

EAD-ASEB-Ssolidissima-OA

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1 index

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

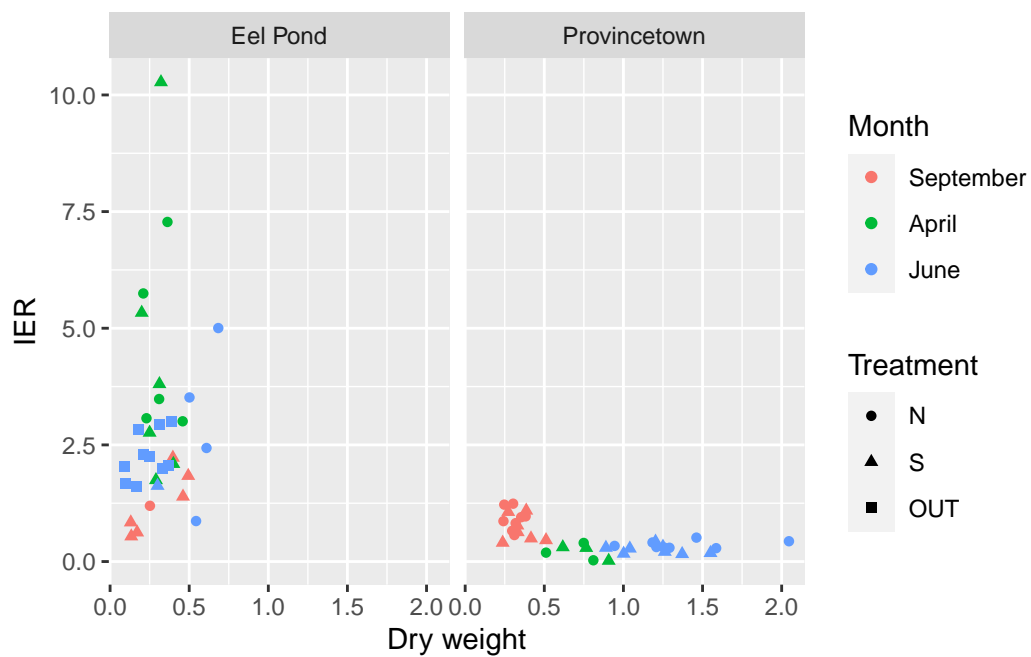
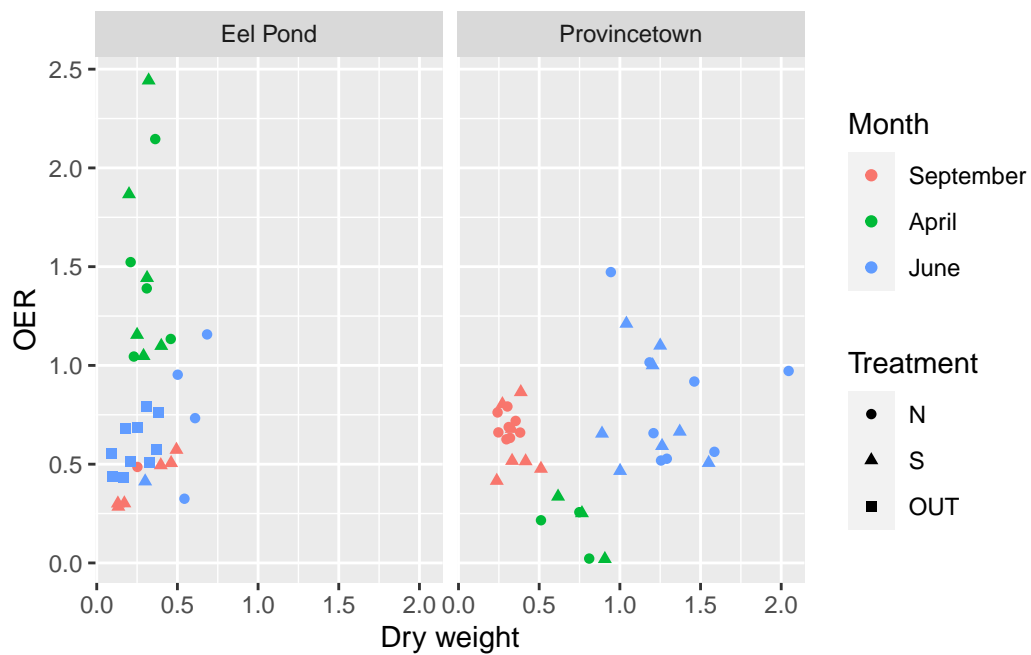
When you click the **Render** button a document will be generated that includes both content and the output of embedded code. You can embed code like this:

```
# 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



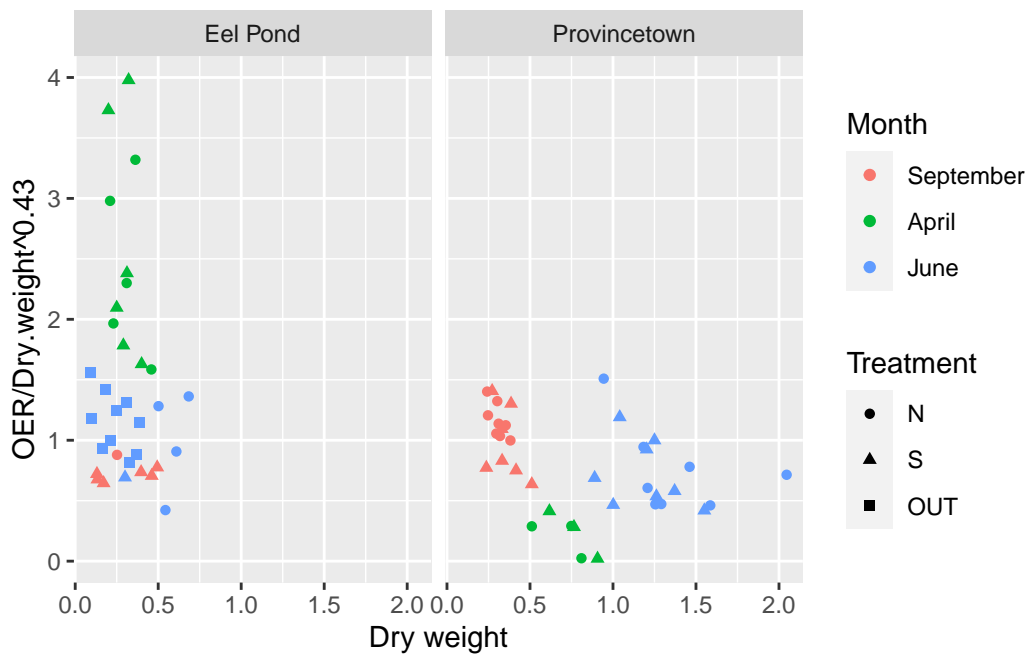
Warning: Removed 1 rows containing missing values (`geom_point()`).



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

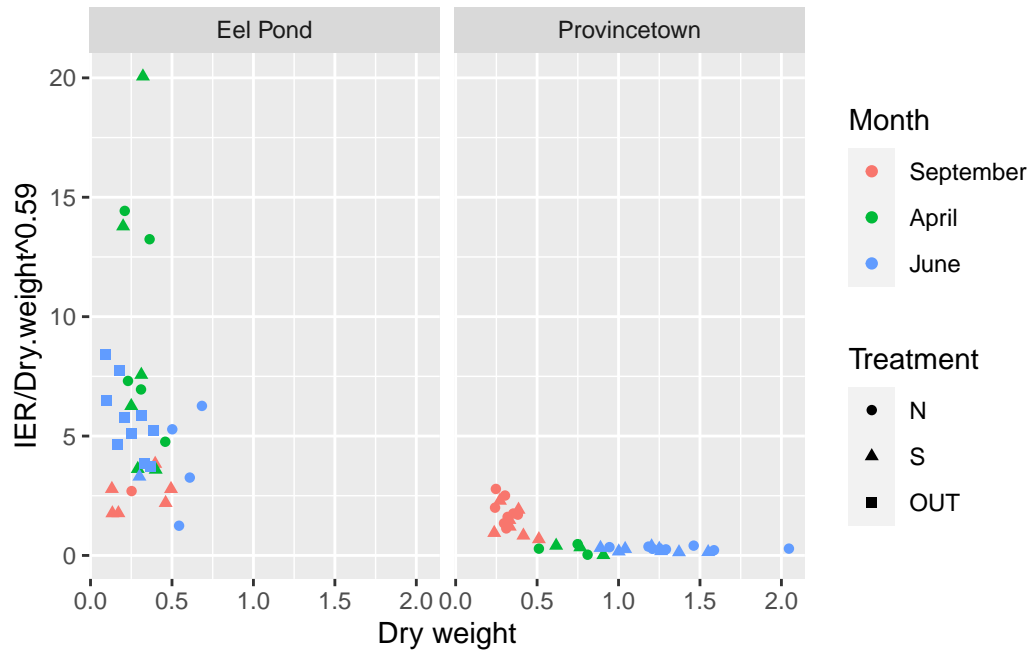
```
gg1 <- ggplot(data = bd, aes(x=Dry.weight, y=OER/Dry.weight.43, color = Month))+
  geom_point(aes(shape=Treatment))+
  xlab("Dry weight") +
  #ylab("OER new scaling")+
  #ylim(0,9)+
  #scale_color_discrete(name="Site")+
  #ggtitle ('OER as a function of DW')+
  facet_wrap(~ Site)
```

gg1

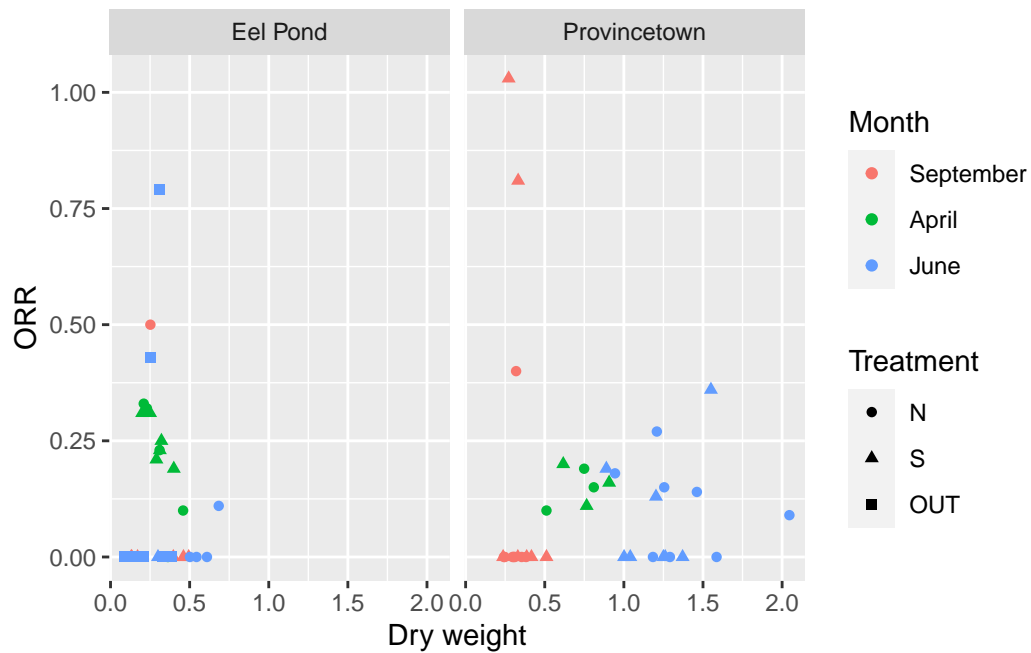


```
gg1 <- ggplot(data = bd, aes(x=Dry.weight, y=IER/Dry.weight.59, color = Month))+
  geom_point(aes(shape=Treatment))+
  xlab("Dry weight") +
  # ylab("IER")+
  #ylim(0,9)+
  #scale_color_discrete(name="Site")+
  #ggtitle ('OER as a function of DW')+
  facet_wrap(~ Site)
```

gg1

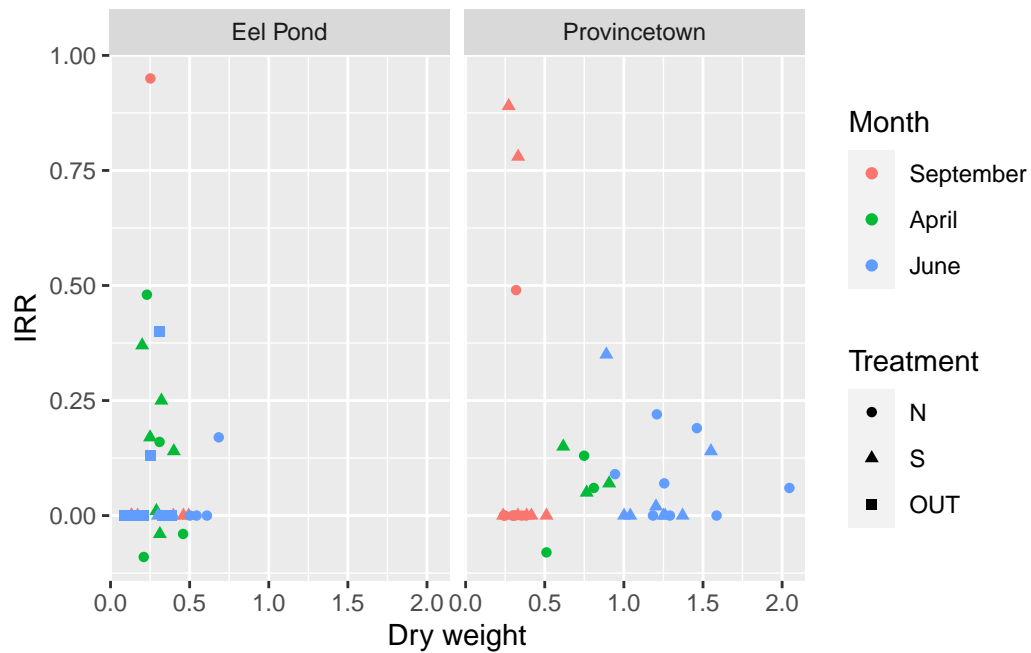


```
gg1 <- ggplot(data = bd, aes(x=Dry.weight, y=ORR, color = Month))+
  geom_point(aes(shape=Treatment))+
  xlab("Dry weight") +
  #ylab("ORR")+
  #ylim(0,9)+
  #scale_color_discrete(name="Site")+
  #ggtitle ('OER as a function of DW')+
  facet_wrap(~ Site)
gg1
```

```
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)
```

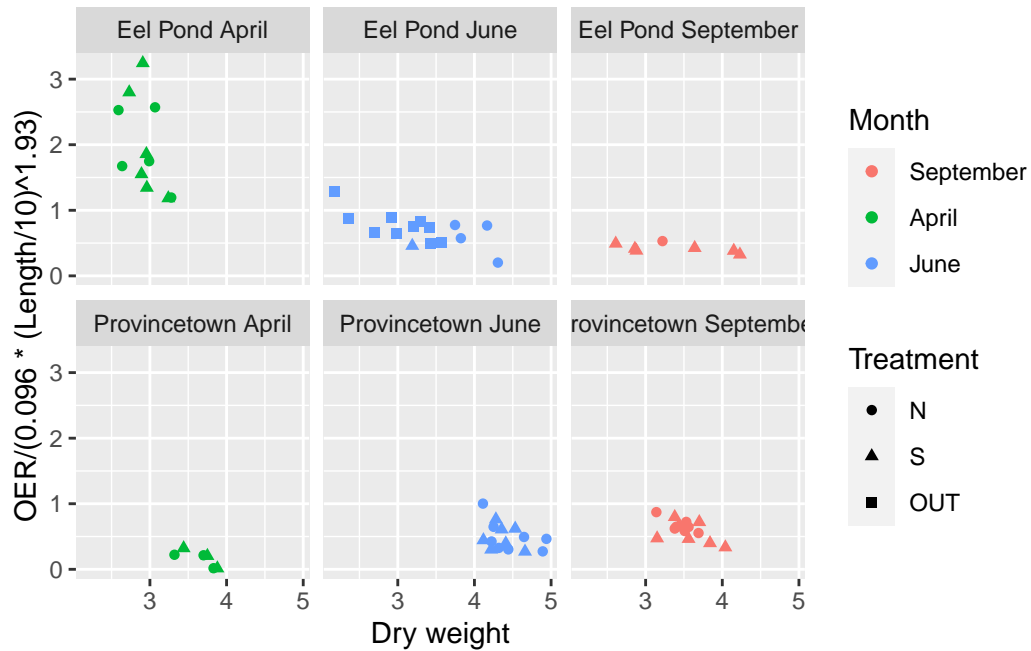
gg1



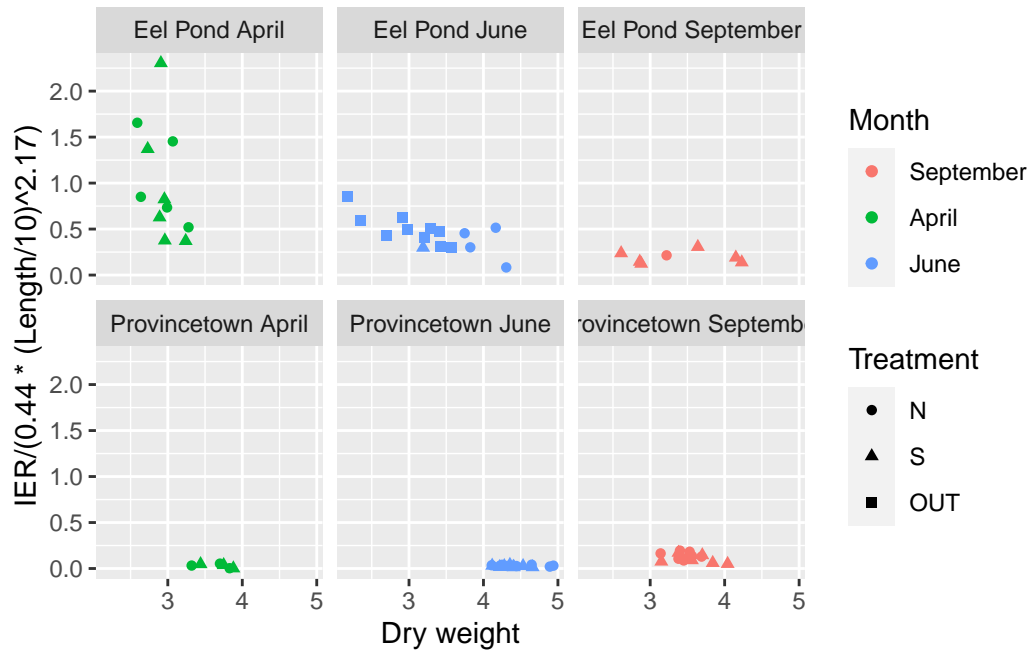
Now using length scaling

```
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

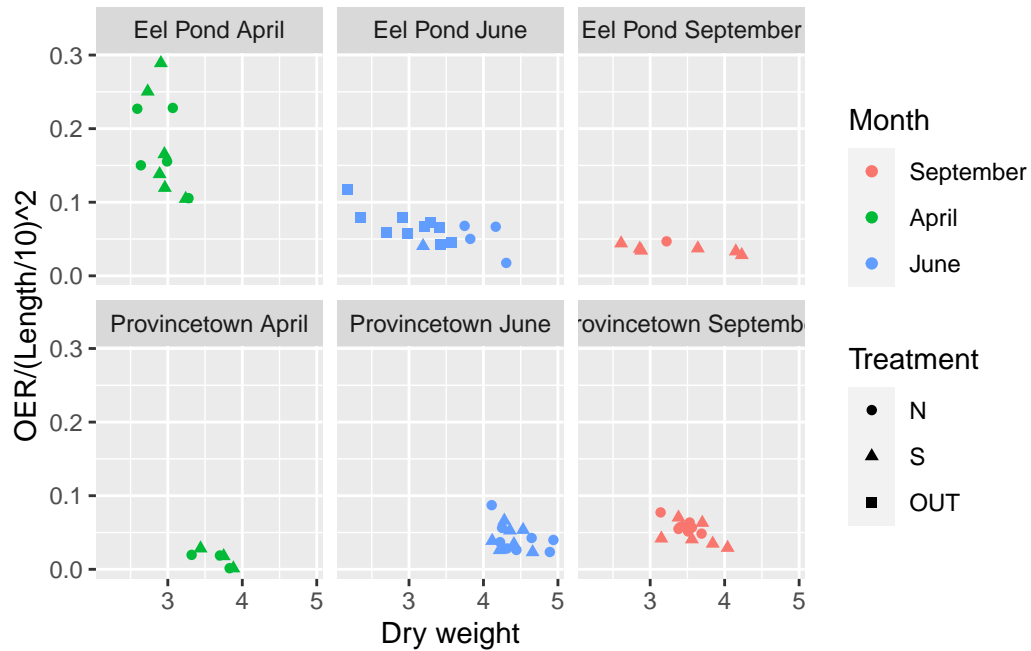


```
gg1 <- ggplot(data = bd, aes(x=Length/10, y=IER/ (.44*(Length/10)^2.17), color = Month))+
  geom_point(aes(shape=Treatment))+
  xlab("Dry weight") +
  #ylab("OER new scaling")+
  #ylim(0,9)+
  #scale_color_discrete(name="Site")+
  #ggtitle ('OER as a function of DW')+
  facet_wrap(~ paste(Site,Month))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



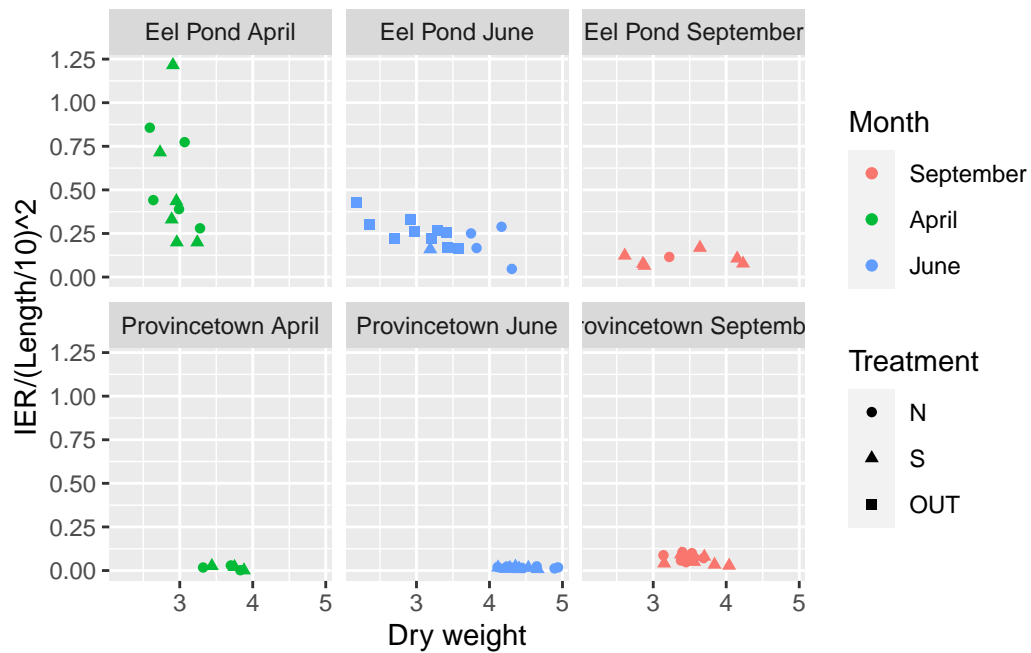
```
gg1 <- ggplot(data = bd, aes(x=Length/10, y=OER/(Length/10)^2, color = Month))+
  geom_point(aes(shape=Treatment))+
  xlab("Dry weight") +
  # ylab("IER")+
  #ylim(0,9)+
  #scale_color_discrete(name="Site")+
  #ggtitle ('OER as a function of DW')+
  facet_wrap(~ paste(Site,Month))
```

gg1

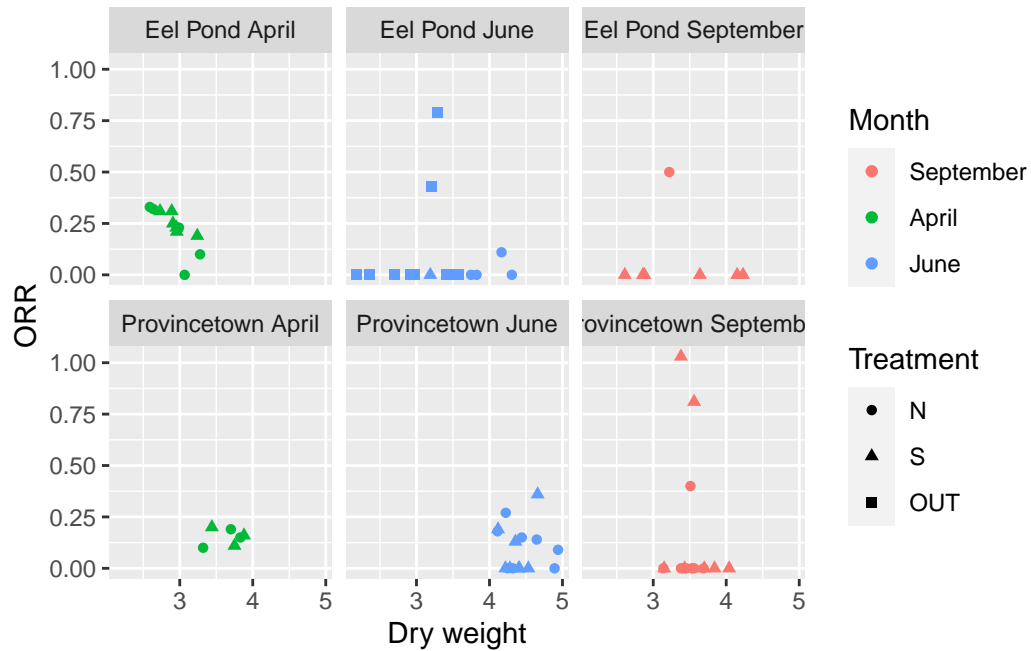


```
gg1 <- ggplot(data = bd, aes(x=Length/10, y=IER/(Length/10)^2, color = Month))+
  geom_point(aes(shape=Treatment))+
  xlab("Dry weight") +
  # ylab("IER")+
  #ylim(0,9)+
  #scale_color_discrete(name="Site")+
  #ggtitle ('OER as a function of DW')+
  facet_wrap(~ paste(Site,Month))
```

gg1

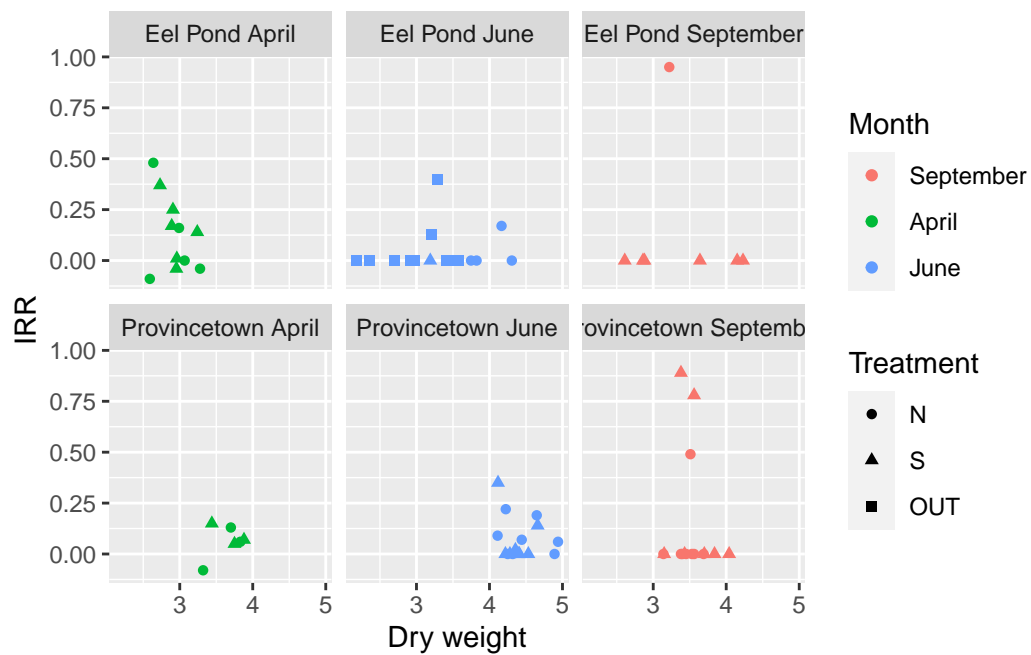


```
gg1 <- ggplot(data = bd, aes(x=Length/10, y=ORR, color = Month))+
  geom_point(aes(shape=Treatment))+
  xlab("Dry weight") +
  #ylab("ORR")+
  #ylim(0,9)+
  #scale_color_discrete(name="Site")+
  #ggtitle ('OER as a function of DW')+
  facet_wrap(~ paste(Site,Month))
gg1
```



```
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))
```

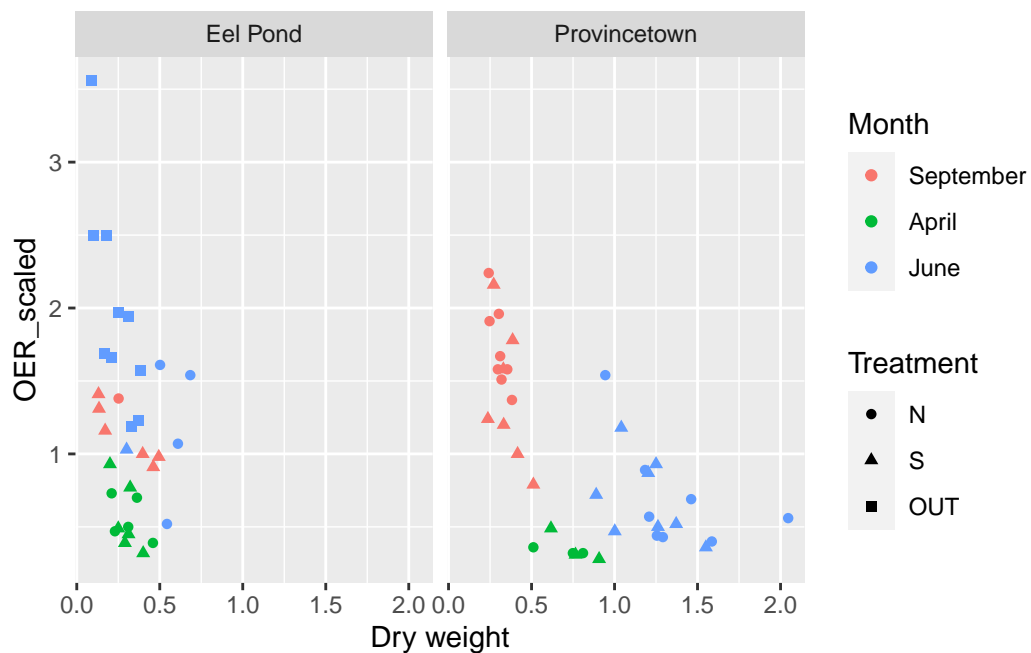
gg1



```

[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 OUT OUT
Levels: N S OUT

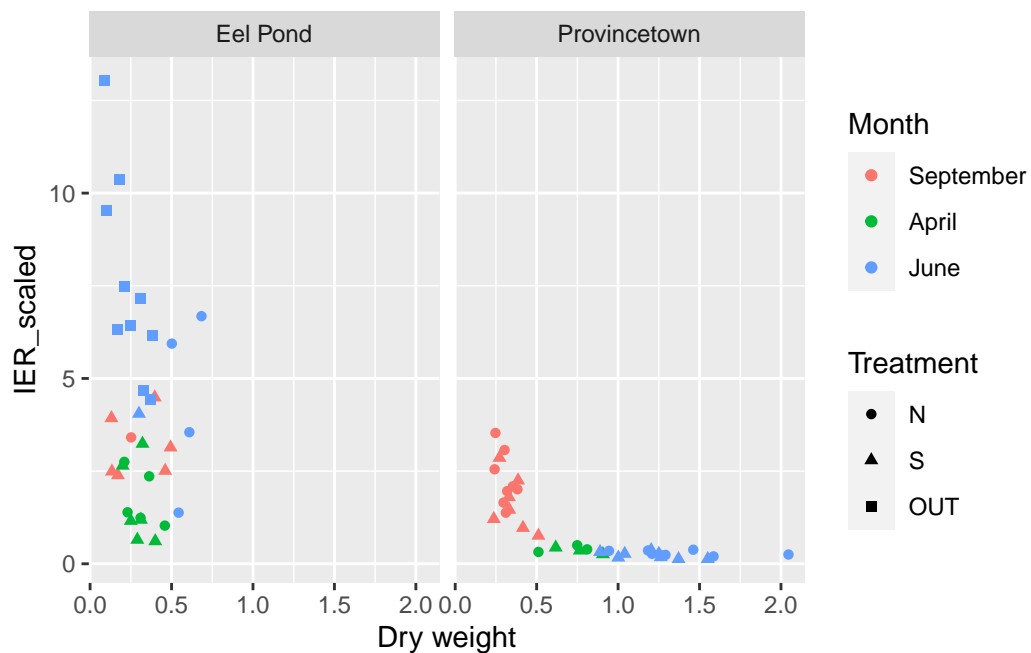
```

```

[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 OUT OUT
Levels: N S OUT

```

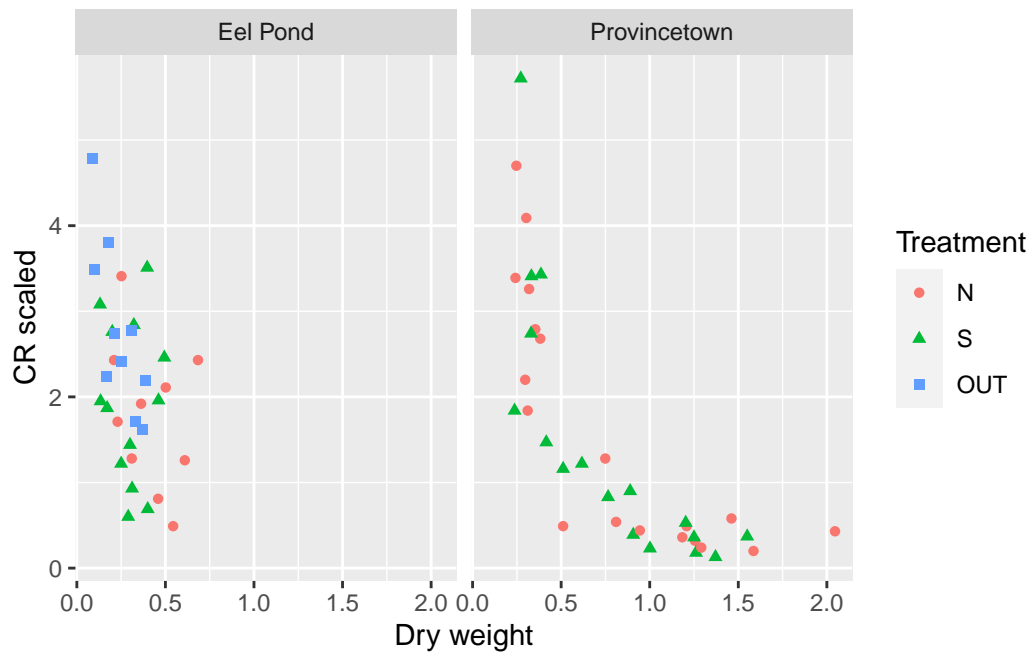


```

[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 OUT OUT
Levels: N S OUT

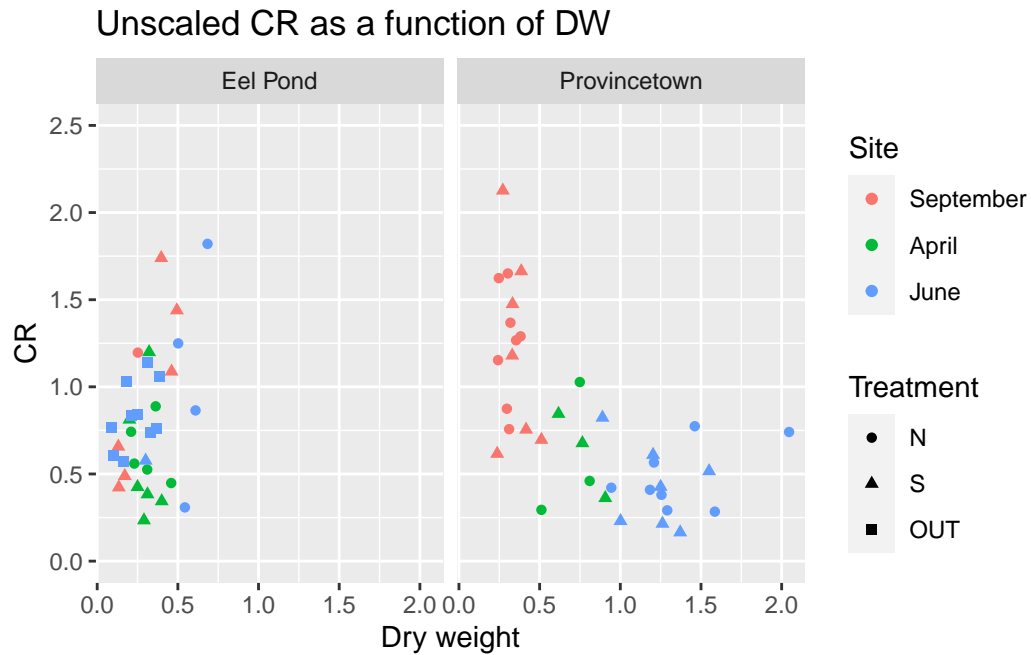
```

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()`).

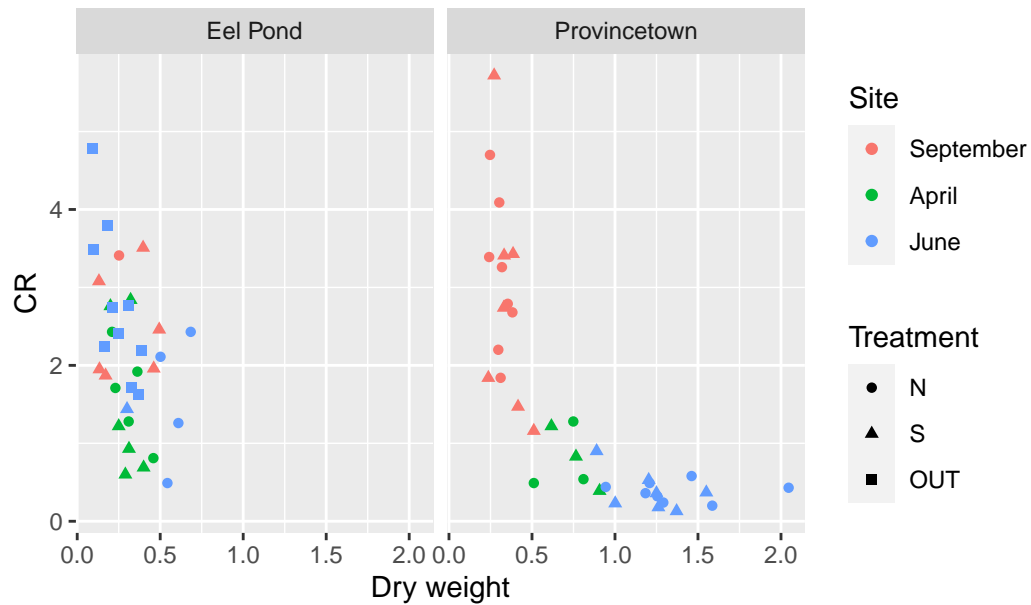


```
gg2 <- ggplot(data = bd, aes(x=Dry.weight, y=CR, color = Month ))+
  geom_point(aes(shape=Treatment))+
  xlab("Dry weight") +
  ylab("CR")+
  #ylim(0,9)+
  scale_color_discrete(name="Site")+
  ggtitle ('Scaled CR as a function of DW')+
  facet_wrap(~ Site)
```

```
gg2
```

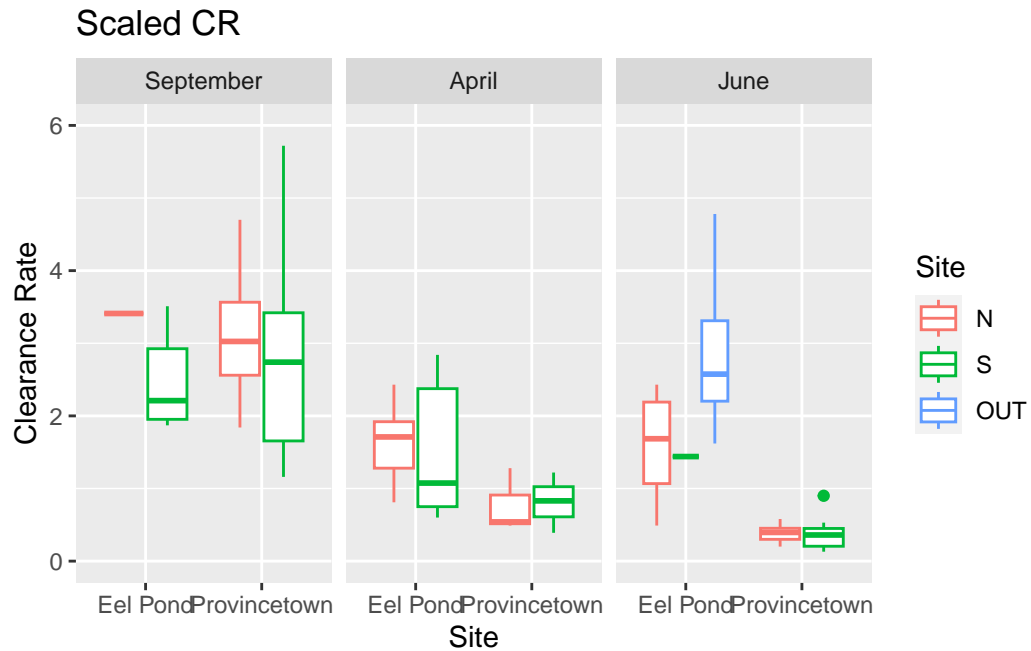
Warning: Removed 1 rows containing missing values (`geom_point()`).

Scaled CR as a function of DW



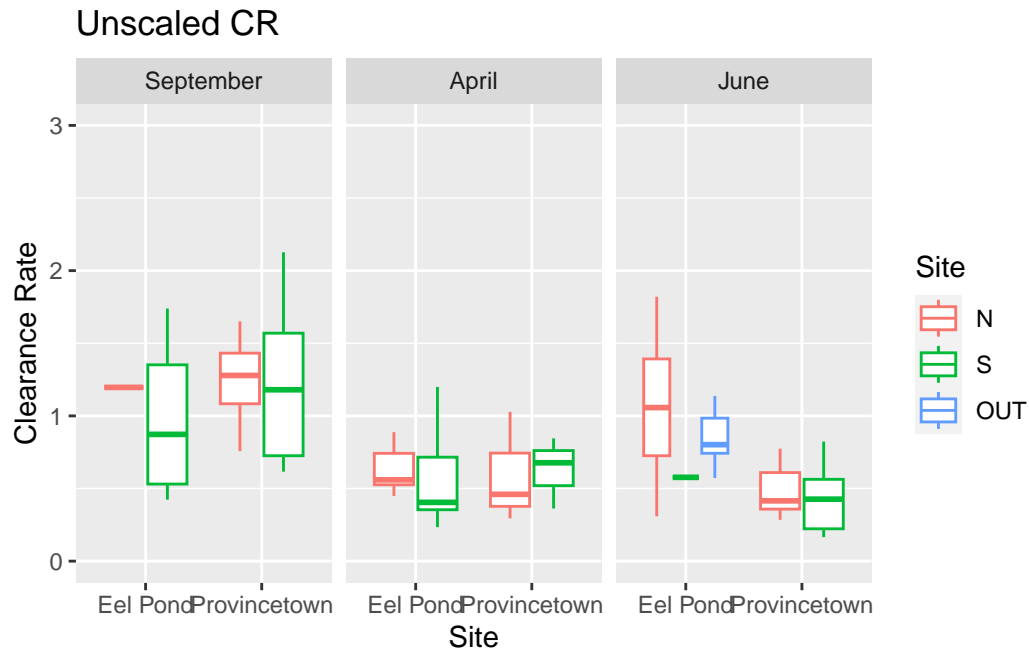
```
gg3 <- ggplot(data = bd, aes(x=Site, y=CR, col = Treatment))+
  geom_boxplot()+
  #xlab("Dry weight") +
  ylab("Clearance Rate")+
  ylim(0,6)+
  scale_color_discrete(name="Site")+
  ggtitle ('Scaled CR')+
  facet_wrap(~ Month)
gg3
```

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



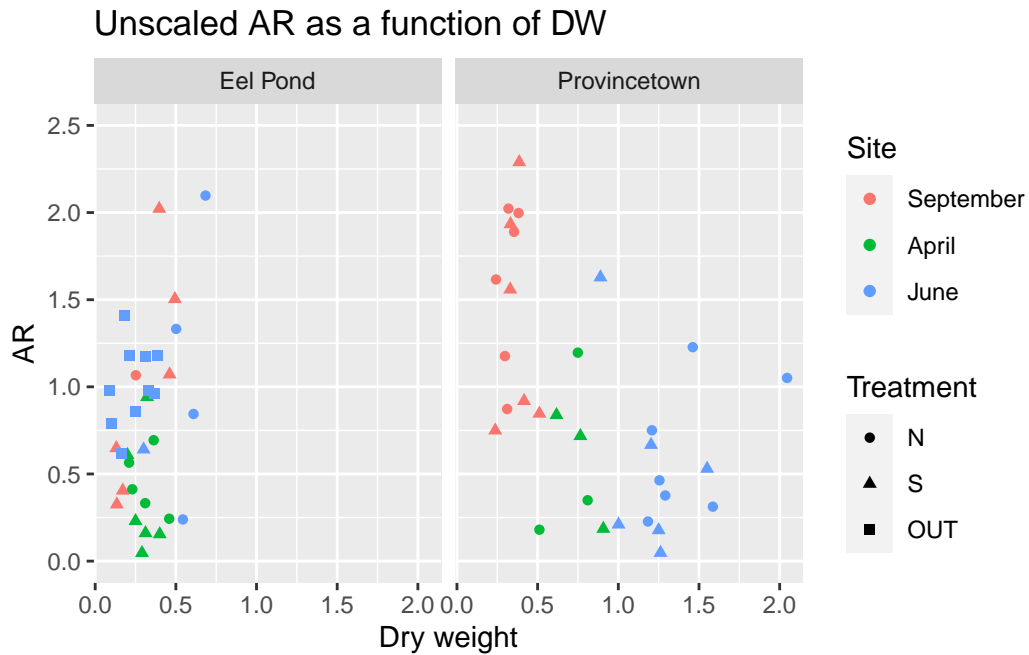
```
gg4 <- ggplot(data = bd, aes(x=Site, y=CR*Dry.weight.76, col = Treatment))+
  geom_boxplot()+
  #xlab("Dry weight") +
  ylab("Clearance Rate")+
  ylim(0,3)+
  scale_color_discrete(name="Site")+
  ggtitle ('Unscaled CR')+
  facet_wrap(~ Month)
gg4
```

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



```
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
```

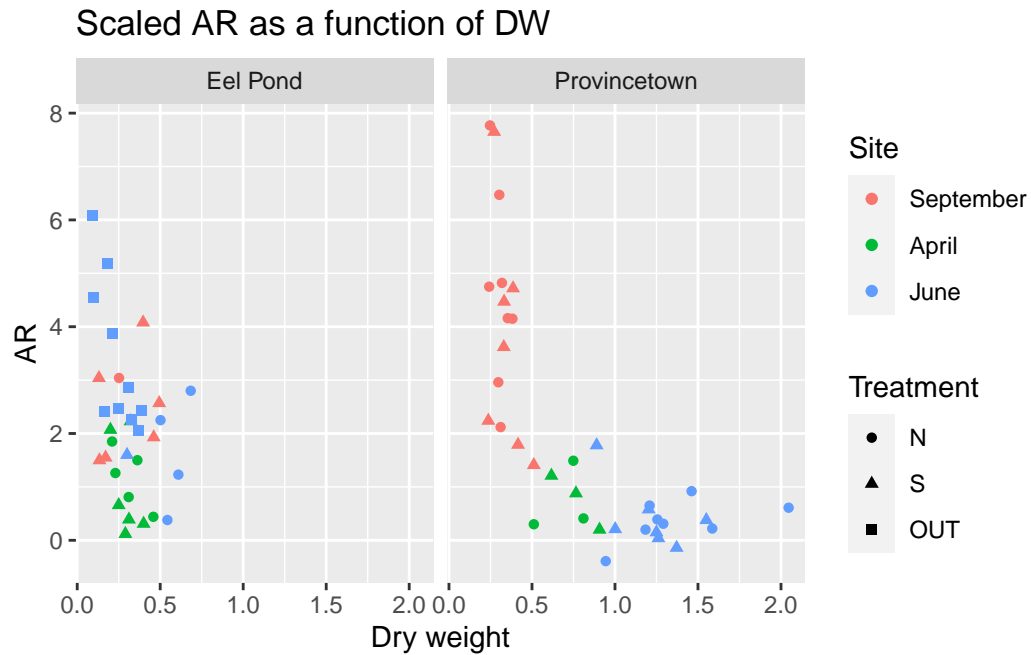
Warning: Removed 6 rows containing missing values (`geom_point()`).



```
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
```

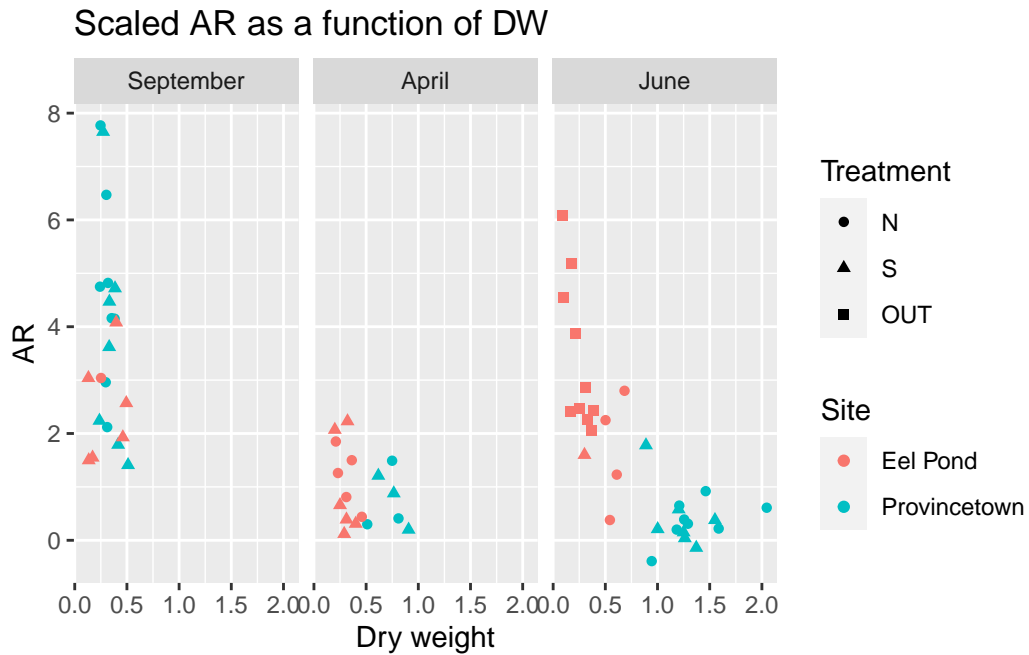
Warning: Removed 1 rows containing missing values (`geom_point()`).



```
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)
```

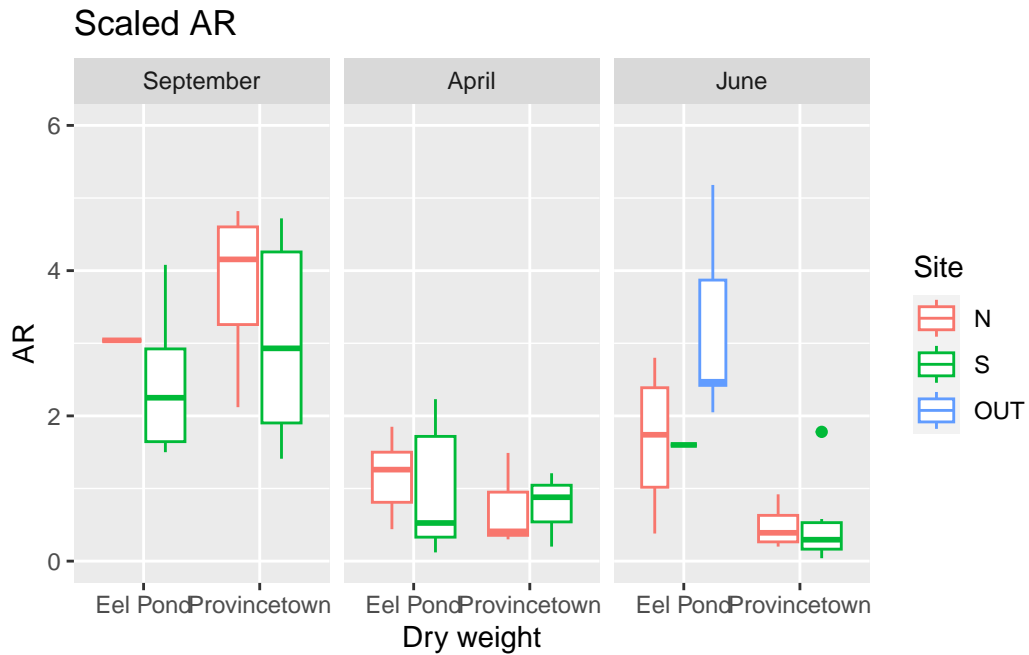
```
gg2
```

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



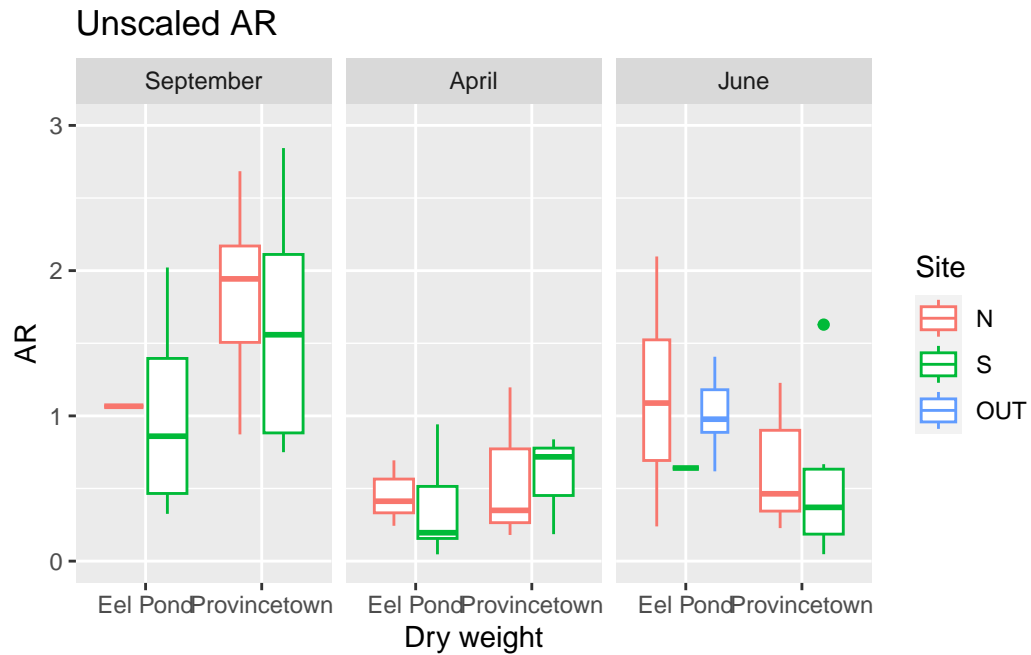
```
gg3 <- ggplot(data = bd, aes(x=Site, y=AR, col = Treatment))+
  geom_boxplot()+
  xlab("Dry weight") +
  ylab("AR")+
  ylim(0,6)+
  scale_color_discrete(name="Site")+
  ggtitle ('Scaled AR')+
  facet_wrap(~ Month)
gg3
```

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



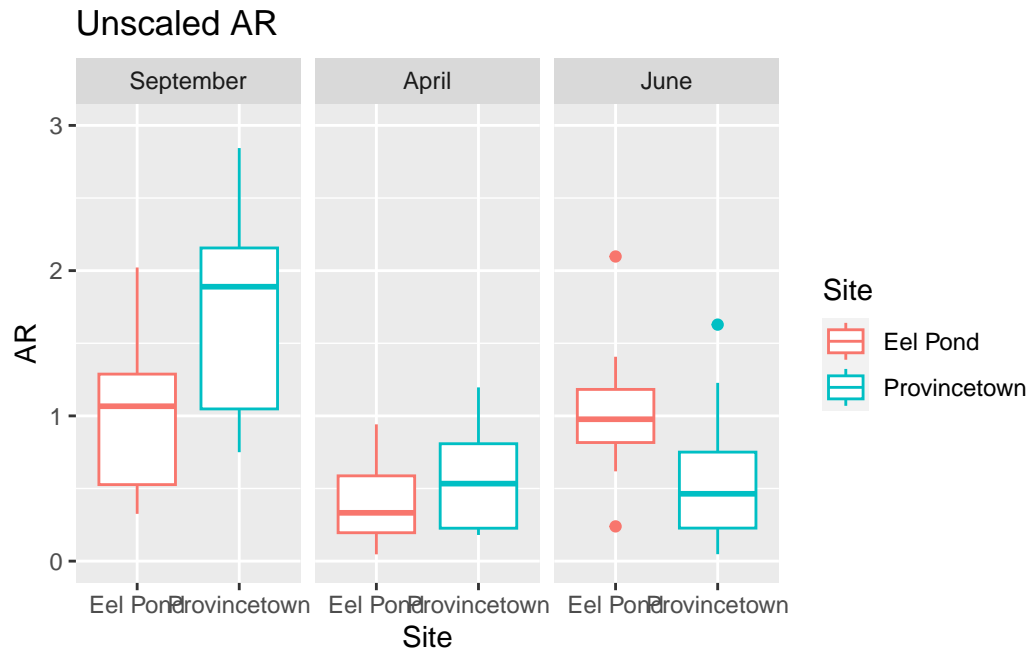
```
gg4 <- ggplot(data = bd, aes(x=Site, y=AR*Dry.weight.76, col = Treatment))+
  geom_boxplot()+
  xlab("Dry weight") +
  ylab("AR")+
  ylim(0,3)+
  scale_color_discrete(name="Site")+
  ggtitle ('Unscaled AR')+
  facet_wrap(~ Month)
gg4
```

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



```
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()``).



```
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 c
summary(gm1)
```

Call:

```
lm(formula = AR * Dry.weight0.76 ~ 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.weight0.76 ~ 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
```

```
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
```

```
#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)"]])+
```

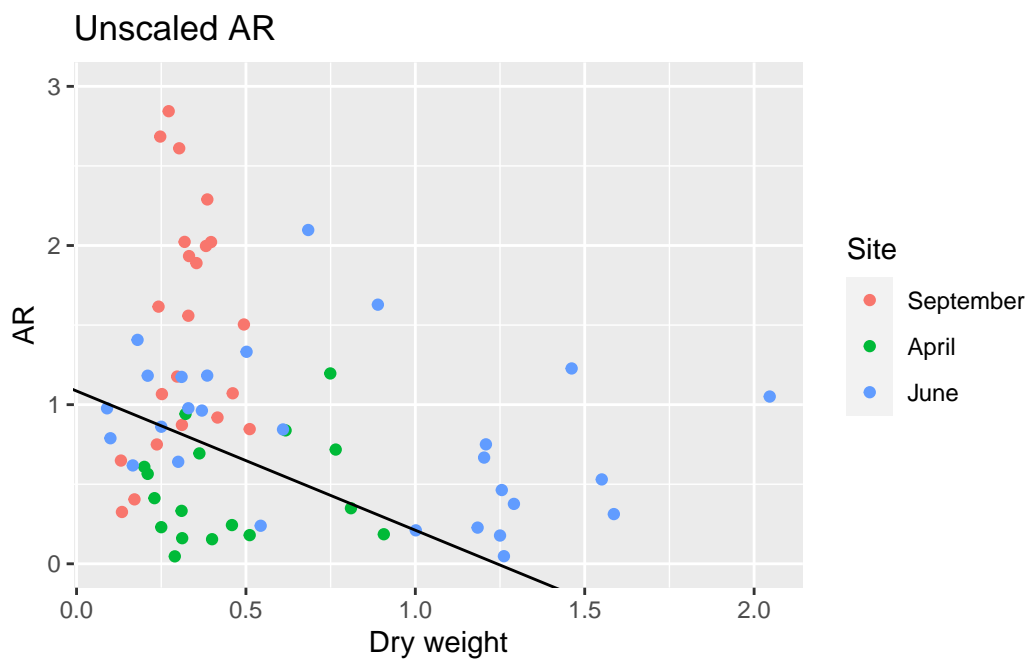


```

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()`).

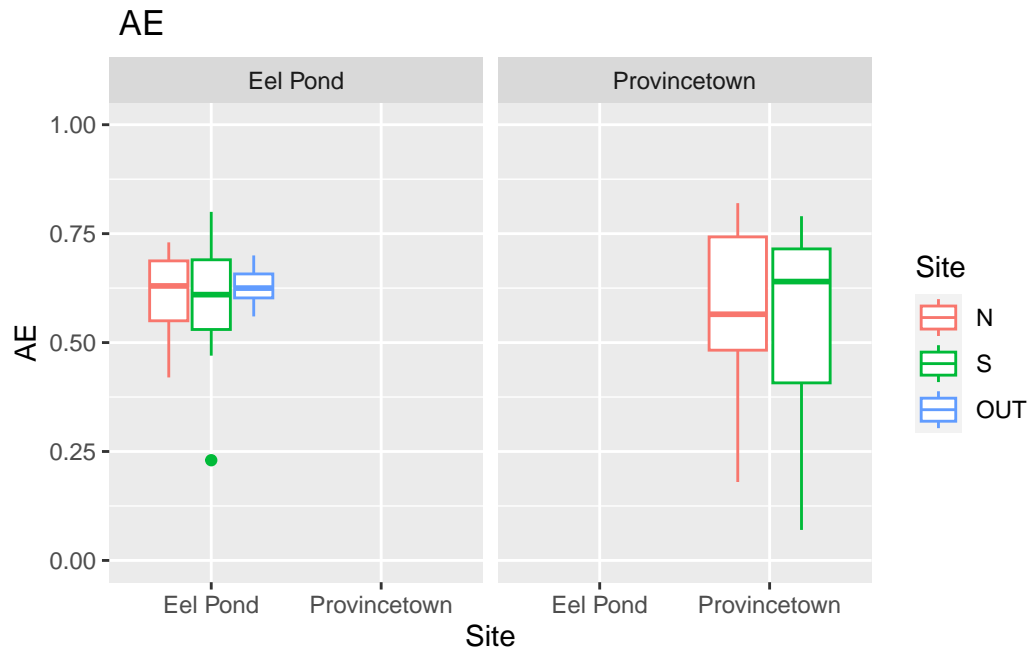


```

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()``).



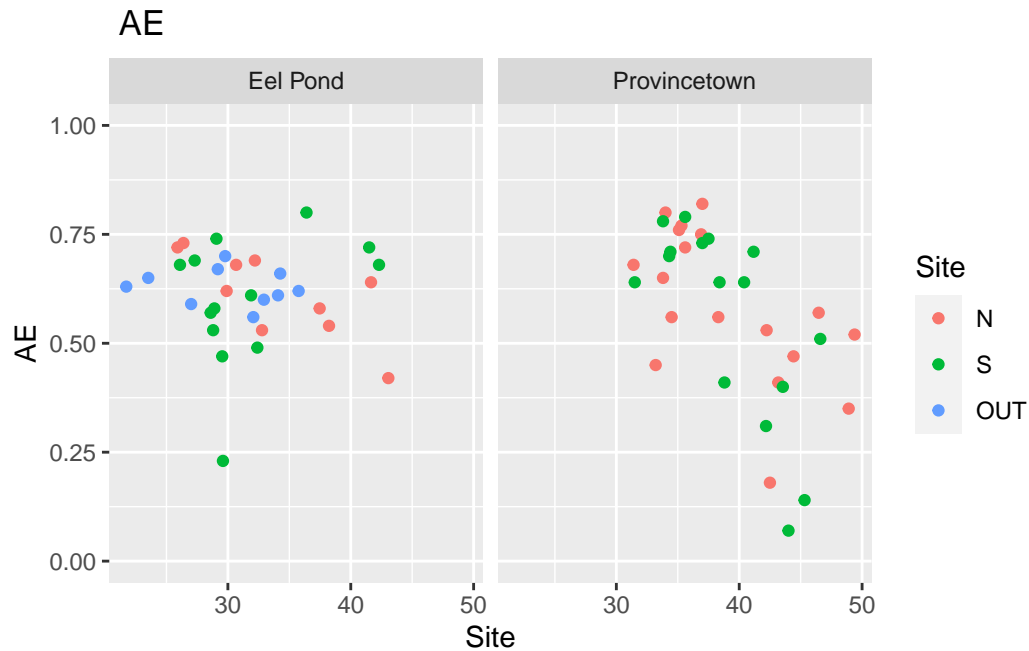
```
gg1 <- ggplot(data = bd, aes(x=Dry.weight, y=AE, col = Treatment))+  
  geom_point()+  
  xlab("Site") +  
  ylab("AE")+  
  ylim(0,1)+  
  scale_color_discrete(name="Site")+  
  ggtitle (' AE')+  
  facet_wrap(~ Site)  
gg1
```

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



```
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()`).



```
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: $OER \sim A * (Length/10)^B$

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

```
# 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

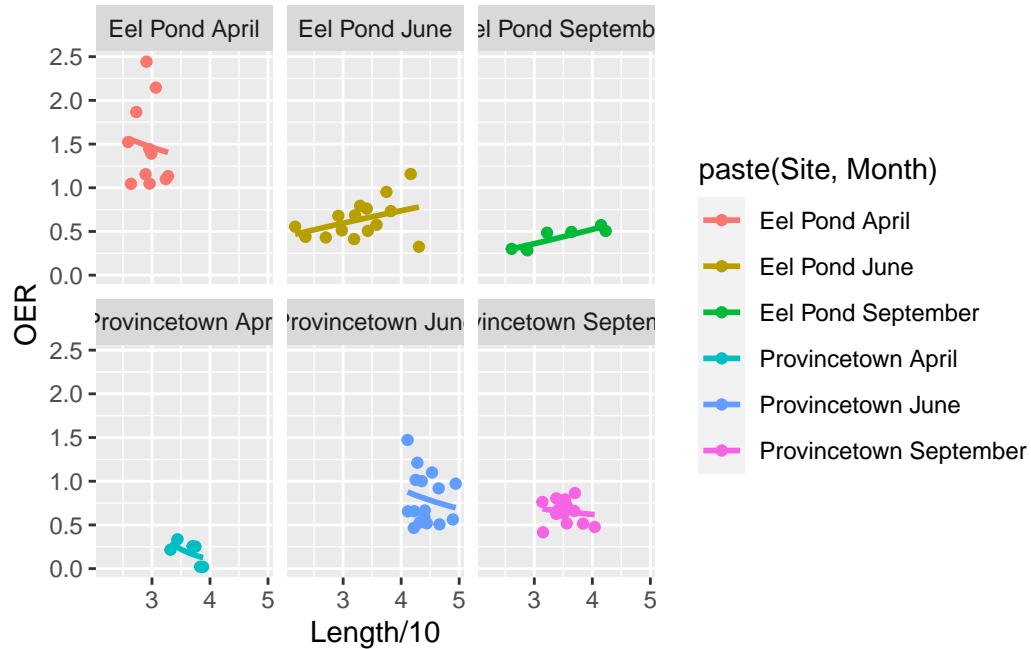
```
gg1 <- ggplot(data = bd, aes(x=Length/10, y=OER, color = paste(Site,Month)))+
  geom_point()+
  #xlab("Dry weight") +
  #ylab("ORR")+
  #ylim(0,9)+
  #scale_color_discrete(name="Site")+
  #ggtitle ('ORR as a function of DW')+
  stat_smooth()
```

```

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^0.76 ~ 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: $CR * Dry.weight^{0.76} \sim A * (Length/10)^B$


```
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

```
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

```
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

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

	df	AIC
fit1	8	56.88835
fit3	3	88.54044

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

	df	BIC
fit1	8	74.76120
fit3	3	95.24276

```

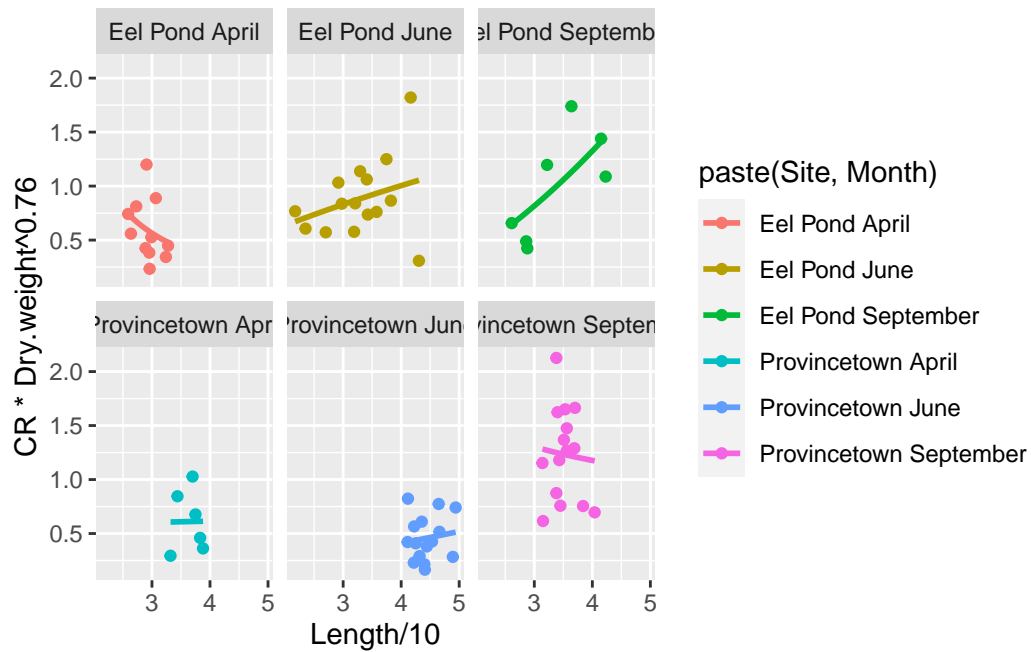
gg1 <- ggplot(data = bd, aes(x=Length/10, y=CR*Dry.weight^.76, color = paste(Site,Month)))
  geom_point()+
  #xlab("Dry weight") +
  #ylab("ORR")+
  #ylim(0,9)+
  #scale_color_discrete(name="Site")+
  #ggtitle ('ORR as a function of DW')+
  stat_smooth(
    method = 'nls',
    formula = y ~ A * x^B,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

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

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

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

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

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

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

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 ...

```

```

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,]

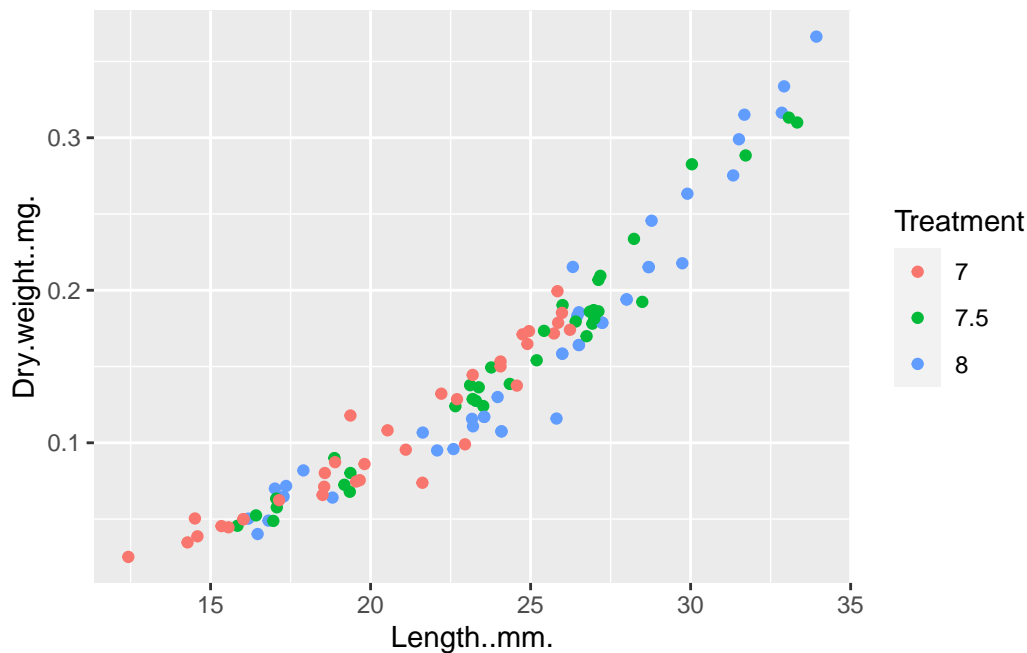
```

```

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

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 P  
#Based on my calculations of IFR and CR and accounting for month (different coefficients f
```

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
```

```

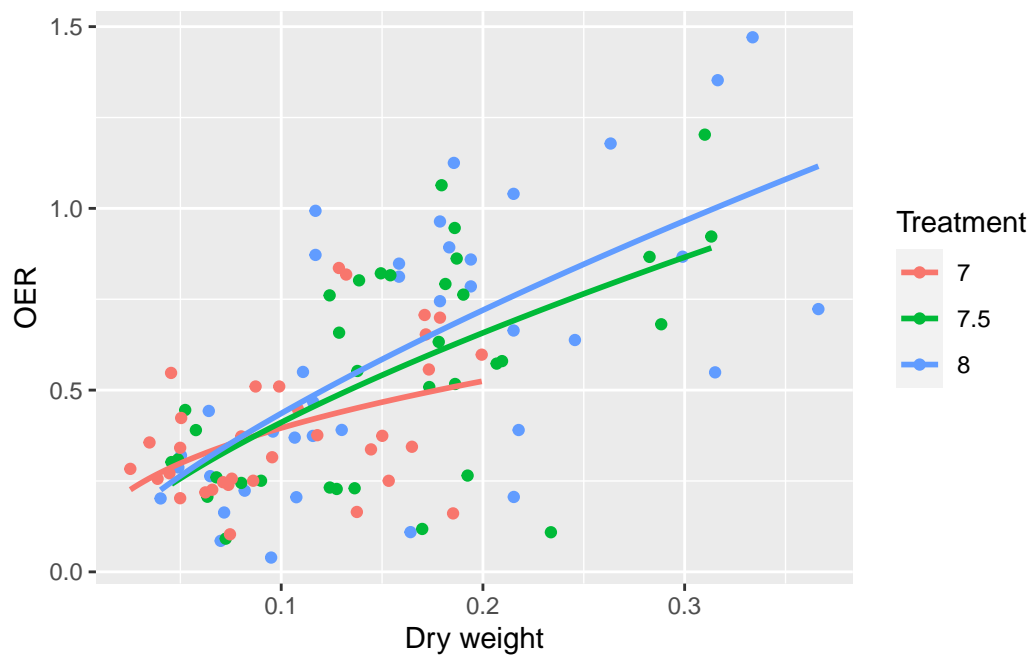
init_scales: function
map_data: function
params: list
setup_data: function
setup_params: function
shrink: TRUE
train_scales: function
vars: function
super: <ggproto object: Class FacetWrap, Facet, gg>

```

```
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)

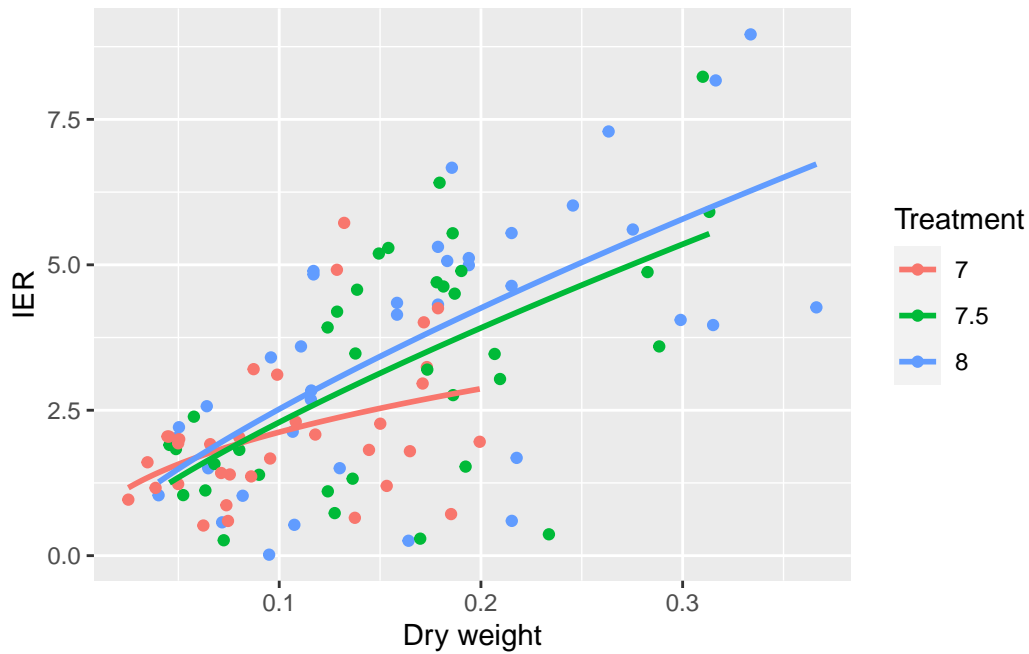
```
gg1 <- ggplot(data = bd_Pousse, aes(x=Dry.weight..mg., y=IER, color = Treatment))+  
  geom_point()+  
  xlab("Dry weight") +  
  ylab("IER")+  
  #ylim(0,9)+  
  #scale_color_discrete(name="Site")+  
  #ggtitle ('IER as a function of DW')+  
  stat_smooth(  
    method = 'nls',  
    formula = y ~ 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>
```

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: $IER \sim A * Dry.weight..mg.^B$

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)

```
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)

```
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)

```

```

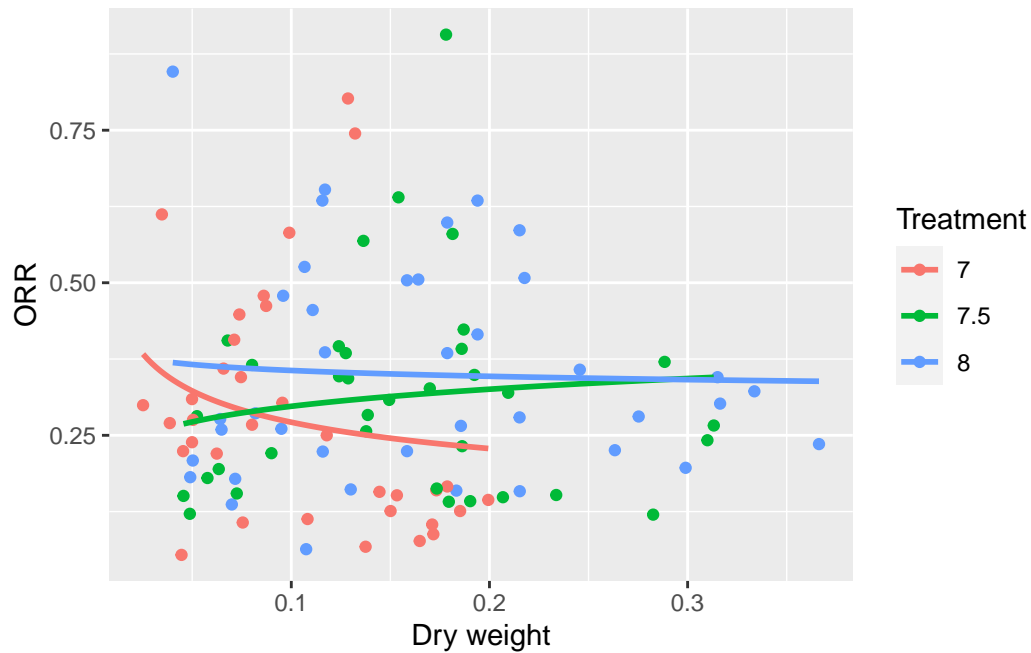
<ggproto object: Class FacetWrap, Facet, gg>
  compute_layout: function
  draw_back: function
  draw_front: function
  draw_labels: function
  draw_panels: function
  finish_data: function
  init_scales: function
  map_data: function
  params: list
  setup_data: function
  setup_params: function
  shrink: 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: $\text{ORR} \sim A * \text{Dry.weight}..mg.^B$

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: $\text{ORR} \sim A * \text{Dry.weight}..mg.^B$

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)

```
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)

```
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)
```

```

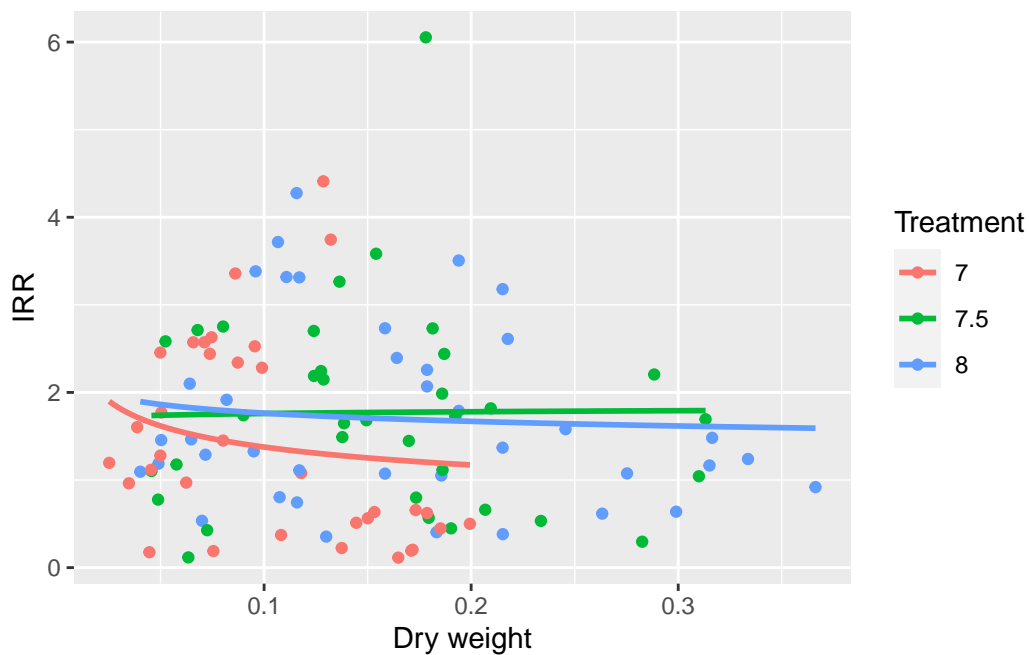
<ggproto object: Class FacetWrap, Facet, gg>
  compute_layout: function
  draw_back: function
  draw_front: function
  draw_labels: function
  draw_panels: function
  finish_data: function
  init_scales: function
  map_data: function
  params: list
  setup_data: function
  setup_params: function
  shrink: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

```

gg1

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

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



```

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: $IRR \sim A * Dry.weight..mg.^B$

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: $IRR \sim A * Dry.weight..mg.^B$

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

```
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

```

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

```
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

```
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

```
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 co
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

```
summary(fit_IER_crossed)
```

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

```
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

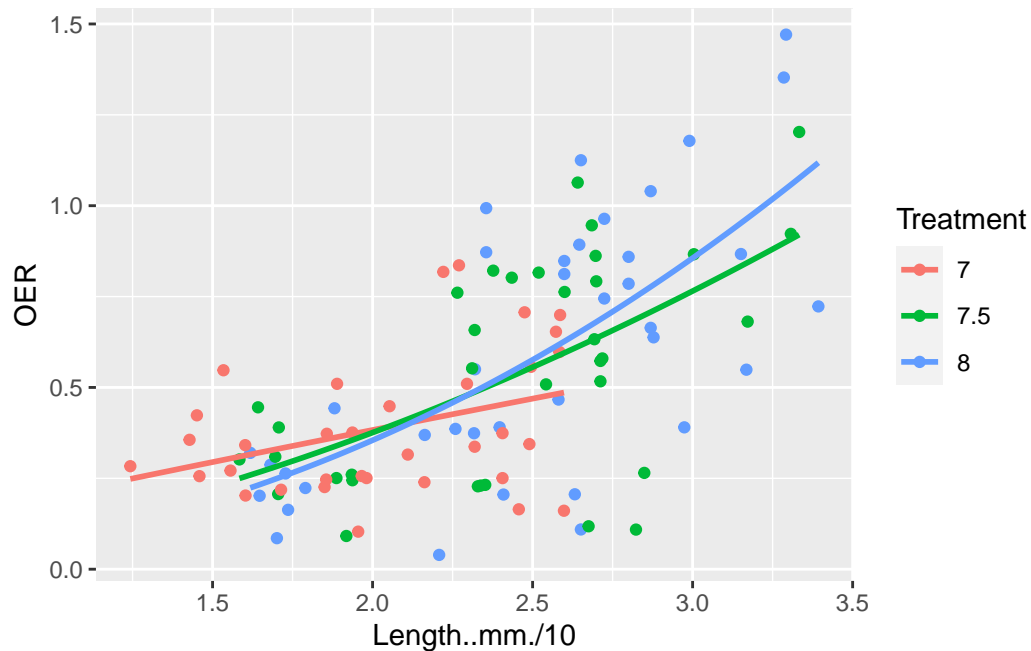
```
BIC(fit1,fit2,fit3)
```

	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.Trt7	1.0000		
A.T7.5	0.9999	1.0000	
A.Trt8	0.9999	0.9999	1.0000

```

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

```

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

```
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)
```

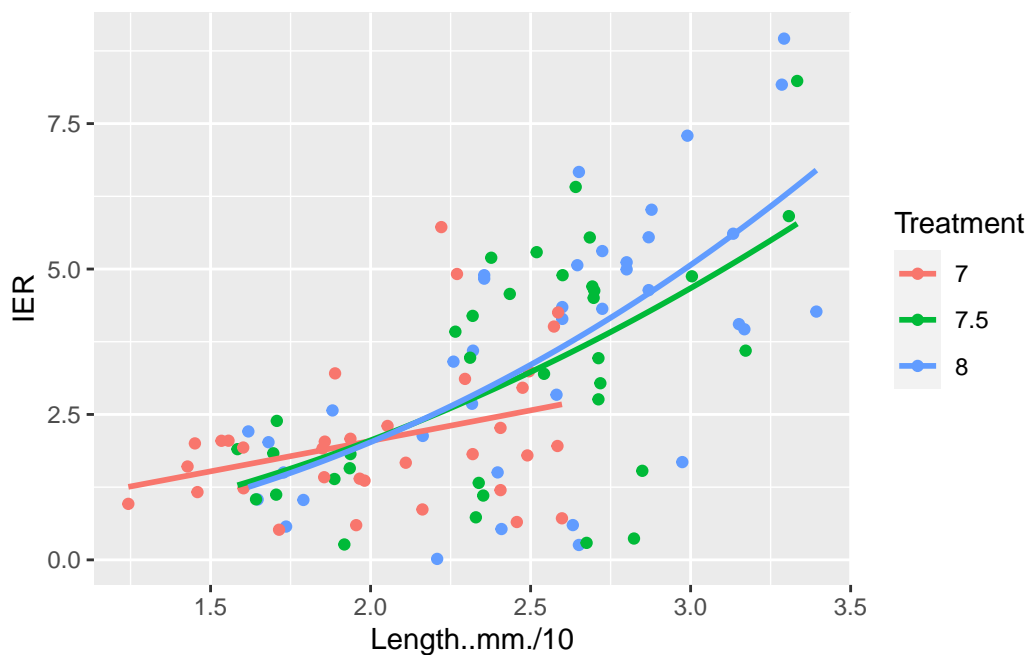
```
      df      BIC
fit1  5 414.5334
fit2  7 421.7818
fit3  3 407.0342
```

```
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()`).



```
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

```
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

```
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

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

	df	AIC
fit1	5	-57.68407

```
fit2  7 -56.13407
fit3  3 -59.13845
```

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

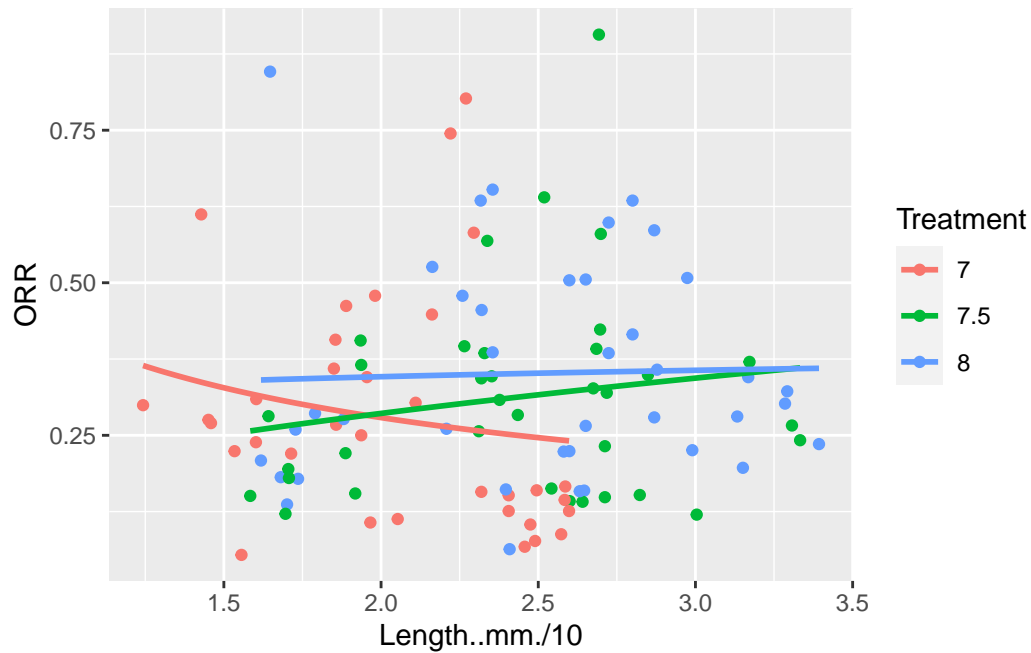
```
      df      BIC
fit1  5 -44.27341
fit2  7 -37.35915
fit3  3 -51.09205
```

```
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: $IRR \sim A * (Length..mm./10)^B$

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

```
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.Tr7	A.T7.5	A.Tr8	B.Tr7	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

```
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

```
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()`).

