504project

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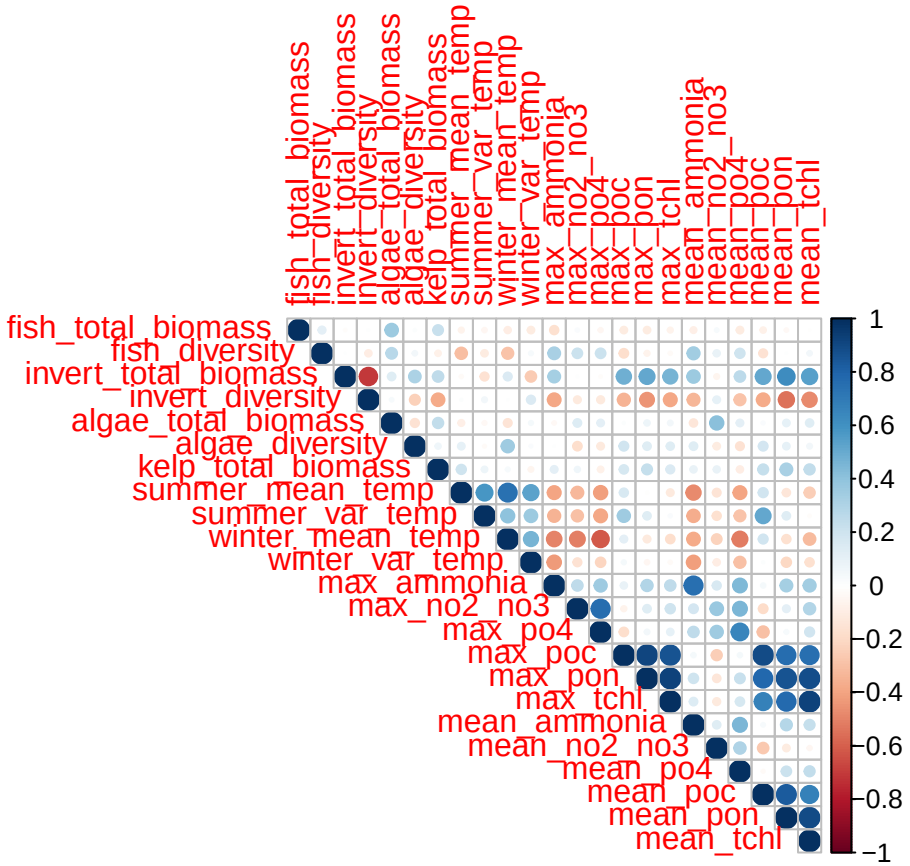
```
data.kelp<-read.csv(file='kelp_prediction_data_complete.csv')
data.waterchem<-read.csv(file='biomass_prediction_data_waterchem_complete.csv')
library(corrplot)
```

```
## Warning: package 'corrplot' was built under R version 3.5.3
```

```
## corrplot 0.84 loaded
```

```
corrplot(cor(data.waterchem[,4:26],use="complete.obs"), type="upper")
```



#fish total biomass

```
fit.initial<-lm(fish_total_biomass~kelp_total_biomass+mean_ammonia+mean_no2_no3+mean_po4+mean_poc+mean_
n<-dim(data.waterchem)[1]
scp<-list(lower=~1,upper=~kelp_total_biomass+mean_ammonia+mean_no2_no3+mean_po4+mean_poc+mean_pon+mean_
fit.final<-step(fit.initial,scope=scp,direction="backward",k=log(n))
```

```
## Start:  AIC=597.45
```

```
## fish_total_biomass ~ 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
##
##                               Df Sum of Sq    RSS    AIC
## - summer_mean_temp             1       105 273685 593.32
## - mean_po4                     1       145 273724 593.33
## - winter_mean_temp             1       601 274181 593.43
## - mean_ammonia                 1       698 274278 593.46
## - mean_pon                     1      1370 274950 593.61
## - mean_no2_no3                 1      2705 276285 593.92
## - mean_tchl                    1      3686 277266 594.15
## - kelp_total_biomass:mean_poc  1     11985 285565 596.04
## <none>                                    273580 597.45
## - site                         4    137225 410805 606.84
##
## Step:  AIC=593.32
## fish_total_biomass ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_poc + mean_pon + mean_tchl + winter_mean_temp +
##     site + kelp_total_biomass:mean_poc
##
##                               Df Sum of Sq    RSS    AIC
## - mean_po4                     1       188 273873 589.20
## - mean_ammonia                 1       594 274278 589.30
## - winter_mean_temp             1      1099 274784 589.42
## - mean_pon                     1      1500 275185 589.51
## - mean_no2_no3                 1      2777 276462 589.81
## - mean_tchl                    1      3623 277307 590.00
## - kelp_total_biomass:mean_poc  1     11880 285565 591.88
## <none>                                    273685 593.32
## - site                         4    143747 417431 603.70
##
## Step:  AIC=589.2
## fish_total_biomass ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_poc + mean_pon + mean_tchl + winter_mean_temp + site +
##     kelp_total_biomass:mean_poc
##
##                               Df Sum of Sq    RSS    AIC
## - mean_ammonia                 1       666 274539 585.20
## - winter_mean_temp             1       921 274794 585.26
## - mean_pon                     1      1511 275384 585.40
## - mean_tchl                    1      3529 277402 585.86
## - mean_no2_no3                 1      3534 277407 585.87
## - kelp_total_biomass:mean_poc  1     12622 286495 587.93
## <none>                                    273873 589.20
## - site                         4    145521 419394 599.84
##
## Step:  AIC=585.2
## fish_total_biomass ~ kelp_total_biomass + mean_no2_no3 + mean_poc +
##     mean_pon + mean_tchl + winter_mean_temp + site + kelp_total_biomass:mean_poc
##
##                               Df Sum of Sq    RSS    AIC
## - winter_mean_temp             1       498 275037 581.16
## - mean_pon                     1      1132 275671 581.30
```

```
## - mean_tchl                    1      3042 277581 581.75
## - mean_no2_no3                 1      3738 278277 581.91
## - kelp_total_biomass:mean_poc  1     12076 286615 583.80
## <none>                                    274539 585.20
## - site                         4    157058 431597 597.52
##
## Step:  AIC=581.16
## fish_total_biomass ~ kelp_total_biomass + mean_no2_no3 + mean_poc +
##     mean_pon + mean_tchl + site + kelp_total_biomass:mean_poc
##
##                               Df Sum of Sq    RSS    AIC
## - mean_pon                     1      1902 276939 577.44
## - mean_tchl                    1      2702 277739 577.62
## - mean_no2_no3                 1      3507 278544 577.81
## - kelp_total_biomass:mean_poc  1     12064 287101 579.75
## <none>                                    275037 581.16
## - site                         4    161608 436645 594.10
##
## Step:  AIC=577.44
## fish_total_biomass ~ kelp_total_biomass + mean_no2_no3 + mean_poc +
##     mean_tchl + site + kelp_total_biomass:mean_poc
##
##                               Df Sum of Sq    RSS    AIC
## - mean_tchl                    1       812 277751 573.47
## - mean_no2_no3                 1      3027 279967 573.98
## - kelp_total_biomass:mean_poc  1     10780 287719 575.72
## <none>                                    276939 577.44
## - site                         4    159757 436697 589.95
##
## Step:  AIC=573.47
## fish_total_biomass ~ kelp_total_biomass + mean_no2_no3 + mean_poc +
##     site + kelp_total_biomass:mean_poc
##
##                               Df Sum of Sq    RSS    AIC
## - mean_no2_no3                 1      3937 281689 570.21
## - kelp_total_biomass:mean_poc  1     12015 289766 572.02
## <none>                                    277751 573.47
## - site                         4    161829 439580 586.21
##
## Step:  AIC=570.21
## fish_total_biomass ~ kelp_total_biomass + mean_poc + site + kelp_total_biomass:mean_poc
##
##                               Df Sum of Sq    RSS    AIC
## - kelp_total_biomass:mean_poc  1     11864 293553 568.69
## <none>                                    281689 570.21
## - site                         4    158599 440288 582.16
##
## Step:  AIC=568.69
## fish_total_biomass ~ kelp_total_biomass + mean_poc + site
##
##                      Df Sum of Sq    RSS    AIC
## - kelp_total_biomass  1       256 293809 564.59
## - mean_poc            1      3669 297222 565.33
## <none>                            293553 568.69
```

```
## - site                4    175934 469486 582.11
##
## Step:  AIC=564.59
## fish_total_biomass ~ mean_poc + site
##
##            Df Sum of Sq    RSS    AIC
## - mean_poc  1      3480 297289 561.18
## <none>                  293809 564.59
## - site      4    207999 501808 582.21
##
## Step:  AIC=561.18
## fish_total_biomass ~ site
##
##        Df Sum of Sq    RSS    AIC
## <none>              297289 561.18
## - site  4    207287 504576 578.40
```

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

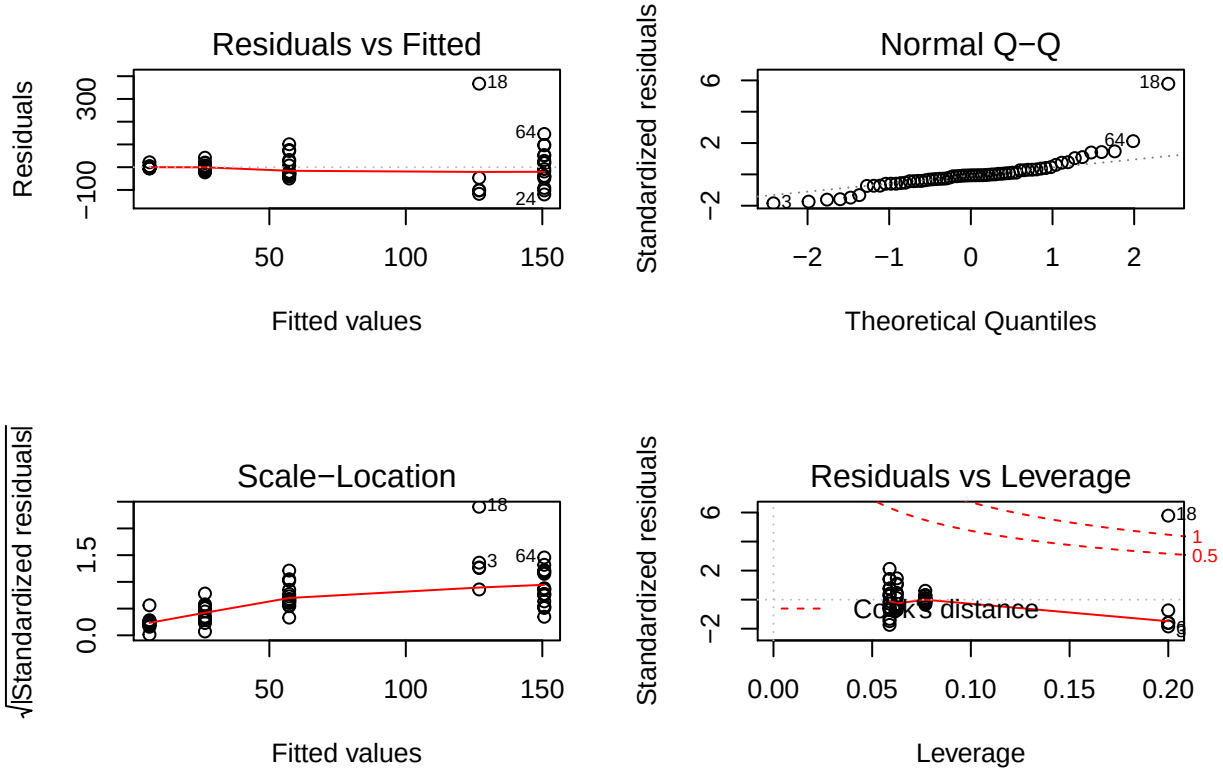
```
## Start:  AIC=578.4
## fish_total_biomass ~ 1
##
##                       Df Sum of Sq    RSS    AIC
## + site                 4    207287 297289 561.18
## <none>                             504576 578.40
## + kelp_total_biomass   1     26292 478284 579.14
## + mean_po4             1      5994 498582 581.80
## + winter_mean_temp     1      4604 499973 581.98
## + mean_ammonia         1      3606 500971 582.10
## + mean_poc             1      2768 501808 582.21
## + summer_mean_temp     1      1947 502629 582.32
## + mean_no2_no3         1       582 503995 582.49
## + mean_pon             1       493 504084 582.50
## + mean_tchl            1         5 504572 582.56
##
## Step:  AIC=561.18
## fish_total_biomass ~ site
##
##                       Df Sum of Sq    RSS    AIC
## <none>                             297289 561.18
## + mean_tchl            1    6704.2 290585 563.88
## + mean_pon             1    4464.8 292824 564.37
## + mean_poc             1    3480.4 293809 564.59
## + mean_no2_no3         1    1699.3 295590 564.98
## + mean_po4             1    1224.4 296065 565.08
## + winter_mean_temp     1      83.1 297206 565.32
## + kelp_total_biomass   1      67.4 297222 565.33
## + summer_mean_temp     1      51.2 297238 565.33
## + mean_ammonia         1      46.7 297243 565.33
```

```
summary(fit.final)
```

```
##
## Call:
## lm(formula = fish_total_biomass ~ site, data = data.waterchem)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -119.83  -29.04   -4.22   18.56  367.16
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)    6.084     19.688   0.309   0.7584
## siteAQUE     120.782     37.355   3.233   0.0020 **
## siteCARP      51.192     26.505   1.931   0.0582 .
## siteMOHK      20.330     27.842   0.730   0.4682
## siteNAPL     144.638     26.153   5.530 7.66e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 70.98 on 59 degrees of freedom
## Multiple R-squared:  0.4108, Adjusted R-squared:  0.3709
## F-statistic: 10.28 on 4 and 59 DF,  p-value: 2.189e-06
```

final model is fish_total_biomass~site

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



#diversity

```
fit.initial2<-lm(fish_diversity~kelp_total_biomass+mean_ammonia+mean_no2_no3+mean_po4+mean_poc+mean_pon
n<-dim(data.waterchem)[1]
scp2<-list(lower=~1,upper=~kelp_total_biomass+mean_ammonia+mean_no2_no3+mean_po4+mean_poc+mean_pon+mean
fit.final2<-step(fit.initial2,scope=scp2,direction="backward",k=log(n))
```

```
## Start:  AIC=-179.85
## 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
##
##                               Df Sum of Sq    RSS     AIC
## - site                         4  0.275394 1.7289 -185.38
## - mean_no2_no3                 1  0.000087 1.4536 -184.01
## - mean_pon                     1  0.002990 1.4565 -183.88
## - mean_tchl                    1  0.003333 1.4568 -183.86
## - mean_po4                     1  0.009527 1.4630 -183.59
## - winter_mean_temp             1  0.017871 1.4714 -183.23
## - summer_mean_temp             1  0.023010 1.4765 -183.00
## <none>                                     1.4535 -179.85
## - kelp_total_biomass:mean_poc  1  0.140605 1.5941 -178.10
## - mean_ammonia                 1  0.226962 1.6804 -174.72
##
## Step:  AIC=-185.38
## fish_diversity ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_poc + mean_pon + mean_tchl + summer_mean_temp +
##     winter_mean_temp + kelp_total_biomass:mean_poc
##
##                               Df Sum of Sq    RSS     AIC
## - summer_mean_temp             1  0.000116 1.7290 -189.54
## - mean_no2_no3                 1  0.001450 1.7303 -189.49
## - mean_pon                     1  0.003555 1.7324 -189.41
## - mean_po4                     1  0.007114 1.7360 -189.28
## - mean_tchl                    1  0.007591 1.7365 -189.26
## - winter_mean_temp             1  0.012039 1.7409 -189.10
## - kelp_total_biomass:mean_poc  1  0.087159 1.8160 -186.39
## <none>                                     1.7289 -185.38
## - mean_ammonia                 1  0.150408 1.8793 -184.20
##
## Step:  AIC=-189.54
## fish_diversity ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_poc + mean_pon + mean_tchl + winter_mean_temp +
##     kelp_total_biomass:mean_poc
##
##                               Df Sum of Sq    RSS     AIC
## - mean_no2_no3                 1  0.001445 1.7304 -193.64
## - mean_pon                     1  0.003773 1.7328 -193.56
## - mean_po4                     1  0.007025 1.7360 -193.44
## - mean_tchl                    1  0.007520 1.7365 -193.42
## - winter_mean_temp             1  0.016018 1.7450 -193.11
## - kelp_total_biomass:mean_poc  1  0.087126 1.8161 -190.55
## <none>                                     1.7290 -189.54
## - mean_ammonia                 1  0.168191 1.8972 -187.75
```

```
##
## Step:  AIC=-193.64
## fish_diversity ~ kelp_total_biomass + mean_ammonia + mean_po4 +
##     mean_poc + mean_pon + mean_tchl + winter_mean_temp + kelp_total_biomass:mean_poc
##
##                               Df Sum of Sq    RSS     AIC
## - mean_pon                     1  0.003773 1.7342 -197.66
## - mean_po4                     1  0.005792 1.7362 -197.59
## - mean_tchl                    1  0.007856 1.7383 -197.51
## - winter_mean_temp             1  0.015828 1.7463 -197.22
## - kelp_total_biomass:mean_poc  1  0.085705 1.8161 -194.71
## <none>                                     1.7304 -193.64
## - mean_ammonia                 1  0.167284 1.8977 -191.90
##
## Step:  AIC=-197.66
## fish_diversity ~ kelp_total_biomass + mean_ammonia + mean_po4 +
##     mean_poc + mean_tchl + winter_mean_temp + kelp_total_biomass:mean_poc
##
##                               Df Sum of Sq    RSS     AIC
## - mean_tchl                    1  0.004110 1.7383 -201.67
## - mean_po4                     1  0.006879 1.7411 -201.57
## - winter_mean_temp             1  0.014640 1.7489 -201.28
## - kelp_total_biomass:mean_poc  1  0.081944 1.8162 -198.87
## <none>                                     1.7342 -197.66
## - mean_ammonia                 1  0.170349 1.9046 -195.82
##
## Step:  AIC=-201.67
## fish_diversity ~ kelp_total_biomass + mean_ammonia + mean_po4 +
##     mean_poc + winter_mean_temp + kelp_total_biomass:mean_poc
##
##                               Df Sum of Sq    RSS     AIC
## - mean_po4                     1  0.006562 1.7449 -205.59
## - winter_mean_temp             1  0.033132 1.7714 -204.62
## - kelp_total_biomass:mean_poc  1  0.084876 1.8232 -202.78
## <none>                                     1.7383 -201.67
## - mean_ammonia                 1  0.172712 1.9110 -199.77
##
## Step:  AIC=-205.59
## fish_diversity ~ kelp_total_biomass + mean_ammonia + mean_poc +
##     winter_mean_temp + kelp_total_biomass:mean_poc
##
##                               Df Sum of Sq    RSS     AIC
## - winter_mean_temp             1  0.026621 1.7715 -208.78
## - kelp_total_biomass:mean_poc  1  0.079746 1.8246 -206.89
## <none>                                     1.7449 -205.59
## - mean_ammonia                 1  0.170495 1.9154 -203.78
##
## Step:  AIC=-208.78
## fish_diversity ~ kelp_total_biomass + mean_ammonia + mean_poc +
##     kelp_total_biomass:mean_poc
##
##                               Df Sum of Sq    RSS     AIC
## - kelp_total_biomass:mean_poc  1  0.093668 1.8652 -209.64
## <none>                                     1.7715 -208.78
```

```
## - mean_ammonia                 1  0.270109 2.0416 -203.85
##
## Step:  AIC=-209.64
## fish_diversity ~ kelp_total_biomass + mean_ammonia + mean_poc
##
##                       Df Sum of Sq    RSS     AIC
## - kelp_total_biomass  1  0.011615 1.8768 -213.40
## - mean_poc            1  0.044951 1.9101 -212.27
## <none>                             1.8652 -209.64
## - mean_ammonia        1  0.275525 2.1407 -204.98
##
## Step:  AIC=-213.4
## fish_diversity ~ mean_ammonia + mean_poc
##
##                Df Sum of Sq    RSS     AIC
## - mean_poc      1  0.059644 1.9364 -215.56
## <none>                      1.8768 -213.40
## - mean_ammonia  1  0.267347 2.1441 -209.04
##
## Step:  AIC=-215.56
## fish_diversity ~ mean_ammonia
##
##                Df Sum of Sq    RSS     AIC
## <none>                      1.9364 -215.56
## - mean_ammonia  1   0.25882 2.1953 -211.69
```

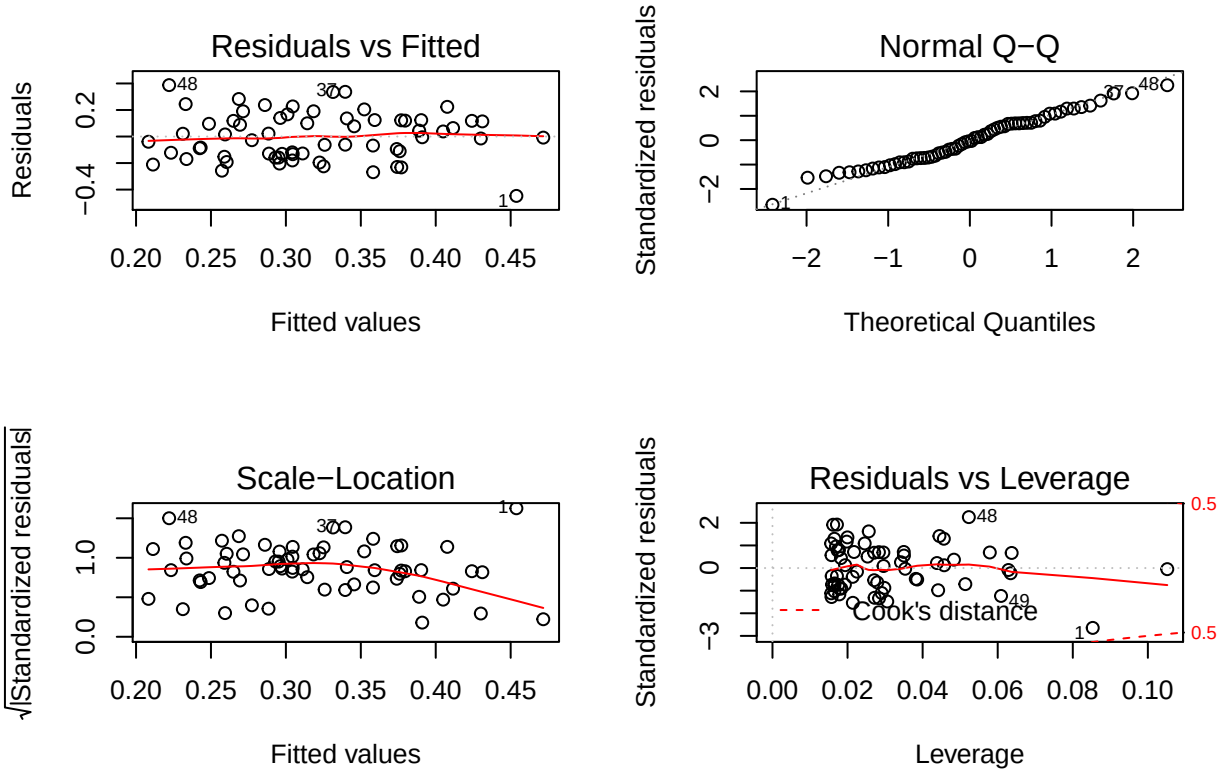
```
fit.null2<-lm(fish_diversity~1,data=data.waterchem)
fit.final2.forward<-step(fit.null2,scope=scp2,direction="forward",k=log(n))
```

```
## Start:  AIC=-211.69
## fish_diversity ~ 1
##
##                       Df Sum of Sq    RSS     AIC
## + mean_ammonia         1  0.258823 1.9364 -215.56
## + summer_mean_temp     1  0.203319 1.9919 -213.75
## + winter_mean_temp     1  0.183136 2.0121 -213.10
## <none>                             2.1953 -211.69
## + mean_po4             1  0.090818 2.1044 -210.23
## + mean_poc             1  0.051120 2.1441 -209.04
## + mean_no2_no3         1  0.020811 2.1745 -208.14
## + kelp_total_biomass   1  0.012239 2.1830 -207.88
## + mean_tchl            1  0.005948 2.1893 -207.70
## + mean_pon             1  0.000033 2.1952 -207.53
## + site                 4  0.163300 2.0320 -200.00
##
## Step:  AIC=-215.56
## fish_diversity ~ mean_ammonia
##
##                       Df Sum of Sq    RSS     AIC
## <none>                             1.9364 -215.56
## + winter_mean_temp     1  0.064667 1.8718 -213.57
## + mean_poc             1  0.059644 1.8768 -213.40
## + summer_mean_temp     1  0.056215 1.8802 -213.28
## + kelp_total_biomass   1  0.026308 1.9101 -212.27
```

```
## + mean_pon             1  0.021396 1.9150 -212.11
## + mean_po4             1  0.006075 1.9304 -211.60
## + mean_no2_no3         1  0.005781 1.9306 -211.59
## + mean_tchl            1  0.001932 1.9345 -211.46
## + site                 4  0.210710 1.7257 -206.29
```

final model is fish_diversity~mean_ammonia

```
par(mfrow=c(2,2))
plot(fit.final2)
```



constant variance assumption checked normality assumption checked.

#invert_total_biomass

```
fit.initial3<-lm(invert_total_biomass~kelp_total_biomass+mean_ammonia+mean_no2_no3+mean_po4+mean_poc+mea
n<-dim(data.waterchem)[1]
scp3<-list(lower=~1,upper=~kelp_total_biomass+mean_ammonia+mean_no2_no3+mean_po4+mean_poc+mean_pon+mean_
fit.final3<-step(fit.initial3,scope=scp3,direction="backward",k=log(n))
```

```
## Start:  AIC=1110.59
## invert_total_biomass ~ 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 + mean_tchl:site +
##     winter_mean_temp:site + summer_mean_temp:site + winter_mean_temp:mean_tchl +
##     summer_mean_temp:mean_tchl
```

```
##
##                               Df Sum of Sq       RSS    AIC
## - mean_tchl:site               4  59501317 393719823 1104.4
## - mean_tchl:winter_mean_temp   1     85257 334303762 1106.4
## - mean_no2_no3                 1    530569 334749075 1106.5
## - mean_po4                     1   1315736 335534242 1106.7
## - mean_ammonia                 1   5954406 340172912 1107.6
## - mean_pon                     1   6669187 340887692 1107.7
## - mean_tchl:summer_mean_temp   1   8735575 342954081 1108.1
## - kelp_total_biomass:mean_poc  1  17841710 352060216 1109.8
## <none>                                     334218506 1110.6
## - winter_mean_temp:site        4 152390130 486608636 1118.0
## - summer_mean_temp:site        4 312643250 646861756 1136.2
##
## Step:  AIC=1104.44
## invert_total_biomass ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_poc + mean_pon + mean_tchl + summer_mean_temp +
##     winter_mean_temp + site + kelp_total_biomass:mean_poc + winter_mean_temp:site +
##     summer_mean_temp:site + mean_tchl:winter_mean_temp + mean_tchl:summer_mean_temp
##
##                               Df Sum of Sq       RSS    AIC
## - mean_ammonia                 1   1240074 394959897 1100.5
## - mean_no2_no3                 1   2063437 395783260 1100.6
## - mean_po4                     1   2633395 396353218 1100.7
## - mean_tchl:summer_mean_temp   1   4939549 398659372 1101.1
## - mean_tchl:winter_mean_temp   1   8062686 401782509 1101.6
## - kelp_total_biomass:mean_poc  1  16401601 410121424 1102.9
## - winter_mean_temp:site        4 106818174 500537997 1103.2
## - mean_pon                     1  20005918 413725741 1103.5
## <none>                                     393719823 1104.4
## - summer_mean_temp:site        4 297576782 691296605 1123.8
##
## Step:  AIC=1100.48
## invert_total_biomass ~ kelp_total_biomass + mean_no2_no3 + mean_po4 +
##     mean_poc + mean_pon + mean_tchl + summer_mean_temp + winter_mean_temp +
##     site + kelp_total_biomass:mean_poc + winter_mean_temp:site +
##     summer_mean_temp:site + mean_tchl:winter_mean_temp + mean_tchl:summer_mean_temp
##
##                               Df Sum of Sq       RSS    AIC
## - mean_po4                     1   2156169 397116066 1096.7
## - mean_no2_no3                 1   2194055 397153953 1096.7
## - mean_tchl:summer_mean_temp   1   5211023 400170920 1097.2
## - mean_tchl:winter_mean_temp   1   7620787 402580685 1097.5
## - kelp_total_biomass:mean_poc  1  16892816 411852713 1099.0
## - winter_mean_temp:site        4 105893568 500853465 1099.0
## - mean_pon                     1  20031213 414991110 1099.5
## <none>                                     394959897 1100.5
## - summer_mean_temp:site        4 301047930 696007827 1120.1
##
## Step:  AIC=1096.67
## invert_total_biomass ~ kelp_total_biomass + mean_no2_no3 + mean_poc +
##     mean_pon + mean_tchl + summer_mean_temp + winter_mean_temp +
##     site + kelp_total_biomass:mean_poc + winter_mean_temp:site +
##     summer_mean_temp:site + mean_tchl:winter_mean_temp + mean_tchl:summer_mean_temp
```

```
##
##                               Df Sum of Sq       RSS    AIC
## - mean_no2_no3                 1   1314353 398430419 1092.7
## - mean_tchl:summer_mean_temp   1   4531401 401647467 1093.2
## - mean_tchl:winter_mean_temp   1   7457000 404573067 1093.7
## - winter_mean_temp:site        4 103762982 500879048 1094.9
## - kelp_total_biomass:mean_poc  1  18025395 415141461 1095.3
## - mean_pon                     1  18798106 415914172 1095.5
## <none>                                    397116066 1096.7
## - summer_mean_temp:site        4 304033519 701149585 1116.4
##
## Step:  AIC=1092.72
## invert_total_biomass ~ kelp_total_biomass + mean_poc + mean_pon +
##     mean_tchl + summer_mean_temp + winter_mean_temp + site +
##     kelp_total_biomass:mean_poc + winter_mean_temp:site + summer_mean_temp:site +
##     mean_tchl:winter_mean_temp + mean_tchl:summer_mean_temp
##
##                               Df Sum of Sq       RSS    AIC
## - mean_tchl:summer_mean_temp   1   5947335 404377754 1089.5
## - mean_tchl:winter_mean_temp   1   7050516 405480935 1089.7
## - winter_mean_temp:site        4 104627036 503057455 1091.0
## - kelp_total_biomass:mean_poc  1  18767544 417197963 1091.5
## - mean_pon                     1  21804090 420234509 1092.0
## <none>                                    398430419 1092.7
## - summer_mean_temp:site        4 307902744 706333163 1112.7
##
## Step:  AIC=1089.51
## invert_total_biomass ~ kelp_total_biomass + mean_poc + mean_pon +
##     mean_tchl + summer_mean_temp + winter_mean_temp + site +
##     kelp_total_biomass:mean_poc + winter_mean_temp:site + summer_mean_temp:site +
##     mean_tchl:winter_mean_temp
##
##                               Df Sum of Sq       RSS    AIC
## - winter_mean_temp:site        4  99339262 503717015 1086.9
## - mean_pon                     1  21169844 425547597 1088.6
## - kelp_total_biomass:mean_poc  1  25321479 429699233 1089.2
## <none>                                    404377754 1089.5
## - mean_tchl:winter_mean_temp   1  62226870 466604624 1094.5
## - summer_mean_temp:site        4 315680602 720058356 1109.8
##
## Step:  AIC=1086.93
## invert_total_biomass ~ kelp_total_biomass + mean_poc + mean_pon +
##     mean_tchl + summer_mean_temp + winter_mean_temp + site +
##     kelp_total_biomass:mean_poc + summer_mean_temp:site + mean_tchl:winter_mean_temp
##
##                               Df Sum of Sq       RSS    AIC
## - mean_pon                     1  11218206 514935221 1084.2
## - kelp_total_biomass:mean_poc  1  12583350 516300366 1084.3
## <none>                                    503717015 1086.9
## - mean_tchl:winter_mean_temp   1  80042787 583759802 1092.2
## - summer_mean_temp:site        4 253071901 756788917 1096.3
##
## Step:  AIC=1084.18
## invert_total_biomass ~ kelp_total_biomass + mean_poc + mean_tchl +
```

```
##     summer_mean_temp + winter_mean_temp + site + kelp_total_biomass:mean_poc +
##     summer_mean_temp:site + mean_tchl:winter_mean_temp
##
##                               Df Sum of Sq       RSS    AIC
## - kelp_total_biomass:mean_poc  1   6794760 521729981 1080.9
## <none>                                     514935221 1084.2
## - mean_tchl:winter_mean_temp   1  71385596 586320817 1088.3
## - summer_mean_temp:site        4 246052835 760988056 1092.5
##
## Step:  AIC=1080.87
## invert_total_biomass ~ kelp_total_biomass + mean_poc + mean_tchl +
##     summer_mean_temp + winter_mean_temp + site + summer_mean_temp:site +
##     mean_tchl:winter_mean_temp
##
##                              Df Sum of Sq       RSS    AIC
## - mean_poc                    1    746146 522476127 1076.8
## - kelp_total_biomass          1  10263650 531993631 1078.0
## <none>                                   521729981 1080.9
## - mean_tchl:winter_mean_temp  1  67597318 589327299 1084.5
## - summer_mean_temp:site       4 257846539 779576520 1089.9
##
## Step:  AIC=1076.8
## invert_total_biomass ~ kelp_total_biomass + mean_tchl + summer_mean_temp +
##     winter_mean_temp + site + summer_mean_temp:site + mean_tchl:winter_mean_temp
##
##                              Df Sum of Sq       RSS    AIC
## - kelp_total_biomass          1  10355464 532831591 1073.9
## <none>                                   522476127 1076.8
## - mean_tchl:winter_mean_temp  1  67761018 590237145 1080.4
## - summer_mean_temp:site       4 257256266 779732393 1085.8
##
## Step:  AIC=1073.89
## invert_total_biomass ~ mean_tchl + summer_mean_temp + winter_mean_temp +
##     site + summer_mean_temp:site + mean_tchl:winter_mean_temp
##
##                              Df Sum of Sq       RSS    AIC
## <none>                                   532831591 1073.9
## - mean_tchl:winter_mean_temp  1  64919694 597751285 1077.1
## - summer_mean_temp:site       4 255269996 788101587 1082.3
```

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

```
## Start:  AIC=1194.83
## invert_total_biomass ~ 1
##
##                       Df  Sum of Sq        RSS    AIC
## + site                 4 6014948051 1675123914 1113.9
## + mean_pon             1 3037783495 4652288469 1166.8
## + mean_tchl            1 2260291376 5429780589 1176.7
## + mean_poc             1 2056731936 5633340028 1179.1
## + mean_ammonia         1 1040501903 6649570062 1189.7
## + mean_po4             1  524366327 7165705637 1194.5
## + kelp_total_biomass   1  519175528 7170896437 1194.5
```

```
## <none>                              7690071964 1194.8
## + winter_mean_temp    1  175095371 7514976593 1197.5
## + mean_no2_no3        1   25378932 7664693033 1198.8
## + summer_mean_temp    1    6220546 7683851418 1198.9
##
## Step:  AIC=1113.93
## invert_total_biomass ~ site
##
##                       Df Sum of Sq        RSS    AIC
## + mean_tchl            1 615244941 1059878973 1088.8
## + mean_pon             1 562652186 1112471728 1091.9
## + mean_poc             1 266130079 1408993835 1107.0
## + summer_mean_temp     1 160764368 1514359546 1111.6
## <none>                             1675123914 1113.9
## + mean_ammonia         1  70620430 1604503484 1115.3
## + winter_mean_temp     1  29665858 1645458055 1117.0
## + mean_no2_no3         1  22644339 1652479575 1117.2
## + mean_po4             1   4151676 1670972238 1117.9
## + kelp_total_biomass   1     37777 1675086137 1118.1
##
## Step:  AIC=1088.8
## invert_total_biomass ~ site + mean_tchl
##
##                       Df Sum of Sq        RSS    AIC
## <none>                             1059878973 1088.8
## + summer_mean_temp     1  31567572 1028311401 1091.0
## + mean_ammonia         1  29002132 1030876841 1091.2
## + mean_no2_no3         1  20279320 1039599653 1091.7
## + winter_mean_temp     1  18770287 1041108686 1091.8
## + mean_pon             1  16272724 1043606249 1092.0
## + mean_po4             1   5626142 1054252831 1092.6
## + kelp_total_biomass   1   2621935 1057257038 1092.8
## + mean_poc             1    688772 1059190201 1092.9
## + mean_tchl:site       4 159239227  900639746 1095.0
```

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

```
##
## Call:
## lm(formula = invert_total_biomass ~ site + mean_tchl, data = data.waterchem)
##
## Residuals:
##    Min     1Q Median     3Q    Max
##  -9570  -1561    307   1297  20612
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -3528.8     1333.8  -2.646   0.0105 *
## siteAQUE     -2375.6     2392.1  -0.993   0.3248
## siteCARP     20461.5     1695.3  12.069  < 2e-16 ***
## siteMOHK       954.6     1676.9   0.569   0.5714
## siteNAPL      2101.0     1583.3   1.327   0.1897
## mean_tchl     1412.6      243.4   5.802 2.88e-07 ***
## ---
```

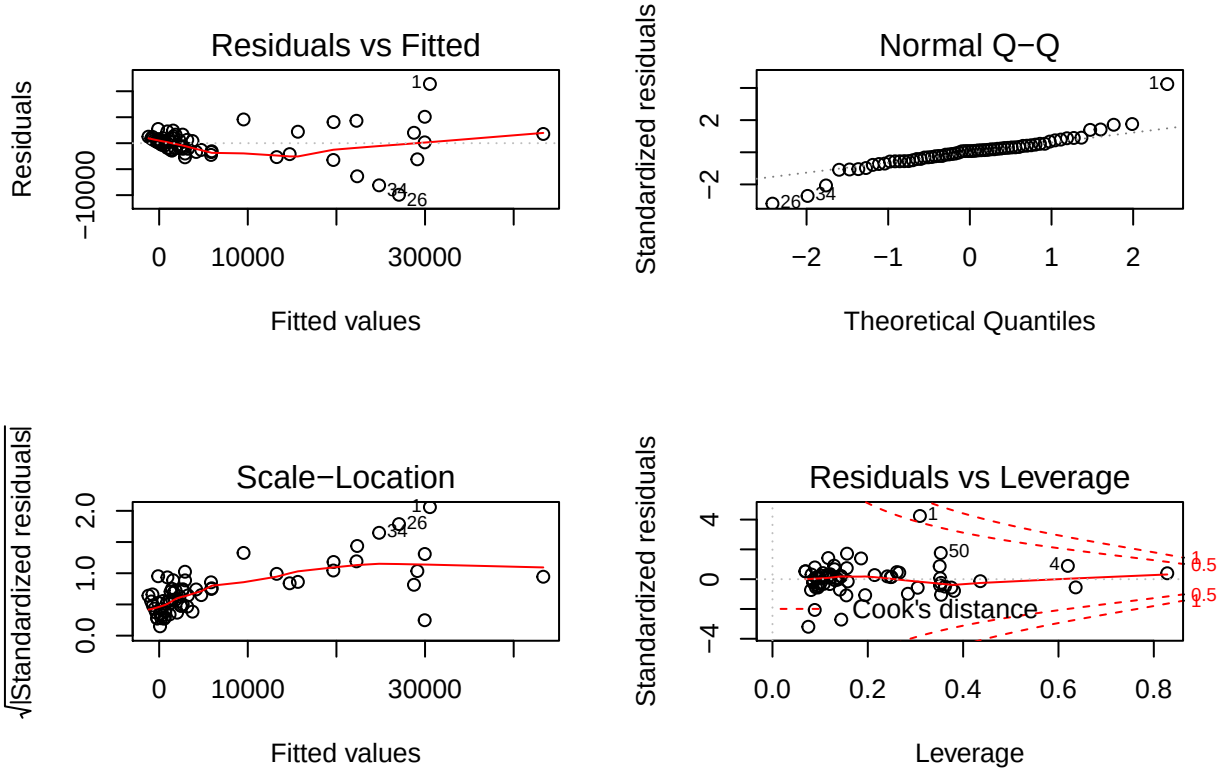
```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4275 on 58 degrees of freedom
## Multiple R-squared:  0.8622, Adjusted R-squared:  0.8503
## F-statistic: 72.57 on 5 and 58 DF,  p-value: < 2.2e-16
```

```
anova(fit.final3,fit.final3.forward)
```

```
## Analysis of Variance Table
##
## Model 1: invert_total_biomass ~ mean_tchl + summer_mean_temp + winter_mean_temp +
##     site + summer_mean_temp:site + mean_tchl:winter_mean_temp
## Model 2: invert_total_biomass ~ site + mean_tchl
##   Res.Df        RSS Df  Sum of Sq      F    Pr(>F)
## 1     51  532831591
## 2     58 1059878973 -7 -527047382 7.2066 5.416e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

seems that the larger model is not that significant. so we take fit.final3, which is mean_tchl + summer_mean_temp + winter_mean_temp + site + summer_mean_temp:site + mean_tchl:winter_mean_temp

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



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

```
##
## Call:
## lm(formula = invert_total_biomass ~ mean_tchl + summer_mean_temp +
##     winter_mean_temp + site + summer_mean_temp:site + mean_tchl:winter_mean_temp,
##     data = data.waterchem)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -9930.5 -1131.0   233.2  1051.6 11392.0
##
## Coefficients:
##                               Estimate Std. Error t value Pr(>|t|)
## (Intercept)                    9515.16   18092.17   0.526 0.601219
## mean_tchl                     -9845.20    4524.98  -2.176 0.034233 *
## summer_mean_temp               -710.91    1053.94  -0.675 0.503022
## winter_mean_temp                -91.72    1218.01  -0.075 0.940270
## siteAQUE                      15774.93   66117.54   0.239 0.812380
## siteCARP                     104639.19   21030.77   4.976 7.79e-06 ***
## siteMOHK                      -2238.93   19929.49  -0.112 0.910993
## siteNAPL                       3892.35   19646.57   0.198 0.843740
## summer_mean_temp:siteAQUE      -948.98    4139.87  -0.229 0.819607
## summer_mean_temp:siteCARP     -5207.01    1291.88  -4.031 0.000186 ***
## summer_mean_temp:siteMOHK       188.38    1225.60   0.154 0.878451
## summer_mean_temp:siteNAPL       -98.04    1230.35  -0.080 0.936797
## mean_tchl:winter_mean_temp      786.80     315.63   2.493 0.015964 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3232 on 51 degrees of freedom
## Multiple R-squared:  0.9307, Adjusted R-squared:  0.9144
## F-statistic: 57.09 on 12 and 51 DF,  p-value: < 2.2e-16
```

#invert_diversity

```r
fit.initial4<-lm(invert_diversity~kelp_total_biomass+mean_ammonia+mean_no2_no3+mean_po4+mean_poc+mean_p
n<-dim(data.waterchem)[1]
scp4<-list(lower=~1,upper=~kelp_total_biomass+mean_ammonia+mean_no2_no3+mean_po4+mean_poc+mean_pon+mean_
fit.final4<-step(fit.initial4,scope=scp4,direction="backward",k=log(n))
```

```
## Start:  AIC=-245.91
## invert_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 + site:winter_mean_temp +
##     site:summer_mean_temp + summer_mean_temp:winter_mean_temp
##
##                                    Df Sum of Sq     RSS     AIC
## - summer_mean_temp:site             4  0.030831 0.31932 -256.05
## - winter_mean_temp:site             4  0.040077 0.32857 -254.22
## - mean_tchl                         1  0.000360 0.28885 -249.99
## - kelp_total_biomass:mean_poc       1  0.000550 0.28904 -249.95
```

```
## - mean_pon                            1  0.003748 0.29224 -249.25
## - mean_po4                            1  0.011481 0.29997 -247.57
## - mean_no2_no3                        1  0.013919 0.30241 -247.06
## - summer_mean_temp:winter_mean_temp   1  0.014201 0.30269 -247.00
## <none>                                           0.28849 -245.91
## - mean_ammonia                        1  0.055606 0.34410 -238.79
##
## Step:  AIC=-256.05
## invert_diversity ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_poc + mean_pon + mean_tchl + summer_mean_temp +
##     winter_mean_temp + site + kelp_total_biomass:mean_poc + winter_mean_temp:site +
##     summer_mean_temp:winter_mean_temp
##
##                                    Df Sum of Sq     RSS     AIC
## - winter_mean_temp:site             4  0.056701 0.37602 -262.23
## - kelp_total_biomass:mean_poc       1  0.000052 0.31937 -260.20
## - mean_tchl                         1  0.000790 0.32011 -260.05
## - mean_pon                          1  0.001332 0.32065 -259.94
## - summer_mean_temp:winter_mean_temp 1  0.006811 0.32613 -258.86
## - mean_no2_no3                      1  0.009401 0.32872 -258.35
## - mean_po4                          1  0.012512 0.33183 -257.75
## <none>                                           0.31932 -256.05
## - mean_ammonia                      1  0.041996 0.36132 -252.30
##
## Step:  AIC=-262.23
## invert_diversity ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_poc + mean_pon + mean_tchl + summer_mean_temp +
##     winter_mean_temp + site + kelp_total_biomass:mean_poc + summer_mean_temp:winter_mean_temp
##
##                                    Df Sum of Sq     RSS     AIC
## - mean_tchl                         1   0.00000 0.37602 -266.38
## - kelp_total_biomass:mean_poc       1   0.00022 0.37624 -266.35
## - mean_pon                          1   0.00056 0.37658 -266.29
## - summer_mean_temp:winter_mean_temp 1   0.00128 0.37730 -266.17
## - mean_po4                          1   0.00517 0.38119 -265.51
## - mean_no2_no3                      1   0.00566 0.38168 -265.43
## - mean_ammonia                      1   0.02512 0.40114 -262.25
## <none>                                          0.37602 -262.23
## - site                              4   1.19961 1.57563 -187.16
##
## Step:  AIC=-266.38
## invert_diversity ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_poc + mean_pon + summer_mean_temp + winter_mean_temp +
##     site + kelp_total_biomass:mean_poc + summer_mean_temp:winter_mean_temp
##
##                                    Df Sum of Sq     RSS     AIC
## - kelp_total_biomass:mean_poc       1   0.00021 0.37624 -270.51
## - mean_pon                          1   0.00094 0.37696 -270.38
## - summer_mean_temp:winter_mean_temp 1   0.00132 0.37735 -270.32
## - mean_po4                          1   0.00518 0.38120 -269.67
## - mean_no2_no3                      1   0.00566 0.38169 -269.59
## <none>                                          0.37602 -266.38
## - mean_ammonia                      1   0.02668 0.40271 -266.15
## - site                              4   1.21176 1.58778 -190.83
```

```
##
## Step:  AIC=-270.51
## invert_diversity ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_poc + mean_pon + summer_mean_temp + winter_mean_temp +
##     site + summer_mean_temp:winter_mean_temp
##
##                                   Df Sum of Sq     RSS     AIC
## - mean_poc                         1   0.00017 0.37641 -274.64
## - mean_pon                         1   0.00075 0.37699 -274.54
## - summer_mean_temp:winter_mean_temp  1   0.00112 0.37736 -274.47
## - mean_po4                         1   0.00496 0.38120 -273.83
## - mean_no2_no3                     1   0.00545 0.38169 -273.74
## <none>                                         0.37624 -270.51
## - mean_ammonia                     1   0.02679 0.40303 -270.26
## - kelp_total_biomass               1   0.02809 0.40433 -270.06
## - site                             4   1.21972 1.59596 -194.66
##
## Step:  AIC=-274.64
## invert_diversity ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_pon + summer_mean_temp + winter_mean_temp +
##     site + summer_mean_temp:winter_mean_temp
##
##                                   Df Sum of Sq     RSS     AIC
## - summer_mean_temp:winter_mean_temp  1   0.00101 0.37742 -278.62
## - mean_pon                         1   0.00156 0.37797 -278.53
## - mean_po4                         1   0.00488 0.38129 -277.97
## - mean_no2_no3                     1   0.00538 0.38179 -277.89
## <none>                                         0.37641 -274.64
## - mean_ammonia                     1   0.02663 0.40304 -274.42
## - kelp_total_biomass               1   0.02882 0.40523 -274.07
## - site                             4   1.29557 1.67198 -195.84
##
## Step:  AIC=-278.62
## invert_diversity ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_pon + summer_mean_temp + winter_mean_temp +
##     site
##
##                       Df Sum of Sq     RSS     AIC
## - mean_pon             1   0.00171 0.37913 -282.49
## - winter_mean_temp     1   0.00174 0.37916 -282.49
## - mean_po4             1   0.00465 0.38207 -282.00
## - mean_no2_no3         1   0.00508 0.38250 -281.93
## - summer_mean_temp     1   0.02319 0.40062 -278.96
## <none>                             0.37742 -278.62
## - mean_ammonia         1   0.02595 0.40337 -278.53
## - kelp_total_biomass   1   0.02790 0.40532 -278.22
## - site                 4   1.30800 1.68543 -199.49
##
## Step:  AIC=-282.49
## invert_diversity ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_po4 + summer_mean_temp + winter_mean_temp + site
##
##                       Df Sum of Sq     RSS     AIC
## - winter_mean_temp     1   0.00238 0.38151 -286.25
```

```
## - mean_po4            1   0.00467 0.38380 -285.87
## - mean_no2_no3        1   0.00631 0.38544 -285.60
## - summer_mean_temp    1   0.02388 0.40302 -282.74
## <none>                            0.37913 -282.49
## - mean_ammonia        1   0.02613 0.40527 -282.38
## - kelp_total_biomass  1   0.03245 0.41159 -281.39
## - site                4   1.59260 1.97173 -193.61
##
## Step:  AIC=-286.25
## invert_diversity ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_po4 + summer_mean_temp + site
##
##                       Df Sum of Sq     RSS     AIC
## - mean_no2_no3         1   0.00631 0.38782 -289.36
## - mean_po4             1   0.01203 0.39355 -288.42
## <none>                             0.38151 -286.25
## - mean_ammonia         1   0.02604 0.40755 -286.19
## - kelp_total_biomass   1   0.03986 0.42137 -284.05
## - summer_mean_temp     1   0.05496 0.43647 -281.80
## - site                 4   1.68601 2.06752 -194.73
##
## Step:  AIC=-289.36
## invert_diversity ~ kelp_total_biomass + mean_ammonia + mean_po4 +
##     summer_mean_temp + site
##
##                       Df Sum of Sq     RSS     AIC
## - mean_po4             1   0.00786 0.39568 -292.24
## <none>                             0.38782 -289.36
## - mean_ammonia         1   0.02768 0.41550 -289.11
## - kelp_total_biomass   1   0.03609 0.42391 -287.82
## - summer_mean_temp     1   0.05564 0.44345 -284.94
## - site                 4   1.87989 2.26770 -192.97
##
## Step:  AIC=-292.23
## invert_diversity ~ kelp_total_biomass + mean_ammonia + summer_mean_temp +
##     site
##
##                       Df Sum of Sq     RSS     AIC
## - mean_ammonia         1   0.02302 0.41870 -292.77
## <none>                             0.39568 -292.24
## - kelp_total_biomass   1   0.03242 0.42810 -291.35
## - summer_mean_temp     1   0.07181 0.46749 -285.72
## - site                 4   2.03541 2.43110 -192.68
##
## Step:  AIC=-292.77
## invert_diversity ~ kelp_total_biomass + summer_mean_temp + site
##
##                       Df Sum of Sq     RSS     AIC
## - kelp_total_biomass   1   0.02371 0.44241 -293.41
## <none>                             0.41870 -292.77
## - summer_mean_temp     1   0.04902 0.46773 -289.85
## - site                 4   2.28652 2.70523 -190.00
##
## Step:  AIC=-293.41
```

```
## invert_diversity ~ summer_mean_temp + site
##
##                     Df Sum of Sq    RSS     AIC
## <none>                           0.4424 -293.41
## - summer_mean_temp  1   0.03716 0.4796 -292.40
## - site              4   2.72601 3.1684 -184.04
```

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

```
## Start:  AIC=-188.19
## invert_diversity ~ 1
##
##                       Df Sum of Sq    RSS     AIC
## + site                 4   2.68938 0.4796 -292.40
## + mean_pon             1   0.93150 2.2375 -206.31
## + mean_tchl            1   0.71364 2.4553 -200.36
## + mean_poc             1   0.45705 2.7119 -194.00
## + kelp_total_biomass   1   0.43830 2.7306 -193.56
## + mean_ammonia         1   0.35419 2.8148 -191.62
## + mean_po4             1   0.26135 2.9076 -189.54
## <none>                             3.1689 -188.19
## + mean_no2_no3         1   0.03833 3.1306 -184.81
## + summer_mean_temp     1   0.00053 3.1684 -184.04
## + winter_mean_temp     1   0.00003 3.1689 -184.03
##
## Step:  AIC=-292.41
## invert_diversity ~ site
##
##                       Df Sum of Sq     RSS     AIC
## + winter_mean_temp     1  0.043357 0.43621 -294.31
## + summer_mean_temp     1  0.037160 0.44241 -293.41
## <none>                             0.47957 -292.40
## + mean_tchl            1  0.023545 0.45603 -291.47
## + mean_pon             1  0.018492 0.46108 -290.76
## + mean_po4             1  0.015901 0.46367 -290.40
## + kelp_total_biomass   1  0.011844 0.46773 -289.85
## + mean_poc             1  0.001308 0.47826 -288.42
## + mean_ammonia         1  0.000313 0.47926 -288.29
## + mean_no2_no3         1  0.000200 0.47937 -288.27
##
## Step:  AIC=-294.31
## invert_diversity ~ site + winter_mean_temp
##
##                          Df Sum of Sq     RSS     AIC
## <none>                                0.43621 -294.31
## + kelp_total_biomass      1  0.013726 0.42249 -292.20
## + mean_ammonia            1  0.010983 0.42523 -291.78
## + mean_pon                1  0.007025 0.42919 -291.19
## + mean_tchl               1  0.006423 0.42979 -291.10
## + mean_no2_no3            1  0.004758 0.43146 -290.85
## + mean_poc                1  0.004574 0.43164 -290.83
## + summer_mean_temp        1  0.003353 0.43286 -290.65
## + mean_po4                1  0.000159 0.43605 -290.18
```

```
## + winter_mean_temp:site  4  0.043564 0.39265 -284.41
```

```
summary(fit.final4)
```

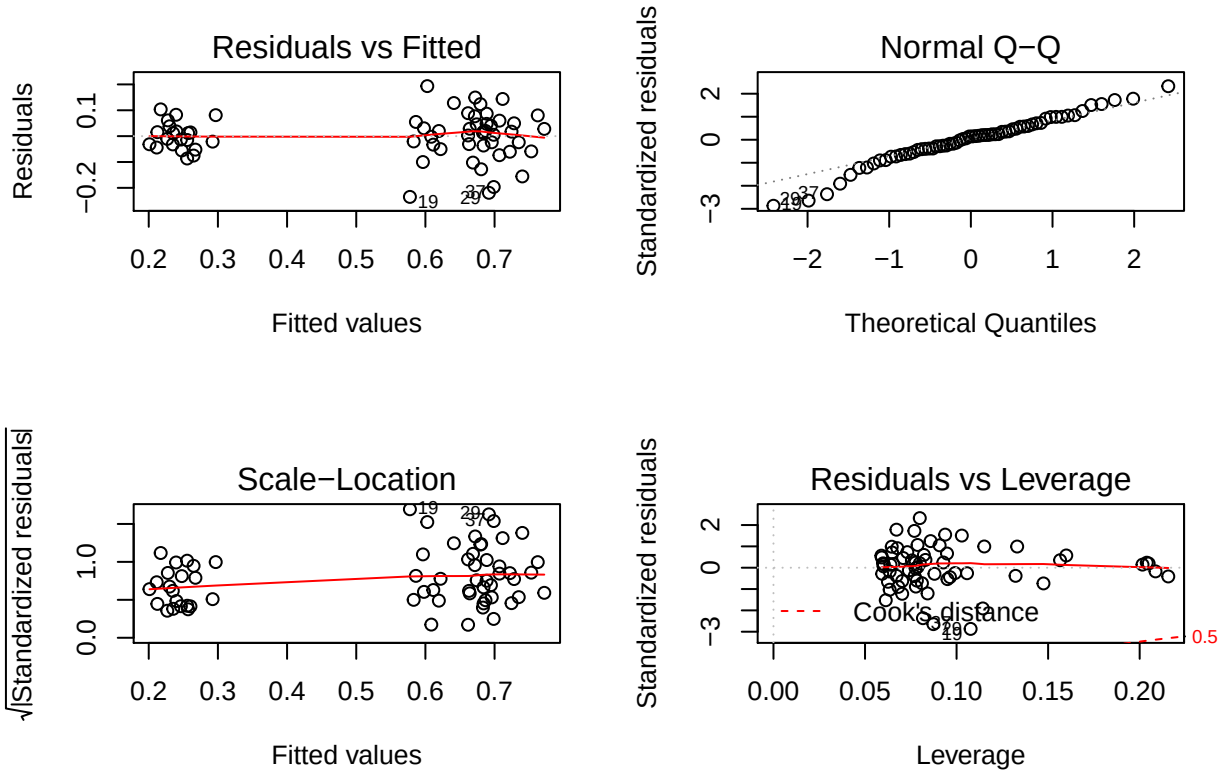
```
##
## Call:
## lm(formula = invert_diversity ~ summer_mean_temp + site, data = data.waterchem)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.259556 -0.036409  0.001901  0.050055  0.198847
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)       0.30200    0.18782   1.608  0.11327
## summer_mean_temp  0.02585    0.01171   2.207  0.03127 *
## siteAQUE         -0.48437    0.04597 -10.538  4.3e-15 ***
## siteCARP         -0.47697    0.03314 -14.394  < 2e-16 ***
## siteMOHK         -0.11615    0.03513  -3.306  0.00163 **
## siteNAPL         -0.02421    0.03219  -0.752  0.45509
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.08734 on 58 degrees of freedom
## Multiple R-squared:  0.8604, Adjusted R-squared:  0.8484
## F-statistic: 71.49 on 5 and 58 DF,  p-value: < 2.2e-16
```

```
summary(fit.final4.forward)
```

```
##
## Call:
## lm(formula = invert_diversity ~ site + winter_mean_temp, data = data.waterchem)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.23496 -0.03837  0.01154  0.04805  0.19339
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)       0.26895    0.18654   1.442  0.15473
## siteAQUE         -0.46853    0.04621 -10.139 1.86e-14 ***
## siteCARP         -0.48000    0.03306 -14.519  < 2e-16 ***
## siteMOHK         -0.10842    0.03424  -3.166  0.00246 **
## siteNAPL         -0.01974    0.03197  -0.617  0.53933
## winter_mean_temp  0.03104    0.01293   2.401  0.01958 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.08672 on 58 degrees of freedom
## Multiple R-squared:  0.8623, Adjusted R-squared:  0.8505
## F-statistic: 72.67 on 5 and 58 DF,  p-value: < 2.2e-16
```

p-value is less than 0.05 the final model is invert_diversity ~ site+ winter_mean_temp(higher adjusted R)

```
par(mfrow=c(2,2))
plot(fit.final4.forward)
```



normality assumption seems to be satisfied but constant variance assumption seems to be violated.

#algae_total_biomass

```
fit.initial5<-lm(algae_total_biomass~kelp_total_biomass+mean_ammonia+mean_no2_no3+mean_po4+mean_poc+mean
n<-dim(data.waterchem)[1]
scp5<-list(lower=~1,upper=~kelp_total_biomass+mean_ammonia+mean_no2_no3+mean_po4+mean_poc+mean_pon+mean_
fit.final5<-step(fit.initial5,scope=scp5,direction="backward",k=log(n))
```

```
## Start:  AIC=788.82
## algae_total_biomass ~ 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
##
##                                Df Sum of Sq      RSS    AIC
## - kelp_total_biomass:mean_poc  1      7872  5448360 784.75
## - mean_po4                     1     13405  5453893 784.81
## - summer_mean_temp             1     18875  5459363 784.88
## - mean_tchl                    1     30543  5471031 785.01
## - winter_mean_temp             1     97205  5537693 785.79
## - mean_pon                     1    105817  5546304 785.89
## <none>                                     5440488 788.82
## - mean_ammonia                 1    408910  5849398 789.29
```

```
## - mean_no2_no3                1    924074  6364562 794.70
## - site                        4   6352168 11792656 821.69
##
## Step:  AIC=784.75
## algae_total_biomass ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_poc + mean_pon + mean_tchl + summer_mean_temp +
##     winter_mean_temp + site
##
##                       Df Sum of Sq      RSS    AIC
## - mean_po4             1     10554  5458913 780.71
## - kelp_total_biomass   1     11962  5460322 780.73
## - summer_mean_temp     1     21402  5469761 780.84
## - mean_poc             1     26061  5474421 780.90
## - mean_tchl            1     28603  5476963 780.92
## - mean_pon             1     99014  5547374 781.74
## - winter_mean_temp     1    101618  5549978 781.77
## <none>                             5448360 784.75
## - mean_ammonia         1    401458  5849817 785.14
## - mean_no2_no3         1    946679  6395038 790.84
## - site                 4   6601937 12050297 818.91
##
## Step:  AIC=780.71
## algae_total_biomass ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_poc + mean_pon + mean_tchl + summer_mean_temp + winter_mean_temp +
##     site
##
##                       Df Sum of Sq      RSS    AIC
## - kelp_total_biomass   1      7191  5466104 776.64
## - mean_poc             1     25881  5484794 776.86
## - summer_mean_temp     1     26279  5485193 776.86
## - mean_tchl            1     31163  5490076 776.92
## - mean_pon             1    101727  5560640 777.74
## - winter_mean_temp     1    182821  5641734 778.66
## <none>                             5458913 780.71
## - mean_ammonia         1    391498  5850412 780.99
## - mean_no2_no3         1   1083771  6542685 788.15
## - site                 4   6666577 12125490 815.15
##
## Step:  AIC=776.64
## algae_total_biomass ~ mean_ammonia + mean_no2_no3 + mean_poc +
##     mean_pon + mean_tchl + summer_mean_temp + winter_mean_temp +
##     site
##
##                     Df Sum of Sq      RSS    AIC
## - mean_poc           1     31980  5498084 772.85
## - mean_tchl          1     36370  5502475 772.90
## - summer_mean_temp   1     40502  5506607 772.95
## - mean_pon           1    127092  5593196 773.95
## - winter_mean_temp   1    188343  5654447 774.65
## <none>                           5466104 776.64
## - mean_ammonia       1    384410  5850515 776.83
## - mean_no2_no3       1   1103000  6569104 784.24
## - site               4   7469981 12936086 815.14
##
```

```
## Step:  AIC=772.85
## algae_total_biomass ~ mean_ammonia + mean_no2_no3 + mean_pon +
##     mean_tchl + summer_mean_temp + winter_mean_temp + site
##
##                     Df Sum of Sq      RSS    AIC
## - summer_mean_temp  1     27471  5525556 769.01
## - mean_tchl         1     31516  5529601 769.06
## - mean_pon          1    106182  5604267 769.92
## - winter_mean_temp  1    259174  5757258 771.64
## <none>                           5498084 772.85
## - mean_ammonia      1    374797  5872882 772.92
## - mean_no2_no3      1   1261255  6759340 781.91
## - site              4   7441394 12939478 810.99
##
## Step:  AIC=769.01
## algae_total_biomass ~ mean_ammonia + mean_no2_no3 + mean_pon +
##     mean_tchl + winter_mean_temp + site
##
##                     Df Sum of Sq      RSS    AIC
## - mean_tchl         1     41384  5566940 765.33
## - mean_pon          1    123704  5649260 766.27
## - winter_mean_temp  1    254684  5780240 767.74
## <none>                           5525556 769.01
## - mean_ammonia      1    541254  6066809 770.84
## - mean_no2_no3      1   1309638  6835194 778.47
## - site              4   7507782 13033337 807.30
##
## Step:  AIC=765.33
## algae_total_biomass ~ mean_ammonia + mean_no2_no3 + mean_pon +
##     winter_mean_temp + site
##
##                     Df Sum of Sq      RSS    AIC
## - mean_pon          1    128720  5695660 762.64
## - winter_mean_temp  1    213959  5780899 763.59
## <none>                           5566940 765.33
## - mean_ammonia      1    503454  6070393 766.71
## - mean_no2_no3      1   1289836  6856776 774.51
## - site              4   7491976 13058916 803.26
##
## Step:  AIC=762.64
## algae_total_biomass ~ mean_ammonia + mean_no2_no3 + winter_mean_temp +
##     site
##
##                     Df Sum of Sq      RSS    AIC
## - winter_mean_temp  1    326653  6022313 762.05
## <none>                           5695660 762.64
## - mean_ammonia      1    495285  6190945 763.81
## - mean_no2_no3      1   1195675  6891335 770.67
## - site              4   8149807 13845467 802.85
##
## Step:  AIC=762.05
## algae_total_biomass ~ mean_ammonia + mean_no2_no3 + site
##
##                Df Sum of Sq      RSS    AIC
```

```
## - mean_ammonia  1    236249  6258562 760.35
## <none>                       6022313 762.05
## - mean_no2_no3  1   1467485  7489798 771.84
## - site          4   8151679 14173993 800.19
##
## Step:  AIC=760.35
## algae_total_biomass ~ mean_no2_no3 + site
##
##                Df Sum of Sq      RSS    AIC
## <none>                       6258562 760.35
## - mean_no2_no3  1   1289168  7547730 768.18
## - site          4   8560115 14818677 798.88
```

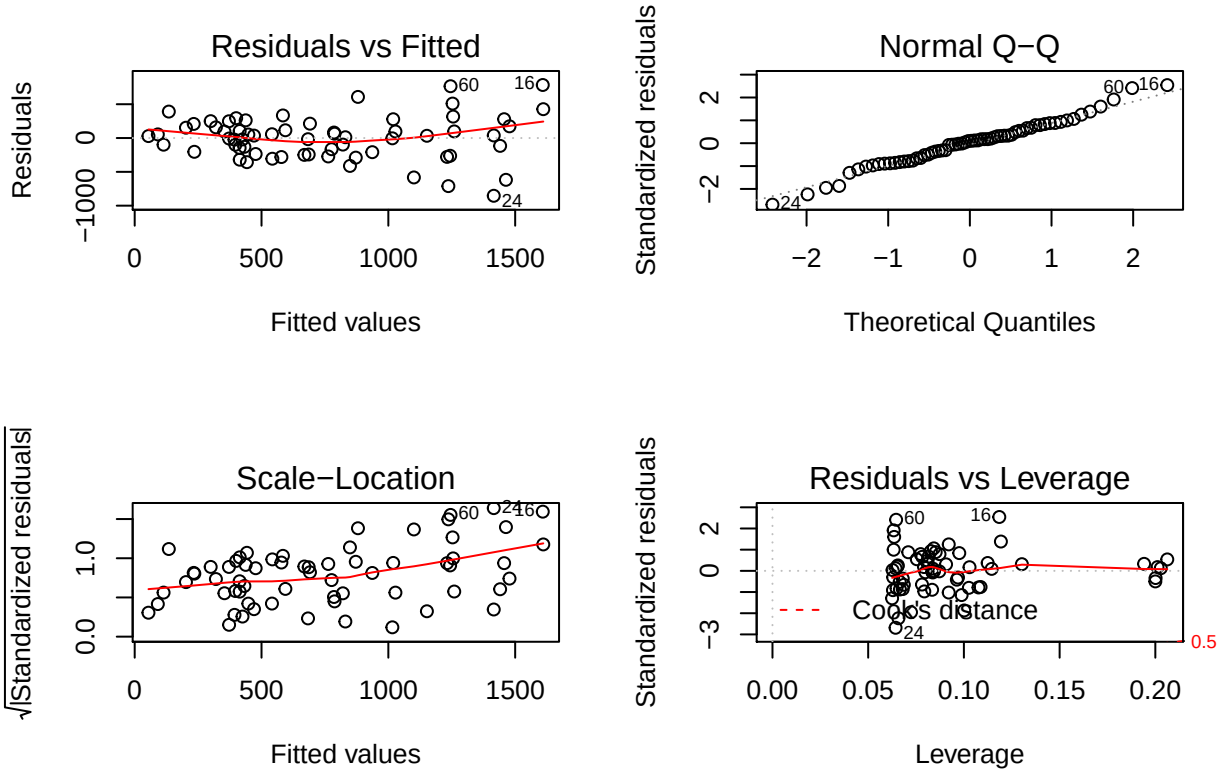
```
fit.null5<-lm(algae_total_biomass~1,data=data.waterchem)
fit.final5.forward<-step(fit.null5,scope=scp5,direction="forward",k=log(n))
```

```
## Start:  AIC=806.69
## algae_total_biomass ~ 1
##
##                      Df Sum of Sq      RSS    AIC
## + site                4  10319388  7547730 768.18
## + mean_no2_no3        1   3048441 14818677 798.88
## <none>                            17867118 806.69
## + kelp_total_biomass  1   1109490 16757629 806.75
## + winter_mean_temp    1    392996 17474122 809.43
## + mean_tchl           1    312892 17554226 809.72
## + mean_ammonia        1    312429 17554690 809.72
## + mean_po4            1    222628 17644490 810.05
## + mean_pon            1    206440 17660678 810.11
## + summer_mean_temp    1    138848 17728271 810.35
## + mean_poc            1     10097 17857021 810.82
##
## Step:  AIC=768.18
## algae_total_biomass ~ site
##
##                      Df Sum of Sq     RSS    AIC
## + mean_no2_no3        1   1289168 6258562 760.35
## <none>                            7547730 768.18
## + mean_po4            1    319422 7228308 769.57
## + winter_mean_temp    1    289847 7257884 769.83
## + mean_tchl           1    116834 7430897 771.34
## + mean_pon            1    102874 7444856 771.46
## + kelp_total_biomass  1     99824 7447906 771.49
## + mean_ammonia        1     57932 7489798 771.84
## + summer_mean_temp    1      4007 7543723 772.30
## + mean_poc            1      1614 7546116 772.32
##
## Step:  AIC=760.35
## algae_total_biomass ~ site + mean_no2_no3
##
##                      Df Sum of Sq     RSS    AIC
## <none>                            6258562 760.35
## + mean_ammonia        1    236249 6022313 762.05
## + mean_pon            1    166783 6091779 762.78
```

```
## + mean_tchl           1    124982 6133580 763.22
## + mean_poc            1     73484 6185079 763.75
## + winter_mean_temp    1     67617 6190945 763.81
## + kelp_total_biomass  1     47631 6210931 764.02
## + mean_po4            1     29019 6229543 764.21
## + summer_mean_temp    1     13334 6245228 764.37
```

final model is algae_total_biomass~mean_no2_no3+site

```
par(mfrow=c(2,2))
plot(fit.final5)
```



#algae_diversity

```
fit.initial6<-lm(algae_diversity~kelp_total_biomass+mean_ammonia+mean_no2_no3+mean_po4+mean_poc+mean_po
n<-dim(data.waterchem)[1]
scp6<-list(lower=~1,upper=~kelp_total_biomass+mean_ammonia+mean_no2_no3+mean_po4+mean_poc+mean_pon+mean_
fit.final6<-step(fit.initial5,scope=scp6,direction="backward",k=log(n))
```

```
## Start:  AIC=788.82
## algae_total_biomass ~ 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
##
##                              Df Sum of Sq      RSS     AIC
```

```
## - kelp_total_biomass:mean_poc  1      7872  5448360 784.75
## - mean_po4                     1     13405  5453893 784.81
## - summer_mean_temp             1     18875  5459363 784.88
## - mean_tchl                    1     30543  5471031 785.01
## - winter_mean_temp             1     97205  5537693 785.79
## - mean_pon                     1    105817  5546304 785.89
## <none>                                      5440488 788.82
## - mean_ammonia                 1    408910  5849398 789.29
## - mean_no2_no3                 1    924074  6364562 794.70
## - site                         4   6352168 11792656 821.69
##
## Step:  AIC=784.75
## algae_total_biomass ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_poc + mean_pon + mean_tchl + summer_mean_temp +
##     winter_mean_temp + site
##
##                       Df Sum of Sq      RSS    AIC
## - mean_po4             1     10554  5458913 780.71
## - kelp_total_biomass   1     11962  5460322 780.73
## - summer_mean_temp     1     21402  5469761 780.84
## - mean_poc             1     26061  5474421 780.90
## - mean_tchl            1     28603  5476963 780.92
## - mean_pon             1     99014  5547374 781.74
## - winter_mean_temp     1    101618  5549978 781.77
## <none>                             5448360 784.75
## - mean_ammonia         1    401458  5849817 785.14
## - mean_no2_no3         1    946679  6395038 790.84
## - site                 4   6601937 12050297 818.91
##
## Step:  AIC=780.71
## algae_total_biomass ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_poc + mean_pon + mean_tchl + summer_mean_temp + winter_mean_temp +
##     site
##
##                       Df Sum of Sq      RSS    AIC
## - kelp_total_biomass   1      7191  5466104 776.64
## - mean_poc             1     25881  5484794 776.86
## - summer_mean_temp     1     26279  5485193 776.86
## - mean_tchl            1     31163  5490076 776.92
## - mean_pon             1    101727  5560640 777.74
## - winter_mean_temp     1    182821  5641734 778.66
## <none>                             5458913 780.71
## - mean_ammonia         1    391498  5850412 780.99
## - mean_no2_no3         1   1083771  6542685 788.15
## - site                 4   6666577 12125490 815.15
##
## Step:  AIC=776.64
## algae_total_biomass ~ mean_ammonia + mean_no2_no3 + mean_poc +
##     mean_pon + mean_tchl + summer_mean_temp + winter_mean_temp +
##     site
##
##                     Df Sum of Sq      RSS    AIC
## - mean_poc           1     31980  5498084 772.85
## - mean_tchl          1     36370  5502475 772.90
```

```
## - summer_mean_temp  1     40502  5506607 772.95
## - mean_pon          1    127092  5593196 773.95
## - winter_mean_temp  1    188343  5654447 774.65
## <none>                           5466104 776.64
## - mean_ammonia      1    384410  5850515 776.83
## - mean_no2_no3      1   1103000  6569104 784.24
## - site              4   7469981 12936086 815.14
##
## Step:  AIC=772.85
## algae_total_biomass ~ mean_ammonia + mean_no2_no3 + mean_pon +
##     mean_tchl + summer_mean_temp + winter_mean_temp + site
##
##                     Df Sum of Sq      RSS    AIC
## - summer_mean_temp  1     27471  5525556 769.01
## - mean_tchl         1     31516  5529601 769.06
## - mean_pon          1    106182  5604267 769.92
## - winter_mean_temp  1    259174  5757258 771.64
## <none>                           5498084 772.85
## - mean_ammonia      1    374797  5872882 772.92
## - mean_no2_no3      1   1261255  6759340 781.91
## - site              4   7441394 12939478 810.99
##
## Step:  AIC=769.01
## algae_total_biomass ~ mean_ammonia + mean_no2_no3 + mean_pon +
##     mean_tchl + winter_mean_temp + site
##
##                     Df Sum of Sq      RSS    AIC
## - mean_tchl         1     41384  5566940 765.33
## - mean_pon          1    123704  5649260 766.27
## - winter_mean_temp  1    254684  5780240 767.74
## <none>                           5525556 769.01
## - mean_ammonia      1    541254  6066809 770.84
## - mean_no2_no3      1   1309638  6835194 778.47
## - site              4   7507782 13033337 807.30
##
## Step:  AIC=765.33
## algae_total_biomass ~ mean_ammonia + mean_no2_no3 + mean_pon +
##     winter_mean_temp + site
##
##                     Df Sum of Sq      RSS    AIC
## - mean_pon          1    128720  5695660 762.64
## - winter_mean_temp  1    213959  5780899 763.59
## <none>                           5566940 765.33
## - mean_ammonia      1    503454  6070393 766.71
## - mean_no2_no3      1   1289836  6856776 774.51
## - site              4   7491976 13058916 803.26
##
## Step:  AIC=762.64
## algae_total_biomass ~ mean_ammonia + mean_no2_no3 + winter_mean_temp +
##     site
##
##                     Df Sum of Sq      RSS    AIC
## - winter_mean_temp  1    326653  6022313 762.05
## <none>                           5695660 762.64
```

```
## - mean_ammonia      1    495285  6190945 763.81
## - mean_no2_no3      1   1195675  6891335 770.67
## - site              4   8149807 13845467 802.85
##
## Step:  AIC=762.05
## algae_total_biomass ~ mean_ammonia + mean_no2_no3 + site
##
##                Df Sum of Sq      RSS    AIC
## - mean_ammonia  1    236249  6258562 760.35
## <none>                       6022313 762.05
## - mean_no2_no3  1   1467485  7489798 771.84
## - site          4   8151679 14173993 800.19
##
## Step:  AIC=760.35
## algae_total_biomass ~ mean_no2_no3 + site
##
##                Df Sum of Sq      RSS    AIC
## <none>                       6258562 760.35
## - mean_no2_no3  1   1289168  7547730 768.18
## - site          4   8560115 14818677 798.88
```

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

```
## Start:  AIC=-233.92
## algae_diversity ~ 1
##
##                       Df Sum of Sq    RSS     AIC
## + winter_mean_temp     1  0.198706 1.3523 -238.54
## <none>                             1.5510 -233.92
## + mean_poc             1  0.054549 1.4964 -232.05
## + mean_po4             1  0.035384 1.5156 -231.24
## + mean_ammonia         1  0.030122 1.5209 -231.02
## + summer_mean_temp     1  0.018426 1.5326 -230.53
## + mean_no2_no3         1  0.017440 1.5335 -230.49
## + mean_pon             1  0.017144 1.5338 -230.47
## + kelp_total_biomass   1  0.007378 1.5436 -230.07
## + mean_tchl            1  0.005027 1.5460 -229.97
## + site                 4  0.272869 1.2781 -229.67
##
## Step:  AIC=-238.54
## algae_diversity ~ winter_mean_temp
##
##                       Df Sum of Sq    RSS     AIC
## + mean_ammonia         1  0.136751 1.2155 -241.20
## + summer_mean_temp     1  0.087343 1.2649 -238.65
## <none>                             1.3523 -238.54
## + mean_tchl            1  0.048840 1.3034 -236.73
## + mean_pon             1  0.042696 1.3096 -236.43
## + mean_poc             1  0.022509 1.3298 -235.45
## + kelp_total_biomass   1  0.004662 1.3476 -234.60
## + mean_po4             1  0.002601 1.3497 -234.50
## + mean_no2_no3         1  0.001145 1.3511 -234.43
## + site                 4  0.192360 1.1599 -231.72
```

```
##
## Step:  AIC=-241.2
## algae_diversity ~ winter_mean_temp + mean_ammonia
##
##                       Df Sum of Sq    RSS     AIC
## <none>                             1.2155 -241.20
## + summer_mean_temp     1  0.035577 1.1800 -238.94
## + mean_tchl            1  0.029980 1.1856 -238.64
## + mean_pon             1  0.014217 1.2013 -237.79
## + mean_poc             1  0.011352 1.2042 -237.64
## + mean_po4             1  0.005531 1.2100 -237.33
## + mean_no2_no3         1  0.003023 1.2125 -237.20
## + kelp_total_biomass   1  0.000509 1.2150 -237.07
## + site                 4  0.101729 1.1138 -230.16
```

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

```
##
## Call:
## lm(formula = algae_total_biomass ~ mean_no2_no3 + site, data = data.waterchem)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -853.85 -215.95   30.89  182.09  784.02
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -114.007    196.312  -0.581  0.56366
## mean_no2_no3    0.795      0.230   3.456  0.00103 **
## siteAQUE      -27.366    173.464  -0.158  0.87519
## siteCARP      342.624    122.769   2.791  0.00711 **
## siteMOHK     -228.806    128.929  -1.775  0.08120 .
## siteNAPL      769.125    122.976   6.254 5.17e-08 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 328.5 on 58 degrees of freedom
## Multiple R-squared:  0.6497, Adjusted R-squared:  0.6195
## F-statistic: 21.52 on 5 and 58 DF,  p-value: 4.134e-12
```

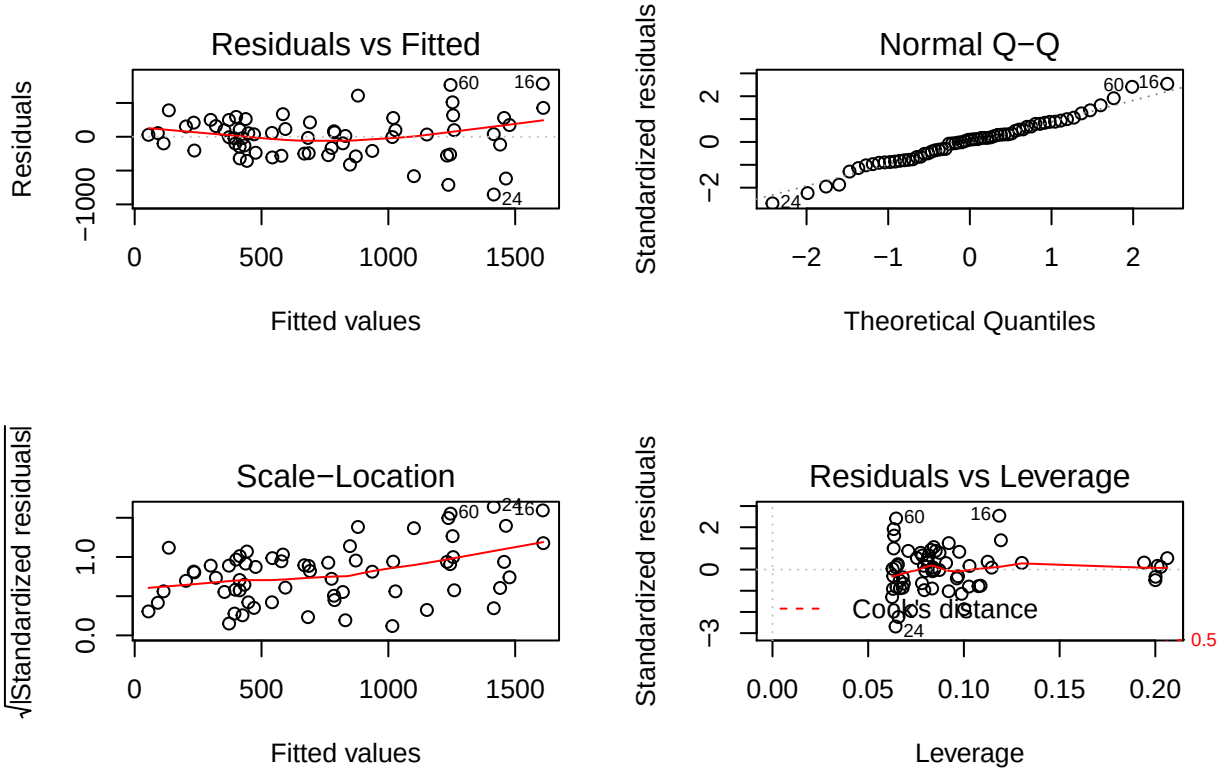
```
summary(fit.final6.forward)
```

```
##
## Call:
## lm(formula = algae_diversity ~ winter_mean_temp + mean_ammonia,
##     data = data.waterchem)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.36116 -0.07195  0.02252  0.10242  0.25152
##
## Coefficients:
##                    Estimate Std. Error t value Pr(>|t|)
```

```
## (Intercept)      -6.515e-01  3.302e-01  -1.973 0.053039 .
## winter_mean_temp  8.352e-02  2.134e-02   3.914 0.000231 ***
## mean_ammonia      1.677e-04  6.401e-05   2.620 0.011091 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1412 on 61 degrees of freedom
## Multiple R-squared:  0.2163, Adjusted R-squared:  0.1906
## F-statistic: 8.417 on 2 and 61 DF,  p-value: 0.0005913
```

the final model is algae_diversity ~ mean_no2_no3 + site

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



###Summary of 6 new models

```
summary(fit.final)
```

```
##
## Call:
## lm(formula = fish_total_biomass ~ site, data = data.waterchem)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
```

```
## -119.83  -29.04   -4.22   18.56  367.16
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)    6.084     19.688   0.309   0.7584
## siteAQUE     120.782     37.355   3.233   0.0020 **
## siteCARP      51.192     26.505   1.931   0.0582 .
## siteMOHK      20.330     27.842   0.730   0.4682
## siteNAPL     144.638     26.153   5.530 7.66e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 70.98 on 59 degrees of freedom
## Multiple R-squared:  0.4108, Adjusted R-squared:  0.3709
## F-statistic: 10.28 on 4 and 59 DF,  p-value: 2.189e-06
```

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

```
##
## Call:
## lm(formula = fish_diversity ~ mean_ammonia, data = data.waterchem)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -0.4474 -0.1312 -0.0069  0.1226  0.3874
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  1.555e-01  6.110e-02   2.546  0.01340 *
## mean_ammonia 2.135e-04  7.417e-05   2.879  0.00547 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1767 on 62 degrees of freedom
## Multiple R-squared:  0.1179, Adjusted R-squared:  0.1037
## F-statistic: 8.287 on 1 and 62 DF,  p-value: 0.005473
```

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

```
##
## Call:
## lm(formula = invert_total_biomass ~ mean_tchl + summer_mean_temp +
##     winter_mean_temp + site + summer_mean_temp:site + mean_tchl:winter_mean_temp,
##     data = data.waterchem)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -9930.5 -1131.0   233.2  1051.6 11392.0
##
## Coefficients:
##                              Estimate Std. Error t value Pr(>|t|)
## (Intercept)                  9515.16   18092.17   0.526 0.601219
## mean_tchl                   -9845.20    4524.98  -2.176 0.034233 *
```

```
## summer_mean_temp             -710.91    1053.94  -0.675 0.503022
## winter_mean_temp              -91.72    1218.01  -0.075 0.940270
## siteAQUE                    15774.93   66117.54   0.239 0.812380
## siteCARP                   104639.19   21030.77   4.976 7.79e-06 ***
## siteMOHK                    -2238.93   19929.49  -0.112 0.910993
## siteNAPL                     3892.35   19646.57   0.198 0.843740
## summer_mean_temp:siteAQUE    -948.98    4139.87  -0.229 0.819607
## summer_mean_temp:siteCARP   -5207.01    1291.88  -4.031 0.000186 ***
## summer_mean_temp:siteMOHK     188.38    1225.60   0.154 0.878451
## summer_mean_temp:siteNAPL     -98.04    1230.35  -0.080 0.936797
## mean_tchl:winter_mean_temp    786.80     315.63   2.493 0.015964 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3232 on 51 degrees of freedom
## Multiple R-squared:  0.9307, Adjusted R-squared:  0.9144
## F-statistic: 57.09 on 12 and 51 DF,  p-value: < 2.2e-16
```

```
summary(fit.final4.forward)
```

```
##
## Call:
## lm(formula = invert_diversity ~ site + winter_mean_temp, data = data.waterchem)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.23496 -0.03837  0.01154  0.04805  0.19339
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)       0.26895    0.18654   1.442  0.15473
## siteAQUE         -0.46853    0.04621 -10.139 1.86e-14 ***
## siteCARP         -0.48000    0.03306 -14.519  < 2e-16 ***
## siteMOHK         -0.10842    0.03424  -3.166  0.00246 **
## siteNAPL         -0.01974    0.03197  -0.617  0.53933
## winter_mean_temp  0.03104    0.01293   2.401  0.01958 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.08672 on 58 degrees of freedom
## Multiple R-squared:  0.8623, Adjusted R-squared:  0.8505
## F-statistic: 72.67 on 5 and 58 DF,  p-value: < 2.2e-16
```

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

```
##
## Call:
## lm(formula = algae_total_biomass ~ mean_no2_no3 + site, data = data.waterchem)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -853.85 -215.95   30.89  182.09  784.02
##
```

```
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -114.007    196.312  -0.581  0.56366
## mean_no2_no3    0.795      0.230   3.456  0.00103 **
## siteAQUE      -27.366    173.464  -0.158  0.87519
## siteCARP      342.624    122.769   2.791  0.00711 **
## siteMOHK     -228.806    128.929  -1.775  0.08120 .
## siteNAPL      769.125    122.976   6.254 5.17e-08 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 328.5 on 58 degrees of freedom
## Multiple R-squared:  0.6497, Adjusted R-squared:  0.6195
## F-statistic: 21.52 on 5 and 58 DF,  p-value: 4.134e-12
```

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

```
##
## Call:
## lm(formula = algae_total_biomass ~ mean_no2_no3 + site, data = data.waterchem)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -853.85 -215.95   30.89  182.09  784.02
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -114.007    196.312  -0.581  0.56366
## mean_no2_no3    0.795      0.230   3.456  0.00103 **
## siteAQUE      -27.366    173.464  -0.158  0.87519
## siteCARP      342.624    122.769   2.791  0.00711 **
## siteMOHK     -228.806    128.929  -1.775  0.08120 .
## siteNAPL      769.125    122.976   6.254 5.17e-08 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 328.5 on 58 degrees of freedom
## Multiple R-squared:  0.6497, Adjusted R-squared:  0.6195
## F-statistic: 21.52 on 5 and 58 DF,  p-value: 4.134e-12
```