11\_HI\_anova\_models

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9/13/2022

#load libraries

# load in the data

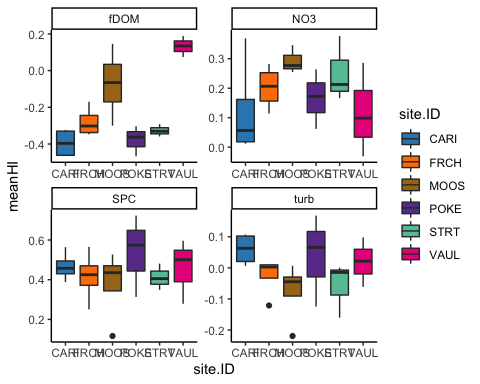
AMC <- read.csv(here("Output\_from\_analysis", "07\_Combine\_HI\_BETA\_FI", "antecedent\_HI\_FI\_AllYears.csv"))  
  
AMC <- AMC[c("Hyst\_index","site.ID", "storm.ID", "response\_var", "Flush\_index", "month.y", "day.y", "year", "Beta\_index", "doy", "burn", "pf", "date")] # selecting the columns that I want  
  
colNames <- c("Hyst\_index", "site.ID", "storm.ID", "response\_var", "Flush\_index", "month", "day", "year", "Beta\_index", "doy", "burn", "pf", "date")  
  
names(AMC)<- colNames # renaming columns   
  
AMC <- AMC %>%   
 group\_by(site.ID, response\_var, year) %>%   
 dplyr::summarise(meanHI = mean(Hyst\_index, na.rm = TRUE),  
 meanBETA = mean(Beta\_index, na.rm = TRUE),  
 sdHI = sd(Hyst\_index, na.rm = TRUE),  
 sdBETA = sd(Beta\_index, na.rm = TRUE),  
 CVhi = sdHI/meanHI,  
 CVbeta = sdBETA/meanBETA,  
 response\_var = paste(response\_var),  
 Date = as.Date(date),  
 DOY = as.numeric(doy),  
 burn = paste(burn),  
 PF = paste(pf))

## `summarise()` has grouped output by 'site.ID', 'response\_var', 'year'. You can  
## override using the `.groups` argument.

AMC <- AMC[!duplicated(AMC$meanHI), ] # removing duplicated rows   
  
  
##subsetting by solute   
# NO3 #  
HI\_FI\_NO3 = subset(AMC, response\_var == "NO3")  
# fDOM #  
HI\_FI\_fDOM = subset(AMC, response\_var == "fDOM")  
# SPC #  
HI\_FI\_SPC = subset(AMC, response\_var == "SPC")  
# turb #  
HI\_FI\_turb = subset(AMC, response\_var == "turb")

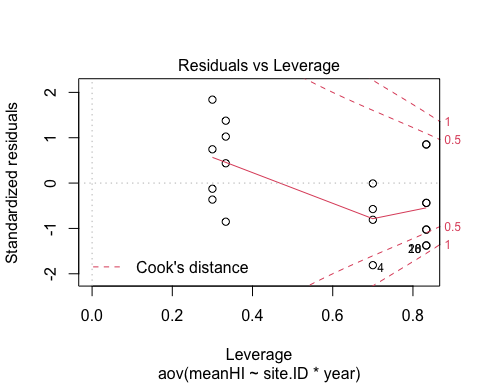
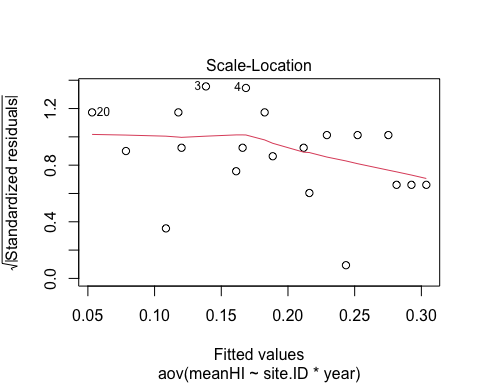
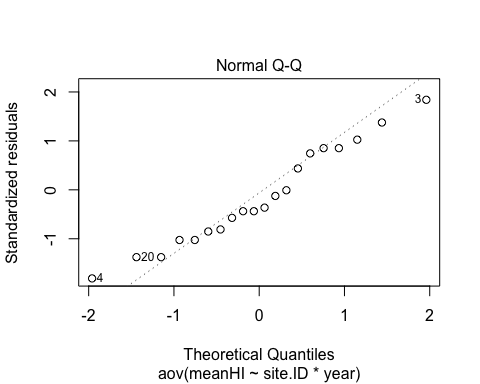
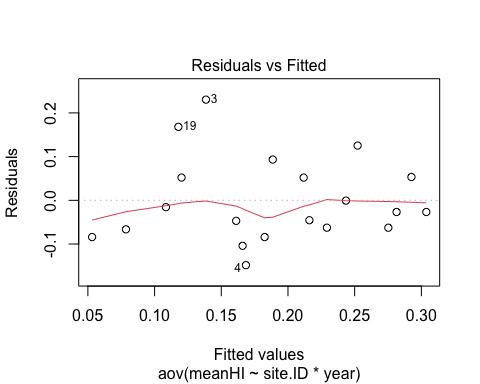
# plot

ggplot(AMC, aes(site.ID, meanHI, fill = site.ID)) +  
 geom\_boxplot() +  
 facet\_wrap(~response\_var, scales = "free") +  
 scale\_fill\_manual(values = c("#3288BD", "#FF7F00","#A6761D", "#6A3D9A", "#66C2A5", "#E7298A")) +  
 theme\_classic()



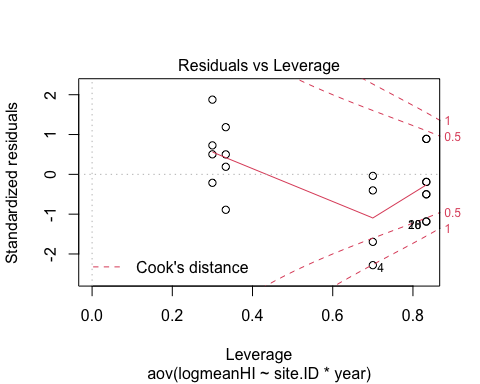
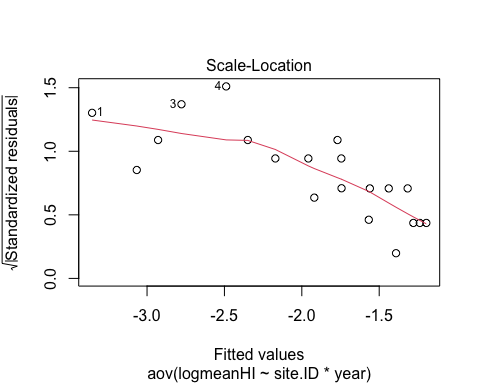
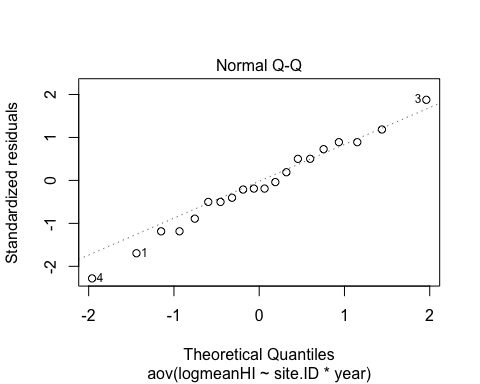
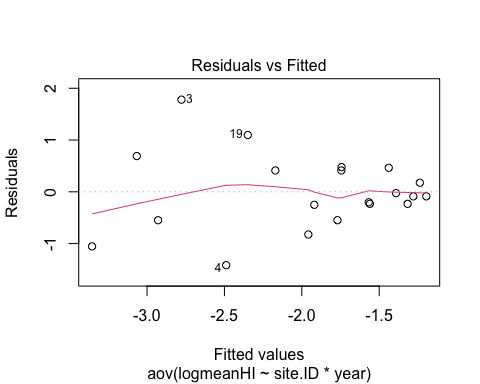
### HI

#NO3  
NO3 <- aov(meanHI ~ site.ID\*year,   
 data = HI\_FI\_NO3)  
plot(NO3)

 normality is not great… lemme try log transform

# log transform

# log transform   
HI\_FI\_NO3$logmeanHI <- log(abs(HI\_FI\_NO3$meanHI))  
  
NO3.log <- aov(logmeanHI ~ site.ID\*year,   
 data = HI\_FI\_NO3)  
  
plot(NO3.log)

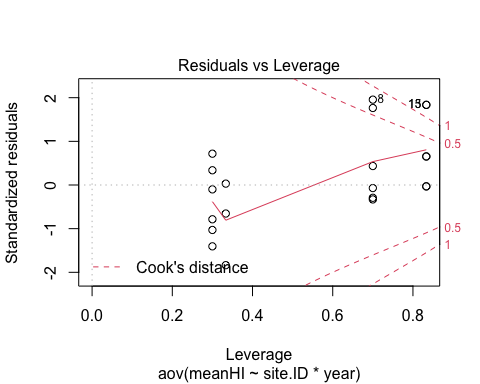
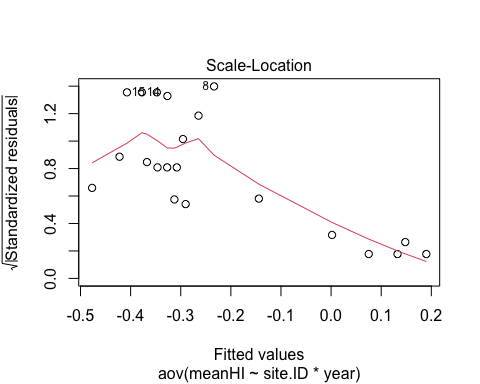
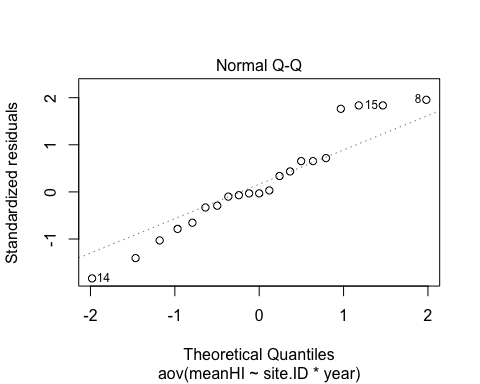
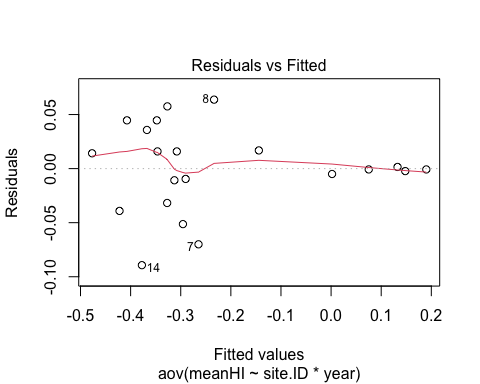
 normality looks a little better

summary(NO3.log) # nothing is showing significance

## Df Sum Sq Mean Sq F value Pr(>F)  
## site.ID 5 6.909 1.3817 1.074 0.441  
## year 1 0.001 0.0014 0.001 0.974  
## site.ID:year 5 1.366 0.2733 0.213 0.948  
## Residuals 8 10.288 1.2860

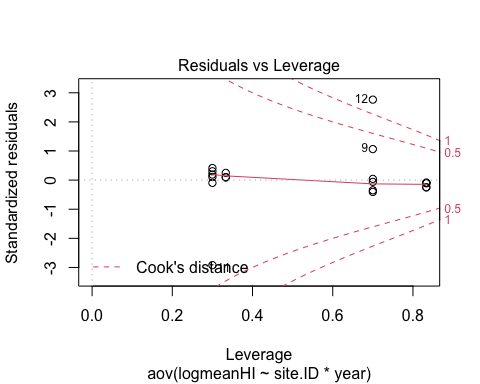
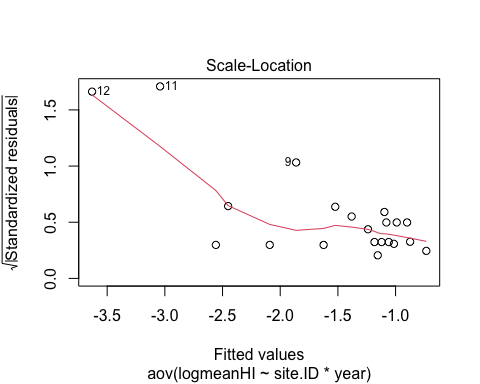
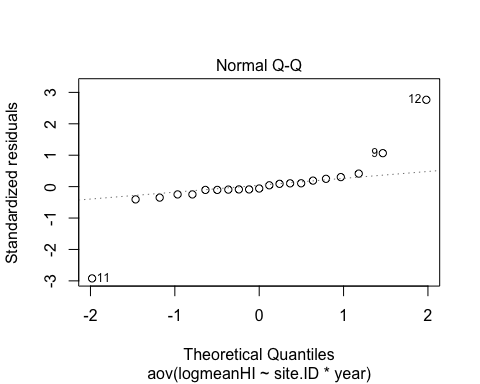
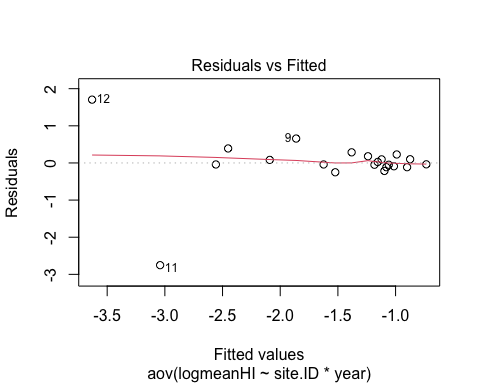
#fDOM

#fDOM  
HI\_FI\_fDOM$site.ID <- as.factor(HI\_FI\_fDOM$site.ID)  
  
fDOM <- aov(meanHI ~ site.ID\*year,   
 data = HI\_FI\_fDOM)  
  
plot(fDOM)

 normality looks good

# log transform

# log transform   
HI\_FI\_fDOM$logmeanHI <- log(abs(HI\_FI\_fDOM$meanHI))  
  
fDOM.log <- aov(logmeanHI ~ site.ID\*year,   
 data = HI\_FI\_fDOM)  
  
plot(fDOM.log)

 This looks worse, lets work with the non-transformed model

summary(fDOM) # this shows that site.ID is significantly different

## Df Sum Sq Mean Sq F value Pr(>F)   
## site.ID 5 0.7068 0.14136 39.853 7.11e-06 \*\*\*  
## year 1 0.0237 0.02372 6.689 0.02940 \*   
## site.ID:year 5 0.1119 0.02238 6.309 0.00877 \*\*   
## Residuals 9 0.0319 0.00355   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

summary.lm(fDOM)

##   
## Call:  
## aov(formula = meanHI ~ site.ID \* year, data = HI\_FI\_fDOM)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.089290 -0.010786 -0.000765 0.016821 0.063779   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 110.13000 53.78831 2.047 0.070903 .   
## site.IDFRCH -173.13723 76.06816 -2.276 0.048875 \*   
## site.IDMOOS -405.19324 76.06816 -5.327 0.000477 \*\*\*  
## site.IDPOKE -50.27458 100.64650 -0.500 0.629399   
## site.IDSTRT -149.41155 100.64650 -1.485 0.171829   
## site.IDVAUL -226.03019 100.64650 -2.246 0.051356 .   
## year -0.05473 0.02663 -2.055 0.070066 .   
## site.IDFRCH:year 0.08579 0.03767 2.278 0.048754 \*   
## site.IDMOOS:year 0.20080 0.03767 5.331 0.000474 \*\*\*  
## site.IDPOKE:year 0.02491 0.04983 0.500 0.629122   
## site.IDSTRT:year 0.07401 0.04983 1.485 0.171611   
## site.IDVAUL:year 0.11217 0.04983 2.251 0.050909 .   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.05956 on 9 degrees of freedom  
## Multiple R-squared: 0.9635, Adjusted R-squared: 0.9189   
## F-statistic: 21.59 on 11 and 9 DF, p-value: 3.925e-05

TukeyHSD(fDOM, which = "site.ID")

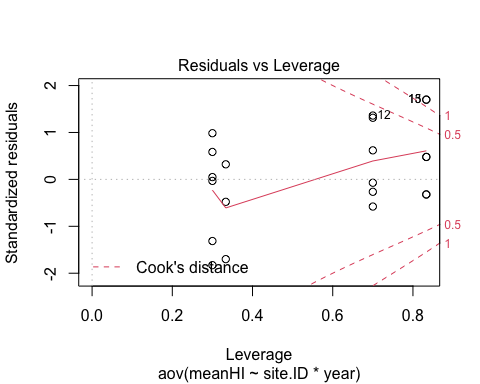
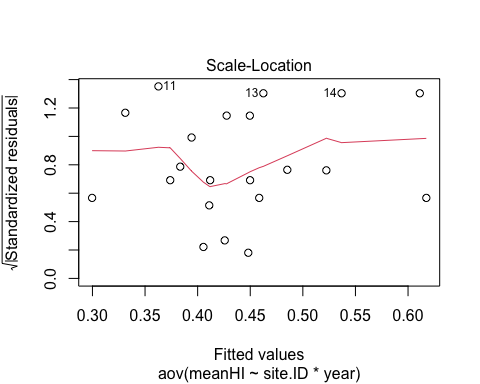
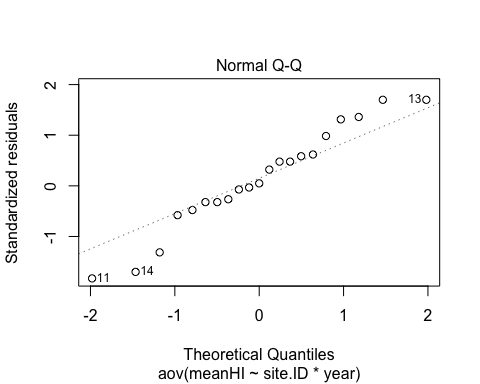
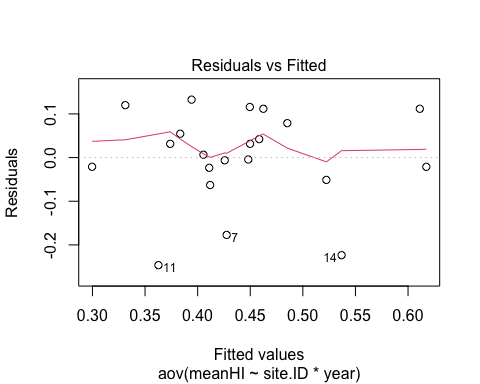
## Warning in replications(paste("~", xx), data = mf): non-factors ignored: year

## Warning in replications(paste("~", xx), data = mf): non-factors ignored:  
## site.ID, year

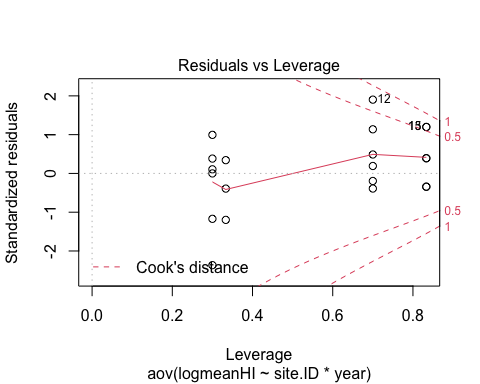
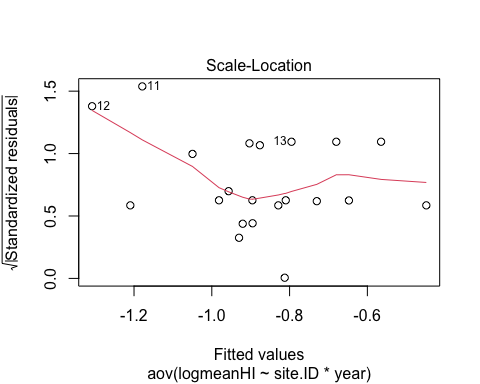
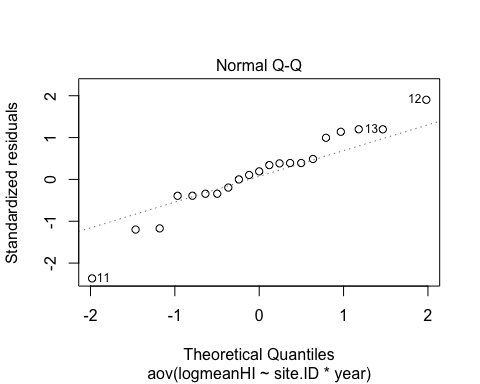
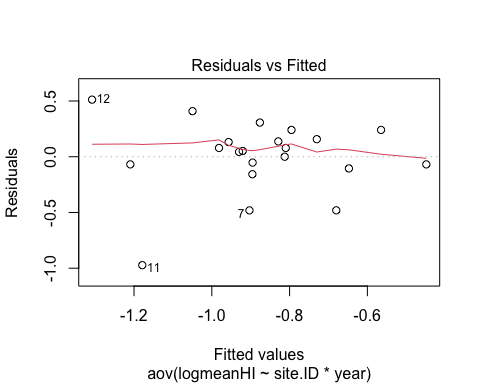
## Tukey multiple comparisons of means  
## 95% family-wise confidence level  
##   
## Fit: aov(formula = meanHI ~ site.ID \* year, data = HI\_FI\_fDOM)  
##   
## $site.ID  
## diff lwr upr p adj  
## FRCH-CARI 0.11472359 -0.03486783 0.26431501 0.1617022  
## MOOS-CARI 0.32370075 0.17410934 0.47329217 0.0003037  
## POKE-CARI 0.01731226 -0.14426494 0.17888946 0.9985751  
## STRT-CARI 0.06768481 -0.09389239 0.22926200 0.6795007  
## VAUL-CARI 0.52737597 0.36579878 0.68895317 0.0000106  
## MOOS-FRCH 0.20897716 0.05938574 0.35856858 0.0071304  
## POKE-FRCH -0.09741133 -0.25898853 0.06416586 0.3466434  
## STRT-FRCH -0.04703878 -0.20861598 0.11453841 0.8949029  
## VAUL-FRCH 0.41265238 0.25107519 0.57422958 0.0000813  
## POKE-MOOS -0.30638849 -0.46796569 -0.14481130 0.0008328  
## STRT-MOOS -0.25601594 -0.41759314 -0.09443875 0.0030506  
## VAUL-MOOS 0.20367522 0.04209803 0.36525242 0.0136490  
## STRT-POKE 0.05037255 -0.12236074 0.22310584 0.8942660  
## VAUL-POKE 0.51006371 0.33733043 0.68279700 0.0000247  
## VAUL-STRT 0.45969117 0.28695788 0.63242446 0.0000582

#CARI/MOOS  
#CARI/VAUL  
#FRCH/MOOS  
#FRCH/VAUL  
#MOOS/POKE  
#MOOS/STRT  
#MOOS/VAUL  
#VAUL/POKE  
#VAUL/STRT  
# all of these sites are significantly different from each other

#SPC  
SPC <- aov(meanHI ~ site.ID\*year,   
 data = HI\_FI\_SPC)  
  
plot(SPC)

 non-normal….lets try to do a log transformation

# log transform  
HI\_FI\_SPC$logmeanHI <- log(abs(HI\_FI\_SPC$meanHI))  
  
SPC.log <- aov(logmeanHI ~ site.ID\*year,   
 data = HI\_FI\_SPC)  
plot(SPC.log)



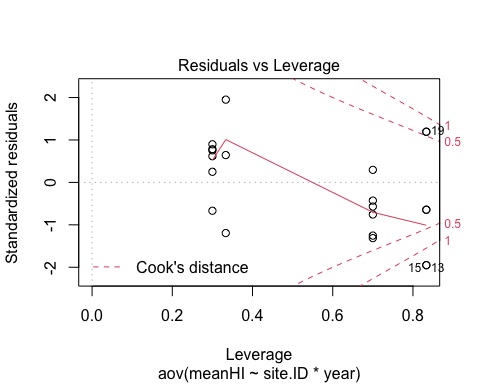
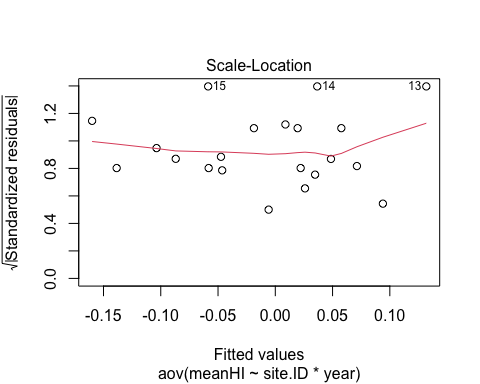
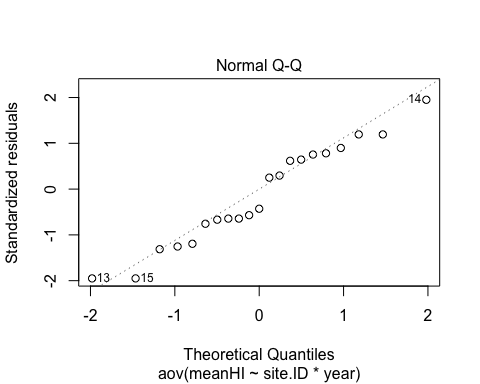
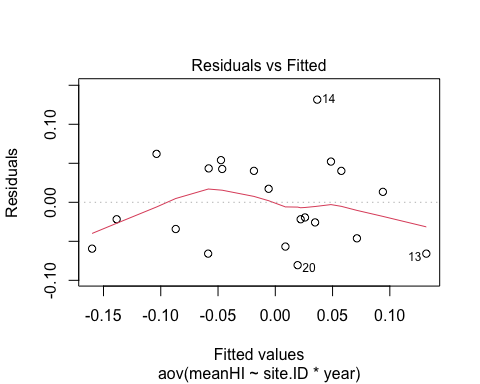
summary(SPC.log) # nothing significant

## Df Sum Sq Mean Sq F value Pr(>F)  
## site.ID 5 0.4005 0.08009 0.332 0.882  
## year 1 0.0306 0.03057 0.127 0.730  
## site.ID:year 5 0.4213 0.08427 0.349 0.871  
## Residuals 9 2.1734 0.24149

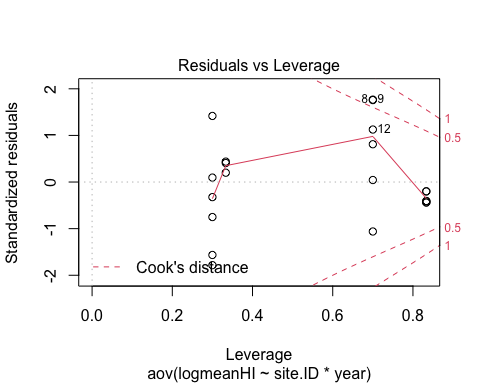
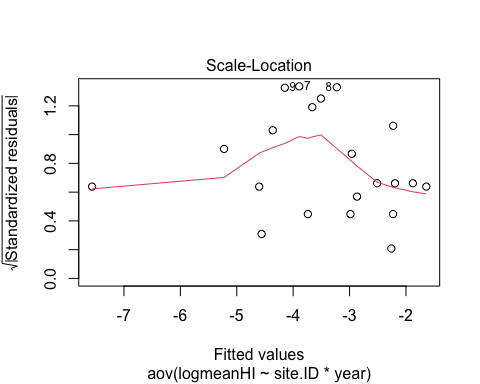
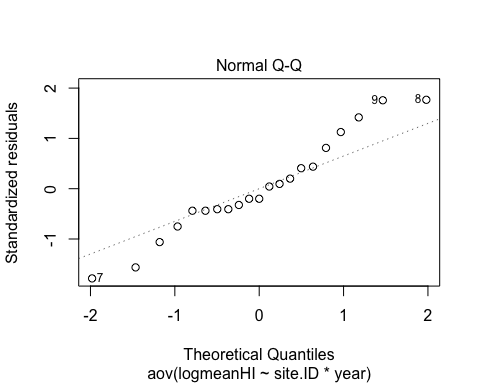
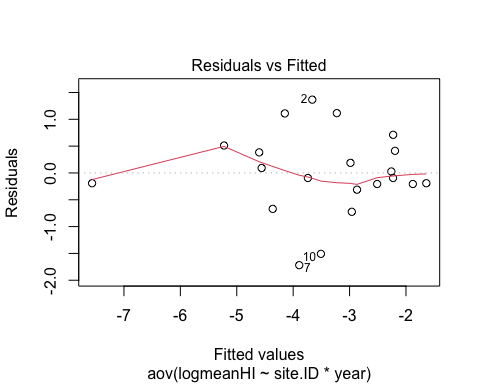
summary.lm(SPC.log)

##   
## Call:  
## aov(formula = logmeanHI ~ site.ID \* year, data = HI\_FI\_SPC)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.97264 -0.06869 0.05161 0.15741 0.51213   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) -167.50724 443.81784 -0.377 0.715  
## site.IDFRCH 112.48515 627.65321 0.179 0.862  
## site.IDMOOS 427.12545 627.65321 0.681 0.513  
## site.IDPOKE -65.78852 830.45396 -0.079 0.939  
## site.IDSTRT 339.99125 830.45396 0.409 0.692  
## site.IDVAUL 935.39911 830.45396 1.126 0.289  
## year 0.08256 0.21977 0.376 0.716  
## site.IDFRCH:year -0.05577 0.31080 -0.179 0.862  
## site.IDMOOS:year -0.21167 0.31080 -0.681 0.513  
## site.IDPOKE:year 0.03259 0.41114 0.079 0.939  
## site.IDSTRT:year -0.16839 0.41114 -0.410 0.692  
## site.IDVAUL:year -0.46312 0.41114 -1.126 0.289  
##   
## Residual standard error: 0.4914 on 9 degrees of freedom  
## Multiple R-squared: 0.2817, Adjusted R-squared: -0.5962   
## F-statistic: 0.3209 on 11 and 9 DF, p-value: 0.9602

#turb  
turb <- aov(meanHI ~ site.ID\*year,   
 data = HI\_FI\_turb)  
plot(turb)



# log transform  
HI\_FI\_turb$logmeanHI <- log(abs(HI\_FI\_turb$meanHI))  
  
turb.log <- aov(logmeanHI ~ site.ID\*year,   
 data = HI\_FI\_turb)  
plot(turb.log)

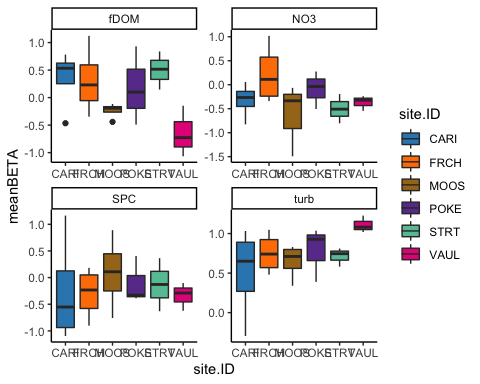
 May need further transformation

summary(turb.log) # this shows that year is significant

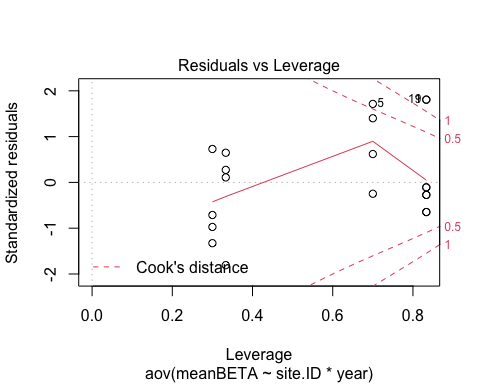
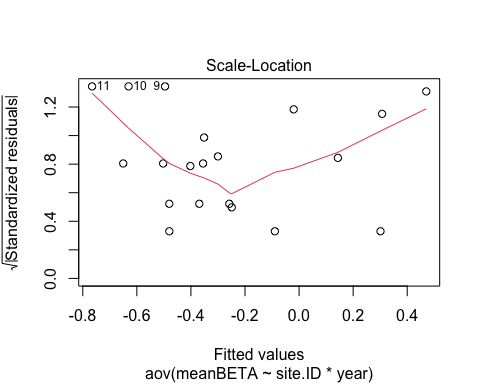
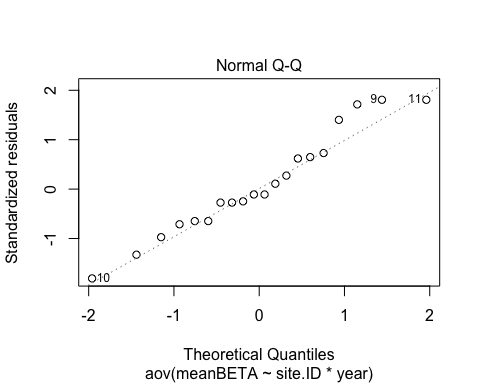
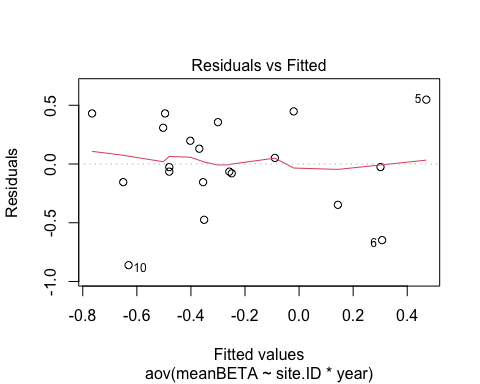
## Df Sum Sq Mean Sq F value Pr(>F)   
## site.ID 5 12.12 2.423 1.826 0.2038   
## year 1 10.84 10.838 8.166 0.0189 \*  
## site.ID:year 5 14.78 2.957 2.228 0.1400   
## Residuals 9 11.95 1.327   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

### BETA

ggplot(AMC, aes(site.ID, meanBETA, fill = site.ID)) +  
 geom\_boxplot() +  
 facet\_wrap(~response\_var, scales = "free") +  
 scale\_fill\_manual(values = c("#3288BD", "#FF7F00","#A6761D", "#6A3D9A", "#66C2A5", "#E7298A")) +  
 theme\_classic()



#NO3  
NO3 <- aov(meanBETA ~ site.ID\*year,   
 data = HI\_FI\_NO3)  
  
plot(NO3)



summary(NO3) # nothing is significant

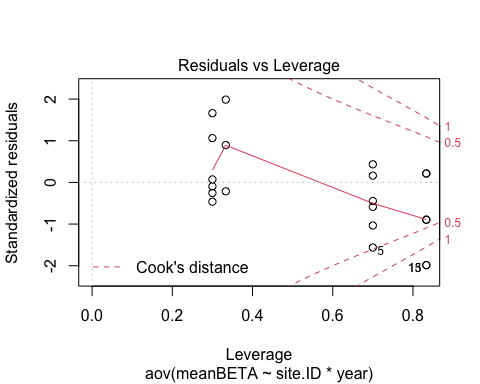
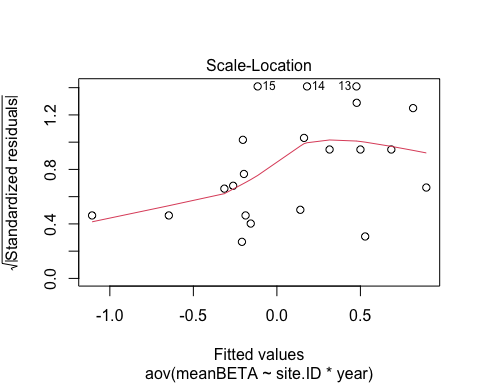
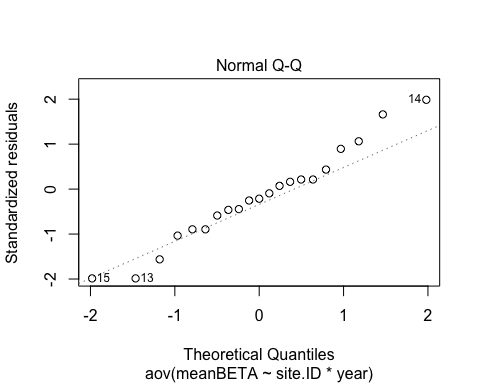
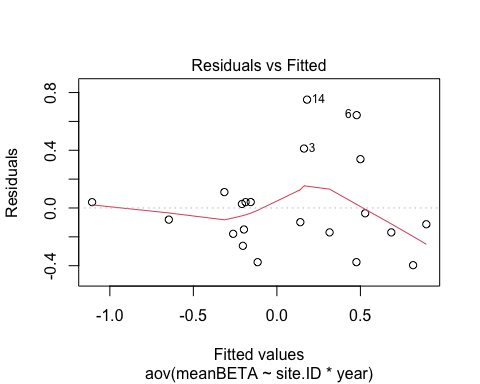
## Df Sum Sq Mean Sq F value Pr(>F)  
## site.ID 5 1.6710 0.3342 0.982 0.484  
## year 1 0.2522 0.2522 0.741 0.414  
## site.ID:year 5 0.3043 0.0609 0.179 0.963  
## Residuals 8 2.7235 0.3404

summary.lm(NO3)

##   
## Call:  
## aov(formula = meanBETA ~ site.ID \* year, data = HI\_FI\_NO3)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.86102 -0.15423 -0.02594 0.32040 0.54788   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) -103.50430 526.96421 -0.196 0.849  
## site.IDFRCH 433.92613 745.23993 0.582 0.576  
## site.IDMOOS 375.30915 985.68538 0.381 0.713  
## site.IDPOKE 892.29259 986.03407 0.905 0.392  
## site.IDSTRT 401.34773 986.03407 0.407 0.695  
## site.IDVAUL 327.51716 986.03407 0.332 0.748  
## year 0.05109 0.26094 0.196 0.850  
## site.IDFRCH:year -0.21460 0.36902 -0.582 0.577  
## site.IDMOOS:year -0.18603 0.48817 -0.381 0.713  
## site.IDPOKE:year -0.44162 0.48817 -0.905 0.392  
## site.IDSTRT:year -0.19879 0.48817 -0.407 0.695  
## site.IDVAUL:year -0.16217 0.48817 -0.332 0.748  
##   
## Residual standard error: 0.5835 on 8 degrees of freedom  
## Multiple R-squared: 0.4499, Adjusted R-squared: -0.3065   
## F-statistic: 0.5948 on 11 and 8 DF, p-value: 0.7914

#fDOM

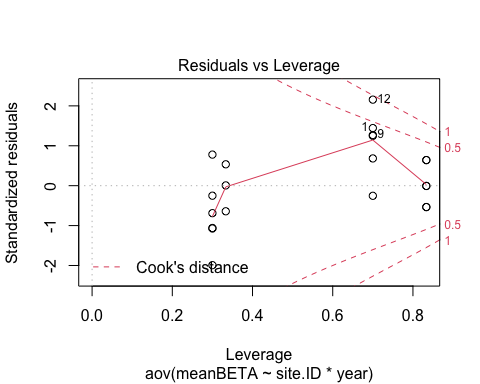
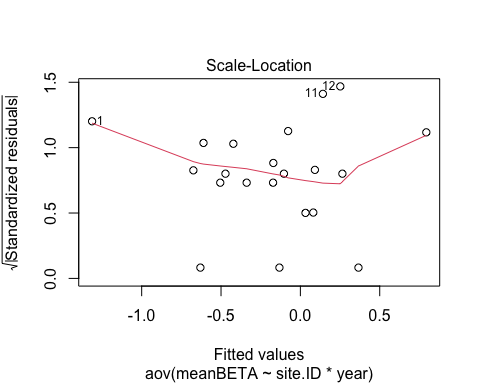
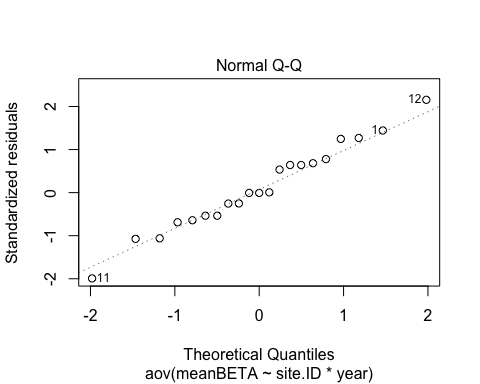
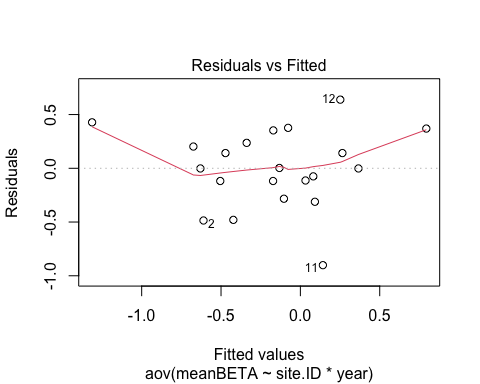
fDOM <- aov(meanBETA ~ site.ID\*year,   
 data = HI\_FI\_fDOM)  
plot(fDOM)



summary(fDOM)

## Df Sum Sq Mean Sq F value Pr(>F)   
## site.ID 5 3.0345 0.6069 2.831 0.0832 .  
## year 1 0.5176 0.5176 2.414 0.1547   
## site.ID:year 5 1.4009 0.2802 1.307 0.3420   
## Residuals 9 1.9296 0.2144   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

#SPC  
SPC <- aov(meanBETA ~ site.ID\*year,   
 data = HI\_FI\_SPC)  
plot(SPC)



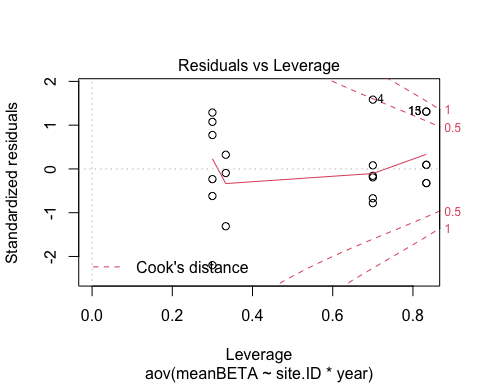
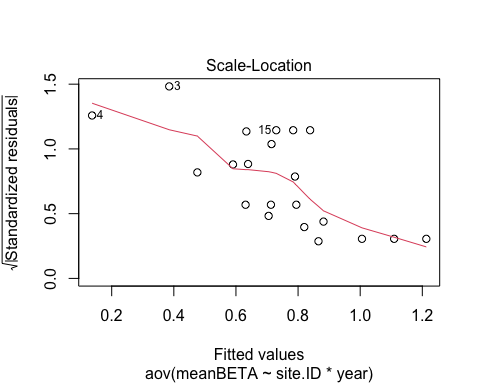
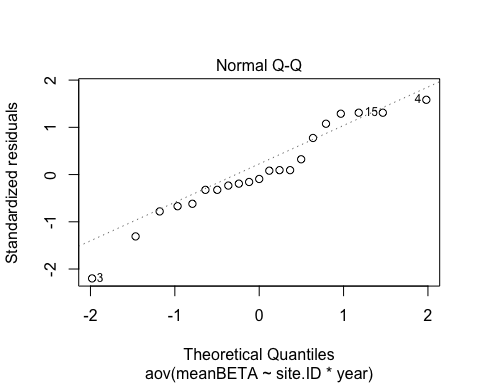
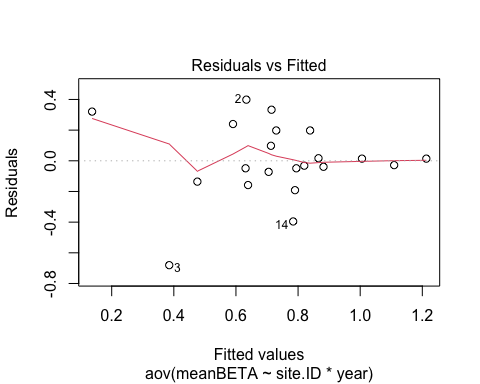
summary(SPC) # year is significant

## Df Sum Sq Mean Sq F value Pr(>F)   
## site.ID 5 0.4631 0.0926 0.317 0.891   
## year 1 2.1488 2.1488 7.346 0.024 \*  
## site.ID:year 5 1.5155 0.3031 1.036 0.452   
## Residuals 9 2.6327 0.2925   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

summary.lm(SPC)

##   
## Call:  
## aov(formula = meanBETA ~ site.ID \* year, data = HI\_FI\_SPC)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.9013 -0.1183 -0.0015 0.2366 0.6387   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -1417.9868 488.4660 -2.903 0.0175 \*  
## site.IDFRCH 909.0372 690.7952 1.316 0.2207   
## site.IDMOOS 1196.7273 690.7952 1.732 0.1172   
## site.IDPOKE 673.6809 913.9978 0.737 0.4799   
## site.IDSTRT 411.9132 913.9978 0.451 0.6629   
## site.IDVAUL 1753.7827 913.9978 1.919 0.0872 .  
## year 0.7020 0.2419 2.902 0.0175 \*  
## site.IDFRCH:year -0.4501 0.3421 -1.316 0.2207   
## site.IDMOOS:year -0.5924 0.3421 -1.732 0.1173   
## site.IDPOKE:year -0.3336 0.4525 -0.737 0.4798   
## site.IDSTRT:year -0.2040 0.4525 -0.451 0.6627   
## site.IDVAUL:year -0.8684 0.4525 -1.919 0.0872 .  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.5408 on 9 degrees of freedom  
## Multiple R-squared: 0.6106, Adjusted R-squared: 0.1346   
## F-statistic: 1.283 on 11 and 9 DF, p-value: 0.36

#turb  
turb <- aov(meanBETA ~ site.ID\*year,   
 data = HI\_FI\_turb)  
  
plot(turb)



summary(turb) # nothing is significant

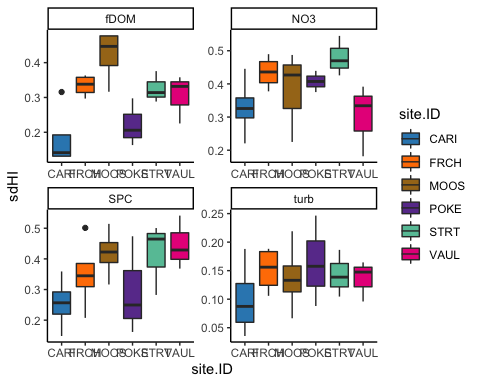
## Df Sum Sq Mean Sq F value Pr(>F)  
## site.ID 5 0.6643 0.13285 0.971 0.484  
## year 1 0.2429 0.24288 1.775 0.216  
## site.ID:year 5 0.2006 0.04012 0.293 0.905  
## Residuals 9 1.2318 0.13686

summary.lm(turb)

##   
## Call:  
## aov(formula = meanBETA ~ site.ID \* year, data = HI\_FI\_turb)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.68052 -0.07211 -0.02821 0.19778 0.39876   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 502.0246 334.1212 1.503 0.167  
## site.IDFRCH -348.6390 472.5188 -0.738 0.479  
## site.IDMOOS -269.7097 472.5188 -0.571 0.582  
## site.IDPOKE -391.1371 625.1941 -0.626 0.547  
## site.IDSTRT -336.2894 625.1941 -0.538 0.604  
## site.IDVAUL -710.1286 625.1941 -1.136 0.285  
## year -0.2483 0.1654 -1.501 0.168  
## site.IDFRCH:year 0.1728 0.2340 0.738 0.479  
## site.IDMOOS:year 0.1336 0.2340 0.571 0.582  
## site.IDPOKE:year 0.1938 0.3095 0.626 0.547  
## site.IDSTRT:year 0.1666 0.3095 0.538 0.603  
## site.IDVAUL:year 0.3519 0.3095 1.137 0.285  
##   
## Residual standard error: 0.37 on 9 degrees of freedom  
## Multiple R-squared: 0.4735, Adjusted R-squared: -0.17   
## F-statistic: 0.7358 on 11 and 9 DF, p-value: 0.6892

### SDs of storm metrics

#plot   
ggplot(AMC, aes(site.ID, sdHI, fill = site.ID)) +  
 geom\_boxplot() +  
 facet\_wrap(~response\_var, scales = "free") +  
 scale\_fill\_manual(values = c("#3288BD", "#FF7F00","#A6761D", "#6A3D9A", "#66C2A5", "#E7298A")) +  
 theme\_classic()

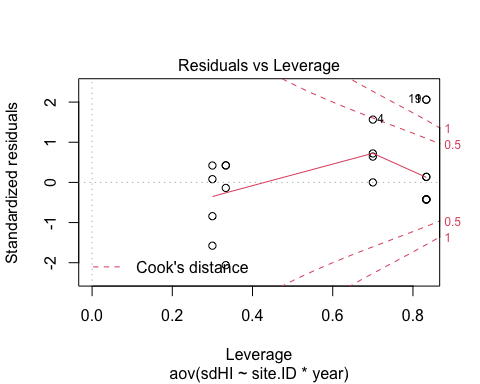
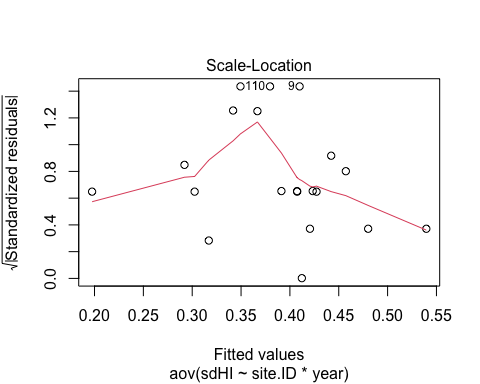
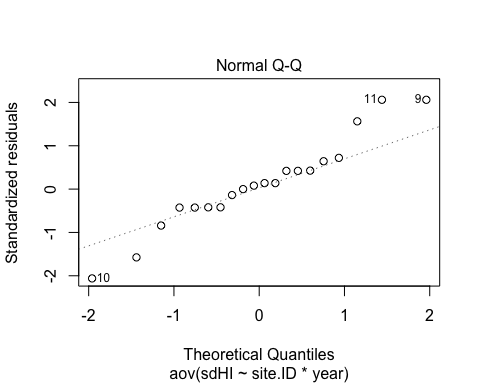
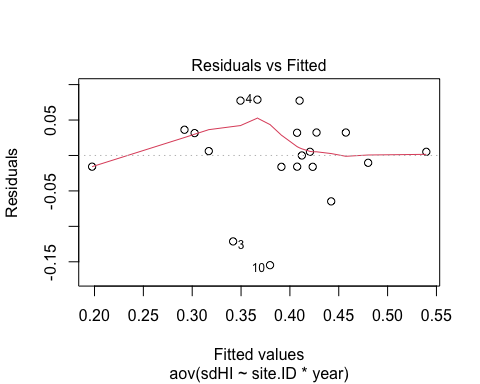


HI\_FI\_NO3$logSDhi <- log(abs(HI\_FI\_NO3$sdHI))  
HI\_FI\_fDOM$logSDhi <- log(abs(HI\_FI\_fDOM$sdHI))  
HI\_FI\_SPC$logSDhi <- log(abs(HI\_FI\_SPC$sdHI))  
HI\_FI\_turb$logSDhi <- log(abs(HI\_FI\_turb$sdHI))  
  
HI\_FI\_NO3$logSDbeta <- log(abs(HI\_FI\_NO3$sdBETA))  
HI\_FI\_fDOM$logSDbeta <- log(abs(HI\_FI\_fDOM$sdBETA))  
HI\_FI\_SPC$logSDbeta <- log(abs(HI\_FI\_SPC$sdBETA))  
HI\_FI\_turb$logSDbeta <- log(abs(HI\_FI\_turb$sdBETA))

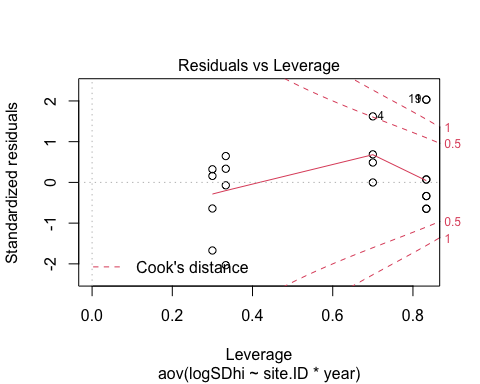
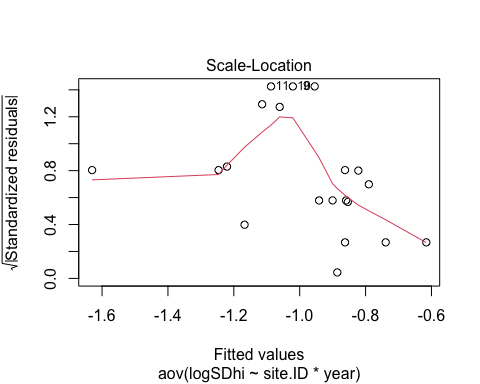
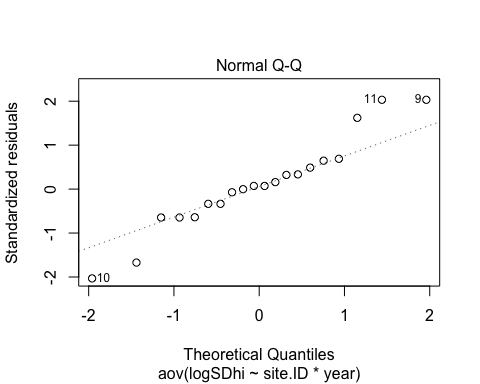
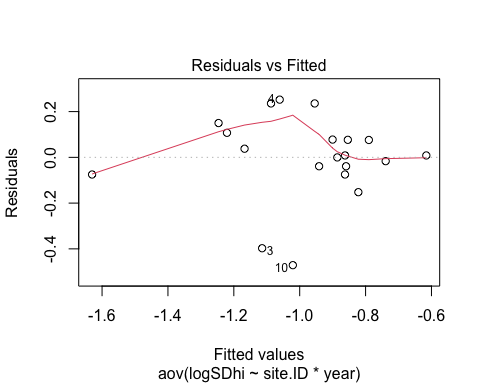
# HI

# NO3-

no3 <- aov(sdHI ~ site.ID\*year,   
 data = HI\_FI\_NO3)  
  
plot(no3)

 let me try log transform

no3.log <- aov(logSDhi ~ site.ID\*year,   
 data = HI\_FI\_NO3)  
plot(no3.log)

 meh, may need further transformation

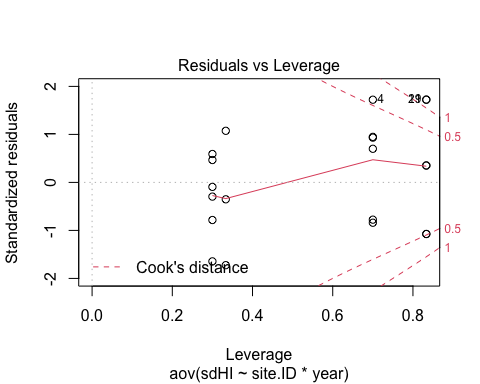
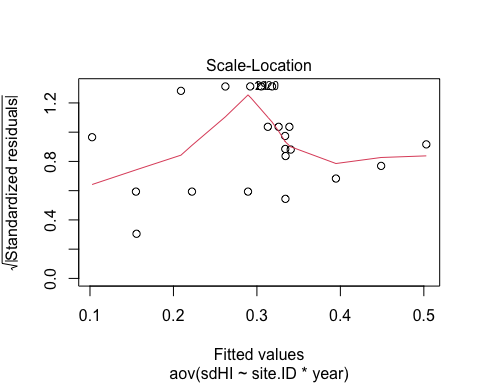
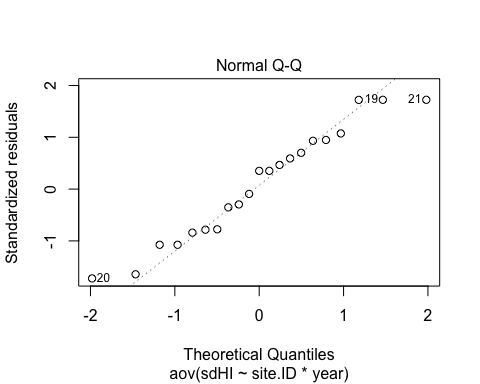
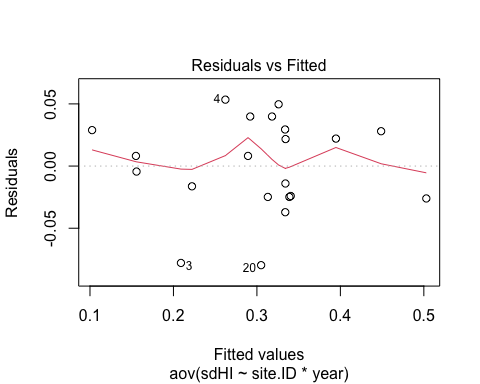
summary(no3.log) # nothing is signficant

## Df Sum Sq Mean Sq F value Pr(>F)  
## site.ID 5 0.5953 0.11905 1.475 0.297  
## year 1 0.0220 0.02196 0.272 0.616  
## site.ID:year 5 0.3347 0.06695 0.830 0.563  
## Residuals 8 0.6455 0.08069

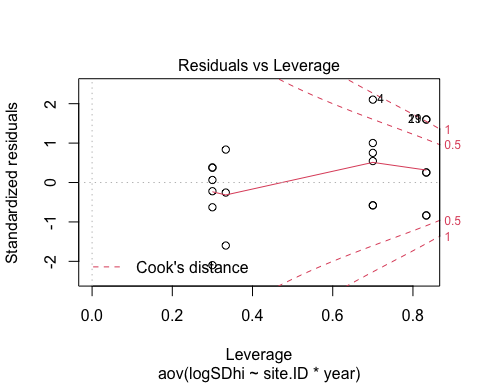
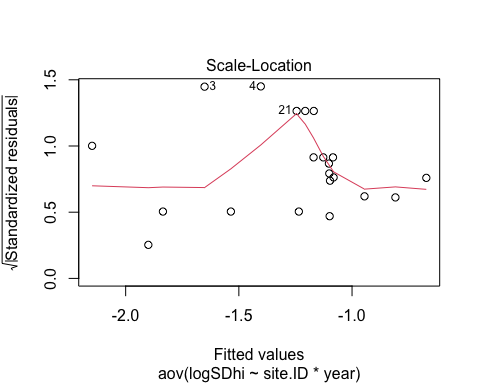
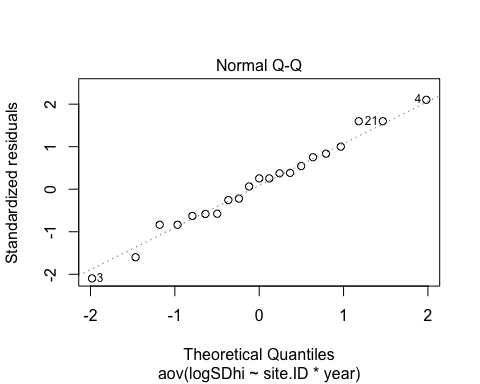
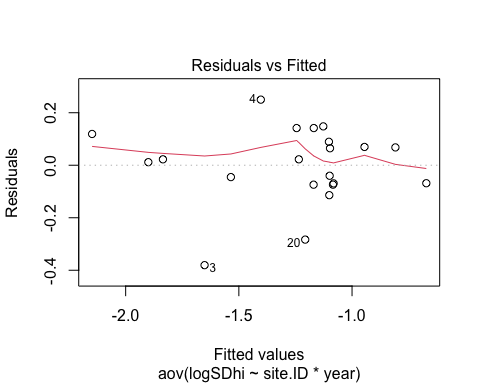
summary.lm(no3.log)

##   
## Call:  
## aov(formula = logSDhi ~ site.ID \* year, data = HI\_FI\_NO3)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.47126 -0.04790 0.00830 0.08511 0.25225   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) -108.87052 256.54512 -0.424 0.682  
## site.IDFRCH 172.52370 362.80959 0.476 0.647  
## site.IDMOOS 241.71438 479.86708 0.504 0.628  
## site.IDPOKE 190.71109 480.03683 0.397 0.702  
## site.IDSTRT -140.99969 480.03683 -0.294 0.776  
## site.IDVAUL 883.14546 480.03683 1.840 0.103  
## year 0.05334 0.12703 0.420 0.686  
## site.IDFRCH:year -0.08528 0.17965 -0.475 0.648  
## site.IDMOOS:year -0.11965 0.23766 -0.503 0.628  
## site.IDPOKE:year -0.09431 0.23766 -0.397 0.702  
## site.IDSTRT:year 0.06999 0.23766 0.294 0.776  
## site.IDVAUL:year -0.43727 0.23766 -1.840 0.103  
##   
## Residual standard error: 0.2841 on 8 degrees of freedom  
## Multiple R-squared: 0.5959, Adjusted R-squared: 0.0403   
## F-statistic: 1.073 on 11 and 8 DF, p-value: 0.4727

fDOM <- aov(sdHI ~ site.ID\*year,   
 data = HI\_FI\_fDOM)  
plot(fDOM)

 Log transform

fDOM.log <- aov(logSDhi ~ site.ID\*year,   
 data = HI\_FI\_fDOM)  
plot(fDOM.log)

 this looks better

summary(fDOM.log) # site.ID is different

## Df Sum Sq Mean Sq F value Pr(>F)   
## site.ID 5 2.0415 0.4083 8.676 0.00298 \*\*  
## year 1 0.0635 0.0635 1.350 0.27523   
## site.ID:year 5 0.5251 0.1050 2.231 0.13953   
## Residuals 9 0.4236 0.0471   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

summary.lm(fDOM.log)

##   
## Call:  
## aov(formula = logSDhi ~ site.ID \* year, data = HI\_FI\_fDOM)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.38060 -0.06910 0.02257 0.08933 0.24985   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -503.49607 195.92731 -2.570 0.0302 \*  
## site.IDFRCH 505.64516 277.08306 1.825 0.1013   
## site.IDMOOS 226.90440 277.08306 0.819 0.4340   
## site.IDPOKE 1108.32302 366.61125 3.023 0.0144 \*  
## site.IDSTRT 588.95529 366.61125 1.606 0.1426   
## site.IDVAUL 578.83890 366.61125 1.579 0.1488   
## year 0.24844 0.09702 2.561 0.0306 \*  
## site.IDFRCH:year -0.25005 0.13720 -1.822 0.1017   
## site.IDMOOS:year -0.11191 0.13720 -0.816 0.4357   
## site.IDPOKE:year -0.54862 0.18150 -3.023 0.0144 \*  
## site.IDSTRT:year -0.29130 0.18150 -1.605 0.1430   
## site.IDVAUL:year -0.28633 0.18150 -1.578 0.1491   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.2169 on 9 degrees of freedom  
## Multiple R-squared: 0.8613, Adjusted R-squared: 0.6918   
## F-statistic: 5.08 on 11 and 9 DF, p-value: 0.01067

TukeyHSD(fDOM.log, which = "site.ID")

## Warning in replications(paste("~", xx), data = mf): non-factors ignored: year

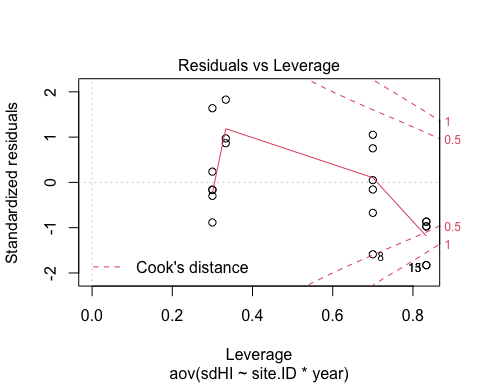
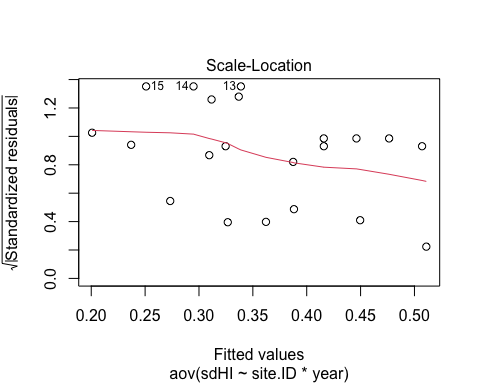
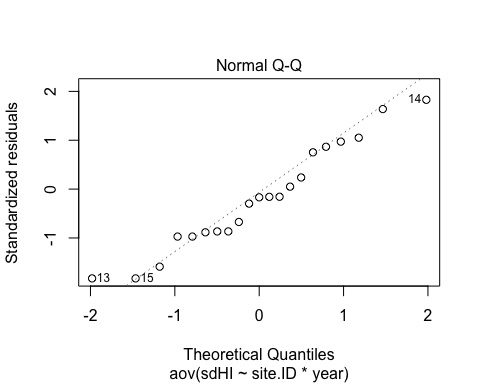
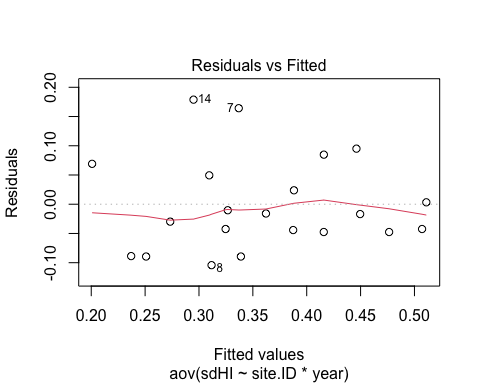
## Warning in replications(paste("~", xx), data = mf): non-factors ignored:  
## site.ID, year

## Tukey multiple comparisons of means  
## 95% family-wise confidence level  
##   
## Fit: aov(formula = logSDhi ~ site.ID \* year, data = HI\_FI\_fDOM)  
##   
## $site.ID  
## diff lwr upr p adj  
## FRCH-CARI 0.67590914 0.13101296 1.22080533 0.0150508  
## MOOS-CARI 0.89894175 0.35404556 1.44383793 0.0022977  
## POKE-CARI 0.24047116 -0.34808399 0.82902631 0.6994648  
## STRT-CARI 0.64858892 0.06003377 1.23714406 0.0298678  
## VAUL-CARI 0.56877723 -0.01977792 1.15733238 0.0593062  
## MOOS-FRCH 0.22303260 -0.32186359 0.76792879 0.6980530  
## POKE-FRCH -0.43543798 -1.02399313 0.15311717 0.1844976  
## STRT-FRCH -0.02732023 -0.61587538 0.56123492 0.9999760  
## VAUL-FRCH -0.10713191 -0.69568706 0.48142324 0.9838321  
## POKE-MOOS -0.65847059 -1.24702573 -0.06991544 0.0274578  
## STRT-MOOS -0.25035283 -0.83890798 0.33820232 0.6669086  
## VAUL-MOOS -0.33016451 -0.91871966 0.25839063 0.4130778  
## STRT-POKE 0.40811775 -0.22107417 1.03730968 0.2831601  
## VAUL-POKE 0.32830607 -0.30088585 0.95749799 0.4817003  
## VAUL-STRT -0.07981168 -0.70900361 0.54938024 0.9968422

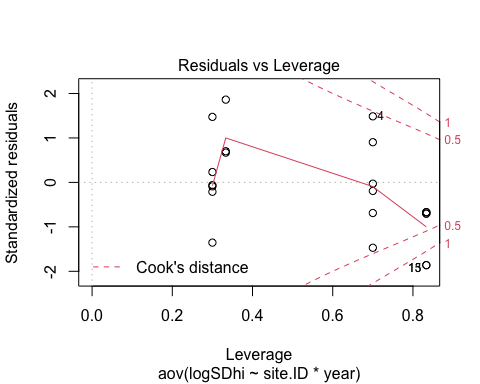
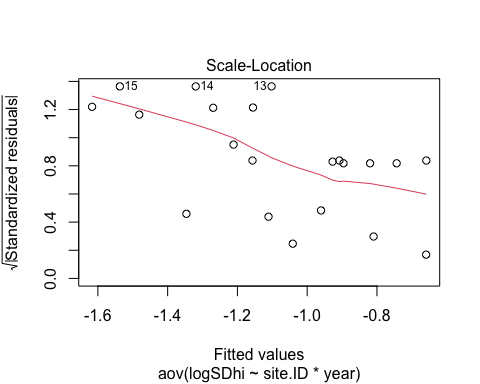
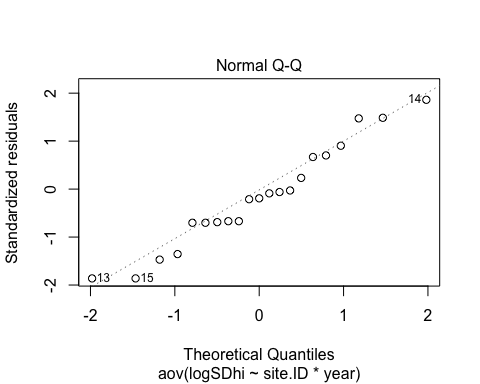
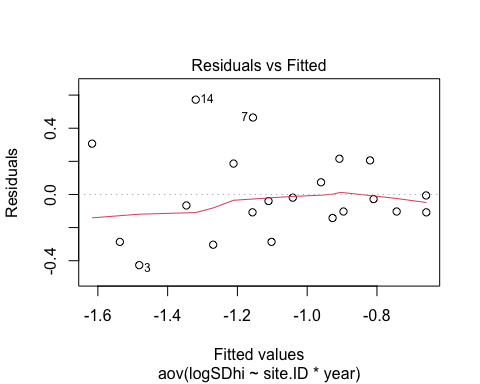
#CARI/FRCH  
#CARI/MOOS  
#CARI/STRT  
#MOOS/POKE

# SPC

SPC <- aov(sdHI ~ site.ID\*year,   
 data = HI\_FI\_SPC)  
plot(SPC)

 log transform

SPC.log <- aov(logSDhi ~ site.ID\*year,   
 data = HI\_FI\_SPC)  
  
plot(SPC.log)

 still meh

summary(SPC.log) # nothing is significant

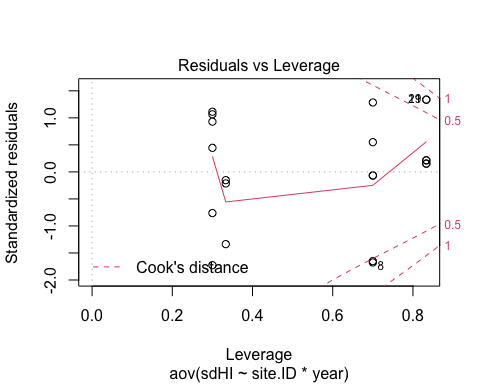
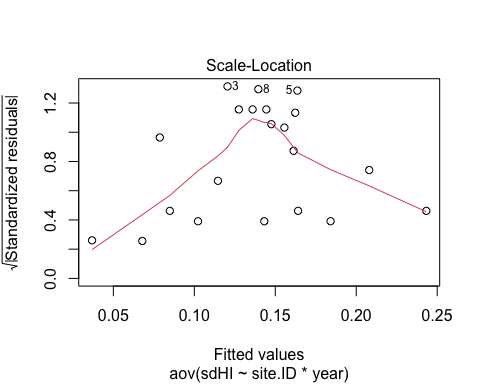
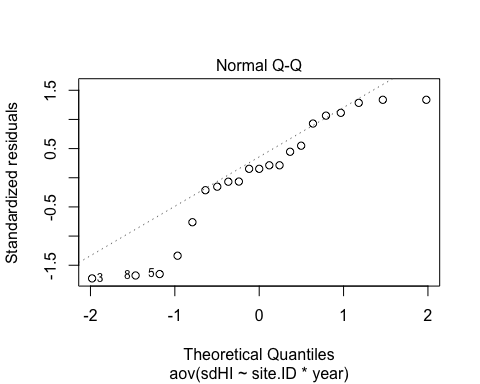
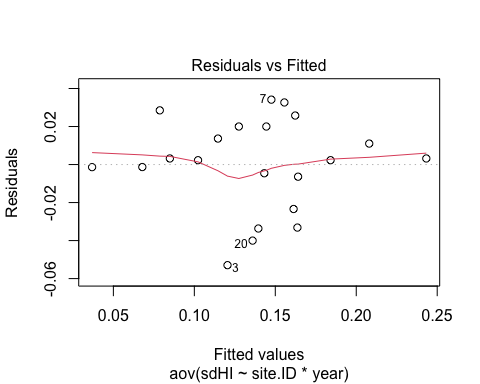
## Df Sum Sq Mean Sq F value Pr(>F)  
## site.ID 5 1.0636 0.21272 1.499 0.281  
## year 1 0.1515 0.15145 1.068 0.328  
## site.ID:year 5 0.3487 0.06973 0.492 0.775  
## Residuals 9 1.2768 0.14186

summary.lm(SPC.log)

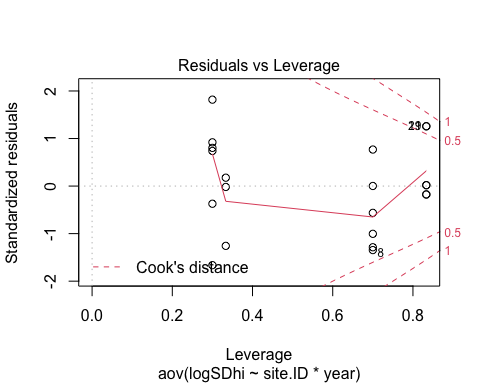
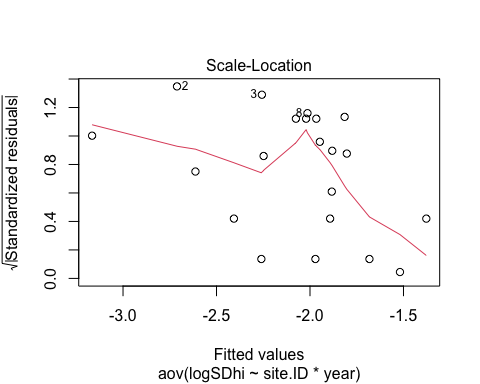
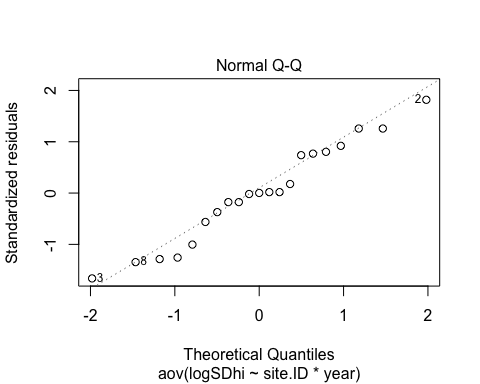
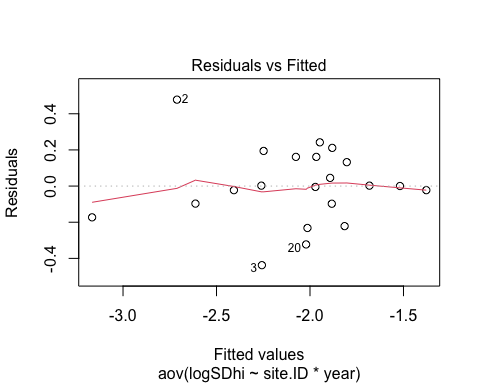
##   
## Call:  
## aov(formula = logSDhi ~ site.ID \* year, data = HI\_FI\_SPC)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.4268 -0.1079 -0.0397 0.1865 0.5726   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 271.55138 340.17027 0.798 0.445  
## site.IDFRCH -42.25591 481.07341 -0.088 0.932  
## site.IDMOOS 31.67890 481.07341 0.066 0.949  
## site.IDPOKE 166.34613 636.51281 0.261 0.800  
## site.IDSTRT -775.68555 636.51281 -1.219 0.254  
## site.IDVAUL -426.31565 636.51281 -0.670 0.520  
## year -0.13516 0.16844 -0.802 0.443  
## site.IDFRCH:year 0.02108 0.23821 0.088 0.931  
## site.IDMOOS:year -0.01542 0.23821 -0.065 0.950  
## site.IDPOKE:year -0.08227 0.31513 -0.261 0.800  
## site.IDSTRT:year 0.38429 0.31513 1.219 0.254  
## site.IDVAUL:year 0.21137 0.31513 0.671 0.519  
##   
## Residual standard error: 0.3766 on 9 degrees of freedom  
## Multiple R-squared: 0.5505, Adjusted R-squared: 0.001124   
## F-statistic: 1.002 on 11 and 9 DF, p-value: 0.5073

# turb

turb <- aov(sdHI ~ site.ID\*year,   
 data = HI\_FI\_turb)  
plot(turb)

 log transform

turb.log <- aov(logSDhi ~ site.ID\*year,   
 data = HI\_FI\_turb)  
plot(turb.log)

 May need further transformation

summary(turb.log) # year is significant

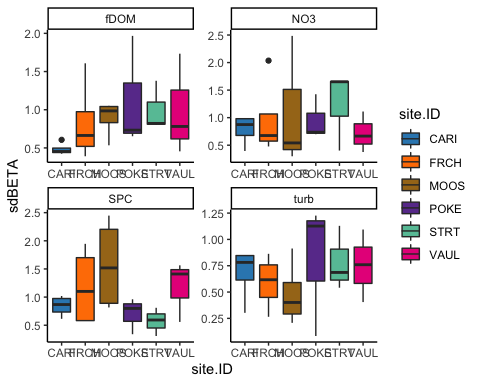
## Df Sum Sq Mean Sq F value Pr(>F)   
## site.ID 5 0.9148 0.1830 1.851 0.1989   
## year 1 0.5572 0.5572 5.637 0.0416 \*  
## site.ID:year 5 1.8631 0.3726 3.770 0.0405 \*  
## Residuals 9 0.8895 0.0988   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

summary.lm(turb.log)

##   
## Call:  
## aov(formula = logSDhi ~ site.ID \* year, data = HI\_FI\_turb)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.43750 -0.09768 0.00035 0.16140 0.47812   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -919.56302 283.93312 -3.239 0.01018 \*   
## site.IDFRCH 1051.42104 401.54208 2.618 0.02788 \*   
## site.IDMOOS 181.11185 401.54208 0.451 0.66263   
## site.IDPOKE 1956.98172 531.28415 3.683 0.00505 \*\*  
## site.IDSTRT 333.76289 531.28415 0.628 0.54547   
## site.IDVAUL 807.47284 531.28415 1.520 0.16287   
## year 0.45411 0.14060 3.230 0.01032 \*   
## site.IDFRCH:year -0.52035 0.19883 -2.617 0.02795 \*   
## site.IDMOOS:year -0.08947 0.19883 -0.450 0.66335   
## site.IDPOKE:year -0.96862 0.26303 -3.683 0.00506 \*\*  
## site.IDSTRT:year -0.16509 0.26303 -0.628 0.54584   
## site.IDVAUL:year -0.39962 0.26303 -1.519 0.16301   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.3144 on 9 degrees of freedom  
## Multiple R-squared: 0.7894, Adjusted R-squared: 0.5321   
## F-statistic: 3.068 on 11 and 9 DF, p-value: 0.05163

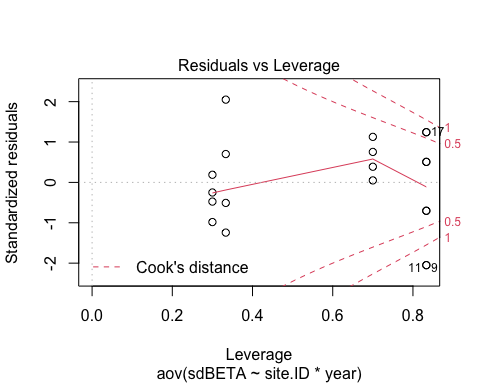
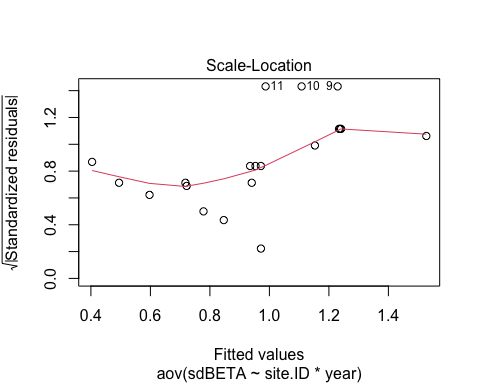
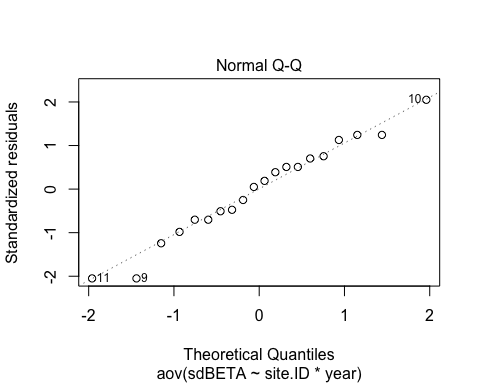
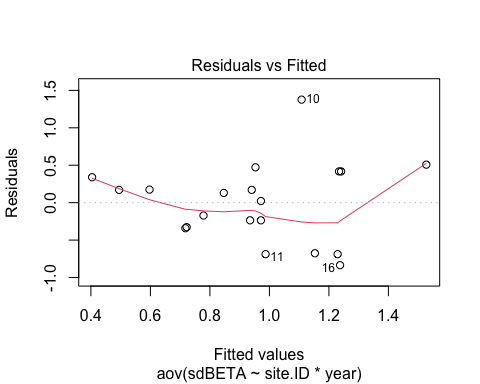
# BETA

#plot   
ggplot(AMC, aes(site.ID, sdBETA, fill = site.ID)) +  
 geom\_boxplot() +  
 facet\_wrap(~response\_var, scales = "free") +  
 scale\_fill\_manual(values = c("#3288BD", "#FF7F00","#A6761D", "#6A3D9A", "#66C2A5", "#E7298A")) +  
 theme\_classic()



# NO3

no3 <- aov(sdBETA ~ site.ID\*year,   
 data = HI\_FI\_NO3)  
  
plot(no3)



summary(no3) # nothing is significant

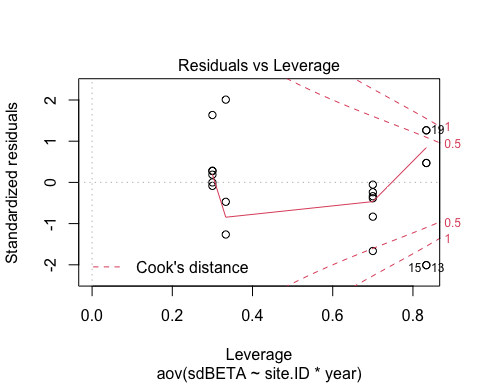
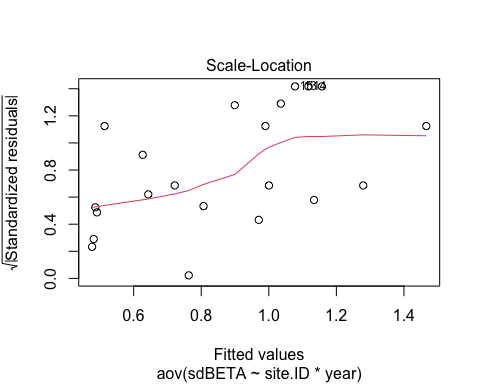
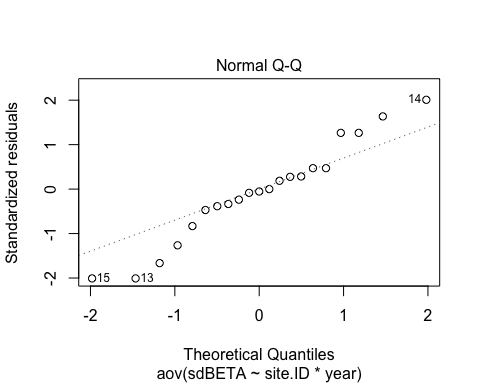
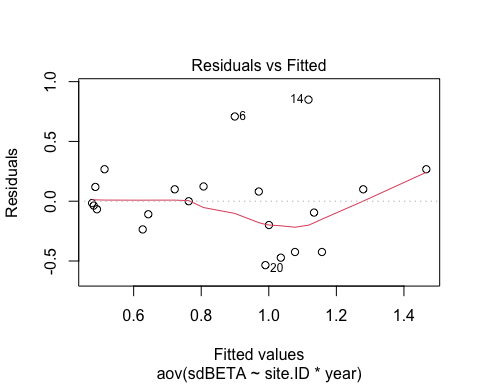
## Df Sum Sq Mean Sq F value Pr(>F)  
## site.ID 5 0.596 0.1192 0.176 0.964  
## year 1 0.574 0.5740 0.849 0.384  
## site.ID:year 5 0.335 0.0669 0.099 0.990  
## Residuals 8 5.409 0.6761

summary.lm(no3)

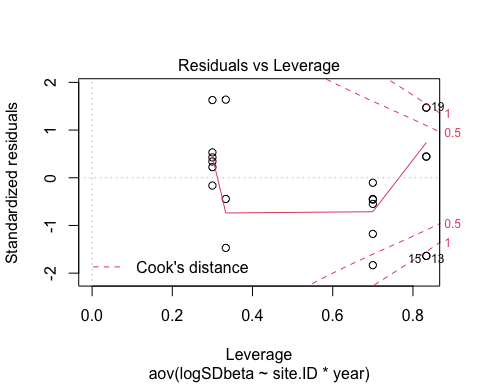
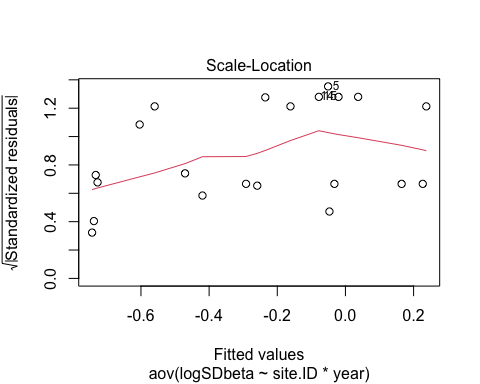
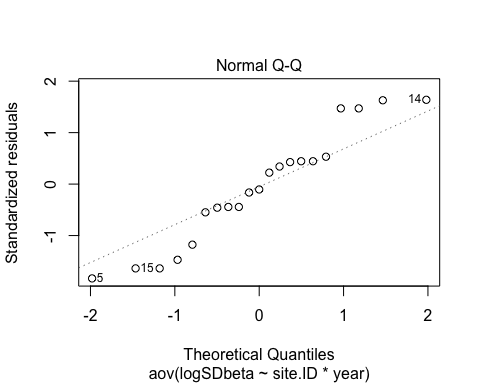
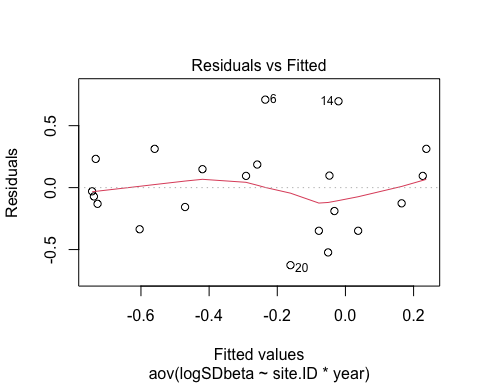
##   
## Call:  
## aov(formula = sdBETA ~ site.ID \* year, data = HI\_FI\_NO3)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.83480 -0.33061 0.07618 0.35921 1.37617   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 2.529e+02 7.426e+02 0.341 0.742  
## site.IDFRCH 5.043e+02 1.050e+03 0.480 0.644  
## site.IDMOOS -7.328e+00 1.389e+03 -0.005 0.996  
## site.IDPOKE -2.153e+02 1.390e+03 -0.155 0.881  
## site.IDSTRT -2.586e+02 1.390e+03 -0.186 0.857  
## site.IDVAUL 1.983e+02 1.390e+03 0.143 0.890  
## year -1.248e-01 3.677e-01 -0.339 0.743  
## site.IDFRCH:year -2.496e-01 5.201e-01 -0.480 0.644  
## site.IDMOOS:year 3.759e-03 6.880e-01 0.005 0.996  
## site.IDPOKE:year 1.067e-01 6.880e-01 0.155 0.881  
## site.IDSTRT:year 1.283e-01 6.880e-01 0.186 0.857  
## site.IDVAUL:year -9.819e-02 6.880e-01 -0.143 0.890  
##   
## Residual standard error: 0.8223 on 8 degrees of freedom  
## Multiple R-squared: 0.2176, Adjusted R-squared: -0.8582   
## F-statistic: 0.2023 on 11 and 8 DF, p-value: 0.9914

# fDOM

fDOM <- aov(sdBETA ~ site.ID\*year,   
 data = HI\_FI\_fDOM)  
plot(fDOM)

 log transform

fDOM.log <- aov(logSDbeta ~ site.ID\*year,   
 data = HI\_FI\_fDOM)  
  
plot(fDOM.log)

 may need further transformation

summary(fDOM.log) # nothing is significant

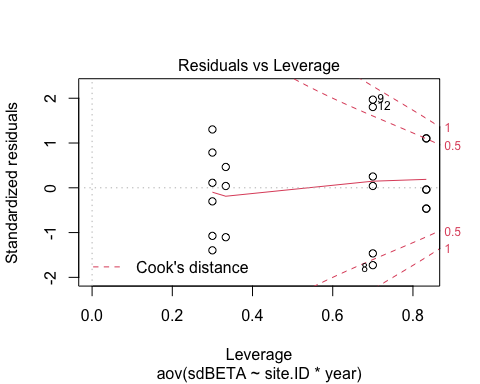
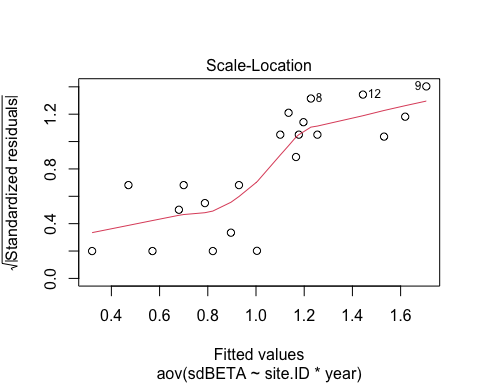
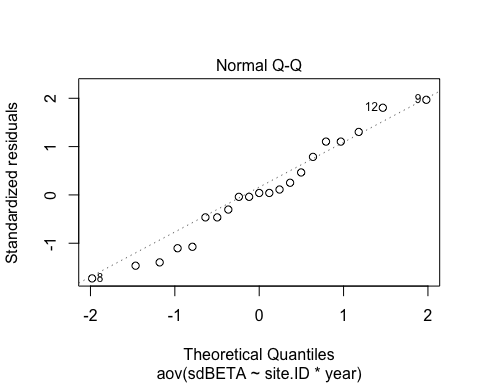
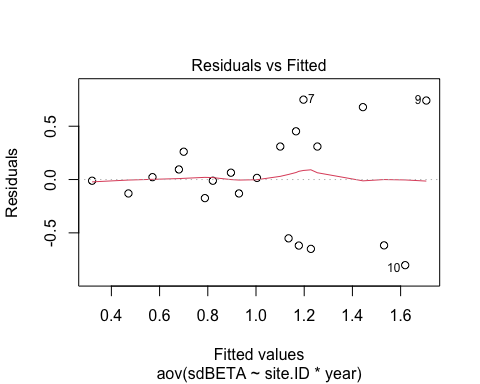
## Df Sum Sq Mean Sq F value Pr(>F)  
## site.ID 5 1.3249 0.2650 0.976 0.481  
## year 1 0.2625 0.2625 0.967 0.351  
## site.ID:year 5 0.5907 0.1181 0.435 0.814  
## Residuals 9 2.4434 0.2715

summary.lm(fDOM.log)

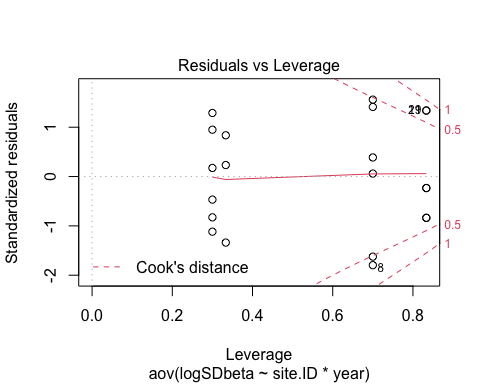
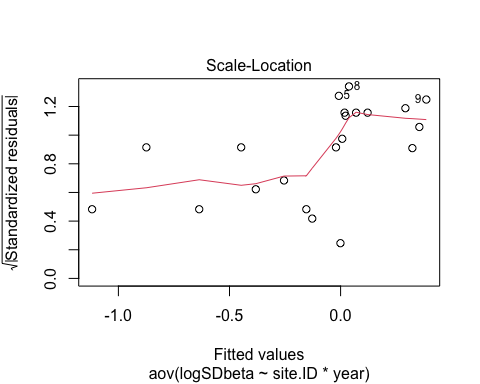
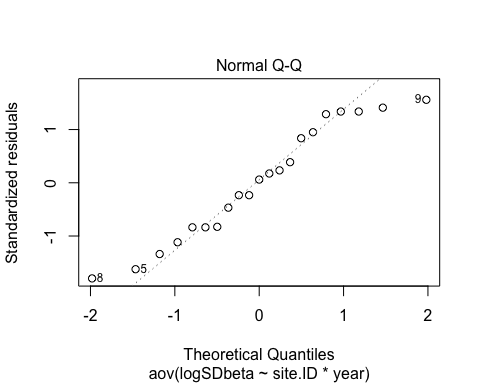
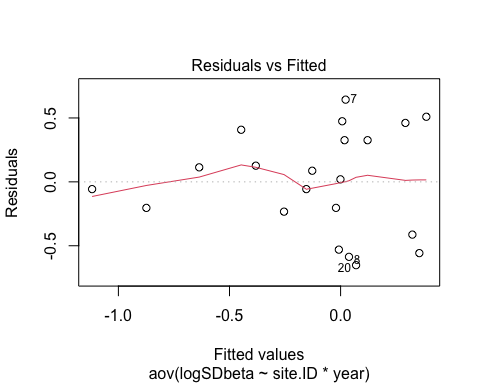
##   
## Call:  
## aov(formula = logSDbeta ~ site.ID \* year, data = HI\_FI\_fDOM)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.62580 -0.18904 -0.02977 0.18633 0.71004   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) -1.153e+01 4.706e+02 -0.024 0.981  
## site.IDFRCH 3.834e+02 6.655e+02 0.576 0.579  
## site.IDMOOS 4.392e+02 6.655e+02 0.660 0.526  
## site.IDPOKE 1.279e+02 8.805e+02 0.145 0.888  
## site.IDSTRT -5.123e+02 8.805e+02 -0.582 0.575  
## site.IDVAUL 8.165e+02 8.805e+02 0.927 0.378  
## year 5.343e-03 2.330e-01 0.023 0.982  
## site.IDFRCH:year -1.897e-01 3.295e-01 -0.576 0.579  
## site.IDMOOS:year -2.172e-01 3.295e-01 -0.659 0.526  
## site.IDPOKE:year -6.296e-02 4.359e-01 -0.144 0.888  
## site.IDSTRT:year 2.539e-01 4.359e-01 0.583 0.575  
## site.IDVAUL:year -4.039e-01 4.359e-01 -0.927 0.378  
##   
## Residual standard error: 0.521 on 9 degrees of freedom  
## Multiple R-squared: 0.4713, Adjusted R-squared: -0.1749   
## F-statistic: 0.7293 on 11 and 9 DF, p-value: 0.694

# SPC

SPC <- aov(sdBETA ~ site.ID\*year,   
 data = HI\_FI\_SPC)  
  
plot(SPC)

 log transform

SPC.log <- aov(logSDbeta ~ site.ID\*year,   
 data = HI\_FI\_SPC)  
plot(SPC.log)

 Looks like we have an outlier issue here.

summary(SPC.log) # nothing is significant

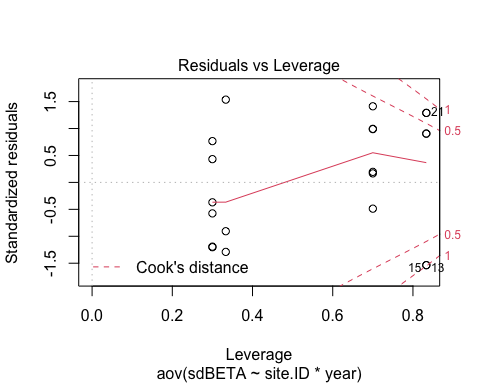
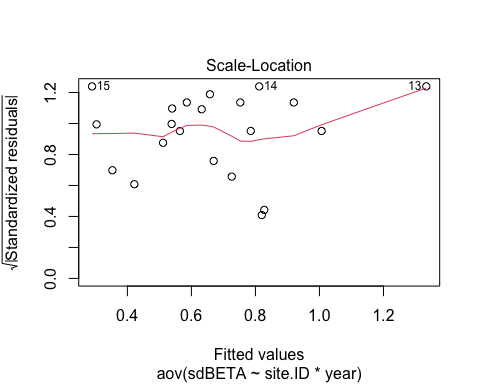
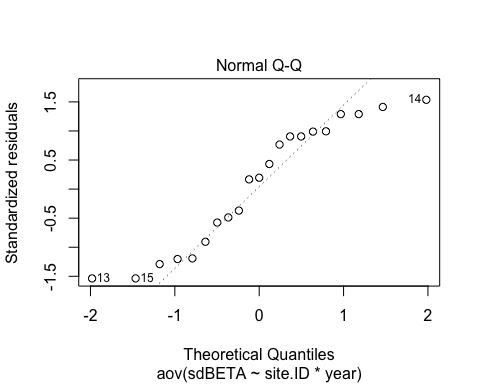
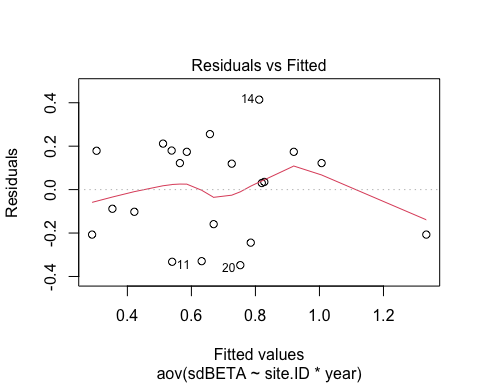
## Df Sum Sq Mean Sq F value Pr(>F)  
## site.ID 5 2.163 0.4326 1.216 0.376  
## year 1 0.069 0.0692 0.194 0.670  
## site.ID:year 5 0.852 0.1704 0.479 0.784  
## Residuals 9 3.203 0.3558

summary.lm(SPC.log)

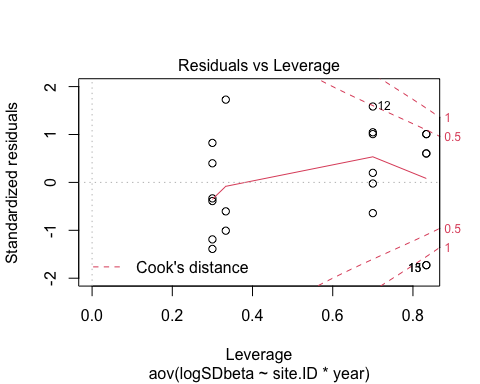
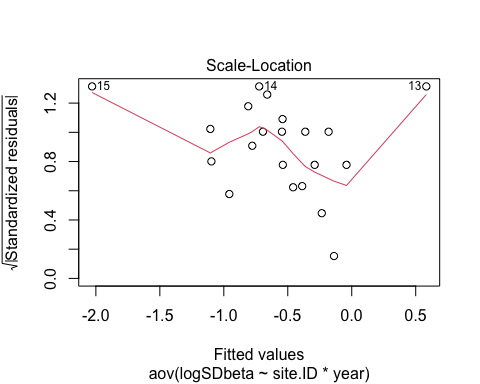
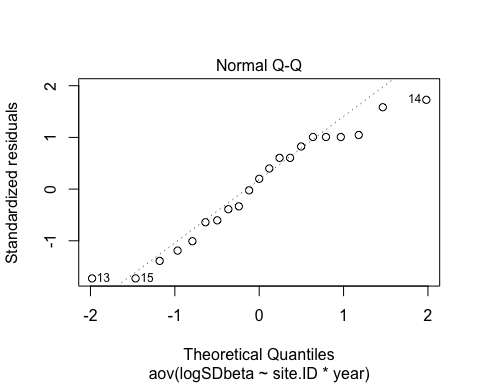
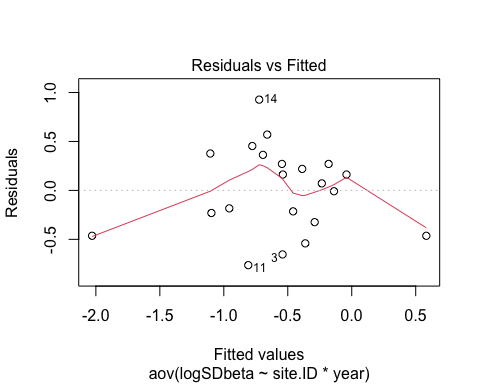
##   
## Call:  
## aov(formula = logSDbeta ~ site.ID \* year, data = HI\_FI\_SPC)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.65194 -0.23326 0.01975 0.32597 0.64330   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 2.562e+02 5.387e+02 0.476 0.646  
## site.IDFRCH -2.869e+02 7.619e+02 -0.377 0.715  
## site.IDMOOS -1.925e+02 7.619e+02 -0.253 0.806  
## site.IDPOKE -1.119e+03 1.008e+03 -1.110 0.296  
## site.IDSTRT -1.231e+03 1.008e+03 -1.221 0.253  
## site.IDVAUL -3.608e+02 1.008e+03 -0.358 0.729  
## year -1.270e-01 2.668e-01 -0.476 0.645  
## site.IDFRCH:year 1.422e-01 3.773e-01 0.377 0.715  
## site.IDMOOS:year 9.559e-02 3.773e-01 0.253 0.806  
## site.IDPOKE:year 5.537e-01 4.991e-01 1.109 0.296  
## site.IDSTRT:year 6.090e-01 4.991e-01 1.220 0.253  
## site.IDVAUL:year 1.788e-01 4.991e-01 0.358 0.728  
##   
## Residual standard error: 0.5965 on 9 degrees of freedom  
## Multiple R-squared: 0.4906, Adjusted R-squared: -0.1321   
## F-statistic: 0.7879 on 11 and 9 DF, p-value: 0.6511

# turb

turb <- aov(sdBETA ~ site.ID\*year,   
 data = HI\_FI\_turb)  
  
plot(turb)

 log transform

turb.log <- aov(logSDbeta ~ site.ID\*year,   
 data = HI\_FI\_turb)  
plot(turb.log)



summary(turb.log) # nothing is significant

## Df Sum Sq Mean Sq F value Pr(>F)  
## site.ID 5 0.880 0.1761 0.408 0.832  
## year 1 0.542 0.5416 1.254 0.292  
## site.ID:year 5 3.799 0.7597 1.759 0.218  
## Residuals 9 3.888 0.4320

summary.lm(turb.log)

##   
## Call:  
## aov(formula = logSDbeta ~ site.ID \* year, data = HI\_FI\_turb)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.76366 -0.32429 0.07177 0.27051 0.92715   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 309.2061 593.6133 0.521 0.6150   
## site.IDFRCH 335.1763 839.4960 0.399 0.6990   
## site.IDMOOS -609.4571 839.4960 -0.726 0.4863   
## site.IDPOKE 2328.6066 1110.7451 2.096 0.0655 .  
## site.IDSTRT -812.2461 1110.7451 -0.731 0.4832   
## site.IDVAUL -677.8716 1110.7451 -0.610 0.5568   
## year -0.1533 0.2939 -0.522 0.6145   
## site.IDFRCH:year -0.1660 0.4157 -0.399 0.6989   
## site.IDMOOS:year 0.3016 0.4157 0.725 0.4866   
## site.IDPOKE:year -1.1529 0.5499 -2.096 0.0655 .  
## site.IDSTRT:year 0.4022 0.5499 0.731 0.4831   
## site.IDVAUL:year 0.3357 0.5499 0.610 0.5567   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.6573 on 9 degrees of freedom  
## Multiple R-squared: 0.5731, Adjusted R-squared: 0.05143   
## F-statistic: 1.099 on 11 and 9 DF, p-value: 0.4512