics), does Asheville have a trend in water usage over time? Yes, over time Asheville uses more water. It's higher in Jan and Feb then dips in March, goes back up from April to July then back down to December. The year 2019 is an outlier year.