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')
```

#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=601.13
## fish_total_biomass ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_poc + mean_pon + mean_tchl + kelp_total_biomass:mean_poc
##
##                               Df Sum of Sq    RSS    AIC
## - mean_po4                     1     169.4 428077 596.99
## - mean_tchl                    1     323.8 428231 597.02
## - mean_no2_no3                 1     558.7 428466 597.05
## - mean_pon                     1    1177.9 429085 597.14
## - mean_ammonia                 1    6863.1 434771 597.99
## <none>                                     427908 601.13
## - kelp_total_biomass:mean_poc  1   31587.5 459495 601.53
##
## Step:  AIC=596.99
## fish_total_biomass ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_poc + mean_pon + mean_tchl + kelp_total_biomass:mean_poc
##
##                               Df Sum of Sq    RSS    AIC
## - mean_tchl                    1       311 428388 592.88
## - mean_no2_no3                 1       828 428905 592.96
## - mean_pon                     1      1081 429158 593.00
## - mean_ammonia                 1      8568 436645 594.10
## <none>                                     428077 596.99
## - kelp_total_biomass:mean_poc  1     33091 461168 597.60
##
## Step:  AIC=592.88
## fish_total_biomass ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_poc + mean_pon + kelp_total_biomass:mean_poc
##
##                               Df Sum of Sq    RSS    AIC
## - mean_no2_no3                 1       776 429164 588.84
## - mean_pon                     1      6342 434730 589.66
## - mean_ammonia                 1      9636 438024 590.15
## <none>                                     428388 592.88
## - kelp_total_biomass:mean_poc  1     34039 462427 593.62
##
```

```
## Step:  AIC=588.84
## fish_total_biomass ~ kelp_total_biomass + mean_ammonia + mean_poc +
##     mean_pon + kelp_total_biomass:mean_poc
##
##                               Df Sum of Sq    RSS    AIC
## - mean_pon                     1      5847 435011 585.55
## - mean_ammonia                 1      9986 439149 586.15
## <none>                                     429164 588.84
## - kelp_total_biomass:mean_poc  1     33455 462618 589.48
##
## Step:  AIC=585.55
## fish_total_biomass ~ kelp_total_biomass + mean_ammonia + mean_poc +
##     kelp_total_biomass:mean_poc
##
##                               Df Sum of Sq    RSS    AIC
## - mean_ammonia                 1    5276.8 440288 582.16
## - kelp_total_biomass:mean_poc  1   28777.6 463788 585.49
## <none>                                     435011 585.55
##
## Step:  AIC=582.16
## fish_total_biomass ~ kelp_total_biomass + mean_poc + kelp_total_biomass:mean_poc
##
##                               Df Sum of Sq    RSS    AIC
## - kelp_total_biomass:mean_poc  1     29199 469486 582.11
## <none>                                     440288 582.16
##
## Step:  AIC=582.11
## fish_total_biomass ~ kelp_total_biomass + mean_poc
##
##                       Df Sum of Sq    RSS    AIC
## - mean_poc             1      8798 478284 579.14
## <none>                             469486 582.11
## - kelp_total_biomass   1     32322 501808 582.21
##
## Step:  AIC=579.14
## fish_total_biomass ~ kelp_total_biomass
##
##                       Df Sum of Sq    RSS    AIC
## - kelp_total_biomass   1     26292 504576 578.40
## <none>                             478284 579.14
##
## Step:  AIC=578.4
## fish_total_biomass ~ 1
```

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

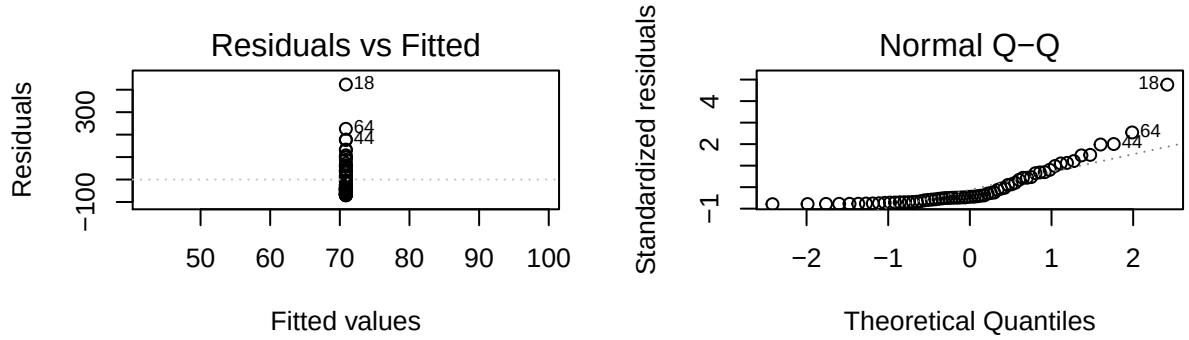
```
## Start:  AIC=578.4
## fish_total_biomass ~ 1
##
##                       Df Sum of Sq    RSS    AIC
## <none>                             504576 578.40
## + kelp_total_biomass   1   26292.0 478284 579.14
## + mean_po4             1    5994.2 498582 581.80
```

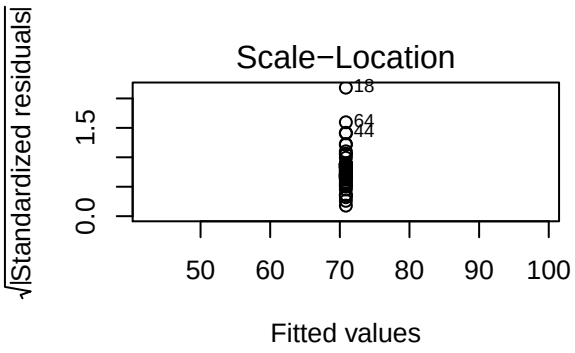
```
## + mean_ammonia        1    3605.8 500971 582.10
## + mean_poc            1    2768.3 501808 582.21
## + mean_no2_no3        1     581.8 503995 582.49
## + mean_pon            1     492.9 504084 582.50
## + mean_tchl           1       4.6 504572 582.56
```

final model is fish_total_biomass~kelp_total_biomass.

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

```
## hat values (leverages) are all = 0.015625
##  and there are no factor predictors; no plot no. 5
```





#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))
```

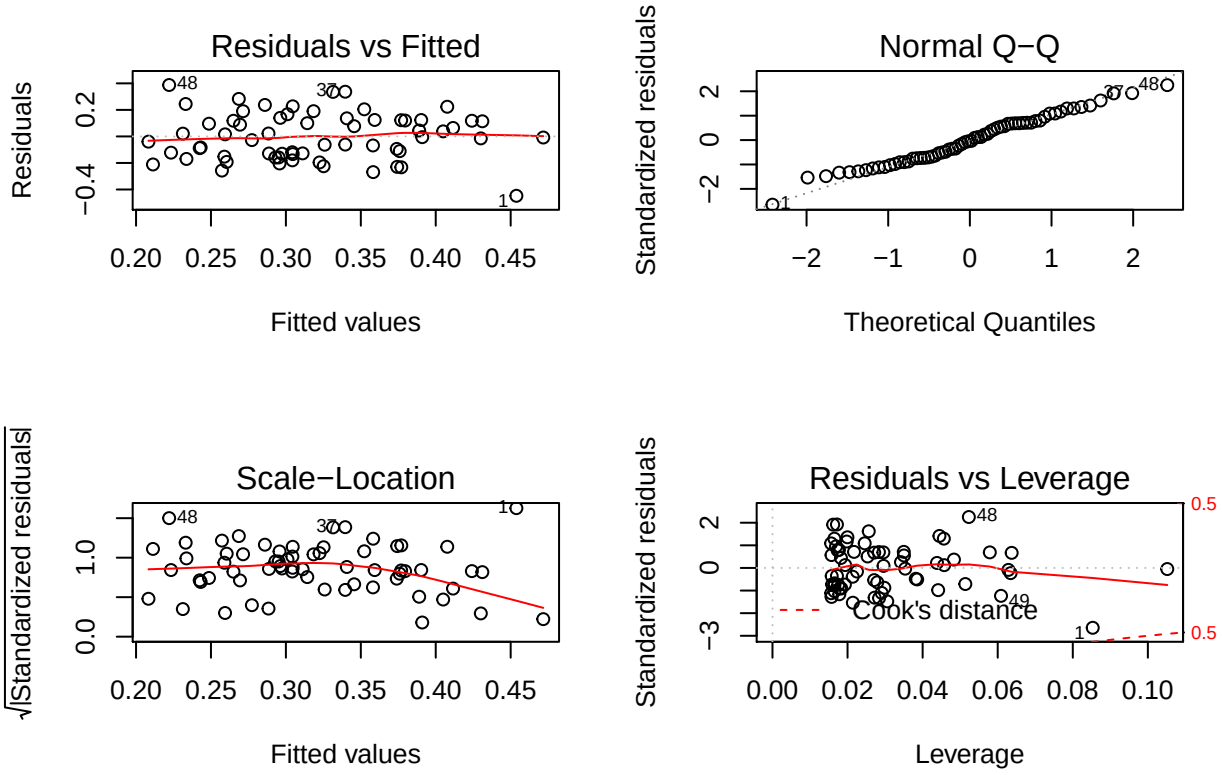
```
## Start:  AIC=-194.17
## fish_diversity ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_poc + mean_pon + mean_tchl
##
```

```
##                       Df Sum of Sq    RSS     AIC
## - mean_po4             1  0.000002 1.8315 -198.33
## - mean_no2_no3         1  0.000006 1.8315 -198.33
## - mean_pon             1  0.000053 1.8316 -198.33
## - mean_tchl            1  0.010170 1.8417 -197.97
## - kelp_total_biomass   1  0.013802 1.8453 -197.85
## - mean_poc             1  0.033312 1.8648 -197.17
## <none>                             1.8315 -194.17
## - mean_ammonia         1  0.148940 1.9805 -193.32
##
## Step:  AIC=-198.33
## fish_diversity ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_poc + mean_pon + mean_tchl
##
##                       Df Sum of Sq    RSS     AIC
## - mean_no2_no3         1  0.000005 1.8315 -202.49
## - mean_pon             1  0.000051 1.8316 -202.48
## - mean_tchl            1  0.010168 1.8417 -202.13
## - kelp_total_biomass   1  0.014782 1.8463 -201.97
## - mean_poc             1  0.034506 1.8660 -201.29
## <none>                             1.8315 -198.33
## - mean_ammonia         1  0.165466 1.9970 -196.95
##
## Step:  AIC=-202.49
## fish_diversity ~ kelp_total_biomass + mean_ammonia + mean_poc +
##     mean_pon + mean_tchl
##
##                       Df Sum of Sq    RSS     AIC
## - mean_pon             1  0.000052 1.8316 -206.64
## - mean_tchl            1  0.010234 1.8417 -206.29
## - kelp_total_biomass   1  0.014976 1.8465 -206.12
## - mean_poc             1  0.036624 1.8681 -205.38
## <none>                             1.8315 -202.49
## - mean_ammonia         1  0.166549 1.9981 -201.07
##
## Step:  AIC=-206.64
## fish_diversity ~ kelp_total_biomass + mean_ammonia + mean_poc +
##     mean_tchl
##
##                       Df Sum of Sq    RSS     AIC
## - kelp_total_biomass   1  0.015523 1.8471 -210.26
## - mean_tchl            1  0.033609 1.8652 -209.64
## - mean_poc             1  0.078510 1.9101 -208.12
## <none>                             1.8316 -206.64
## - mean_ammonia         1  0.204669 2.0362 -204.02
##
## Step:  AIC=-210.26
## fish_diversity ~ mean_ammonia + mean_poc + mean_tchl
##
##                Df Sum of Sq    RSS     AIC
## - mean_tchl     1  0.029701 1.8768 -213.40
## - mean_poc      1  0.087413 1.9345 -211.46
## <none>                      1.8471 -210.26
## - mean_ammonia  1  0.198374 2.0455 -207.89
```

```
##
## 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
```

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

```r
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=1184.37
## invert_total_biomass ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_poc + mean_pon + mean_tchl + mean_pon:mean_ammonia
##
##                          Df Sum of Sq        RSS    AIC
## - mean_tchl               1    151191 3882766248 1180.2
## - mean_no2_no3            1  33825581 3916440637 1180.8
## - mean_poc                1  63371354 3945986410 1181.2
## - kelp_total_biomass      1  69244743 3951859800 1181.3
## - mean_po4                1  71018553 3953633609 1181.4
## <none>                                3882615057 1184.4
## - mean_ammonia:mean_pon   1 338494110 4221109167 1185.6
##
## Step:  AIC=1180.21
## invert_total_biomass ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_poc + mean_pon + mean_ammonia:mean_pon
##
##                          Df Sum of Sq        RSS    AIC
## - mean_no2_no3            1  34209524 3916975772 1176.6
## - mean_po4                1  70947152 3953713399 1177.2
## - kelp_total_biomass      1  71838096 3954604343 1177.2
## - mean_poc                1  72537628 3955303876 1177.2
## <none>                                3882766248 1180.2
## - mean_ammonia:mean_pon   1 339189158 4221955406 1181.4
##
## Step:  AIC=1176.61
## invert_total_biomass ~ kelp_total_biomass + mean_ammonia + mean_po4 +
##     mean_poc + mean_pon + mean_ammonia:mean_pon
##
##                          Df Sum of Sq        RSS    AIC
## - mean_po4                1  49798006 3966773778 1173.3
## - kelp_total_biomass      1  55735153 3972710925 1173.4
## - mean_poc                1  94482531 4011458303 1174.0
## <none>                                3916975772 1176.6
## - mean_ammonia:mean_pon   1 317422283 4234398055 1177.4
##
## Step:  AIC=1173.26
## invert_total_biomass ~ kelp_total_biomass + mean_ammonia + mean_poc +
##     mean_pon + mean_ammonia:mean_pon
##
##                          Df Sum of Sq        RSS    AIC
## - kelp_total_biomass      1  35963873 4002737652 1169.7
## - mean_poc                1  65576882 4032350661 1170.2
## <none>                                3966773778 1173.3
## - mean_ammonia:mean_pon   1 326042429 4292816207 1174.2
##
## Step:  AIC=1169.68
## invert_total_biomass ~ mean_ammonia + mean_poc + mean_pon + mean_ammonia:mean_pon
```

```
##
##                          Df Sum of Sq        RSS    AIC
## - mean_poc                1  58919111 4061656763 1166.5
## <none>                                4002737652 1169.7
## - mean_ammonia:mean_pon   1 318690906 4321428557 1170.4
##
## Step:  AIC=1166.46
## invert_total_biomass ~ mean_ammonia + mean_pon + mean_ammonia:mean_pon
##
##                          Df Sum of Sq        RSS    AIC
## <none>                                4061656763 1166.5
## - mean_ammonia:mean_pon   1 295767875 4357424638 1166.8
```

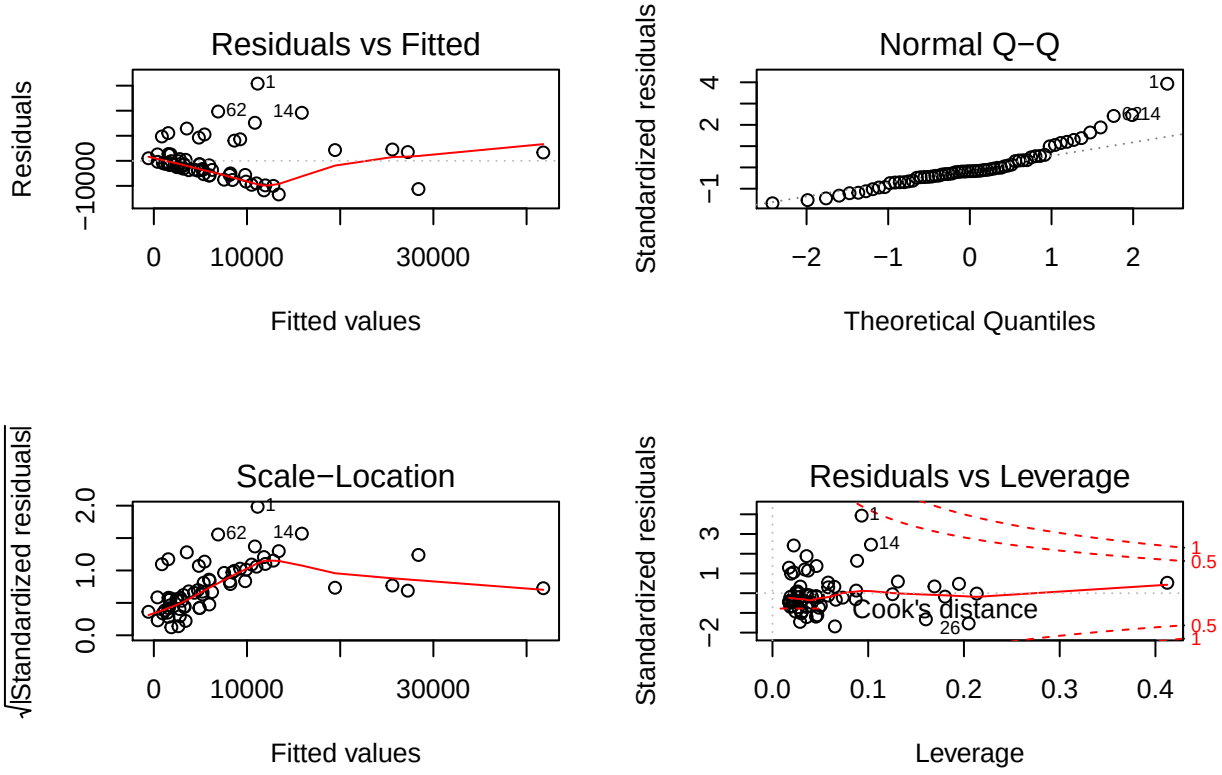
```
fit.null3<-lm(invert_total_biomass~1,data=data.waterchem)
fit.final3.forward<-step(fit.null3,scope=scp3,direction="forward",k=log(n))
```

```
## Start:  AIC=1194.83
## invert_total_biomass ~ 1
##
##                       Df  Sum of Sq        RSS    AIC
## + 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
## + mean_no2_no3         1   25378932 7664693033 1198.8
##
## Step:  AIC=1166.83
## invert_total_biomass ~ mean_pon
##
##                       Df Sum of Sq        RSS    AIC
## + mean_ammonia         1 294863831 4357424638 1166.8
## <none>                             4652288469 1166.8
## + mean_po4             1 126945481 4525342988 1169.2
## + kelp_total_biomass   1  25233873 4627054596 1170.6
## + mean_tchl            1  20197504 4632090966 1170.7
## + mean_poc             1   1154017 4651134452 1171.0
## + mean_no2_no3         1    810025 4651478445 1171.0
##
## Step:  AIC=1166.8
## invert_total_biomass ~ mean_pon + mean_ammonia
##
##                          Df Sum of Sq        RSS    AIC
## + mean_ammonia:mean_pon   1 295767875 4061656763 1166.5
## <none>                                4357424638 1166.8
## + mean_poc                1  35996080 4321428557 1170.4
## + kelp_total_biomass      1  24120416 4333304222 1170.6
## + mean_po4                1  19768464 4337656174 1170.7
## + mean_tchl               1  12946507 4344478131 1170.8
## + mean_no2_no3            1   4545919 4352878719 1170.9
##
## Step:  AIC=1166.46
```

```
## invert_total_biomass ~ mean_pon + mean_ammonia + mean_pon:mean_ammonia
##
##                       Df Sum of Sq        RSS    AIC
## <none>                              4061656763 1166.5
## + mean_poc             1  58919111 4002737652 1169.7
## + kelp_total_biomass   1  29306102 4032350661 1170.2
## + mean_no2_no3         1  22115053 4039541709 1170.3
## + mean_tchl            1  15287922 4046368841 1170.4
## + mean_po4             1  11341064 4050315698 1170.4
```

final model is invert_total_biomass~mean_pon+mean_ammonia+mean_pon:mean_ammonia

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



#invert_diversity

```
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=~invert_diversity~kelp_total_biomass+mean_ammonia+mean_no2_no3+mean_po4+mean_
fit.final4<-step(fit.initial4,scope=scp4,direction="backward",k=log(n))
```

```
## Start:  AIC=-182.14
## invert_diversity ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_poc + mean_pon + mean_tchl + kelp_total_biomass:mean_pon +
```

```
##     kelp_total_biomass:mean_po4 + mean_pon:mean_po4 + kelp_total_biomass:mean_pon:mean_po4
##
##                                       Df Sum of Sq    RSS     AIC
## - mean_tchl                            1  0.000209 1.7046 -186.29
## - mean_poc                             1  0.000670 1.7050 -186.27
## - mean_ammonia                         1  0.031131 1.7355 -185.14
## - mean_no2_no3                         1  0.070120 1.7745 -183.72
## - kelp_total_biomass:mean_po4:mean_pon  1  0.088920 1.7933 -183.04
## <none>                                             1.7043 -182.14
##
## Step:  AIC=-186.29
## invert_diversity ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_poc + mean_pon + kelp_total_biomass:mean_pon +
##     kelp_total_biomass:mean_po4 + mean_po4:mean_pon + kelp_total_biomass:mean_po4:mean_pon
##
##                                       Df Sum of Sq    RSS     AIC
## - mean_poc                             1  0.000978 1.7055 -190.41
## - mean_ammonia                         1  0.033214 1.7378 -189.21
## - mean_no2_no3                         1  0.070319 1.7749 -187.86
## - kelp_total_biomass:mean_po4:mean_pon  1  0.089686 1.7942 -187.17
## <none>                                             1.7046 -186.29
##
## Step:  AIC=-190.41
## invert_diversity ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_pon + kelp_total_biomass:mean_pon + kelp_total_biomass:mean_po4 +
##     mean_po4:mean_pon + kelp_total_biomass:mean_po4:mean_pon
##
##                                       Df Sum of Sq    RSS     AIC
## - mean_ammonia                         1  0.032921 1.7385 -193.35
## - mean_no2_no3                         1  0.079583 1.7851 -191.65
## - kelp_total_biomass:mean_po4:mean_pon  1  0.093551 1.7991 -191.15
## <none>                                             1.7055 -190.41
##
## Step:  AIC=-193.35
## invert_diversity ~ kelp_total_biomass + mean_no2_no3 + mean_po4 +
##     mean_pon + kelp_total_biomass:mean_pon + kelp_total_biomass:mean_po4 +
##     mean_po4:mean_pon + kelp_total_biomass:mean_po4:mean_pon
##
##                                       Df Sum of Sq    RSS     AIC
## - mean_no2_no3                         1  0.078989 1.8174 -194.66
## - kelp_total_biomass:mean_po4:mean_pon  1  0.093249 1.8317 -194.16
## <none>                                             1.7385 -193.35
##
## Step:  AIC=-194.66
## invert_diversity ~ kelp_total_biomass + mean_po4 + mean_pon +
##     kelp_total_biomass:mean_pon + kelp_total_biomass:mean_po4 +
##     mean_po4:mean_pon + kelp_total_biomass:mean_po4:mean_pon
##
##                                       Df Sum of Sq    RSS     AIC
## - kelp_total_biomass:mean_po4:mean_pon  1  0.097169 1.9146 -195.49
## <none>                                             1.8174 -194.66
##
## Step:  AIC=-195.49
## invert_diversity ~ kelp_total_biomass + mean_po4 + mean_pon +
```

```
##     kelp_total_biomass:mean_pon + kelp_total_biomass:mean_po4 +
##     mean_po4:mean_pon
##
##                               Df Sum of Sq    RSS     AIC
## - kelp_total_biomass:mean_pon  1 0.0003918 1.9150 -199.63
## - kelp_total_biomass:mean_po4  1 0.0178888 1.9325 -199.05
## - mean_po4:mean_pon            1 0.0304891 1.9451 -198.63
## <none>                                     1.9146 -195.49
##
## Step:  AIC=-199.63
## invert_diversity ~ kelp_total_biomass + mean_po4 + mean_pon +
##     kelp_total_biomass:mean_po4 + mean_po4:mean_pon
##
##                               Df Sum of Sq    RSS     AIC
## - kelp_total_biomass:mean_po4  1  0.023905 1.9389 -203.00
## - mean_po4:mean_pon            1  0.030856 1.9459 -202.77
## <none>                                     1.9150 -199.63
##
## Step:  AIC=-203
## invert_diversity ~ kelp_total_biomass + mean_po4 + mean_pon +
##     mean_po4:mean_pon
##
##                       Df Sum of Sq    RSS     AIC
## - mean_po4:mean_pon    1  0.016814 1.9557 -206.60
## <none>                             1.9389 -203.00
## - kelp_total_biomass   1  0.196483 2.1354 -200.98
##
## Step:  AIC=-206.6
## invert_diversity ~ kelp_total_biomass + mean_po4 + mean_pon
##
##                       Df Sum of Sq    RSS     AIC
## <none>                             1.9557 -206.60
## - mean_po4             1   0.14753 2.1033 -206.11
## - kelp_total_biomass   1   0.18551 2.1412 -204.96
## - mean_pon             1   0.43900 2.3947 -197.80
```

```
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
## + 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
##
## Step:  AIC=-206.31
## invert_diversity ~ mean_pon
```

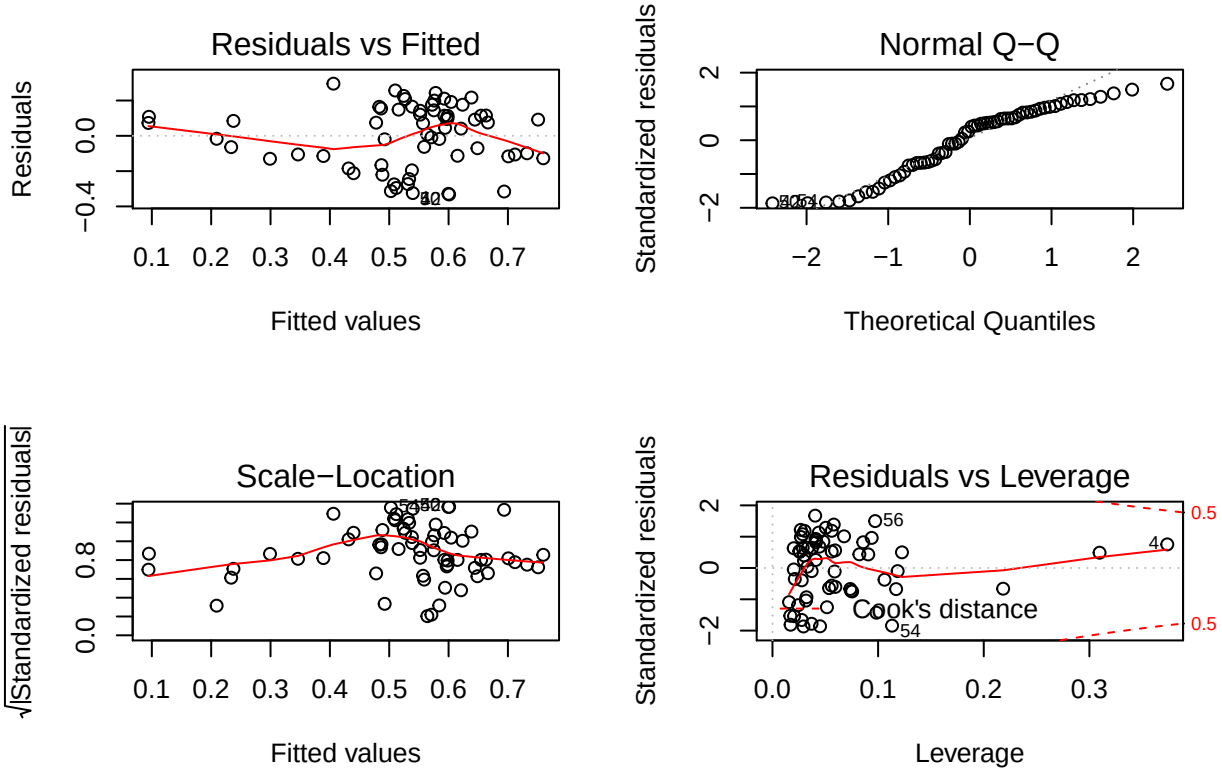
```
##
##                       Df Sum of Sq    RSS     AIC
## <none>                               2.2374 -206.31
## + kelp_total_biomass  1  0.134206 2.1033 -206.11
## + mean_ammonia        1  0.110432 2.1270 -205.39
## + mean_po4            1  0.096221 2.1412 -204.96
## + mean_poc            1  0.054103 2.1833 -203.72
## + mean_no2_no3        1  0.008545 2.2289 -202.40
## + mean_tchl           1  0.002580 2.2349 -202.22
```

```
anova(fit.final4,fit.final4.forward)
```

```
## Analysis of Variance Table
##
## Model 1: invert_diversity ~ kelp_total_biomass + mean_po4 + mean_pon
## Model 2: invert_diversity ~ mean_pon
##   Res.Df    RSS Df Sum of Sq      F  Pr(>F)
## 1     60 1.9557
## 2     62 2.2374 -2  -0.28173 4.3217 0.01764 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

p-value is less than 0.05 the final model is invert_diversity~kelp_total_biomass+mean_po4+mean_pon

```
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~kelp_total_biomass+mean_ammonia+mean_no2_no3+mean_po4+mean_poc+mea
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=813.53
## algae_total_biomass ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_poc + mean_pon + mean_tchl
##
##                      Df Sum of Sq      RSS    AIC
## - mean_tchl           1      3050 12618771 809.39
## - mean_poc            1     40618 12656340 809.58
## - mean_pon            1     61802 12677524 809.69
## - mean_po4            1    101438 12717159 809.89
## - kelp_total_biomass  1    556291 13172013 812.13
## <none>                             12615721 813.53
## - mean_ammonia        1   1195514 13811236 815.17
## - mean_no2_no3        1   2350217 14965939 820.31
##
## Step:  AIC=809.39
## algae_total_biomass ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_poc + mean_pon
##
##                      Df Sum of Sq      RSS    AIC
## - mean_poc            1     53148 12671919 805.50
## - mean_po4            1    101904 12720675 805.74
## - mean_pon            1    232327 12851098 806.40
## - kelp_total_biomass  1    556420 13175191 807.99
## <none>                             12618771 809.39
## - mean_ammonia        1   1262865 13881636 811.33
## - mean_no2_no3        1   2366902 14985673 816.23
##
## Step:  AIC=805.5
## algae_total_biomass ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_pon
##
##                      Df Sum of Sq      RSS    AIC
## - mean_po4            1    140858 12812777 802.05
## - mean_pon            1    300988 12972907 802.84
## - kelp_total_biomass  1    592333 13264252 804.26
## <none>                             12671919 805.50
## - mean_ammonia        1   1213891 13885810 807.19
## - mean_no2_no3        1   2594651 15266570 813.26
##
## Step:  AIC=802.05
## algae_total_biomass ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_pon
##
##                      Df Sum of Sq      RSS    AIC
## - mean_pon            1    426964 13239741 799.99
```

```
## - kelp_total_biomass  1    483976 13296752 800.26
## <none>                             12812777 802.05
## - mean_ammonia        1   1077934 13890711 803.06
## - mean_no2_no3        1   3404684 16217461 812.97
##
## Step:  AIC=799.99
## algae_total_biomass ~ kelp_total_biomass + mean_ammonia + mean_no2_no3
##
##                       Df Sum of Sq      RSS    AIC
## - mean_ammonia         1    783228 14022969 799.51
## <none>                             13239741 799.99
## - kelp_total_biomass   1    934252 14173993 800.19
## - mean_no2_no3         1   3072493 16312234 809.18
##
## Step:  AIC=799.51
## algae_total_biomass ~ kelp_total_biomass + mean_no2_no3
##
##                       Df Sum of Sq      RSS    AIC
## - kelp_total_biomass   1    795708 14818677 798.88
## <none>                             14022969 799.51
## - mean_no2_no3         1   2734660 16757629 806.75
##
## Step:  AIC=798.88
## algae_total_biomass ~ mean_no2_no3
##
##                 Df Sum of Sq      RSS    AIC
## <none>                        14818677 798.88
## - mean_no2_no3   1   3048441 17867118 806.69
```

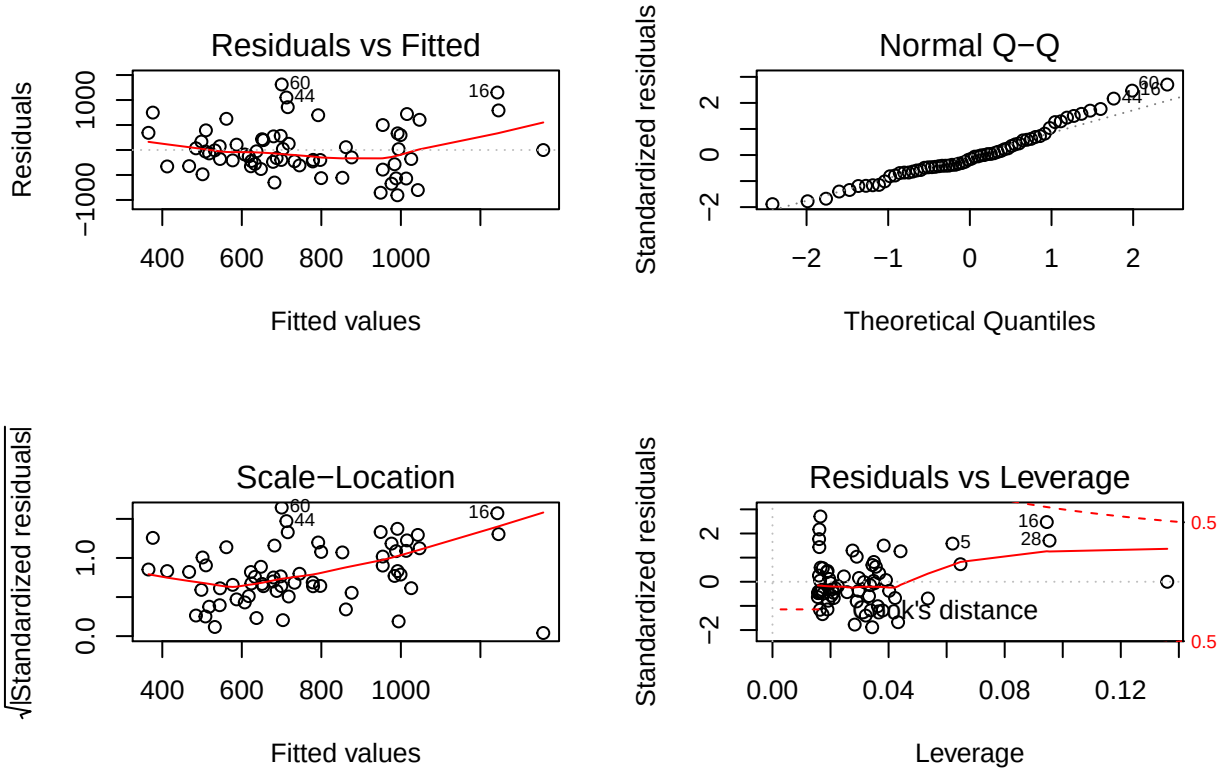
```
fit.null5<-lm(algae_total_biomass~1,data=data.waterchem)
fit.final5.forward<-step(fit.null5,scope=scp5,direction="forward",k=log(n))
```

```
## Start:  AIC=806.69
## algae_total_biomass ~ 1
##
##                       Df Sum of Sq      RSS    AIC
## + mean_no2_no3         1   3048441 14818677 798.88
## <none>                             17867118 806.69
## + kelp_total_biomass   1   1109490 16757629 806.75
## + 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
## + mean_poc             1     10097 17857021 810.82
##
## Step:  AIC=798.88
## algae_total_biomass ~ mean_no2_no3
##
##                       Df Sum of Sq      RSS    AIC
## <none>                             14818677 798.88
## + kelp_total_biomass   1    795708 14022969 799.51
## + mean_ammonia         1    644684 14173993 800.19
## + mean_pon             1    417370 14401307 801.21
## + mean_tchl            1    409232 14409445 801.25
```

```
## + mean_poc             1    333601 14485076 801.58
## + mean_po4             1      4406 14814271 803.02
```

final model is algae_total_biomass~mean_no2_no3

```
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=813.53
## algae_total_biomass ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_poc + mean_pon + mean_tchl
##
##                       Df Sum of Sq      RSS    AIC
## - mean_tchl            1      3050 12618771 809.39
## - mean_poc             1     40618 12656340 809.58
## - mean_pon             1     61802 12677524 809.69
## - mean_po4             1    101438 12717159 809.89
## - kelp_total_biomass   1    556291 13172013 812.13
```

```
## <none>                             12615721 813.53
## - mean_ammonia        1   1195514 13811236 815.17
## - mean_no2_no3        1   2350217 14965939 820.31
##
## Step:  AIC=809.39
## algae_total_biomass ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_poc + mean_pon
##
##                      Df Sum of Sq      RSS    AIC
## - mean_poc            1     53148 12671919 805.50
## - mean_po4            1    101904 12720675 805.74
## - mean_pon            1    232327 12851098 806.40
## - kelp_total_biomass  1    556420 13175191 807.99
## <none>                             12618771 809.39
## - mean_ammonia        1   1262865 13881636 811.33
## - mean_no2_no3        1   2366902 14985673 816.23
##
## Step:  AIC=805.5
## algae_total_biomass ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_po4 + mean_pon
##
##                      Df Sum of Sq      RSS    AIC
## - mean_po4            1    140858 12812777 802.05
## - mean_pon            1    300988 12972907 802.84
## - kelp_total_biomass  1    592333 13264252 804.26
## <none>                             12671919 805.50
## - mean_ammonia        1   1213891 13885810 807.19
## - mean_no2_no3        1   2594651 15266570 813.26
##
## Step:  AIC=802.05
## algae_total_biomass ~ kelp_total_biomass + mean_ammonia + mean_no2_no3 +
##     mean_pon
##
##                      Df Sum of Sq      RSS    AIC
## - mean_pon            1    426964 13239741 799.99
## - kelp_total_biomass  1    483976 13296752 800.26
## <none>                             12812777 802.05
## - mean_ammonia        1   1077934 13890711 803.06
## - mean_no2_no3        1   3404684 16217461 812.97
##
## Step:  AIC=799.99
## algae_total_biomass ~ kelp_total_biomass + mean_ammonia + mean_no2_no3
##
##                      Df Sum of Sq      RSS    AIC
## - mean_ammonia        1    783228 14022969 799.51
## <none>                             13239741 799.99
## - kelp_total_biomass  1    934252 14173993 800.19
## - mean_no2_no3        1   3072493 16312234 809.18
##
## Step:  AIC=799.51
## algae_total_biomass ~ kelp_total_biomass + mean_no2_no3
##
##                      Df Sum of Sq      RSS    AIC
## - kelp_total_biomass  1    795708 14818677 798.88
```

```
## <none>                            14022969 799.51
## - mean_no2_no3        1   2734660 16757629 806.75
##
## Step:  AIC=798.88
## algae_total_biomass ~ mean_no2_no3
##
##                Df Sum of Sq      RSS    AIC
## <none>                       14818677 798.88
## - mean_no2_no3  1   3048441 17867118 806.69
```

```
summary(fit.initial6)
```

```
##
## Call:
## lm(formula = algae_diversity ~ kelp_total_biomass + mean_ammonia +
##     mean_no2_no3 + mean_po4 + mean_poc + mean_pon + mean_tchl +
##     mean_ammonia:mean_no2_no3, data = data.waterchem)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.41970 -0.07853  0.03607  0.09777  0.20877
##
## Coefficients:
##                              Estimate Std. Error t value Pr(>|t|)
## (Intercept)                 8.691e-01  2.715e-01   3.201  0.00228 **
## kelp_total_biomass          1.621e-06  1.068e-05   0.152  0.87997
## mean_ammonia               -9.704e-05  3.510e-04  -0.276  0.78323
## mean_no2_no3               -2.174e-04  3.045e-04  -0.714  0.47838
## mean_po4                   -1.497e-04  1.017e-04  -1.472  0.14682
## mean_poc                    2.467e-03  1.909e-03   1.292  0.20179
## mean_pon                   -2.380e-02  3.198e-02  -0.744  0.45998
## mean_tchl                   7.314e-03  2.036e-02   0.359  0.72082
## mean_ammonia:mean_no2_no3  3.169e-07  4.244e-07   0.747  0.45845
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1566 on 55 degrees of freedom
## Multiple R-squared:  0.1299, Adjusted R-squared:  0.003313
## F-statistic: 1.026 on 8 and 55 DF,  p-value: 0.4278
```

```
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
## <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
## + 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
```

```
anova(fit.final6,fit.final6.forward)
```

```
## Warning in anova.lmlist(object, ...): models with response
## '"algae_diversity"' removed because response differs from model 1
```

```
## Analysis of Variance Table
##
## Response: algae_total_biomass
##              Df   Sum Sq Mean Sq F value    Pr(>F)
## mean_no2_no3  1  3048441 3048441  12.754 0.0006934 ***
## Residuals    62 14818677  239011
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

the final model is algae_diversity~mean_no2_no3

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