11: Crafting Reports

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LESSON OBJECTIVES

1. Describe the purpose of using R Markdown as a communication and workflow tool
2. Incorporate Markdown syntax into documents
3. Communicate the process and findings of an analysis session in the style of a report

USE OF R STUDIO & R MARKDOWN SO FAR...

1. Write code
2. Document that code
3. Generate PDFs of code and its outputs
4. Integrate with Git/GitHub for version control

BASIC R MARKDOWN DOCUMENT STRUCTURE

1. **YAML Header** surrounded by — on top and bottom
   - YAML templates include options for html, pdf, word, markdown, and interactive
   - More information on formatting the YAML header can be found in the cheat sheet
2. **R Code Chunks** surrounded by "`on top and bottom`   + Create using`Cmd/Ctrl+Alt+I`
   - Can be named {r name} to facilitate navigation and autoreferencing
   - Chunk options allow for flexibility when the code runs and when the document is knitted
3. **Text** with formatting options for readability in knitted document

RESOURCES

Handy cheat sheets for R markdown can be found: here, and here.

There's also a quick reference available via the `Help→Markdown Quick Reference` menu.

Lastly, this website give a great & thorough overview.

THE KNITTING PROCESS

- The knitting sequence

- Knitting commands in code chunks:

- `include = FALSE` - code is run, but neither code nor results appear in knitted file

- `echo = FALSE` - code not included in knitted file, but results are

- `eval = FALSE` - code is not run in the knitted file

- `message = FALSE` - messages do not appear in knitted file

- `warning = FALSE` - warnings do not appear. . .

- `fig.cap = "..."` - adds a caption to graphical results

WHAT ELSE CAN R MARKDOWN DO?

See: https://rmarkdown.rstudio.com and class recording. * Languages other than R. . . * Various outputs. . .

Documents Presentations Shiny etc.

*Can also create codechunks that are NOT R - can use Python as well (potentially) –> must have kernels installed (executables) in order to run the code

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WHY R MARKDOWN?

<Fill in our discussion below with bullet points. Use italics and bold for emphasis (hint: use the cheat sheets or `Help` →`Markdown Quick Reference` to figure out how to make bold and italic text).>

- R **is** –not– open-use

- Can utilize *non-R* code
  - however, you must have these code kernels **installed**

- Can create more than just documents - ability to knit to PowerPoint and other types
  - Easily incorporate plots *and* graphs within your PowerPoint

  - Can also include table formatting

- Creates ease for collaboration due to easy reading format and ability to push/pull through GitHub

TEXT EDITING CHALLENGE

Create a table below that details the example datasets we have been using in class. The first column should contain the names of the datasets and the second column should include some relevant information about the datasets. (Hint: use the cheat sheets to figure out how to make a table in Rmd)

Table 1: Leaf Litter Mass (g) - June 2016

collectDate	functionalGroup	dryMass
2016-06-16	Seeds	0.00
2016-06-16	Other	0.27
2016-06-16	Woody material	0.12
2016-06-16	Seeds	0.00
2016-06-16	Needles	1.11
2016-06-16	Leaves	0.00
2016-06-16	Leaves	0.00
2016-06-16	Seeds	0.00
2016-06-16	Twigs/branches	0.07
2016-06-16	Woody material	0.02

R CHUNK EDITING CHALLENGE

Installing packages

Create an R chunk below that installs the package `knitr`. Instead of commenting out the code, customize the chunk options such that the code is not evaluated (i.e., not run).

```r
#can also edit output options in the little tool widget in the upper right corner of chunk

#don't want to fully knit in chunks that have install packages function
install.packages('knitr')
```

Setup

Create an R chunk below called "setup" that checks your working directory, loads the packages `tidyverse`, `lubridate`, and `knitr`, and sets a ggplot theme. Remember that you need to disable R throwing a message, which contains a check mark that cannot be knitted.

Load the NTL-LTER_Lake_Nutrients_Raw dataset, display the head of the dataset, and set the date column to a date format.

```
##   lakeid  lakename year4 daynum sampledate depth_id depth tn_ug tp_ug nh34 no23
## 1        L Paul Lake  1991    140 1991-05-20        1  0.00   538    25   NA   NA
## 2        L Paul Lake  1991    140 1991-05-20        2  0.85   285    14   NA   NA
## 3        L Paul Lake  1991    140 1991-05-20        3  1.75   399    14   NA   NA
## 4        L Paul Lake  1991    140 1991-05-20        4  3.00   453    14   NA   NA
## 5        L Paul Lake  1991    140 1991-05-20        5  4.00   363    13   NA   NA
## 6        L Paul Lake  1991    140 1991-05-20        6  6.00   583    37   NA   NA
##   po4 comments
## 1  NA
## 2  NA
## 3  NA
## 4  NA
## 5  NA
## 6  NA
```

Customize the chunk options such that the code is run but is not displayed in the final document.

Data Exploration, Wrangling, and Visualization

Create an R chunk below to create a processed dataset do the following operations:

- Include all columns except lakeid, depth_id, and comments
- Include only surface samples (depth = 0 m)
- Drop rows with missing data

Create a second R chunk to create a summary dataset with the mean, minimum, maximum, and standard deviation of total nitrogen concentrations for each lake. Create a second summary dataset that is identical except that it evaluates total phosphorus. Customize the chunk options such that the code is run but not displayed in the final document.

Create a third R chunk that uses the function `kable` in the knitr package to display two tables: one for the summary dataframe for total N and one for the summary dataframe of total P. Use the `caption = " "` code within that function to title your tables. Customize the chunk options such that the final table is displayed but not the code used to generate the table.

Table 2: Nitrogen content of Peter and Paul Lake

lakename	depth	sampledate	nh34	no23	Mean.NH34	Min.NH34	Max.NH34	StanDev.NH34	Mean.NO23	Min.NO23	Max.NO23	StanDev.NO23	SO23N
Peter Lake	0	1991-06-04	21.533	3.818	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	25.351
Peter Lake	0	1991-06-11	14.579	6.827	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	21.406
Peter Lake	0	1991-06-18	5.749	2.429	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	8.178
Peter Lake	0	1991-06-25	5.817	1.510	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	7.327
Peter Lake	0	1991-07-02	12.448	2.742	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	15.190
Peter Lake	0	1991-07-09	9.495	8.907	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	18.402
Peter Lake	0	1991-07-16	24.334	5.071	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	29.405
Peter Lake	0	1991-07-23	17.350	3.003	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	20.353
Peter Lake	0	1991-08-06	4.556	0.463	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	5.019
Peter Lake	0	1991-08-13	8.638	0.579	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	9.217
Peter Lake	0	1991-08-20	9.608	1.294	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	10.902
Peter Lake	0	1992-05-27	15.020	0.080	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	15.100
Peter Lake	0	1992-06-10	8.160	1.360	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	9.520
Peter Lake	0	1992-06-24	10.810	1.810	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	12.620
Peter Lake	0	1992-07-08	7.580	5.370	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	12.950
Peter Lake	0	1992-07-22	8.010	1.690	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	9.700
Peter Lake	0	1992-08-05	8.970	3.830	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	12.800
Peter Lake	0	1992-08-19	22.250	0.000	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	22.250
Peter Lake	0	1993-05-19	0.000	5.497	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	5.497
Peter Lake	0	1993-05-26	9.701	9.925	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	19.626
Peter Lake	0	1993-06-02	10.638	11.537	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	22.175
Peter Lake	0	1993-06-09	20.739	39.475	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	60.214
Peter Lake	0	1993-06-16	89.413	79.911	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	169.324
Peter Lake	0	1993-06-23	58.699	48.244	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	106.943
Peter Lake	0	1993-06-30	0.000	4.579	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	4.579

lakename	depth	sampledate	nh34	no23	Mean.NH34	Min.NH34	Max.NH34	StanDev.NH34	Mean.NO23	Min.NO23	Max.NO23	StanDev.NO23	SUM023N
Peter Lake	0	1993-07-21	4.312	8.945	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	13.257
Peter Lake	0	1993-07-28	35.613	26.438	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	62.051
Peter Lake	0	1993-08-04	6.303	30.800	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	37.103
Peter Lake	0	1993-08-11	15.706	16.092	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	31.798
Peter Lake	0	1993-08-18	4.847	6.293	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	11.140
Peter Lake	0	1993-08-25	0.317	1.658	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	1.975
Peter Lake	0	1993-08-31	0.000	2.969	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	2.969
Peter Lake	0	1993-09-07	1.364	2.506	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	3.870
Peter Lake	0	1994-05-25	13.789	2.862	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	16.651
Peter Lake	0	1994-06-01	11.417	9.359	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	20.776
Peter Lake	0	1994-06-08	15.810	10.064	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	25.874
Peter Lake	0	1994-06-15	18.911	1.117	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	20.028
Peter Lake	0	1994-06-22	14.800	7.688	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	22.488
Peter Lake	0	1994-06-29	30.133	10.607	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	40.740
Peter Lake	0	1994-07-06	49.395	37.282	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	86.677
Peter Lake	0	1994-07-13	22.593	49.247	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	71.840
Peter Lake	0	1994-07-20	8.049	0.421	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	8.470
Peter Lake	0	1994-07-27	7.239	3.690	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	10.929
Peter Lake	0	1994-08-03	3.017	2.053	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	5.070
Peter Lake	0	1994-08-10	86.092	34.278	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	120.370
Peter Lake	0	1994-08-17	94.697	49.864	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	144.561
Peter Lake	0	1994-08-24	77.811	59.668	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	137.479
Peter Lake	0	1994-08-31	111.259	91.963	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	203.222
Peter Lake	0	1994-09-06	116.107	99.193	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	215.300
Peter Lake	0	1995-05-24	10.342	72.863	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	83.205
Peter Lake	0	1995-05-31	9.860	63.721	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	73.581

lakename	depth	sampledate	nh34	no23	Mean.NH34	Min.NH34	Max.NH34	StanDev.NH34	Mean.NO23	Min.NO23	Max.NO23	StanDev.NO23	SumN
Peter Lake	0	1995-06-07	23.319	49.610	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	72.929
Peter Lake	0	1995-06-14	19.993	58.040	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	78.033
Peter Lake	0	1995-06-21	18.306	58.865	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	77.171
Peter Lake	0	1995-06-28	34.268	66.545	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	100.813
Peter Lake	0	1995-07-05	13.667	79.151	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	92.818
Peter Lake	0	1995-07-12	13.762	62.473	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	76.235
Peter Lake	0	1995-07-19	13.529	42.341	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	55.870
Peter Lake	0	1995-07-26	12.064	16.348	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	28.412
Peter Lake	0	1995-08-02	5.748	5.642	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	11.390
Peter Lake	0	1995-08-09	8.216	7.193	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	15.409
Peter Lake	0	1995-08-16	3.019	4.349	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	7.368
Peter Lake	0	1995-08-23	17.985	3.750	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	21.735
Peter Lake	0	1996-05-28	17.509	37.764	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	55.273
Peter Lake	0	1996-06-25	230.895	217.750	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	448.645
Peter Lake	0	1996-07-23	532.858	451.758	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	984.616
Peter Lake	0	1997-05-27	22.591	188.394	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	210.985
Peter Lake	0	1997-06-24	25.692	290.803	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	316.495
Peter Lake	0	1997-07-22	10.216	317.931	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	328.147
Peter Lake	0	1997-08-19	6.642	272.335	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	278.977
Peter Lake	0	1998-05-26	14.821	5.033	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	19.854
Peter Lake	0	1998-06-23	15.322	0.819	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	16.141
Peter Lake	0	1998-07-21	7.981	4.868	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	12.849
Peter Lake	0	1998-08-25	6.349	0.988	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	7.337
Peter Lake	0	1999-05-24	15.550	35.375	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	50.925
Peter Lake	0	1999-06-21	22.951	1.858	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	24.809
Peter Lake	0	1999-07-19	9.380	1.333	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	10.713

lakename	depth	sampledate	nh34	no23	Mean.NH34	Min.NH34	Max.NH34	StanDev.NH34	Mean.NO23	Min.NO23	Max.NO23	StanDev.NO23	SoluN
Peter Lake	0	1999-08-16	7.545	1.625	29.53921	0	532.858	67.06840	41.46837	0	451.758	80.049647	9.170
Paul Lake	0	1991-05-27	18.981	10.299	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	29.280
Paul Lake	0	1991-06-03	20.736	5.934	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	26.670
Paul Lake	0	1991-06-10	20.303	11.381	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	31.684
Paul Lake	0	1991-06-17	6.441	2.375	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	8.816
Paul Lake	0	1991-06-24	19.559	1.550	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	21.109
Paul Lake	0	1991-07-01	21.958	11.954	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	33.912
Paul Lake	0	1991-07-08	18.406	5.232	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	23.638
Paul Lake	0	1991-07-15	21.606	3.500	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	25.106
Paul Lake	0	1991-07-22	20.225	3.863	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	24.088
Paul Lake	0	1991-07-29	8.904	2.993	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	11.897
Paul Lake	0	1991-08-05	8.653	1.320	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	9.973
Paul Lake	0	1991-08-12	16.211	0.314	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	16.525
Paul Lake	0	1991-08-19	11.667	1.685	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	13.352
Paul Lake	0	1992-05-27	6.220	0.000	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	6.220
Paul Lake	0	1992-06-10	9.940	4.920	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	14.860
Paul Lake	0	1992-06-24	8.130	2.470	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	10.600
Paul Lake	0	1992-07-08	17.270	18.060	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	35.330
Paul Lake	0	1992-07-22	12.590	1.900	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	14.490
Paul Lake	0	1992-08-05	10.530	2.320	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	12.850
Paul Lake	0	1992-08-19	16.770	0.500	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	17.270
Paul Lake	0	1993-05-20	0.000	1.147	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	1.147
Paul Lake	0	1993-05-27	8.658	3.210	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	11.868
Paul Lake	0	1993-06-03	4.374	2.118	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	6.492
Paul Lake	0	1993-06-10	11.071	3.403	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	14.474
Paul Lake	0	1993-06-17	7.684	5.125	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	12.809

lakename	depth	sampledate	nh34	no23	Mean.NH34	Min.NH34	Max.NH34	StanDev.NH34	Mean.NO23	Min.NO23	Max.NO23	StanDev.NO23	SO23N
Paul Lake	0	1993-06-24	75.649	1.766	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	77.415
Paul Lake	0	1993-07-01	10.168	4.432	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	14.600
Paul Lake	0	1993-07-22	9.121	0.789	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	9.910
Paul Lake	0	1993-07-29	2.048	1.417	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	3.465
Paul Lake	0	1993-08-05	11.436	1.763	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	13.199
Paul Lake	0	1993-08-12	39.431	1.439	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	40.870
Paul Lake	0	1993-08-19	0.000	0.000	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	0.000
Paul Lake	0	1993-08-26	8.239	0.066	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	8.305
Paul Lake	0	1993-08-31	0.000	2.026	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	2.026
Paul Lake	0	1993-09-07	0.000	4.672	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	4.672
Paul Lake	0	1994-05-26	13.631	3.664	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	17.295
Paul Lake	0	1994-06-09	8.260	4.259	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	12.519
Paul Lake	0	1994-06-16	7.221	1.848	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	9.069
Paul Lake	0	1994-06-23	11.994	2.699	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	14.693
Paul Lake	0	1994-06-30	19.486	2.787	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	22.273
Paul Lake	0	1994-07-07	16.571	4.681	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	21.252
Paul Lake	0	1994-07-14	3.935	2.438	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	6.373
Paul Lake	0	1994-07-21	5.831	4.901	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	10.732
Paul Lake	0	1994-07-28	3.008	2.370	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	5.378
Paul Lake	0	1994-08-04	9.548	2.125	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	11.673
Paul Lake	0	1994-08-11	5.120	2.739	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	7.859
Paul Lake	0	1994-08-18	9.403	1.428	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	10.831
Paul Lake	0	1994-08-25	9.775	2.348	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	12.123
Paul Lake	0	1994-09-01	13.376	5.957	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	19.333
Paul Lake	0	1994-09-06	10.272	4.390	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	14.662
Paul Lake	0	1995-05-25	6.253	2.059	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	8.312

lakename	depth	sampledate	nh34	no23	Mean.NH34	Min.NH34	Max.NH34	StanDev.NH34	Mean.NO23	Min.NO23	Max.NO23	StanDev.NO23	SO23N
Paul Lake	0	1995-06-01	16.443	2.763	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	19.206
Paul Lake	0	1995-06-08	8.879	4.075	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	12.954
Paul Lake	0	1995-06-15	9.692	1.843	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	11.535
Paul Lake	0	1995-06-22	12.210	0.539	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	12.749
Paul Lake	0	1995-06-29	21.643	5.331	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	26.974
Paul Lake	0	1995-07-06	26.361	6.323	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	32.684
Paul Lake	0	1995-07-13	16.969	5.912	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	22.881
Paul Lake	0	1995-07-20	17.282	6.119	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	23.401
Paul Lake	0	1995-07-27	10.387	0.631	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	11.018
Paul Lake	0	1995-08-03	13.018	0.923	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	13.941
Paul Lake	0	1995-08-10	10.487	1.257	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	11.744
Paul Lake	0	1995-08-17	3.664	2.458	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	6.122
Paul Lake	0	1995-08-24	7.465	2.005	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	9.470
Paul Lake	0	1996-05-27	6.768	2.193	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	8.961
Paul Lake	0	1996-06-24	7.141	7.825	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	14.966
Paul Lake	0	1996-07-22	8.329	2.906	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	11.235
Paul Lake	0	1997-05-26	34.550	15.485	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	50.035
Paul Lake	0	1997-06-23	16.580	0.839	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	17.419
Paul Lake	0	1997-07-21	13.505	2.448	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	15.953
Paul Lake	0	1997-08-18	10.344	11.250	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	21.594
Paul Lake	0	1998-05-25	24.666	4.178	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	28.844
Paul Lake	0	1998-06-22	15.343	2.425	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	17.768
Paul Lake	0	1998-07-20	13.237	1.151	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	14.388
Paul Lake	0	1998-08-24	24.279	5.386	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	29.665
Paul Lake	0	1999-05-24	21.375	4.255	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	25.630
Paul Lake	0	1999-06-21	26.973	5.075	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	32.048

lakename	depth	sampledate	nh34	no23	Mean.NH34	Min.NH34	Max.NH34	StanDev.NH34	Mean.NO23	Min.NO23	Max.NO23	StanDev.NO23	SO23N
Paul Lake	0	1999-07-19	14.758	5.033	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	19.791
Paul Lake	0	1999-08-16	11.579	3.994	13.42519	0	75.649	10.30827	3.68681	0	18.060	3.294013	15.573

Table 3: Phosphorus content of Peter and Paul Lake

lakename	depth	sampledate	po4	Mean.PO4	Min.PO4	Max.PO4	StanDev.PO4
Peter Lake	0	1991-06-04	4.000	3.175346	0	12	2.803945
Peter Lake	0	1991-06-11	4.000	3.175346	0	12	2.803945
Peter Lake	0	1991-06-18	4.000	3.175346	0	12	2.803945
Peter Lake	0	1991-06-25	4.000	3.175346	0	12	2.803945
Peter Lake	0	1991-07-02	7.000	3.175346	0	12	2.803945
Peter Lake	0	1991-07-09	12.000	3.175346	0	12	2.803945
Peter Lake	0	1991-07-16	4.000	3.175346	0	12	2.803945
Peter Lake	0	1991-07-23	1.000	3.175346	0	12	2.803945
Peter Lake	0	1991-08-06	2.000	3.175346	0	12	2.803945
Peter Lake	0	1991-08-13	1.000	3.175346	0	12	2.803945
Peter Lake	0	1991-08-20	5.000	3.175346	0	12	2.803945
Peter Lake	0	1992-05-27	11.000	3.175346	0	12	2.803945
Peter Lake	0	1992-06-10	4.000	3.175346	0	12	2.803945
Peter Lake	0	1992-06-24	6.000	3.175346	0	12	2.803945
Peter Lake	0	1992-07-08	5.000	3.175346	0	12	2.803945
Peter Lake	0	1992-07-22	5.000	3.175346	0	12	2.803945
Peter Lake	0	1992-08-05	8.000	3.175346	0	12	2.803945
Peter Lake	0	1992-08-19	1.000	3.175346	0	12	2.803945
Peter Lake	0	1993-05-19	1.000	3.175346	0	12	2.803945
Peter Lake	0	1993-05-26	2.000	3.175346	0	12	2.803945
Peter Lake	0	1993-06-02	3.000	3.175346	0	12	2.803945
Peter Lake	0	1993-06-09	4.000	3.175346	0	12	2.803945
Peter Lake	0	1993-06-16	5.000	3.175346	0	12	2.803945
Peter Lake	0	1993-06-23	8.000	3.175346	0	12	2.803945
Peter Lake	0	1993-06-30	2.000	3.175346	0	12	2.803945
Peter Lake	0	1993-07-21	1.000	3.175346	0	12	2.803945
Peter Lake	0	1993-07-28	3.000	3.175346	0	12	2.803945
Peter Lake	0	1993-08-04	1.000	3.175346	0	12	2.803945
Peter Lake	0	1993-08-11	0.000	3.175346	0	12	2.803945
Peter Lake	0	1993-08-18	1.000	3.175346	0	12	2.803945
Peter Lake	0	1993-08-25	0.000	3.175346	0	12	2.803945
Peter Lake	0	1993-08-31	0.000	3.175346	0	12	2.803945
Peter Lake	0	1993-09-07	1.000	3.175346	0	12	2.803945
Peter Lake	0	1994-05-25	2.337	3.175346	0	12	2.803945
Peter Lake	0	1994-06-01	1.848	3.175346	0	12	2.803945
Peter Lake	0	1994-06-08	1.557	3.175346	0	12	2.803945
Peter Lake	0	1994-06-15	1.070	3.175346	0	12	2.803945
Peter Lake	0	1994-06-22	2.349	3.175346	0	12	2.803945
Peter Lake	0	1994-06-29	1.807	3.175346	0	12	2.803945
Peter Lake	0	1994-07-06	6.265	3.175346	0	12	2.803945
Peter Lake	0	1994-07-13	0.896	3.175346	0	12	2.803945
Peter Lake	0	1994-07-20	2.279	3.175346	0	12	2.803945

lakename	depth	sampledate	po4	Mean.PO4	Min.PO4	Max.PO4	StanDev.PO4
Peter Lake	0	1994-07-27	2.633	3.175346	0	12	2.803945
Peter Lake	0	1994-08-03	0.650	3.175346	0	12	2.803945
Peter Lake	0	1994-08-10	0.828	3.175346	0	12	2.803945
Peter Lake	0	1994-08-17	2.063	3.175346	0	12	2.803945
Peter Lake	0	1994-08-24	2.403	3.175346	0	12	2.803945
Peter Lake	0	1994-08-31	1.779	3.175346	0	12	2.803945
Peter Lake	0	1994-09-06	1.133	3.175346	0	12	2.803945
Peter Lake	0	1995-05-24	4.086	3.175346	0	12	2.803945
Peter Lake	0	1995-05-31	0.916	3.175346	0	12	2.803945
Peter Lake	0	1995-06-07	3.685	3.175346	0	12	2.803945
Peter Lake	0	1995-06-14	1.317	3.175346	0	12	2.803945
Peter Lake	0	1995-06-21	1.226	3.175346	0	12	2.803945
Peter Lake	0	1995-06-28	0.000	3.175346	0	12	2.803945
Peter Lake	0	1995-07-05	0.666	3.175346	0	12	2.803945
Peter Lake	0	1995-07-12	0.830	3.175346	0	12	2.803945
Peter Lake	0	1995-07-19	0.938	3.175346	0	12	2.803945
Peter Lake	0	1995-07-26	2.018	3.175346	0	12	2.803945
Peter Lake	0	1995-08-02	2.427	3.175346	0	12	2.803945
Peter Lake	0	1995-08-09	2.046	3.175346	0	12	2.803945
Peter Lake	0	1995-08-16	2.600	3.175346	0	12	2.803945
Peter Lake	0	1995-08-23	2.381	3.175346	0	12	2.803945
Peter Lake	0	1996-05-28	10.493	3.175346	0	12	2.803945
Peter Lake	0	1996-06-25	11.770	3.175346	0	12	2.803945
Peter Lake	0	1996-07-23	5.624	3.175346	0	12	2.803945
Peter Lake	0	1997-05-27	3.099	3.175346	0	12	2.803945
Peter Lake	0	1997-06-24	5.930	3.175346	0	12	2.803945
Peter Lake	0	1997-07-22	1.976	3.175346	0	12	2.803945
Peter Lake	0	1997-08-19	8.218	3.175346	0	12	2.803945
Peter Lake	0	1998-05-26	6.541	3.175346	0	12	2.803945
Peter Lake	0	1998-06-23	3.152	3.175346	0	12	2.803945
Peter Lake	0	1998-07-21	7.327	3.175346	0	12	2.803945
Peter Lake	0	1998-08-25	1.659	3.175346	0	12	2.803945
Peter Lake	0	1999-05-24	0.943	3.175346	0	12	2.803945
Peter Lake	0	1999-06-21	0.954	3.175346	0	12	2.803945
Peter Lake	0	1999-07-19	1.255	3.175346	0	12	2.803945
Peter Lake	0	1999-08-16	1.703	3.175346	0	12	2.803945
Paul Lake	0	1991-05-27	8.000	2.276544	0	10	2.133501
Paul Lake	0	1991-06-03	4.000	2.276544	0	10	2.133501
Paul Lake	0	1991-06-10	6.000	2.276544	0	10	2.133501
Paul Lake	0	1991-06-17	5.000	2.276544	0	10	2.133501
Paul Lake	0	1991-06-24	4.000	2.276544	0	10	2.133501
Paul Lake	0	1991-07-01	7.000	2.276544	0	10	2.133501
Paul Lake	0	1991-07-08	3.000	2.276544	0	10	2.133501
Paul Lake	0	1991-07-15	3.000	2.276544	0	10	2.133501
Paul Lake	0	1991-07-22	0.000	2.276544	0	10	2.133501
Paul Lake	0	1991-07-29	1.000	2.276544	0	10	2.133501
Paul Lake	0	1991-08-05	8.000	2.276544	0	10	2.133501
Paul Lake	0	1991-08-12	0.000	2.276544	0	10	2.133501
Paul Lake	0	1991-08-19	5.000	2.276544	0	10	2.133501
Paul Lake	0	1992-05-27	0.000	2.276544	0	10	2.133501
Paul Lake	0	1992-06-10	3.000	2.276544	0	10	2.133501
Paul Lake	0	1992-06-24	6.000	2.276544	0	10	2.133501

lakename	depth	sampledate	po4	Mean.PO4	Min.PO4	Max.PO4	StanDev.PO4
Paul Lake	0	1992-07-08	3.000	2.276544	0	10	2.133501
Paul Lake	0	1992-07-22	6.000	2.276544	0	10	2.133501
Paul Lake	0	1992-08-05	10.000	2.276544	0	10	2.133501
Paul Lake	0	1992-08-19	1.000	2.276544	0	10	2.133501
Paul Lake	0	1993-05-20	2.000	2.276544	0	10	2.133501
Paul Lake	0	1993-05-27	1.000	2.276544	0	10	2.133501
Paul Lake	0	1993-06-03	1.000	2.276544	0	10	2.133501
Paul Lake	0	1993-06-10	2.000	2.276544	0	10	2.133501
Paul Lake	0	1993-06-17	0.000	2.276544	0	10	2.133501
Paul Lake	0	1993-06-24	2.000	2.276544	0	10	2.133501
Paul Lake	0	1993-07-01	1.000	2.276544	0	10	2.133501
Paul Lake	0	1993-07-22	1.000	2.276544	0	10	2.133501
Paul Lake	0	1993-07-29	1.000	2.276544	0	10	2.133501
Paul Lake	0	1993-08-05	1.000	2.276544	0	10	2.133501
Paul Lake	0	1993-08-12	0.000	2.276544	0	10	2.133501
Paul Lake	0	1993-08-19	0.000	2.276544	0	10	2.133501
Paul Lake	0	1993-08-26	0.000	2.276544	0	10	2.133501
Paul Lake	0	1993-08-31	0.000	2.276544	0	10	2.133501
Paul Lake	0	1993-09-07	2.000	2.276544	0	10	2.133501
Paul Lake	0	1994-05-26	2.632	2.276544	0	10	2.133501
Paul Lake	0	1994-06-09	2.076	2.276544	0	10	2.133501
Paul Lake	0	1994-06-16	0.982	2.276544	0	10	2.133501
Paul Lake	0	1994-06-23	1.036	2.276544	0	10	2.133501
Paul Lake	0	1994-06-30	5.070	2.276544	0	10	2.133501
Paul Lake	0	1994-07-07	2.436	2.276544	0	10	2.133501
Paul Lake	0	1994-07-14	0.823	2.276544	0	10	2.133501
Paul Lake	0	1994-07-21	1.604	2.276544	0	10	2.133501
Paul Lake	0	1994-07-28	3.708	2.276544	0	10	2.133501
Paul Lake	0	1994-08-04	0.466	2.276544	0	10	2.133501
Paul Lake	0	1994-08-11	1.299	2.276544	0	10	2.133501
Paul Lake	0	1994-08-18	1.523	2.276544	0	10	2.133501
Paul Lake	0	1994-08-25	0.729	2.276544	0	10	2.133501
Paul Lake	0	1994-09-01	0.836	2.276544	0	10	2.133501
Paul Lake	0	1994-09-06	0.467	2.276544	0	10	2.133501
Paul Lake	0	1995-05-25	1.372	2.276544	0	10	2.133501
Paul Lake	0	1995-06-01	0.148	2.276544	0	10	2.133501
Paul Lake	0	1995-06-08	3.657	2.276544	0	10	2.133501
Paul Lake	0	1995-06-15	1.220	2.276544	0	10	2.133501
Paul Lake	0	1995-06-22	1.858	2.276544	0	10	2.133501
Paul Lake	0	1995-06-29	0.736	2.276544	0	10	2.133501
Paul Lake	0	1995-07-06	2.873	2.276544	0	10	2.133501
Paul Lake	0	1995-07-13	0.460	2.276544	0	10	2.133501
Paul Lake	0	1995-07-20	1.480	2.276544	0	10	2.133501
Paul Lake	0	1995-07-27	1.656	2.276544	0	10	2.133501
Paul Lake	0	1995-08-03	1.321	2.276544	0	10	2.133501
Paul Lake	0	1995-08-10	1.263	2.276544	0	10	2.133501
Paul Lake	0	1995-08-17	1.690	2.276544	0	10	2.133501
Paul Lake	0	1995-08-24	2.126	2.276544	0	10	2.133501
Paul Lake	0	1996-05-27	5.723	2.276544	0	10	2.133501
Paul Lake	0	1996-06-24	3.468	2.276544	0	10	2.133501
Paul Lake	0	1996-07-22	0.687	2.276544	0	10	2.133501
Paul Lake	0	1997-05-26	3.077	2.276544	0	10	2.133501

lakename	depth	sampledate	po4	Mean.PO4	Min.PO4	Max.PO4	StanDev.PO4
Paul Lake	0	1997-06-23	1.975	2.276544	0	10	2.133501
Paul Lake	0	1997-07-21	2.011	2.276544	0	10	2.133501
Paul Lake	0	1997-08-18	0.000	2.276544	0	10	2.133501
Paul Lake	0	1998-05-25	4.122	2.276544	0	10	2.133501
Paul Lake	0	1998-06-22	2.962	2.276544	0	10	2.133501
Paul Lake	0	1998-07-20	1.499	2.276544	0	10	2.133501
Paul Lake	0	1998-08-24	4.770	2.276544	0	10	2.133501
Paul Lake	0	1999-05-24	1.106	2.276544	0	10	2.133501
Paul Lake	0	1999-06-21	0.750	2.276544	0	10	2.133501
Paul Lake	0	1999-07-19	3.130	2.276544	0	10	2.133501
Paul Lake	0	1999-08-16	0.020	2.276544	0	10	2.133501

Create a fourth and fifth R chunk that generates two plots (one in each chunk): one for total N over time with different colors for each lake, and one with the same setup but for total P. Decide which geom option will be appropriate for your purpose, and select a color palette that is visually pleasing and accessible. Customize the chunk options such that the final figures are displayed but not the code used to generate the figures. In addition, customize the chunk options such that the figures are aligned on the left side of the page. Lastly, add a fig.cap chunk option to add a caption (title) to your plot that will display underneath the figure.

Nitrogen Concentrations over Time in Peter and Paul Lake
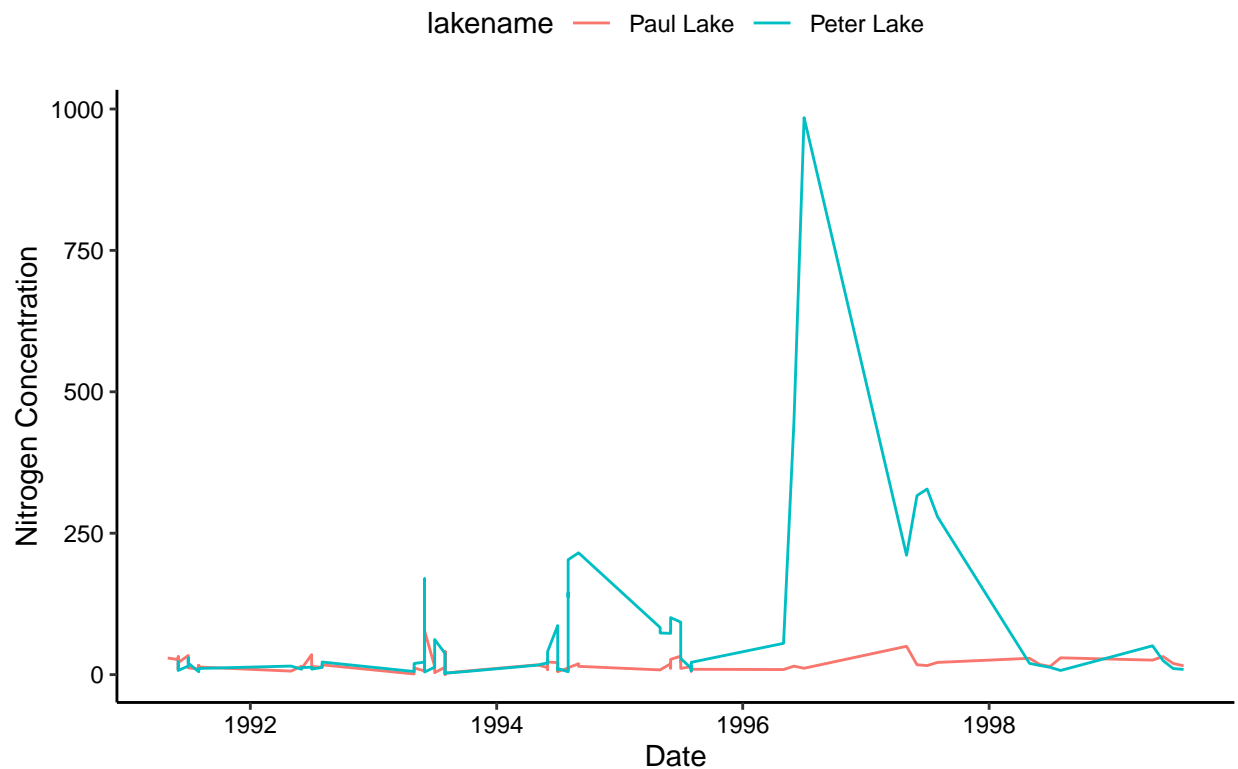
Phosphorus Concentrations over Time in Peter and Paul Lake
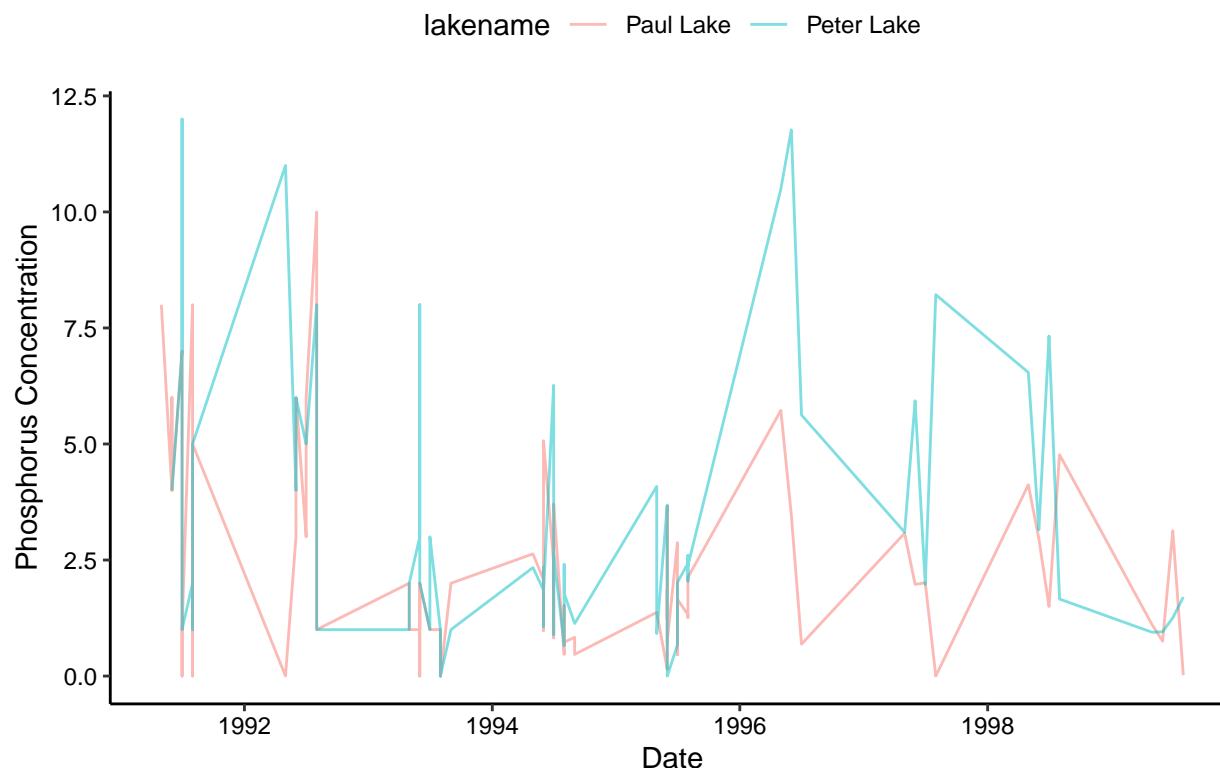
Communicating results

Write a paragraph describing your findings from the R coding challenge above. This should be geared toward an educated audience but one that is not necessarily familiar with the dataset. Then insert a horizontal rule below the paragraph. Below the horizontal rule, write another paragraph describing the next steps you might take in analyzing this dataset. What questions might you be able to answer, and what analyses would you conduct to answer those questions?

From our data wrangling, we see that Peter Lake has an overall higher mean concentration of nitrogen and phosphorus compared to Paul Lake. In particular, Peter Lake's nitrogen concentration is much higher than Paul Lake's - through the Nitrogen concentration plot by lake, we see that Peter Lake's concentrations have higher variability over time. Uniquely, Peter Lake had a huge peak in concentration between 1996-1997, but nitrogen levels decreased to "base levels" by 1998. With phosphorus concentrations, both Peter and Paul lakes have high variability with phosphorus concentrations over time. However, Peter Lake seems to have higher variability in comparison with Paul Lake. Phosphorus concentrations look to cycle through a boom-bust pattern with period of sudden peaks and then a sudden decrease. From 1993-1995, there was a period for Peter and Paul lakes where overall phosphorus levels were lower than previous and future levels.

Moving forward, I would run a time-series analysis to see if there are specific trends within nitrogen and phosphorus concentrations in Peter and Paul lakes over time. Next, I may pull for spatial datasets of Peter and Paul lakes and perform a GLM. A question I would like to explore is if the location of Peter and Paul lakes is impacting the nitrogen and phosphorus concentrations within each lake. In particular, I would like to see why Peter Lake's concentrations are so much higher than Paul lakes.

KNIT YOUR PDF

When you have completed the above steps, try knitting your PDF to see if all of the formatting options you specified turned out as planned. This may take some troubleshooting.

OTHER R MARKDOWN CUSTOMIZATION OPTIONS

We have covered the basics in class today, but R Markdown offers many customization options. A word of caution: customizing templates will often require more interaction with LaTeX and installations on your computer, so be ready to troubleshoot issues.

Customization options for pdf output include:

- Table of contents
- Number sections
- Control default size of figures
- Citations
- Template (more info here)

pdf_document:
toc: true
number_sections: true
fig_height: 3
fig_width: 4
citation_package: natbib
template: