504project

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2020/2/28

```r
library(tidyverse)
```

```
## Warning: package 'tidyverse' was built under R version 3.6.3

## -- Attaching packages ----------------------------------------------------------------

## v ggplot2 3.3.0     v purrr   0.3.3
## v tibble  2.1.3     v dplyr   0.8.5
## v tidyr   1.0.2     v stringr 1.4.0
## v readr   1.3.1     v forcats 0.5.0

## Warning: package 'ggplot2' was built under R version 3.6.3

## Warning: package 'tibble' was built under R version 3.6.2

## Warning: package 'tidyr' was built under R version 3.6.3

## Warning: package 'readr' was built under R version 3.6.3

## Warning: package 'purrr' was built under R version 3.6.3

## Warning: package 'dplyr' was built under R version 3.6.3

## Warning: package 'stringr' was built under R version 3.6.3

## Warning: package 'forcats' was built under R version 3.6.3

## -- Conflicts --------------------------------------------------------------------- tidy
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```r
library(janitor)
```

```
## Warning: package 'janitor' was built under R version 3.6.3

##
## Attaching package: 'janitor'

## The following objects are masked from 'package:stats':
##
##     chisq.test, fisher.test
```

```r
library(vegan)
```

```
## Warning: package 'vegan' was built under R version 3.6.3
```

```
## Loading required package: permute
```

```
## Warning: package 'permute' was built under R version 3.6.3
```

```
## Loading required package: lattice
```

```
## This is vegan 2.5-6
```

```r
library(lubridate)
```

```
## Warning: package 'lubridate' was built under R version 3.6.3
```

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

```
## The following object is masked from 'package:base':
##
##     date
```

```r
library(corrplot)
```

```
## Warning: package 'corrplot' was built under R version 3.6.3
```

```
## corrplot 0.84 loaded
```

```r
library(MASS)
```

```
## Warning: package 'MASS' was built under R version 3.6.3
```

```
##
## Attaching package: 'MASS'
```

```
## The following object is masked from 'package:dplyr':
##
##     select
```

```r
library(here)
```

```
## Warning: package 'here' was built under R version 3.6.3
```

```
## here() starts at C:/Users/ASUS/Desktop/504project
```

```
##
## Attaching package: 'here'
```

```
## The following object is masked from 'package:lubridate':
##
##     here
```

```r
data.kelp<-read.csv(file='kelp_prediction_data_complete.csv')
data.waterchem<-read.csv(file='biomass_prediction_data_waterchem_complete.csv')
mydat2 <- read.csv(file='biomass_prediction_data_waterchem_bysite_complete.csv')
corrplot(cor(data.waterchem[,4:26],use="complete.obs"), type="upper")
```
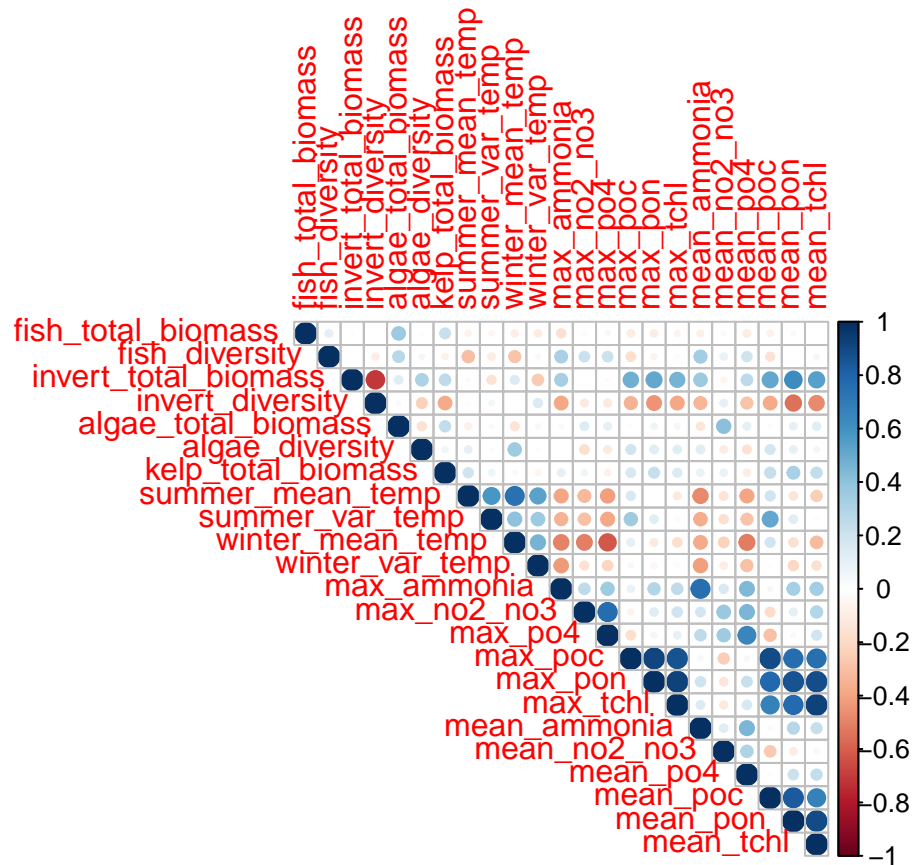


```r
mydat2$kelp_total_biomass<-mydat2$kelp_total_biomass^(1/3)
mydat2$mean_pon<-log(mydat2$mean_pon)
mydat2$mean_tchl<-log(mydat2$mean_tchl)
mydat2$summer_mean_temp<-log(mydat2$summer_mean_temp)
mydat2$winter_mean_temp<-log(log(mydat2$winter_mean_temp))
```

```r
library(MASS)
boxcox(lm(fish_diversity~kelp_total_biomass+site, data=mydat2),ylab="fish diversity log-L")
```
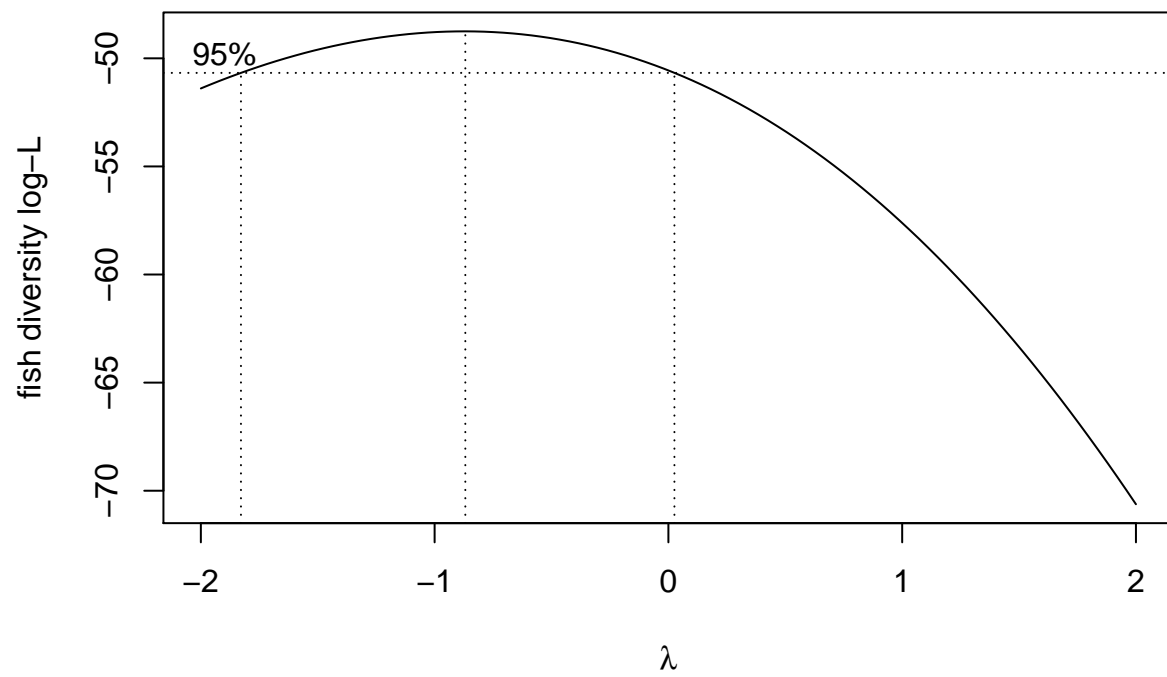
```
boxcox(lm(fish_total_biomass ~kelp_total_biomass + site, data=mydat2),ylab="fish biomass log-L")
```
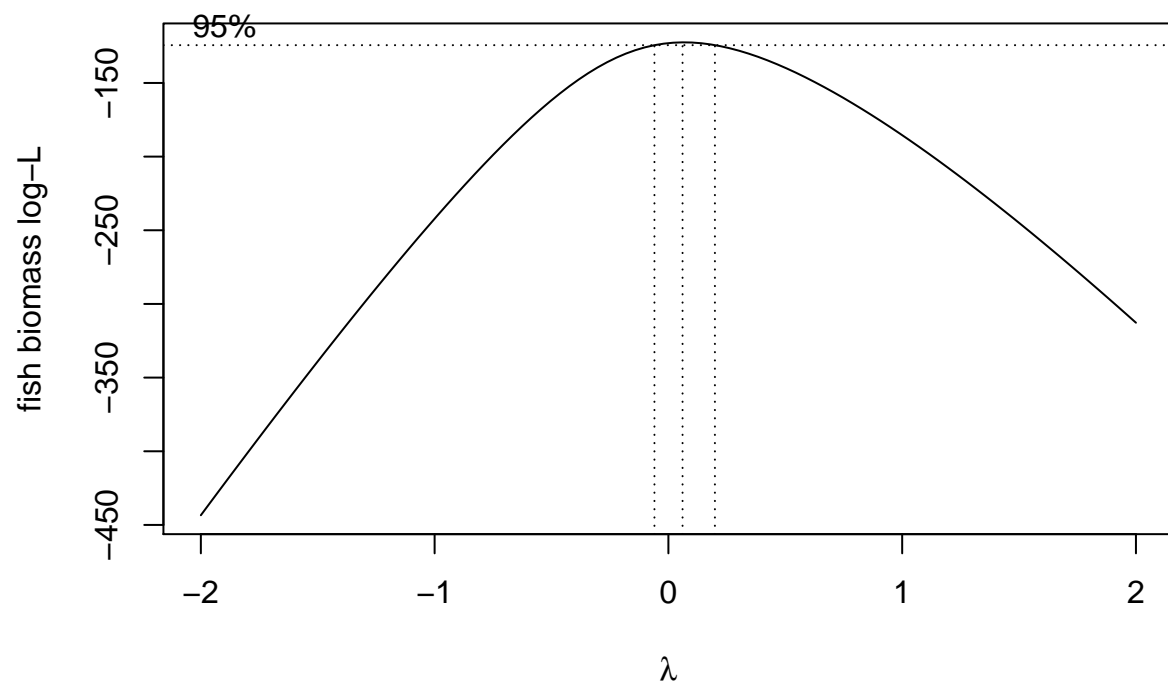
```
boxcox(lm(invert_diversity ~ kelp_total_biomass + site+summer_mean_temp+winter_mean_temp+mean_ammonia,
```
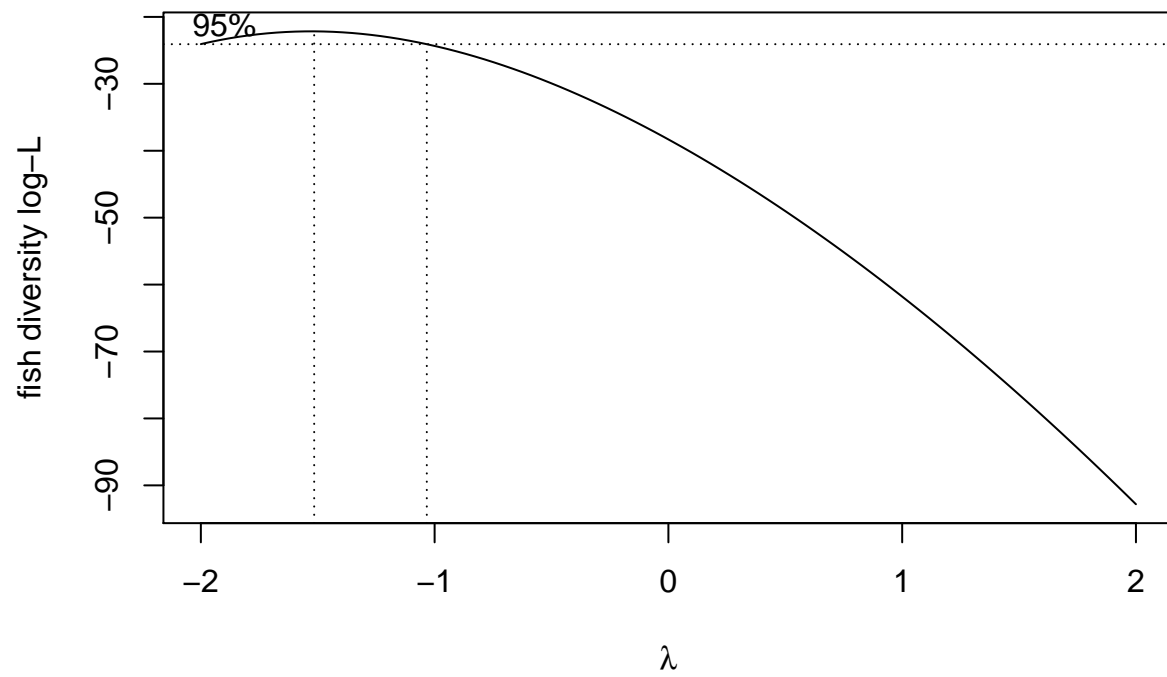
```
boxcox(lm(invert_total_biomass ~mean_tchl + summer_mean_temp + winter_mean_temp +
    site + winter_mean_temp:site + summer_mean_temp:site, data=mydat2),ylab="fish biomass log-L")
```

6
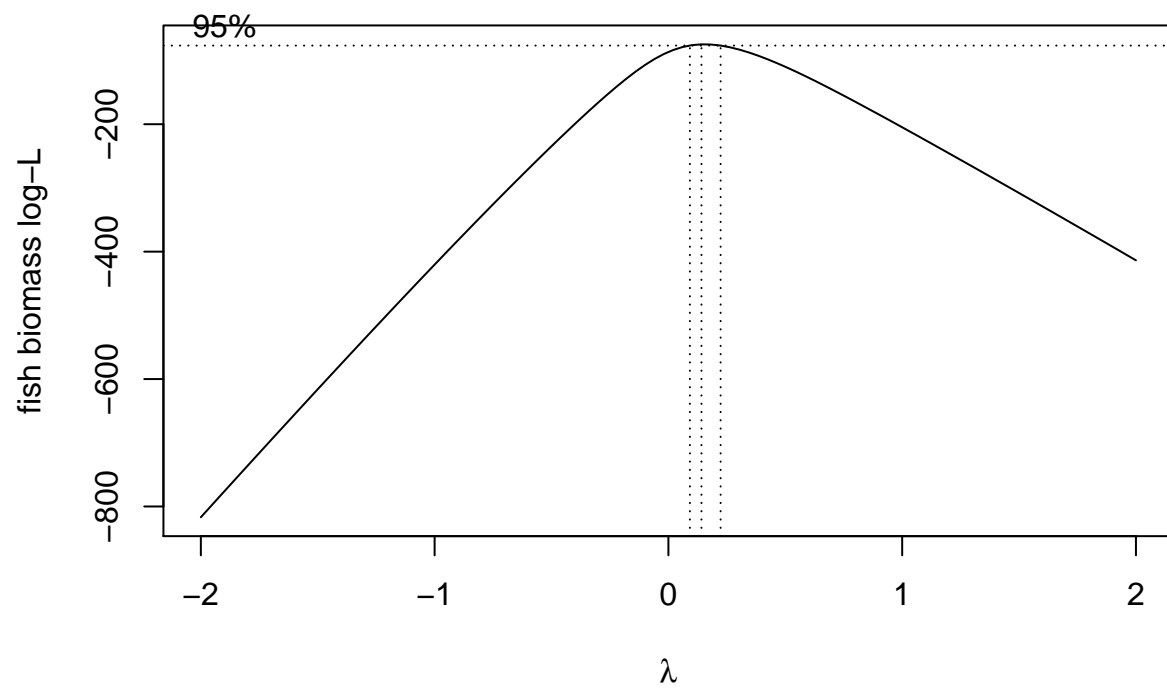
```
boxcox(lm(algae_diversity ~ mean_ammonia+ winter_mean_temp, data=mydat2),ylab="algae diversity log-L")
```
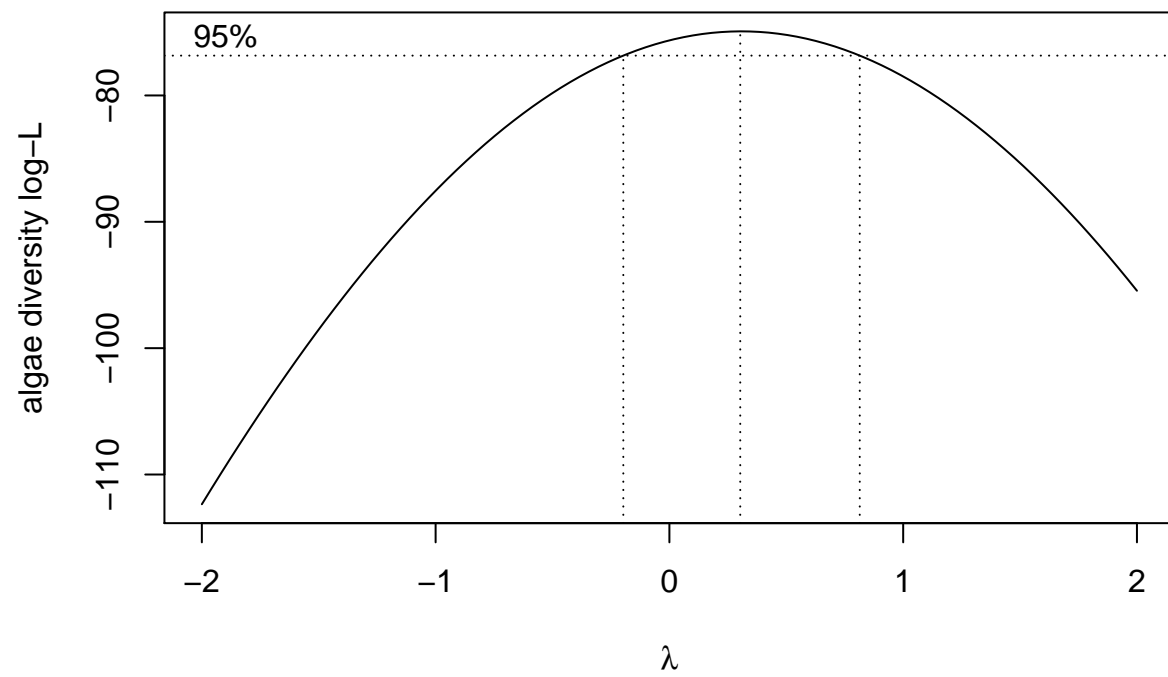
```r
boxcox(lm(algae_total_biomass ~ mean_no2_no3 + site, data=mydat2),ylab="algae biomass log-L")
```

preidctor transformed

#fish total biomass

```
fit.initial<-lm(fish_total_biomass^(0.06)~mean_ammonia+mean_no2_no3+mean_po4+mean_poc+mean_pon+mean_tchl
n<-dim(mydat2)[1]
scp<-list(lower=~1,upper=~mean_ammonia+mean_no2_no3+mean_po4+mean_poc+mean_pon+mean_tchl+summer_mean_ter
fit.final<-step(fit.initial, scope=scp, direction="backward",k=log(n))
```
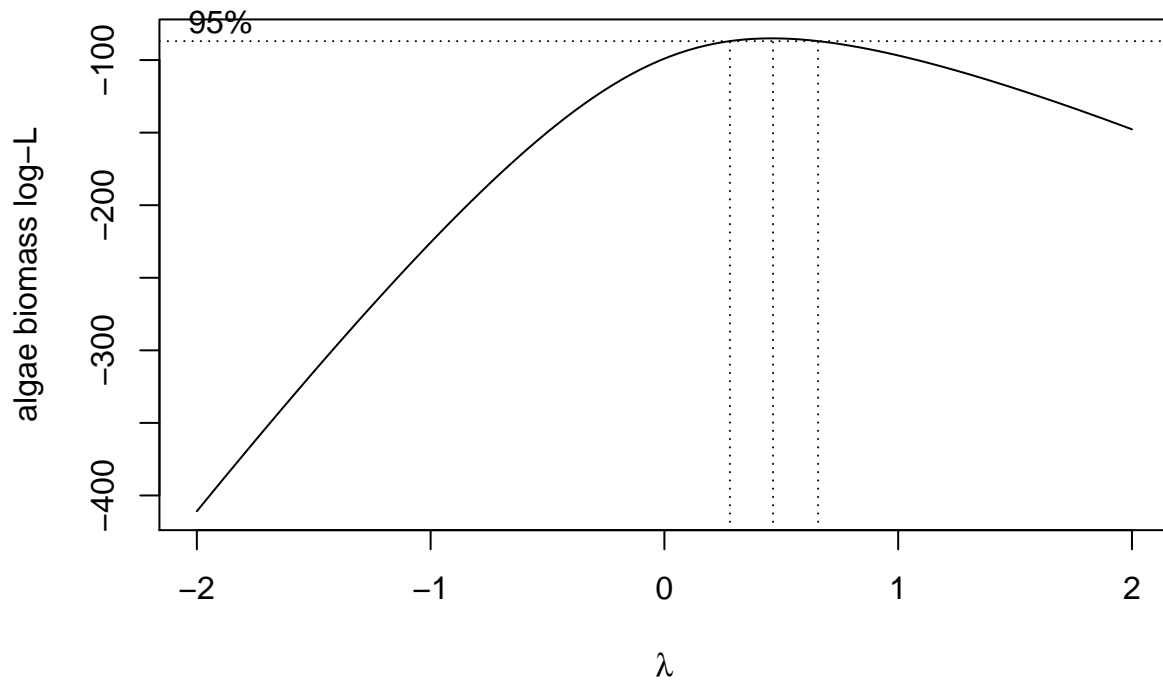
```
## Start:  AIC=-305.89
## fish_total_biomass^(0.06) ~ mean_ammonia + mean_no2_no3 + mean_po4 +
##     mean_poc + mean_pon + mean_tchl + summer_mean_temp + winter_mean_temp +
##     kelp_total_biomass + site
##
##                      Df Sum of Sq     RSS     AIC
## - mean_no2_no3        1  0.000058 0.21652 -310.03
## - winter_mean_temp    1  0.000330 0.21679 -309.95
## - summer_mean_temp    1  0.000453 0.21691 -309.91
## - mean_po4            1  0.000599 0.21706 -309.87
## - kelp_total_biomass  1  0.001046 0.21750 -309.74
## - mean_ammonia        1  0.001087 0.21755 -309.73
## - mean_tchl           1  0.010190 0.22665 -307.10
## <none>                           0.21646 -305.89
## - mean_pon            1  0.017096 0.23356 -305.18
## - mean_poc            1  0.017155 0.23361 -305.17
## - site                4  0.308992 0.52545 -265.76
```

```
##
## Step:  AIC=-310.03
## fish_total_biomass^(0.06) ~ mean_ammonia + mean_po4 + mean_poc +
##     mean_pon + mean_tchl + summer_mean_temp + winter_mean_temp +
##     kelp_total_biomass + site
##
##                       Df Sum of Sq     RSS     AIC
## - winter_mean_temp     1  0.000356 0.21687 -314.08
## - summer_mean_temp     1  0.000431 0.21695 -314.06
## - mean_po4             1  0.000543 0.21706 -314.03
## - mean_ammonia         1  0.001057 0.21757 -313.88
## - kelp_total_biomass   1  0.001131 0.21765 -313.85
## - mean_tchl            1  0.010336 0.22685 -311.20
## <none>                              0.21652 -310.03
## - mean_pon             1  0.017039 0.23356 -309.34
## - mean_poc             1  0.018180 0.23470 -309.03
## - site                 4  0.311567 0.52808 -269.60
##
## Step:  AIC=-314.08
## fish_total_biomass^(0.06) ~ mean_ammonia + mean_po4 + mean_poc +
##     mean_pon + mean_tchl + summer_mean_temp + kelp_total_biomass +
##     site
##
##                       Df Sum of Sq     RSS     AIC
## - summer_mean_temp     1   0.00023 0.21711 -318.17
## - kelp_total_biomass   1   0.00102 0.21790 -317.94
## - mean_ammonia         1   0.00110 0.21797 -317.92
## - mean_po4             1   0.00137 0.21824 -317.84
## - mean_tchl            1   0.01230 0.22917 -314.71
## <none>                              0.21687 -314.08
## - mean_pon             1   0.01669 0.23356 -313.50
## - mean_poc             1   0.01832 0.23520 -313.05
## - site                 4   0.32049 0.53736 -272.65
##
## Step:  AIC=-318.17
## fish_total_biomass^(0.06) ~ mean_ammonia + mean_po4 + mean_poc +
##     mean_pon + mean_tchl + kelp_total_biomass + site
##
##                       Df Sum of Sq     RSS     AIC
## - kelp_total_biomass   1   0.00079 0.21790 -322.10
## - mean_ammonia         1   0.00087 0.21797 -322.08
## - mean_po4             1   0.00136 0.21846 -321.93
## - mean_tchl            1   0.01237 0.22948 -318.78
## <none>                              0.21711 -318.17
## - mean_pon             1   0.01799 0.23510 -317.24
## - mean_poc             1   0.02379 0.24090 -315.68
## - site                 4   0.33229 0.54940 -275.39
##
## Step:  AIC=-322.1
## fish_total_biomass^(0.06) ~ mean_ammonia + mean_po4 + mean_poc +
##     mean_pon + mean_tchl + site
##
##                   Df Sum of Sq     RSS     AIC
## - mean_ammonia     1   0.00072 0.21862 -326.04
```

```
## - mean_po4       1   0.00196 0.21986 -325.68
## - mean_tchl      1   0.01308 0.23098 -322.53
## <none>                       0.21790 -322.10
## - mean_pon       1   0.01962 0.23752 -320.74
## - mean_poc       1   0.02409 0.24199 -319.55
## - site           4   0.49282 0.71072 -263.07
##
## Step:  AIC=-326.04
## fish_total_biomass^(0.06) ~ mean_po4 + mean_poc + mean_pon +
##     mean_tchl + site
##
##               Df Sum of Sq     RSS     AIC
## - mean_po4   1   0.00275 0.22137 -329.40
## - mean_tchl  1   0.01300 0.23163 -326.51
## <none>                   0.21862 -326.04
## - mean_pon   1   0.01894 0.23756 -324.89
## - mean_poc   1   0.02388 0.24250 -323.57
## - site       4   0.49722 0.71584 -266.77
##
## Step:  AIC=-329.4
## fish_total_biomass^(0.06) ~ mean_poc + mean_pon + mean_tchl +
##     site
##
##               Df Sum of Sq     RSS     AIC
## <none>                   0.22137 -329.40
## - mean_tchl  1   0.01599 0.23736 -329.10
## - mean_pon   1   0.01760 0.23897 -328.67
## - mean_poc   1   0.02113 0.24250 -327.73
## - site       4   0.51416 0.73553 -269.19
```

```r
fit.null1<-lm(fish_total_biomass^(0.06)~1,data=mydat2)
fit.final.forward<-step(fit.null1,scope=scp,direction="forward",k=log(n))
```

```
## Start:  AIC=-279.43
## fish_total_biomass^(0.06) ~ 1
##
##                       Df Sum of Sq     RSS     AIC
## + site                 4   0.51175 0.24991 -334.12
## + kelp_total_biomass   1   0.17124 0.59041 -291.57
## <none>                             0.76166 -279.43
## + mean_no2_no3         1   0.01520 0.74646 -276.56
## + mean_tchl            1   0.01076 0.75090 -276.19
## + mean_pon             1   0.00508 0.75658 -275.70
## + mean_po4             1   0.00319 0.75847 -275.54
## + mean_poc             1   0.00093 0.76073 -275.35
## + mean_ammonia         1   0.00076 0.76090 -275.34
## + winter_mean_temp     1   0.00010 0.76155 -275.28
## + summer_mean_temp     1   0.00001 0.76165 -275.28
##
## Step:  AIC=-334.12
## fish_total_biomass^(0.06) ~ site
##
##                       Df Sum of Sq     RSS     AIC
## <none>                             0.24991 -334.12
```

```
## + mean_poc            1 0.0099528 0.23996 -332.56
## + mean_tchl           1 0.0058729 0.24404 -331.48
## + mean_pon            1 0.0018252 0.24808 -330.43
## + kelp_total_biomass  1 0.0013306 0.24858 -330.30
## + mean_po4            1 0.0009784 0.24893 -330.21
## + winter_mean_temp    1 0.0002556 0.24965 -330.03
## + mean_no2_no3        1 0.0001584 0.24975 -330.00
## + summer_mean_temp    1 0.0000160 0.24989 -329.97
## + mean_ammonia        1 0.0000072 0.24990 -329.96
```
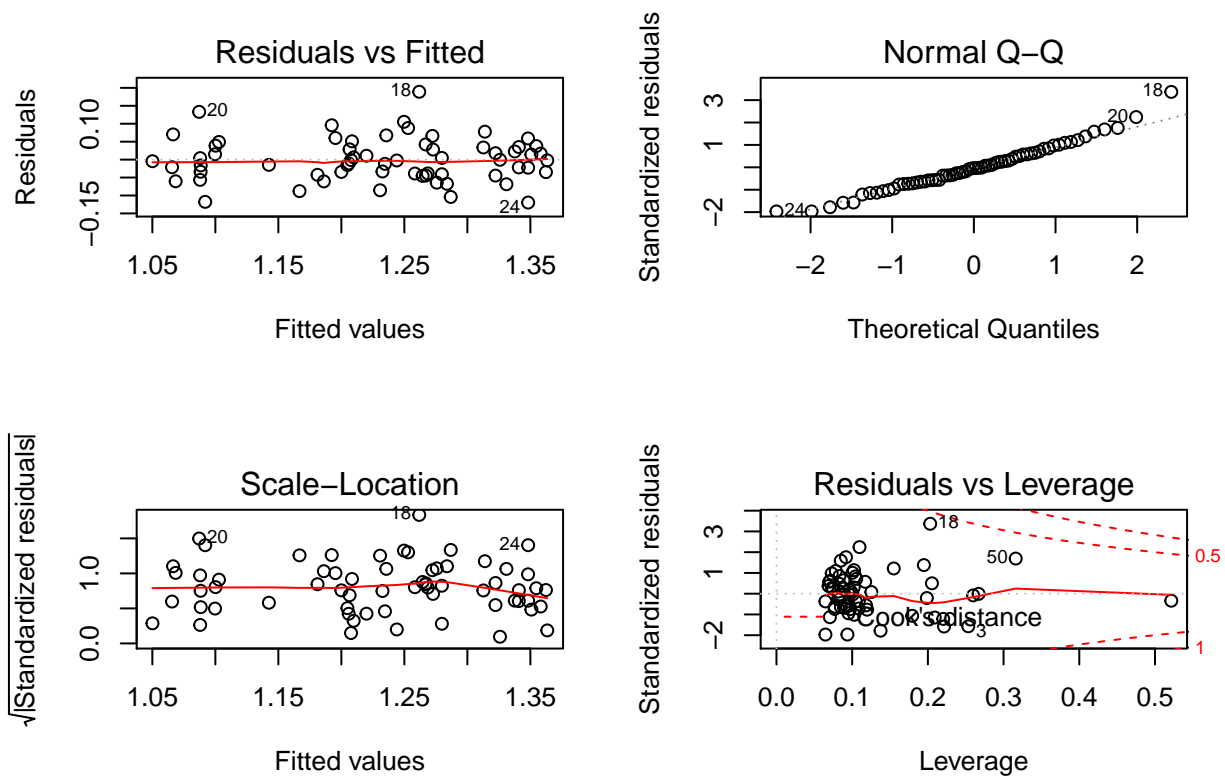
`summary(fit.final)`

```
##
## Call:
## lm(formula = fish_total_biomass^(0.06) ~ mean_poc + mean_pon +
##     mean_tchl + site, data = mydat2)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.119713 -0.039258 -0.002225  0.035699  0.189046
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.9874416  0.0624219  15.819  < 2e-16 ***
## mean_poc    -0.0014767  0.0006387  -2.312   0.0245 *
## mean_pon     0.1397910  0.0662556   2.110   0.0394 *
## mean_tchl   -0.0681026  0.0338659  -2.011   0.0492 *
## siteAQUE     0.1901052  0.0360849   5.268 2.27e-06 ***
## siteCARP     0.1791283  0.0254950   7.026 3.13e-09 ***
## siteMOHK     0.1170187  0.0247072   4.736 1.53e-05 ***
## siteNAPL     0.2656967  0.0237393  11.192 6.59e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.06287 on 56 degrees of freedom
## Multiple R-squared:  0.7094, Adjusted R-squared:  0.673
## F-statistic: 19.52 on 7 and 56 DF,  p-value: 6.007e-13
```

`summary(fit.final.forward)`

```
##
## Call:
## lm(formula = fish_total_biomass^(0.06) ~ site, data = mydat2)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.124439 -0.038144 -0.006519  0.039913  0.185888
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  1.08347    0.01805  60.024  < 2e-16 ***
## siteAQUE     0.18150    0.03425   5.299 1.81e-06 ***
## siteCARP     0.16879    0.02430   6.946 3.34e-09 ***
```

```
## siteMOHK      0.11536     0.02553    4.519 3.04e-05 ***
## siteNAPL      0.25663     0.02398   10.702 1.90e-15 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.06508 on 59 degrees of freedom
## Multiple R-squared:  0.6719, Adjusted R-squared:  0.6496
## F-statistic:  30.2 on 4 and 59 DF,  p-value: 1.099e-13
```

```r
par(mfrow=c(2,2))
plot(fit.final)
```


GLM

```r
fit1.glm<-glm(fish_total_biomass^(0.06)~mean_ammonia+mean_no2_no3+mean_po4+mean_poc+mean_pon+mean_tchl+s
summary(fit1.glm)
```

```
##
## Call:
## glm(formula = fish_total_biomass^(0.06) ~ mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_poc + mean_pon + mean_tchl + summer_mean_temp +
##     winter_mean_temp + kelp_total_biomass + site, family = Gamma,
##     data = mydat2)
##
## Deviance Residuals:
```

```
##        Min         1Q      Median         3Q         Max
## -0.106438  -0.034694  -0.002001   0.030774    0.141903
##
## Coefficients:
##                     Estimate Std. Error t value Pr(>|t|)
## (Intercept)        9.649e-01  6.065e-01   1.591  0.11796
## mean_ammonia       1.312e-05  2.627e-05   0.499  0.61974
## mean_no2_no3      -5.461e-06  3.493e-05  -0.156  0.87637
## mean_po4           1.378e-05  3.413e-05   0.404  0.68806
## mean_poc           1.173e-03  5.980e-04   1.962  0.05536 .
## mean_pon          -9.871e-02  5.053e-02  -1.954  0.05636 .
## mean_tchl          4.120e-02  2.708e-02   1.521  0.13447
## summer_mean_temp   4.183e-02  1.746e-01   0.240  0.81167
## winter_mean_temp  -1.037e-01  5.012e-01  -0.207  0.83687
## kelp_total_biomass -8.199e-04  1.896e-03  -0.432  0.66737
## siteAQUE          -1.306e-01  2.989e-02  -4.368 6.31e-05 ***
## siteCARP          -1.292e-01  2.542e-02  -5.083 5.58e-06 ***
## siteMOHK          -8.614e-02  2.119e-02  -4.064  0.00017 ***
## siteNAPL          -1.743e-01  2.127e-02  -8.196 8.30e-11 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for Gamma family taken to be 0.002979981)
##
##     Null deviance: 0.51588  on 63  degrees of freedom
## Residual deviance: 0.14695  on 50  degrees of freedom
## AIC: -151.12
##
## Number of Fisher Scoring iterations: 4
```

```
drop1(fit.final)
```

```
## Single term deletions
##
## Model:
## fish_total_biomass^(0.06) ~ mean_poc + mean_pon + mean_tchl +
##     site
##           Df Sum of Sq     RSS     AIC
## <none>                 0.22137 -346.67
## mean_poc   1   0.02113 0.24250 -342.84
## mean_pon   1   0.01760 0.23897 -343.78
## mean_tchl  1   0.01599 0.23736 -344.21
## site       4   0.51416 0.73553 -277.83
```

From above the final model we get is fish_total_biomass^(0.06) ~ mean_poc + log(mean_pon) + log(mean_tchl) + site

#diversity

```
fit.initial2<-lm(fish_diversity^(-0.9)~mean_ammonia+mean_no2_no3+mean_po4+mean_poc+mean_pon+mean_tchl+su
n<-dim(mydat2)[1]
scp2<-list(lower=~1,upper=~mean_ammonia+mean_no2_no3+mean_po4+mean_poc+mean_pon+mean_tchl+summer_mean_te
fit.final2<-step(fit.initial2, scope=scp2, direction="backward", k=log(n))
```

```
## Start:  AIC=-189.1
## fish_diversity^(-0.9) ~ mean_ammonia + mean_no2_no3 + mean_po4 +
##     mean_poc + mean_pon + mean_tchl + summer_mean_temp + winter_mean_temp +
##     kelp_total_biomass + site
##
##                          Df Sum of Sq    RSS      AIC
## - site                    4  0.184584 1.5270  -197.49
## - mean_po4                1  0.001261 1.3436  -193.20
## - mean_no2_no3            1  0.002645 1.3450  -193.13
## - mean_poc                1  0.004427 1.3468  -193.05
## - summer_mean_temp        1  0.008279 1.3507  -192.87
## - winter_mean_temp        1  0.016604 1.3590  -192.47
## - mean_tchl               1  0.026754 1.3691  -192.00
## - kelp_total_biomass      1  0.035053 1.3774  -191.61
## - mean_pon                1  0.056389 1.3988  -190.62
## <none>                               1.3424  -189.10
## - mean_ammonia            1  0.185923 1.5283  -184.96
##
## Step:  AIC=-197.49
## fish_diversity^(-0.9) ~ mean_ammonia + mean_no2_no3 + mean_po4 +
##     mean_poc + mean_pon + mean_tchl + summer_mean_temp + winter_mean_temp +
##     kelp_total_biomass
##
##                          Df Sum of Sq    RSS      AIC
## - summer_mean_temp        1  0.000016 1.5270  -201.65
## - mean_po4                1  0.000585 1.5275  -201.62
## - mean_no2_no3            1  0.000994 1.5280  -201.61
## - mean_poc                1  0.004817 1.5318  -201.45
## - kelp_total_biomass      1  0.005474 1.5324  -201.42
## - winter_mean_temp        1  0.010253 1.5372  -201.22
## - mean_tchl               1  0.056436 1.5834  -199.33
## - mean_pon                1  0.067822 1.5948  -198.87
## <none>                               1.5270  -197.49
## - mean_ammonia            1  0.144498 1.6715  -195.86
##
## Step:  AIC=-201.65
## fish_diversity^(-0.9) ~ mean_ammonia + mean_no2_no3 + mean_po4 +
##     mean_poc + mean_pon + mean_tchl + winter_mean_temp + kelp_total_biomass
##
##                          Df Sum of Sq    RSS      AIC
## - mean_po4                1  0.000648 1.5276  -205.78
## - mean_no2_no3            1  0.000996 1.5280  -205.76
## - mean_poc                1  0.004956 1.5319  -205.60
## - kelp_total_biomass      1  0.007273 1.5342  -205.50
## - winter_mean_temp        1  0.013370 1.5404  -205.25
## - mean_tchl               1  0.059014 1.5860  -203.38
## - mean_pon                1  0.068048 1.5950  -203.02
## <none>                               1.5270  -201.65
## - mean_ammonia            1  0.172441 1.6994  -198.96
##
## Step:  AIC=-205.78
## fish_diversity^(-0.9) ~ mean_ammonia + mean_no2_no3 + mean_poc +
##     mean_pon + mean_tchl + winter_mean_temp + kelp_total_biomass
##
```

```
##                     Df Sum of Sq    RSS     AIC
## - mean_no2_no3        1   0.001616 1.5292 -209.87
## - mean_poc            1   0.004892 1.5325 -209.73
## - kelp_total_biomass  1   0.006674 1.5343 -209.66
## - winter_mean_temp    1   0.012777 1.5404 -209.41
## - mean_tchl           1   0.059560 1.5872 -207.49
## - mean_pon            1   0.069443 1.5971 -207.09
## <none>                            1.5276 -205.78
## - mean_ammonia        1   0.183198 1.7108 -202.69
##
## Step:  AIC=-209.87
## fish_diversity^(-0.9) ~ mean_ammonia + mean_poc + mean_pon +
##     mean_tchl + winter_mean_temp + kelp_total_biomass
##
##                     Df Sum of Sq    RSS     AIC
## - mean_poc            1   0.005744 1.5350 -213.79
## - kelp_total_biomass  1   0.007644 1.5369 -213.71
## - winter_mean_temp    1   0.012569 1.5418 -213.51
## - mean_tchl           1   0.057955 1.5872 -211.65
## - mean_pon            1   0.067995 1.5972 -211.25
## <none>                            1.5292 -209.87
## - mean_ammonia        1   0.181631 1.7109 -206.85
##
## Step:  AIC=-213.79
## fish_diversity^(-0.9) ~ mean_ammonia + mean_pon + mean_tchl +
##     winter_mean_temp + kelp_total_biomass
##
##                     Df Sum of Sq    RSS     AIC
## - winter_mean_temp    1   0.007369 1.5424 -217.64
## - kelp_total_biomass  1   0.009236 1.5442 -217.56
## - mean_tchl           1   0.054116 1.5891 -215.73
## - mean_pon            1   0.091100 1.6261 -214.26
## <none>                            1.5350 -213.79
## - mean_ammonia        1   0.176564 1.7115 -210.98
##
## Step:  AIC=-217.64
## fish_diversity^(-0.9) ~ mean_ammonia + mean_pon + mean_tchl +
##     kelp_total_biomass
##
##                     Df Sum of Sq    RSS     AIC
## - kelp_total_biomass  1   0.013875 1.5562 -221.23
## <none>                            1.5424 -217.64
## - mean_tchl           1   0.110061 1.6524 -217.39
## - mean_pon            1   0.130638 1.6730 -216.60
## - mean_ammonia        1   0.219548 1.7619 -213.28
##
## Step:  AIC=-221.23
## fish_diversity^(-0.9) ~ mean_ammonia + mean_pon + mean_tchl
##
##                Df Sum of Sq    RSS     AIC
## <none>                       1.5562 -221.23
## - mean_tchl     1   0.11083 1.6671 -220.98
## - mean_pon      1   0.14998 1.7062 -219.50
## - mean_ammonia  1   0.21862 1.7749 -216.97
```

```
fit.null2<-lm(fish_diversity^(-0.9)~1,data=mydat2)
fit.final2.forward<-step(fit.null2,scope=scp2,direction="forward",k=log(n))
```

```
## Start:  AIC=-219.82
## fish_diversity^(-0.9) ~ 1
##
##                      Df Sum of Sq    RSS     AIC
## + mean_ammonia        1  0.226986 1.7063 -223.66
## + summer_mean_temp    1  0.177263 1.7560 -221.82
## + winter_mean_temp    1  0.157829 1.7754 -221.11
## <none>                            1.9332 -219.82
## + mean_po4            1  0.078253 1.8550 -218.31
## + mean_poc            1  0.045738 1.8875 -217.19
## + mean_tchl           1  0.027595 1.9057 -216.58
## + mean_no2_no3        1  0.018477 1.9148 -216.28
## + kelp_total_biomass  1  0.015105 1.9181 -216.16
## + mean_pon            1  0.001372 1.9319 -215.71
## + site                4  0.144514 1.7887 -208.16
##
## Step:  AIC=-223.66
## fish_diversity^(-0.9) ~ mean_ammonia
##
##                      Df Sum of Sq    RSS     AIC
## <none>                            1.7063 -223.66
## + winter_mean_temp    1  0.056924 1.6493 -221.67
## + mean_poc            1  0.053286 1.6530 -221.53
## + summer_mean_temp    1  0.048685 1.6576 -221.35
## + mean_pon            1  0.039202 1.6671 -220.98
## + kelp_total_biomass  1  0.030538 1.6757 -220.65
## + mean_no2_no3        1  0.005190 1.7011 -219.69
## + mean_po4            1  0.004929 1.7013 -219.68
## + mean_tchl           1  0.000048 1.7062 -219.50
## + site                4  0.186567 1.5197 -214.43
```

```
summary(fit.final2)
```

```
##
## Call:
## lm(formula = fish_diversity^(-0.9) ~ mean_ammonia + mean_pon +
##     mean_tchl, data = mydat2)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.31077 -0.10650  0.01496  0.10812  0.41368
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  6.157e-01  1.184e-01   5.202 2.51e-06 ***
## mean_ammonia -2.086e-04 7.185e-05  -2.903  0.00516 **
## mean_pon      2.610e-01  1.085e-01   2.405  0.01929 *
## mean_tchl    -1.572e-01  7.604e-02  -2.067  0.04305 *
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1611 on 60 degrees of freedom
## Multiple R-squared:  0.195,  Adjusted R-squared:  0.1548
## F-statistic: 4.845 on 3 and 60 DF,  p-value: 0.004381
```

```r
summary(glm(fish_diversity~kelp_total_biomass+mean_ammonia+mean_no2_no3+mean_po4+mean_poc+mean_pon+mean_
```

```
##
## Call:
## glm(formula = fish_diversity ~ kelp_total_biomass + mean_ammonia +
##     mean_no2_no3 + mean_po4 + mean_poc + mean_pon + mean_tchl +
##     kelp_total_biomass:mean_poc + summer_mean_temp + winter_mean_temp +
##     site, family = "Gamma", data = mydat2)
##
## Deviance Residuals:
##      Min        1Q    Median        3Q       Max
## -0.55123  -0.19364  -0.06179   0.12093   0.58216
##
## Coefficients:
##                               Estimate Std. Error t value Pr(>|t|)
## (Intercept)                  1.836e-01  2.372e+00   0.077   0.9386
## kelp_total_biomass           3.473e-02  1.614e-02   2.152   0.0364 *
## mean_ammonia                -3.105e-04  1.040e-04  -2.987   0.0044 **
## mean_no2_no3                 2.392e-05  1.515e-04   0.158   0.8752
## mean_po4                     3.132e-05  1.412e-04   0.222   0.8254
## mean_poc                     6.795e-03  4.511e-03   1.506   0.1384
## mean_pon                     3.044e-01  1.975e-01   1.541   0.1297
## mean_tchl                   -8.584e-02  1.064e-01  -0.807   0.4236
## summer_mean_temp            -4.686e-01  6.942e-01  -0.675   0.5028
## winter_mean_temp             1.277e+00  2.040e+00   0.626   0.5343
## siteAQUE                    -1.173e-01  1.140e-01  -1.029   0.3086
## siteCARP                    -4.457e-02  1.012e-01  -0.440   0.6616
## siteMOHK                     8.259e-02  8.704e-02   0.949   0.3473
## siteNAPL                    -1.132e-01  8.125e-02  -1.393   0.1700
## kelp_total_biomass:mean_poc -6.717e-04  3.336e-04  -2.013   0.0496 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for Gamma family taken to be 0.07780034)
##
##     Null deviance: 5.5986  on 63  degrees of freedom
## Residual deviance: 3.6105  on 49  degrees of freedom
## AIC: 84.652
##
## Number of Fisher Scoring iterations: 5
```

The final model can be GLM with Gamma family fish_diversity~kelp_total_biomass^(1/3)+mean_ammonia+kelp_total_bio

#invert_total_biomass

```r
fit.initial3<-lm(invert_total_biomass^(0.125)~mean_ammonia+mean_no2_no3+mean_po4+mean_poc+mean_pon+mean_
n<-dim(data.waterchem)[1]
```

```
scp3<-list(lower=~1,upper=~mean_ammonia+mean_no2_no3+mean_po4+mean_poc+mean_pon+mean_tchl+summer_mean_te
fit.final3<-step(fit.initial3,scope=scp3,direction="backward",k=log(n))
```

```
## Start:  AIC=-198.02
## invert_total_biomass^(0.125) ~ mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_poc + mean_pon + mean_tchl + summer_mean_temp +
##     winter_mean_temp + kelp_total_biomass + site
##
##                       Df Sum of Sq     RSS      AIC
## - mean_poc             1    0.0012  1.1689 -202.117
## - winter_mean_temp     1    0.0023  1.1700 -202.056
## - mean_pon             1    0.0101  1.1777 -201.633
## - mean_ammonia         1    0.0180  1.1857 -201.201
## - mean_po4             1    0.0441  1.2118 -199.808
## - summer_mean_temp     1    0.0594  1.2271 -199.007
## <none>                             1.1677 -198.023
## - kelp_total_biomass   1    0.0806  1.2483 -197.908
## - mean_tchl            1    0.1014  1.2691 -196.851
## - mean_no2_no3         1    0.1124  1.2800 -196.302
## - site                 4   15.5795 16.7472  -44.213
##
## Step:  AIC=-202.12
## invert_total_biomass^(0.125) ~ mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_pon + mean_tchl + summer_mean_temp + winter_mean_temp +
##     kelp_total_biomass + site
##
##                       Df Sum of Sq     RSS      AIC
## - winter_mean_temp     1    0.0015  1.1704 -206.191
## - mean_ammonia         1    0.0178  1.1867 -205.307
## - mean_pon             1    0.0309  1.1998 -204.605
## - mean_po4             1    0.0438  1.2127 -203.921
## - summer_mean_temp     1    0.0689  1.2377 -202.612
## <none>                             1.1689 -202.117
## - kelp_total_biomass   1    0.0847  1.2535 -201.799
## - mean_tchl            1    0.1016  1.2705 -200.939
## - mean_no2_no3         1    0.1120  1.2809 -200.417
## - site                 4   15.6196 16.7885  -48.214
##
## Step:  AIC=-206.19
## invert_total_biomass^(0.125) ~ mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_pon + mean_tchl + summer_mean_temp + kelp_total_biomass +
##     site
##
##                       Df Sum of Sq     RSS      AIC
## - mean_ammonia         1    0.0184  1.1888 -209.353
## - mean_pon             1    0.0296  1.2000 -208.753
## - mean_po4             1    0.0481  1.2185 -207.771
## - summer_mean_temp     1    0.0751  1.2455 -206.372
## <none>                             1.1704 -206.191
## - kelp_total_biomass   1    0.0832  1.2536 -205.957
## - mean_tchl            1    0.1035  1.2739 -204.926
## - mean_no2_no3         1    0.1114  1.2818 -204.533
## - site                 4   19.4110 20.5814  -39.337
```

```
##
## Step:  AIC=-209.35
## invert_total_biomass^(0.125) ~ mean_no2_no3 + mean_po4 + mean_pon +
##     mean_tchl + summer_mean_temp + kelp_total_biomass + site
##
##                        Df Sum of Sq     RSS      AIC
## - mean_pon              1    0.0350  1.2238 -211.654
## - mean_po4              1    0.0385  1.2273 -211.471
## - summer_mean_temp      1    0.0571  1.2459 -210.511
## - kelp_total_biomass    1    0.0679  1.2567 -209.958
## <none>                             1.1888 -209.353
## - mean_no2_no3          1    0.1190  1.3078 -207.406
## - mean_tchl             1    0.1198  1.3086 -207.368
## - site                  4   19.5704 20.7592  -42.945
##
## Step:  AIC=-211.65
## invert_total_biomass^(0.125) ~ mean_no2_no3 + mean_po4 + mean_tchl +
##     summer_mean_temp + kelp_total_biomass + site
##
##                        Df Sum of Sq     RSS      AIC
## - mean_po4              1    0.0385  1.2623 -213.830
## - kelp_total_biomass    1    0.0532  1.2770 -213.088
## - summer_mean_temp      1    0.0735  1.2973 -212.083
## <none>                             1.2238 -211.654
## - mean_no2_no3          1    0.0933  1.3171 -211.113
## - mean_tchl             1    0.1190  1.3428 -209.874
## - site                  4   19.5383 20.7621  -47.095
##
## Step:  AIC=-213.83
## invert_total_biomass^(0.125) ~ mean_no2_no3 + mean_tchl + summer_mean_temp +
##     kelp_total_biomass + site
##
##                        Df Sum of Sq     RSS      AIC
## - kelp_total_biomass    1    0.0410  1.3034 -215.941
## - mean_no2_no3          1    0.0645  1.3268 -214.801
## <none>                             1.2623 -213.830
## - summer_mean_temp      1    0.1162  1.3786 -212.351
## - mean_tchl             1    0.1422  1.4045 -211.157
## - site                  4   21.1027 22.3650  -46.494
##
## Step:  AIC=-215.94
## invert_total_biomass^(0.125) ~ mean_no2_no3 + mean_tchl + summer_mean_temp +
##     site
##
##                        Df Sum of Sq     RSS      AIC
## - mean_no2_no3          1    0.0551  1.3584 -217.451
## - summer_mean_temp      1    0.0816  1.3850 -216.214
## <none>                             1.3034 -215.941
## - mean_tchl             1    0.1946  1.4980 -211.192
## - site                  4   26.2231 27.5265  -37.364
##
## Step:  AIC=-217.45
## invert_total_biomass^(0.125) ~ mean_tchl + summer_mean_temp +
##     site
```

```
## 
##                     Df Sum of Sq     RSS      AIC
## - summer_mean_temp  1     0.0674  1.4259 -218.510
## <none>                            1.3584 -217.451
## - mean_tchl         1     0.1859  1.5443 -213.402
## - site              4    26.2360 27.5945  -41.364
## 
## Step:  AIC=-218.51
## invert_total_biomass^(0.125) ~ mean_tchl + site
## 
##              Df Sum of Sq     RSS      AIC
## <none>                    1.4259 -218.510
## - mean_tchl   1    0.3847  1.8106 -207.381
## - site        4   28.1298 29.5556  -41.129
```

```
fit.null3<-lm(invert_total_biomass^(0.125)~1,data=mydat2)
fit.final3.forward<-step(fit.null3,scope=scp3,direction="forward",k=log(n))
```

```
## Start:  AIC=-31.97
## invert_total_biomass^(0.125) ~ 1
## 
##                       Df Sum of Sq    RSS      AIC
## + site                 4    34.583  1.811 -207.381
## + kelp_total_biomass   1    10.719 25.675  -50.137
## + mean_pon             1     6.849 29.545  -41.152
## + mean_tchl            1     6.838 29.556  -41.129
## + mean_poc             1     4.148 32.246  -35.553
## <none>                           36.394  -31.968
## + mean_ammonia         1     2.286 34.108  -31.960
## + mean_po4             1     1.689 34.705  -30.851
## + winter_mean_temp     1     0.195 36.199  -28.154
## + summer_mean_temp     1     0.062 36.332  -27.918
## + mean_no2_no3         1     0.056 36.338  -27.907
## 
## Step:  AIC=-207.38
## invert_total_biomass^(0.125) ~ site
## 
##                       Df Sum of Sq    RSS     AIC
## + mean_tchl            1   0.38472 1.4259 -218.51
## + summer_mean_temp     1   0.26627 1.5443 -213.40
## + winter_mean_temp     1   0.26098 1.5496 -213.18
## + mean_pon             1   0.19412 1.6164 -210.48
## + mean_po4             1   0.12057 1.6900 -207.63
## <none>                          1.8106 -207.38
## + mean_ammonia         1   0.05494 1.7556 -205.19
## + mean_poc             1   0.01927 1.7913 -203.91
## + mean_no2_no3         1   0.01750 1.7931 -203.84
## + kelp_total_biomass   1   0.01436 1.7962 -203.73
## 
## Step:  AIC=-218.51
## invert_total_biomass^(0.125) ~ site + mean_tchl
## 
##                       Df Sum of Sq    RSS     AIC
## <none>                          1.4259 -218.51
```

```
## + summer_mean_temp    1  0.067430 1.3584 -217.45
## + mean_no2_no3        1  0.040908 1.3849 -216.21
## + winter_mean_temp    1  0.038854 1.3870 -216.12
## + mean_poc            1  0.037355 1.3885 -216.05
## + mean_po4            1  0.028437 1.3974 -215.64
## + mean_pon            1  0.020629 1.4052 -215.28
## + mean_ammonia        1  0.005124 1.4207 -214.58
## + kelp_total_biomass  1  0.004882 1.4210 -214.57
```

```r
summary(fit.final3.forward)
```

```
##
## Call:
## lm(formula = invert_total_biomass^(0.125) ~ site + mean_tchl,
##     data = mydat2)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.31182 -0.07891  0.00384  0.08597  0.37674
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  1.20349    0.05672  21.217  < 2e-16 ***
## siteAQUE     1.14651    0.08953  12.806  < 2e-16 ***
## siteCARP     2.05996    0.06215  33.145  < 2e-16 ***
## siteMOHK     0.90419    0.06153  14.694  < 2e-16 ***
## siteNAPL     1.32431    0.05851  22.635  < 2e-16 ***
## mean_tchl    0.16766    0.04238   3.956  0.00021 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1568 on 58 degrees of freedom
## Multiple R-squared:  0.9608, Adjusted R-squared:  0.9574
## F-statistic: 284.5 on 5 and 58 DF,  p-value: < 2.2e-16
```

```r
summary(fit.final3)
```

```
##
## Call:
## lm(formula = invert_total_biomass^(0.125) ~ mean_tchl + site,
##     data = mydat2)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.31182 -0.07891  0.00384  0.08597  0.37674
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  1.20349    0.05672  21.217  < 2e-16 ***
## mean_tchl    0.16766    0.04238   3.956  0.00021 ***
## siteAQUE     1.14651    0.08953  12.806  < 2e-16 ***
## siteCARP     2.05996    0.06215  33.145  < 2e-16 ***
## siteMOHK     0.90419    0.06153  14.694  < 2e-16 ***
```

```
## siteNAPL      1.32431     0.05851  22.635   < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1568 on 58 degrees of freedom
## Multiple R-squared:  0.9608, Adjusted R-squared:  0.9574
## F-statistic: 284.5 on 5 and 58 DF,  p-value: < 2.2e-16
```

so we take fit.final3, which is invert_total_biomass^(0.125) ~ log(mean_tchl) + site

```r
par(mfrow=c(2,2))
plot(fit.final3)
```



```r
summary(fit.final3)
```

```
##
## Call:
## lm(formula = invert_total_biomass^(0.125) ~ mean_tchl + site,
##     data = mydat2)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.31182 -0.07891  0.00384  0.08597  0.37674
##
## Coefficients:
```

```
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  1.20349    0.05672  21.217  < 2e-16 ***
## mean_tchl    0.16766    0.04238   3.956  0.00021 ***
## siteAQUE     1.14651    0.08953  12.806  < 2e-16 ***
## siteCARP     2.05996    0.06215  33.145  < 2e-16 ***
## siteMOHK     0.90419    0.06153  14.694  < 2e-16 ***
## siteNAPL     1.32431    0.05851  22.635  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1568 on 58 degrees of freedom
## Multiple R-squared:  0.9608, Adjusted R-squared:  0.9574
## F-statistic: 284.5 on 5 and 58 DF,  p-value: < 2.2e-16
```
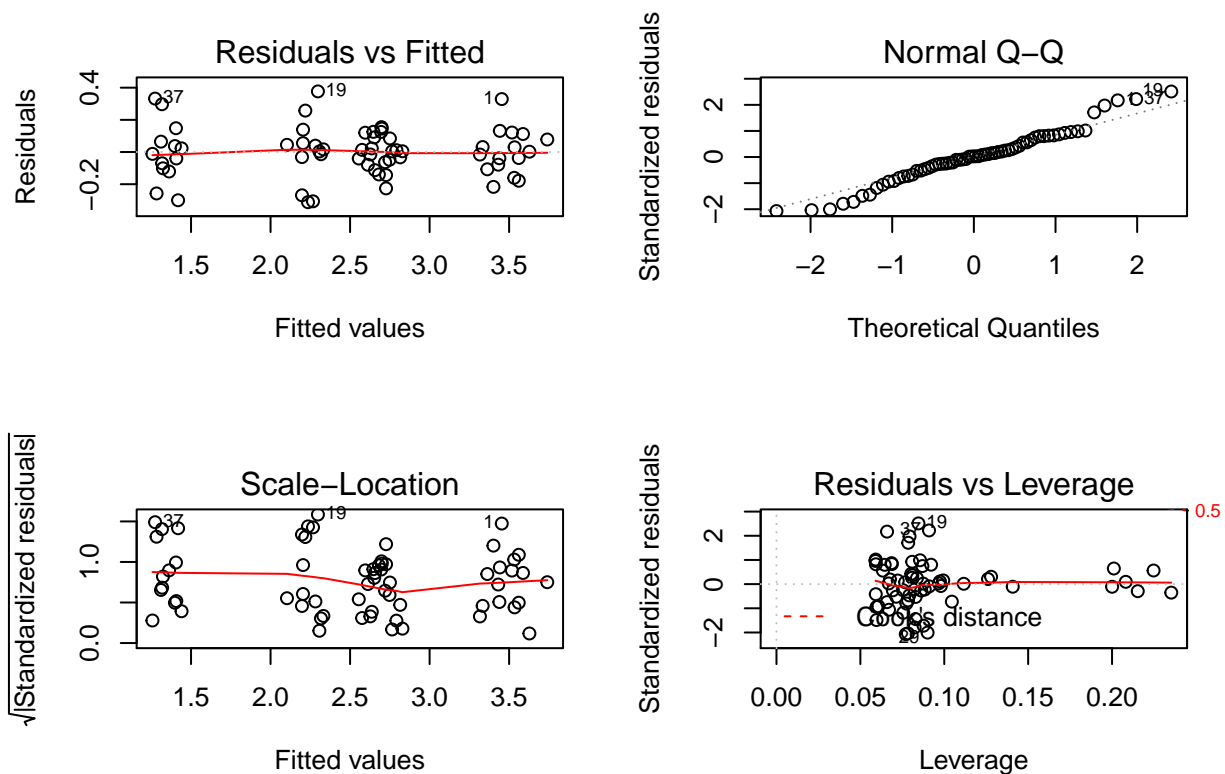
#invert_diversity

```
fit.initial4<-lm(invert_diversity^(-2)~mean_ammonia+mean_no2_no3+mean_po4+mean_poc+mean_pon+mean_tchl+su
n<-dim(mydat2)[1]
scp4<-list(lower=~1,upper=~mean_ammonia+mean_no2_no3+mean_po4+mean_poc+mean_pon+mean_tchl+summer_mean_t
fit.final4<-step(fit.initial4,scope=scp4,direction="backward",k=log(n))
```

```
## Start:  AIC=-298.05
## invert_diversity^(-2) ~ mean_ammonia + mean_no2_no3 + mean_po4 +
##     mean_poc + mean_pon + mean_tchl + summer_mean_temp + winter_mean_temp +
##     kelp_total_biomass + site
##
##                      Df Sum of Sq     RSS     AIC
## - mean_tchl           1   0.00000 0.24465 -302.21
## - mean_no2_no3        1   0.00170 0.24635 -301.77
## - mean_pon            1   0.00177 0.24641 -301.75
## - mean_po4            1   0.00226 0.24691 -301.62
## - winter_mean_temp    1   0.00290 0.24754 -301.46
## - mean_poc            1   0.00550 0.25014 -300.79
## <none>                            0.24464 -298.05
## - mean_ammonia        1   0.02589 0.27053 -295.77
## - summer_mean_temp    1   0.03780 0.28244 -293.02
## - kelp_total_biomass  1   0.05998 0.30462 -288.18
## - site                4   1.33201 1.57665 -195.44
##
## Step:  AIC=-302.21
## invert_diversity^(-2) ~ mean_ammonia + mean_no2_no3 + mean_po4 +
##     mean_poc + mean_pon + summer_mean_temp + winter_mean_temp +
##     kelp_total_biomass + site
##
##                      Df Sum of Sq     RSS     AIC
## - mean_no2_no3        1   0.00175 0.24640 -305.91
## - mean_po4            1   0.00226 0.24691 -305.78
## - mean_pon            1   0.00260 0.24725 -305.69
## - winter_mean_temp    1   0.00321 0.24786 -305.54
## - mean_poc            1   0.00549 0.25014 -304.95
## <none>                            0.24465 -302.21
## - mean_ammonia        1   0.02665 0.27130 -299.75
## - summer_mean_temp    1   0.03924 0.28389 -296.85
```

```
## - kelp_total_biomass  1    0.05997 0.30462 -292.34
## - site                4    1.39451 1.63916 -197.11
##
## Step:  AIC=-305.91
## invert_diversity^(-2) ~ mean_ammonia + mean_po4 + mean_poc +
##     mean_pon + summer_mean_temp + winter_mean_temp + kelp_total_biomass +
##     site
##
##                       Df Sum of Sq     RSS     AIC
## - mean_po4             1    0.00142 0.24781 -309.71
## - mean_pon             1    0.00299 0.24939 -309.30
## - winter_mean_temp     1    0.00335 0.24974 -309.21
## - mean_poc             1    0.00704 0.25343 -308.27
## <none>                            0.24640 -305.91
## - mean_ammonia         1    0.02722 0.27362 -303.37
## - summer_mean_temp     1    0.04000 0.28640 -300.44
## - kelp_total_biomass   1    0.05832 0.30471 -296.48
## - site                4    1.48551 1.73190 -197.75
##
## Step:  AIC=-309.71
## invert_diversity^(-2) ~ mean_ammonia + mean_poc + mean_pon +
##     summer_mean_temp + winter_mean_temp + kelp_total_biomass +
##     site
##
##                       Df Sum of Sq     RSS     AIC
## - mean_pon             1    0.00298 0.25080 -313.10
## - mean_poc             1    0.00686 0.25468 -312.12
## - winter_mean_temp     1    0.00786 0.25568 -311.87
## <none>                            0.24781 -309.71
## - mean_ammonia         1    0.02587 0.27369 -307.51
## - summer_mean_temp     1    0.03863 0.28644 -304.59
## - kelp_total_biomass   1    0.05713 0.30494 -300.59
## - site                4    1.64827 1.89609 -196.11
##
## Step:  AIC=-313.1
## invert_diversity^(-2) ~ mean_ammonia + mean_poc + summer_mean_temp +
##     winter_mean_temp + kelp_total_biomass + site
##
##                       Df Sum of Sq     RSS     AIC
## - winter_mean_temp     1    0.00520 0.25600 -315.94
## - mean_poc             1    0.00527 0.25606 -315.93
## <none>                            0.25080 -313.10
## - mean_ammonia         1    0.02597 0.27677 -310.95
## - summer_mean_temp     1    0.03565 0.28645 -308.75
## - kelp_total_biomass   1    0.05423 0.30503 -304.73
## - site                4    1.90264 2.15344 -192.12
##
## Step:  AIC=-315.94
## invert_diversity^(-2) ~ mean_ammonia + mean_poc + summer_mean_temp +
##     kelp_total_biomass + site
##
##                       Df Sum of Sq     RSS     AIC
## - mean_poc             1    0.00500 0.26100 -318.86
## <none>                            0.25600 -315.94
```

```
## - mean_ammonia          1   0.02377 0.27976 -314.42
## - kelp_total_biomass  1   0.05937 0.31536 -306.76
## - summer_mean_temp     1   0.08251 0.33851 -302.22
## - site                 4   1.90827 2.16427 -195.96
##
## Step:  AIC=-318.86
## invert_diversity^(-2) ~ mean_ammonia + summer_mean_temp + kelp_total_biomass +
##     site
##
##                      Df Sum of Sq     RSS     AIC
## <none>                            0.26100 -318.86
## - mean_ammonia          1   0.02552 0.28652 -317.05
## - kelp_total_biomass  1   0.06665 0.32765 -308.47
## - summer_mean_temp     1   0.08044 0.34144 -305.83
## - site                 4   2.22894 2.48994 -191.15
```

```r
fit.null4<-lm(invert_diversity^(-2)~1,data=mydat2)
fit.final4.forward<-step(fit.null4,scope=scp4,direction="forward",k=log(n))
```

```
## Start:  AIC=-184.08
## invert_diversity^(-2) ~ 1
##
##                      Df Sum of Sq    RSS     AIC
## + site                 4   3.01090 0.3683 -309.30
## + mean_pon             1   1.02755 2.3516 -203.12
## + mean_tchl            1   0.81974 2.5594 -197.70
## + mean_poc             1   0.57063 2.8086 -191.76
## + kelp_total_biomass  1   0.56381 2.8154 -191.60
## + mean_ammonia         1   0.41168 2.9675 -188.24
## + mean_po4             1   0.25566 3.1235 -184.96
## <none>                            3.3792 -184.08
## + mean_no2_no3         1   0.04242 3.3368 -180.73
## + summer_mean_temp     1   0.00021 3.3790 -179.93
## + winter_mean_temp     1   0.00017 3.3790 -179.93
##
## Step:  AIC=-309.3
## invert_diversity^(-2) ~ site
##
##                      Df Sum of Sq     RSS     AIC
## + winter_mean_temp     1  0.035407 0.33288 -311.61
## + mean_tchl            1  0.034135 0.33415 -311.37
## + summer_mean_temp     1  0.032050 0.33623 -310.97
## + kelp_total_biomass  1  0.026200 0.34209 -309.87
## + mean_pon             1  0.025729 0.34256 -309.78
## <none>                            0.36828 -309.30
## + mean_po4             1  0.008547 0.35974 -306.65
## + mean_poc             1  0.006329 0.36196 -306.25
## + mean_ammonia         1  0.001012 0.36727 -305.32
## + mean_no2_no3         1  0.000023 0.36826 -305.15
##
## Step:  AIC=-311.61
## invert_diversity^(-2) ~ site + winter_mean_temp
##
##                      Df Sum of Sq     RSS     AIC
```

```
## + kelp_total_biomass  1  0.033122 0.29976 -314.16
## <none>                             0.33288 -311.61
## + mean_poc            1  0.011256 0.32162 -309.66
## + mean_pon            1  0.010428 0.32245 -309.49
## + mean_tchl           1  0.009168 0.32371 -309.24
## + mean_ammonia        1  0.005505 0.32737 -308.52
## + summer_mean_temp    1  0.004045 0.32883 -308.24
## + mean_no2_no3        1  0.002859 0.33002 -308.01
## + mean_po4            1  0.001631 0.33125 -307.77
##
## Step:  AIC=-314.16
## invert_diversity^(-2) ~ site + winter_mean_temp + kelp_total_biomass
##
##                   Df Sum of Sq     RSS      AIC
## <none>                         0.29975 -314.16
## + summer_mean_temp 1 0.0159291 0.28383 -313.50
## + mean_ammonia     1 0.0088630 0.29089 -311.93
## + mean_poc         1 0.0056422 0.29411 -311.22
## + mean_no2_no3     1 0.0048275 0.29493 -311.04
## + mean_tchl        1 0.0043811 0.29537 -310.95
## + mean_pon         1 0.0035637 0.29619 -310.77
## + mean_po4         1 0.0000702 0.29968 -310.02
```

summary(fit.final4)

```
##
## Call:
## lm(formula = invert_diversity^(-2) ~ mean_ammonia + summer_mean_temp +
##     kelp_total_biomass + site, data = mydat2)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.147026 -0.041752 -0.003618  0.033195  0.240452
##
## Coefficients:
##                     Estimate Std. Error t value Pr(>|t|)
## (Intercept)         2.424e+00  5.709e-01   4.245 8.29e-05 ***
## mean_ammonia       -9.353e-05  3.997e-05  -2.340 0.022864 *
## summer_mean_temp   -8.383e-01  2.018e-01  -4.154 0.000113 ***
## kelp_total_biomass  1.023e-02  2.706e-03   3.782 0.000381 ***
## siteAQUE            4.292e-01  4.296e-02   9.991 4.73e-14 ***
## siteCARP            4.451e-01  3.184e-02  13.979  < 2e-16 ***
## siteMOHK            4.497e-02  3.032e-02   1.483 0.143561
## siteNAPL           -6.683e-02  3.122e-02  -2.141 0.036663 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.06827 on 56 degrees of freedom
## Multiple R-squared:  0.9228, Adjusted R-squared:  0.9131
## F-statistic: 95.58 on 7 and 56 DF,  p-value: < 2.2e-16
```

summary(fit.final4.forward)

```
## 
## Call:
## lm(formula = invert_diversity^(-2) ~ site + winter_mean_temp +
##     kelp_total_biomass, data = mydat2)
## 
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.140361 -0.039101 -0.006535  0.034351  0.225002
## 
## Coefficients:
##                     Estimate Std. Error t value Pr(>|t|)
## (Intercept)         1.250375   0.418966   2.984  0.00418 **
## siteAQUE            0.432695   0.045805   9.446 2.91e-13 ***
## siteCARP            0.439861   0.033107  13.286  < 2e-16 ***
## siteMOHK            0.038254   0.032111   1.191  0.23847
## siteNAPL           -0.042886   0.032049  -1.338  0.18616
## winter_mean_temp   -1.218238   0.429393  -2.837  0.00629 **
## kelp_total_biomass  0.006678   0.002661   2.510  0.01495 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## Residual standard error: 0.07252 on 57 degrees of freedom
## Multiple R-squared:  0.9113, Adjusted R-squared:  0.902
## F-statistic: 97.59 on 6 and 57 DF,  p-value: < 2.2e-16
```

the final model is invert_diversity^(-2) ~ mean_ammonia + log(summer_mean_temp) + kelp_total_biomass^(1/3) + site

```
par(mfrow=c(2,2))
plot(fit.final4)
```
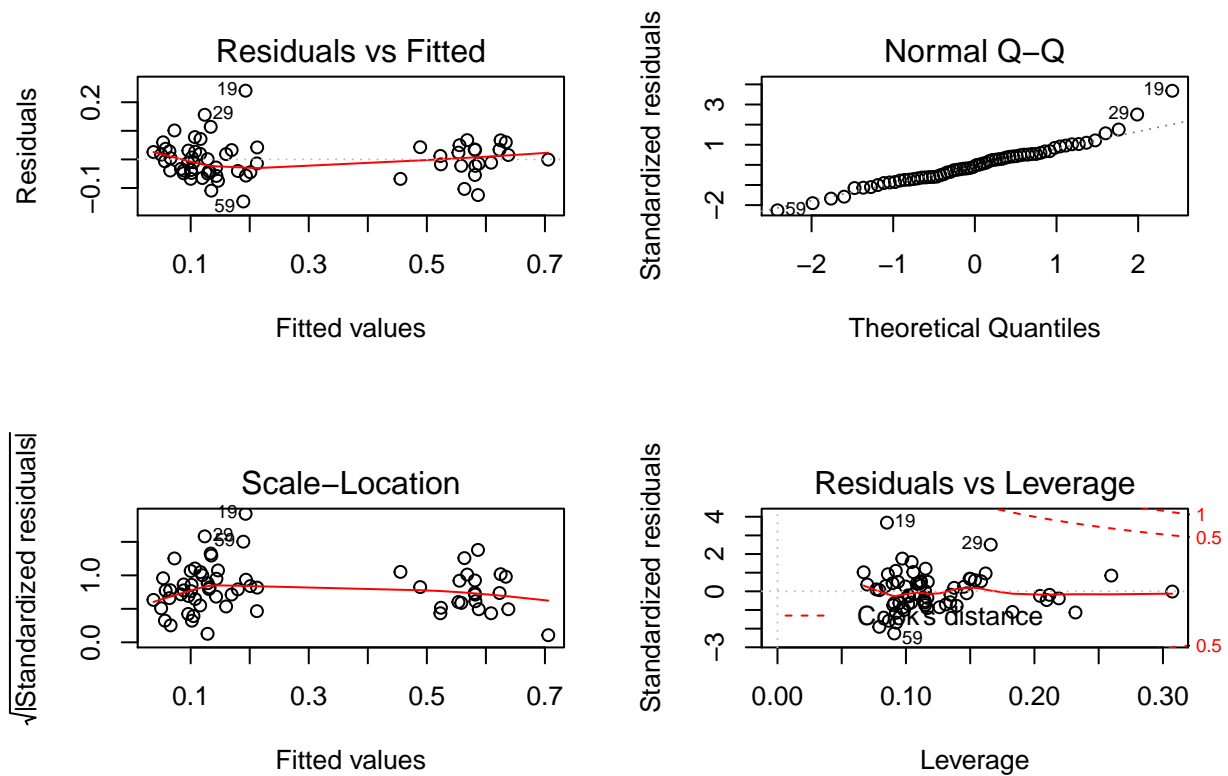
normality assumption seems to be satisfied but constant variance assumption seems to be violated.

#algae_total_biomass

```
fit.initial5<-lm(algae_total_biomass^(0.45)~mean_ammonia+mean_no2_no3+mean_po4+mean_poc+mean_pon+mean_t
n<-dim(mydat2)[1]
scp5<-list(lower=~1,upper=~mean_ammonia+mean_no2_no3+mean_po4+mean_poc+mean_pon+mean_tchl+summer_mean_t
fit.final5<-step(fit.initial5,scope=scp5,direction="backward",k=log(n))
```

```
## Start:  AIC=216.81
## algae_total_biomass^(0.45) ~ mean_ammonia + mean_no2_no3 + mean_po4 +
##     mean_poc + mean_pon + mean_tchl + summer_mean_temp + winter_mean_temp +
##     kelp_total_biomass + site
##
##                      Df Sum of Sq     RSS    AIC
## - mean_tchl           1      0.74  763.42 212.72
## - summer_mean_temp    1      0.93  763.61 212.73
## - mean_po4            1      2.56  765.24 212.87
## - kelp_total_biomass  1      3.88  766.56 212.98
## - mean_pon            1      4.41  767.09 213.02
## - mean_poc            1      7.71  770.39 213.30
## - mean_ammonia        1     22.64  785.32 214.53
## - winter_mean_temp    1     39.49  802.17 215.88
## <none>                              762.68 216.81
## - mean_no2_no3        1    103.91  866.59 220.83
## - site                4   1131.01 1893.69 258.38
##
```

```
## Step:  AIC=212.72
## algae_total_biomass^(0.45) ~ mean_ammonia + mean_no2_no3 + mean_po4 +
##     mean_poc + mean_pon + summer_mean_temp + winter_mean_temp +
##     kelp_total_biomass + site
##
##                         Df Sum of Sq     RSS    AIC
## - summer_mean_temp       1      0.68  764.10 208.62
## - mean_po4               1      2.74  766.17 208.79
## - kelp_total_biomass     1      3.84  767.26 208.88
## - mean_pon               1      3.90  767.32 208.88
## - mean_poc               1      7.66  771.09 209.20
## - mean_ammonia           1     24.57  788.00 210.59
## - winter_mean_temp       1     46.25  809.68 212.32
## <none>                              763.42 212.72
## - mean_no2_no3           1    112.82  876.25 217.38
## - site                   4   1141.87 1905.29 254.61
##
## Step:  AIC=208.61
## algae_total_biomass^(0.45) ~ mean_ammonia + mean_no2_no3 + mean_po4 +
##     mean_poc + mean_pon + winter_mean_temp + kelp_total_biomass +
##     site
##
##                         Df Sum of Sq     RSS    AIC
## - mean_po4               1      2.43  766.53 204.66
## - mean_pon               1      5.35  769.44 204.90
## - kelp_total_biomass     1      6.55  770.65 205.00
## - mean_poc               1      9.68  773.78 205.26
## - mean_ammonia           1     34.73  798.82 207.30
## - winter_mean_temp       1     50.01  814.11 208.51
## <none>                              764.10 208.62
## - mean_no2_no3           1    113.74  877.84 213.34
## - site                   4   1215.43 1979.53 252.90
##
## Step:  AIC=204.66
## algae_total_biomass^(0.45) ~ mean_ammonia + mean_no2_no3 + mean_poc +
##     mean_pon + winter_mean_temp + kelp_total_biomass + site
##
##                         Df Sum of Sq     RSS    AIC
## - mean_pon               1      4.92  771.44 200.91
## - kelp_total_biomass     1      8.66  775.19 201.22
## - mean_poc               1      9.09  775.62 201.25
## - mean_ammonia           1     37.30  803.82 203.54
## <none>                              766.53 204.66
## - winter_mean_temp       1     51.94  818.47 204.70
## - mean_no2_no3           1    113.47  880.00 209.34
## - site                   4   1213.36 1979.89 248.75
##
## Step:  AIC=200.91
## algae_total_biomass^(0.45) ~ mean_ammonia + mean_no2_no3 + mean_poc +
##     winter_mean_temp + kelp_total_biomass + site
##
##                         Df Sum of Sq     RSS    AIC
## - mean_poc               1      4.72  776.17 197.14
## - kelp_total_biomass     1      6.89  778.33 197.32
```

```
## - mean_ammonia          1      42.06   813.50 200.15
## <none>                                771.44 200.91
## - winter_mean_temp      1      54.45   825.89 201.12
## - mean_no2_no3          1     111.10   882.54 205.36
## - site                  4    1208.72  1980.16 244.60
##
## Step:  AIC=197.14
## algae_total_biomass^(0.45) ~ mean_ammonia + mean_no2_no3 + winter_mean_temp +
##     kelp_total_biomass + site
##
##                       Df Sum of Sq     RSS    AIC
## - kelp_total_biomass   1      9.95   786.12 193.80
## - mean_ammonia         1     44.37   820.54 196.54
## <none>                                776.17 197.14
## - winter_mean_temp     1     54.18   830.35 197.30
## - mean_no2_no3         1    106.67   882.83 201.22
## - site                 4   1262.16  2038.33 242.30
##
## Step:  AIC=193.8
## algae_total_biomass^(0.45) ~ mean_ammonia + mean_no2_no3 + winter_mean_temp +
##     site
##
##                      Df Sum of Sq     RSS    AIC
## - mean_ammonia        1     40.70   826.82 192.87
## - winter_mean_temp    1     48.44   834.56 193.47
## <none>                               786.12 193.80
## - mean_no2_no3        1    112.42   898.53 198.19
## - site                4   1358.44  2144.55 241.39
##
## Step:  AIC=192.87
## algae_total_biomass^(0.45) ~ mean_no2_no3 + winter_mean_temp +
##     site
##
##                      Df Sum of Sq     RSS    AIC
## - winter_mean_temp    1     19.65   846.47 190.21
## <none>                               826.82 192.87
## - mean_no2_no3        1    100.75   927.57 196.07
## - site                4   1378.23  2205.05 239.01
##
## Step:  AIC=190.21
## algae_total_biomass^(0.45) ~ mean_no2_no3 + site
##
##                 Df Sum of Sq     RSS    AIC
## <none>                          846.47 190.21
## - mean_no2_no3   1    132.45   978.91 195.36
## - site           4   1374.85  2221.32 235.32
```

```
fit.null5<-lm(algae_total_biomass^(0.45)~1,data=mydat2)
fit.final5.forward<-step(fit.null5,scope=scp5,direction="forward",k=log(n))
```

```
## Start:  AIC=240.07
## algae_total_biomass^(0.45) ~ 1
##
##                       Df Sum of Sq     RSS     AIC
```

```
## + site                    4    1574.18   978.91 195.36
## + mean_no2_no3            1     331.78  2221.32 235.32
## <none>                                  2553.10 240.07
## + mean_tchl               1     130.89  2422.20 240.87
## + kelp_total_biomass      1      98.10  2455.00 241.73
## + winter_mean_temp        1      62.54  2490.55 242.65
## + mean_pon                1      43.56  2509.54 243.13
## + summer_mean_temp        1      34.70  2518.39 243.36
## + mean_po4                1      28.94  2524.16 243.50
## + mean_ammonia            1      11.22  2541.88 243.95
## + mean_poc                1      10.76  2542.34 243.96
##
## Step:  AIC=195.36
## algae_total_biomass^(0.45) ~ site
##
##                        Df Sum of Sq     RSS    AIC
## + mean_no2_no3          1   132.449  846.47 190.21
## <none>                              978.91 195.36
## + winter_mean_temp      1    51.343  927.57 196.07
## + mean_tchl             1    25.751  953.16 197.81
## + mean_po4              1    23.611  955.30 197.96
## + kelp_total_biomass    1     6.847  972.07 199.07
## + mean_pon              1     4.436  974.48 199.23
## + summer_mean_temp      1     2.555  976.36 199.35
## + mean_ammonia          1     0.991  977.92 199.45
## + mean_poc              1     0.149  978.77 199.51
##
## Step:  AIC=190.21
## algae_total_biomass^(0.45) ~ site + mean_no2_no3
##
##                        Df Sum of Sq     RSS    AIC
## <none>                              846.47 190.21
## + winter_mean_temp      1   19.6484  826.82 192.87
## + mean_tchl             1   14.6167  831.85 193.26
## + mean_ammonia          1   11.9069  834.56 193.47
## + mean_pon              1    8.1832  838.28 193.75
## + mean_poc              1    7.6729  838.79 193.79
## + kelp_total_biomass    1    3.8172  842.65 194.08
## + mean_po4              1    0.6328  845.83 194.32
## + summer_mean_temp      1    0.0377  846.43 194.37
```

```
summary(fit.final5)
```

```
##
## Call:
## lm(formula = algae_total_biomass^(0.45) ~ mean_no2_no3 + site,
##     data = mydat2)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -8.4609 -2.1032  0.3618  2.5013  6.8497
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
```

```
## (Intercept)    9.859108    2.283040    4.318 6.22e-05 ***
## mean_no2_no3  0.008058    0.002675    3.013  0.00384 **
## siteAQUE     -0.593074    2.017330   -0.294  0.76982
## siteCARP      4.351614    1.427759    3.048  0.00347 **
## siteMOHK     -4.787155    1.499408   -3.193  0.00228 **
## siteNAPL      8.163657    1.430169    5.708 4.11e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.82 on 58 degrees of freedom
## Multiple R-squared:  0.6685, Adjusted R-squared:  0.6399
## F-statistic: 23.39 on 5 and 58 DF,  p-value: 8.739e-13
```

```
fit5.glm<-glm(algae_total_biomass^(0.45)~mean_ammonia+mean_no2_no3+mean_po4+mean_poc+mean_pon+mean_tchl
summary(fit5.glm)
```

```
##
## Call:
## glm(formula = algae_total_biomass^(0.45) ~ mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_poc + mean_pon + mean_tchl + summer_mean_temp +
##     winter_mean_temp + kelp_total_biomass + site, family = Gamma,
##     data = mydat2)
##
## Deviance Residuals:
##      Min        1Q    Median        3Q       Max
## -0.95012  -0.12682   0.01286   0.10802   0.44479
##
## Coefficients:
##                      Estimate Std. Error t value Pr(>|t|)
## (Intercept)        -1.695e-01  2.009e-01  -0.844  0.40292
## mean_ammonia        6.714e-06  7.840e-06   0.856  0.39591
## mean_no2_no3       -2.060e-05  1.010e-05  -2.039  0.04679 *
## mean_po4            7.321e-06  1.070e-05   0.684  0.49704
## mean_poc           -1.146e-04  1.771e-04  -0.647  0.52038
## mean_pon            6.424e-03  1.423e-02   0.451  0.65362
## mean_tchl          -2.655e-04  7.971e-03  -0.033  0.97356
## summer_mean_temp    2.906e-04  5.614e-02   0.005  0.99589
## winter_mean_temp    2.375e-01  1.614e-01   1.472  0.14731
## kelp_total_biomass -3.166e-04  5.471e-04  -0.579  0.56543
## siteAQUE            7.786e-03  1.042e-02   0.747  0.45861
## siteCARP           -1.622e-02  7.850e-03  -2.066  0.04405 *
## siteMOHK            2.636e-02  8.141e-03   3.237  0.00214 **
## siteNAPL           -1.690e-02  6.210e-03  -2.722  0.00891 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for Gamma family taken to be 0.06530744)
##
##     Null deviance: 9.4352  on 63  degrees of freedom
## Residual deviance: 3.8779  on 50  degrees of freedom
## AIC: 396.41
##
## Number of Fisher Scoring iterations: 5
```

we may take a GLM model with Gamma family algae_total_biomass^(0.45) ~ mean_no2_no3 +site

#algae_diversity

```
fit.initial6<-lm(algae_diversity^(0.25)~mean_ammonia+mean_no2_no3+mean_po4+mean_poc+mean_pon+mean_tchl+s
n<-dim(mydat2)[1]
scp6<-list(lower=~1,upper=~mean_ammonia+mean_no2_no3+mean_po4+mean_poc+mean_pon+mean_tchl+summer_mean_te
fit.final6<-step(fit.initial6,scope=scp6,direction="backward",k=log(n))
```

```
## Start:  AIC=-207.32
## algae_diversity^(0.25) ~ mean_ammonia + mean_no2_no3 + mean_po4 +
##     mean_poc + mean_pon + mean_tchl + summer_mean_temp + winter_mean_temp +
##     kelp_total_biomass + site + winter_mean_temp:mean_ammonia
##
##                                 Df Sum of Sq     RSS     AIC
## - site                           4  0.130155 1.07649 -215.70
## - mean_no2_no3                   1  0.000688 0.94703 -211.43
## - summer_mean_temp               1  0.007197 0.95353 -210.99
## - mean_poc                       1  0.009818 0.95616 -210.81
## - mean_ammonia:winter_mean_temp  1  0.011209 0.95755 -210.72
## - kelp_total_biomass             1  0.015075 0.96141 -210.46
## - mean_pon                       1  0.024626 0.97096 -209.83
## - mean_tchl                      1  0.026350 0.97269 -209.72
## - mean_po4                       1  0.050484 0.99682 -208.15
## <none>                                       0.94634 -207.31
##
## Step:  AIC=-215.7
## algae_diversity^(0.25) ~ mean_ammonia + mean_no2_no3 + mean_po4 +
##     mean_poc + mean_pon + mean_tchl + summer_mean_temp + winter_mean_temp +
##     kelp_total_biomass + mean_ammonia:winter_mean_temp
##
##                                 Df Sum of Sq    RSS     AIC
## - mean_no2_no3                    1  0.000046 1.0765 -219.86
## - mean_ammonia:winter_mean_temp   1  0.000069 1.0766 -219.86
## - summer_mean_temp                1  0.003540 1.0800 -219.65
## - mean_po4                        1  0.007787 1.0843 -219.40
## - mean_poc                        1  0.012967 1.0895 -219.10
## - mean_pon                        1  0.015032 1.0915 -218.97
## - mean_tchl                       1  0.031643 1.1081 -218.01
## - kelp_total_biomass              1  0.037425 1.1139 -217.68
## <none>                                        1.0765 -215.70
##
## Step:  AIC=-219.86
## algae_diversity^(0.25) ~ mean_ammonia + mean_po4 + mean_poc +
##     mean_pon + mean_tchl + summer_mean_temp + winter_mean_temp +
##     kelp_total_biomass + mean_ammonia:winter_mean_temp
##
##                                 Df Sum of Sq    RSS     AIC
## - mean_ammonia:winter_mean_temp   1  0.000075 1.0766 -224.01
## - summer_mean_temp                1  0.003535 1.0801 -223.81
## - mean_po4                        1  0.008065 1.0846 -223.54
## - mean_poc                        1  0.012993 1.0895 -223.25
## - mean_pon                        1  0.015388 1.0919 -223.11
## - mean_tchl                       1  0.033223 1.1098 -222.07
```

```
## - kelp_total_biomass              1  0.037956 1.1145 -221.80
## <none>                                        1.0765 -219.86
##
## Step:  AIC=-224.01
## algae_diversity^(0.25) ~ mean_ammonia + mean_po4 + mean_poc +
##     mean_pon + mean_tchl + summer_mean_temp + winter_mean_temp +
##     kelp_total_biomass
##
##                        Df Sum of Sq    RSS     AIC
## - summer_mean_temp      1  0.003515 1.0801 -227.96
## - mean_po4              1  0.008226 1.0848 -227.69
## - mean_pon              1  0.016659 1.0933 -227.19
## - mean_poc              1  0.016744 1.0934 -227.19
## - mean_tchl             1  0.033992 1.1106 -226.18
## - kelp_total_biomass    1  0.038263 1.1149 -225.94
## <none>                             1.0766 -224.01
## - mean_ammonia          1  0.090182 1.1668 -223.03
## - winter_mean_temp      1  0.171681 1.2483 -218.70
##
## Step:  AIC=-227.96
## algae_diversity^(0.25) ~ mean_ammonia + mean_po4 + mean_poc +
##     mean_pon + mean_tchl + winter_mean_temp + kelp_total_biomass
##
##                        Df Sum of Sq    RSS     AIC
## - mean_po4              1  0.011040 1.0912 -231.47
## - mean_poc              1  0.014132 1.0943 -231.29
## - mean_pon              1  0.015607 1.0957 -231.21
## - mean_tchl             1  0.039936 1.1201 -229.80
## - kelp_total_biomass    1  0.063532 1.1437 -228.47
## <none>                             1.0801 -227.96
## - mean_ammonia          1  0.124005 1.2041 -225.17
## - winter_mean_temp      1  0.189124 1.2692 -221.80
##
## Step:  AIC=-231.47
## algae_diversity^(0.25) ~ mean_ammonia + mean_poc + mean_pon +
##     mean_tchl + winter_mean_temp + kelp_total_biomass
##
##                        Df Sum of Sq    RSS     AIC
## - mean_poc              1  0.014606 1.1058 -234.78
## - mean_pon              1  0.016812 1.1080 -234.65
## - mean_tchl             1  0.039365 1.1305 -233.36
## - kelp_total_biomass    1  0.056224 1.1474 -232.42
## <none>                             1.0912 -231.47
## - mean_ammonia          1  0.113002 1.2042 -229.32
## - winter_mean_temp      1  0.233269 1.3244 -223.23
##
## Step:  AIC=-234.78
## algae_diversity^(0.25) ~ mean_ammonia + mean_pon + mean_tchl +
##     winter_mean_temp + kelp_total_biomass
##
##                        Df Sum of Sq    RSS     AIC
## - mean_pon              1   0.00364 1.1094 -238.73
## - mean_tchl             1   0.03377 1.1395 -237.01
## - kelp_total_biomass    1   0.06326 1.1690 -235.38
```

```
## <none>                                   1.1058 -234.78
## - mean_ammonia         1   0.10019 1.2060 -233.39
## - winter_mean_temp     1   0.39042 1.4962 -219.59
##
## Step:  AIC=-238.73
## algae_diversity^(0.25) ~ mean_ammonia + mean_tchl + winter_mean_temp +
##     kelp_total_biomass
##
##                       Df Sum of Sq    RSS     AIC
## - kelp_total_biomass   1   0.06577 1.1752 -239.20
## - mean_tchl            1   0.06616 1.1756 -239.18
## <none>                             1.1094 -238.73
## - mean_ammonia         1   0.09663 1.2060 -237.54
## - winter_mean_temp     1   0.42328 1.5327 -222.20
##
## Step:  AIC=-239.2
## algae_diversity^(0.25) ~ mean_ammonia + mean_tchl + winter_mean_temp
##
##                    Df Sum of Sq    RSS     AIC
## - mean_tchl         1   0.03302 1.2082 -241.59
## <none>                          1.1752 -239.20
## - mean_ammonia      1   0.08380 1.2590 -238.95
## - winter_mean_temp  1   0.36490 1.5401 -226.05
##
## Step:  AIC=-241.59
## algae_diversity^(0.25) ~ mean_ammonia + winter_mean_temp
##
##                    Df Sum of Sq    RSS     AIC
## <none>                          1.2082 -241.59
## - mean_ammonia      1   0.10989 1.3181 -240.17
## - winter_mean_temp  1   0.33620 1.5444 -230.03
```

```r
fit.null6<-lm(algae_diversity^(0.25)~1,data=mydat2)
fit.final6.forward<-step(fit.null6,scope=scp6,direction="forward",k=log(n))
```

```
## Start:  AIC=-233.53
## algae_diversity^(0.25) ~ 1
##
##                      Df Sum of Sq    RSS     AIC
## + winter_mean_temp    1   0.24241 1.3181 -240.17
## <none>                            1.5605 -233.53
## + mean_poc            1   0.08312 1.4774 -232.87
## + site                4   0.32230 1.2382 -231.70
## + mean_po4            1   0.04163 1.5189 -231.10
## + summer_mean_temp    1   0.03059 1.5299 -230.64
## + mean_no2_no3        1   0.02127 1.5392 -230.25
## + mean_ammonia        1   0.01610 1.5444 -230.03
## + kelp_total_biomass  1   0.00732 1.5532 -229.67
## + mean_pon            1   0.00545 1.5551 -229.59
## + mean_tchl           1   0.00038 1.5601 -229.38
##
## Step:  AIC=-240.17
## algae_diversity^(0.25) ~ winter_mean_temp
##
```

```
##                        Df Sum of Sq    RSS     AIC
## + mean_ammonia          1  0.109894 1.2082 -241.59
## <none>                            1.3181 -240.17
## + summer_mean_temp      1  0.069742 1.2484 -239.50
## + mean_tchl             1  0.059114 1.2590 -238.95
## + mean_poc              1  0.040124 1.2780 -237.99
## + mean_pon              1  0.040031 1.2781 -237.99
## + kelp_total_biomass    1  0.016618 1.3015 -236.83
## + mean_po4              1  0.003519 1.3146 -236.19
## + mean_no2_no3          1  0.001555 1.3166 -236.09
## + site                  4  0.205616 1.1125 -234.39
##
## Step:  AIC=-241.59
## algae_diversity^(0.25) ~ winter_mean_temp + mean_ammonia
##
##                                Df Sum of Sq    RSS     AIC
## <none>                                     1.2082 -241.59
## + mean_tchl                     1  0.033020 1.1752 -239.20
## + kelp_total_biomass            1  0.032626 1.1756 -239.18
## + summer_mean_temp              1  0.027115 1.1811 -238.88
## + mean_poc                      1  0.026803 1.1814 -238.86
## + mean_pon                      1  0.014556 1.1937 -238.20
## + mean_no2_no3                  1  0.003564 1.2046 -237.62
## + mean_po4                      1  0.002959 1.2052 -237.59
## + mean_ammonia:winter_mean_temp 1  0.000564 1.2076 -237.46
## + site                          4  0.121569 1.0866 -231.74
```

```r
summary(fit.final6)
```

```
##
## Call:
## lm(formula = algae_diversity^(0.25) ~ mean_ammonia + winter_mean_temp,
##     data = mydat2)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.28776 -0.09295  0.01628  0.08949  0.34254
##
## Coefficients:
##                    Estimate Std. Error t value Pr(>|t|)
## (Intercept)      -2.112e+00  8.371e-01  -2.523 0.014267 *
## mean_ammonia      1.497e-04  6.353e-05   2.355 0.021730 *
## winter_mean_temp  3.435e+00  8.336e-01   4.120 0.000116 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1407 on 61 degrees of freedom
## Multiple R-squared:  0.2258, Adjusted R-squared:  0.2004
## F-statistic: 8.894 on 2 and 61 DF,  p-value: 0.000408
```

```r
summary(glm(algae_diversity~mean_ammonia+mean_no2_no3+mean_po4+mean_poc+mean_pon+mean_tchl+summer_mean_
```

```
##
```

```
## Call:
## glm(formula = algae_diversity ~ mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_poc + mean_pon + mean_tchl + summer_mean_temp +
##     winter_mean_temp + kelp_total_biomass + site + winter_mean_temp:mean_ammonia,
##     family = "Gamma", data = mydat2)
##
## Deviance Residuals:
##       Min        1Q    Median        3Q       Max
## -0.67700  -0.32292  -0.01747   0.19830   0.75350
##
## Coefficients:
##                                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)                    2.381e+00  2.268e+00   1.050    0.299
## mean_ammonia                  -2.160e-03  2.482e-03  -0.870    0.388
## mean_no2_no3                  -4.233e-05  9.009e-05  -0.470    0.641
## mean_po4                       1.324e-04  8.114e-05   1.632    0.109
## mean_poc                      -6.545e-04  1.315e-03  -0.498    0.621
## mean_pon                       7.838e-02  1.111e-01   0.705    0.484
## mean_tchl                     -5.268e-02  5.252e-02  -1.003    0.321
## summer_mean_temp               2.853e-01  4.154e-01   0.687    0.495
## winter_mean_temp              -3.076e+00  2.233e+00  -1.378    0.175
## kelp_total_biomass             4.210e-03  4.663e-03   0.903    0.371
## siteAQUE                       6.029e-02  8.684e-02   0.694    0.491
## siteCARP                      -7.133e-02  5.816e-02  -1.227    0.226
## siteMOHK                       1.677e-02  5.102e-02   0.329    0.744
## siteNAPL                       3.505e-02  5.385e-02   0.651    0.518
## mean_ammonia:winter_mean_temp  2.138e-03  2.528e-03   0.846    0.402
##
## (Dispersion parameter for Gamma family taken to be 0.1703372)
##
##     Null deviance: 12.9312  on 63  degrees of freedom
## Residual deviance:  8.4956  on 49  degrees of freedom
## AIC: 244.39
##
## Number of Fisher Scoring iterations: 5
```

the final model is algae_diversity^(0.5) ~ mean_ammonia + log(log(winter_mean_temp)) though it's not that good. . . .

```
par(mfrow=c(2,2))
plot(fit.final6)
```