TSM and Chl

Libraries

```
Warning: package 'reshape2' was built under R version 4.3.2
```

```
Attaching package: 'dplyr'
```

```
The following objects are masked from 'package:stats':

    filter, lag
```

```
The following objects are masked from 'package:base':

    intersect, setdiff, setequal, union
```

Plot settings

Read in data

```
dir1 <- "~/GitHub/EAD-ASEB-Ssolidissima-OA/projects/Seawater data/data/TSM and Chl/"
filter_TSM<- read.csv(paste(dir1,"TSM and Chl data - TSM filters.csv",sep = ""), header =

# Separate out header row with unit information from dataframe
unit <- filter_TSM[1,]
filter_TSM <- filter_TSM[2:nrow(filter_TSM),]
str(filter_TSM)
```

```
'data.frame':   214 obs. of  24 variables:
 $ Date                              : chr  "8/10/2021" "8/10/2021" "8/10/2021" "8/10/2021" ..
 $ Site                              : chr  "Eel Pond" "Chatham" "Nobscusset" "Barnstable" ...
 $ ID                                : int  NA NA NA NA NA NA NA NA NA NA ...
 $ TSM.SW.volume_mL                  : num  500 250 500 500 500 500 250 250 350 500 ...
 $ Chl.SW.vol_mL                     : int  NA NA NA NA NA NA NA NA NA NA ...
 $ Chl.measured.ug.L                 : num  NA NA NA NA NA NA NA NA NA NA ...
 $ Dry.weight_filter_only            : num  25.5 24.2 25.5 26 25.7 ...
 $ Date.dried_60C                    : chr  "10/27/21" "10/27/21" "10/27/21" "10/27/21" ...
 $ Dry.weight_mg_filter_and_TSM      : num  27.5 27.6 27.6 27.9 29.6 ...
 $ Amt.Aluminum.on.filter            : chr  "" "" "" "M" ...
 $ Dry.weight_mg                     : num  2.01 3.47 2.09 1.83 3.96 ...
 $ TSM_mg.L_all_data                 : num  4.03 13.87 4.19 3.66 7.93 ...
 $ TSM_mg.L                          : num  4.03 13.87 4.19 NA 7.93 ...
 $ Pre.ash.wt_mg_filter_and_ash      : num  NA NA NA NA NA NA NA NA NA NA ...
 $ Ash.weight_mg_Filter_and_ash      : num  26.1 24.9 26.4 26.8 27.3 ...
 $ ash.only.mg                       : num  0.626 0.719 0.888 0.715 1.616 ...
 $ AFDW.mg                           : num  1.39 2.75 1.21 1.12 2.35 ...
 $ AFDW.mg.L                         : num  2.8 11 2.4 2.2 4.7 3.6 3 5.7 3.8 2 ...
 $ X..organic                        : num  0.69 0.79 0.58 NA 0.59 NA NA NA NA NA ...
 $ POM..ug...L.                      : num  2.8 11 2.4 2.2 4.7 3.6 3 5.7 3.8 2 ...
 $ Filter.appearance.notes...Dry.wt: chr  "Not folded in half" "" "" "Aluminum foil corrosio
 $ Filter.appearance.notes...Ash.wt: chr  "Not folded in half" "small spot of aluminum corro
 $ Other.notes                       : chr  "" "" "Ash weight filter + POM - not sure if this
 $ More.notes                        : chr  "" "" "" "" ...
```

Update site labels to be consistent. Format dates.

```
#Save site label info
filter_TSM$Site.info <- filter_TSM$Site


#Categorize site
filter_TSM$Site[filter_TSM$Site=="Cockle Cove"] <- "Chatham"
filter_TSM$Site[filter_TSM$Site=="Cockle cove"] <- "Chatham"
filter_TSM$Site[filter_TSM$Site=="Nobscussett"] <- "Dennis"
filter_TSM$Site[filter_TSM$Site=="Nobscusset"] <- "Dennis"
filter_TSM$Site[filter_TSM$Site=="Chatham all"] <- "Chatham"
filter_TSM$Site[filter_TSM$Site=="East Dennis"] <- "Dennis"
filter_TSM$Site[filter_TSM$Site=="Provincetown collection site"] <- "Provincetown"
filter_TSM$Site[filter_TSM$Site=="Ptown"] <- "Provincetown"
filter_TSM$Site[filter_TSM$Site=="Sea street"] <- "Dennis"
```

```r
filter_TSM$Site[filter_TSM$Site=="South st Dennis"] <- "Dennis"
filter_TSM$Site[filter_TSM$Site=="Barn"] <- "Barnstable"
filter_TSM$Site[filter_TSM$Site=="Barnstable Harbor"] <- "Barnstable"

filter_TSM <- filter_TSM[filter_TSM$Site!="Eden"&filter_TSM$Site!="Unknown"&
                         filter_TSM$Site!="Popponesset Bay"&filter_TSM$Site!="NA",]



#Dataframe formatting
filter_TSM$Site <- as.factor(filter_TSM$Site)
filter_TSM$Site <- factor(filter_TSM$Site, levels=c('Provincetown', 'Dennis', 'Barnstable'
filter_TSM$Date <- as.Date(filter_TSM$Date, format = "%m/%d/%Y")
filter_TSM$Date.factor <- as.factor(filter_TSM$Date)
filter_TSM$AFDW.mg.L <- as.numeric(filter_TSM$AFDW.mg.L)
filter_TSM$TSM_mg.L <- as.numeric(filter_TSM$TSM_mg.L)

#QC step
filter_TSM <- filter_TSM[filter_TSM$POM..ug...L.>0,]
filter_TSM <- filter_TSM[filter_TSM$Date>as.Date("1/1/21", format = "%m/%d/%Y"),]
tail(filter_TSM)
```

```
          Date         Site ID TSM.SW.volume_mL Chl.SW.vol_mL Chl.measured.ug.L
210 2023-05-12       Dennis  1              400           150             3.597
211 2023-06-09     Eel Pond  3              400           150                NA
212 2023-06-09     Eel Pond  2              400           150                NA
213 2023-06-09     Eel Pond  1              400           150                NA
214 2023-06-11 Provincetown NA              400           150                NA
215 2023-06-11 Provincetown NA              400           150                NA
    Dry.weight_filter_only Date.dried_60C Dry.weight_mg_filter_and_TSM
210                 24.968                                     27.810
211                 25.380                                     34.663
212                 25.428                                     33.056
213                 25.067                                     42.314
214                 25.418                                     27.995
215                 25.938                                     28.738
                                  Amt.Aluminum.on.filter Dry.weight_mg
210                                                (AL)         2.842
211                                                  AL         9.283
212                                                  AL         7.628
213 (AL) (Sediment in sample so reran as #3 - field notes)        17.247
```

```
214                                                  (AL)         2.577
215                                                  (AL)         2.800
    TSM_mg.L_all_data TSM_mg.L Pre.ash.wt_mg_filter_and_ash
210             7.105       NA                           NA
211            23.208       NA                           NA
212            19.070       NA                           NA
213            43.118       NA                           NA
214             6.443       NA                           NA
215             7.000       NA                           NA
    Ash.weight_mg_Filter_and_ash ash.only.mg AFDW.mg AFDW.mg.L X..organic
210                       25.694       0.726   2.116       5.3         NA
211                       31.517       6.137   3.146       7.9         NA
212                       31.003       5.575   2.053       5.1         NA
213                       39.103      14.036   3.211       8.0         NA
214                       26.689       1.271   1.306       3.3         NA
215                       27.374       1.436   1.364       3.4         NA
    POM..ug...L. Filter.appearance.notes...Dry.wt
210          5.3
211          7.9
212          5.1
213          8.0
214          3.3
215          3.4
    Filter.appearance.notes...Ash.wt Other.notes More.notes   Site.info
210                                                          East Dennis
211                                                             Eel Pond
212                                                             Eel Pond
213                                                             Eel Pond
214                                                                Ptown
215                                                                Ptown
    Date.factor
210  2023-05-12
211  2023-06-09
212  2023-06-09
213  2023-06-09
214  2023-06-11
215  2023-06-11
```

I'm skipping a quality control step for now of removing TSM's for filters that had aluminum oxide issues. This will probably increase perc org and decrease PIM.

Summarize data

```r
df_summary <- filter_TSM %>%
  group_by(Site) %>%
  summarise(
            POM = round(mean(AFDW.mg.L, na.rm = TRUE),1),

            POM_SE = round(sd(AFDW.mg.L, na.rm = TRUE) /
                      sqrt(sum(!is.na(AFDW.mg.L))),1),

            TSM = round(mean(TSM_mg.L, na.rm = TRUE),1),

            TSM_SE = round(sd(TSM_mg.L, na.rm = TRUE) /
                           sqrt(sum(!is.na(TSM_mg.L))),1),

            Perc_org = round(mean(X..organic, na.rm = TRUE)*100,0),

            Perc_SE = round(sd(X..organic*100, na.rm = TRUE) /
                      sqrt(sum(!is.na(X..organic))),0)
            )


kable(df_summary)
```

Site	POM	POM_SE	TSM	TSM_SE	Perc_org	Perc_SE
Provincetown	5.8	0.6	10.3	1.1	51	3
Dennis	6.6	0.9	13.3	2.6	48	3
Barnstable	3.3	0.3	6.5	0.5	47	3
Chatham	6.7	0.7	15.9	2.4	44	3
Eel Pond	4.9	0.6	11.1	1.9	49	3
NA	NaN	NA	NaN	NA	NaN	NA

```r
df_summary <- filter_TSM %>%
  group_by(Site,Date.factor) %>%
  summarise(
            POM = round(mean(AFDW.mg.L, na.rm = TRUE),1),

            POM_SE = round(sd(AFDW.mg.L, na.rm = TRUE) /
                      sqrt(sum(!is.na(AFDW.mg.L))),1),

            TSM = round(mean(TSM_mg.L, na.rm = TRUE),1),
```

```
            TSM_SE = round(sd(TSM_mg.L, na.rm = TRUE) /
                             sqrt(sum(!is.na(TSM_mg.L))),1),

            Perc_org = round(mean(X..organic, na.rm = TRUE)*100,0),

            Perc_SE = round(sd(X..organic*100, na.rm = TRUE) /
                      sqrt(sum(!is.na(X..organic))),0)
            )
```

```
`summarise()` has grouped output by 'Site'. You can override using the
`.groups` argument.
```

```
kable(df_summary)
```

Site	Date.factor	POM	POM_SE	TSM	TSM_SE	Perc_org	Perc_SE
Provincetown	2022-04-20	1.6	NA	3.2	NA	49	NA
Provincetown	2022-04-21	1.7	NA	3.9	NA	44	NA
Provincetown	2022-05-18	2.4	0.9	3.6	0.3	64	20
Provincetown	2022-06-15	6.7	1.2	13.8	2.2	48	1
Provincetown	2022-07-01	9.2	0.3	NaN	NA	NaN	NA
Provincetown	2022-07-14	15.6	NA	NaN	NA	NaN	NA
Provincetown	2022-07-27	3.6	0.0	7.3	0.4	49	3
Provincetown	2022-08-03	4.6	0.8	16.0	NA	24	NA
Provincetown	2022-08-05	5.7	0.4	21.1	1.7	27	0
Provincetown	2022-08-14	7.6	1.5	15.7	2.3	48	3
Provincetown	2022-08-29	5.5	1.1	9.4	1.8	58	1
Provincetown	2022-10-11	2.5	1.8	9.2	0.2	27	19
Provincetown	2022-10-25	6.6	1.0	11.5	NA	65	NA
Provincetown	2022-11-04	9.1	1.7	12.8	2.0	71	2
Provincetown	2022-11-29	6.6	1.3	9.7	2.0	68	0
Provincetown	2022-12-04	0.9	0.3	NaN	NA	NaN	NA
Provincetown	2023-01-21	3.9	1.4	6.7	2.2	57	1
Provincetown	2023-02-21	3.2	0.9	4.7	NA	50	NA
Provincetown	2023-03-20	9.9	0.1	NaN	NA	NaN	NA
Provincetown	2023-04-17	11.9	3.8	NaN	NA	NaN	NA
Provincetown	2023-05-10	5.9	0.4	NaN	NA	NaN	NA
Provincetown	2023-06-11	3.3	0.1	NaN	NA	NaN	NA
Dennis	2021-06-15	4.7	NA	7.9	NA	59	NA
Dennis	2021-07-26	5.7	NA	NaN	NA	NaN	NA
Dennis	2021-08-10	2.4	NA	4.2	NA	58	NA

Site	Date.factor	POM	POM_SE	TSM	TSM_SE	Perc_org	Perc_SE
Dennis	2021-10-06	12.4	2.5	21.0	5.4	60	4
Dennis	2021-12-02	1.9	0.2	6.8	1.7	29	3
Dennis	2022-03-03	2.0	0.6	6.8	2.2	30	1
Dennis	2022-04-21	4.2	NA	5.0	NA	83	NA
Dennis	2022-04-22	3.9	NA	7.6	NA	52	NA
Dennis	2022-05-17	3.5	0.0	9.0	0.1	39	0
Dennis	2022-06-17	7.8	5.3	16.9	10.2	42	5
Dennis	2022-06-28	10.4	4.2	24.8	12.0	44	4
Dennis	2022-07-18	5.2	2.0	14.5	NA	50	NA
Dennis	2022-07-27	4.8	0.8	NaN	NA	NaN	NA
Dennis	2022-08-05	5.8	1.2	20.5	4.0	28	1
Dennis	2022-08-14	3.2	0.4	6.3	0.9	51	0
Dennis	2022-08-28	15.3	12.2	39.4	33.9	46	9
Dennis	2022-10-26	2.8	0.6	7.0	1.7	40	1
Dennis	2022-11-07	2.8	0.1	4.6	0.0	61	2
Dennis	2022-12-03	12.0	6.7	NaN	NA	NaN	NA
Dennis	2023-01-22	3.9	1.1	5.8	1.3	68	4
Dennis	2023-02-16	4.4	1.2	NaN	NA	NaN	NA
Dennis	2023-03-22	16.0	2.5	21.2	NA	48	NA
Dennis	2023-04-19	3.2	0.0	NaN	NA	NaN	NA
Dennis	2023-05-12	4.8	0.5	NaN	NA	NaN	NA
Barnstable	2021-07-26	2.0	NA	NaN	NA	NaN	NA
Barnstable	2021-08-10	2.2	NA	NaN	NA	NaN	NA
Barnstable	2021-12-02	2.2	0.2	6.3	0.3	35	1
Barnstable	2022-03-01	1.8	0.1	5.8	0.2	31	1
Barnstable	2022-04-20	3.2	0.5	8.8	1.3	36	0
Barnstable	2022-06-16	3.5	0.2	6.7	0.4	53	6
Barnstable	2022-07-13	2.2	NA	NaN	NA	NaN	NA
Barnstable	2022-08-16	2.2	0.1	4.7	0.2	46	2
Barnstable	2022-10-27	3.5	2.0	10.5	0.6	32	18
Barnstable	2022-11-05	2.6	0.1	4.1	0.1	64	2
Barnstable	2022-12-06	2.9	1.4	4.6	1.7	60	8
Barnstable	2023-01-19	8.9	0.2	NaN	NA	NaN	NA
Barnstable	2023-02-23	4.8	0.4	7.3	0.5	66	1
Barnstable	2023-03-21	3.2	1.1	5.1	NA	40	NA
Barnstable	2023-04-20	3.0	0.2	NaN	NA	NaN	NA
Barnstable	2023-05-09	2.7	0.0	NaN	NA	NaN	NA
Chatham	2021-08-10	11.0	NA	13.9	NA	79	NA
Chatham	2021-12-02	10.8	1.2	37.5	5.6	29	1
Chatham	2022-03-04	3.2	0.4	7.8	1.2	42	2
Chatham	2022-04-20	3.1	NA	8.0	NA	39	NA

Site	Date.factor	POM	POM_SE	TSM	TSM_SE	Perc_org	Perc_SE
Chatham	2022-04-22	3.3	NA	8.5	NA	39	NA
Chatham	2022-06-14	10.1	0.5	21.3	3.8	48	7
Chatham	2022-07-15	10.8	1.4	18.7	NA	50	NA
Chatham	2022-08-13	5.7	0.5	14.5	0.9	40	0
Chatham	2022-10-28	3.6	2.4	10.9	1.2	30	18
Chatham	2022-11-08	8.2	2.8	15.1	4.7	53	3
Chatham	2022-12-07	4.5	1.0	6.9	NA	51	NA
Chatham	2023-01-18	7.2	2.0	NaN	NA	NaN	NA
Chatham	2023-02-22	5.2	0.0	NaN	NA	NaN	NA
Chatham	2023-03-22	12.1	5.0	NaN	NA	NaN	NA
Chatham	2023-04-19	4.7	1.6	NaN	NA	NaN	NA
Chatham	2023-05-11	3.1	0.1	NaN	NA	NaN	NA
Eel Pond	2021-06-15	3.0	NA	NaN	NA	NaN	NA
Eel Pond	2021-07-26	3.8	NA	NaN	NA	NaN	NA
Eel Pond	2021-08-10	2.8	NA	4.0	NA	69	NA
Eel Pond	2021-10-06	4.1	NA	7.8	NA	53	NA
Eel Pond	2021-11-08	1.8	0.3	3.2	0.3	54	6
Eel Pond	2021-12-01	1.8	0.2	4.3	0.5	40	1
Eel Pond	2022-03-02	1.5	0.1	3.2	0.2	48	0
Eel Pond	2022-04-18	1.4	0.1	2.8	0.2	50	7
Eel Pond	2022-05-20	2.4	0.1	5.9	0.3	40	0
Eel Pond	2022-06-17	16.2	0.2	39.3	3.2	42	2
Eel Pond	2022-06-30	4.1	1.5	8.4	3.0	48	0
Eel Pond	2022-07-15	6.4	2.9	7.8	NA	45	NA
Eel Pond	2022-07-27	6.4	2.4	14.7	4.0	42	4
Eel Pond	2022-08-01	6.3	3.2	26.4	16.9	27	5
Eel Pond	2022-08-02	5.2	0.4	18.9	5.8	29	7
Eel Pond	2022-08-15	2.6	0.2	5.8	0.6	44	1
Eel Pond	2022-08-30	5.3	1.1	12.8	2.2	42	1
Eel Pond	2022-09-26	6.8	NA	NaN	NA	NaN	NA
Eel Pond	2022-10-12	2.1	NA	5.8	NA	36	NA
Eel Pond	2022-10-24	16.4	9.3	31.5	NA	82	NA
Eel Pond	2022-11-06	5.7	3.8	7.7	3.5	63	22
Eel Pond	2022-11-28	4.4	0.7	6.0	1.0	74	0
Eel Pond	2023-01-20	4.8	1.0	7.8	NA	73	NA
Eel Pond	2023-02-24	2.0	0.3	NaN	NA	NaN	NA
Eel Pond	2023-04-18	1.5	0.5	NaN	NA	NaN	NA
Eel Pond	2023-05-08	3.0	1.3	NaN	NA	NaN	NA
Eel Pond	2023-06-09	7.0	1.0	NaN	NA	NaN	NA
NA	NA	NaN	NA	NaN	NA	NaN	NA

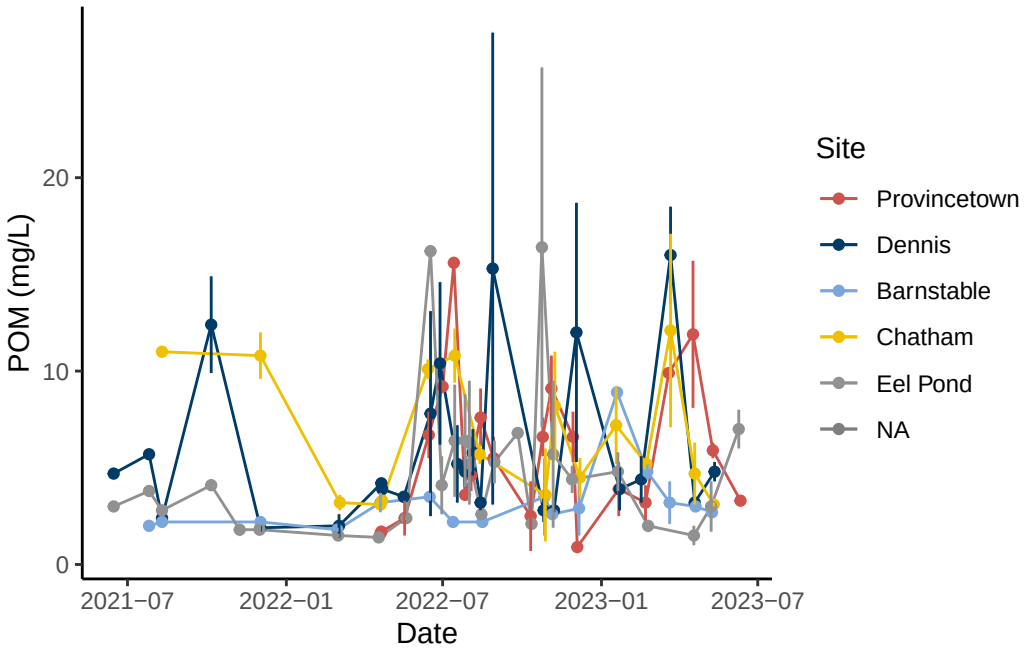
```r
tail(df_summary)
```

```
# A tibble: 6 x 8
# Groups:   Site [2]
  Site     Date.factor   POM POM_SE   TSM TSM_SE Perc_org Perc_SE
  <fct>    <fct>       <dbl>  <dbl> <dbl>  <dbl>    <dbl>   <dbl>
1 Eel Pond 2023-01-20    4.8    1     7.8     NA       73      NA
2 Eel Pond 2023-02-24    2      0.3 NaN       NA      NaN      NA
3 Eel Pond 2023-04-18    1.5    0.5 NaN       NA      NaN      NA
4 Eel Pond 2023-05-08    3      1.3 NaN       NA      NaN      NA
5 Eel Pond 2023-06-09    7      1   NaN       NA      NaN      NA
6 <NA>     <NA>        NaN     NA   NaN       NA      NaN      NA
```

```r
df_summary$Date.factor <- as.Date(df_summary$Date.factor)
p<- ggplot(df_summary, aes(x=as.Date(Date.factor), y=POM, group=Site, color=Site)) +
  geom_line() +
  geom_point()+
  geom_errorbar(aes(ymin=POM-POM_SE, ymax=POM+POM_SE), width=.2,
                position=position_dodge(0.05))
p+labs(x="Date", y = "POM (mg/L)")+
  theme_classic() +
  scale_color_manual(values = new.pal)
```

```
Warning: Removed 1 row containing missing values (`geom_line()`).
```

```
Warning: Removed 1 rows containing missing values (`geom_point()`).
```



Monthly averages

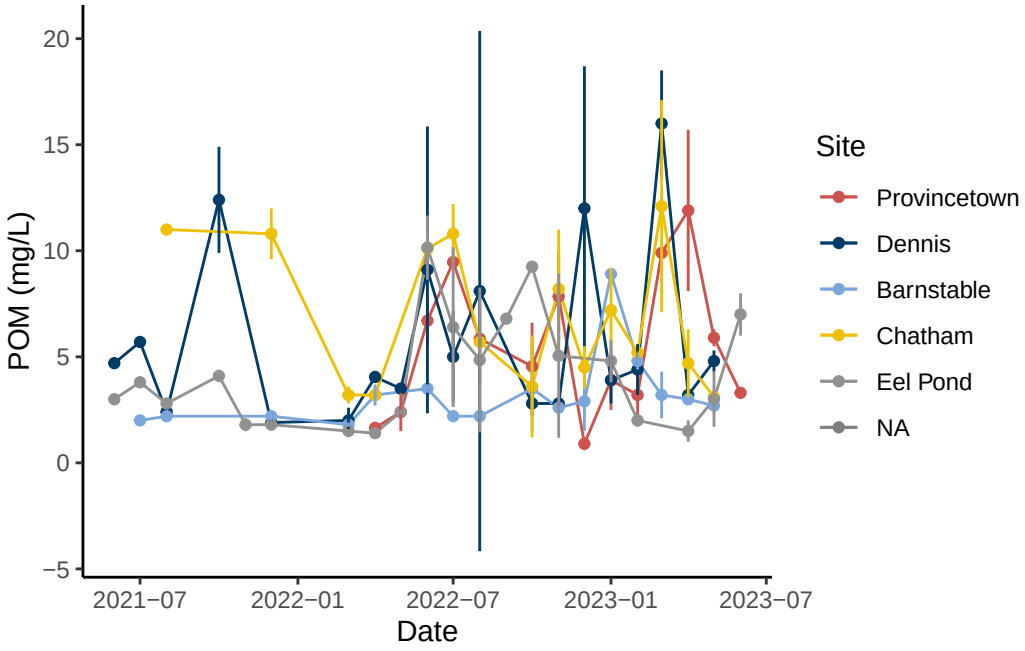
```
df_month <- df_summary %>%
group_by(Site,Month = lubridate::floor_date(Date.factor, "month")) %>%
summarize(POM = mean(POM),
          POM_SE = sqrt(sum(POM_SE^2))
          )
```

```
`summarise()` has grouped output by 'Site'. You can override using the
`.groups` argument.
```

```
p<- ggplot(df_month, aes(x=as.Date(Month), y=POM, group=Site, color=Site)) +
  geom_line() +
  geom_point()+
  geom_errorbar(aes(ymin=POM-POM_SE, ymax=POM+POM_SE), width=.2,
                position=position_dodge(0.05))
p+labs(x="Date", y = "POM (mg/L)")+
  theme_classic() +
  scale_color_manual(values = new.pal)
```

```
Warning: Removed 1 row containing missing values (`geom_line()`).
```

```
Warning: Removed 1 rows containing missing values (`geom_point()`).
```

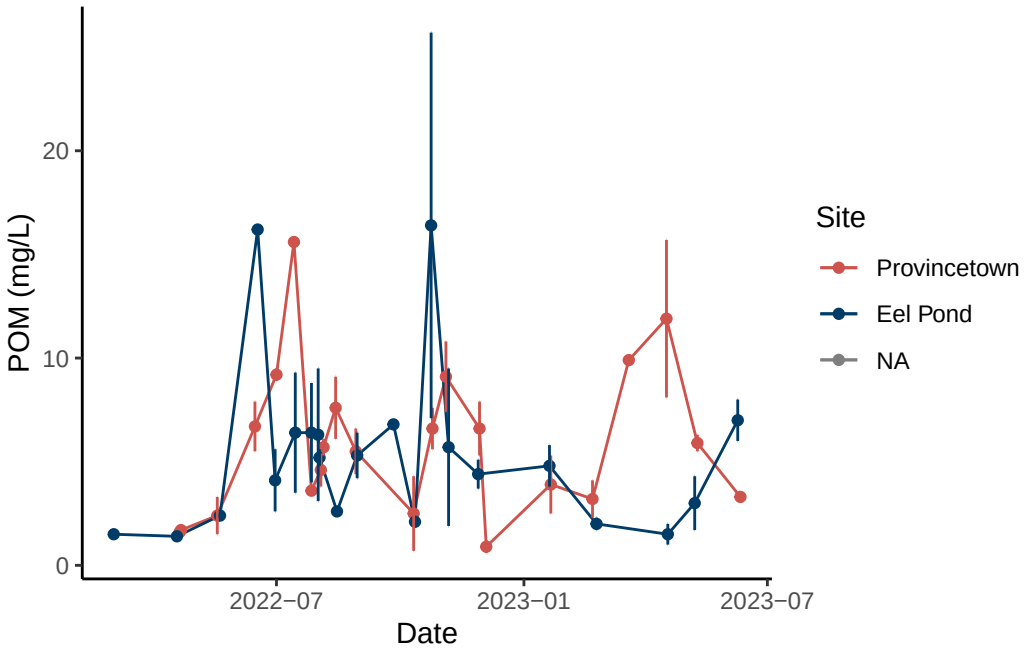



```
df_transplant <- df_summary[df_summary$Site=="Provincetown"|df_summary$Site=="Eel Pond",]
df_transplant <- df_transplant[as.Date(df_transplant$Date.factor)>=as.Date("2022-01-01"),]

p<- ggplot(df_transplant, aes(x=as.Date(Date.factor), y=POM, group=Site, color=Site)) +
  geom_line() +
  geom_point()+
  geom_errorbar(aes(ymin=POM-POM_SE, ymax=POM+POM_SE), width=.2,
                position=position_dodge(0.05))
p+labs(x="Date", y = "POM (mg/L)")+
  theme_classic() +
  scale_color_manual(values = new.pal)
```

```
Warning: Removed 1 row containing missing values (`geom_line()`).
```

```
Warning: Removed 1 rows containing missing values (`geom_point()`).
```



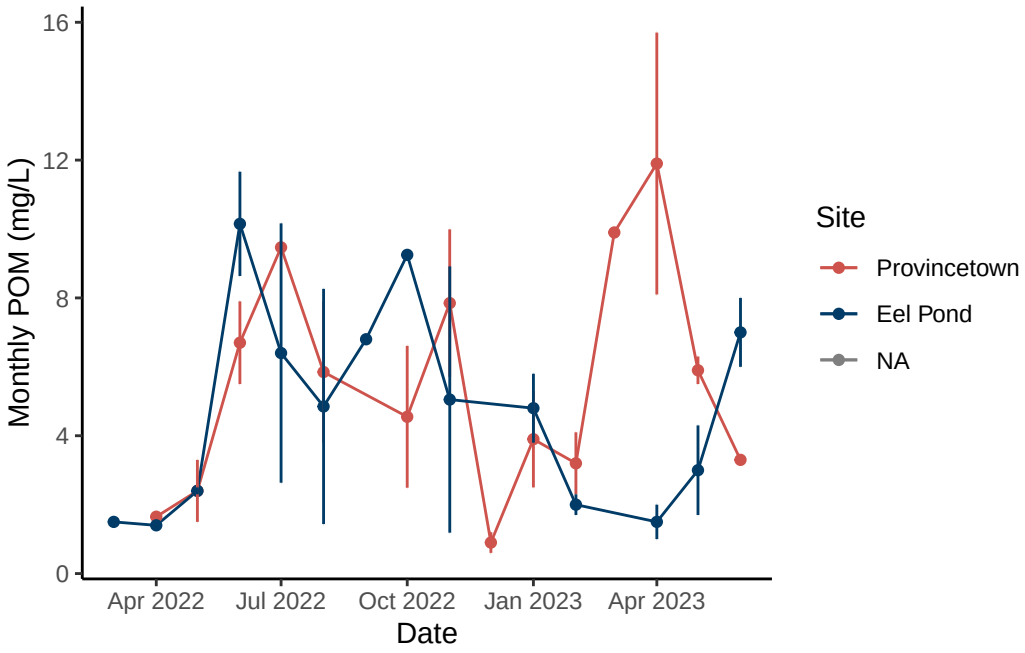
Monthly summary

```
df_transplant <- df_month[df_month$Site=="Provincetown"|df_month$Site=="Eel Pond",]
df_transplant <- df_transplant[as.Date(df_transplant$Month)>=as.Date("2022-01-01"),]

p<- ggplot(df_transplant, aes(x=as.Date(Month), y=POM, group=Site, color=Site)) +
  geom_line() +
  geom_point()+
  geom_errorbar(aes(ymin=POM-POM_SE, ymax=POM+POM_SE), width=.2,
                position=position_dodge(0.05))
p+labs(x="Date", y = "Monthly POM (mg/L)")+
  theme_classic() +
  scale_color_manual(values = new.pal)
```

```
Warning: Removed 1 row containing missing values (`geom_line()`).
```

```
Warning: Removed 1 rows containing missing values (`geom_point()`).
```


16
12
8
4
0
Monthly POM (mg/L)
Apr 2022
Jul 2022
Oct 2022
Jan 2023
Apr 2023
Date
Site
Provincetown
Eel Pond
NA