EAD-ASEB-Ssolidissima-OA

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1.1 Welcome

This is the Atlantic surfclam project.

1.2 Quarto information

This project uses quarto. Quarto is similar to Rmarkdown and enables you to weave together content and executable code into a finished document. To learn more about Quarto see https://quarto.org.

When you click the **Render** button a document will be generated that includes both content and the output of embedded code.

2 Biodeposition

2.1 Quarto

Quarto enables you to weave together content and executable code into a finished document. To learn more about Quarto see https://quarto.org.

2.2 Running Code

When you click the **Render** button a document will be generated that includes both content and the output of embedded code. You can embed code like this:

```
# bd <- bd[!is.na(bd$Month),]
# bd <- bd[!is.na(bd$Site),]
#print(rownames(bd))


#bd <- bd[complete.cases(bd), ]
bd<- bd[bd$Month =="September"|bd$Month =="April"|bd$Month =="June",]
bd$Site <- as.factor(bd$Site)
bd$Month <- as.factor(bd$Month)
bd$Month <- factor(bd$Month, levels=c("September", "April", "June"))
bd$Treatment <- as.factor(bd$Treatment)
bd$Treatment <- factor(bd$Treatment, levels=c("N", "S", "OUT"))


#print(rownames(bd))
#bd$Treatment[bd$Site=="Eel Pond"] <- "N"
bd <- bd[bd$TPM>=.9,]
#bd$OER
#str(bd)
```

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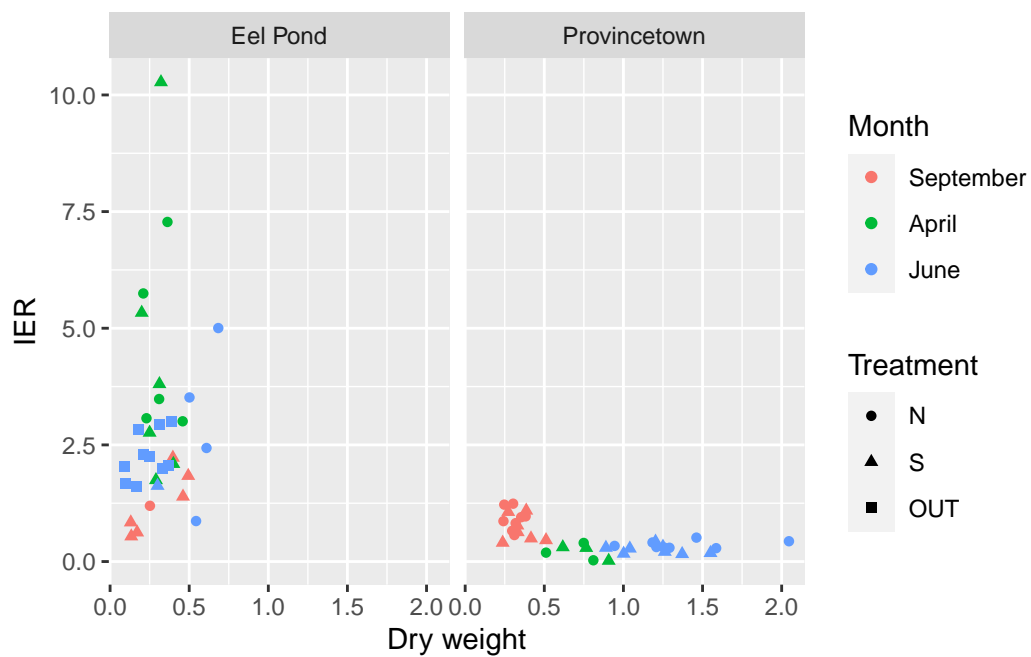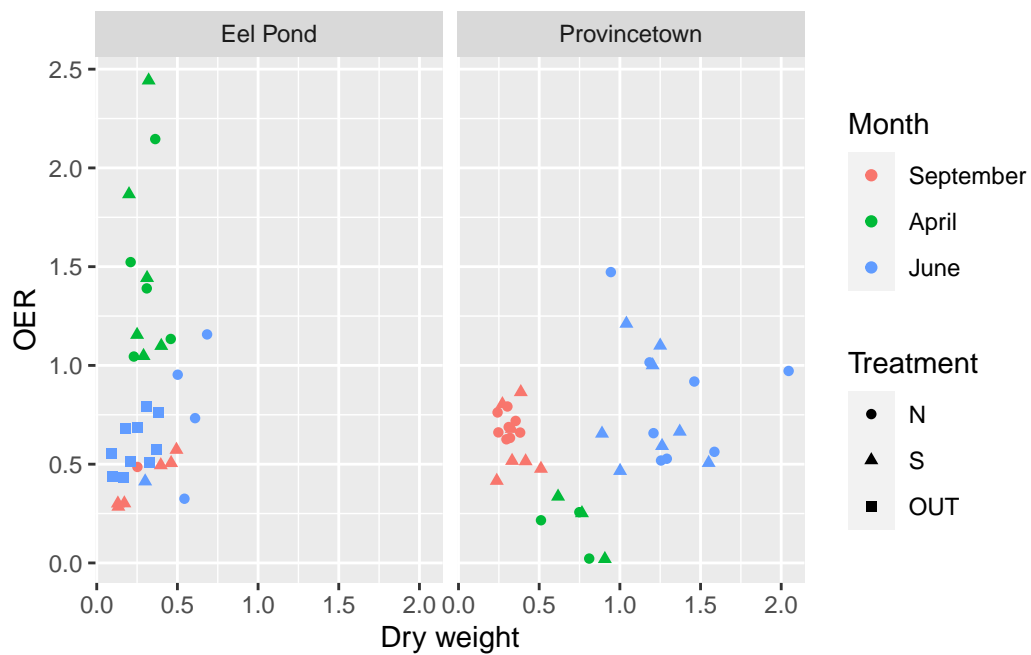
Warning: Removed 1 rows containing missing values (`geom_point()`).

Check out new scaling from QC and subsetting Emilien's data to include clams >20mm and June and July datasets only

```
gg1 <- ggplot(data = bd, aes(x=Dry.weight, y=OER/Dry.weight^.43, color = Month))+
  geom_point(aes(shape=Treatment))+
  xlab("Dry weight") +
  #ylab("OER new scaling")+
  #ylim(0,9)+
  #scale_color_discrete(name="Site")+
  #ggtitle ('OER as a function of DW')+
  facet_wrap(~ Site)

gg1
```
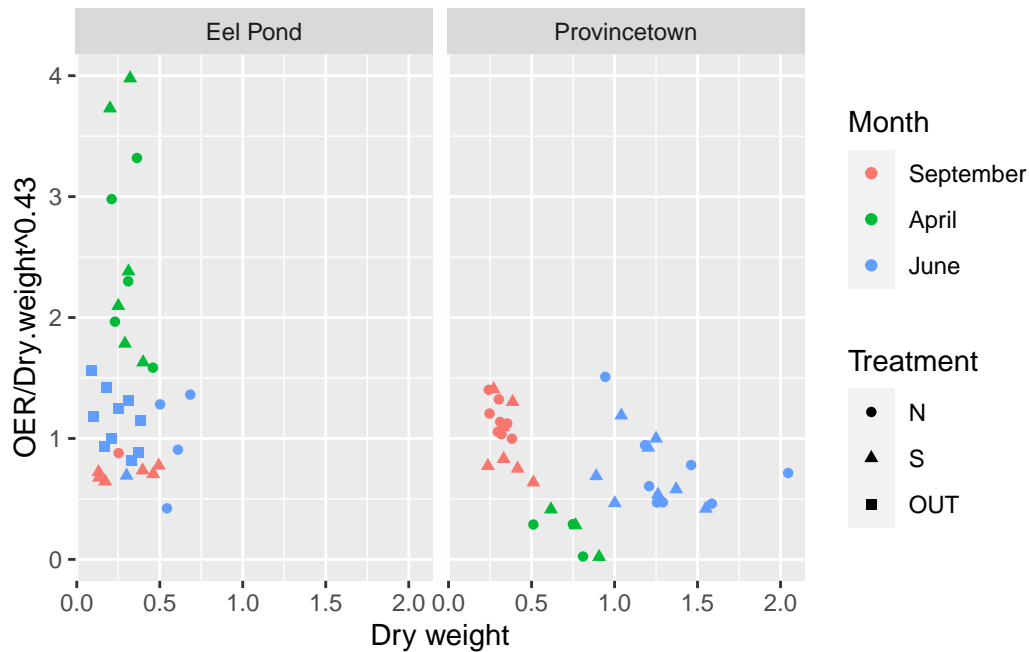


```
gg1 <- ggplot(data = bd, aes(x=Dry.weight, y=IER/Dry.weight^.59, color = Month))+
  geom_point(aes(shape=Treatment))+
  xlab("Dry weight") +
 # ylab("IER")+
  #ylim(0,9)+
  #scale_color_discrete(name="Site")+
  #ggtitle ('OER as a function of DW')+
  facet_wrap(~ Site)

gg1
```

```
gg1 <- ggplot(data = bd, aes(x=Dry.weight, y=ORR, color = Month))+
  geom_point(aes(shape=Treatment))+
  xlab("Dry weight") +
  #ylab("ORR")+
  #ylim(0,9)+
  #scale_color_discrete(name="Site")+
  #ggtitle ('OER as a function of DW')+
  facet_wrap(~ Site)
gg1
```
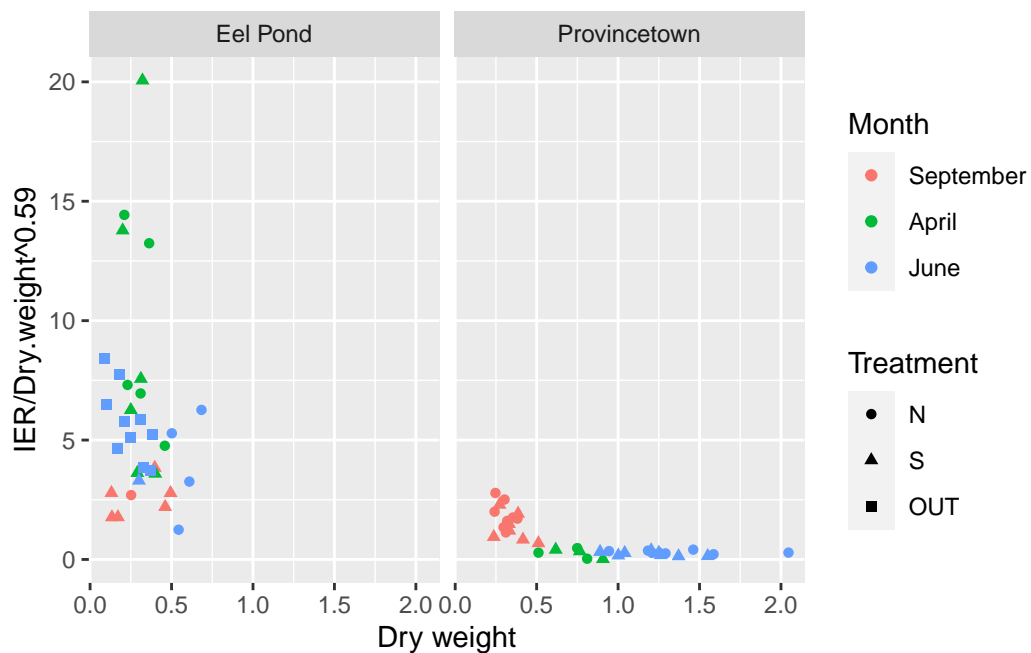
```
gg1 <- ggplot(data = bd, aes(x=Dry.weight, y=IRR, color = Month))+
  geom_point(aes(shape=Treatment))+
  xlab("Dry weight") +
 # ylab("IRR")+
  #ylim(0,9)+
  #scale_color_discrete(name="Site")+
  #ggtitle ('OER as a function of DW')+
  facet_wrap(~ Site)

gg1
```

Now using length scaling

```r
gg1 <- ggplot(data = bd, aes(x=Length/10, y=OER/(0.096*(Length/10)^1.93), color = Month))+
  geom_point(aes(shape=Treatment))+
  xlab("Dry weight") +
  #ylab("OER new scaling")+
  #ylim(0,9)+
  #scale_color_discrete(name="Site")+-
  #ggtitle ('OER as a function of DW')+
  facet_wrap(~ paste(Site,Month))

gg1
```
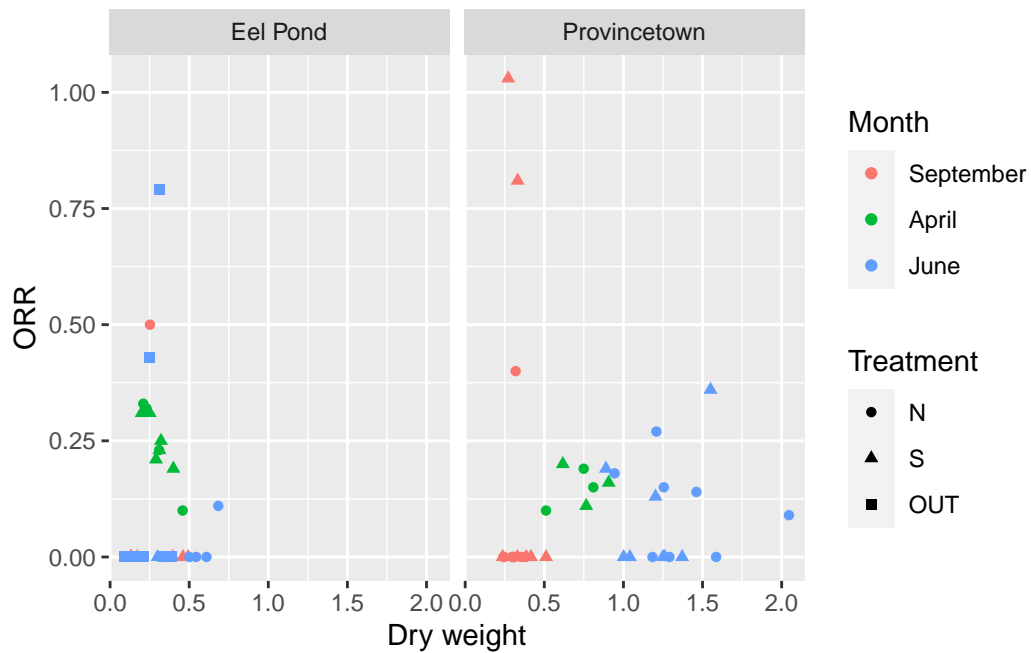
```
gg1 <- ggplot(data = bd, aes(x=Length/10, y=IER/(.44*(Length/10)^2.17), color = Month))+
  geom_point(aes(shape=Treatment))+
  xlab("Dry weight") +
  #ylab("OER new scaling")+
  #ylim(0,9)+
  #scale_color_discrete(name="Site")+-
  #ggtitle ('OER as a function of DW')+
  facet_wrap(~ paste(Site,Month))
gg1
```

```
gg1 <- ggplot(data = bd, aes(x=Length/10, y=OER/(Length/10)^2, color = Month))+
  geom_point(aes(shape=Treatment))+
  xlab("Dry weight") +
# ylab("IER")+
  #ylim(0,9)+
  #scale_color_discrete(name="Site")+
  #ggtitle ('OER as a function of DW')+
   facet_wrap(~ paste(Site,Month))

gg1
```
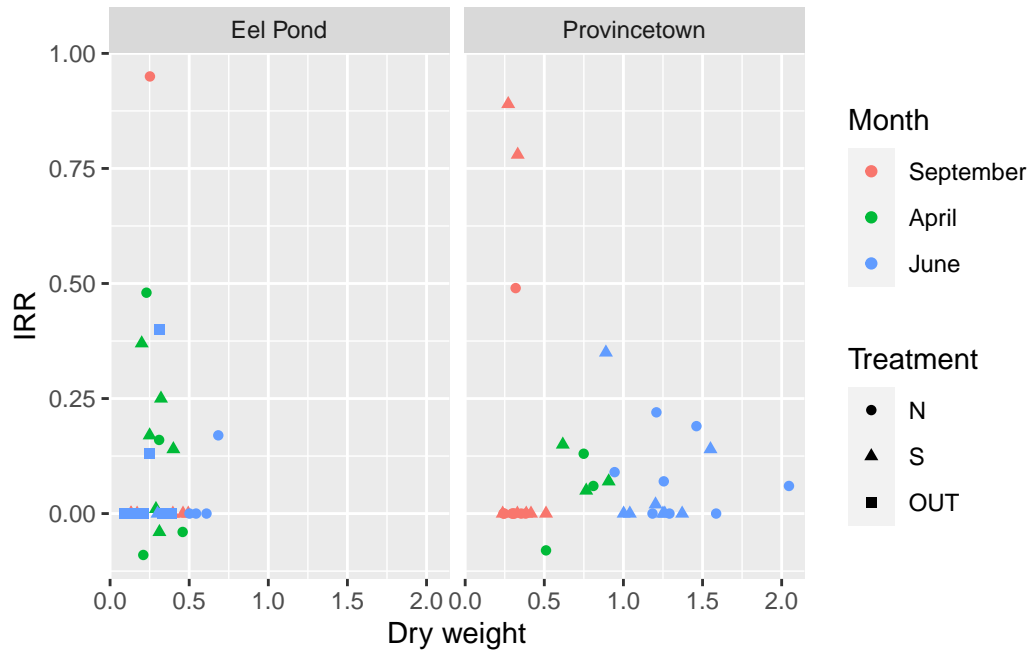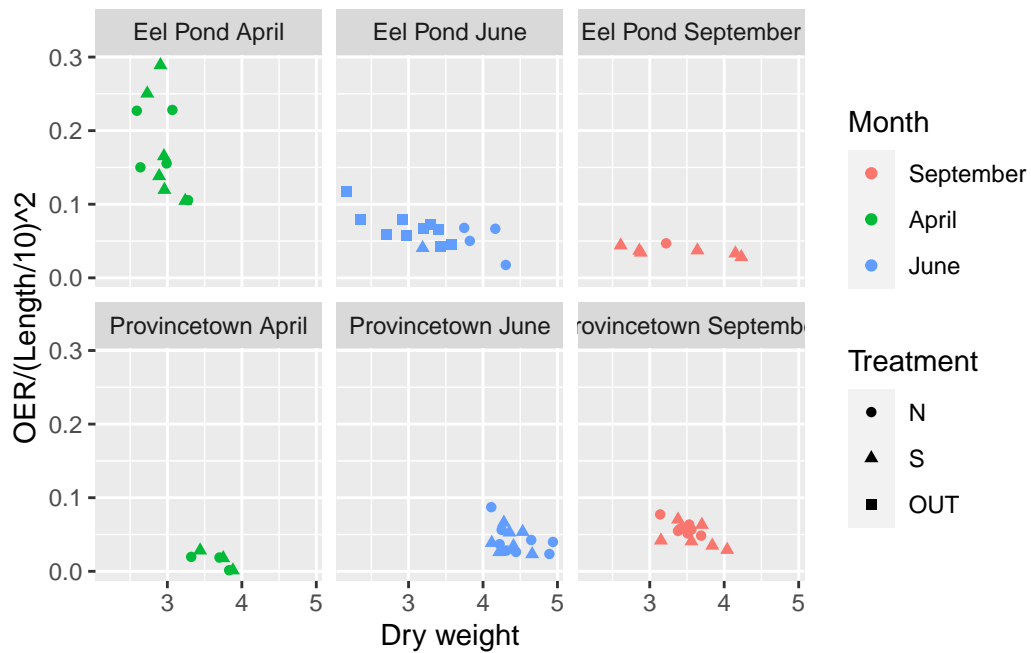
```r
gg1 <- ggplot(data = bd, aes(x=Length/10, y=IER/(Length/10)^2, color = Month))+
  geom_point(aes(shape=Treatment))+
  xlab("Dry weight") +
# ylab("IER")+
  #ylim(0,9)+
  #scale_color_discrete(name="Site")+
  #ggtitle ('OER as a function of DW')+
   facet_wrap(~ paste(Site,Month))

gg1
```
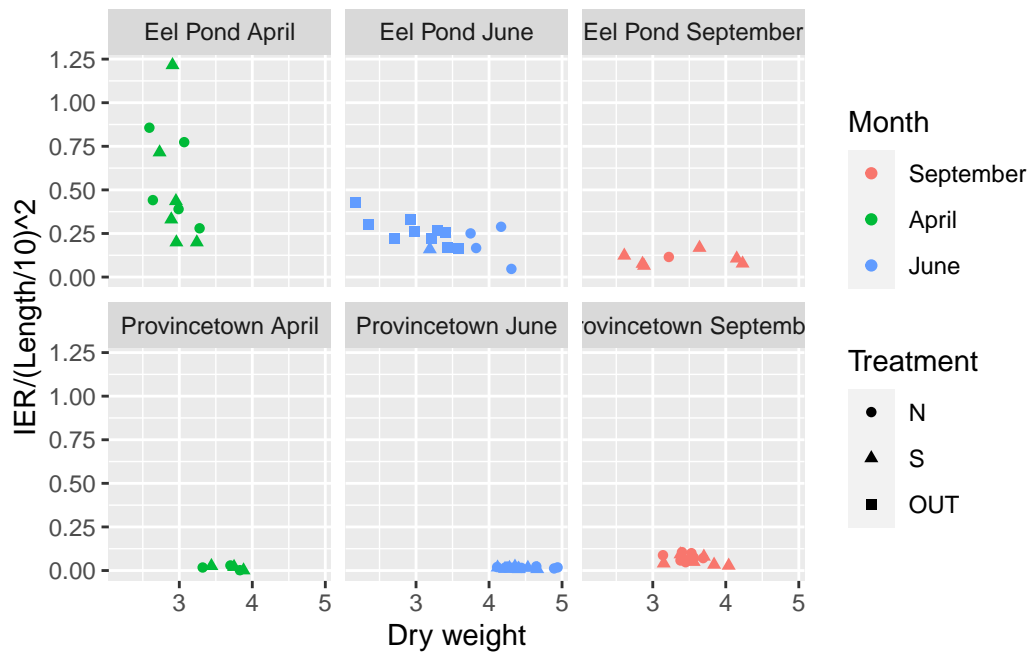
```
gg1 <- ggplot(data = bd, aes(x=Length/10, y=ORR, color = Month))+
  geom_point(aes(shape=Treatment))+
  xlab("Dry weight") +
  #ylab("ORR")+
  #ylim(0,9)+
  #scale_color_discrete(name="Site")+
  #ggtitle ('OER as a function of DW')+
   facet_wrap(~ paste(Site,Month))
gg1
```
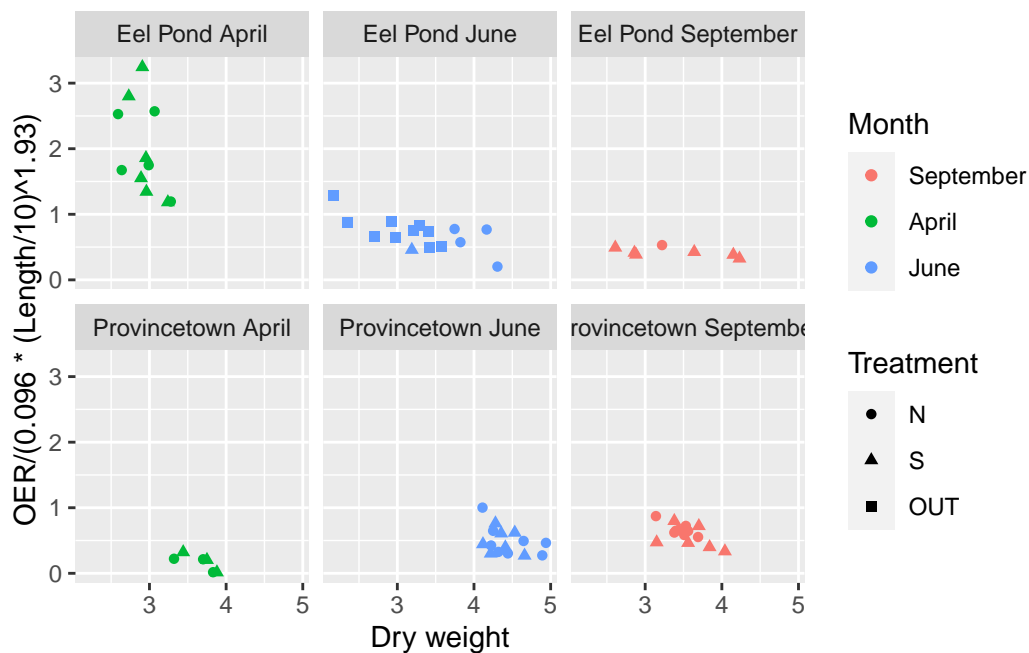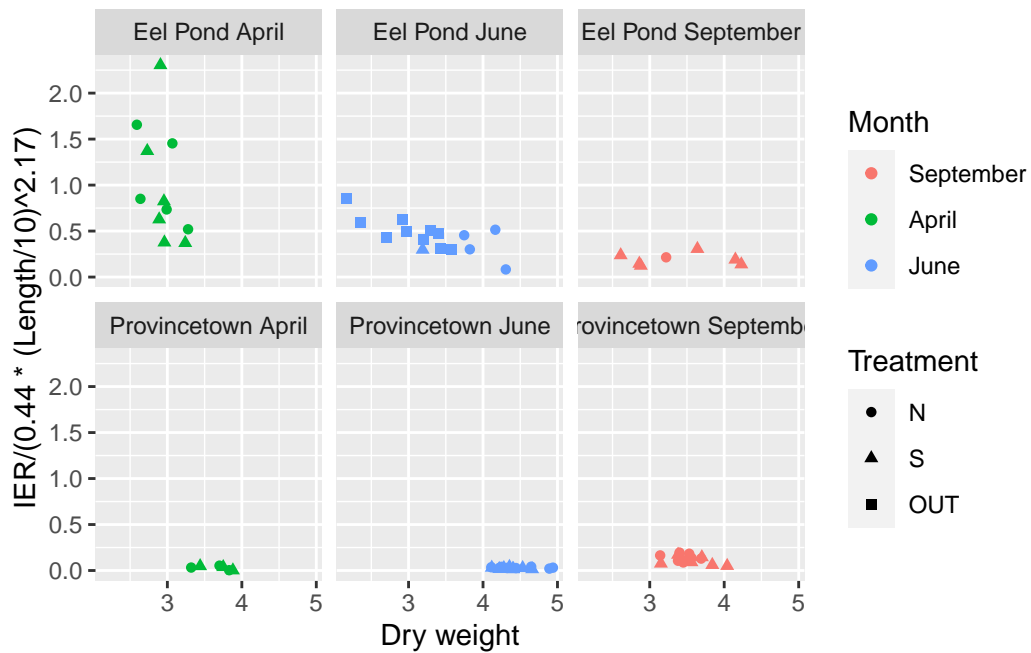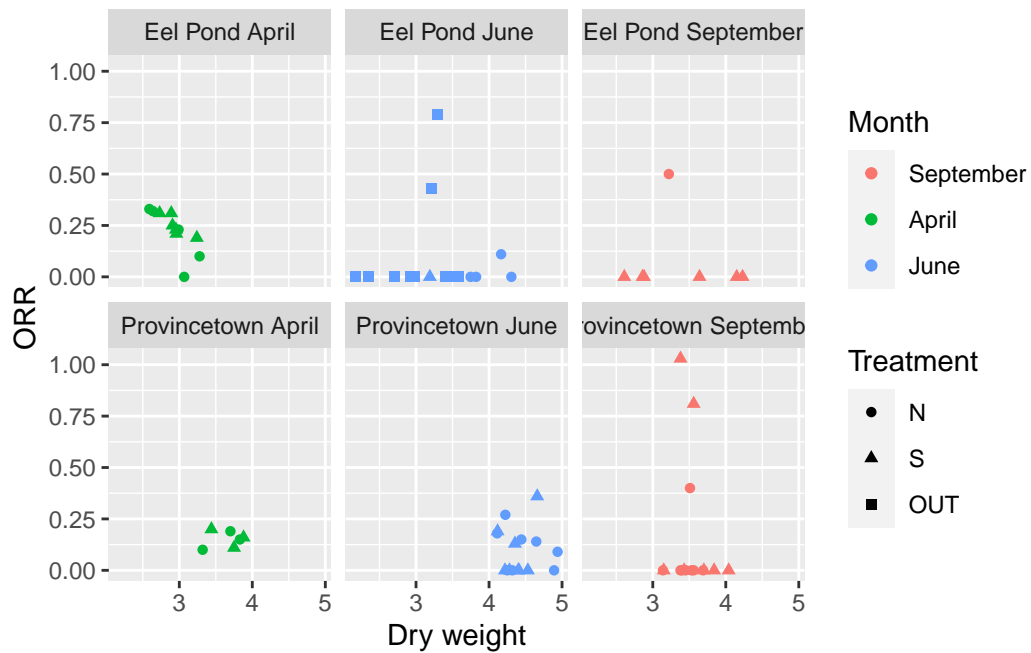
```
gg1 <- ggplot(data = bd, aes(x=Length/10, y=IRR, color = Month))+
  geom_point(aes(shape=Treatment))+
  xlab("Dry weight") +
 # ylab("IRR")+
  #ylim(0,9)+
  #scale_color_discrete(name="Site")+
  #ggtitle ('OER as a function of DW')+
  facet_wrap(~ paste(Site,Month))

gg1
```

```
[1]  N   N   N   N   N   N   N   N   S   S   S   S   S   S   S   N   S   S   S
[20] S   S   S   N   S   S   N   N   S   S   S   N   N   N   N   N   S   S   S
[39] S   N   N   N   N   N   S   S   N   N   S   S   S   S   S   S   N   N   N
[58] N   N   S   OUT OUT OUT OUT OUT OUT OUT OUT OUT OUT
Levels: N S OUT
```

```
 [1] N    N    N    N    N    N    N    N    S    S    S    S    S    S    S    N    S    S    S
[20] S    S    S    N    S    S    N    N    S    S    S    N    N    N    N    N    S    S    S
[39] S    N    N    N    N    N    S    S    N    N    S    S    S    S    S    S    N    N    N
[58] N    N    S    OUT  OUT  OUT  OUT  OUT  OUT  OUT  OUT  OUT  OUT
Levels: N S OUT
```

```
 [1] N    N    N    N    N    N    N    N    S    S    S    S    S    S    S    N    S    S    S
[20] S    S    S    N    S    S    N    N    S    S    S    N    N    N    N    N    S    S    S
[39] S    N    N    N    N    N    S    S    N    N    S    S    S    S    S    S    N    N    N
[58] N    N    S    OUT  OUT  OUT  OUT  OUT  OUT  OUT  OUT  OUT  OUT
Levels: N S OUT
```

```
Warning: Removed 1 rows containing missing values (`geom_point()`).
```
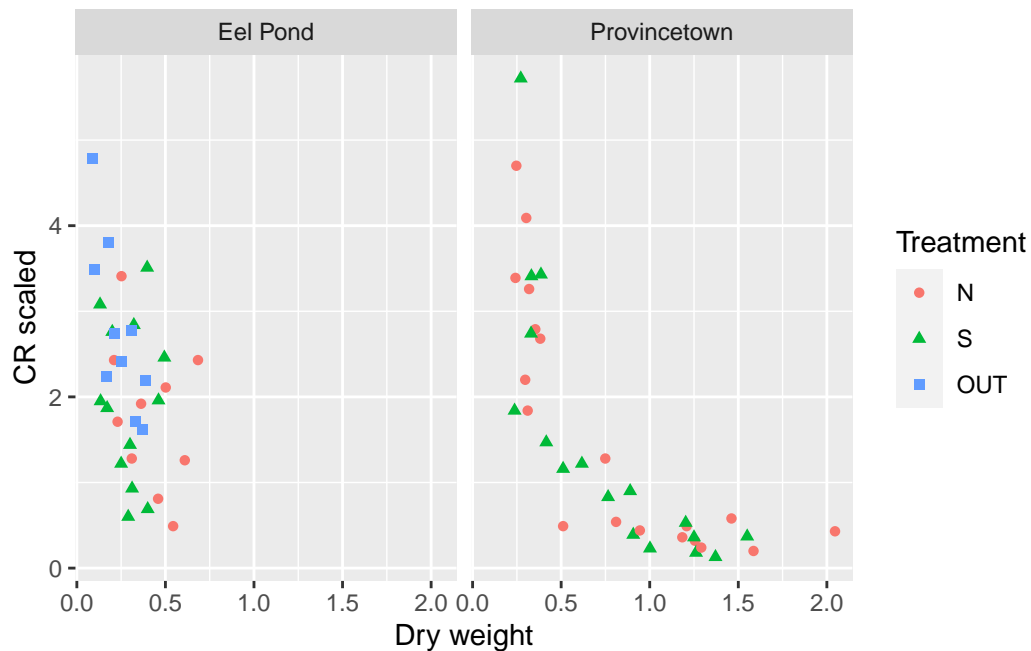
```
gg1 <- ggplot(data = bd, aes(x=Dry.weight, y=CR*Dry.weight^.76, color = Month ))+
  geom_point(aes(shape=Treatment))+
  xlab("Dry weight") +
  ylab("CR")+
  ylim(0,2.5)+
  scale_color_discrete(name="Site")+
  ggtitle ('Unscaled CR as a function of DW')+
  facet_wrap(~ Site)
gg1
```

Warning: Removed 1 rows containing missing values (`geom_point()`).
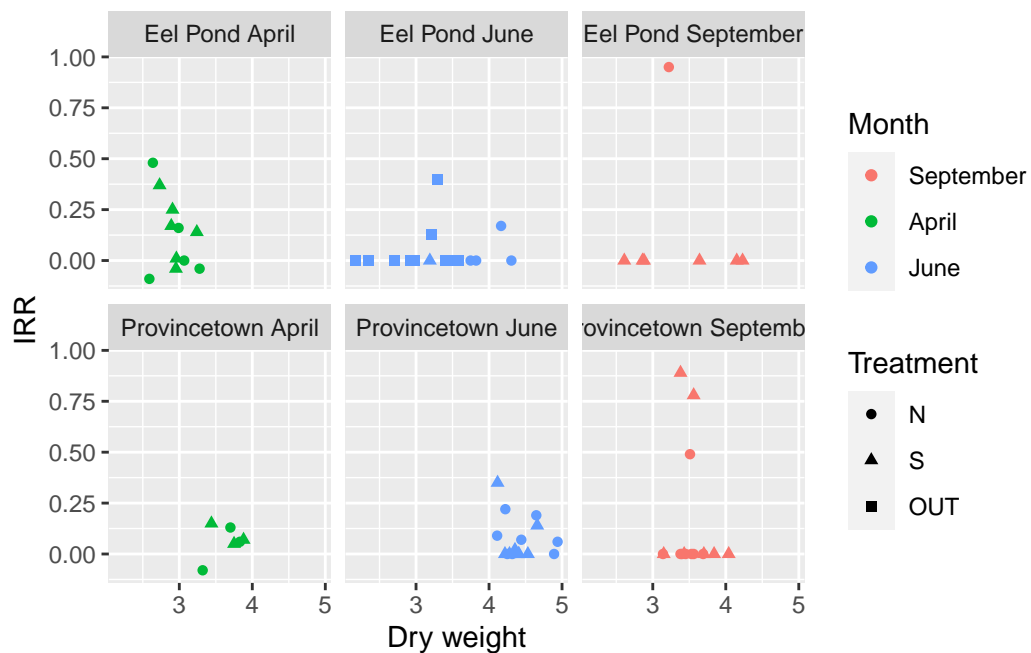
Unscaled CR as a function of DW
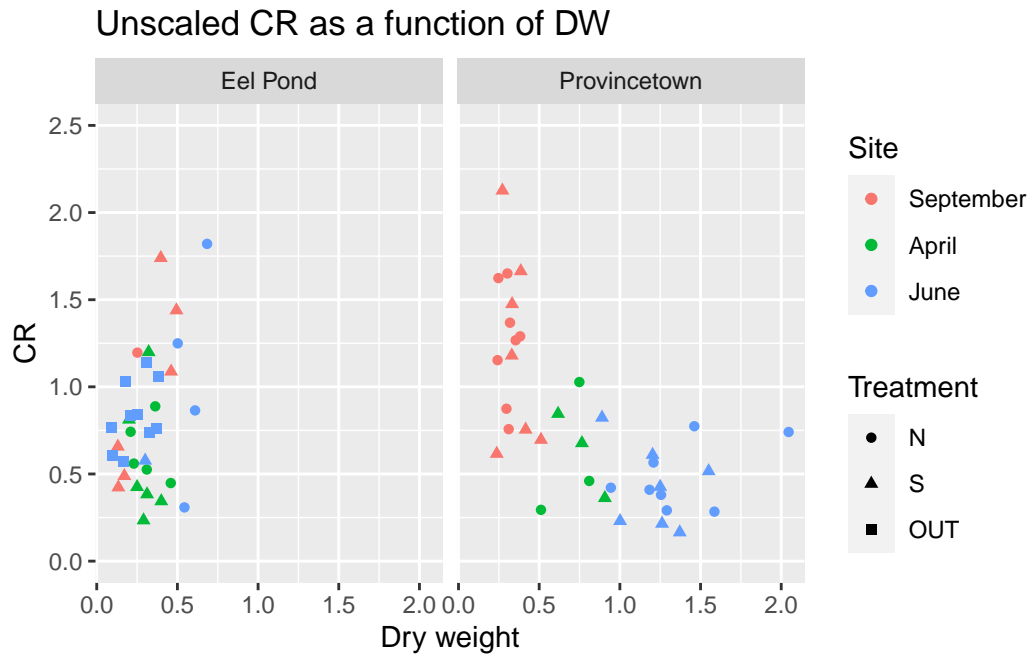

```
gg2 <- ggplot(data = bd, aes(x=Dry.weight, y=CR, color = Month ))+
  geom_point(aes(shape=Treatment))+
  xlab("Dry weight") +
  ylab("CR")+
  #ylim(0,9)+
  scale_color_discrete(name="Site")+
  ggtitle ('Scaled CR as a function of DW')+
  facet_wrap(~ Site)

  gg2
```
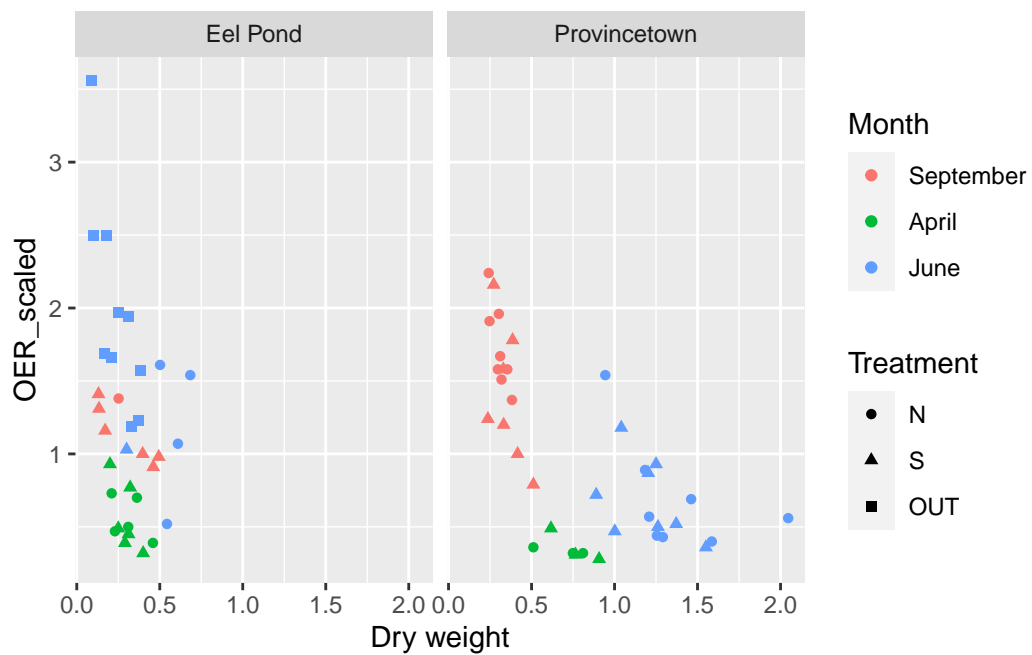
Warning: Removed 1 rows containing missing values (`geom_point()`).

Scaled CR as a function of DW
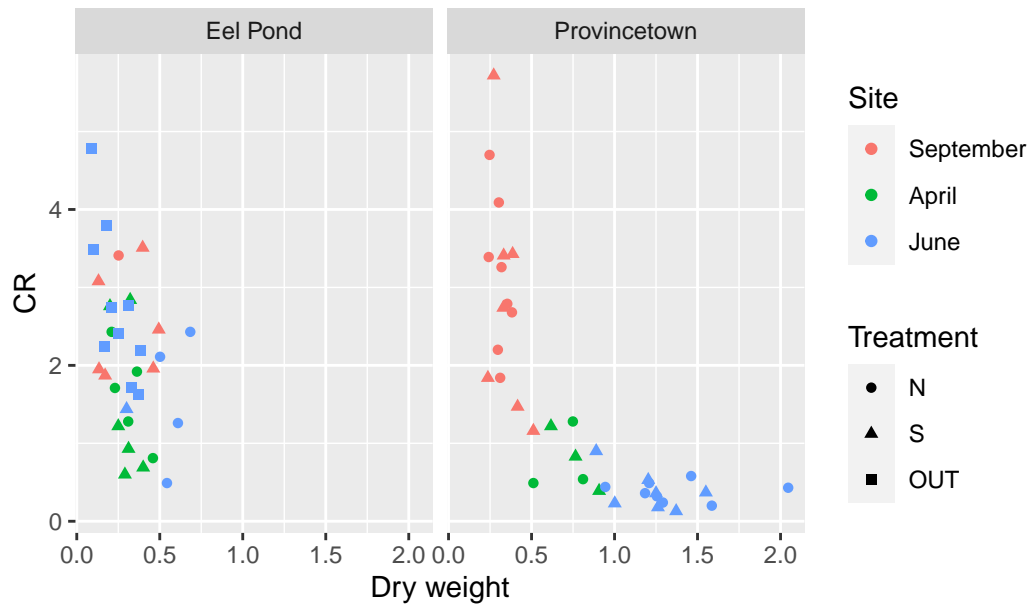

```
gg3 <- ggplot(data = bd, aes(x=Site, y=CR, col = Treatment))+
  geom_boxplot()+
  #xlab("Dry weight") +
  ylab("Clearance Rate")+
  ylim(0,6)+
  scale_color_discrete(name="Site")+
  ggtitle ('Scaled CR')+
  facet_wrap(~ Month)
gg3
```

Warning: Removed 1 rows containing non-finite values (`stat_boxplot()`).

Scaled CR


```
gg4 <- ggplot(data = bd, aes(x=Site, y=CR*Dry.weight^.76, col = Treatment))+
  geom_boxplot()+
  #xlab("Dry weight") +
  ylab("Clearance Rate")+
  ylim(0,3)+
  scale_color_discrete(name="Site")+
  ggtitle ('Unscaled CR')+
  facet_wrap(~ Month)
gg4
```

Warning: Removed 1 rows containing non-finite values (`stat_boxplot()`).
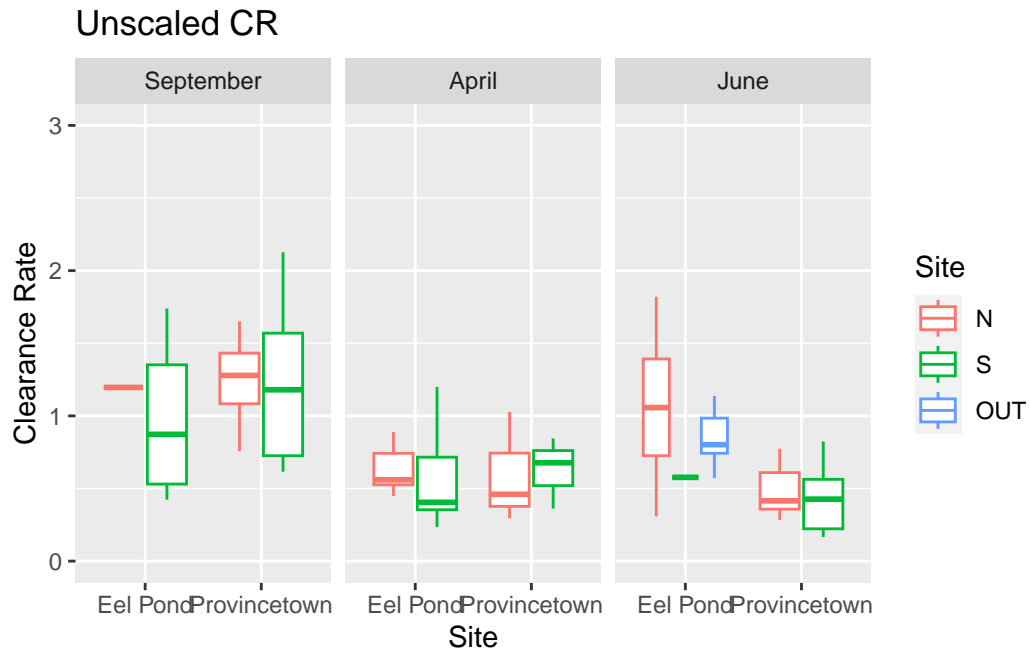
Unscaled CR


```
gg1 <- ggplot(data = bd, aes(x=Dry.weight, y=AR*Dry.weight^.76, color = Month ))+
  geom_point(aes(shape=Treatment))+
  xlab("Dry weight") +
  ylab("AR")+
  ylim(0,2.5)+
  scale_color_discrete(name="Site")+
  ggtitle ('Unscaled AR as a function of DW')+
  facet_wrap(~ Site)
gg1
```

Warning: Removed 6 rows containing missing values (`geom_point()`).

Unscaled AR as a function of DW
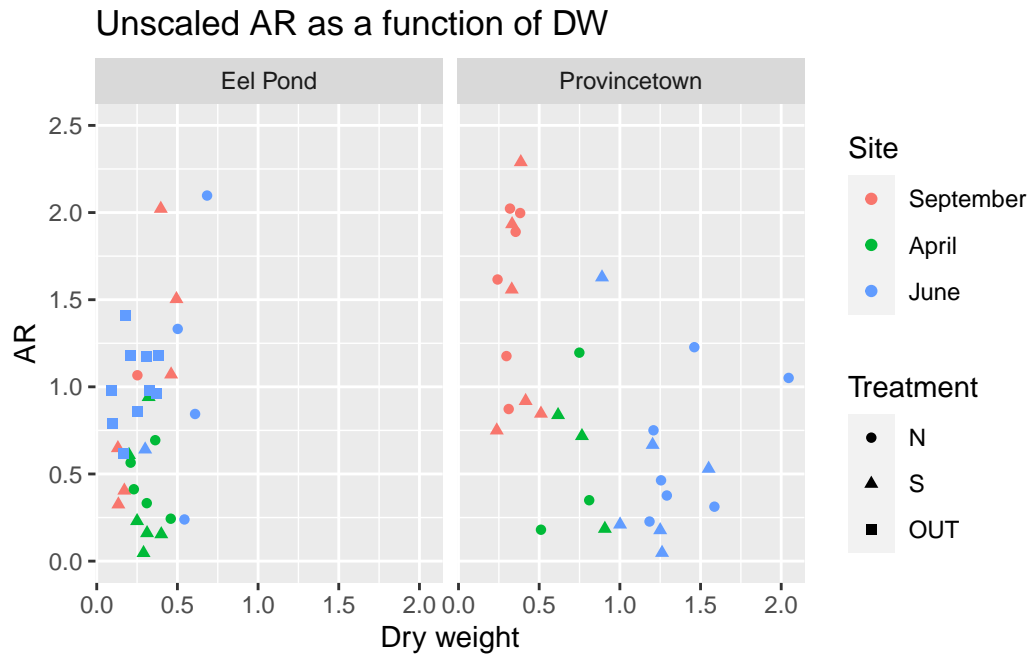

```
gg2 <- ggplot(data = bd, aes(x=Dry.weight, y=AR, color = Month ))+
  geom_point(aes(shape=Treatment))+
  xlab("Dry weight") +
  ylab("AR")+
  #ylim(0,9)+
  scale_color_discrete(name="Site")+
  ggtitle ('Scaled AR as a function of DW')+
  facet_wrap(~ Site)

  gg2
```

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

Scaled AR as a function of DW
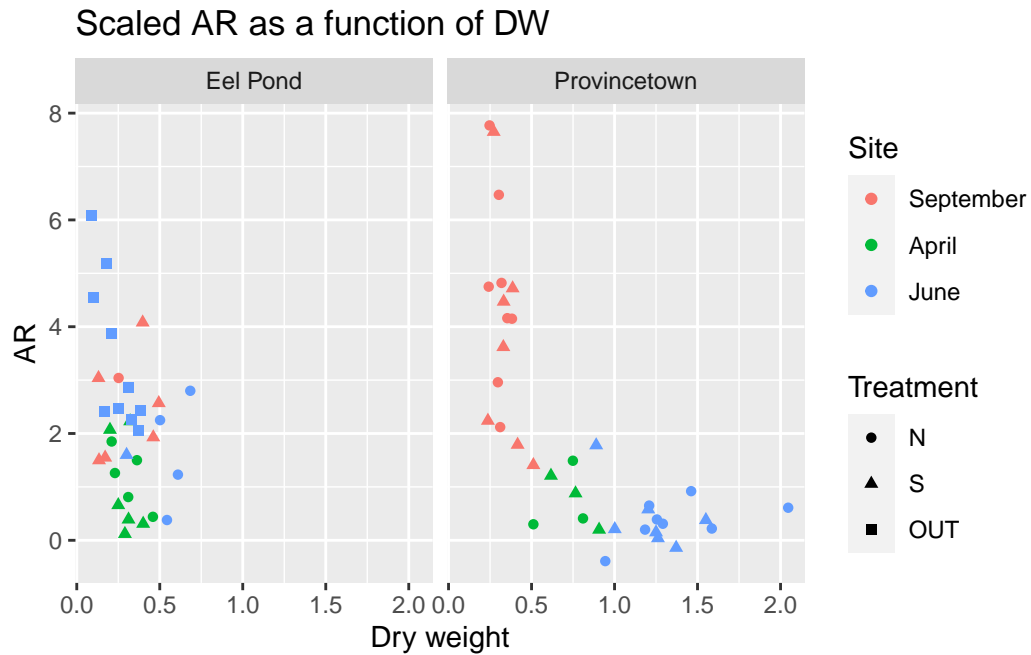

```
gg2 <- ggplot(data = bd, aes(x=Dry.weight, y=AR, color = Site ))+
  geom_point(aes(shape=Treatment))+
  xlab("Dry weight") +
  ylab("AR")+
  #ylim(0,9)+
  scale_color_discrete(name="Site")+
  ggtitle ('Scaled AR as a function of DW')+
  facet_wrap(~ Month)

  gg2
```

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

Scaled AR as a function of DW
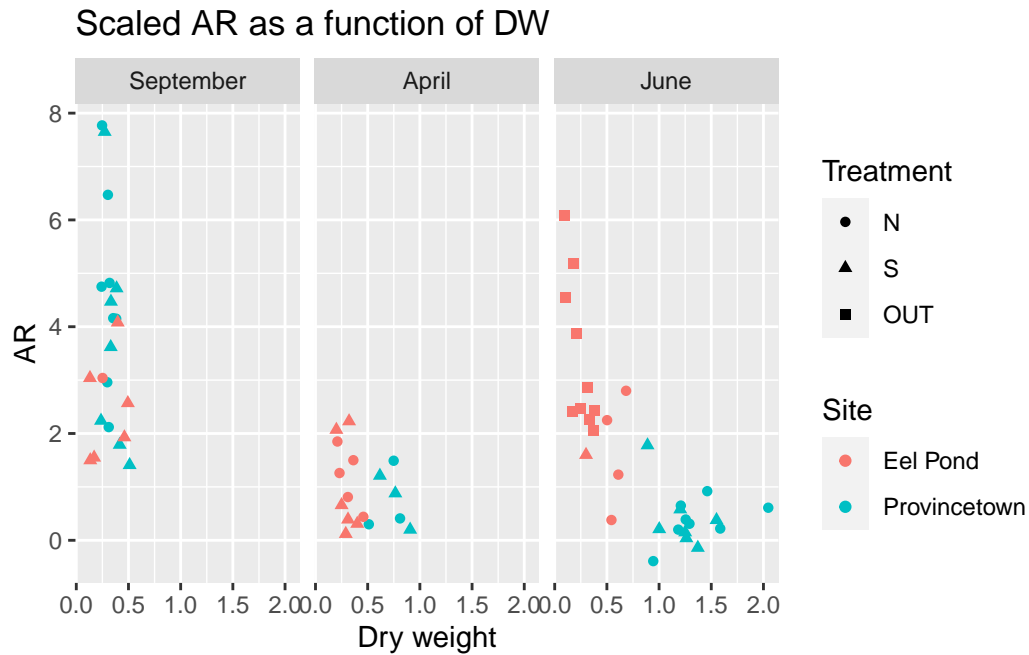

```
gg3 <- ggplot(data = bd, aes(x=Site, y=AR, col = Treatment))+
  geom_boxplot()+
  xlab("Dry weight") +
  ylab("AR")+
  ylim(0,6)+
  scale_color_discrete(name="Site")+
  ggtitle ('Scaled AR')+
  facet_wrap(~ Month)
gg3
```

Warning: Removed 7 rows containing non-finite values (`stat_boxplot()`).
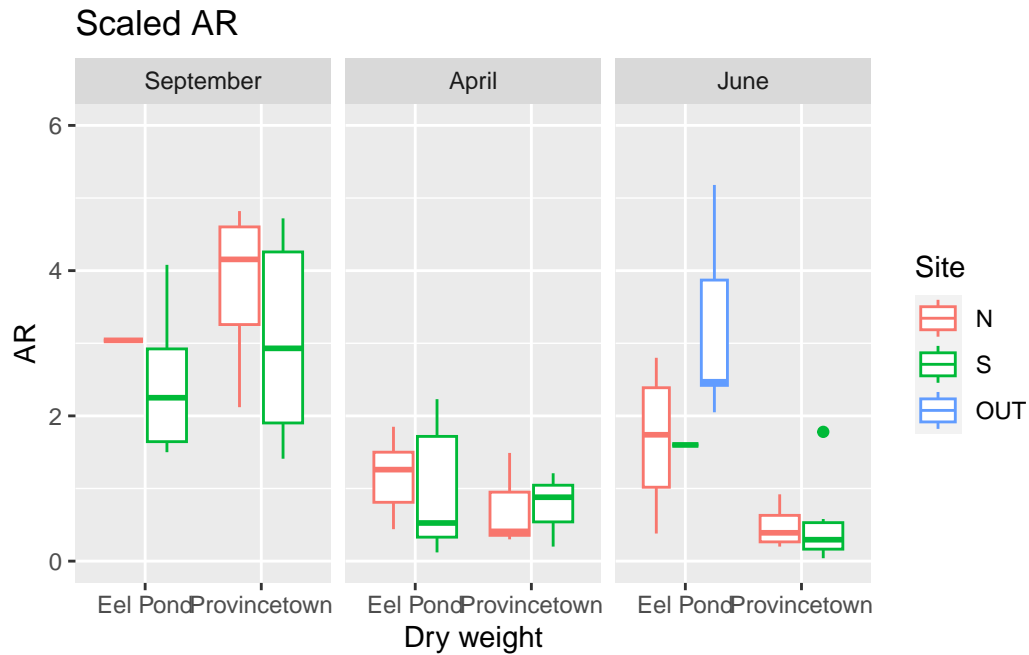
Scaled AR


```
gg4 <- ggplot(data = bd, aes(x=Site, y=AR*Dry.weight^.76, col = Treatment))+
  geom_boxplot()+
  xlab("Dry weight") +
  ylab("AR")+
  ylim(0,3)+
  scale_color_discrete(name="Site")+
  ggtitle ('Unscaled AR')+
  facet_wrap(~ Month)
gg4
```

Warning: Removed 3 rows containing non-finite values (`stat_boxplot()`).
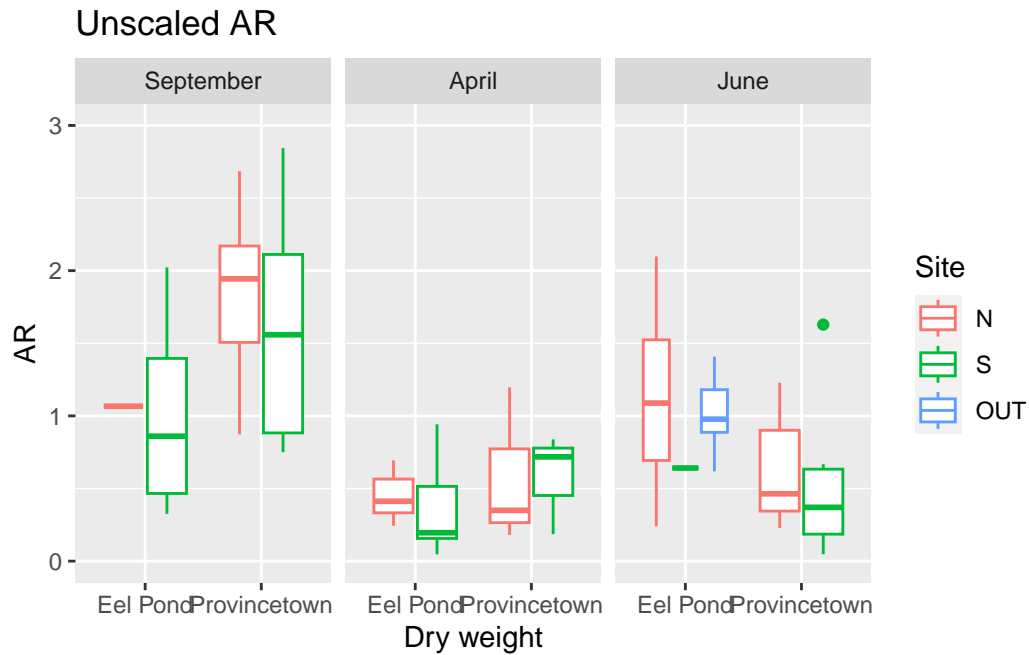
Unscaled AR

```
gg4 <- ggplot(data = bd, aes(x=Site, y=AR*Dry.weight^.76, col = Site))+
  geom_boxplot()+
  #xlab("Dry weight") +
  ylab("AR")+
  ylim(0,3)+
  scale_color_discrete(name="Site")+
  ggtitle ('Unscaled AR')+
  facet_wrap(~ Month)
gg4
```

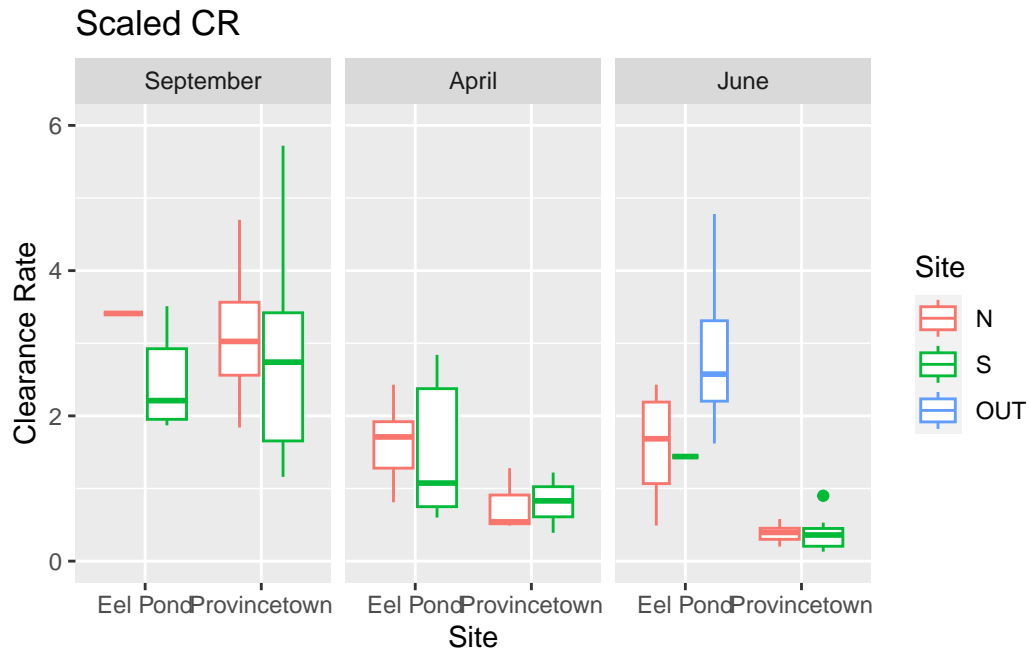Warning: Removed 3 rows containing non-finite values (`stat_boxplot()`).

Unscaled AR
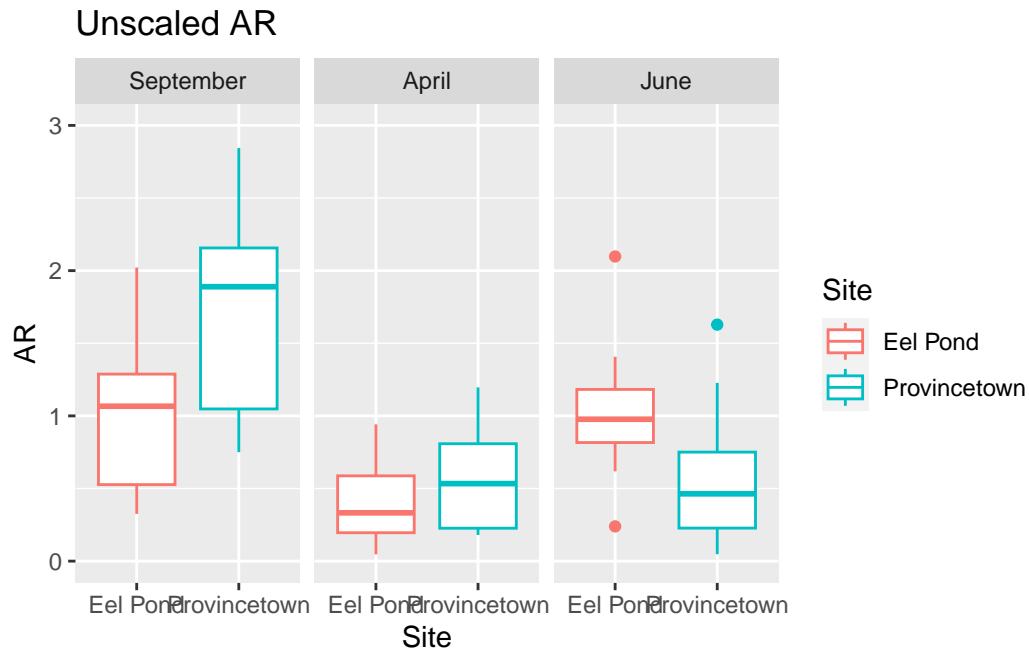

```
gm1 <- lm(AR*Dry.weight^.76 ~ Site*Dry.weight*Month+Treatment,
            data = bd)
gm2 <- lm(AR*Dry.weight^.76 ~ Site+Dry.weight,
            data = bd)
gm3 <- lm(AR ~ Treatment,
            data = bd[bd$Site=="Provincetown",]) #Separate analysis on Provincetown to con
summary(gm1)
```

```
Call:
lm(formula = AR * Dry.weight^0.76 ~ Site * Dry.weight * Month +
    Treatment, data = bd)

Residuals:
    Min       1Q   Median       3Q      Max
-1.18407 -0.26698 -0.07919  0.26462  1.32257

Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept)           0.17523    0.45048   0.389  0.69879
SiteProvincetown      2.47106    0.78259   3.158  0.00258 **
Dry.weight            3.09740    1.33860   2.314  0.02444 *
```

```
MonthApril                                      0.51011    0.76689   0.665  0.50872
MonthJune                                       0.13123    0.79744   0.165  0.86989
TreatmentS                                     -0.08378    0.14717  -0.569  0.57149
TreatmentOUT                                    0.37085    0.45098   0.822  0.41444
SiteProvincetown:Dry.weight                    -5.74908    2.32024  -2.478  0.01632 *
SiteProvincetown:MonthApril                    -2.50614    1.55666  -1.610  0.11314
SiteProvincetown:MonthJune                     -2.65692    1.21551  -2.186  0.03310 *
Dry.weight:MonthApril                          -3.88836    2.42129  -1.606  0.11402
Dry.weight:MonthJune                           -1.69307    1.80279  -0.939  0.35177
SiteProvincetown:Dry.weight:MonthApril  6.49811    3.46105   1.877  0.06576 .
SiteProvincetown:Dry.weight:MonthJune   4.64709    2.64008   1.760  0.08393 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5139 on 55 degrees of freedom
  (1 observation deleted due to missingness)
Multiple R-squared:  0.573, Adjusted R-squared:  0.4721
F-statistic: 5.678 on 13 and 55 DF,  p-value: 1.958e-06
```

```
summary(gm2)
```

```
Call:
lm(formula = AR * Dry.weight^0.76 ~ Site + Dry.weight, data = bd)

Residuals:
     Min       1Q   Median       3Q      Max
-1.26383 -0.45350 -0.07471  0.38898  1.60996

Coefficients:
                 Estimate Std. Error t value Pr(>|t|)
(Intercept)        1.0858     0.1281   8.473 3.78e-12 ***
SiteProvincetown   0.6307     0.1827   3.452 0.000975 ***
Dry.weight        -0.8748     0.2089  -4.187 8.54e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6312 on 66 degrees of freedom
  (1 observation deleted due to missingness)
Multiple R-squared:  0.227, Adjusted R-squared:  0.2036
F-statistic: 9.692 on 2 and 66 DF,  p-value: 0.000204
```

```
summary(gm3)
```

```
Call:
lm(formula = AR ~ Treatment, data = bd[bd$Site == "Provincetown",
    ])

Residuals:
    Min      1Q  Median      3Q     Max
-2.6168 -1.7122 -0.8458  1.8198  5.8153

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   2.2268     0.5265   4.229 0.000167 ***
TreatmentS   -0.3921     0.7662  -0.512 0.612107
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 2.295 on 34 degrees of freedom
  (1 observation deleted due to missingness)
Multiple R-squared:  0.007645,  Adjusted R-squared:  -0.02154
F-statistic: 0.2619 on 1 and 34 DF,  p-value: 0.6121
```

```
gm2 <- lm(AR*Dry.weight^.76 ~ Site*Dry.weight,
          data = bd)
summary(gm2)
```

```
Call:
lm(formula = AR * Dry.weight^0.76 ~ Site * Dry.weight, data = bd)

Residuals:
     Min       1Q   Median       3Q      Max
-1.24011 -0.47053  0.01922  0.37110  1.32959

Coefficients:
                          Estimate Std. Error t value Pr(>|t|)
(Intercept)                 0.4496     0.2502   1.797  0.07705 .
SiteProvincetown            1.3986     0.3158   4.429 3.71e-05 ***
Dry.weight                  1.1409     0.7210   1.583  0.11838
SiteProvincetown:Dry.weight -2.1803     0.7498  -2.908  0.00497 **
```

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5983 on 65 degrees of freedom
  (1 observation deleted due to missingness)
Multiple R-squared: 0.316, Adjusted R-squared: 0.2844
F-statistic: 10.01 on 3 and 65 DF, p-value: 1.644e-05

```r
gm2 <- lm(AR*Dry.weight^.76 ~ Site+Dry.weight,
          data = bd)
summary(gm2)
```

Call:
lm(formula = AR * Dry.weight^0.76 ~ Site + Dry.weight, data = bd)

Residuals:
     Min   1Q   Median   3Q   Max
-1.26383 -0.45350 -0.07471 0.38898 1.60996

Coefficients:
                Estimate Std. Error t value Pr(>|t|)
(Intercept)   1.0858   0.1281   8.473 3.78e-12 ***
SiteProvincetown 0.6307   0.1827   3.452 0.000975 ***
Dry.weight   -0.8748   0.2089 -4.187 8.54e-05 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6312 on 66 degrees of freedom
  (1 observation deleted due to missingness)
Multiple R-squared: 0.227, Adjusted R-squared: 0.2036
F-statistic: 9.692 on 2 and 66 DF, p-value: 0.000204

```r
#effects(gm2)

gg4 <- ggplot(data = bd, aes(x=Dry.weight, y=AR*Dry.weight^.76, col = Month))+
  geom_point()+
  geom_abline(slope = coef(gm2)[["Dry.weight"]],
              intercept = coef(gm2)[["(Intercept)"]])+
  xlab("Dry weight") +
  ylab("AR")+
```

```
  ylim(0,3)+
  scale_color_discrete(name="Site")+
  ggtitle ('Unscaled AR')
#+
  #facet_wrap(~ Site)
gg4
```

Warning: Removed 3 rows containing missing values (`geom_point()`).

Unscaled AR
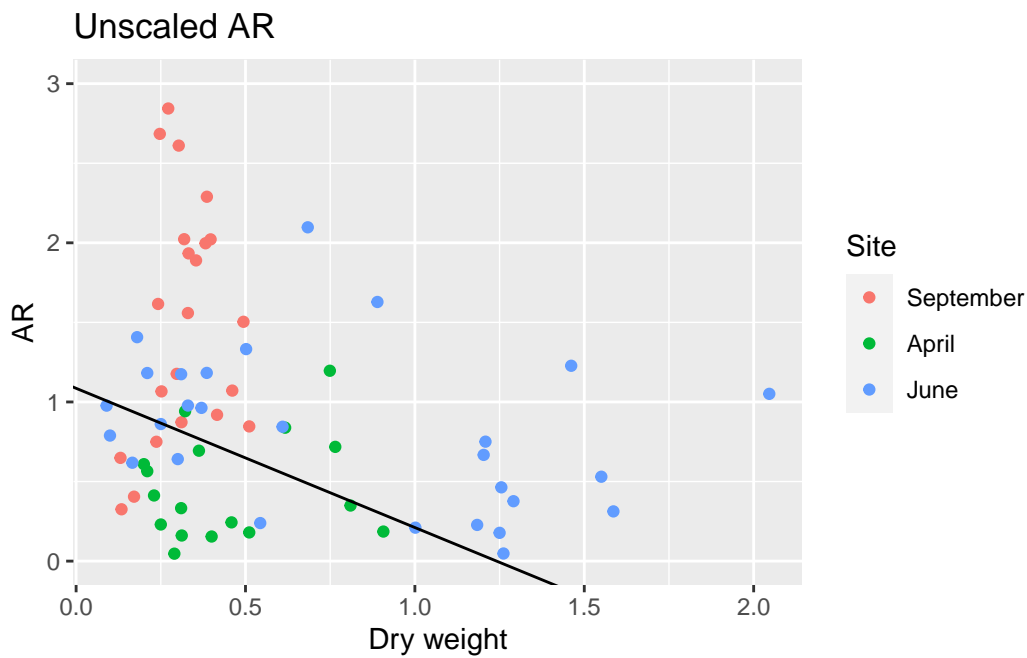
```
gg1 <- ggplot(data = bd, aes(x=Site, y=AE, col = Treatment))+
  geom_boxplot()+
  xlab("Site") +
  ylab("AE")+
  ylim(0,1)+
  scale_color_discrete(name="Site")+
  ggtitle (' AE')+
    facet_wrap(~ Site)
gg1
```

Warning: Removed 3 rows containing non-finite values (`stat_boxplot()`).
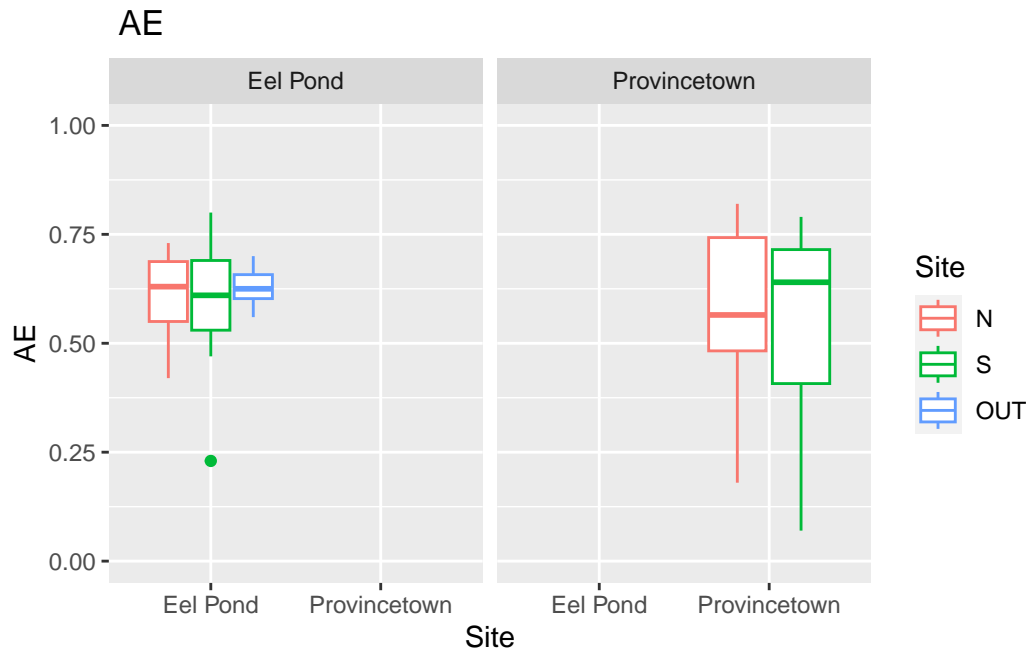
```
gg1 <- ggplot(data = bd, aes(x=Dry.weight, y=AE, col = Treatment))+
  geom_point()+
  xlab("Site") +
  ylab("AE")+
  ylim(0,1)+
  scale_color_discrete(name="Site")+
  ggtitle (' AE')+
    facet_wrap(~ Site)
gg1
```

Warning: Removed 3 rows containing missing values (`geom_point()`).

AE
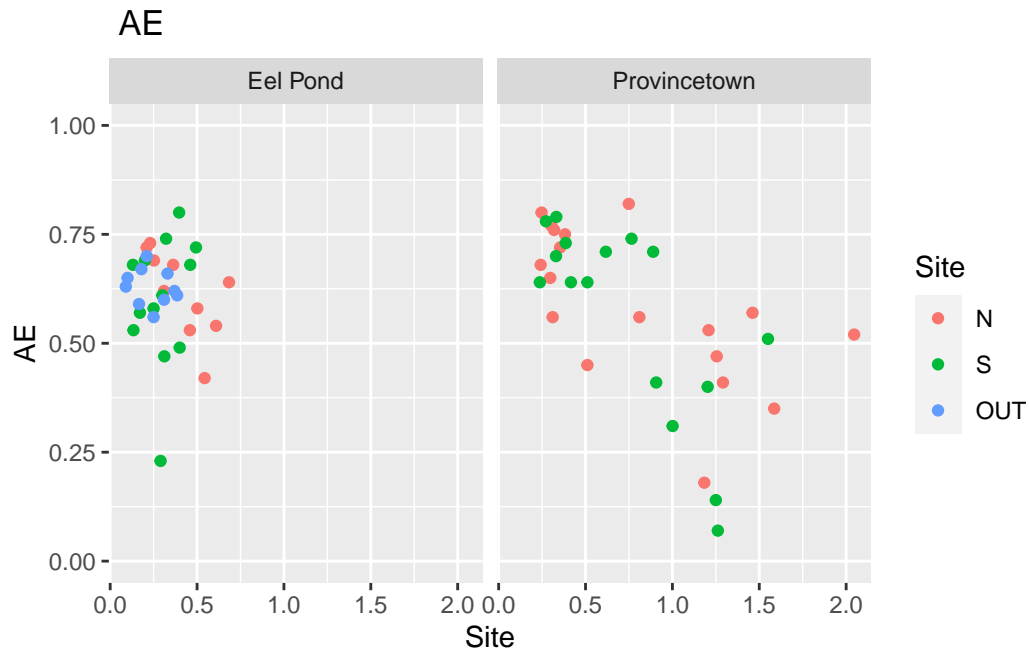
```
gg1 <- ggplot(data = bd, aes(x=Length, y=AE, col = Treatment))+
  geom_point()+
  xlab("Site") +
  ylab("AE")+
  ylim(0,1)+
  scale_color_discrete(name="Site")+
  ggtitle (' AE')+
    facet_wrap(~ Site)
gg1
```

Warning: Removed 3 rows containing missing values (`geom_point()`).

AE


```
fit1 <- nlme::gnls(OER~ A*(Length/10)^B,
          params = list(A~paste(Site,Month)-1, B~1),
          data=bd,
          na.action = na.exclude,
          start = list(A=c(1,1,1,1,1,1), B = .3 ))
summary(fit1)
```

```
Generalized nonlinear least squares fit
  Model: OER ~ A * (Length/10)^B
  Data: bd
       AIC      BIC    logLik
  25.77933 43.7673 -4.889667
```

Coefficients:

	Value	Std.Error	t-value	p-value
A.paste(Site, Month)Eel Pond April	1.1912439	0.5413981	2.200310	0.0315
A.paste(Site, Month)Eel Pond June	0.5022929	0.2561003	1.961313	0.0543
A.paste(Site, Month)Eel Pond September	0.3326396	0.1875521	1.773585	0.0810
A.paste(Site, Month)Provincetown April	0.1407754	0.1150654	1.223438	0.2257
A.paste(Site, Month)Provincetown June	0.5938241	0.3739325	1.588052	0.1173
A.paste(Site, Month)Provincetown September	0.5072131	0.2731387	1.856980	0.0680
B	0.2022421	0.4196051	0.481982	0.6315

```
 Correlation:
                                                 A.(MPA A.(MPJ A.(MPS A.(SMA A.(SMJ
A.paste(Site, Month)Eel Pond June                 0.969
A.paste(Site, Month)Eel Pond September            0.895  0.880
A.paste(Site, Month)Provincetown April            0.660  0.649  0.600
A.paste(Site, Month)Provincetown June             0.983  0.967  0.894  0.659
A.paste(Site, Month)Provincetown September  0.972  0.956  0.884  0.651  0.971
B                                          -0.992 -0.976 -0.902 -0.665 -0.991
                                                 A.(SMS
A.paste(Site, Month)Eel Pond June
A.paste(Site, Month)Eel Pond September
A.paste(Site, Month)Provincetown April
A.paste(Site, Month)Provincetown June
A.paste(Site, Month)Provincetown September
B                                                -0.980


Standardized residuals:
        Min            Q1           Med            Q3           Max
-1.59259716 -0.59069467 -0.03900329  0.44377293   3.52749181

Residual standard error: 0.2735131
Degrees of freedom: 70 total; 63 residual
```

```r
# fit2 <- nlme::gnls(OER~ A*(Length/10)^B,
#          params = list(A~paste(Site,Month)-1, B~paste(Site,Month)-1),
#          data=bd,
#          na.action = na.exclude,
#          start = list(A=c(1,1,1,1,1,1), B = c(1,1,1,1,1,1) ))
# summary(fit2)

fit3 <- nlme::gnls(OER~ A*(Length/10)^B,
         params = list(A~1, B~1),
         data=bd,
         na.action = na.exclude,
         start = list(A=1, B = .3 ))
summary(fit1)
```

```
Generalized nonlinear least squares fit
  Model: OER ~ A * (Length/10)^B
  Data: bd
      AIC     BIC    logLik
```

```
    25.77933 43.7673 -4.889667

Coefficients:
                                           Value Std.Error  t-value p-value
A.paste(Site, Month)Eel Pond April     1.1912439 0.5413981 2.200310  0.0315
A.paste(Site, Month)Eel Pond June      0.5022929 0.2561003 1.961313  0.0543
A.paste(Site, Month)Eel Pond September 0.3326396 0.1875521 1.773585  0.0810
A.paste(Site, Month)Provincetown April 0.1407754 0.1150654 1.223438  0.2257
A.paste(Site, Month)Provincetown June  0.5938241 0.3739325 1.588052  0.1173
A.paste(Site, Month)Provincetown September 0.5072131 0.2731387 1.856980  0.0680
B                                      0.2022421 0.4196051 0.481982  0.6315

 Correlation:
                                           A.(MPA A.(MPJ A.(MPS A.(SMA A.(SMJ
A.paste(Site, Month)Eel Pond June           0.969
A.paste(Site, Month)Eel Pond September      0.895  0.880
A.paste(Site, Month)Provincetown April      0.660  0.649  0.600
A.paste(Site, Month)Provincetown June       0.983  0.967  0.894  0.659
A.paste(Site, Month)Provincetown September  0.972  0.956  0.884  0.651  0.971
B                                          -0.992 -0.976 -0.902 -0.665 -0.991
                                           A.(SMS
A.paste(Site, Month)Eel Pond June
A.paste(Site, Month)Eel Pond September
A.paste(Site, Month)Provincetown April
A.paste(Site, Month)Provincetown June
A.paste(Site, Month)Provincetown September
B                                          -0.980

Standardized residuals:
       Min          Q1         Med          Q3         Max
-1.59259716 -0.59069467 -0.03900329  0.44377293  3.52749181

Residual standard error: 0.2735131
Degrees of freedom: 70 total; 63 residual
```

summary(fit3)

```
Generalized nonlinear least squares fit
  Model: OER ~ A * (Length/10)^B
  Data: bd
      AIC      BIC    logLik
  88.47039 95.21587 -41.23519
```

```
Coefficients:
       Value Std.Error   t-value p-value
A  1.4461728 0.6820059  2.120470  0.0376
B -0.5246761 0.3808781 -1.377544  0.1729


 Correlation:
  A
B -0.989


Standardized residuals:
       Min          Q1        Med         Q3        Max
-1.5659052 -0.5604893 -0.1701492  0.5193628  3.6540902


Residual standard error: 0.4424753
Degrees of freedom: 70 total; 68 residual
```

```
AIC(fit1,fit3)
```

```
     df      AIC
fit1  8 25.77933
fit3  3 88.47039
```

```
BIC(fit1,fit3)
```

```
     df      BIC
fit1  8 43.76730
fit3  3 95.21587
```

```
gg1 <- ggplot(data = bd, aes(x=Length/10, y=OER, color = paste(Site,Month)))+
  geom_point()+
  #xlab("Dry weight") +
  #ylab("ORR")+
  #ylim(0,9)+
  #scale_color_discrete(name="Site")+
  #ggtitle ('ORR as a function of DW')+
  stat_smooth(
    method = 'nls',
    formula = y ~ A * x^B,
    method.args = list(start = c(A = 2.3, B = 2)),
    se = FALSE
```

```
) +
facet_wrap(~ paste(Site,Month))

gg1
```
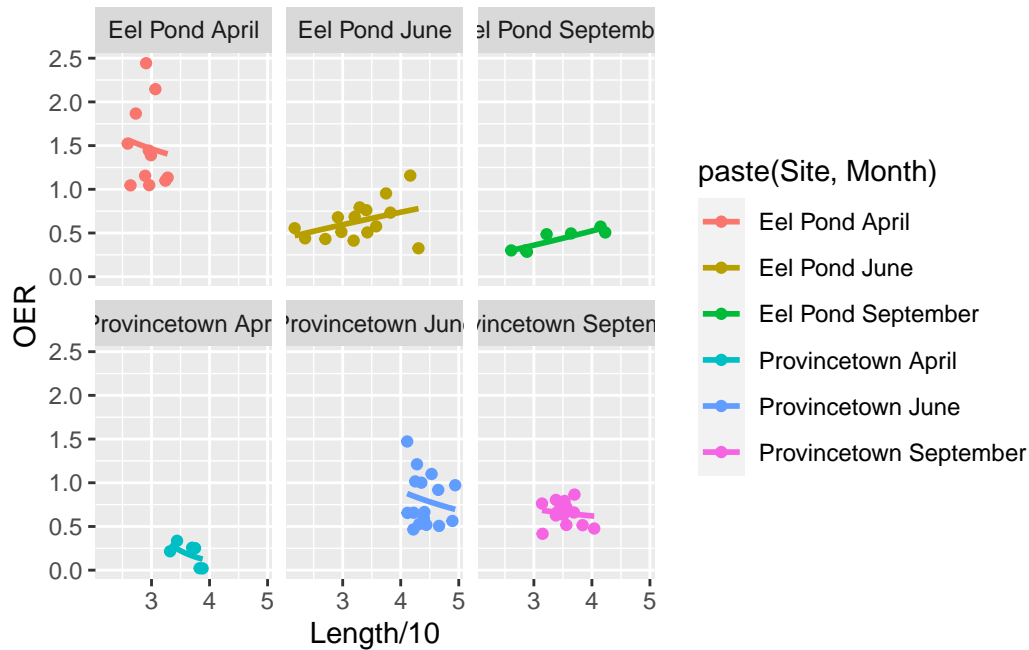

CR is scaled in excel spreadsheet, so to unscale it multiply it... and then here I'm looking at the relationship between length and unscaled CR... I'm not getting a value of 2...

```
fit1 <- nlme::gnls(CR*Dry.weight^.76~ A*(Length/10)^B,
          params = list(A~paste(Site,Month)-1, B~1),
          data=bd,
          na.action = na.exclude,
          start = list(A=c(1,1,1,1,1,1), B = .3 ))
summary(fit1)


Generalized nonlinear least squares fit
  Model: CR * Dry.weight^0.76 ~ A * (Length/10)^B
  Data: bd
       AIC      BIC    logLik
  56.88835 74.7612 -20.44417


Coefficients:
```

```
                                                 Value Std.Error   t-value p-value
A.paste(Site, Month)Eel Pond April           0.2560434 0.1213874 2.109308  0.0390
A.paste(Site, Month)Eel Pond June            0.3488175 0.1772280 1.968185  0.0535
A.paste(Site, Month)Eel Pond September       0.4024601 0.2107537 1.909623  0.0608
A.paste(Site, Month)Provincetown April       0.2230504 0.1287165 1.732881  0.0881
A.paste(Site, Month)Provincetown June        0.1438257 0.0918314 1.566192  0.1224
A.paste(Site, Month)Provincetown September   0.4625192 0.2402667 1.925024  0.0588
B                                            0.7765549 0.4075953 1.905211  0.0614

 Correlation:
                                             A.(MPA A.(MPJ A.(MPS A.(SMA A.(SMJ
A.paste(Site, Month)Eel Pond June             0.911
A.paste(Site, Month)Eel Pond September        0.903  0.952
A.paste(Site, Month)Provincetown April        0.853  0.899  0.891
A.paste(Site, Month)Provincetown June         0.885  0.934  0.925  0.874
A.paste(Site, Month)Provincetown September    0.920  0.971  0.962  0.909  0.944
B                                            -0.929 -0.980 -0.971 -0.917 -0.953
                                             A.(SMS
A.paste(Site, Month)Eel Pond June
A.paste(Site, Month)Eel Pond September
A.paste(Site, Month)Provincetown April
A.paste(Site, Month)Provincetown June
A.paste(Site, Month)Provincetown September
B                                            -0.990

Standardized residuals:
       Min          Q1         Med          Q3         Max
-2.25934022 -0.61005308 -0.06371923  0.67295723  2.72548315

Residual standard error: 0.3432967
Degrees of freedom: 69 total; 62 residual
```

```r
fit2 <- nlme::gnls(CR*Dry.weight^.76~ A*(Length/10)^B,
          params = list(A~paste(Site,Month)-1, B~paste(Site,Month)-1),
          data=bd,
          na.action = na.exclude,
          start = list(A=c(1,1,1,1,1,1), B = c(1,1,1,1,1,1) ))
summary(fit2)
```

```
Generalized nonlinear least squares fit
  Model: CR * Dry.weight^0.76 ~ A * (Length/10)^B
  Data: bd
```

```
        AIC       BIC    logLik
   61.76457 90.80796 -17.88229


Coefficients:
                                             Value Std.Error    t-value
A.paste(Site, Month)Eel Pond April        4.335165 10.998719  0.3941518
A.paste(Site, Month)Eel Pond June         0.401470  0.286231  1.4026097
A.paste(Site, Month)Eel Pond September    0.128397  0.128146  1.0019640
A.paste(Site, Month)Provincetown April    0.554486  2.915631  0.1901769
A.paste(Site, Month)Provincetown June     0.092114  0.472748  0.1948480
A.paste(Site, Month)Provincetown September 1.922962  2.716251  0.7079471
B.paste(Site, Month)Eel Pond April       -1.856429  2.402488 -0.7727109
B.paste(Site, Month)Eel Pond June         0.661359  0.580814  1.1386753
B.paste(Site, Month)Eel Pond September    1.683562  0.761724  2.2101980
B.paste(Site, Month)Provincetown April    0.075060  4.058026  0.0184968
B.paste(Site, Month)Provincetown June     1.074964  3.431508  0.3132627
B.paste(Site, Month)Provincetown September -0.354019 1.126131 -0.3143675
                                           p-value
A.paste(Site, Month)Eel Pond April          0.6949
A.paste(Site, Month)Eel Pond June           0.1662
A.paste(Site, Month)Eel Pond September      0.3206
A.paste(Site, Month)Provincetown April      0.8498
A.paste(Site, Month)Provincetown June       0.8462
A.paste(Site, Month)Provincetown September  0.4819
B.paste(Site, Month)Eel Pond April          0.4429
B.paste(Site, Month)Eel Pond June           0.2596
B.paste(Site, Month)Eel Pond September      0.0311
B.paste(Site, Month)Provincetown April      0.9853
B.paste(Site, Month)Provincetown June       0.7552
B.paste(Site, Month)Provincetown September  0.7544


 Correlation:
                                           A.(MPA A.(MPJ A.(MPS A.(SMA A.(SMJ
A.paste(Site, Month)Eel Pond June           0.000
A.paste(Site, Month)Eel Pond September      0.000  0.000
A.paste(Site, Month)Provincetown April      0.000  0.000  0.000
A.paste(Site, Month)Provincetown June       0.000  0.000  0.000  0.000
A.paste(Site, Month)Provincetown September  0.000  0.000  0.000  0.000  0.000
B.paste(Site, Month)Eel Pond April         -0.998  0.000  0.000  0.000  0.000
B.paste(Site, Month)Eel Pond June           0.000 -0.990  0.000  0.000  0.000
B.paste(Site, Month)Eel Pond September      0.000  0.000 -0.992  0.000  0.000
B.paste(Site, Month)Provincetown April      0.000  0.000  0.000 -0.999  0.000
B.paste(Site, Month)Provincetown June       0.000  0.000  0.000  0.000 -0.999
```

```
B.paste(Site, Month)Provincetown September  0.000  0.000  0.000  0.000  0.000
                                           A.(SMS B.(MPA B.(MPJ B.(MPS B.(SMA
A.paste(Site, Month)Eel Pond June
A.paste(Site, Month)Eel Pond September
A.paste(Site, Month)Provincetown April
A.paste(Site, Month)Provincetown June
A.paste(Site, Month)Provincetown September
B.paste(Site, Month)Eel Pond April           0.000
B.paste(Site, Month)Eel Pond June            0.000  0.000
B.paste(Site, Month)Eel Pond September       0.000  0.000  0.000
B.paste(Site, Month)Provincetown April       0.000  0.000  0.000  0.000
B.paste(Site, Month)Provincetown June        0.000  0.000  0.000  0.000  0.000
B.paste(Site, Month)Provincetown September  -0.999  0.000  0.000  0.000  0.000
                                           B.(SMJ
A.paste(Site, Month)Eel Pond June
A.paste(Site, Month)Eel Pond September
A.paste(Site, Month)Provincetown April
A.paste(Site, Month)Provincetown June
A.paste(Site, Month)Provincetown September
B.paste(Site, Month)Eel Pond April
B.paste(Site, Month)Eel Pond June
B.paste(Site, Month)Eel Pond September
B.paste(Site, Month)Provincetown April
B.paste(Site, Month)Provincetown June
B.paste(Site, Month)Provincetown September   0.000


Standardized residuals:
        Min           Q1          Med           Q3          Max
-2.16273012  -0.58659285  -0.07930908   0.62931579   2.54226464


Residual standard error: 0.3449874
Degrees of freedom: 69 total; 57 residual
```

```r
fit3 <- nlme::gnls(CR*Dry.weight^.76~ A*(Length/10)^B,
          params = list(A~1, B~1),
          data=bd,
          na.action = na.exclude,
          start = list(A=1, B = .3 ))
summary(fit1)
```

```
Generalized nonlinear least squares fit
  Model: CR * Dry.weight^0.76 ~ A * (Length/10)^B
```

```
  Data: bd
       AIC      BIC    logLik
  56.88835 74.7612 -20.44417


Coefficients:
                                                  Value Std.Error  t-value p-value
A.paste(Site, Month)Eel Pond April            0.2560434 0.1213874 2.109308  0.0390
A.paste(Site, Month)Eel Pond June             0.3488175 0.1772280 1.968185  0.0535
A.paste(Site, Month)Eel Pond September        0.4024601 0.2107537 1.909623  0.0608
A.paste(Site, Month)Provincetown April        0.2230504 0.1287165 1.732881  0.0881
A.paste(Site, Month)Provincetown June         0.1438257 0.0918314 1.566192  0.1224
A.paste(Site, Month)Provincetown September    0.4625192 0.2402667 1.925024  0.0588
B                                             0.7765549 0.4075953 1.905211  0.0614


 Correlation:
                                            A.(MPA A.(MPJ A.(MPS A.(SMA A.(SMJ
A.paste(Site, Month)Eel Pond June            0.911
A.paste(Site, Month)Eel Pond September       0.903  0.952
A.paste(Site, Month)Provincetown April       0.853  0.899  0.891
A.paste(Site, Month)Provincetown June        0.885  0.934  0.925  0.874
A.paste(Site, Month)Provincetown September   0.920  0.971  0.962  0.909  0.944
B                                           -0.929 -0.980 -0.971 -0.917 -0.953
                                            A.(SMS
A.paste(Site, Month)Eel Pond June
A.paste(Site, Month)Eel Pond September
A.paste(Site, Month)Provincetown April
A.paste(Site, Month)Provincetown June
A.paste(Site, Month)Provincetown September
B                                           -0.990


Standardized residuals:
        Min          Q1         Med          Q3         Max
-2.25934022 -0.61005308 -0.06371923  0.67295723  2.72548315


Residual standard error: 0.3432967
Degrees of freedom: 69 total; 62 residual
```

```
summary(fit3)
```

```
Generalized nonlinear least squares fit
  Model: CR * Dry.weight^0.76 ~ A * (Length/10)^B
  Data: bd
```

```
        AIC       BIC     logLik
  88.54044 95.24276 -41.27022


Coefficients:
        Value Std.Error     t-value p-value
A  0.9936092 0.4586190   2.1665241  0.0338
B -0.1644273 0.3666569  -0.4484499  0.6553


 Correlation:
   A
B -0.99


Standardized residuals:
        Min          Q1         Med          Q3         Max
 -1.3732219  -0.7802869  -0.1683142   0.6812916   2.9405469


Residual standard error: 0.4465908
Degrees of freedom: 69 total; 67 residual
```

```r
AIC(fit1,fit3)
```

```
     df      AIC
fit1  8 56.88835
fit3  3 88.54044
```

```r
BIC(fit1,fit3)
```

```
     df      BIC
fit1  8 74.76120
fit3  3 95.24276
```

```r
gg1 <- ggplot(data = bd, aes(x=Length/10, y=CR*Dry.weight^.76, color = paste(Site,Month)))+
  geom_point()+
  #xlab("Dry weight") +
  #ylab("ORR")+
  #ylim(0,9)+
  #scale_color_discrete(name="Site")+
  #ggtitle ('ORR as a function of DW')+
  stat_smooth(
    method = 'nls',
    formula = y ~ A * x^B,
```

```
    method.args = list(start = c(A = 2.3, B = 2)),
    se = FALSE
  ) +
  facet_wrap(~ paste(Site,Month))

gg1
```

Warning: Removed 1 rows containing non-finite values (`stat_smooth()`).

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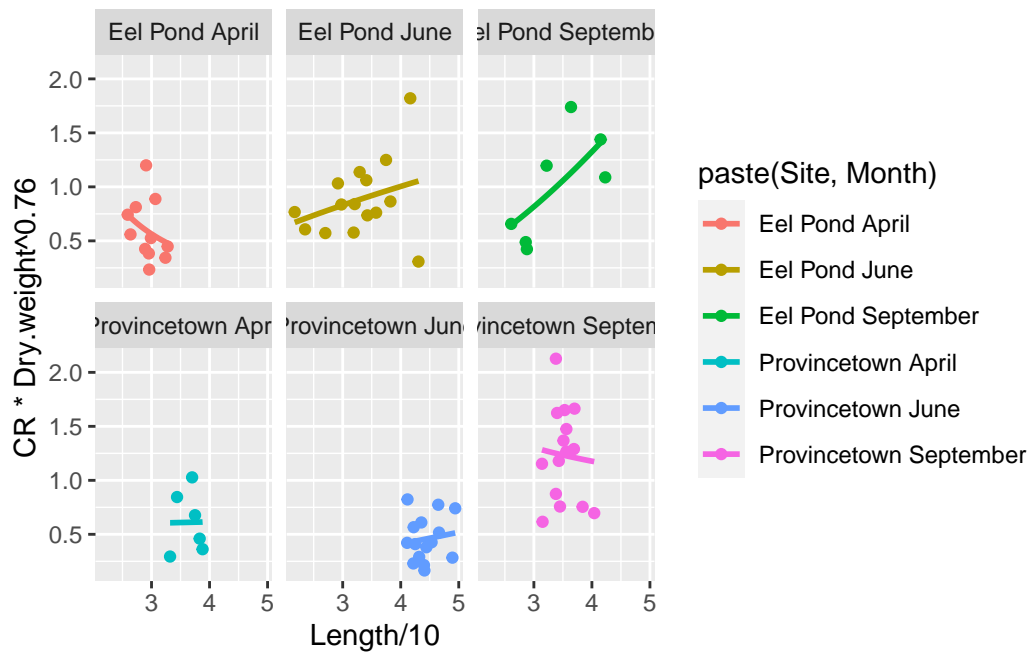
3 Biodeposition_size_scaling

3.1 Quarto

```r
library(ggplot2)
library(ggpubr)
library(nlme)
```

Warning: package 'nlme' was built under R version 4.3.2

```r
library(data.table)
```

Warning: package 'data.table' was built under R version 4.3.2

```r
setwd("~/GitHub/EAD-ASEB-Ssolidissima-OA/projects/Biodeposition/data")

bd_Pousse <- read.csv("Pousse_Meseck_Raw Data Surfclam Biodeposition.csv", stringsAsFactors =

bd_Pousse$Dry.weight..mg. <- bd_Pousse$DW_corr

str(bd_Pousse)
```

```
'data.frame':    112 obs. of  32 variables:
 $ Date           : chr  "5/15/2019" "5/15/2019" "5/15/2019" "5/15/2019" ...
 $ pH             : num  8 8 8 8 8 8 8 7.5 7.5 7.5 ...
 $ Length..mm.    : num  16.5 16.2 17.3 17.9 16.8 ...
 $ Dry.weight..mg.: num  0.0402 0.0503 0.0648 0.0819 0.049 0.0717 0.07 0.0802 0.0634 0.09 ..
 $ Length20mm     : num  NA NA NA NA NA NA NA NA NA NA ...
 $ DW_Pred        : num  NA NA NA NA NA NA NA NA NA NA ...
 $ DW_diff        : num  NA NA NA NA NA NA NA NA NA NA ...
 $ DW_corr        : num  0.0402 0.0503 0.0648 0.0819 0.049 0.0717 0.07 0.0802 0.0634 0.09 ..
 $ time.h.        : num  1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 ...
 $ slope          : num  0.0176 NA NA NA NA ...
```

```
$ int            : num   -0.269 NA NA NA NA ...
$ sum            : num   15.9 NA NA NA NA ...
$ feces          : int   2 3 4 5 6 7 8 2 3 4 ...
$ TPM            : num   1.86 3.79 2.65 1.88 3.46 ...
$ PIM            : num   1.56 3.31 2.25 1.54 3.03 ...
$ POM            : num   0.303 0.48 0.395 0.335 0.431 0.245 0.128 0.367 0.31 0.376 ...
$ X..organic     : num   16.3 12.7 14.9 17.8 12.4 ...
$ ER..mg.h.      : num   1.24 2.53 1.77 1.25 2.31 ...
$ OER            : num   0.202 0.32 0.263 0.223 0.287 ...
$ IER            : num   1.04 2.21 1.5 1.03 2.02 ...
$ X              : logi  NA NA NA NA NA NA ...
$ pseudofeces    : int   2 3 4 5 6 7 8 2 3 4 ...
$ TPM.1          : num   2.91 2.5 2.58 3.3 2.05 ...
$ PIM.1          : num   1.64 2.18 2.2 2.87 1.78 ...
$ POM.1          : num   1.269 0.313 0.389 0.429 0.272 ...
$ X..organ       : num   43.6 12.5 15 13 13.3 ...
$ RR..mg.h.      : num   1.94 1.66 1.72 2.2 1.37 ...
$ ORR            : num   0.846 0.209 0.259 0.286 0.181 ...
$ IRR            : num   1.09 1.46 1.46 1.92 1.19 ...
$ TSM            : num   15.8 15.8 15.8 15.8 15.8 ...
$ PIM.2          : num   13.4 13.4 13.4 13.4 13.4 ...
$ POM.2          : num   2.38 2.38 2.38 2.38 2.38 ...
```

```r
bd_Pousse$Treatment <- as.factor(bd_Pousse$pH)
bd_Pousse$OER[bd_Pousse$OER<=-.5]<-NA
bd_Pousse$IER[bd_Pousse$IER<=-.5]<-NA
bd_Pousse$Dry.weight..mg.[bd_Pousse$Dry.weight..mg.>=.5]<-NA

ambient <- bd_Pousse[bd_Pousse$Treatment==8,]


gg1 <- ggplot(data = bd_Pousse, aes(x=Length..mm., y=Dry.weight..mg., color = Treatment))+ ge
  gg1
```

```
Warning: Removed 1 rows containing missing values (`geom_point()`).
```
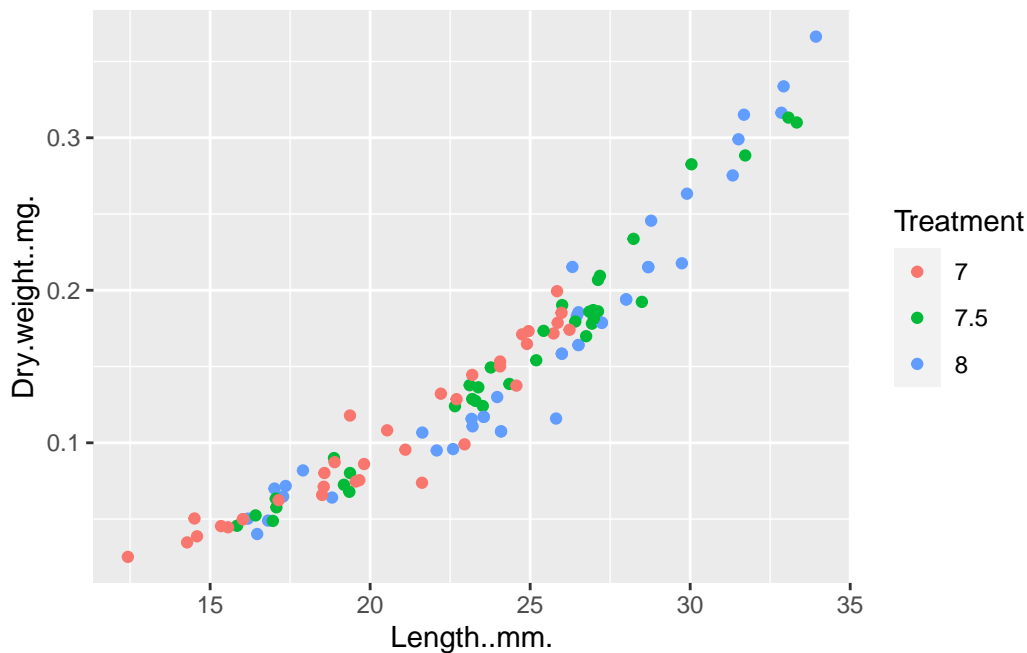
```
bd_Pousse$Treatment <- as.factor(bd_Pousse$pH)
bd_Pousse$Date <- as.Date(bd_Pousse$Date, format = "%m/%d/%Y")
bd_Pousse$Date[bd_Pousse$Date=="2019-06-12"] <-"2019-06-11"
bd_Pousse$Month <- as.factor(bd_Pousse$Date)

nls <- nls(Dry.weight..mg. ~ A * Length..mm.^B,
           start = list(A = 3, B = 3),
           data = bd_Pousse,
           na.action=na.exclude)
summary(nls)
```

```
Formula: Dry.weight..mg. ~ A * Length..mm.^B

Parameters:
   Estimate Std. Error t value Pr(>|t|)
A 3.035e-05  6.047e-06    5.018 2.04e-06 ***
B 2.652e+00  6.003e-02   44.180  < 2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.0155 on 109 degrees of freedom
```

49

```
Number of iterations to convergence: 6
Achieved convergence tolerance: 1.432e-07
  (1 observation deleted due to missingness)
```

```
2.652*.76
```

```
[1] 2.01552
```

```
#Note the summary data does not have length included, so am getting the relationship between
#This file has PIMs, but I don't think I'm correctly calculating CR from IFR using these PIMs
#Based on my calculations of IFR and CR and accounting for month (different coefficients for
```

You can add options to executable code like this

```
gg1 <- ggplot(data = bd_Pousse, aes(x=Dry.weight..mg., y=OER, color = Treatment))+
  geom_point()+
  xlab("Dry weight") +
  ylab("OER")+
  #ylim(0,9)+
  #scale_color_discrete(name="Site")+
  #ggtitle ('OER as a function of DW')+
  stat_smooth(
    method = 'nls',
    formula = y ~ A * x^B,
    method.args = list(start = c(A = 2.3, B = 0.72)),
    se = FALSE
  )#stat_smooth(color = 1, method = 'nls', formula = 'y~a*exp(b*x)',
  #              method.args = list(start=c(A = 2.3, B=.72)), se=FALSE) +
  facet_wrap(~ Treatment)
```

```
<ggproto object: Class FacetWrap, Facet, gg>
    compute_layout: function
    draw_back: function
    draw_front: function
    draw_labels: function
    draw_panels: function
    finish_data: function
    init_scales: function
```

```
map_data: function
params: list
setup_data: function
setup_params: function
shrink: TRUE
train_scales: function
vars: function
super:  <ggproto object: Class FacetWrap, Facet, gg>
```

gg1

Warning: Removed 5 rows containing non-finite values (`stat_smooth()`).

Warning: Removed 5 rows containing missing values (`geom_point()`).


```
nls_8 <- nls(OER ~ A * Dry.weight..mg.^B,
             start = list(A = 2.3, B = 0.72),
             data = bd_Pousse[bd_Pousse$Treatment=="8",],
             na.action=na.exclude)
nls_7.5 <- nls(OER ~ A * Dry.weight..mg.^B,
               start = list(A = 2.3, B = 0.72),
```

```
                data = bd_Pousse[bd_Pousse$Treatment=="7.5",],
                na.action=na.exclude)
nls_7 <- nls(OER ~ A * Dry.weight..mg.^B,
                start = list(A = 2.3, B = 0.72),
                data = bd_Pousse[bd_Pousse$Treatment=="7",],
                na.action=na.exclude)
summary(nls_8)
```

```
Formula: OER ~ A * Dry.weight..mg.^B

Parameters:
  Estimate Std. Error t value Pr(>|t|)
A   2.3096     0.5933   3.893 0.000412 ***
B   0.7242     0.1567   4.622 4.73e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.2824 on 36 degrees of freedom

Number of iterations to convergence: 3
Achieved convergence tolerance: 2.313e-06
  (4 observations deleted due to missingness)
```

```
summary(nls_7.5)
```

```
Formula: OER ~ A * Dry.weight..mg.^B

Parameters:
  Estimate Std. Error t value Pr(>|t|)
A   1.9579     0.6121   3.199 0.003044 **
B   0.6779     0.1806   3.754 0.000672 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.2477 on 33 degrees of freedom

Number of iterations to convergence: 3
Achieved convergence tolerance: 9.866e-07
```

```
summary(nls_7)
```

```
Formula: OER ~ A * Dry.weight..mg.^B

Parameters:
  Estimate Std. Error t value Pr(>|t|)
A   1.0098      0.3569   2.829  0.00799 **
B   0.4067      0.1580   2.574  0.01488 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.1761 on 32 degrees of freedom

Number of iterations to convergence: 5
Achieved convergence tolerance: 7.596e-06
  (1 observation deleted due to missingness)
```

```
nls_all <- nls(OER ~ A * Dry.weight..mg.^B,
               start = list(A = 2.3, B = 0.72),
               data = bd_Pousse,
               na.action=na.exclude)
summary(nls_all)
```

```
Formula: OER ~ A * Dry.weight..mg.^B

Parameters:
  Estimate Std. Error t value Pr(>|t|)
A   2.1245      0.3439   6.178 1.25e-08 ***
B   0.7121      0.0913   7.800 4.78e-12 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.2414 on 105 degrees of freedom

Number of iterations to convergence: 3
Achieved convergence tolerance: 8.352e-07
  (5 observations deleted due to missingness)
```

```r
gg1 <- ggplot(data = bd_Pousse, aes(x=Dry.weight..mg., y=IER, color = Treatment))+
  geom_point()+
  xlab("Dry weight") +
  ylab("IER")+
  #ylim(0,9)+
  #scale_color_discrete(name="Site")+
  #ggtitle ('IER as a function of DW')+
  stat_smooth(
    method = 'nls',
    formula = y ~ A * x^B,
    method.args = list(start = c(A = 2.3, B = 0.72)),
    se = FALSE
  )#stat_smooth(color = 1, method = 'nls', formula = 'y~a*exp(b*x)',
  #              method.args = list(start=c(A = 2.3, B=.72)), se=FALSE) +
  facet_wrap(~ Treatment)
```

```
<ggproto object: Class FacetWrap, Facet, gg>
    compute_layout: function
    draw_back: function
    draw_front: function
    draw_labels: function
    draw_panels: function
    finish_data: function
    init_scales: function
    map_data: function
    params: list
    setup_data: function
    setup_params: function
    shrink: TRUE
    train_scales: function
    vars: function
    super:  <ggproto object: Class FacetWrap, Facet, gg>
```

```r
gg1
```

```
Warning: Removed 5 rows containing non-finite values (`stat_smooth()`).
```

```
Warning: Removed 5 rows containing missing values (`geom_point()`).
```

```
nls_8 <- nls(IER ~ A * Dry.weight..mg.^B,
             start = list(A = 2.3, B = 0.72),
             data = bd_Pousse[bd_Pousse$Treatment=="8",],
             na.action=na.exclude)
nls_7.5 <- nls(IER ~ A * Dry.weight..mg.^B,
               start = list(A = 2.3, B = 0.72),
               data = bd_Pousse[bd_Pousse$Treatment=="7.5",],
               na.action=na.exclude)
nls_7 <- nls(IER ~ A * Dry.weight..mg.^B,
             start = list(A = 2.3, B = 0.72),
             data = bd_Pousse[bd_Pousse$Treatment=="7",],
             na.action=na.exclude)
summary(nls_8)
```

```
Formula: IER ~ A * Dry.weight..mg.^B

Parameters:
  Estimate Std. Error t value Pr(>|t|)
A  14.3955     3.8196   3.769 0.000588 ***
B   0.7569     0.1657   4.569 5.56e-05 ***
---
```

```
Signif. codes:   0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.725 on 36 degrees of freedom

Number of iterations to convergence: 5
Achieved convergence tolerance: 4.534e-06
  (4 observations deleted due to missingness)
```
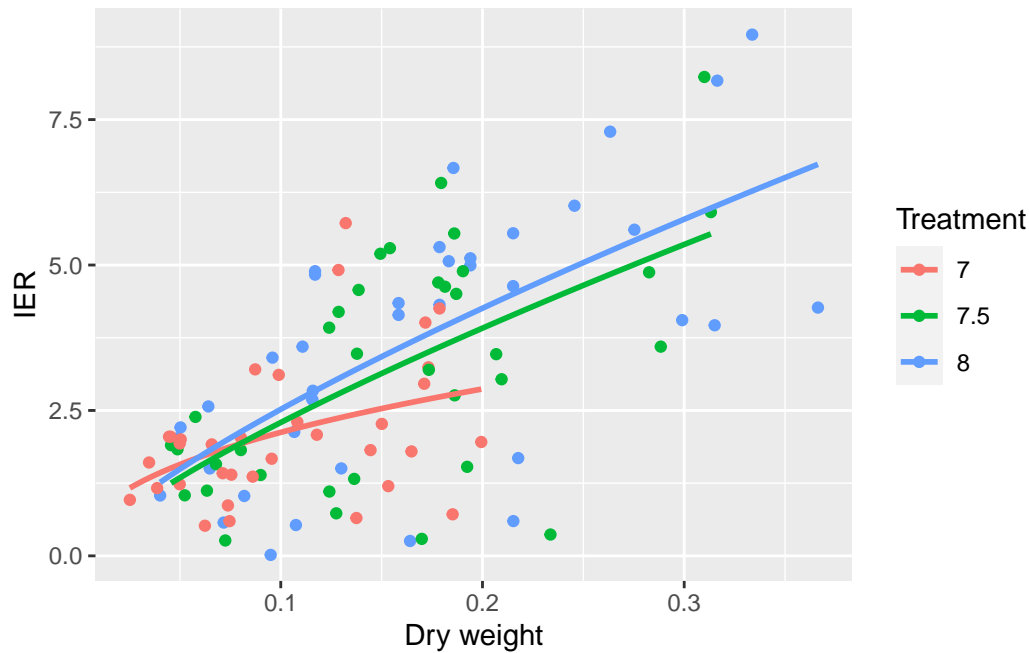
```
summary(nls_7.5)
```

```
Formula: IER ~ A * Dry.weight..mg.^B

Parameters:
  Estimate Std. Error t value Pr(>|t|)
A  13.5589     4.8227   2.812 0.008235 **
B   0.7718     0.2094   3.686 0.000812 ***
---
Signif. codes:   0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.638 on 33 degrees of freedom

Number of iterations to convergence: 5
Achieved convergence tolerance: 3.898e-06
```

```
summary(nls_7)
```

```
Formula: IER ~ A * Dry.weight..mg.^B

Parameters:
  Estimate Std. Error t value Pr(>|t|)
A   5.7753     2.4843   2.325   0.0266 *
B   0.4346     0.1934   2.247   0.0317 *
---
Signif. codes:   0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.147 on 32 degrees of freedom

Number of iterations to convergence: 5
Achieved convergence tolerance: 3.588e-06
  (1 observation deleted due to missingness)
```

```r
nls_all <- nls(IER ~ A * Dry.weight..mg.^B,
               start = list(A = 2.3, B = 0.72),
               data = bd_Pousse,
               na.action=na.exclude)
summary(nls_all)
```

```
Formula: IER ~ A * Dry.weight..mg.^B

Parameters:
  Estimate Std. Error t value Pr(>|t|)
A  14.1691     2.5090   5.647 1.40e-07 ***
B   0.7912     0.1026   7.709 7.55e-12 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.54 on 105 degrees of freedom

Number of iterations to convergence: 6
Achieved convergence tolerance: 2.999e-06
  (5 observations deleted due to missingness)
```

```r
gg1 <- ggplot(data = bd_Pousse, aes(x=Dry.weight..mg., y=ORR, color = Treatment))+
  geom_point()+
  xlab("Dry weight") +
  ylab("ORR")+
  #ylim(0,9)+
  #scale_color_discrete(name="Site")+
  #ggtitle ('ORR as a function of DW')+
  stat_smooth(
    method = 'nls',
    formula = y ~ A * x^B,
    method.args = list(start = c(A = 2.3, B = 0.72)),
    se = FALSE
  )#stat_smooth(color = 1, method = 'nls', formula = 'y~a*exp(b*x)',
   #            method.args = list(start=c(A = 2.3, B=.72)), se=FALSE) +
  facet_wrap(~ Treatment)
```

```
<ggproto object: Class FacetWrap, Facet, gg>
    compute_layout: function
    draw_back: function
```

```
draw_front: function
draw_labels: function
draw_panels: function
finish_data: function
init_scales: function
map_data: function
params: list
setup_data: function
setup_params: function
shrink: TRUE
train_scales: function
vars: function
super:  <ggproto object: Class FacetWrap, Facet, gg>
```

gg1

Warning: Removed 4 rows containing non-finite values (`stat_smooth()`).

Warning: Removed 4 rows containing missing values (`geom_point()`).

```
nls_8 <- nls(ORR ~ A * Dry.weight..mg.^B,
             start = list(A = 2.3, B = 0.72),
             data = bd_Pousse[bd_Pousse$Treatment=="8",],
             na.action=na.exclude)
nls_7.5 <- nls(ORR ~ A * Dry.weight..mg.^B,
             start = list(A = 2.3, B = 0.72),
             data = bd_Pousse[bd_Pousse$Treatment=="7.5",],
             na.action=na.exclude)
nls_7 <- nls(ORR ~ A * Dry.weight..mg.^B,
             start = list(A = 2.3, B = 0.72),
             data = bd_Pousse[bd_Pousse$Treatment=="7",],
             na.action=na.exclude)
summary(nls_8)
```

```
Formula: ORR ~ A * Dry.weight..mg.^B

Parameters:
  Estimate Std. Error t value Pr(>|t|)
A  0.32548    0.09497   3.427  0.00151 **
B -0.03923    0.14204  -0.276  0.78395
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.1798 on 37 degrees of freedom

Number of iterations to convergence: 6
Achieved convergence tolerance: 7.096e-06
  (3 observations deleted due to missingness)
```

```
summary(nls_7.5)
```

```
Formula: ORR ~ A * Dry.weight..mg.^B

Parameters:
  Estimate Std. Error t value Pr(>|t|)
A   0.4011     0.1433   2.798  0.00852 **
B   0.1297     0.1806   0.718  0.47785
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
Residual standard error: 0.1692 on 33 degrees of freedom

Number of iterations to convergence: 10
Achieved convergence tolerance: 3.312e-06
```

summary(nls_7)

```
Formula: ORR ~ A * Dry.weight..mg.^B

Parameters:
  Estimate Std. Error t value Pr(>|t|)
A  0.15264    0.08087   1.888   0.0682 .
B -0.24997    0.20202  -1.237   0.2250
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.19 on 32 degrees of freedom

Number of iterations to convergence: 11
Achieved convergence tolerance: 2.023e-06
  (1 observation deleted due to missingness)
```

```r
nls_all <- nls(ORR ~ A * Dry.weight..mg.^B,
               start = list(A = 2.3, B = 0.72),
               data = bd_Pousse,
               na.action=na.exclude)
summary(nls_all)
```

```
Formula: ORR ~ A * Dry.weight..mg.^B

Parameters:
   Estimate Std. Error t value Pr(>|t|)
A  0.315202   0.064442   4.891 3.59e-06 ***
B -0.001062   0.093649  -0.011    0.991
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.181 on 106 degrees of freedom
```

```
Number of iterations to convergence: 7
Achieved convergence tolerance: 2.754e-06
  (4 observations deleted due to missingness)
```

```r
gg1 <- ggplot(data = bd_Pousse, aes(x=Dry.weight..mg., y=IRR, color = Treatment))+
  geom_point()+
  xlab("Dry weight") +
  ylab("IRR")+
  #ylim(0,9)+
  #scale_color_discrete(name="Site")+
  #ggtitle ('IRR as a function of DW')+
  stat_smooth(
    method = 'nls',
    formula = y ~ A * x^B,
    method.args = list(start = c(A = 2.3, B = 0.72)),
    se = FALSE
  )#stat_smooth(color = 1, method = 'nls', formula = 'y~a*exp(b*x)',
    #            method.args = list(start=c(A = 2.3, B=.72)), se=FALSE) +
  facet_wrap(~ Treatment)
```

```
<ggproto object: Class FacetWrap, Facet, gg>
    compute_layout: function
    draw_back: function
    draw_front: function
    draw_labels: function
    draw_panels: function
    finish_data: function
    init_scales: function
    map_data: function
    params: list
    setup_data: function
    setup_params: function
    shrink: TRUE
    train_scales: function
    vars: function
    super:  <ggproto object: Class FacetWrap, Facet, gg>
```

```r
gg1
```

```
Warning: Removed 4 rows containing non-finite values (`stat_smooth()`).
```

```
Warning: Removed 4 rows containing missing values (`geom_point()`).
```



```r
nls_8 <- nls(IRR ~ A * Dry.weight..mg.^B,
             start = list(A = 2.3, B = 0.72),
             data = bd_Pousse[bd_Pousse$Treatment=="8",],
             na.action=na.exclude)
nls_7.5 <- nls(IRR ~ A * Dry.weight..mg.^B,
             start = list(A = 2.3, B = 0.72),
             data = bd_Pousse[bd_Pousse$Treatment=="7.5",],
             na.action=na.exclude)
nls_7 <- nls(IRR ~ A * Dry.weight..mg.^B,
             start = list(A = 2.3, B = 0.72),
             data = bd_Pousse[bd_Pousse$Treatment=="7",],
             na.action=na.exclude)
summary(nls_8)
```

```
Formula: IRR ~ A * Dry.weight..mg.^B

Parameters:
  Estimate Std. Error t value Pr(>|t|)
A   1.4707     0.5196   2.830  0.00747 **
```

```
B  -0.0789    0.1698  -0.465  0.64489
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.058 on 37 degrees of freedom

Number of iterations to convergence: 9
Achieved convergence tolerance: 3.173e-06
  (3 observations deleted due to missingness)
```
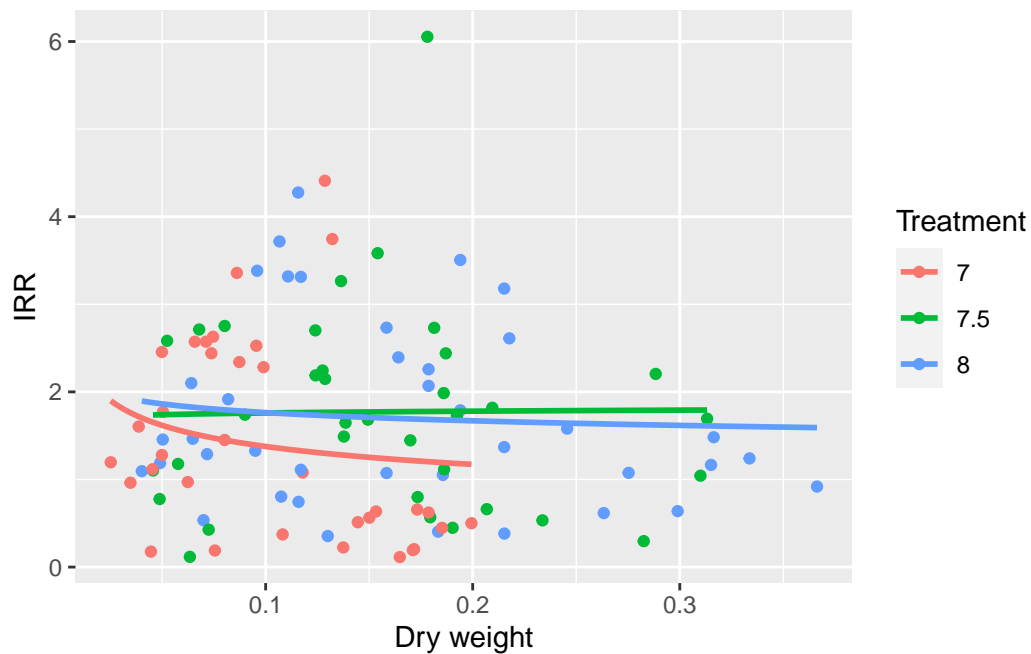
summary(nls_7.5)

```
Formula: IRR ~ A * Dry.weight..mg.^B

Parameters:
  Estimate Std. Error t value Pr(>|t|)
A   1.8275     0.7976   2.291   0.0285 *
B   0.0165     0.2137   0.077   0.9389
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.18 on 33 degrees of freedom

Number of iterations to convergence: 8
Achieved convergence tolerance: 5e-06
```

summary(nls_7)

```
Formula: IRR ~ A * Dry.weight..mg.^B

Parameters:
  Estimate Std. Error t value Pr(>|t|)
A   0.8056     0.5072   1.588    0.122
B  -0.2328     0.2411  -0.965    0.342

Residual standard error: 1.144 on 32 degrees of freedom

Number of iterations to convergence: 12
Achieved convergence tolerance: 5.953e-06
  (1 observation deleted due to missingness)
```

```
nls_all <- nls(IRR ~ A * Dry.weight..mg.^B,
               start = list(A = 2.3, B = 0.72),
               data = bd_Pousse,
               na.action=na.exclude)
summary(nls_all)
```

```
Formula: IRR ~ A * Dry.weight..mg.^B

Parameters:
   Estimate Std. Error t value Pr(>|t|)
A   1.4948     0.3667   4.076 8.88e-05 ***
B  -0.0437     0.1109  -0.394    0.694
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.122 on 106 degrees of freedom

Number of iterations to convergence: 8
Achieved convergence tolerance: 3.669e-06
  (4 observations deleted due to missingness)
```

```
fit1 <- nlme::gnls(OER~ A*Dry.weight..mg.^B,
           params = list(A~Treatment-1, B~1),
           data=bd_Pousse,
           na.action = na.exclude,
           start = list(A=c(1,1,1), B = .7 ))
summary(fit1)
```

```
Generalized nonlinear least squares fit
  Model: OER ~ A * Dry.weight..mg.^B
  Data: bd_Pousse
       AIC      BIC    logLik
  4.853311 18.21745 2.573345

Coefficients:
                  Value Std.Error  t-value p-value
A.Treatment7   1.7335946 0.3907440 4.436651       0
A.Treatment7.5 1.9105770 0.3384029 5.645864       0
A.Treatment8   2.0961135 0.3464099 6.050963       0
B              0.6633785 0.0960590 6.905949       0
```

```
Correlation:
              A.Trt7 A.T7.5 A.Trt8
A.Treatment7.5 0.811
A.Treatment8   0.825  0.852
B              0.886  0.915  0.931


Standardized residuals:
        Min           Q1          Med           Q3          Max
-2.57264637  -0.54686202   0.01601255   0.69985020   2.02837182


Residual standard error: 0.2407639
Degrees of freedom: 107 total; 103 residual
```

```r
fit2 <- nlme::gnls(OER~ A*Dry.weight..mg.^B,
          params = list(A~Treatment-1, B~Treatment-1),
          data=bd_Pousse,
          na.action = na.exclude,
          start = list(A=c(1,1,1), B = c(1,1,1) ))
summary(fit2)
```

```
Generalized nonlinear least squares fit
  Model: OER ~ A * Dry.weight..mg.^B
  Data: bd_Pousse
       AIC      BIC   logLik
  7.379111 26.08891 3.310444


Coefficients:
                   Value Std.Error  t-value p-value
A.Treatment7   1.0097516 0.4893917 2.063279  0.0417
A.Treatment7.5 1.9579171 0.5966757 3.281376  0.0014
A.Treatment8   2.3096866 0.5072903 4.552988  0.0000
B.Treatment7   0.4066719 0.2166225 1.877330  0.0634
B.Treatment7.5 0.6778915 0.1760267 3.851071  0.0002
B.Treatment8   0.7241743 0.1339397 5.406720  0.0000


 Correlation:
              A.Trt7 A.T7.5 A.Trt8 B.Trt7 B.T7.5
A.Treatment7.5 0.000
A.Treatment8   0.000  0.000
B.Treatment7   0.977  0.000  0.000
B.Treatment7.5 0.000  0.972  0.000  0.000
```

```
B.Treatment8    0.000   0.000   0.961   0.000   0.000


Standardized residuals:
        Min          Q1          Med          Q3          Max
-2.57536384 -0.50673800 -0.05415554   0.68404928   2.09119265


Residual standard error: 0.2414668
Degrees of freedom: 107 total; 101 residual
```

```r
fit3 <- nlme::gnls(OER~ A*Dry.weight..mg.^B,
          params = list(A~1, B~1),
          data=bd_Pousse,
          na.action = na.exclude,
          start = list(A=1, B = .7 ))
summary(fit3)
```

```
Generalized nonlinear least squares fit
  Model: OER ~ A * Dry.weight..mg.^B
  Data: bd_Pousse
       AIC       BIC    logLik
  3.487331 11.50582 1.256334


Coefficients:
      Value Std.Error  t-value p-value
A 2.1244875 0.3438641 6.178276       0
B 0.7121494 0.0912972 7.800344       0


 Correlation:
  A
B 0.965


Standardized residuals:
        Min          Q1          Med          Q3          Max
-2.67390205 -0.53146579 -0.02817086   0.67123866   2.20523656


Residual standard error: 0.2414131
Degrees of freedom: 107 total; 105 residual
```

```r
AIC(fit1,fit2,fit3)
```

```
    df       AIC
```

```
fit1  5 4.853311
fit2  7 7.379111
fit3  3 3.487331
```

```
BIC(fit1,fit2,fit3)
```

```
      df      BIC
fit1  5 18.21745
fit2  7 26.08891
fit3  3 11.50582
```

```
fit_OER_treat <- nlme(OER~ A*Dry.weight..mg.^B,
          fixed = A + B ~ 1,
          random = A ~ 1|Treatment,
          data=bd_Pousse,
          na.action = na.exclude,
          start = c(A=1, B = .7 ))

fit_OER_month <- nlme(OER~ A*Dry.weight..mg.^B,
          fixed = A + B ~ 1,
          random = A ~ 1|Month,
          data=bd_Pousse,
          na.action = na.exclude,
          start = c(A=1, B = .7 ))

fit_OER_crossed <- nlme(OER~ A*Dry.weight..mg.^B,
          fixed = A + B ~ 1,
          random = list(Treatment=(A+B~1),Month=(A~1)),
          data=bd_Pousse,
          na.action = na.exclude,
          start = c(A=1, B = .7 ))

summary(fit_OER_treat)
```

```
Nonlinear mixed-effects model fit by maximum likelihood
  Model: OER ~ A * Dry.weight..mg.^B
  Data: bd_Pousse
       AIC      BIC   logLik
  5.487331 16.17865 1.256334

Random effects:
```

```
 Formula: A ~ 1 | Treatment
                    A  Residual
StdDev: 2.939036e-05 0.2391463

Fixed effects:  A + B ~ 1
      Value Std.Error  DF  t-value p-value
A 2.1244875 0.3438642 103 6.178276       0
B 0.7121494 0.0912972 103 7.800344       0
 Correlation:
  A
B 0.965

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-2.6992477 -0.5365035 -0.0284379  0.6776013  2.2261397

Number of Observations: 107
Number of Groups: 3
```

```
summary(fit_OER_month)
```

```
Nonlinear mixed-effects model fit by maximum likelihood
  Model: OER ~ A * Dry.weight..mg.^B
  Data: bd_Pousse
        AIC       BIC  logLik
  -10.21828 0.4730363 9.10914

Random effects:
 Formula: A ~ 1 | Month
                A  Residual
StdDev: 0.4298785 0.2139649

Fixed effects:  A + B ~ 1
      Value Std.Error  DF  t-value p-value
A 2.3583317 0.5052313 101 4.667826       0
B 0.7689894 0.1024072 101 7.509137       0
 Correlation:
  A
B 0.899

Standardized Within-Group Residuals:
        Min         Q1        Med         Q3        Max
```

```
-3.33824715 -0.54182672  0.07714807  0.65787227  2.03575835


Number of Observations: 107
Number of Groups: 5
```

```
Nonlinear mixed-effects model fit by maximum likelihood
  Model: OER ~ A * Dry.weight..mg.^B
  Data: bd_Pousse
        AIC      BIC    logLik
   1.333443 20.04324 6.333279


Random effects:
 Formula: list(A ~ 1, B ~ 1)
 Level: Treatment
 Structure: General positive-definite, Log-Cholesky parametrization
  StdDev       Corr
A 1.904067e-05 A
B 1.916928e-08 0


 Formula: A ~ 1 | Month %in% Treatment
                A  Residual
StdDev: 0.3330295 0.2102274


Fixed effects:  A + B ~ 1
      Value Std.Error DF  t-value p-value
A 1.4383438 0.3197207 91 4.498750        0
B 0.5142906 0.1077050 91 4.774993        0
 Correlation:
  A
B 0.943


Standardized Within-Group Residuals:
        Min         Q1        Med         Q3        Max
-2.85392669 -0.54127778  0.01701554  0.59453380  2.20672688


Number of Observations: 107
Number of Groups:
          Treatment Month %in% Treatment
                  3                   15
```

```
fit_OER_crossed <- nlme(OER~ A*Dry.weight..mg.^B,
          fixed = A + B ~ 1,
          random = list(Treatment=(A+B~1),Month=(A~1)),
          data=bd_Pousse,
          na.action = na.exclude,
          start = c(A=1, B = .7 ))
fit_IER_crossed <- nlme(IER~ A*Dry.weight..mg.^B,
          fixed = A + B ~ 1,
          random = list(Treatment=(A+B~1),Month=(A~1)),
          data=bd_Pousse,
          na.action = na.exclude,
          start = c(A=1, B = .7 ))
fit_ORR_crossed <- nlme(ORR~ A*Dry.weight..mg.^B,
          fixed = A + B ~ 1,
          random = list(Treatment=(A~1)), #Removed random effect of month bc would not conve
          data=bd_Pousse,
          na.action = na.exclude,
          start = c(A=1, B = .7 ))
fit_IRR_crossed <- nlme(IRR~ A*Dry.weight..mg.^B,
          fixed = A + B ~ 1,
          random = list(Treatment=(A+B~1),Month=(A~1)),
          data=bd_Pousse,
          na.action = na.exclude,
          start = c(A=1, B = .7 ))

summary(fit_OER_crossed)
```

```
Nonlinear mixed-effects model fit by maximum likelihood
  Model: OER ~ A * Dry.weight..mg.^B
  Data: bd_Pousse
       AIC      BIC    logLik
  1.333443 20.04324 6.333279

Random effects:
 Formula: list(A ~ 1, B ~ 1)
 Level: Treatment
 Structure: General positive-definite, Log-Cholesky parametrization
  StdDev       Corr
A 1.904067e-05 A
B 1.916928e-08 0

 Formula: A ~ 1 | Month %in% Treatment
```

```
                  A   Residual
StdDev: 0.3330295 0.2102274


Fixed effects:   A + B ~ 1
       Value Std.Error DF  t-value p-value
A 1.4383438 0.3197207 91 4.498750       0
B 0.5142906 0.1077050 91 4.774993       0
 Correlation:
   A
B 0.943


Standardized Within-Group Residuals:
        Min          Q1          Med          Q3          Max
-2.85392669 -0.54127778   0.01701554   0.59453380   2.20672688


Number of Observations: 107
Number of Groups:
           Treatment Month %in% Treatment
                   3                    15
```

```
Nonlinear mixed-effects model fit by maximum likelihood
  Model: IER ~ A * Dry.weight..mg.^B
  Data: bd_Pousse
       AIC      BIC     logLik
  399.8229 418.5327 -192.9114


Random effects:
 Formula: list(A ~ 1, B ~ 1)
 Level: Treatment
 Structure: General positive-definite, Log-Cholesky parametrization
  StdDev        Corr
A 2.486702e-04 A
B 2.244356e-07 0


 Formula: A ~ 1 | Month %in% Treatment
               A Residual
StdDev: 2.252674 1.375624


Fixed effects:   A + B ~ 1
       Value Std.Error DF  t-value p-value
```

```
A 10.459513 2.3585562 91 4.434710        0
B  0.631461 0.1125008 91 5.612946        0
 Correlation:
   A
B 0.944

Standardized Within-Group Residuals:
        Min            Q1           Med            Q3           Max
-2.836393322 -0.472751163 -0.004826624   0.539504100   2.275859320

Number of Observations: 107
Number of Groups:
          Treatment Month %in% Treatment
                3                     15
```

```
summary(fit_ORR_crossed)
```

```
Nonlinear mixed-effects model fit by maximum likelihood
  Model: ORR ~ A * Dry.weight..mg.^B
  Data: bd_Pousse
      AIC       BIC  logLik
  -56.755 -46.02648 32.3775

Random effects:
 Formula: A ~ 1 | Treatment
                 A  Residual
StdDev: 0.000644228 0.1792925

Fixed effects:  A + B ~ 1
        Value  Std.Error  DF   t-value p-value
A   0.31522344 0.06445193 104   4.890830  0.0000
B -0.00102379 0.09365732 104 -0.010931  0.9913
 Correlation:
   A
B 0.963

Standardized Within-Group Residuals:
       Min            Q1           Med           Q3          Max
-1.4624874 -0.8394831 -0.2115732   0.4595231   3.2956680

Number of Observations: 108
Number of Groups: 3
```

```
summary(fit_IRR_crossed)
```

```
Nonlinear mixed-effects model fit by maximum likelihood
  Model: IRR ~ A * Dry.weight..mg.^B
  Data: bd_Pousse
        AIC      BIC     logLik
   343.3118 362.0868 -164.6559

Random effects:
 Formula: list(A ~ 1, B ~ 1)
 Level: Treatment
 Structure: General positive-definite, Log-Cholesky parametrization
  StdDev        Corr
A 3.134309e-04 A
B 3.966123e-05 0.001

 Formula: A ~ 1 | Month %in% Treatment
                  A Residual
StdDev: 8.081668e-05 1.111436

Fixed effects:  A + B ~ 1
      Value Std.Error DF   t-value p-value
A  1.496221 0.3670782 92  4.076028  0.0001
B -0.043238 0.1108656 92 -0.390004  0.6974
 Correlation:
  A
B 0.963

Standardized Within-Group Residuals:
       Min        Q1       Med        Q3       Max
-1.4117544 -0.8373900 -0.2023488 0.6797753 3.9965273

Number of Observations: 108
Number of Groups:
          Treatment Month %in% Treatment
                  3                    15
```

```
fit1 <- nlme::gnls(OER~ A*(Length..mm./10)^B,
          params = list(A~Treatment-1, B~1),
          data=bd_Pousse,
          na.action = na.exclude,
```

```
            start = list(A=c(1,1,1), B = .3 ))
summary(fit1)
```

```
Generalized nonlinear least squares fit
  Model: OER ~ A * (Length..mm./10)^B
  Data: bd_Pousse
       AIC      BIC    logLik
  5.582898 18.94704 2.208551

Coefficients:
                  Value  Std.Error  t-value p-value
A.Treatment7   0.0973070 0.02380870 4.087037    1e-04
A.Treatment7.5 0.1029169 0.02855707 3.603904    5e-04
A.Treatment8   0.1111913 0.03149990 3.529893    6e-04
B              1.8344623 0.27164763 6.753095    0e+00

 Correlation:
                A.Trt7 A.T7.5 A.Trt8
A.Treatment7.5  0.871
A.Treatment8    0.881  0.944
B              -0.901 -0.966 -0.977

Standardized residuals:
        Min          Q1         Med          Q3         Max
-2.40806503 -0.53830392 -0.00303497  0.70306688  1.99271682

Residual standard error: 0.2415861
Degrees of freedom: 107 total; 103 residual
```

```
fit2 <- nlme::gnls(OER~ A*(Length..mm./10)^B,
          params = list(A~Treatment-1, B~Treatment-1),
          data=bd_Pousse,
          na.action = na.exclude,
          start = list(A=c(1,1,1), B = c(.3,.3,.3) ))
summary(fit2)
```

```
Generalized nonlinear least squares fit
  Model: OER ~ A * (Length..mm./10)^B
  Data: bd_Pousse
       AIC      BIC    logLik
  6.687948 25.39775 3.656026
```

```
Coefficients:
                Value Std.Error  t-value p-value
A.Treatment7    0.2036831 0.0922850 2.207110  0.0296
A.Treatment7.5 0.1114925 0.0500520 2.227535  0.0281
A.Treatment8    0.0787001 0.0334569 2.352281  0.0206
B.Treatment7    0.9107550 0.5793866 1.571930  0.1191
B.Treatment7.5 1.7532733 0.4509770 3.887722  0.0002
B.Treatment8    2.1723459 0.4068003 5.340079  0.0000

 Correlation:
               A.Trt7 A.T7.5 A.Trt8 B.Trt7 B.T7.5
A.Treatment7.5  0.000
A.Treatment8    0.000  0.000
B.Treatment7   -0.973  0.000  0.000
B.Treatment7.5  0.000 -0.987  0.000  0.000
B.Treatment8    0.000  0.000 -0.990  0.000  0.000

Standardized residuals:
       Min          Q1         Med          Q3         Max
-2.40495512 -0.51428075  0.01691518  0.70238271  2.02514620

Residual standard error: 0.2406882
Degrees of freedom: 107 total; 101 residual
```

```r
fit3 <- nlme::gnls(OER~ A*(Length..mm./10)^B,
          params = list(A~1, B~1),
          data=bd_Pousse,
          na.action = na.exclude,
          start = list(A=1, B = .3 ))
summary(fit3)
```

```
Generalized nonlinear least squares fit
  Model: OER ~ A * (Length..mm./10)^B
  Data: bd_Pousse
       AIC      BIC    logLik
  2.943235 10.96172 1.528382

Coefficients:
      Value  Std.Error  t-value p-value
A 0.0956827 0.02339266 4.090289    1e-04
B 1.9355590 0.24718721 7.830336    0e+00
```

```
 Correlation:
   A
B -0.985

Standardized residuals:
        Min           Q1          Med           Q3          Max
-2.50929987 -0.50686280 -0.01971863  0.66995680  2.11967734

Residual standard error: 0.2408001
Degrees of freedom: 107 total; 105 residual
```

AIC(fit1,fit2,fit3)

```
     df      AIC
fit1  5 5.582898
fit2  7 6.687948
fit3  3 2.943235
```

BIC(fit1,fit2,fit3)

```
     df      BIC
fit1  5 18.94704
fit2  7 25.39775
fit3  3 10.96172
```

```
gg1 <- ggplot(data = bd_Pousse, aes(x=Length..mm./10, y=OER, color = Treatment))+
  geom_point()+
  #xlab("Dry weight") +
  #ylab("ORR")+
  #ylim(0,9)+
  #scale_color_discrete(name="Site")+
  #ggtitle ('ORR as a function of DW')+
  stat_smooth(
    method = 'nls',
    formula = y ~ A * x^B,
    method.args = list(start = c(A = 2.3, B = 2)),
    se = FALSE
  )
#+
  #facet_wrap(~ Treatment)
```

```
gg1
```

Warning: Removed 5 rows containing non-finite values (`stat_smooth()`).

Warning: Removed 5 rows containing missing values (`geom_point()`).
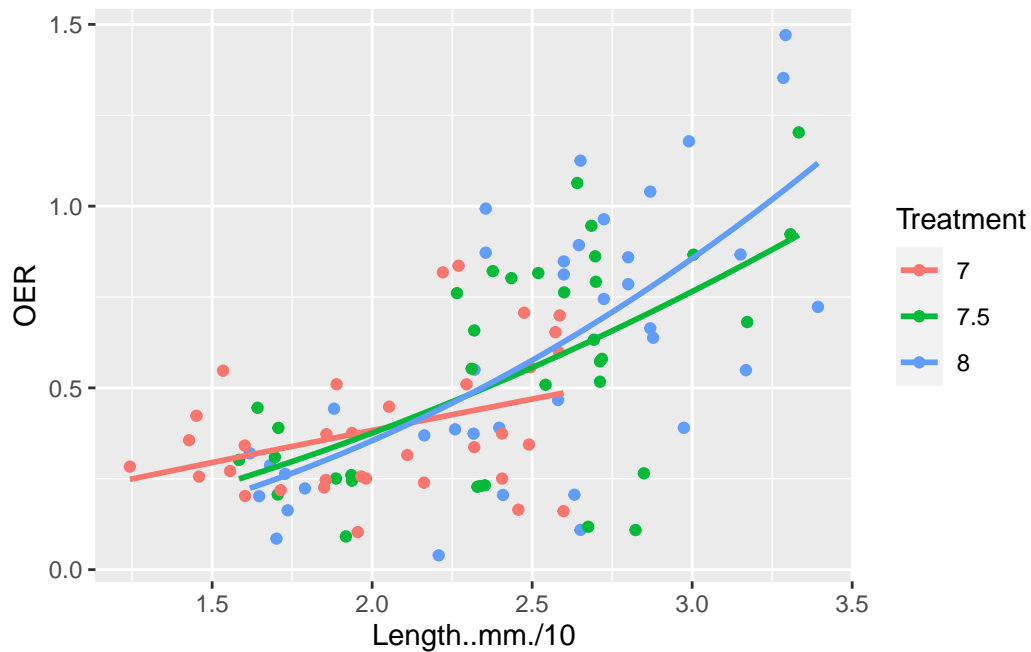

```
fit1 <- nlme::gnls(IER~ A*(Length..mm./10)^B,
          params = list(A~Treatment-1, B~1),
          data=bd_Pousse,
          na.action = na.exclude,
          start = list(A=c(1,1,1), B = .3 ))
summary(fit1)
```

```
Generalized nonlinear least squares fit
  Model: IER ~ A * (Length..mm./10)^B
  Data: bd_Pousse
       AIC      BIC    logLik
  401.1693 414.5334 -195.5846

Coefficients:
```

```
                 Value Std.Error  t-value p-value
A.Treatment7    0.4572221 0.1279428 3.573646  0.0005
A.Treatment7.5 0.5181582 0.1623990 3.190649  0.0019
A.Treatment8   0.5547207 0.1788415 3.101745  0.0025
B              1.9990503 0.3054852 6.543852  0.0000

 Correlation:
              A.Trt7 A.T7.5 A.Trt8
A.Treatment7.5  0.867
A.Treatment8    0.877  0.951
B              -0.894 -0.970 -0.981

Standardized residuals:
      Min         Q1        Med        Q3        Max
-2.4498758 -0.5468184  0.1328319  0.6152599  2.2597997

Residual standard error: 1.534194
Degrees of freedom: 107 total; 103 residual
```

```r
fit2 <- nlme::gnls(IER~ A*(Length..mm./10)^B,
          params = list(A~Treatment-1, B~Treatment-1),
          data=bd_Pousse,
          na.action = na.exclude,
          start = list(A=c(1,1,1), B = c(.3,.3,.3) ))
summary(fit2)
```

```
Generalized nonlinear least squares fit
  Model: IER ~ A * (Length..mm./10)^B
  Data: bd_Pousse
     AIC      BIC   logLik
  403.072 421.7818 -194.536

Coefficients:
                 Value Std.Error  t-value p-value
A.Treatment7    1.0039269 0.5537211 1.813055  0.0728
A.Treatment7.5 0.5054045 0.2563311 1.971686  0.0514
A.Treatment8   0.4206189 0.2003098 2.099842  0.0382
B.Treatment7   1.0260338 0.6996277 1.466542  0.1456
B.Treatment7.5 2.0240970 0.5034159 4.020725  0.0001
B.Treatment8   2.2657591 0.4513386 5.020087  0.0000

 Correlation:
```

```
               A.Trt7 A.T7.5 A.Trt8 B.Trt7 B.T7.5
A.Treatment7.5   0.000
A.Treatment8     0.000   0.000
B.Treatment7    -0.975   0.000   0.000
B.Treatment7.5   0.000  -0.988   0.000   0.000
B.Treatment8     0.000   0.000  -0.991   0.000   0.000


Standardized residuals:
        Min          Q1         Med          Q3          Max
-2.45275038 -0.49878689   0.06754884   0.57154993   2.24491008

Residual standard error: 1.5342
Degrees of freedom: 107 total; 101 residual
```

```r
fit3 <- nlme::gnls(IER~ A*(Length..mm./10)^B,
        params = list(A~1, B~1),
        data=bd_Pousse,
        na.action = na.exclude,
        start = list(A=1, B = .3 ))
summary(fit3)
```

```
Generalized nonlinear least squares fit
  Model: IER ~ A * (Length..mm./10)^B
  Data: bd_Pousse
       AIC      BIC    logLik
  399.0157 407.0342 -196.5079


Coefficients:
     Value Std.Error  t-value p-value
A 0.443513 0.1241451 3.572538    5e-04
B 2.169206 0.2784169 7.791214    0e+00


 Correlation:
   A
B -0.987


Standardized residuals:
       Min         Q1         Med         Q3         Max
-2.5095101 -0.5885213   0.1244992   0.5942316   2.0986938

Residual standard error: 1.53268
Degrees of freedom: 107 total; 105 residual
```

```
AIC(fit1,fit2,fit3)
```

```
      df      AIC
fit1  5 401.1693
fit2  7 403.0720
fit3  3 399.0157
```

```
BIC(fit1,fit2,fit3)
```

```
      df      BIC
fit1  5 414.5334
fit2  7 421.7818
fit3  3 407.0342
```

```r
gg1 <- ggplot(data = bd_Pousse, aes(x=Length..mm./10, y=IER, color = Treatment))+
  geom_point()+
  #xlab("Dry weight") +
  #ylab("ORR")+
  #ylim(0,9)+
  #scale_color_discrete(name="Site")+
  #ggtitle ('ORR as a function of DW')+
  stat_smooth(
    method = 'nls',
    formula = y ~ A * x^B,
    method.args = list(start = c(A = 2.3, B = 2)),
    se = FALSE
  )
#+
  #facet_wrap(~ Treatment)

gg1
```

Warning: Removed 5 rows containing non-finite values (`stat_smooth()`).

Warning: Removed 5 rows containing missing values (`geom_point()`).
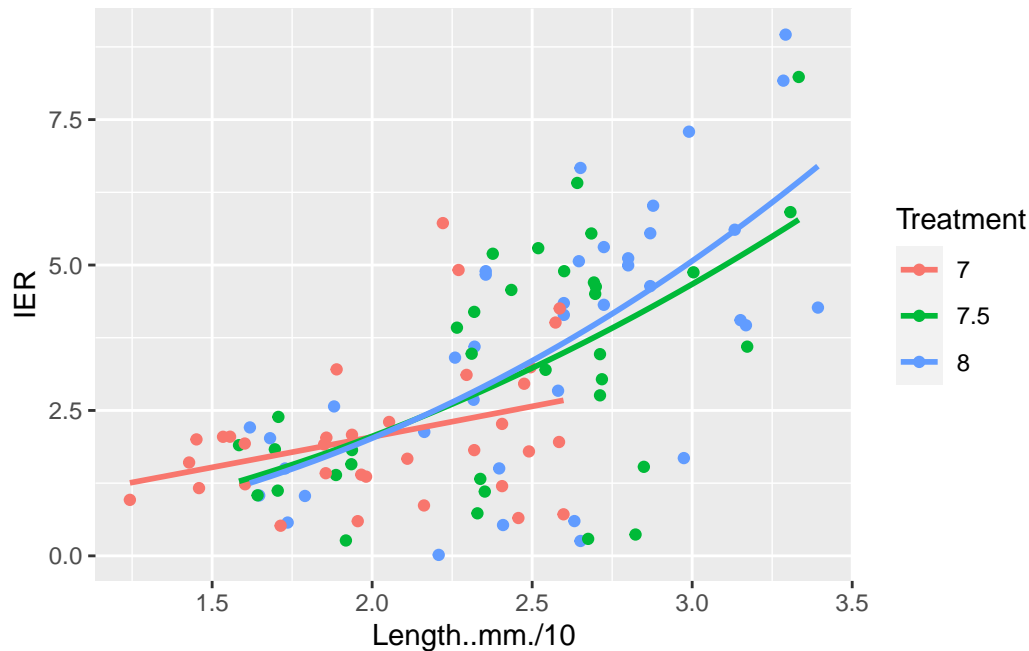
```r
fit1 <- nlme::gnls(ORR~ A*(Length..mm./10)^B,
           params = list(A~Treatment-1, B~1),
           data=bd_Pousse,
           na.action = na.exclude,
           start = list(A=c(1,1,1), B = .3 ))
summary(fit1)
```

```
Generalized nonlinear least squares fit
  Model: ORR ~ A * (Length..mm./10)^B
  Data: bd_Pousse
       AIC       BIC    logLik
 -57.68407 -44.27341 33.84203

Coefficients:
                   Value  Std.Error  t-value p-value
A.Treatment7   0.2752024 0.05910500 4.656161  0.0000
A.Treatment7.5 0.3038002 0.07622111 3.985776  0.0001
A.Treatment8   0.3431002 0.08671211 3.956774  0.0001
B              0.0265632 0.26502546 0.100229  0.9204

 Correlation:
               A.Trt7 A.T7.5 A.Trt8
```

```
A.Treatment7.5  0.790
A.Treatment8     0.812  0.871
B               -0.858 -0.921 -0.946


Standardized residuals:
       Min          Q1         Med          Q3         Max
-1.5971008 -0.7673370 -0.1998771  0.4506859  3.2997067

Residual standard error: 0.1802482
Degrees of freedom: 108 total; 104 residual
```

```r
fit2 <- nlme::gnls(ORR~ A*(Length..mm./10)^B,
          params = list(A~Treatment-1, B~Treatment-1),
          data=bd_Pousse,
          na.action = na.exclude,
          start = list(A=c(1,1,1), B = c(.3,.3,.3) ))
summary(fit2)
```

```
Generalized nonlinear least squares fit
  Model: ORR ~ A * (Length..mm./10)^B
  Data: bd_Pousse
       AIC       BIC    logLik
  -56.13407 -37.35915 35.06704


Coefficients:
                   Value Std.Error    t-value p-value
A.Treatment7    0.4116627 0.1433324  2.8720841  0.0050
A.Treatment7.5  0.2086449 0.0988228  2.1113028  0.0372
A.Treatment8    0.3288236 0.1188672  2.7663114  0.0067
B.Treatment7   -0.5612090 0.5131991 -1.0935501  0.2767
B.Treatment7.5  0.4543274 0.5127255  0.8861026  0.3776
B.Treatment8    0.0736379 0.3885703  0.1895098  0.8501


 Correlation:
               A.Trt7 A.T7.5 A.Trt8 B.Trt7 B.T7.5
A.Treatment7.5  0.000
A.Treatment8    0.000  0.000
B.Treatment7   -0.950  0.000  0.000
B.Treatment7.5  0.000 -0.979  0.000  0.000
B.Treatment8    0.000  0.000 -0.974  0.000  0.000


Standardized residuals:
```

```
      Min         Q1        Med         Q3        Max
-1.5975417 -0.6982954 -0.3194695   0.4782606  3.2198221


Residual standard error: 0.179954
Degrees of freedom: 108 total; 102 residual
```

```r
fit3 <- nlme::gnls(ORR~ A*(Length..mm./10)^B,
          params = list(A~1, B~1),
          data=bd_Pousse,
          na.action = na.exclude,
          start = list(A=1, B = .3 ))
summary(fit3)
```

```
Generalized nonlinear least squares fit
  Model: ORR ~ A * (Length..mm./10)^B
  Data: bd_Pousse
        AIC       BIC    logLik
  -59.13845 -51.09205 32.56922


Coefficients:
      Value  Std.Error  t-value p-value
A 0.2795575 0.06026682 4.638664  0.0000
B 0.1475814 0.24830764 0.594349  0.5535


 Correlation:
   A
B -0.967


Standardized residuals:
       Min         Q1        Med         Q3        Max
-1.4112834 -0.8284690 -0.1847145   0.4589861  3.2276697


Residual standard error: 0.1806562
Degrees of freedom: 108 total; 106 residual
```

```r
AIC(fit1,fit2,fit3)
```

```
     df       AIC
fit1  5 -57.68407
fit2  7 -56.13407
fit3  3 -59.13845
```

```
BIC(fit1,fit2,fit3)
```

```
        df      BIC
fit1    5 -44.27341
fit2    7 -37.35915
fit3    3 -51.09205
```

```
gg1 <- ggplot(data = bd_Pousse, aes(x=Length..mm./10, y=ORR, color = Treatment))+
  geom_point()+
  #xlab("Dry weight") +
  #ylab("ORR")+
  #ylim(0,9)+
  #scale_color_discrete(name="Site")+
  #ggtitle ('ORR as a function of DW')+
  stat_smooth(
    method = 'nls',
    formula = y ~ A * x^B,
    method.args = list(start = c(A = 2.3, B = 2)),
    se = FALSE
  )
#+
  #facet_wrap(~ Treatment)

gg1
```

Warning: Removed 4 rows containing non-finite values (`stat_smooth()`).

Warning: Removed 4 rows containing missing values (`geom_point()`).
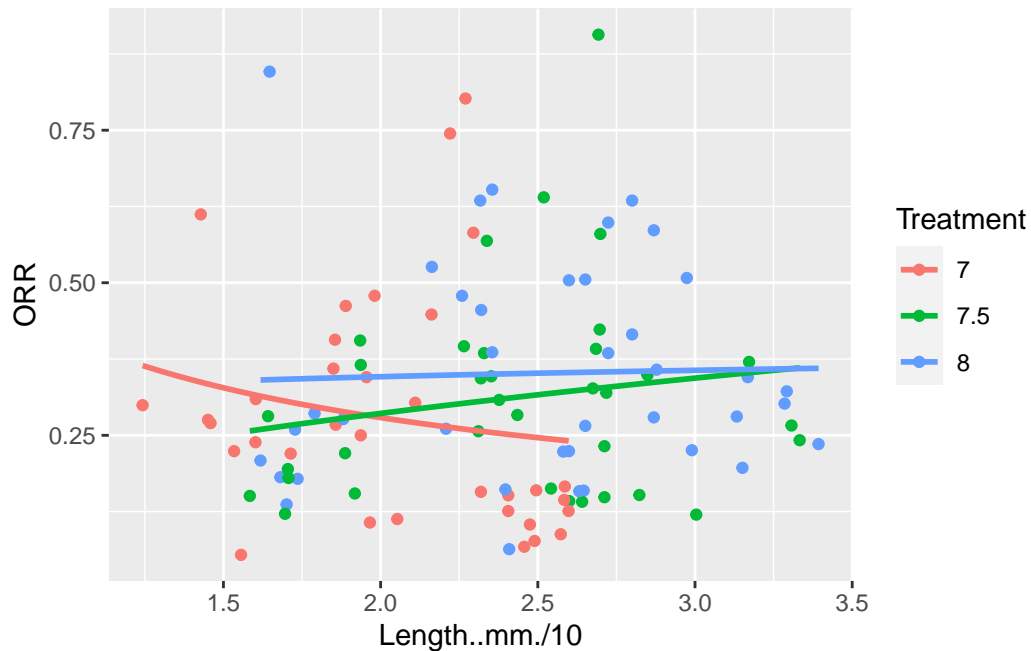
```
fit1 <- nlme::gnls(IRR~ A*(Length..mm./10)^B,
          params = list(A~Treatment-1, B~1),
          data=bd_Pousse,
          na.action = na.exclude,
          start = list(A=c(1,1,1), B = .3 ))
summary(fit1)
```

```
Generalized nonlinear least squares fit
  Model: IRR ~ A * (Length..mm./10)^B
  Data: bd_Pousse
       AIC      BIC    logLik
  337.2855 350.6962 -163.6428

Coefficients:
                  Value Std.Error    t-value p-value
A.Treatment7    1.5411751 0.3910295  3.941327  0.0001
A.Treatment7.5  1.9556583 0.5682653  3.441453  0.0008
A.Treatment8    1.9066430 0.5682767  3.355131  0.0011
B              -0.1175519 0.3140424 -0.374319  0.7089

 Correlation:
            A.Trt7 A.T7.5 A.Trt8
```

```
A.Treatment7.5  0.786
A.Treatment8     0.792  0.870
B               -0.846 -0.929 -0.936


Standardized residuals:
       Min          Q1         Med          Q3         Max
-1.5330178 -0.7479955 -0.2680821   0.6905940   3.8442038

Residual standard error: 1.122033
Degrees of freedom: 108 total; 104 residual
```

```r
fit2 <- nlme::gnls(IRR~ A*(Length..mm./10)^B,
          params = list(A~Treatment-1, B~Treatment-1),
          data=bd_Pousse,
          na.action = na.exclude,
          start = list(A=c(1,1,1), B = c(.3,.3,.3) ))
summary(fit2)
```

```
Generalized nonlinear least squares fit
  Model: IRR ~ A * (Length..mm./10)^B
  Data: bd_Pousse
       AIC      BIC    logLik
  340.4051 359.1801 -163.2026

Coefficients:
                    Value Std.Error    t-value p-value
A.Treatment7    2.0351779 0.8846866  2.3004506  0.0235
A.Treatment7.5  1.5443301 0.7633024  2.0232218  0.0457
A.Treatment8    1.8561279 0.8323219  2.2300600  0.0279
B.Treatment7   -0.5280379 0.6381486 -0.8274529  0.4099
B.Treatment7.5  0.1556260 0.5471325  0.2844394  0.7767
B.Treatment8   -0.0873537 0.4889758 -0.1786463  0.8586

 Correlation:
               A.Trt7 A.T7.5 A.Trt8 B.Trt7 B.T7.5
A.Treatment7.5  0.000
A.Treatment8    0.000  0.000
B.Treatment7   -0.950  0.000  0.000
B.Treatment7.5  0.000 -0.976  0.000  0.000
B.Treatment8    0.000  0.000 -0.972  0.000  0.000

Standardized residuals:
```

```
      Min         Q1        Med         Q3        Max
-1.3837406 -0.6710881 -0.2796251   0.7739305   3.7684779


Residual standard error: 1.128372
Degrees of freedom: 108 total; 102 residual
```

```r
fit3 <- nlme::gnls(IRR~ A*(Length..mm./10)^B,
          params = list(A~1, B~1),
          data=bd_Pousse,
          na.action = na.exclude,
          start = list(A=1, B = .3 ))
summary(fit3)
```

```
Generalized nonlinear least squares fit
  Model: IRR ~ A * (Length..mm./10)^B
  Data: bd_Pousse
       AIC      BIC    logLik
  335.4969 343.5433 -164.7484


Coefficients:
      Value Std.Error  t-value p-value
A 1.6248086 0.4080025 3.982350  0.0001
B 0.0105338 0.2934046 0.035902  0.9714


 Correlation:
   A
B -0.965


Standardized residuals:
       Min         Q1        Med         Q3        Max
-1.3592906 -0.8172054 -0.1691198   0.6802826   3.9294734


Residual standard error: 1.122834
Degrees of freedom: 108 total; 106 residual
```

```r
AIC(fit1,fit2,fit3)
```

```
     df      AIC
fit1  5 337.2855
fit2  7 340.4051
fit3  3 335.4969
```

```
BIC(fit1,fit2,fit3)
```

```
       df       BIC
fit1   5 350.6962
fit2   7 359.1801
fit3   3 343.5433
```

```
gg1 <- ggplot(data = bd_Pousse, aes(x=Length..mm./10, y=IRR, color = Treatment))+
  geom_point()+
  #xlab("Dry weight") +
  #ylab("ORR")+
  #ylim(0,9)+
  #scale_color_discrete(name="Site")+
  #ggtitle ('ORR as a function of DW')+
  stat_smooth(
    method = 'nls',
    formula = y ~ A * x^B,
    method.args = list(start = c(A = 2.3, B = 2)),
    se = FALSE
  )
#+
  #facet_wrap(~ Treatment)

gg1
```

Warning: Removed 4 rows containing non-finite values (`stat_smooth()`).

Warning: Removed 4 rows containing missing values (`geom_point()`).