2A & B: Pond Water Microbes

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Data wrangling and analysis the AE microrganisms in pond water experiment using the SFEB (San Francisco East Bay) water samples for part A (nicknamed “fifteen sites” in our lab) and the follow up experiment part B with SBNCOS (Santa Barbara North Campus Open Space) pond water samples. These are the data presented in Figure 3A and 3B in the manuscript, and information is under the section “Experiment 2: Assessment of AE microorganisms’ inhibitory effects on Bd growth”.

# Load in data and libraries

## read in and clean data  
library(tidyverse) # for cleaning and viewing data  
library(gt) # pretty stats tables  
library(broom) # cleaning for gt  
library(here) # for importing data  
library(car) # stats tests  
library(Hmisc) # autocalculate stat summaries in ggplot  
library(multcomp) # stats  
library(nlme) # mixed effects models  
library(emmeans) # for pairwise comparisons, especially on mixed effects models and glms  
library(ggpubr) # for making ggqq plot  
library(patchwork) # for combining figures  
library(multcompView) # for posthoc visualization  
  
# load "East Bay" experiment data  
fs\_pw\_bd <- read.csv(here("data", "fifteen-sites-PW-on-Bd - Sheet1.csv"))  
  
# load "SBNCOS" experiment data  
## note the data file is called 2b because it was initially the second figure but we added in a methods figure so this will be 3b  
sbncos\_raw <- read.csv(here("data", "final\_NCOS\_2024\_reformatted\_for\_R.xlsx - Fig2B.csv"))  
  
# Colors: these are from Paul Tol's colorblind friendly palette  
with\_microbes\_40\_color <- "#999933"  
no\_microbes\_.22\_color <- "#88ccee"  
  
# custom theme for EDA  
myCustomTheme <- function() {  
 theme\_light() +  
 theme(axis.text = element\_text(size = 12, family = "Times", color = "black"),  
 axis.title.x = element\_text(margin = margin(t = 10), size = 14, face = "bold", family = "Times", color = "black"), # Add space between x-axis label and axis  
 axis.title.y = element\_text(margin = margin(r = 10), size = 14, face = "bold", family = "Times", color = "black"), # Add space between y-axis label and axis  
 title = element\_text(size = 12, face = "bold", family = "Times"),  
 plot.caption = element\_text(size = 10, face = "italic", family = "Times"),  
 legend.text = element\_text(size = 10, family = "Times"), # Increase legend text size  
 panel.grid.major.x = element\_blank(), # Remove major vertical grid lines  
 panel.grid.minor.x = element\_blank(), # Remove minor vertical grid lines  
 panel.grid.major.y = element\_blank(), # Remove major horizontal grid lines  
 panel.grid.minor.y = element\_blank(), # Remove minor horizontal grid lines  
 strip.text = element\_text(size = 12, face = "bold", family = "Times", color = "black"), # Set strip text style  
 strip.background = element\_rect(fill = "white", color = "grey"), # Set strip background to white, # color = "black"  
 axis.ticks = element\_blank() # Remove x and y axis ticks  
 )}

# Part A: SFEB Microorganisms

## Data Wrangling

# make dataframe with only field data (milliq controls added into visualization later)  
eb\_pw <- fs\_pw\_bd %>%   
 filter(site != "sterile MQ") # keep all sites except this control  
  
# dataframe of controls for labeling plot later  
eb\_pw\_controls <- fs\_pw\_bd %>%   
 filter(site =="sterile MQ") %>% # keep all sites except this control  
 pivot\_wider(names\_from = bd\_location, values\_from = bd\_qty) %>% # make "wide" format to allow for combining the Bd from different locations in the wells  
 mutate(combined\_bd = adherent + floating) %>% # add Bd quantity from the adherent fraction (DNA adhered to bottom and sides of well) and the floating fraction (not adhered to well)  
 mutate(  
 day = case\_when( # change the format of day from a number to ensure it will be a factor in analysis  
 day == 1 ~ "Day\_1",  
 day == 7 ~ "Day\_7"))  
  
# data type cleaning  
eb\_pw$bd\_location <- factor(eb\_pw$bd\_location, levels = c("floating", "adherent")) # bd location (aka location of DNA in the well) is a factor, set levels for barchart figure in SI  
eb\_pw$filter <- factor(eb\_pw$filter,  
 levels = c("40um\_filter", "0.22um\_filter")) # filter type levels for correct order in visualization  
eb\_pw$day <- factor(eb\_pw$day, levels = c("1", "7"),  
 labels = c("Day\_1", "Day\_7")) # set levels for visualization, set labels for visualization too  
eb\_pw$site <- factor(eb\_pw$site,  
 levels = c("BARN", "CABIN", "NORTH", "GRAMPS", "WEST", "GDPND004", "GDPND005", "GDPND006", "GDPND008", "GDPND009", "PRPND002", "PRPND003", "PRPND004", "PRPND009", "PRPND010", "sterile MQ")) # set site name as a factor and gave levels to ensure correct order when plotting  
  
# new dataframe to allow for the calculation of the rate loss of Bd from the total sample days by combining both "locations" (adherent and supernatant) of Bd   
eb\_pw\_total\_diff <- eb\_pw %>%  
 # combine floating and adherent for total\_Bd  
 pivot\_wider(names\_from = bd\_location, values\_from = bd\_qty) %>%  
 mutate(combined\_bd = adherent + floating) %>% # for exploration purposes only, the rate loss is used for analyses  
 # remove uneeded columns  
 subset(select = -c(adherent,floating)) %>%   
  
# pivot wider to calculate the rate loss  
 pivot\_wider(names\_from = day, values\_from = combined\_bd) %>%  
 # calculate the rate loss by taking the log of each before subtracting  
 mutate(rate\_loss = log(Day\_1) - log(Day\_7))  
  
# Split into 2 data frames one for 40 um filter and one for .22 um filter for later stats assumption checks  
eb\_pw\_total\_diff\_40um <- eb\_pw\_total\_diff %>%   
 filter(filter =="40um\_filter") # for AE microorganisms +  
eb\_pw\_total\_diff.22um <- eb\_pw\_total\_diff%>%   
 filter(filter =="0.22um\_filter") # for AE microorganisms -  
  
# save clean data as a csv  
write.csv(eb\_pw\_total\_diff, "data/eb\_pw\_total\_diff.csv", row.names = FALSE)

# SFEB EDA

Exploratory data analysis

## Assumption testing for stats

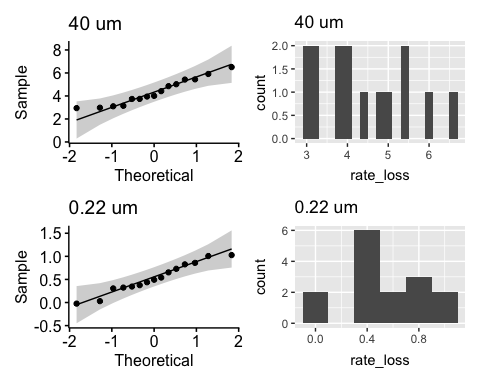
Question: Does the rate loss in Bd from day 1 to day 7 (aka Bd-inhibitory potency) differ between the two filter types (40 and 0.22 um; aka AE microorganisms + and AE microorganisms -)?

The samples are paired by site, so a paired t-test is most appropriate. The null hypothesis of our paired t-test is:

**Statistical question**: Is there a difference in the **rate of gain or loss of Bd over 6 days** (aka Bd-inhibitory potency) between the **filter sizes** (looking at the TOTAL BD from each well)

Assumption testing:

# check normality of the differences across groups  
  
# numeric check using shapiro wilks test, a p > 0.05 says the data is indeed normal  
eb\_pw\_40um\_shapiro.test <- shapiro.test(eb\_pw\_total\_diff\_40um$rate\_loss) # normal, yay!  
eb\_pw\_0.22um\_shapiro.test <- shapiro.test(eb\_pw\_total\_diff.22um$rate\_loss) # normal, yay!  
  
#...............With microorganisms (40 um filter)...............  
  
# visual check using qq plot to see normality of the rate loss  
eb\_pw\_40um\_qq <- eb\_pw\_total\_diff\_40um %>%   
 ggqqplot("rate\_loss", title = "40 um") # normal, yay!  
  
# visual check using histogram of the rate loss to see normality  
eb\_pw\_40um\_hist <- eb\_pw\_total\_diff\_40um %>%   
 ggplot(aes(x = rate\_loss)) +  
 geom\_histogram(binwidth = 0.2) +  
 labs(title = "40 um") # good enough, especially with confirmed shapiro and qq  
  
#............Without microorganisms (0.22 um filter).............  
# visual check using qq plot to see normality of the rate loss  
eb\_pw\_0.22um\_qq <- eb\_pw\_total\_diff.22um %>%   
 ggqqplot("rate\_loss", title = "0.22 um") # normal, yay!  
  
# visual check using histogram of the rate loss to see normality  
eb\_pw\_0.22um\_hist <- eb\_pw\_total\_diff.22um %>%   
 ggplot(aes(x = rate\_loss)) +  
 geom\_histogram(binwidth = 0.2) +  
 labs(title = "0.22 um") # good enough, especially with confirmed shapiro and qq  
  
# show all assumption testing visualizations together  
eb\_pw\_40um\_qq + eb\_pw\_40um\_hist + eb\_pw\_0.22um\_qq + eb\_pw\_0.22um\_hist



# print shapiro test results  
eb\_pw\_40um\_shapiro.test

Shapiro-Wilk normality test  
  
data: eb\_pw\_total\_diff\_40um$rate\_loss  
W = 0.93591, p-value = 0.3337

eb\_pw\_0.22um\_shapiro.test

Shapiro-Wilk normality test  
  
data: eb\_pw\_total\_diff.22um$rate\_loss  
W = 0.96119, p-value = 0.7131

Assumptions test statement:

The data for the 40um filter is normally distributed (Shapiro-Wilk test, W = 0.93591, p = 0.3337), and so is the data for the 0.22 filter (Shapiro-Wilk test, W = 0.96119, p = 0.7131).

## SFEB Analysis

# Run the paired t-test on the rate loss across the 6 days  
eb\_pw\_paired\_ttest\_result <- t.test(eb\_pw\_total\_diff\_40um$rate\_loss, eb\_pw\_total\_diff.22um$rate\_loss, paired = TRUE)  
  
# print the result  
eb\_pw\_paired\_ttest\_result

Paired t-test  
  
data: eb\_pw\_total\_diff\_40um$rate\_loss and eb\_pw\_total\_diff.22um$rate\_loss  
t = 12.449, df = 14, p-value = 5.83e-09  
alternative hypothesis: true mean difference is not equal to 0  
95 percent confidence interval:  
 3.159637 4.474996  
sample estimates:  
mean difference   
 3.817316

Results statement:

**There is a significant difference in the rate loss or gain in the total quantity of Bd from Day 1 to Day 7 across the filter types (t = 12.4488129, df = 14, p-value = 5.8299032^{-9})**

The t-value is positive, which shows that the first item entered (40 um filter aka with microbes) has a larger loss of Bd than the second item entered (no microbes.) Df of 14 is expected, because it’s 15 sites.

# Part B: SBNCOS AE microorganisms

## Data wrangling

pw <- sbncos\_raw %>%   
# add column for microbes presence yes or no this will be used in visualization, but not the stats  
 mutate(microbes = case\_when(   
 str\_detect(sample\_ID, "\\+microorganism") ~ "y", # if the raw data has microorganism in the sample id then it has microorganisms  
 TRUE ~ "n" # otherwise, it does not  
 )) %>%   
# add column for water\_treatment (this WILL be in the stats)  
 mutate(water\_treatment = case\_when(  
 sample\_ID %in% c("1%TB", "MQ", "Added Bd") ~ "sterile-water", # these treatments had a base of sterile water (aka MQ). if the sample id contains one of these treatments in the id, then we know the water treatment  
 sample\_ID %in% c("1%TB+PW+microorganism", "PW+microorganism") ~ "PW+MO", # same as above, except these sample id's had pond water with microorganisms still present, so pond water + microorganism (PW+MO)  
 sample\_ID %in% c("1%TB+PW-microorganism", "PW-microorganism") ~ "PW-MO" # same as above, except these sample id's had filtered pond water aka pond water without microorganisms(PW-MO)  
 )) %>%   
# add column for TB (tryptone broth) or no (this WILL be in the stats)  
 mutate(TB = case\_when(  
 str\_detect(sample\_ID, "TB") ~ "y", # if the raw data has TB in the sample id then it has TB  
 TRUE ~ "n" # otherwise, it does not  
 )) %>%   
 # update day column to have the word Day in it (this WILL be in the stats)  
 mutate(day = case\_when(  
 day == 1 ~ "Day\_1",  
 day == 3 ~ "Day\_3",  
 day == 5 ~ "Day\_5",  
 day == 7 ~ "Day\_7",  
 day == 0 ~ "Day\_0"  
 )) %>%   
 # also create a column with day as just a number  
 mutate(day\_numeric = as.numeric(gsub("Day\_", "", as.character(day))))  
  
## make a summary dataframe for ggplot creation  
pw\_summary <- pw %>%   
 group\_by(day, sample\_ID) %>% # this groups all the replicates of the same day and treatmenttogether  
 # note: adh\_plus\_sup means: total bd in the well (adherent plus supernatant material)  
 reframe(mean = mean(adh\_plus\_sup), # calculate the mean   
 n = length(adh\_plus\_sup), # count the number of observations within the day and sample id  
 df = n - 1, # calculate the degrees of freedom  
 sd = sd(adh\_plus\_sup), # calculate the standard deviation  
 se = sd/sqrt(n)) %>% # calculate the standard error  
   
 ## Now that it is in a new summarized format, recreate the columns made above  
 mutate(microbes = case\_when( # make column for microbes y or n  
 str\_detect(sample\_ID, "\\+microorganism") ~ "y",TRUE ~ "n")) %>% # if the sample id contains \+microorganism then it has the microorganism, otherwise it doesnt. \\ is needed because it begins with symbol "+"  
 # add column for TB (tryptone broth) or no  
 mutate(TB = case\_when(  
 str\_detect(sample\_ID, "TB") ~ "y", TRUE ~ "n")) %>%   
 # add column for water treatment  
 mutate(water\_treatment = case\_when(  
 sample\_ID %in% c("1%TB", "MQ", "Added Bd") ~ "sterile-water",  
 sample\_ID %in% c("1%TB+PW+microorganism", "PW+microorganism") ~ "PW+MO",  
 sample\_ID %in% c("1%TB+PW-microorganism", "PW-microorganism") ~ "PW-MO"  
 )) %>%   
 mutate(day\_numeric = as.numeric(gsub("Day\_", "", as.character(day))))  
  
# dataframe of only controls, controls will be plotted separately on the plot  
pw\_control\_data <- pw %>%  
 filter(day == "Day\_0") %>% # day 0 are the "controls" here, the day Bd was added, only include these  
 mutate(day\_numeric = as.numeric(gsub("Day\_", "", as.character(day)))) %>% # make column for day  
 dplyr::select(day, adh\_plus\_sup, day\_numeric) # select only relevant columns  
  
# dataframe without controls, controls will be plotted separately on the plot  
pw\_noday0 <- pw %>%  
 filter(day != "Day\_0") %>% # day 0 are the "controls" here, we dont want these  
 # log transform  
 # note: no zeroes so no +1 to the log needed. log function is the natural log.   
 mutate(log\_adh\_plus\_sup = log(adh\_plus\_sup)) %>%   
 mutate(day = factor(day,   
 levels = c("Day\_1", "Day\_3", "Day\_5", "Day\_7"))) # set day as a factor, set levels for plotting  
  
# set MQ (sterile water MilliQ) as reference for sample ID  
pw\_noday0$sample\_ID <- factor(pw\_noday0$sample\_ID) # set as factor  
pw\_noday0$sample\_ID <- relevel(pw\_noday0$sample\_ID, ref = "MQ") # set as reference  
  
# set sterile water as reference water treatment  
pw\_noday0$water\_treatment <- factor(pw\_noday0$water\_treatment) # set as factor  
pw\_noday0$water\_treatment <- relevel(pw\_noday0$water\_treatment, ref = "sterile-water") # set as reference  
  
# set no TB as reference  
pw\_noday0$TB <- factor(pw\_noday0$TB) # set as factor  
pw\_noday0$TB <- relevel(pw\_noday0$TB, ref = "n") # set as reference  
  
# set no microbes as reference  
pw\_noday0$microbes <- factor(pw\_noday0$microbes) # set as factor  
pw\_noday0$microbes <- relevel(pw\_noday0$microbes, ref = "n") # set as reference  
  
# export clean data   
write.csv(pw\_noday0, "data/pw\_noday0.csv", row.names = FALSE)

## SBNCOS EDA

General visualization

pw\_summary %>%   
 # reorder sample\_ID factor levels to match Renwei's plot  
 mutate(sample\_ID = factor(sample\_ID,   
 levels = c("1%TB", "MQ", "1%TB+PW+microorganism", "PW+microorganism", "1%TB+PW-microorganism", "PW-microorganism", "Added Bd"))) %>%   
  
# plot it!  
 ggplot(aes(x = day\_numeric, # x = numeric day  
 y = mean, # y = mean Bd quantity per treatment per day  
 color = sample\_ID)) + # color points and lines by treatment  
 geom\_point(size = 2) + # plot points for means  
 geom\_errorbar(aes(ymin = mean - se, # plot the standard error  
 ymax = mean + se),  
 width = 0.1) +  
 # log scale for y-axis  
 scale\_y\_log10(limits = c(1e3, 1e8), # set y-axis range  
 breaks = c(1e3, 1e4, 1e5, 1e6, 1e7, 1e8)) + # breaks for y-axis ticks  
 # labels  
 labs(x = "Day",  
 y = "Bd Quantity per sample (ZE/well)",  
 color = "Medium", # color legend title  
 linetype = "Microbes Present" ) + # linetype legend title  
 scale\_color\_manual(values = c("1%TB" = "#CCBB44",   
 "MQ" = "#228833",   
 "1%TB+PW+microorganism" = "#4477AA",   
 "PW+microorganism" = "#EE6677",   
 "1%TB+PW-microorganism" = "#66CCEE",  
 "PW-microorganism" = "#AA3377"),   
 # Custom labels for the color legend  
 labels = c("1%TB" = "TB",  
 "MQ" = "MQ",  
 "1%TB+PW+microorganism" = "TB + PW + MO",  
 "PW+microorganism" = "PW + MO",  
 "1%TB+PW-microorganism" = "TB + PW - MO",  
 "PW-microorganism" = "PW - MO",  
 "Added Bd" = "Initial Bd")) +   
 # add lines to connect points across days  
 geom\_line(aes(linetype = microbes)) +   
 # manually assign line types based on presence/absence of microbes  
 scale\_linetype\_manual(values = c("n" = "dashed",   
 "y" = "solid"),  
 labels = c("n" = "N", "y" = "Y")) + # Change labels to uppercase N and Y  
 # custom x-axis breaks and labels, replace 0 with "Initial Bd"  
 scale\_x\_continuous(breaks = c(0, 1, 3, 5, 7),  
 labels = c("Initial\nBd", "1", "3", "5", "7")) +  
 theme(legend.position = "right")

visualize y variable: bd load

log transformed will get me closer to normal, so we will use that in the models! Note we only need to worry about the normality of *MODEL RESIDUALS* though which will be analyzed later on, so commented out the transformation and exploration of the data for space, feel free to uncomment and explore on your own though!

# # untransformed  
# ggqqplot(pw\_noday0, "adh\_plus\_sup", title = "untransformed")  
# shapiro.test(pw\_noday0$adh\_plus\_sup) # nope  
# hist(pw\_noday0$adh\_plus\_sup) # note  
#   
# # sqrt  
# hist(sqrt(pw\_noday0$adh\_plus\_sup)) # nope  
#   
# # log 10  
# hist(log10(pw\_noday0$adh\_plus\_sup)) # much better...?  
# shapiro.test(log10(pw\_noday0$adh\_plus\_sup)) # closer  
#   
# # log transformed  
# ggqqplot(pw\_noday0, "log\_adh\_plus\_sup", title = "log transformed") # gorgeous  
# hist(pw\_noday0$log\_adh\_plus\_sup) # better  
# shapiro.test(pw\_noday0$log\_adh\_plus\_sup) # p-value = 0.01361, does not pass shapiro, but this has an n of 72 which is more than the recommended <50 samples  
  
# visualize comparisons  
# TB y or n  
# pw\_noday0 %>%   
# ggplot(aes(x = TB,   
# y = log\_adh\_plus\_sup)) +  
# geom\_boxplot()  
# # water\_treat  
# pw\_noday0 %>%   
# ggplot(aes(x = water\_treatment,   
# y = log\_adh\_plus\_sup)) +  
# geom\_boxplot()  
# # day  
# pw\_noday0 %>%   
# ggplot(aes(x = day,   
# y = log\_adh\_plus\_sup)) +  
# geom\_boxplot()

## SBNCOS Assumption testing: ANOVA

Most appropriate comparison for study design: day\*microbes\*water\_treatment

* y variable: amount of Bd
* x vars: day, TB y/n, water\_treatment (pw with microbes, pw without, sterile water)

Question: Does the amount of Bd in the sample differ across the treatments of presence of water type (pw with microbes, pw without, sterile water), TB, and day?

Model: 3-way anova

## null model

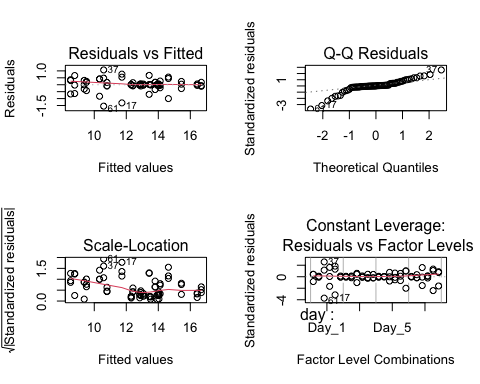
null <- lm(log\_adh\_plus\_sup ~ 1,  
 data = pw\_noday0)  
AIC(null) #326.4356, this is higher than the

[1] 326.4356

## ANOVA with interactions: Bd ~ day\*TB\*water\_treatment

Note: this ANOVA does not have perfectly normally distributed residuals, but it is the best tool we have to answer our question. A Kruskall Wallace isn’t the best move here because we aim to analyze interactions, if I cut the interactions, a non-interaction anova does have the perfect residuals, so no need for a KW at all!

# create the model  
aov\_sbncos <- aov(log\_adh\_plus\_sup ~ day\*TB\*water\_treatment,  
 data = pw\_noday0)  
  
# diagnostic plot  
par(mfrow = c(2,2))  
plot(aov\_sbncos) # diagnostic plot



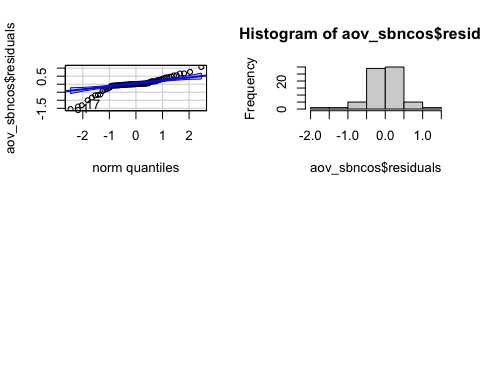
AIC(aov\_sbncos) # better than null 127.7922!

[1] 127.7922

# make qqplot to look at normality of residuals in car package with 95% CI  
qqPlot(aov\_sbncos$residuals) # not ideal

[1] 61 17

hist(aov\_sbncos$residuals) # but this looks great!!  
  
# tried a sqrt transformed, did not work!   
# mod5 <- aov(sqrt(adh\_plus\_sup) ~ day\*TB\*water\_treatment,  
# data = pw\_noday0)  
#   
# # diagnostic plot  
# par(mfrow = c(2,2))  
# plot(mod5) # NOT normal...  
# AIC(mod5) # horrible 968.6406  
#   
# # make qq in car with 95% CI  
# qqPlot(mod5$residuals)



## anova results

# interpret results  
summary(aov\_sbncos)

Df Sum Sq Mean Sq F value Pr(>F)   
day 3 35.40 11.80 45.608 4.31e-14 \*\*\*  
TB 1 20.99 20.99 81.127 6.92e-12 \*\*\*  
water\_treatment 2 228.85 114.42 442.251 < 2e-16 \*\*\*  
day:TB 3 11.71 3.90 15.084 4.78e-07 \*\*\*  
day:water\_treatment 6 37.33 6.22 24.047 6.45e-13 \*\*\*  
TB:water\_treatment 2 0.06 0.03 0.109 0.897   
day:TB:water\_treatment 6 24.57 4.09 15.825 6.30e-10 \*\*\*  
Residuals 48 12.42 0.26   
---  
Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

### post hoc

Using a Tukey test on the anova model

# post hoc  
TukeyHSD(aov\_sbncos)

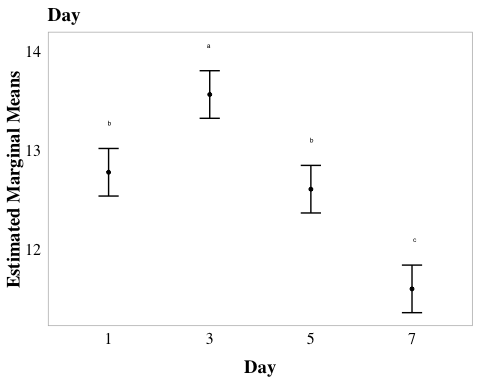
Tukey multiple comparisons of means  
 95% family-wise confidence level  
  
Fit: aov(formula = log\_adh\_plus\_sup ~ day \* TB \* water\_treatment, data = pw\_noday0)  
  
$day  
 diff lwr upr p adj  
Day\_3-Day\_1 0.7878386 0.3365970 1.2390802 0.0001521  
Day\_5-Day\_1 -0.1715069 -0.6227485 0.2797347 0.7434984  
Day\_7-Day\_1 -1.1817503 -1.6329919 -0.7305087 0.0000000  
Day\_5-Day\_3 -0.9593455 -1.4105871 -0.5081039 0.0000049  
Day\_7-Day\_3 -1.9695889 -2.4208305 -1.5183474 0.0000000  
Day\_7-Day\_5 -1.0102434 -1.4614850 -0.5590018 0.0000017  
  
$TB  
 diff lwr upr p adj  
y-n 1.079872 0.8388136 1.32093 0  
  
$water\_treatment  
 diff lwr upr p adj  
PW-MO-sterile-water 0.340284 -0.01483837 0.6954063 0.0629087  
PW+MO-sterile-water -3.600293 -3.95541555 -3.2451709 0.0000000  
PW+MO-PW-MO -3.940577 -4.29569952 -3.5854549 0.0000000  
  
$`day:TB`  
 diff lwr upr p adj  
Day\_3:n-Day\_1:n -0.31984147 -1.07954248 0.43985955 0.8811923  
Day\_5:n-Day\_1:n -0.89827967 -1.65798069 -0.13857865 0.0104952  
Day\_7:n-Day\_1:n -1.64257839 -2.40227940 -0.88287737 0.0000003  
Day\_1:y-Day\_1:n -0.06776878 -0.82746980 0.69193223 0.9999917  
Day\_3:y-Day\_1:n 1.82774990 1.06804888 2.58745091 0.0000000  
Day\_5:y-Day\_1:n 0.48749705 -0.27220396 1.24719807 0.4714340  
Day\_7:y-Day\_1:n -0.78869107 -1.54839209 -0.02899005 0.0367370  
Day\_5:n-Day\_3:n -0.57843820 -1.33813922 0.18126282 0.2589734  
Day\_7:n-Day\_3:n -1.32273692 -2.08243794 -0.56303590 0.0000356  
Day\_1:y-Day\_3:n 0.25207268 -0.50762833 1.01177370 0.9635870  
Day\_3:y-Day\_3:n 2.14759136 1.38789035 2.90729238 0.0000000  
Day\_5:y-Day\_3:n 0.80733852 0.04763750 1.56703954 0.0299644  
Day\_7:y-Day\_3:n -0.46884960 -1.22855062 0.29085141 0.5214920  
Day\_7:n-Day\_5:n -0.74429872 -1.50399974 0.01540230 0.0586353  
Day\_1:y-Day\_5:n 0.83051089 0.07080987 1.59021190 0.0231296  
Day\_3:y-Day\_5:n 2.72602956 1.96632855 3.48573058 0.0000000  
Day\_5:y-Day\_5:n 1.38577672 0.62607571 2.14547774 0.0000144  
Day\_7:y-Day\_5:n 0.10958860 -0.65011242 0.86928962 0.9997851  
Day\_1:y-Day\_7:n 1.57480960 0.81510859 2.33451062 0.0000009  
Day\_3:y-Day\_7:n 3.47032828 2.71062727 4.23002930 0.0000000  
Day\_5:y-Day\_7:n 2.13007544 1.37037442 2.88977646 0.0000000  
Day\_7:y-Day\_7:n 0.85388732 0.09418630 1.61358833 0.0177057  
Day\_3:y-Day\_1:y 1.89551868 1.13581766 2.65521970 0.0000000  
Day\_5:y-Day\_1:y 0.55526584 -0.20443518 1.31496685 0.3066017  
Day\_7:y-Day\_1:y -0.72092229 -1.48062330 0.03877873 0.0742107  
Day\_5:y-Day\_3:y -1.34025284 -2.09995386 -0.58055182 0.0000277  
Day\_7:y-Day\_3:y -2.61644097 -3.37614198 -1.85673995 0.0000000  
Day\_7:y-Day\_5:y -1.27618812 -2.03588914 -0.51648711 0.0000691  
  
$`day:water\_treatment`  
 diff lwr upr  
Day\_3:sterile-water-Day\_1:sterile-water 1.56409952 0.55570514 2.572493908  
Day\_5:sterile-water-Day\_1:sterile-water -0.13666277 -1.14505716 0.871731612  
Day\_7:sterile-water-Day\_1:sterile-water -1.00670881 -2.01510319 0.001685579  
Day\_1:PW-MO-Day\_1:sterile-water -0.73277523 -1.74116961 0.275619158  
Day\_3:PW-MO-Day\_1:sterile-water 1.74122159 0.73282720 2.749615972  
Day\_5:PW-MO-Day\_1:sterile-water 0.86539619 -0.14299819 1.873790576  
Day\_7:PW-MO-Day\_1:sterile-water -0.09197876 -1.10037314 0.916415625  
Day\_1:PW+MO-Day\_1:sterile-water -1.78762409 -2.79601848 -0.779229708  
Day\_3:PW+MO-Day\_1:sterile-water -3.46220461 -4.47059900 -2.453810227  
Day\_5:PW+MO-Day\_1:sterile-water -3.76365348 -4.77204787 -2.755259100  
Day\_7:PW+MO-Day\_1:sterile-water -4.96696276 -5.97535715 -3.958568379  
Day\_5:sterile-water-Day\_3:sterile-water -1.70076230 -2.70915668 -0.692367913  
Day\_7:sterile-water-Day\_3:sterile-water -2.57080833 -3.57920271 -1.562413946  
Day\_1:PW-MO-Day\_3:sterile-water -2.29687475 -3.30526913 -1.288480366  
Day\_3:PW-MO-Day\_3:sterile-water 0.17712206 -0.83127232 1.185516448  
Day\_5:PW-MO-Day\_3:sterile-water -0.69870333 -1.70709772 0.309691052  
Day\_7:PW-MO-Day\_3:sterile-water -1.65607828 -2.66447267 -0.647683900  
Day\_1:PW+MO-Day\_3:sterile-water -3.35172362 -4.36011800 -2.343329232  
Day\_3:PW+MO-Day\_3:sterile-water -5.02630414 -6.03469852 -4.017909751  
Day\_5:PW+MO-Day\_3:sterile-water -5.32775301 -6.33614739 -4.319358624  
Day\_7:PW+MO-Day\_3:sterile-water -6.53106229 -7.53945667 -5.522667903  
Day\_7:sterile-water-Day\_5:sterile-water -0.87004603 -1.87844042 0.138348351  
Day\_1:PW-MO-Day\_5:sterile-water -0.59611245 -1.60450684 0.412281930  
Day\_3:PW-MO-Day\_5:sterile-water 1.87788436 0.86948998 2.886278745  
Day\_5:PW-MO-Day\_5:sterile-water 1.00205896 -0.00633542 2.010453348  
Day\_7:PW-MO-Day\_5:sterile-water 0.04468401 -0.96371037 1.053078397  
Day\_1:PW+MO-Day\_5:sterile-water -1.65096132 -2.65935570 -0.642566935  
Day\_3:PW+MO-Day\_5:sterile-water -3.32554184 -4.33393622 -2.317147455  
Day\_5:PW+MO-Day\_5:sterile-water -3.62699071 -4.63538510 -2.618596327  
Day\_7:PW+MO-Day\_5:sterile-water -4.83029999 -5.83869437 -3.821905606  
Day\_1:PW-MO-Day\_7:sterile-water 0.27393358 -0.73446080 1.282327963  
Day\_3:PW-MO-Day\_7:sterile-water 2.74793039 1.73953601 3.756324778  
Day\_5:PW-MO-Day\_7:sterile-water 1.87210500 0.86371061 2.880499381  
Day\_7:PW-MO-Day\_7:sterile-water 0.91473005 -0.09366434 1.923124430  
Day\_1:PW+MO-Day\_7:sterile-water -0.78091529 -1.78930967 0.227479098  
Day\_3:PW+MO-Day\_7:sterile-water -2.45549581 -3.46389019 -1.447101422  
Day\_5:PW+MO-Day\_7:sterile-water -2.75694468 -3.76533906 -1.748550294  
Day\_7:PW+MO-Day\_7:sterile-water -3.96025396 -4.96864834 -2.951859573  
Day\_3:PW-MO-Day\_1:PW-MO 2.47399681 1.46560243 3.482391198  
Day\_5:PW-MO-Day\_1:PW-MO 1.59817142 0.58977703 2.606565802  
Day\_7:PW-MO-Day\_1:PW-MO 0.64079647 -0.36759792 1.649190851  
Day\_1:PW+MO-Day\_1:PW-MO -1.05484887 -2.06324325 -0.046454482  
Day\_3:PW+MO-Day\_1:PW-MO -2.72942939 -3.73782377 -1.721035001  
Day\_5:PW+MO-Day\_1:PW-MO -3.03087826 -4.03927264 -2.022483874  
Day\_7:PW+MO-Day\_1:PW-MO -4.23418754 -5.24258192 -3.225793153  
Day\_5:PW-MO-Day\_3:PW-MO -0.87582540 -1.88421978 0.132568987  
Day\_7:PW-MO-Day\_3:PW-MO -1.83320035 -2.84159473 -0.824805964  
Day\_1:PW+MO-Day\_3:PW-MO -3.52884568 -4.53724006 -2.520451296  
Day\_3:PW+MO-Day\_3:PW-MO -5.20342620 -6.21182058 -4.195031816  
Day\_5:PW+MO-Day\_3:PW-MO -5.50487507 -6.51326946 -4.496480688  
Day\_7:PW+MO-Day\_3:PW-MO -6.70818435 -7.71657874 -5.699789967  
Day\_7:PW-MO-Day\_5:PW-MO -0.95737495 -1.96576934 0.051019433  
Day\_1:PW+MO-Day\_5:PW-MO -2.65302028 -3.66141467 -1.644625900  
Day\_3:PW+MO-Day\_5:PW-MO -4.32760080 -5.33599519 -3.319206419  
Day\_5:PW+MO-Day\_5:PW-MO -4.62904968 -5.63744406 -3.620655292  
Day\_7:PW+MO-Day\_5:PW-MO -5.83235895 -6.84075334 -4.823964571  
Day\_1:PW+MO-Day\_7:PW-MO -1.69564533 -2.70403972 -0.687250948  
Day\_3:PW+MO-Day\_7:PW-MO -3.37022585 -4.37862024 -2.361831468  
Day\_5:PW+MO-Day\_7:PW-MO -3.67167472 -4.68006911 -2.663280340  
Day\_7:PW+MO-Day\_7:PW-MO -4.87498400 -5.88337839 -3.866589619  
Day\_3:PW+MO-Day\_1:PW+MO -1.67458052 -2.68297490 -0.666186136  
Day\_5:PW+MO-Day\_1:PW+MO -1.97602939 -2.98442378 -0.967635008  
Day\_7:PW+MO-Day\_1:PW+MO -3.17933867 -4.18773306 -2.170944287  
Day\_5:PW+MO-Day\_3:PW+MO -0.30144887 -1.30984326 0.706945511  
Day\_7:PW+MO-Day\_3:PW+MO -1.50475815 -2.51315254 -0.496363768  
Day\_7:PW+MO-Day\_5:PW+MO -1.20330928 -2.21170366 -0.194914895  
 p adj  
Day\_3:sterile-water-Day\_1:sterile-water 0.0001540  
Day\_5:sterile-water-Day\_1:sterile-water 0.9999983  
Day\_7:sterile-water-Day\_1:sterile-water 0.0507394  
Day\_1:PW-MO-Day\_1:sterile-water 0.3673389  
Day\_3:PW-MO-Day\_1:sterile-water 0.0000195  
Day\_5:PW-MO-Day\_1:sterile-water 0.1573217  
Day\_7:PW-MO-Day\_1:sterile-water 1.0000000  
Day\_1:PW+MO-Day\_1:sterile-water 0.0000113  
Day\_3:PW+MO-Day\_1:sterile-water 0.0000000  
Day\_5:PW+MO-Day\_1:sterile-water 0.0000000  
Day\_7:PW+MO-Day\_1:sterile-water 0.0000000  
Day\_5:sterile-water-Day\_3:sterile-water 0.0000315  
Day\_7:sterile-water-Day\_3:sterile-water 0.0000000  
Day\_1:PW-MO-Day\_3:sterile-water 0.0000000  
Day\_3:PW-MO-Day\_3:sterile-water 0.9999751  
Day\_5:PW-MO-Day\_3:sterile-water 0.4388765  
Day\_7:PW-MO-Day\_3:sterile-water 0.0000531  
Day\_1:PW+MO-Day\_3:sterile-water 0.0000000  
Day\_3:PW+MO-Day\_3:sterile-water 0.0000000  
Day\_5:PW+MO-Day\_3:sterile-water 0.0000000  
Day\_7:PW+MO-Day\_3:sterile-water 0.0000000  
Day\_7:sterile-water-Day\_5:sterile-water 0.1520910  
Day\_1:PW-MO-Day\_5:sterile-water 0.6716810  
Day\_3:PW-MO-Day\_5:sterile-water 0.0000039  
Day\_5:PW-MO-Day\_5:sterile-water 0.0528293  
Day\_7:PW-MO-Day\_5:sterile-water 1.0000000  
Day\_1:PW+MO-Day\_5:sterile-water 0.0000563  
Day\_3:PW+MO-Day\_5:sterile-water 0.0000000  
Day\_5:PW+MO-Day\_5:sterile-water 0.0000000  
Day\_7:PW+MO-Day\_5:sterile-water 0.0000000  
Day\_1:PW-MO-Day\_7:sterile-water 0.9983727  
Day\_3:PW-MO-Day\_7:sterile-water 0.0000000  
Day\_5:PW-MO-Day\_7:sterile-water 0.0000041  
Day\_7:PW-MO-Day\_7:sterile-water 0.1085209  
Day\_1:PW+MO-Day\_7:sterile-water 0.2775082  
Day\_3:PW+MO-Day\_7:sterile-water 0.0000000  
Day\_5:PW+MO-Day\_7:sterile-water 0.0000000  
Day\_7:PW+MO-Day\_7:sterile-water 0.0000000  
Day\_3:PW-MO-Day\_1:PW-MO 0.0000000  
Day\_5:PW-MO-Day\_1:PW-MO 0.0001040  
Day\_7:PW-MO-Day\_1:PW-MO 0.5697876  
Day\_1:PW+MO-Day\_1:PW-MO 0.0330451  
Day\_3:PW+MO-Day\_1:PW-MO 0.0000000  
Day\_5:PW+MO-Day\_1:PW-MO 0.0000000  
Day\_7:PW+MO-Day\_1:PW-MO 0.0000000  
Day\_5:PW-MO-Day\_3:PW-MO 0.1457799  
Day\_7:PW-MO-Day\_3:PW-MO 0.0000066  
Day\_1:PW+MO-Day\_3:PW-MO 0.0000000  
Day\_3:PW+MO-Day\_3:PW-MO 0.0000000  
Day\_5:PW+MO-Day\_3:PW-MO 0.0000000  
Day\_7:PW+MO-Day\_3:PW-MO 0.0000000  
Day\_7:PW-MO-Day\_5:PW-MO 0.0770752  
Day\_1:PW+MO-Day\_5:PW-MO 0.0000000  
Day\_3:PW+MO-Day\_5:PW-MO 0.0000000  
Day\_5:PW+MO-Day\_5:PW-MO 0.0000000  
Day\_7:PW+MO-Day\_5:PW-MO 0.0000000  
Day\_1:PW+MO-Day\_7:PW-MO 0.0000334  
Day\_3:PW+MO-Day\_7:PW-MO 0.0000000  
Day\_5:PW+MO-Day\_7:PW-MO 0.0000000  
Day\_7:PW+MO-Day\_7:PW-MO 0.0000000  
Day\_3:PW+MO-Day\_1:PW+MO 0.0000428  
Day\_5:PW+MO-Day\_1:PW+MO 0.0000012  
Day\_7:PW+MO-Day\_1:PW+MO 0.0000000  
Day\_5:PW+MO-Day\_3:PW+MO 0.9962387  
Day\_7:PW+MO-Day\_3:PW+MO 0.0003034  
Day\_7:PW+MO-Day\_5:PW+MO 0.0078960  
  
$`TB:water\_treatment`  
 diff lwr upr p adj  
y:sterile-water-n:sterile-water 1.0008405 0.3845328 1.6171483 0.0002063  
n:PW-MO-n:sterile-water 0.2793426 -0.3369651 0.8956503 0.7585152  
y:PW-MO-n:sterile-water 1.4020658 0.7857581 2.0183736 0.0000003  
n:PW+MO-n:sterile-water -3.6578986 -4.2742063 -3.0415908 0.0000000  
y:PW+MO-n:sterile-water -2.5418473 -3.1581551 -1.9255396 0.0000000  
n:PW-MO-y:sterile-water -0.7214979 -1.3378056 -0.1051902 0.0131854  
y:PW-MO-y:sterile-water 0.4012253 -0.2150824 1.0175330 0.3958413  
n:PW+MO-y:sterile-water -4.6587391 -5.2750468 -4.0424314 0.0000000  
y:PW+MO-y:sterile-water -3.5426879 -4.1589956 -2.9263802 0.0000000  
y:PW-MO-n:PW-MO 1.1227232 0.5064155 1.7390309 0.0000284  
n:PW+MO-n:PW-MO -3.9372412 -4.5535489 -3.3209335 0.0000000  
y:PW+MO-n:PW-MO -2.8211900 -3.4374977 -2.2048822 0.0000000  
n:PW+MO-y:PW-MO -5.0599644 -5.6762721 -4.4436567 0.0000000  
y:PW+MO-y:PW-MO -3.9439132 -4.5602209 -3.3276055 0.0000000  
y:PW+MO-n:PW+MO 1.1160512 0.4997435 1.7323589 0.0000317  
  
$`day:TB:water\_treatment`  
 diff lwr upr  
Day\_3:n:sterile-water-Day\_1:n:sterile-water 0.12748302 -1.47333045 1.72829649  
Day\_5:n:sterile-water-Day\_1:n:sterile-water -0.95922474 -2.56003820 0.64158873  
Day\_7:n:sterile-water-Day\_1:n:sterile-water -1.49396778 -3.09478124 0.10684569  
Day\_1:y:sterile-water-Day\_1:n:sterile-water -0.37237819 -1.97319165 1.22843528  
Day\_3:y:sterile-water-Day\_1:n:sterile-water 2.62833784 1.02752437 4.22915131  
Day\_5:y:sterile-water-Day\_1:n:sterile-water 0.31352101 -1.28729246 1.91433447  
Day\_7:y:sterile-water-Day\_1:n:sterile-water -0.89182802 -2.49264149 0.70898545  
Day\_1:n:PW-MO-Day\_1:n:sterile-water 0.23735219 -1.36346128 1.83816566  
Day\_3:n:PW-MO-Day\_1:n:sterile-water 0.22486268 -1.37595078 1.82567615  
Day\_5:n:PW-MO-Day\_1:n:sterile-water -0.28368820 -1.88450167 1.31712526  
Day\_7:n:PW-MO-Day\_1:n:sterile-water -1.38686565 -2.98767912 0.21394782  
Day\_1:y:PW-MO-Day\_1:n:sterile-water -2.07528082 -3.67609429 -0.47446736  
Day\_3:y:PW-MO-Day\_1:n:sterile-water 2.88520231 1.28438884 4.48601578  
Day\_5:y:PW-MO-Day\_1:n:sterile-water 1.64210240 0.04128893 3.24291587  
Day\_7:y:PW-MO-Day\_1:n:sterile-water 0.83052995 -0.77028352 2.43134342  
Day\_1:n:PW+MO-Day\_1:n:sterile-water -3.21466561 -4.81547908 -1.61385214  
Day\_3:n:PW+MO-Day\_1:n:sterile-water -4.28918353 -5.88999699 -2.68837006  
Day\_5:n:PW+MO-Day\_1:n:sterile-water -4.42923949 -6.03005295 -2.82842602  
Day\_7:n:PW+MO-Day\_1:n:sterile-water -5.02421515 -6.62502862 -3.42340168  
Day\_1:y:PW+MO-Day\_1:n:sterile-water -0.73296076 -2.33377423 0.86785271  
Day\_3:y:PW+MO-Day\_1:n:sterile-water -3.00760388 -4.60841735 -1.40679041  
Day\_5:y:PW+MO-Day\_1:n:sterile-water -3.47044567 -5.07125913 -1.86963220  
Day\_7:y:PW+MO-Day\_1:n:sterile-water -5.28208856 -6.88290203 -3.68127509  
Day\_5:n:sterile-water-Day\_3:n:sterile-water -1.08670776 -2.68752123 0.51410571  
Day\_7:n:sterile-water-Day\_3:n:sterile-water -1.62145080 -3.22226426 -0.02063733  
Day\_1:y:sterile-water-Day\_3:n:sterile-water -0.49986121 -2.10067467 1.10095226  
Day\_3:y:sterile-water-Day\_3:n:sterile-water 2.50085482 0.90004135 4.10166829  
Day\_5:y:sterile-water-Day\_3:n:sterile-water 0.18603799 -1.41477548 1.78685145  
Day\_7:y:sterile-water-Day\_3:n:sterile-water -1.01931104 -2.62012451 0.58150243  
Day\_1:n:PW-MO-Day\_3:n:sterile-water 0.10986917 -1.49094430 1.71068263  
Day\_3:n:PW-MO-Day\_3:n:sterile-water 0.09737966 -1.50343381 1.69819313  
Day\_5:n:PW-MO-Day\_3:n:sterile-water -0.41117123 -2.01198469 1.18964224  
Day\_7:n:PW-MO-Day\_3:n:sterile-water -1.51434867 -3.11516214 0.08646479  
Day\_1:y:PW-MO-Day\_3:n:sterile-water -2.20276385 -3.80357731 -0.60195038  
Day\_3:y:PW-MO-Day\_3:n:sterile-water 2.75771929 1.15690582 4.35853275  
Day\_5:y:PW-MO-Day\_3:n:sterile-water 1.51461938 -0.08619409 3.11543285  
Day\_7:y:PW-MO-Day\_3:n:sterile-water 0.70304693 -0.89776654 2.30386040  
Day\_1:n:PW+MO-Day\_3:n:sterile-water -3.34214863 -4.94296210 -1.74133516  
Day\_3:n:PW+MO-Day\_3:n:sterile-water -4.41666655 -6.01748001 -2.81585308  
Day\_5:n:PW+MO-Day\_3:n:sterile-water -4.55672251 -6.15753597 -2.95590904  
Day\_7:n:PW+MO-Day\_3:n:sterile-water -5.15169817 -6.75251164 -3.55088470  
Day\_1:y:PW+MO-Day\_3:n:sterile-water -0.86044378 -2.46125725 0.74036969  
Day\_3:y:PW+MO-Day\_3:n:sterile-water -3.13508690 -4.73590037 -1.53427344  
Day\_5:y:PW+MO-Day\_3:n:sterile-water -3.59792869 -5.19874216 -1.99711522  
Day\_7:y:PW+MO-Day\_3:n:sterile-water -5.40957158 -7.01038505 -3.80875811  
Day\_7:n:sterile-water-Day\_5:n:sterile-water -0.53474304 -2.13555651 1.06607043  
Day\_1:y:sterile-water-Day\_5:n:sterile-water 0.58684655 -1.01396692 2.18766002  
Day\_3:y:sterile-water-Day\_5:n:sterile-water 3.58756258 1.98674911 5.18837605  
Day\_5:y:sterile-water-Day\_5:n:sterile-water 1.27274574 -0.32806772 2.87355921  
Day\_7:y:sterile-water-Day\_5:n:sterile-water 0.06739672 -1.53341675 1.66821018  
Day\_1:n:PW-MO-Day\_5:n:sterile-water 1.19657692 -0.40423654 2.79739039  
Day\_3:n:PW-MO-Day\_5:n:sterile-water 1.18408742 -0.41672605 2.78490089  
Day\_5:n:PW-MO-Day\_5:n:sterile-water 0.67553653 -0.92527694 2.27635000  
Day\_7:n:PW-MO-Day\_5:n:sterile-water -0.42764092 -2.02845438 1.17317255  
Day\_1:y:PW-MO-Day\_5:n:sterile-water -1.11605609 -2.71686956 0.48475738  
Day\_3:y:PW-MO-Day\_5:n:sterile-water 3.84442704 2.24361358 5.44524051  
Day\_5:y:PW-MO-Day\_5:n:sterile-water 2.60132714 1.00051367 4.20214061  
Day\_7:y:PW-MO-Day\_5:n:sterile-water 1.78975469 0.18894122 3.39056815  
Day\_1:n:PW+MO-Day\_5:n:sterile-water -2.25544087 -3.85625434 -0.65462740  
Day\_3:n:PW+MO-Day\_5:n:sterile-water -3.32995879 -4.93077226 -1.72914532  
Day\_5:n:PW+MO-Day\_5:n:sterile-water -3.47001475 -5.07082822 -1.86920128  
Day\_7:n:PW+MO-Day\_5:n:sterile-water -4.06499041 -5.66580388 -2.46417695  
Day\_1:y:PW+MO-Day\_5:n:sterile-water 0.22626398 -1.37454949 1.82707744  
Day\_3:y:PW+MO-Day\_5:n:sterile-water -2.04837915 -3.64919261 -0.44756568  
Day\_5:y:PW+MO-Day\_5:n:sterile-water -2.51122093 -4.11203440 -0.91040746  
Day\_7:y:PW+MO-Day\_5:n:sterile-water -4.32286382 -5.92367729 -2.72205035  
Day\_1:y:sterile-water-Day\_7:n:sterile-water 1.12158959 -0.47922388 2.72240306  
Day\_3:y:sterile-water-Day\_7:n:sterile-water 4.12230562 2.52149215 5.72311909  
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Day\_7:y:sterile-water-Day\_7:n:sterile-water 0.60213976 -0.99867371 2.20295322  
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Day\_5:y:PW+MO-Day\_7:n:PW+MO 1.55376948 -0.04704398 3.15458295  
Day\_7:y:PW+MO-Day\_7:n:PW+MO -0.25787341 -1.85868688 1.34294006  
Day\_3:y:PW+MO-Day\_1:y:PW+MO -2.27464312 -3.87545659 -0.67382965  
Day\_5:y:PW+MO-Day\_1:y:PW+MO -2.73748491 -4.33829837 -1.13667144  
Day\_7:y:PW+MO-Day\_1:y:PW+MO -4.54912780 -6.14994127 -2.94831433  
Day\_5:y:PW+MO-Day\_3:y:PW+MO -0.46284179 -2.06365525 1.13797168  
Day\_7:y:PW+MO-Day\_3:y:PW+MO -2.27448468 -3.87529815 -0.67367121  
Day\_7:y:PW+MO-Day\_5:y:PW+MO -1.81164289 -3.41245636 -0.21082942  
 p adj  
Day\_3:n:sterile-water-Day\_1:n:sterile-water 1.0000000  
Day\_5:n:sterile-water-Day\_1:n:sterile-water 0.7919930  
Day\_7:n:sterile-water-Day\_1:n:sterile-water 0.0956261  
Day\_1:y:sterile-water-Day\_1:n:sterile-water 0.9999993  
Day\_3:y:sterile-water-Day\_1:n:sterile-water 0.0000192  
Day\_5:y:sterile-water-Day\_1:n:sterile-water 1.0000000  
Day\_7:y:sterile-water-Day\_1:n:sterile-water 0.8753436  
Day\_1:n:PW-MO-Day\_1:n:sterile-water 1.0000000  
Day\_3:n:PW-MO-Day\_1:n:sterile-water 1.0000000  
Day\_5:n:PW-MO-Day\_1:n:sterile-water 1.0000000  
Day\_7:n:PW-MO-Day\_1:n:sterile-water 0.1723490  
Day\_1:y:PW-MO-Day\_1:n:sterile-water 0.0016944  
Day\_3:y:PW-MO-Day\_1:n:sterile-water 0.0000022  
Day\_5:y:PW-MO-Day\_1:n:sterile-water 0.0383727  
Day\_7:y:PW-MO-Day\_1:n:sterile-water 0.9304923  
Day\_1:n:PW+MO-Day\_1:n:sterile-water 0.0000001  
Day\_3:n:PW+MO-Day\_1:n:sterile-water 0.0000000  
Day\_5:n:PW+MO-Day\_1:n:sterile-water 0.0000000  
Day\_7:n:PW+MO-Day\_1:n:sterile-water 0.0000000  
Day\_1:y:PW+MO-Day\_1:n:sterile-water 0.9795458  
Day\_3:y:PW+MO-Day\_1:n:sterile-water 0.0000008  
Day\_5:y:PW+MO-Day\_1:n:sterile-water 0.0000000  
Day\_7:y:PW+MO-Day\_1:n:sterile-water 0.0000000  
Day\_5:n:sterile-water-Day\_3:n:sterile-water 0.5893047  
Day\_7:n:sterile-water-Day\_3:n:sterile-water 0.0438443  
Day\_1:y:sterile-water-Day\_3:n:sterile-water 0.9998839  
Day\_3:y:sterile-water-Day\_3:n:sterile-water 0.0000552  
Day\_5:y:sterile-water-Day\_3:n:sterile-water 1.0000000  
Day\_7:y:sterile-water-Day\_3:n:sterile-water 0.7013754  
Day\_1:n:PW-MO-Day\_3:n:sterile-water 1.0000000  
Day\_3:n:PW-MO-Day\_3:n:sterile-water 1.0000000  
Day\_5:n:PW-MO-Day\_3:n:sterile-water 0.9999958  
Day\_7:n:PW-MO-Day\_3:n:sterile-water 0.0848700  
Day\_1:y:PW-MO-Day\_3:n:sterile-water 0.0006225  
Day\_3:y:PW-MO-Day\_3:n:sterile-water 0.0000065  
Day\_5:y:PW-MO-Day\_3:n:sterile-water 0.0847344  
Day\_7:y:PW-MO-Day\_3:n:sterile-water 0.9871203  
Day\_1:n:PW+MO-Day\_3:n:sterile-water 0.0000000  
Day\_3:n:PW+MO-Day\_3:n:sterile-water 0.0000000  
Day\_5:n:PW+MO-Day\_3:n:sterile-water 0.0000000  
Day\_7:n:PW+MO-Day\_3:n:sterile-water 0.0000000  
Day\_1:y:PW+MO-Day\_3:n:sterile-water 0.9061180  
Day\_3:y:PW+MO-Day\_3:n:sterile-water 0.0000003  
Day\_5:y:PW+MO-Day\_3:n:sterile-water 0.0000000  
Day\_7:y:PW+MO-Day\_3:n:sterile-water 0.0000000  
Day\_7:n:sterile-water-Day\_5:n:sterile-water 0.9996681  
Day\_1:y:sterile-water-Day\_5:n:sterile-water 0.9987106  
Day\_3:y:sterile-water-Day\_5:n:sterile-water 0.0000000  
Day\_5:y:sterile-water-Day\_5:n:sterile-water 0.2981239  
Day\_7:y:sterile-water-Day\_5:n:sterile-water 1.0000000  
Day\_1:n:PW-MO-Day\_5:n:sterile-water 0.4077348  
Day\_3:n:PW-MO-Day\_5:n:sterile-water 0.4273429  
Day\_5:n:PW-MO-Day\_5:n:sterile-water 0.9919330  
Day\_7:n:PW-MO-Day\_5:n:sterile-water 0.9999915  
Day\_1:y:PW-MO-Day\_5:n:sterile-water 0.5394993  
Day\_3:y:PW-MO-Day\_5:n:sterile-water 0.0000000  
Day\_5:y:PW-MO-Day\_5:n:sterile-water 0.0000240  
Day\_7:y:PW-MO-Day\_5:n:sterile-water 0.0141042  
Day\_1:n:PW+MO-Day\_5:n:sterile-water 0.0004086  
Day\_3:n:PW+MO-Day\_5:n:sterile-water 0.0000001  
Day\_5:n:PW+MO-Day\_5:n:sterile-water 0.0000000  
Day\_7:n:PW+MO-Day\_5:n:sterile-water 0.0000000  
Day\_1:y:PW+MO-Day\_5:n:sterile-water 1.0000000  
Day\_3:y:PW+MO-Day\_5:n:sterile-water 0.0020854  
Day\_5:y:PW+MO-Day\_5:n:sterile-water 0.0000507  
Day\_7:y:PW+MO-Day\_5:n:sterile-water 0.0000000  
Day\_1:y:sterile-water-Day\_7:n:sterile-water 0.5301471  
Day\_3:y:sterile-water-Day\_7:n:sterile-water 0.0000000  
Day\_5:y:sterile-water-Day\_7:n:sterile-water 0.0124434  
Day\_7:y:sterile-water-Day\_7:n:sterile-water 0.9981598  
Day\_1:n:PW-MO-Day\_7:n:sterile-water 0.0211573  
Day\_3:n:PW-MO-Day\_7:n:sterile-water 0.0230377  
Day\_5:n:PW-MO-Day\_7:n:sterile-water 0.3866947  
Day\_7:n:PW-MO-Day\_7:n:sterile-water 1.0000000  
Day\_1:y:PW-MO-Day\_7:n:sterile-water 0.9988714  
Day\_3:y:PW-MO-Day\_7:n:sterile-water 0.0000000  
Day\_5:y:PW-MO-Day\_7:n:sterile-water 0.0000003  
Day\_7:y:PW-MO-Day\_7:n:sterile-water 0.0002341  
Day\_1:n:PW+MO-Day\_7:n:sterile-water 0.0227471  
Day\_3:n:PW+MO-Day\_7:n:sterile-water 0.0000048  
Day\_5:n:PW+MO-Day\_7:n:sterile-water 0.0000015  
Day\_7:n:PW+MO-Day\_7:n:sterile-water 0.0000000  
Day\_1:y:PW+MO-Day\_7:n:sterile-water 0.9696777  
Day\_3:y:PW+MO-Day\_7:n:sterile-water 0.0852279  
Day\_5:y:PW+MO-Day\_7:n:sterile-water 0.0036067  
Day\_7:y:PW+MO-Day\_7:n:sterile-water 0.0000000  
Day\_3:y:sterile-water-Day\_1:y:sterile-water 0.0000008  
Day\_5:y:sterile-water-Day\_1:y:sterile-water 0.9903299  
Day\_7:y:sterile-water-Day\_1:y:sterile-water 0.9997874  
Day\_1:n:PW-MO-Day\_1:y:sterile-water 0.9978188  
Day\_3:n:PW-MO-Day\_1:y:sterile-water 0.9983547  
Day\_5:n:PW-MO-Day\_1:y:sterile-water 1.0000000  
Day\_7:n:PW-MO-Day\_1:y:sterile-water 0.7090765  
Day\_1:y:PW-MO-Day\_1:y:sterile-water 0.0256590  
Day\_3:y:PW-MO-Day\_1:y:sterile-water 0.0000001  
Day\_5:y:PW-MO-Day\_1:y:sterile-water 0.0027036  
Day\_7:y:PW-MO-Day\_1:y:sterile-water 0.3979493  
Day\_1:n:PW+MO-Day\_1:y:sterile-water 0.0000032  
Day\_3:n:PW+MO-Day\_1:y:sterile-water 0.0000000  
Day\_5:n:PW+MO-Day\_1:y:sterile-water 0.0000000  
Day\_7:n:PW+MO-Day\_1:y:sterile-water 0.0000000  
Day\_1:y:PW+MO-Day\_1:y:sterile-water 0.9999996  
Day\_3:y:PW+MO-Day\_1:y:sterile-water 0.0000181  
Day\_5:y:PW+MO-Day\_1:y:sterile-water 0.0000004  
Day\_7:y:PW+MO-Day\_1:y:sterile-water 0.0000000  
Day\_5:y:sterile-water-Day\_3:y:sterile-water 0.0002532  
Day\_7:y:sterile-water-Day\_3:y:sterile-water 0.0000000  
Day\_1:n:PW-MO-Day\_3:y:sterile-water 0.0001362  
Day\_3:n:PW-MO-Day\_3:y:sterile-water 0.0001230  
Day\_5:n:PW-MO-Day\_3:y:sterile-water 0.0000018  
Day\_7:n:PW-MO-Day\_3:y:sterile-water 0.0000000  
Day\_1:y:PW-MO-Day\_3:y:sterile-water 0.0000000  
Day\_3:y:PW-MO-Day\_3:y:sterile-water 1.0000000  
Day\_5:y:PW-MO-Day\_3:y:sterile-water 0.7528131  
Day\_7:y:PW-MO-Day\_3:y:sterile-water 0.0133258  
Day\_1:n:PW+MO-Day\_3:y:sterile-water 0.0000000  
Day\_3:n:PW+MO-Day\_3:y:sterile-water 0.0000000  
Day\_5:n:PW+MO-Day\_3:y:sterile-water 0.0000000  
Day\_7:n:PW+MO-Day\_3:y:sterile-water 0.0000000  
Day\_1:y:PW+MO-Day\_3:y:sterile-water 0.0000000  
Day\_3:y:PW+MO-Day\_3:y:sterile-water 0.0000000  
Day\_5:y:PW+MO-Day\_3:y:sterile-water 0.0000000  
Day\_7:y:PW+MO-Day\_3:y:sterile-water 0.0000000  
Day\_7:y:sterile-water-Day\_5:y:sterile-water 0.3942057  
Day\_1:n:PW-MO-Day\_5:y:sterile-water 1.0000000  
Day\_3:n:PW-MO-Day\_5:y:sterile-water 1.0000000  
Day\_5:n:PW-MO-Day\_5:y:sterile-water 0.9983559  
Day\_7:n:PW-MO-Day\_5:y:sterile-water 0.0260973  
Day\_1:y:PW-MO-Day\_5:y:sterile-water 0.0001387  
Day\_3:y:PW-MO-Day\_5:y:sterile-water 0.0000307  
Day\_5:y:PW-MO-Day\_5:y:sterile-water 0.2305634  
Day\_7:y:PW-MO-Day\_5:y:sterile-water 0.9998024  
Day\_1:n:PW+MO-Day\_5:y:sterile-water 0.0000000  
Day\_3:n:PW+MO-Day\_5:y:sterile-water 0.0000000  
Day\_5:n:PW+MO-Day\_5:y:sterile-water 0.0000000  
Day\_7:n:PW+MO-Day\_5:y:sterile-water 0.0000000  
Day\_1:y:PW+MO-Day\_5:y:sterile-water 0.6570027  
Day\_3:y:PW+MO-Day\_5:y:sterile-water 0.0000001  
Day\_5:y:PW+MO-Day\_5:y:sterile-water 0.0000000  
Day\_7:y:PW+MO-Day\_5:y:sterile-water 0.0000000  
Day\_1:n:PW-MO-Day\_7:y:sterile-water 0.5173594  
Day\_3:n:PW-MO-Day\_7:y:sterile-water 0.5384257  
Day\_5:n:PW-MO-Day\_7:y:sterile-water 0.9978944  
Day\_7:n:PW-MO-Day\_7:y:sterile-water 0.9999006  
Day\_1:y:PW-MO-Day\_7:y:sterile-water 0.4283495  
Day\_3:y:PW-MO-Day\_7:y:sterile-water 0.0000000  
Day\_5:y:PW-MO-Day\_7:y:sterile-water 0.0000420  
Day\_7:y:PW-MO-Day\_7:y:sterile-water 0.0224915  
Day\_1:n:PW+MO-Day\_7:y:sterile-water 0.0002373  
Day\_3:n:PW+MO-Day\_7:y:sterile-water 0.0000000  
Day\_5:n:PW+MO-Day\_7:y:sterile-water 0.0000000  
Day\_7:n:PW+MO-Day\_7:y:sterile-water 0.0000000  
Day\_1:y:PW+MO-Day\_7:y:sterile-water 1.0000000  
Day\_3:y:PW+MO-Day\_7:y:sterile-water 0.0012364  
Day\_5:y:PW+MO-Day\_7:y:sterile-water 0.0000290  
Day\_7:y:PW+MO-Day\_7:y:sterile-water 0.0000000  
Day\_3:n:PW-MO-Day\_1:n:PW-MO 1.0000000  
Day\_5:n:PW-MO-Day\_1:n:PW-MO 0.9997770  
Day\_7:n:PW-MO-Day\_1:n:PW-MO 0.0430727  
Day\_1:y:PW-MO-Day\_1:n:PW-MO 0.0002577  
Day\_3:y:PW-MO-Day\_1:n:PW-MO 0.0000163  
Day\_5:y:PW-MO-Day\_1:n:PW-MO 0.1569390  
Day\_7:y:PW-MO-Day\_1:n:PW-MO 0.9985027  
Day\_1:n:PW+MO-Day\_1:n:PW-MO 0.0000000  
Day\_3:n:PW+MO-Day\_1:n:PW-MO 0.0000000  
Day\_5:n:PW+MO-Day\_1:n:PW-MO 0.0000000  
Day\_7:n:PW+MO-Day\_1:n:PW-MO 0.0000000  
Day\_1:y:PW+MO-Day\_1:n:PW-MO 0.7762575  
Day\_3:y:PW+MO-Day\_1:n:PW-MO 0.0000001  
Day\_5:y:PW+MO-Day\_1:n:PW-MO 0.0000000  
Day\_7:y:PW+MO-Day\_1:n:PW-MO 0.0000000  
Day\_5:n:PW-MO-Day\_3:n:PW-MO 0.9998474  
Day\_7:n:PW-MO-Day\_3:n:PW-MO 0.0466545  
Day\_1:y:PW-MO-Day\_3:n:PW-MO 0.0002851  
Day\_3:y:PW-MO-Day\_3:n:PW-MO 0.0000147  
Day\_5:y:PW-MO-Day\_3:n:PW-MO 0.1468313  
Day\_7:y:PW-MO-Day\_3:n:PW-MO 0.9980074  
Day\_1:n:PW+MO-Day\_3:n:PW-MO 0.0000000  
Day\_3:n:PW+MO-Day\_3:n:PW-MO 0.0000000  
Day\_5:n:PW+MO-Day\_3:n:PW-MO 0.0000000  
Day\_7:n:PW+MO-Day\_3:n:PW-MO 0.0000000  
Day\_1:y:PW+MO-Day\_3:n:PW-MO 0.7939449  
Day\_3:y:PW+MO-Day\_3:n:PW-MO 0.0000001  
Day\_5:y:PW+MO-Day\_3:n:PW-MO 0.0000000  
Day\_7:y:PW+MO-Day\_3:n:PW-MO 0.0000000  
Day\_7:n:PW-MO-Day\_5:n:PW-MO 0.5613329  
Day\_1:y:PW-MO-Day\_5:n:PW-MO 0.0139229  
Day\_3:y:PW-MO-Day\_5:n:PW-MO 0.0000002  
Day\_5:y:PW-MO-Day\_5:n:PW-MO 0.0052700  
Day\_7:y:PW-MO-Day\_5:n:PW-MO 0.5426102  
Day\_1:n:PW+MO-Day\_5:n:PW-MO 0.0000015  
Day\_3:n:PW+MO-Day\_5:n:PW-MO 0.0000000  
Day\_5:n:PW+MO-Day\_5:n:PW-MO 0.0000000  
Day\_7:n:PW+MO-Day\_5:n:PW-MO 0.0000000  
Day\_1:y:PW+MO-Day\_5:n:PW-MO 0.9999801  
Day\_3:y:PW+MO-Day\_5:n:PW-MO 0.0000086  
Day\_5:y:PW+MO-Day\_5:n:PW-MO 0.0000002  
Day\_7:y:PW+MO-Day\_5:n:PW-MO 0.0000000  
Day\_1:y:PW-MO-Day\_7:n:PW-MO 0.9899042  
Day\_3:y:PW-MO-Day\_7:n:PW-MO 0.0000000  
Day\_5:y:PW-MO-Day\_7:n:PW-MO 0.0000007  
Day\_7:y:PW-MO-Day\_7:n:PW-MO 0.0005540  
Day\_1:n:PW+MO-Day\_7:n:PW-MO 0.0107673  
Day\_3:n:PW+MO-Day\_7:n:PW-MO 0.0000019  
Day\_5:n:PW+MO-Day\_7:n:PW-MO 0.0000006  
Day\_7:n:PW+MO-Day\_7:n:PW-MO 0.0000000  
Day\_1:y:PW+MO-Day\_7:n:PW-MO 0.9945870  
Day\_3:y:PW+MO-Day\_7:n:PW-MO 0.0440450  
Day\_5:y:PW+MO-Day\_7:n:PW-MO 0.0015888  
Day\_7:y:PW+MO-Day\_7:n:PW-MO 0.0000000  
Day\_3:y:PW-MO-Day\_1:y:PW-MO 0.0000000  
Day\_5:y:PW-MO-Day\_1:y:PW-MO 0.0000000  
Day\_7:y:PW-MO-Day\_1:y:PW-MO 0.0000019  
Day\_1:n:PW+MO-Day\_1:y:PW-MO 0.5002634  
Day\_3:n:PW+MO-Day\_1:y:PW-MO 0.0005697  
Day\_5:n:PW+MO-Day\_1:y:PW-MO 0.0001843  
Day\_7:n:PW+MO-Day\_1:y:PW-MO 0.0000013  
Day\_1:y:PW+MO-Day\_1:y:PW-MO 0.2157143  
Day\_3:y:PW+MO-Day\_1:y:PW-MO 0.8279277  
Day\_5:y:PW+MO-Day\_1:y:PW-MO 0.1650591  
Day\_7:y:PW+MO-Day\_1:y:PW-MO 0.0000002  
Day\_5:y:PW-MO-Day\_3:y:PW-MO 0.3385588  
Day\_7:y:PW-MO-Day\_3:y:PW-MO 0.0019868  
Day\_1:n:PW+MO-Day\_3:y:PW-MO 0.0000000  
Day\_3:n:PW+MO-Day\_3:y:PW-MO 0.0000000  
Day\_5:n:PW+MO-Day\_3:y:PW-MO 0.0000000  
Day\_7:n:PW+MO-Day\_3:y:PW-MO 0.0000000  
Day\_1:y:PW+MO-Day\_3:y:PW-MO 0.0000000  
Day\_3:y:PW+MO-Day\_3:y:PW-MO 0.0000000  
Day\_5:y:PW+MO-Day\_3:y:PW-MO 0.0000000  
Day\_7:y:PW+MO-Day\_3:y:PW-MO 0.0000000  
Day\_7:y:PW-MO-Day\_5:y:PW-MO 0.9434968  
Day\_1:n:PW+MO-Day\_5:y:PW-MO 0.0000000  
Day\_3:n:PW+MO-Day\_5:y:PW-MO 0.0000000  
Day\_5:n:PW+MO-Day\_5:y:PW-MO 0.0000000  
Day\_7:n:PW+MO-Day\_5:y:PW-MO 0.0000000  
Day\_1:y:PW+MO-Day\_5:y:PW-MO 0.0001552  
Day\_3:y:PW+MO-Day\_5:y:PW-MO 0.0000000  
Day\_5:y:PW+MO-Day\_5:y:PW-MO 0.0000000  
Day\_7:y:PW+MO-Day\_5:y:PW-MO 0.0000000  
Day\_1:n:PW+MO-Day\_7:y:PW-MO 0.0000000  
Day\_3:n:PW+MO-Day\_7:y:PW-MO 0.0000000  
Day\_5:n:PW+MO-Day\_7:y:PW-MO 0.0000000  
Day\_7:n:PW+MO-Day\_7:y:PW-MO 0.0000000  
Day\_1:y:PW+MO-Day\_7:y:PW-MO 0.0631035  
Day\_3:y:PW+MO-Day\_7:y:PW-MO 0.0000000  
Day\_5:y:PW+MO-Day\_7:y:PW-MO 0.0000000  
Day\_7:y:PW+MO-Day\_7:y:PW-MO 0.0000000  
Day\_3:n:PW+MO-Day\_1:n:PW+MO 0.6099665  
Day\_5:n:PW+MO-Day\_1:n:PW+MO 0.3802096  
Day\_7:n:PW+MO-Day\_1:n:PW+MO 0.0122628  
Day\_1:y:PW+MO-Day\_1:n:PW+MO 0.0000647  
Day\_3:y:PW+MO-Day\_1:n:PW+MO 1.0000000  
Day\_5:y:PW+MO-Day\_1:n:PW+MO 1.0000000  
Day\_7:y:PW+MO-Day\_1:n:PW+MO 0.0018006  
Day\_5:n:PW+MO-Day\_3:n:PW+MO 1.0000000  
Day\_7:n:PW+MO-Day\_3:n:PW+MO 0.9789155  
Day\_1:y:PW+MO-Day\_3:n:PW+MO 0.0000000  
Day\_3:y:PW+MO-Day\_3:n:PW+MO 0.2866730  
Day\_5:y:PW+MO-Day\_3:n:PW+MO 0.9387984  
Day\_7:y:PW+MO-Day\_3:n:PW+MO 0.7427186  
Day\_7:n:PW+MO-Day\_5:n:PW+MO 0.9984387  
Day\_1:y:PW+MO-Day\_5:n:PW+MO 0.0000000  
Day\_3:y:PW+MO-Day\_5:n:PW+MO 0.1433988  
Day\_5:y:PW+MO-Day\_5:n:PW+MO 0.7925941  
Day\_7:y:PW+MO-Day\_5:n:PW+MO 0.9127621  
Day\_1:y:PW+MO-Day\_7:n:PW+MO 0.0000000  
Day\_3:y:PW+MO-Day\_7:n:PW+MO 0.0026601  
Day\_5:y:PW+MO-Day\_7:n:PW+MO 0.0669760  
Day\_7:y:PW+MO-Day\_7:n:PW+MO 1.0000000  
Day\_3:y:PW+MO-Day\_1:y:PW+MO 0.0003502  
Day\_5:y:PW+MO-Day\_1:y:PW+MO 0.0000077  
Day\_7:y:PW+MO-Day\_1:y:PW+MO 0.0000000  
Day\_5:y:PW+MO-Day\_3:y:PW+MO 0.9999671  
Day\_7:y:PW+MO-Day\_3:y:PW+MO 0.0003506  
Day\_7:y:PW+MO-Day\_5:y:PW+MO 0.0120819

Now let’s get this in a format to visualize this data. I will use the emmeans function to extract the estimated marginal means using a tukey adjustment, and from that, will use R to differentiate between the ones with significant differences, and show that with a compact letter display (cld) plot for each comparison type.

# emmeans and cld (compact letter display)  
  
#..............................day...............................  
  
# perform tukey pairwise comparisons across day only & et cld letters  
cld\_day <- emmeans(aov\_sbncos, pairwise ~ day, adjust = "tukey") %>%   
 # add compact letter display (cld) to group days that are not significantly different  
 cld(Letters = letters, reverse = TRUE) # reverse = TRUE ensures "a" goes to the highest mean

NOTE: Results may be misleading due to involvement in interactions

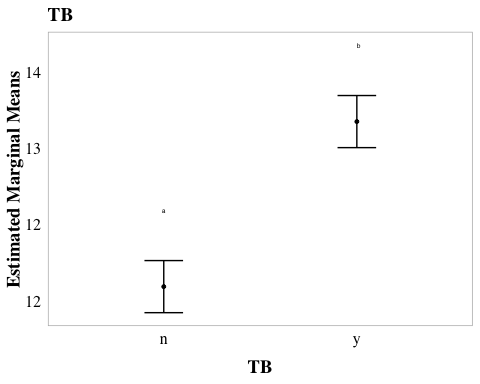
# make a plot of estimated marginal means with CLD letters for each day  
cld\_day\_2b <- ggplot(cld\_day, aes(x = day, y = emmean)) +  
 geom\_point(size = 1) + # Plot the estimated means  
 geom\_errorbar(aes(ymin = lower.CL, ymax = upper.CL), width = 0.2) + # add 95% confidence intervals  
 geom\_text(aes(label = .group), nudge\_y = 0.5, size = 1.75, color = "black") + # add cld group letters above points  
 xlab("Day") + # axis label  
 ylab("Estimated Marginal Means") + # axis label  
 scale\_y\_continuous(labels = scales::label\_number(accuracy = 1))+ # format y-axis: whole numbers onl  
 ggtitle("Day") + # panel title  
 scale\_x\_discrete(labels= c("Day\_1" = "1", "Day\_3" = "3", "Day\_5" = "5", "Day\_7" = "7")) + # clean up x-axis labels  
 myCustomTheme()+ # apply my custom theme  
 theme(axis.title.y = element\_text(margin = margin(r = 1))) # give y-axis label a little breathing room  
  
cld\_day\_2b



#..............................TB...............................  
## same as above but for another factor, see "day" example for code comments  
  
# perform tukey pairwise comparisons across TB only & get cld letters  
cld\_TB <- emmeans(aov\_sbncos, pairwise ~ TB, adjust = "tukey") %>%  
 cld(Letters = letters)

NOTE: Results may be misleading due to involvement in interactions

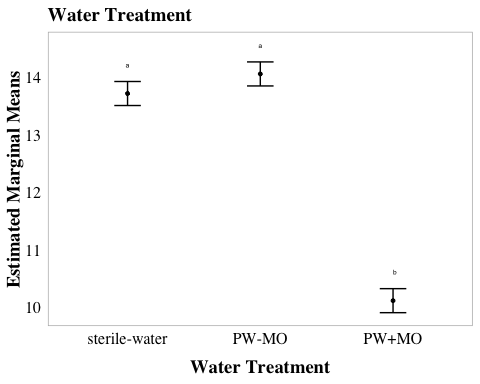
# make a plot of estimated marginal means with CLD letters for TB yes or no  
cld\_TB\_2b <- ggplot(cld\_TB, aes(x = TB, y = emmean)) +  
 geom\_point(size = 1) + # Plot the estimated means  
 geom\_errorbar(aes(ymin = lower.CL, ymax = upper.CL), width = 0.2) +   
 geom\_text(aes(label = .group), nudge\_y = 0.5, size = 1.75, color = "black") +   
 xlab("TB") +  
 ylab("Estimated Marginal Means") +  
 scale\_y\_continuous(labels = scales::label\_number(accuracy = 1))+   
 ggtitle("TB") +  
 myCustomTheme() +  
 theme(axis.title.y = element\_text(margin = margin(r = 1)))  
cld\_TB\_2b



#............................water treatment...............................  
## same as above but for another factor, see "day" example for code comments  
  
# perform tukey pairwise comparisons across TB only & get cld letters  
cld\_water\_treatment <- emmeans(aov\_sbncos, pairwise ~ water\_treatment, adjust = "tukey") %>%  
 cld(Letters = letters, reverse = TRUE)

NOTE: Results may be misleading due to involvement in interactions

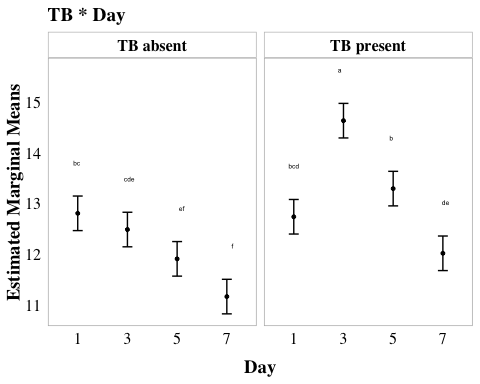
# make a plot of estimated marginal means with CLD letters  
cld\_water\_treatment\_2b <-ggplot(cld\_water\_treatment, aes(x = water\_treatment, y = emmean)) +  
 geom\_point(size = 1) + # Plot the estimated means  
 geom\_errorbar(aes(ymin = lower.CL, ymax = upper.CL), width = 0.2) +   
 geom\_text(aes(label = .group), nudge\_y = 0.5, size = 1.75, color = "black") +   
 xlab("Water Treatment") +  
 ylab("Estimated Marginal Means") +  
 scale\_y\_continuous(labels = scales::label\_number(accuracy = 1))+   
 ggtitle("Water Treatment") +  
 myCustomTheme()+  
 theme(axis.title.y = element\_text(margin = margin(r = 1)))  
cld\_water\_treatment\_2b



#............................TB \* day............................  
  
## perform tukey pairwise comparisons across the interaction of TB presence and day  
cld\_day\_TB <- emmeans(aov\_sbncos, pairwise ~ TB \* day, adjust = "tukey") %>%  
 cld(Letters = letters, reverse = TRUE)

NOTE: Results may be misleading due to involvement in interactions

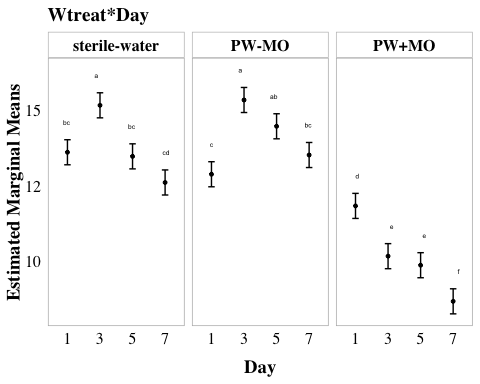
## make labels for the TB facet panels (n = absent, y = present)  
tb\_labels <- c("n" = "TB absent", "y" = "TB present")  
  
## make a plot of estimated marginal means across day, faceted by TB presence  
cld\_tb\_day\_int\_2b <- ggplot(cld\_day\_TB, aes(x = factor(day), y = emmean)) +   
 geom\_point(size = 1) + # plot estimated marginal means for each TB \* day combo  
 geom\_errorbar(aes(ymin = lower.CL, ymax = upper.CL), width = 0.2) + # add 95% confidence intervals  
 geom\_text(aes(label = .group), nudge\_y = 1, size = 1.75, color = "black") +   
 facet\_wrap(~ TB, # facet by TB   
 labeller = as\_labeller(tb\_labels)) + # and apply custom labels  
 xlab("Day") +  
 ylab("Estimated Marginal Means") +  
 scale\_y\_continuous(labels = scales::label\_number(accuracy = 1))+ # format y-axis: whole numbers only  
 ggtitle("TB \* Day") +  
 scale\_x\_discrete(labels= c("Day\_1" = "1", "Day\_3" = "3", "Day\_5" = "5", "Day\_7" = "7")) +  
 myCustomTheme()+  
 theme(axis.title.y = element\_text(margin = margin(r = 1)))  
cld\_tb\_day\_int\_2b



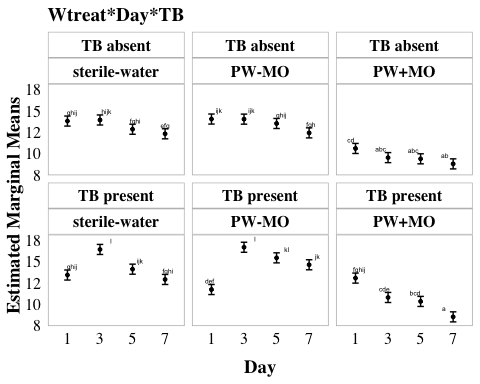
#........................water treat \* day.......................  
## same as above but for another interaction, see TB \* day example for code comments  
  
cld\_water\_treatment\_day <- emmeans(aov\_sbncos, pairwise ~ water\_treatment \* day, adjust = "tukey") %>%  
 cld(Letters = letters, reverse = TRUE)

NOTE: Results may be misleading due to involvement in interactions

cld\_watertreat\_day\_int\_2b <- ggplot(cld\_water\_treatment\_day, aes(x = factor(day), y = emmean)) +  
 geom\_point(size = 1) + # Plot the estimated means  
 geom\_errorbar(aes(ymin = lower.CL, ymax = upper.CL), width = 0.2) +   
 geom\_text(aes(label = .group), nudge\_y = 1, size = 1.75, color = "black") +   
 facet\_wrap(~ water\_treatment) +   
 xlab("Day") +  
 ylab("Estimated Marginal Means") +  
 scale\_y\_continuous(labels = scales::label\_number(accuracy = 1))+ # no decimals y axis  
 ggtitle("Wtreat\*Day") +  
 scale\_x\_discrete(labels= c("Day\_1" = "1", "Day\_3" = "3", "Day\_5" = "5", "Day\_7" = "7")) +  
 myCustomTheme()+  
 theme(axis.title.y = element\_text(margin = margin(r = 1)))  
cld\_watertreat\_day\_int\_2b



#....................third order comparisons.....................  
## same as above but for another interaction, see TB \* day example for code comments  
  
cld\_water\_thirdorder <- emmeans(aov\_sbncos, pairwise ~ water\_treatment \* day \* TB, adjust = "tukey") %>%  
 cld(Letters = letters)  
tb\_labels <- c("n" = "TB absent", "y" = "TB present")  
cld\_water\_thirdorder\_2b <- ggplot(cld\_water\_thirdorder, aes(x = factor(day), y = emmean)) +  
 geom\_point(size = 1) +   
 geom\_errorbar(aes(ymin = lower.CL, ymax = upper.CL), width = 0.2) + #  
 geom\_text(aes(label = .group), nudge\_y = 1, size = 1.75, color = "black") +   
 facet\_wrap(TB ~ water\_treatment, labeller = labeller(TB = tb\_labels)) +   
 xlab("Day") +  
 ylab("Estimated Marginal Means") +  
 scale\_y\_continuous(labels = scales::label\_number(accuracy = 1))+ # no decimals y axis  
 ggtitle("Wtreat\*Day\*TB") +  
 scale\_x\_discrete(labels= c("Day\_1" = "1", "Day\_3" = "3", "Day\_5" = "5", "Day\_7" = "7")) +  
 myCustomTheme()+  
 theme(axis.title.y = element\_text(margin = margin(r = 1)))  
cld\_water\_thirdorder\_2b



Get the posthoc values

# get the stats for posthoc (ph) each comparison  
ph\_2b\_day <- emmeans(aov\_sbncos, pairwise ~ day, adjust = "tukey")$contrasts

NOTE: Results may be misleading due to involvement in interactions

ph\_2b\_TB <- emmeans(aov\_sbncos, pairwise ~ TB, adjust = "tukey")$contrasts

NOTE: Results may be misleading due to involvement in interactions

ph\_2b\_water\_treatment <- emmeans(aov\_sbncos, pairwise ~ water\_treatment, adjust = "tukey")$contrasts

NOTE: Results may be misleading due to involvement in interactions

ph\_2b\_day\_TB <- emmeans(aov\_sbncos, pairwise ~ TB \* day, adjust = "tukey")$contrasts

NOTE: Results may be misleading due to involvement in interactions

ph\_2b\_water\_treatment\_day <- emmeans(aov\_sbncos, pairwise ~ water\_treatment \* day, adjust = "tukey")$contrasts

NOTE: Results may be misleading due to involvement in interactions

ph\_2b\_water\_thirdorder <- emmeans(aov\_sbncos, pairwise ~ water\_treatment \* day \* TB, adjust = "tukey")$contrasts  
  
# print the values  
ph\_2b\_day

contrast estimate SE df t.ratio p.value  
 Day\_1 - Day\_3 -0.788 0.17 48 -4.647 0.0002  
 Day\_1 - Day\_5 0.172 0.17 48 1.012 0.7435  
 Day\_1 - Day\_7 1.182 0.17 48 6.970 <.0001  
 Day\_3 - Day\_5 0.959 0.17 48 5.658 <.0001  
 Day\_3 - Day\_7 1.970 0.17 48 11.616 <.0001  
 Day\_5 - Day\_7 1.010 0.17 48 5.958 <.0001  
  
Results are averaged over the levels of: TB, water\_treatment   
P value adjustment: tukey method for comparing a family of 4 estimates

ph\_2b\_TB

contrast estimate SE df t.ratio p.value  
 n - y -1.08 0.12 48 -9.007 <.0001  
  
Results are averaged over the levels of: day, water\_treatment

ph\_2b\_water\_treatment

contrast estimate SE df t.ratio p.value  
 (sterile-water) - (PW-MO) -0.34 0.147 48 -2.317 0.0629  
 (sterile-water) - (PW+MO) 3.60 0.147 48 24.519 <.0001  
 (PW-MO) - (PW+MO) 3.94 0.147 48 26.836 <.0001  
  
Results are averaged over the levels of: day, TB   
P value adjustment: tukey method for comparing a family of 3 estimates

ph\_2b\_day\_TB

contrast estimate SE df t.ratio p.value  
 n Day\_1 - y Day\_1 0.0678 0.24 48 0.283 1.0000  
 n Day\_1 - n Day\_3 0.3198 0.24 48 1.334 0.8812  
 n Day\_1 - y Day\_3 -1.8277 0.24 48 -7.623 <.0001  
 n Day\_1 - n Day\_5 0.8983 0.24 48 3.746 0.0105  
 n Day\_1 - y Day\_5 -0.4875 0.24 48 -2.033 0.4714  
 n Day\_1 - n Day\_7 1.6426 0.24 48 6.850 <.0001  
 n Day\_1 - y Day\_7 0.7887 0.24 48 3.289 0.0367  
 y Day\_1 - n Day\_3 0.2521 0.24 48 1.051 0.9636  
 y Day\_1 - y Day\_3 -1.8955 0.24 48 -7.905 <.0001  
 y Day\_1 - n Day\_5 0.8305 0.24 48 3.464 0.0231  
 y Day\_1 - y Day\_5 -0.5553 0.24 48 -2.316 0.3066  
 y Day\_1 - n Day\_7 1.5748 0.24 48 6.568 <.0001  
 y Day\_1 - y Day\_7 0.7209 0.24 48 3.007 0.0742  
 n Day\_3 - y Day\_3 -2.1476 0.24 48 -8.956 <.0001  
 n Day\_3 - n Day\_5 0.5784 0.24 48 2.412 0.2590  
 n Day\_3 - y Day\_5 -0.8073 0.24 48 -3.367 0.0300  
 n Day\_3 - n Day\_7 1.3227 0.24 48 5.516 <.0001  
 n Day\_3 - y Day\_7 0.4688 0.24 48 1.955 0.5215  
 y Day\_3 - n Day\_5 2.7260 0.24 48 11.369 <.0001  
 y Day\_3 - y Day\_5 1.3403 0.24 48 5.589 <.0001  
 y Day\_3 - n Day\_7 3.4703 0.24 48 14.473 <.0001  
 y Day\_3 - y Day\_7 2.6164 0.24 48 10.912 <.0001  
 n Day\_5 - y Day\_5 -1.3858 0.24 48 -5.779 <.0001  
 n Day\_5 - n Day\_7 0.7443 0.24 48 3.104 0.0586  
 n Day\_5 - y Day\_7 -0.1096 0.24 48 -0.457 0.9998  
 y Day\_5 - n Day\_7 2.1301 0.24 48 8.883 <.0001  
 y Day\_5 - y Day\_7 1.2762 0.24 48 5.322 0.0001  
 n Day\_7 - y Day\_7 -0.8539 0.24 48 -3.561 0.0177  
  
Results are averaged over the levels of: water\_treatment   
P value adjustment: tukey method for comparing a family of 8 estimates

ph\_2b\_water\_treatment\_day

contrast estimate SE df t.ratio  
 (sterile-water Day\_1) - (PW-MO Day\_1) 0.7328 0.294 48 2.495  
 (sterile-water Day\_1) - (PW+MO Day\_1) 1.7876 0.294 48 6.087  
 (sterile-water Day\_1) - (sterile-water Day\_3) -1.5641 0.294 48 -5.326  
 (sterile-water Day\_1) - (PW-MO Day\_3) -1.7412 0.294 48 -5.929  
 (sterile-water Day\_1) - (PW+MO Day\_3) 3.4622 0.294 48 11.789  
 (sterile-water Day\_1) - (sterile-water Day\_5) 0.1367 0.294 48 0.465  
 (sterile-water Day\_1) - (PW-MO Day\_5) -0.8654 0.294 48 -2.947  
 (sterile-water Day\_1) - (PW+MO Day\_5) 3.7637 0.294 48 12.816  
 (sterile-water Day\_1) - (sterile-water Day\_7) 1.0067 0.294 48 3.428  
 (sterile-water Day\_1) - (PW-MO Day\_7) 0.0920 0.294 48 0.313  
 (sterile-water Day\_1) - (PW+MO Day\_7) 4.9670 0.294 48 16.913  
 (PW-MO Day\_1) - (PW+MO Day\_1) 1.0548 0.294 48 3.592  
 (PW-MO Day\_1) - (sterile-water Day\_3) -2.2969 0.294 48 -7.821  
 (PW-MO Day\_1) - (PW-MO Day\_3) -2.4740 0.294 48 -8.424  
 (PW-MO Day\_1) - (PW+MO Day\_3) 2.7294 0.294 48 9.294  
 (PW-MO Day\_1) - (sterile-water Day\_5) -0.5961 0.294 48 -2.030  
 (PW-MO Day\_1) - (PW-MO Day\_5) -1.5982 0.294 48 -5.442  
 (PW-MO Day\_1) - (PW+MO Day\_5) 3.0309 0.294 48 10.321  
 (PW-MO Day\_1) - (sterile-water Day\_7) 0.2739 0.294 48 0.933  
 (PW-MO Day\_1) - (PW-MO Day\_7) -0.6408 0.294 48 -2.182  
 (PW-MO Day\_1) - (PW+MO Day\_7) 4.2342 0.294 48 14.418  
 (PW+MO Day\_1) - (sterile-water Day\_3) -3.3517 0.294 48 -11.413  
 (PW+MO Day\_1) - (PW-MO Day\_3) -3.5288 0.294 48 -12.016  
 (PW+MO Day\_1) - (PW+MO Day\_3) 1.6746 0.294 48 5.702  
 (PW+MO Day\_1) - (sterile-water Day\_5) -1.6510 0.294 48 -5.622  
 (PW+MO Day\_1) - (PW-MO Day\_5) -2.6530 0.294 48 -9.034  
 (PW+MO Day\_1) - (PW+MO Day\_5) 1.9760 0.294 48 6.729  
 (PW+MO Day\_1) - (sterile-water Day\_7) -0.7809 0.294 48 -2.659  
 (PW+MO Day\_1) - (PW-MO Day\_7) -1.6956 0.294 48 -5.774  
 (PW+MO Day\_1) - (PW+MO Day\_7) 3.1793 0.294 48 10.826  
 (sterile-water Day\_3) - (PW-MO Day\_3) -0.1771 0.294 48 -0.603  
 (sterile-water Day\_3) - (PW+MO Day\_3) 5.0263 0.294 48 17.115  
 (sterile-water Day\_3) - (sterile-water Day\_5) 1.7008 0.294 48 5.791  
 (sterile-water Day\_3) - (PW-MO Day\_5) 0.6987 0.294 48 2.379  
 (sterile-water Day\_3) - (PW+MO Day\_5) 5.3278 0.294 48 18.142  
 (sterile-water Day\_3) - (sterile-water Day\_7) 2.5708 0.294 48 8.754  
 (sterile-water Day\_3) - (PW-MO Day\_7) 1.6561 0.294 48 5.639  
 (sterile-water Day\_3) - (PW+MO Day\_7) 6.5311 0.294 48 22.239  
 (PW-MO Day\_3) - (PW+MO Day\_3) 5.2034 0.294 48 17.718  
 (PW-MO Day\_3) - (sterile-water Day\_5) 1.8779 0.294 48 6.394  
 (PW-MO Day\_3) - (PW-MO Day\_5) 0.8758 0.294 48 2.982  
 (PW-MO Day\_3) - (PW+MO Day\_5) 5.5049 0.294 48 18.745  
 (PW-MO Day\_3) - (sterile-water Day\_7) 2.7479 0.294 48 9.357  
 (PW-MO Day\_3) - (PW-MO Day\_7) 1.8332 0.294 48 6.242  
 (PW-MO Day\_3) - (PW+MO Day\_7) 6.7082 0.294 48 22.842  
 (PW+MO Day\_3) - (sterile-water Day\_5) -3.3255 0.294 48 -11.324  
 (PW+MO Day\_3) - (PW-MO Day\_5) -4.3276 0.294 48 -14.736  
 (PW+MO Day\_3) - (PW+MO Day\_5) 0.3014 0.294 48 1.026  
 (PW+MO Day\_3) - (sterile-water Day\_7) -2.4555 0.294 48 -8.361  
 (PW+MO Day\_3) - (PW-MO Day\_7) -3.3702 0.294 48 -11.476  
 (PW+MO Day\_3) - (PW+MO Day\_7) 1.5048 0.294 48 5.124  
 (sterile-water Day\_5) - (PW-MO Day\_5) -1.0021 0.294 48 -3.412  
 (sterile-water Day\_5) - (PW+MO Day\_5) 3.6270 0.294 48 12.350  
 (sterile-water Day\_5) - (sterile-water Day\_7) 0.8700 0.294 48 2.963  
 (sterile-water Day\_5) - (PW-MO Day\_7) -0.0447 0.294 48 -0.152  
 (sterile-water Day\_5) - (PW+MO Day\_7) 4.8303 0.294 48 16.448  
 (PW-MO Day\_5) - (PW+MO Day\_5) 4.6291 0.294 48 15.763  
 (PW-MO Day\_5) - (sterile-water Day\_7) 1.8721 0.294 48 6.375  
 (PW-MO Day\_5) - (PW-MO Day\_7) 0.9574 0.294 48 3.260  
 (PW-MO Day\_5) - (PW+MO Day\_7) 5.8324 0.294 48 19.860  
 (PW+MO Day\_5) - (sterile-water Day\_7) -2.7569 0.294 48 -9.388  
 (PW+MO Day\_5) - (PW-MO Day\_7) -3.6717 0.294 48 -12.503  
 (PW+MO Day\_5) - (PW+MO Day\_7) 1.2033 0.294 48 4.097  
 (sterile-water Day\_7) - (PW-MO Day\_7) -0.9147 0.294 48 -3.115  
 (sterile-water Day\_7) - (PW+MO Day\_7) 3.9603 0.294 48 13.485  
 (PW-MO Day\_7) - (PW+MO Day\_7) 4.8750 0.294 48 16.600  
 p.value  
 0.3673  
 <.0001  
 0.0002  
 <.0001  
 <.0001  
 1.0000  
 0.1573  
 <.0001  
 0.0507  
 1.0000  
 <.0001  
 0.0330  
 <.0001  
 <.0001  
 <.0001  
 0.6717  
 0.0001  
 <.0001  
 0.9984  
 0.5698  
 <.0001  
 <.0001  
 <.0001  
 <.0001  
 0.0001  
 <.0001  
 <.0001  
 0.2775  
 <.0001  
 <.0001  
 1.0000  
 <.0001  
 <.0001  
 0.4389  
 <.0001  
 <.0001  
 0.0001  
 <.0001  
 <.0001  
 <.0001  
 0.1458  
 <.0001  
 <.0001  
 <.0001  
 <.0001  
 <.0001  
 <.0001  
 0.9962  
 <.0001  
 <.0001  
 0.0003  
 0.0528  
 <.0001  
 0.1521  
 1.0000  
 <.0001  
 <.0001  
 <.0001  
 0.0771  
 <.0001  
 <.0001  
 <.0001  
 0.0079  
 0.1085  
 <.0001  
 <.0001  
  
Results are averaged over the levels of: TB   
P value adjustment: tukey method for comparing a family of 12 estimates

ph\_2b\_water\_thirdorder

contrast estimate SE df t.ratio  
 (sterile-water Day\_1 n) - (PW-MO Day\_1 n) -0.2374 0.415 48 -0.571  
 (sterile-water Day\_1 n) - (PW+MO Day\_1 n) 3.2147 0.415 48 7.740  
 (sterile-water Day\_1 n) - (sterile-water Day\_3 n) -0.1275 0.415 48 -0.307  
 (sterile-water Day\_1 n) - (PW-MO Day\_3 n) -0.2249 0.415 48 -0.541  
 (sterile-water Day\_1 n) - (PW+MO Day\_3 n) 4.2892 0.415 48 10.328  
 (sterile-water Day\_1 n) - (sterile-water Day\_5 n) 0.9592 0.415 48 2.310  
 (sterile-water Day\_1 n) - (PW-MO Day\_5 n) 0.2837 0.415 48 0.683  
 (sterile-water Day\_1 n) - (PW+MO Day\_5 n) 4.4292 0.415 48 10.665  
 (sterile-water Day\_1 n) - (sterile-water Day\_7 n) 1.4940 0.415 48 3.597  
 (sterile-water Day\_1 n) - (PW-MO Day\_7 n) 1.3869 0.415 48 3.339  
 (sterile-water Day\_1 n) - (PW+MO Day\_7 n) 5.0242 0.415 48 12.097  
 (sterile-water Day\_1 n) - (sterile-water Day\_1 y) 0.3724 0.415 48 0.897  
 (sterile-water Day\_1 n) - (PW-MO Day\_1 y) 2.0753 0.415 48 4.997  
 (sterile-water Day\_1 n) - (PW+MO Day\_1 y) 0.7330 0.415 48 1.765  
 (sterile-water Day\_1 n) - (sterile-water Day\_3 y) -2.6283 0.415 48 -6.329  
 (sterile-water Day\_1 n) - (PW-MO Day\_3 y) -2.8852 0.415 48 -6.947  
 (sterile-water Day\_1 n) - (PW+MO Day\_3 y) 3.0076 0.415 48 7.242  
 (sterile-water Day\_1 n) - (sterile-water Day\_5 y) -0.3135 0.415 48 -0.755  
 (sterile-water Day\_1 n) - (PW-MO Day\_5 y) -1.6421 0.415 48 -3.954  
 (sterile-water Day\_1 n) - (PW+MO Day\_5 y) 3.4704 0.415 48 8.356  
 (sterile-water Day\_1 n) - (sterile-water Day\_7 y) 0.8918 0.415 48 2.147  
 (sterile-water Day\_1 n) - (PW-MO Day\_7 y) -0.8305 0.415 48 -2.000  
 (sterile-water Day\_1 n) - (PW+MO Day\_7 y) 5.2821 0.415 48 12.718  
 (PW-MO Day\_1 n) - (PW+MO Day\_1 n) 3.4520 0.415 48 8.312  
 (PW-MO Day\_1 n) - (sterile-water Day\_3 n) 0.1099 0.415 48 0.265  
 (PW-MO Day\_1 n) - (PW-MO Day\_3 n) 0.0125 0.415 48 0.030  
 (PW-MO Day\_1 n) - (PW+MO Day\_3 n) 4.5265 0.415 48 10.899  
 (PW-MO Day\_1 n) - (sterile-water Day\_5 n) 1.1966 0.415 48 2.881  
 (PW-MO Day\_1 n) - (PW-MO Day\_5 n) 0.5210 0.415 48 1.255  
 (PW-MO Day\_1 n) - (PW+MO Day\_5 n) 4.6666 0.415 48 11.236  
 (PW-MO Day\_1 n) - (sterile-water Day\_7 n) 1.7313 0.415 48 4.169  
 (PW-MO Day\_1 n) - (PW-MO Day\_7 n) 1.6242 0.415 48 3.911  
 (PW-MO Day\_1 n) - (PW+MO Day\_7 n) 5.2616 0.415 48 12.669  
 (PW-MO Day\_1 n) - (sterile-water Day\_1 y) 0.6097 0.415 48 1.468  
 (PW-MO Day\_1 n) - (PW-MO Day\_1 y) 2.3126 0.415 48 5.568  
 (PW-MO Day\_1 n) - (PW+MO Day\_1 y) 0.9703 0.415 48 2.336  
 (PW-MO Day\_1 n) - (sterile-water Day\_3 y) -2.3910 0.415 48 -5.757  
 (PW-MO Day\_1 n) - (PW-MO Day\_3 y) -2.6479 0.415 48 -6.376  
 (PW-MO Day\_1 n) - (PW+MO Day\_3 y) 3.2450 0.415 48 7.813  
 (PW-MO Day\_1 n) - (sterile-water Day\_5 y) -0.0762 0.415 48 -0.183  
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 (PW-MO Day\_1 n) - (PW+MO Day\_5 y) 3.7078 0.415 48 8.928  
 (PW-MO Day\_1 n) - (sterile-water Day\_7 y) 1.1292 0.415 48 2.719  
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 (PW+MO Day\_1 n) - (sterile-water Day\_3 n) -3.3421 0.415 48 -8.047  
 (PW+MO Day\_1 n) - (PW-MO Day\_3 n) -3.4395 0.415 48 -8.282  
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 (PW-MO Day\_3 n) - (PW+MO Day\_7 y) 5.5070 0.415 48 13.260  
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 (PW+MO Day\_3 n) - (PW-MO Day\_5 n) -4.0055 0.415 48 -9.644  
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 (PW+MO Day\_3 n) - (sterile-water Day\_7 n) -2.7952 0.415 48 -6.730  
 (PW+MO Day\_3 n) - (PW-MO Day\_7 n) -2.9023 0.415 48 -6.988  
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 (PW+MO Day\_3 n) - (PW-MO Day\_1 y) -2.2139 0.415 48 -5.331  
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 (PW+MO Day\_3 n) - (PW-MO Day\_5 y) -5.9313 0.415 48 -14.281  
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 (PW+MO Day\_3 n) - (PW-MO Day\_7 y) -5.1197 0.415 48 -12.327  
 (PW+MO Day\_3 n) - (PW+MO Day\_7 y) 0.9929 0.415 48 2.391  
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 (PW-MO Day\_5 n) - (PW+MO Day\_7 n) 4.7405 0.415 48 11.414  
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 (PW-MO Day\_5 n) - (PW-MO Day\_1 y) 1.7916 0.415 48 4.314  
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 (PW-MO Day\_5 n) - (sterile-water Day\_5 y) -0.5972 0.415 48 -1.438  
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 (PW-MO Day\_7 n) - (PW-MO Day\_1 y) 0.6884 0.415 48 1.658  
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 (PW+MO Day\_5 y) - (PW-MO Day\_7 y) -4.3010 0.415 48 -10.356  
 (PW+MO Day\_5 y) - (PW+MO Day\_7 y) 1.8116 0.415 48 4.362  
 (sterile-water Day\_7 y) - (PW-MO Day\_7 y) -1.7224 0.415 48 -4.147  
 (sterile-water Day\_7 y) - (PW+MO Day\_7 y) 4.3903 0.415 48 10.571  
 (PW-MO Day\_7 y) - (PW+MO Day\_7 y) 6.1126 0.415 48 14.718  
 p.value  
 1.0000  
 <.0001  
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 0.7920  
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 0.6100  
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 0.3802  
 0.0227  
 0.0108  
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 0.0002  
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 0.0438  
 0.0849  
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 0.9999  
 0.0006  
 0.9061  
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 1.0000  
 0.0847  
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 0.7014  
 0.9871  
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 0.4273  
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 0.0230  
 0.0467  
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 0.0003  
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 1.0000  
 0.1468  
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 0.9789  
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 0.9388  
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 0.0021  
 0.2981  
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 1.0000  
 0.0141  
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 0.5613  
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 0.9984  
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 0.9979  
 0.5426  
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 0.7926  
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 0.9989  
 0.9697  
 <.0001  
 <.0001  
 0.0852  
 0.0124  
 <.0001  
 0.0036  
 0.9982  
 0.0002  
 <.0001  
 <.0001  
 0.7091  
 0.9899  
 0.9946  
 <.0001  
 <.0001  
 0.0440  
 0.0261  
 <.0001  
 0.0016  
 0.9999  
 0.0006  
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 <.0001  
 0.0027  
 <.0001  
 <.0001  
 0.0670  
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 <.0001  
 1.0000  
 0.0257  
 1.0000  
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 <.0001  
 0.9903  
 0.0027  
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 0.9998  
 0.3979  
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 0.2157  
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 0.8279  
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 <.0001  
 0.1651  
 0.4283  
 <.0001  
 <.0001  
 <.0001  
 <.0001  
 0.0004  
 0.6570  
 0.0002  
 <.0001  
 1.0000  
 0.0631  
 <.0001  
 1.0000  
 <.0001  
 0.0003  
 0.7528  
 <.0001  
 <.0001  
 0.0133  
 <.0001  
 <.0001  
 <.0001  
 0.3386  
 <.0001  
 <.0001  
 0.0020  
 <.0001  
 <.0001  
 <.0001  
 1.0000  
 0.0012  
 <.0001  
 0.0004  
 0.2306  
 <.0001  
 0.3942  
 0.9998  
 <.0001  
 <.0001  
 <.0001  
 0.9435  
 <.0001  
 <.0001  
 <.0001  
 0.0121  
 0.0225  
 <.0001  
 <.0001  
  
P value adjustment: tukey method for comparing a family of 24 estimates

# These all match the previous estimates from the other package TukeyHSD(aov\_sbncos) and show the same trends

# \*Publication figures

Custom theme

# set up custom theme  
myCustomTheme <- function() {  
 theme\_light() + # base theme with light background  
 theme(axis.text = element\_text(size = 7, family = "Helvetica", color = "black"), # set font for axis tick labels  
 axis.title.x = element\_text(margin = margin(t = 10), # add spacing between x-axis label and plot  
 size = 7, face = "plain", family = "Helvetica", color = "black"), # Add space between x-axis label and axis  
 axis.title.y = element\_text(margin = margin(r = 10), # add spacing between y-axis label and plot  
 size = 7, face = "plain", family = "Helvetica", color = "black"), # Add space between y-axis label and axis  
 title = element\_text(size = 7, face = "bold", family = "Helvetica"),  
 plot.caption = element\_text(size = 7, face = "italic", family = "Helvetica"),  
 legend.text = element\_text(size = 7, family = "Helvetica"), # increase legend text size  
 panel.grid = element\_blank(), # remove all gridlines (major and minor, x and y)  
 # axis.line.x = element\_line(color = "grey"), # uncomment if axis lines are needed  
 # axis.line.y = element\_line(color = "grey"), # uncomment if axis lines are needed  
 axis.ticks = element\_line(color = "grey", size = 0.5), # keep tick markers  
 axis.ticks.x = element\_line(color = "grey", size = 0.5), # ensure bottom axis ticks  
 axis.ticks.y = element\_line(color = "grey", size = 0.5), # ensure side axis ticks  
 strip.text = element\_text(size = 7, face = "bold", family = "Helvetica", color = "black"), # formatting for facet labels  
 strip.background = element\_rect(fill = "white", color = "grey", size = 0.5))} # set background of facet strips to white with grey border

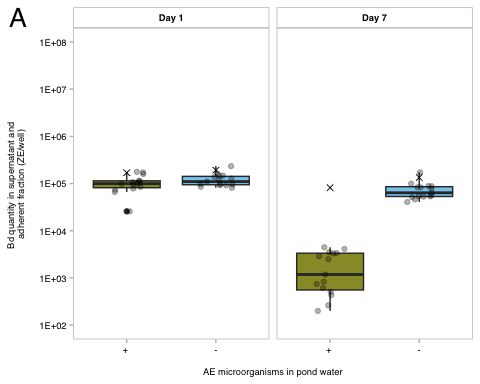
# SFEB microorganisms (3A)

fig\_SFEB\_microorganisms <- eb\_pw %>%  
 # combine floating and adherent for combined\_bd  
 pivot\_wider(names\_from = bd\_location, values\_from = bd\_qty) %>%  
 mutate(combined\_bd = adherent + floating) %>% # create a new column that combines floating and adherent fractions  
   
 # create the plot  
 ggplot(aes(y= combined\_bd, x = filter, fill = filter)) +   
 geom\_boxplot() +  
 geom\_jitter(width = 0.2, alpha = 0.3) + # overlay individual points, add some transparency  
 scale\_y\_log10(labels = function(x) {gsub("e", "E", scales::scientific\_format()(x))}, # show scientific notation as 1E3, 1E6, etc  
 # update to consistent scale across all figures per reviewer request  
 limits = c(1e+02, 1e+08), # set y-axis limits  
 breaks = c(1e2, 1e3, 1e4, 1e5, 1e6, 1e7, 1e8)) + # y-axis tick breaks  
   
 facet\_wrap(~day, # facet by day  
 labeller = labeller(day = c("Day\_1" = "Day 1", # make labels pretty  
 "Day\_7" = "Day 7"))) +  
 # assign custom fill colors to each filter treatment  
 scale\_fill\_manual(values = c("40um\_filter" = with\_microbes\_40\_color,   
 "0.22um\_filter" = no\_microbes\_.22\_color)) +  
 myCustomTheme() +  
 theme(legend.position = "none", # remove legend  
 panel.border = element\_rect(color = "gray", size = 0.5, fill = NA)) + # add border around each panel  
   
 # re-label x-axis ticks for clarity ("+" = microbes present, "-" = no microbes)  
 scale\_x\_discrete (labels= c("40um\_filter" = "+ ", "0.22um\_filter" = "-")) +  
 xlab("AE microorganisms in pond water") +  
 ylab("Bd quantity in supernatant and \nadherent fraction (ZE/well)") +  
   
 # add controls as x's  
 geom\_point(data = eb\_pw\_controls, aes(x = filter, y = combined\_bd), shape = 4, size = 2)

Warning: The `size` argument of `element\_line()` is deprecated as of ggplot2 3.4.0.  
ℹ Please use the `linewidth` argument instead.

Warning: The `size` argument of `element\_rect()` is deprecated as of ggplot2 3.4.0.  
ℹ Please use the `linewidth` argument instead.

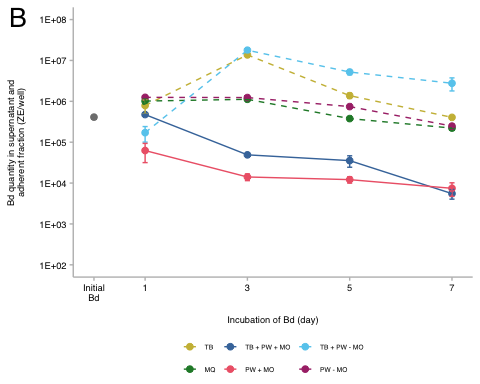
# add plot tag label  
fig\_SFEB\_microorganisms <- fig\_SFEB\_microorganisms +  
 labs(tag = "A") +  
 theme(  
 plot.tag = element\_text(family = "Helvetica", size = 20, face = "plain", hjust = -0.1, vjust = 1), # position and style for the tag  
 plot.tag.position = c(0, 1) # place in top-left corner  
 )  
  
fig\_SFEB\_microorganisms



#ggsave("paper-figures/expt2-SFEB\_AE\_microorgranisms\_fig3a\_updated.pdf", plot = fig\_SFEB\_microorganisms, width = 3.46, height = 3.46)

# SBNCOS microorganisms (3B)

SBNCOS\_AE\_microorgranisms\_fig3b <- pw\_summary %>%   
 # reorder to have them appear in desired order  
 mutate(sample\_ID = factor(sample\_ID,   
 levels = c("1%TB", "MQ", "1%TB+PW+microorganism", "PW+microorganism", "1%TB+PW-microorganism", "PW-microorganism", "Added Bd"))) %>%   
 ggplot(aes(x = day\_numeric,   
 y = mean,   
 color = sample\_ID)) +  
 geom\_point(size = 2) +  
 geom\_errorbar(aes(ymin = mean - se, # plot the standard error  
 ymax = mean + se),  
 width = 0.1) +  
  
 # Adding the raw data as a layer with jitter, Renwei didn't like this so it is commented out  
 # geom\_point(data = pw\_noday0,   
 # aes(x = day\_numeric,   
 # y = adh\_plus\_sup,   
 # color = sample\_ID),   
 # position = position\_jitter(width = 0.1, seed = 1),  
 # alpha = 0.3) +  
 # # add control raw data too  
 # geom\_point(data = pw\_control\_data,   
 # aes(x = day\_numeric,   
 # y = adh\_plus\_sup,   
 # color = "#BBBBBB"),   
 # position = position\_jitter(width = 0.1, seed = 1),  
 # alpha = 0.3) +  
  
## Update y axis scale per reviewer request!  
 scale\_y\_log10(limits = c(1e2, 1e8),   
 breaks = c(1e2, 1e3, 1e4, 1e5, 1e6, 1e7, 1e8),  
 labels = function(x) {gsub("e", "E", scales::scientific\_format()(x))}) +  
 labs(x = "Incubation of Bd (day)",  
 y = "Bd quantity in supernatant and\nadherent fraction (ZE/well)",  
 color = "Medium", # Title for color legend  
 linetype = "Microbes\nPresent" # Title for linetype legend  
 ) +  
 scale\_color\_manual(values = c("1%TB" = "#CCBB44",   
 "MQ" = "#228833",   
 "1%TB+PW+microorganism" = "#4477AA",   
 "PW+microorganism" = "#EE6677",   
 "1%TB+PW-microorganism" = "#66CCEE",  
 #"Added Bd" = "#BBBBBB" # removed bc not really a medium  
 "PW-microorganism" = "#AA3377"),   
 labels = c("1%TB" = "TB",  
 "MQ" = "MQ",  
 "1%TB+PW+microorganism" = "TB + PW + MO",  
 "PW+microorganism" = "PW + MO",  
 "1%TB+PW-microorganism" = "TB + PW - MO",  
 "PW-microorganism" = "PW - MO",  
 "Added Bd" = "Initial Bd")) + # Custom labels for the color legend  
   
 geom\_line(aes(linetype = microbes), show.legend = FALSE) +   
 scale\_linetype\_manual(values = c("n" = "dashed",   
 "y" = "solid"),  
 labels = c("n" = "N", "y" = "Y")) + # Change labels to uppercase N and Y  
 myCustomTheme()+  
 scale\_x\_continuous(breaks = c(0, 1, 3, 5, 7),  
 labels = c("Initial\nBd", "1", "3", "5", "7")) +  
 theme(legend.position = "bottom",  
 panel.border = element\_blank(),  
 legend.text = element\_text(size = 5), # Set legend text font size to 5pt  
 legend.key.size = unit(0.4, "cm"), # Reduce size of legend keys  
 legend.spacing.y = unit(0.1, "cm"), # Reduce vertical spacing between legend items  
 legend.margin = margin(t = 0, r = 0, b = 0, l = 0), # Remove margins around legend  
 axis.line.x = element\_line(color = "grey", size = 0.5), # Keep the x-axis line, make ~2.35 pt  
 axis.line.y = element\_line(color = "grey", size = 0.5)) + # Keep the x-axis line, make ~2.35 pt  
  
 guides(color = guide\_legend(title = NULL))  
  
#SBNCOS\_AE\_microorgranisms\_fig3b  
  
SBNCOS\_AE\_microorgranisms\_fig3b <- SBNCOS\_AE\_microorgranisms\_fig3b +  
 labs(tag = "B") +  
 theme(  
 plot.tag = element\_text(family = "Helvetica", size = 20, face = "plain", hjust = -0.1, vjust = 1),  
 plot.tag.position = c(0, 1)  
 )  
  
SBNCOS\_AE\_microorgranisms\_fig3b

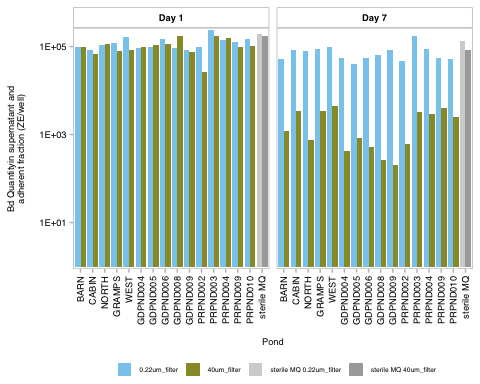


#ggsave("paper-figures/expt2-SBNCOS\_AE\_microorgranisms\_fig3b\_updated.pdf", plot = SBNCOS\_AE\_microorgranisms\_fig3b, width = 3.46, height = 3.46)

# \*SI figures and tables

## S4: barplot

#.............................prep data..............................  
  
# reformat the controls dataset: rename filters to match the style of sterile MQ samples  
eb\_pw\_controls <- eb\_pw\_controls %>%  
 mutate(filter = case\_when(  
 filter == "40um\_filter" ~ "sterile MQ 40um\_filter",  
 filter == "0.22um\_filter" ~ "sterile MQ 0.22um\_filter",  
 TRUE ~ filter  
 ))  
  
# combine main dataset and controls into one  
combined\_data <- bind\_rows(  
 eb\_pw %>%  
 # combine floating and adherent for total Bd  
 pivot\_wider(names\_from = bd\_location, values\_from = bd\_qty) %>%  
 mutate(combined\_bd = adherent + floating),  
 eb\_pw\_controls # controls data is already in the required format  
)  
  
#.............................make plot..............................  
  
fig\_SI2A <- combined\_data %>%  
 ggplot(aes(y = combined\_bd, x = site, fill = filter)) +   
 geom\_col(position = position\_dodge()) + # use side-by-side columns for filter types within each site  
 scale\_y\_continuous(  
 expand = c(0.01, 0.01), # small expansion so bars aren't cut off  
 trans = "log", # natural log scale  
 breaks = c(1e+01, 1e+03, 1e+05), # show these tick marks  
 labels = function(x) {gsub("e", "E", scales::label\_scientific()(x))}) + # use 1E1 format  
 facet\_wrap(~day, labeller = labeller(day = c("Day\_1" = "Day 1", "Day\_7" = "Day 7"))) + # facet by day (Day 1 and Day 7)  
 scale\_x\_discrete(limits = c("BARN", "CABIN", "NORTH", "GRAMPS", "WEST", "GDPND004", "GDPND005", "GDPND006", "GDPND008", "GDPND009", "PRPND002", "PRPND003", "PRPND004", "PRPND009", "PRPND010", "sterile MQ")) + # order x-axis (sites) so sterile MQ is last  
 scale\_fill\_manual(values = c( # colors  
 "40um\_filter" = with\_microbes\_40\_color,   
 "0.22um\_filter" = no\_microbes\_.22\_color,  
 "sterile MQ 40um\_filter" = "darkgray",  
 "sterile MQ 0.22um\_filter" = "lightgray" )) +  
 myCustomTheme() +   
 theme(  
 axis.text.x = element\_text(angle = 90, vjust = 0.5, hjust = 1), # rotate x-axis labels  
 legend.position = "bottom", # move legend below plot  
 panel.border = element\_rect(color = "gray", size = 0.5, fill = NA), # add subtle border around panel  
 legend.text = element\_text(size = 5), # shrink legend text  
 legend.key.size = unit(0.4, "cm"), # shrink legend key size  
 legend.spacing.y = unit(0.1, "cm"), # reduce vertical space between legend items  
 legend.margin = margin(t = 0, r = 0, b = 0, l = 0)) + # remove outer margin from legend  
 xlab("Pond") +  
 ylab("Bd Quantityin supernatant and\nadherent fraction (ZE/well)") +  
 guides(fill = guide\_legend(title = "")) # remove legend title  
  
fig\_SI2A

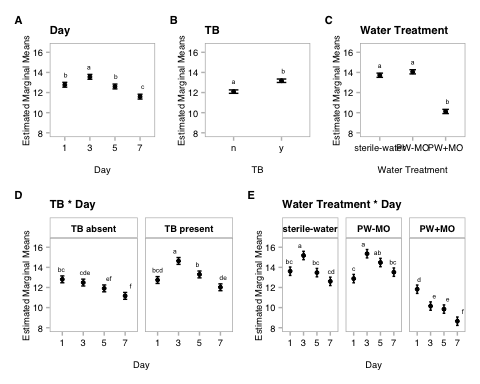


#ggsave("paper-figures/SI\_FigS2.pdf", plot = fig\_SI2A, width = 7.09, height = 3.46)

## S5: posthoc

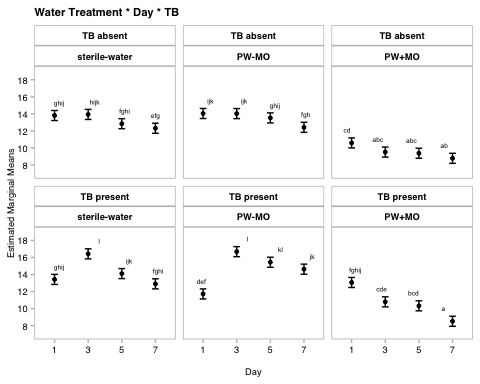
Note this one has global y limits and breaks to ensure consistency and help with comparisons

#.......................... global axis settings ..........................  
  
# set consistent y-axis limits and breaks for all cld plots  
global\_y\_limits <- c(8, 16.5)  
global\_y\_breaks <- seq(8, 16, by = 2)  
global\_y\_limits <- c(8, 16.5)  
global\_y\_breaks <- seq(8, 16, by = 2)  
  
#..............................day...............................  
# make a plot of estimated marginal means with CLD letters for each day  
cld\_day\_2b <- ggplot(cld\_day, aes(x = day, y = emmean)) +  
 geom\_point(size = 1) + # plot the estimated means  
 geom\_errorbar(aes(ymin = lower.CL, ymax = upper.CL), width = 0.2) + # add 95% confidence intervals  
 geom\_text(aes(label = .group), nudge\_y = 1, size = 1.75, color = "black") + # add cld group letters above points  
 xlab("Day") +  
 ylab("Estimated Marginal Means") +  
 scale\_y\_continuous(labels = scales::label\_number(accuracy = 1),   
 limits = global\_y\_limits, breaks = global\_y\_breaks) + # consistent y-axis  
 ggtitle("Day") +  
 scale\_x\_discrete(labels= c("Day\_1" = "1", "Day\_3" = "3", "Day\_5" = "5", "Day\_7" = "7")) + # simplify x-axis labels  
 myCustomTheme() +  
 theme(axis.title.y = element\_text(margin = margin(r = 1))) # add breathing room  
  
#..............................TB...............................  
## same as above but for another factor, see "day" example for code comments  
cld\_TB\_2b <- ggplot(cld\_TB, aes(x = TB, y = emmean)) +  
 geom\_point(size = 1) +  
 geom\_errorbar(aes(ymin = lower.CL, ymax = upper.CL), width = 0.2) +  
 geom\_text(aes(label = .group), nudge\_y = 1, size = 1.75, color = "black") +  
 xlab("TB") +  
 ylab("Estimated Marginal Means") +  
 scale\_y\_continuous(labels = scales::label\_number(accuracy = 1), limits = global\_y\_limits, breaks = global\_y\_breaks) +  
 ggtitle("TB") +  
 myCustomTheme() +  
 theme(axis.title.y = element\_text(margin = margin(r = 1)))  
  
#............................water treatment...............................  
## same as above but for another factor, see "day" example for code comments  
cld\_water\_treatment\_2b <- ggplot(cld\_water\_treatment, aes(x = water\_treatment, y = emmean)) +  
 geom\_point(size = 1) +  
 geom\_errorbar(aes(ymin = lower.CL, ymax = upper.CL), width = 0.2) +  
 geom\_text(aes(label = .group), nudge\_y = 1, size = 1.75, color = "black") +  
 xlab("Water Treatment") +  
 ylab("Estimated Marginal Means") +  
 scale\_y\_continuous(labels = scales::label\_number(accuracy = 1), limits = global\_y\_limits, breaks = global\_y\_breaks) +  
 ggtitle("Water Treatment") +  
 myCustomTheme() +  
 theme(axis.title.y = element\_text(margin = margin(r = 1)))  
  
#............................TB \* day............................  
  
## make labels for the TB facet panels (n = absent, y = present)  
tb\_labels <- c("n" = "TB absent", "y" = "TB present")  
  
## make a plot of estimated marginal means across day, faceted by TB presence  
cld\_tb\_day\_int\_2b <- ggplot(cld\_day\_TB, aes(x = factor(day), y = emmean)) +  
 geom\_point(size = 1) +  
 geom\_errorbar(aes(ymin = lower.CL, ymax = upper.CL), width = 0.2) +  
 geom\_text(aes(label = .group), nudge\_y = 1, size = 1.75, color = "black") +  
 facet\_wrap(~ TB, labeller = as\_labeller(tb\_labels)) +  
 xlab("Day") +  
 ylab("Estimated Marginal Means") +  
 scale\_y\_continuous(labels = scales::label\_number(accuracy = 1), limits = global\_y\_limits, breaks = global\_y\_breaks) +  
 ggtitle("TB \* Day") +  
 scale\_x\_discrete(labels = c("Day\_1" = "1", "Day\_3" = "3", "Day\_5" = "5", "Day\_7" = "7")) +  
 myCustomTheme() +  
 theme(axis.title.y = element\_text(margin = margin(r = 1)))  
  
  
#.....................water treat \* day.........................  
## same as above but for another interaction, see TB \* day example for code comments  
cld\_watertreat\_day\_int\_2b <- ggplot(cld\_water\_treatment\_day, aes(x = factor(day), y = emmean)) +  
 geom\_point(size = 1) +  
 geom\_errorbar(aes(ymin = lower.CL, ymax = upper.CL), width = 0.2) +  
 geom\_text(aes(label = .group), nudge\_y = 1, size = 1.75, color = "black") +  
 facet\_wrap(~ water\_treatment) +  
 xlab("Day") +  
 ylab("Estimated Marginal Means") +  
 scale\_y\_continuous(labels = scales::label\_number(accuracy = 1), limits = global\_y\_limits, breaks = global\_y\_breaks) +  
 ggtitle("Water Treatment \* Day") +  
 scale\_x\_discrete(labels = c("Day\_1" = "1", "Day\_3" = "3", "Day\_5" = "5", "Day\_7" = "7")) +  
 myCustomTheme() +  
 theme(axis.title.y = element\_text(margin = margin(r = 1)))  
  
#......................combine all panels.........................  
## use patchwork to arrange all cld plots into one figure  
pairwise\_cld\_2b <- (cld\_day\_2b + cld\_TB\_2b + cld\_water\_treatment\_2b) /  
 (cld\_tb\_day\_int\_2b + cld\_watertreat\_day\_int\_2b) +  
 plot\_annotation(tag\_levels = 'A')  
  
pairwise\_cld\_2b



#ggsave("paper-figures/SI\_2b\_updated.pdf", plot = pairwise\_cld\_2b, width = 7.09, height = 3.46)

global\_y\_limits <- c(7, 19)  
global\_y\_breaks <- seq(8, 18, by = 2)  
  
cld\_water\_thirdorder\_2b <- ggplot(cld\_water\_thirdorder, aes(x = factor(day), y = emmean)) +  
 geom\_point(size = 1) +  
 geom\_errorbar(aes(ymin = lower.CL, ymax = upper.CL), width = 0.2) +  
 geom\_text(aes(label = .group), nudge\_y = 1.5, size = 1.75, color = "black") +  
 facet\_wrap(TB ~ water\_treatment, labeller = labeller(TB = tb\_labels)) +  
 xlab("Day") +  
 ylab("Estimated Marginal Means") +  
 scale\_y\_continuous(  
 labels = scales::label\_number(accuracy = 1),   
 limits = global\_y\_limits,   
 breaks = global\_y\_breaks  
 ) +  
 ggtitle("Water Treatment \* Day \* TB") +  
 scale\_x\_discrete(labels = c("Day\_1" = "1", "Day\_3" = "3", "Day\_5" = "5", "Day\_7" = "7")) +  
 myCustomTheme() +  
 theme(axis.title.y = element\_text(margin = margin(r = 1)))  
  
cld\_water\_thirdorder\_2b



#ggsave("paper-figures/SI\_2b\_thirdorder\_updated.pdf", plot = cld\_water\_thirdorder\_2b , width = 7.09, height = 3.46)

# Appendix

## Anova table

Not in paper, stating information in sentences and using CLD plot instead

# anova table  
anova\_output <- tidy(aov\_sbncos)  
  
aov\_sbncos\_tbl <- anova\_output %>%  
 dplyr::select(term, df, sumsq, meansq, statistic, p.value) %>%  
 gt() %>%  
 tab\_header(  
 title = "ANOVA Table"  
 ) %>%  
 fmt\_number(  
 columns = c(sumsq, meansq, statistic),  
 decimals = 2  
 ) %>%  
 cols\_label(  
 term = "Term",  
 df = "Df",  
 sumsq = "Sum Sq",  
 meansq = "Mean Sq",  
 statistic = "F value",  
 p.value = "P-value"  
 ) %>% # scientific number format for values <0.001 in p values  
 fmt\_scientific(  
 columns = c(p.value),  
 decimals = 1,  
 rows = p.value < 0.001  
 ) %>%  
 # 3 decimals for p values >=0.001  
 fmt\_number(  
 columns = c(p.value),  
 decimals = 3,  
 rows = p.value >= 0.001  
 )  
aov\_sbncos\_tbl

Table 1: ANOVA Table

| Term | Df | Sum Sq | Mean Sq | F value | P-value |
| --- | --- | --- | --- | --- | --- |
| day | 3 | 35.40 | 11.80 | 45.61 | 4.3 × 10^-14 |
| TB | 1 | 20.99 | 20.99 | 81.13 | 6.9 × 10^-12 |
| water\_treatment | 2 | 228.85 | 114.42 | 442.25 | 1.2 × 10^-31 |
| day:TB | 3 | 11.71 | 3.90 | 15.08 | 4.8 × 10^-7 |
| day:water\_treatment | 6 | 37.33 | 6.22 | 24.05 | 6.4 × 10^-13 |
| TB:water\_treatment | 2 | 0.06 | 0.03 | 0.11 | 0.897 |
| day:TB:water\_treatment | 6 | 24.57 | 4.09 | 15.82 | 6.3 × 10^-10 |
| Residuals | 48 | 12.42 | 0.26 | NA | NA |

# prettier, simplified  
anova\_output <- tidy(aov\_sbncos)  
  
# Modify term to include degrees of freedom in \*italics\*  
anova\_output <- anova\_output %>%  
 mutate(term = ifelse(grepl("day:medium", term), "day x medium", term)) %>%   
 mutate (term = paste0(term, " (\*df = ", df, ", ", anova\_output[df == max(df), "df"], "\*)")) %>%   
 filter(term != "Residuals (\*df = 48, 48\*)")  
  
# Create the gt table with selected columns  
aov\_sbncos\_tbl\_b <- anova\_output %>%  
 dplyr::select(term, statistic, p.value) %>%  
 gt() %>%  
 tab\_header(  
 title = "ANOVA Table"  
 ) %>%  
 fmt\_markdown(  
 columns = c(term)  
 ) %>%  
 fmt\_number(  
 columns = c(statistic),  
 decimals = 2  
 ) %>%  
 cols\_label(  
 term = "",  
 statistic = "F value",  
 p.value = "P-value"  
 ) %>%  
 fmt\_scientific(  
 columns = c(p.value),  
 decimals = 1,  
 rows = p.value < 0.001  
 ) %>%  
 fmt\_number(  
 columns = c(p.value),  
 decimals = 3,  
 rows = p.value >= 0.001  
 )  
  
aov\_sbncos\_tbl\_b

Table 1: ANOVA Table

|  | F value | P-value |
| --- | --- | --- |
| day (*df = 3, 48*) | 45.61 | 4.3 × 10^-14 |
| TB (*df = 1, 48*) | 81.13 | 6.9 × 10^-12 |
| water\_treatment (*df = 2, 48*) | 442.25 | 1.2 × 10^-31 |
| day:TB (*df = 3, 48*) | 15.08 | 4.8 × 10^-7 |
| day:water\_treatment (*df = 6, 48*) | 24.05 | 6.4 × 10^-13 |
| TB:water\_treatment (*df = 2, 48*) | 0.11 | 0.897 |
| day:TB:water\_treatment (*df = 6, 48*) | 15.82 | 6.3 × 10^-10 |

## 2b posthoc table

We likely will not include this, but if we need to find these specific t and p values we can locate them here

ph\_2b\_day\_df <- as.data.frame(ph\_2b\_day)  
ph\_2b\_TB\_df <- as.data.frame(ph\_2b\_TB)  
ph\_2b\_water\_treatment\_df <- as.data.frame(ph\_2b\_water\_treatment)  
ph\_2b\_water\_treatment\_day\_df <- as.data.frame(ph\_2b\_water\_treatment\_day)  
ph\_2b\_day\_TB\_df <- as.data.frame(ph\_2b\_day\_TB)  
   
ph\_2b\_day\_df <- ph\_2b\_day\_df %>% mutate(factor = "Day")  
ph\_2b\_TB\_df <- ph\_2b\_TB\_df %>% mutate(factor = "TB")  
ph\_2b\_water\_treatment\_df <- ph\_2b\_water\_treatment\_df %>% mutate(factor = "WTreat")  
ph\_2b\_water\_treatment\_day\_df <- ph\_2b\_water\_treatment\_day\_df %>% mutate(factor = "Day\*WTreat")  
ph\_2b\_day\_TB\_df <- ph\_2b\_day\_TB\_df %>% mutate(factor = "Day\*TB")  
  
# combine all pairwise comparisons  
f2b\_all\_tukey\_df <- bind\_rows(ph\_2b\_day\_df, ph\_2b\_TB\_df, ph\_2b\_water\_treatment\_df, ph\_2b\_water\_treatment\_day\_df, ph\_2b\_day\_TB\_df)  
  
f2b\_all\_tukey\_df

contrast estimate SE df  
1 Day\_1 - Day\_3 -0.78783861 0.1695522 48  
2 Day\_1 - Day\_5 0.17150692 0.1695522 48  
3 Day\_1 - Day\_7 1.18175034 0.1695522 48  
4 Day\_3 - Day\_5 0.95934552 0.1695522 48  
5 Day\_3 - Day\_7 1.96958894 0.1695522 48  
6 Day\_5 - Day\_7 1.01024342 0.1695522 48  
7 n - y -1.07987165 0.1198915 48  
8 (sterile-water) - (PW-MO) -0.34028396 0.1468365 48  
9 (sterile-water) - (PW+MO) 3.60029322 0.1468365 48  
10 (PW-MO) - (PW+MO) 3.94057719 0.1468365 48  
11 (sterile-water Day\_1) - (PW-MO Day\_1) 0.73277523 0.2936731 48  
12 (sterile-water Day\_1) - (PW+MO Day\_1) 1.78762409 0.2936731 48  
13 (sterile-water Day\_1) - (sterile-water Day\_3) -1.56409952 0.2936731 48  
14 (sterile-water Day\_1) - (PW-MO Day\_3) -1.74122159 0.2936731 48  
15 (sterile-water Day\_1) - (PW+MO Day\_3) 3.46220461 0.2936731 48  
16 (sterile-water Day\_1) - (sterile-water Day\_5) 0.13666277 0.2936731 48  
17 (sterile-water Day\_1) - (PW-MO Day\_5) -0.86539619 0.2936731 48  
18 (sterile-water Day\_1) - (PW+MO Day\_5) 3.76365348 0.2936731 48  
19 (sterile-water Day\_1) - (sterile-water Day\_7) 1.00670881 0.2936731 48  
20 (sterile-water Day\_1) - (PW-MO Day\_7) 0.09197876 0.2936731 48  
21 (sterile-water Day\_1) - (PW+MO Day\_7) 4.96696276 0.2936731 48  
22 (PW-MO Day\_1) - (PW+MO Day\_1) 1.05484887 0.2936731 48  
23 (PW-MO Day\_1) - (sterile-water Day\_3) -2.29687475 0.2936731 48  
24 (PW-MO Day\_1) - (PW-MO Day\_3) -2.47399681 0.2936731 48  
25 (PW-MO Day\_1) - (PW+MO Day\_3) 2.72942939 0.2936731 48  
26 (PW-MO Day\_1) - (sterile-water Day\_5) -0.59611245 0.2936731 48  
27 (PW-MO Day\_1) - (PW-MO Day\_5) -1.59817142 0.2936731 48  
28 (PW-MO Day\_1) - (PW+MO Day\_5) 3.03087826 0.2936731 48  
29 (PW-MO Day\_1) - (sterile-water Day\_7) 0.27393358 0.2936731 48  
30 (PW-MO Day\_1) - (PW-MO Day\_7) -0.64079647 0.2936731 48  
31 (PW-MO Day\_1) - (PW+MO Day\_7) 4.23418754 0.2936731 48  
32 (PW+MO Day\_1) - (sterile-water Day\_3) -3.35172362 0.2936731 48  
33 (PW+MO Day\_1) - (PW-MO Day\_3) -3.52884568 0.2936731 48  
34 (PW+MO Day\_1) - (PW+MO Day\_3) 1.67458052 0.2936731 48  
35 (PW+MO Day\_1) - (sterile-water Day\_5) -1.65096132 0.2936731 48  
36 (PW+MO Day\_1) - (PW-MO Day\_5) -2.65302028 0.2936731 48  
37 (PW+MO Day\_1) - (PW+MO Day\_5) 1.97602939 0.2936731 48  
38 (PW+MO Day\_1) - (sterile-water Day\_7) -0.78091529 0.2936731 48  
39 (PW+MO Day\_1) - (PW-MO Day\_7) -1.69564533 0.2936731 48  
40 (PW+MO Day\_1) - (PW+MO Day\_7) 3.17933867 0.2936731 48  
41 (sterile-water Day\_3) - (PW-MO Day\_3) -0.17712206 0.2936731 48  
42 (sterile-water Day\_3) - (PW+MO Day\_3) 5.02630414 0.2936731 48  
43 (sterile-water Day\_3) - (sterile-water Day\_5) 1.70076230 0.2936731 48  
44 (sterile-water Day\_3) - (PW-MO Day\_5) 0.69870333 0.2936731 48  
45 (sterile-water Day\_3) - (PW+MO Day\_5) 5.32775301 0.2936731 48  
46 (sterile-water Day\_3) - (sterile-water Day\_7) 2.57080833 0.2936731 48  
47 (sterile-water Day\_3) - (PW-MO Day\_7) 1.65607828 0.2936731 48  
48 (sterile-water Day\_3) - (PW+MO Day\_7) 6.53106229 0.2936731 48  
49 (PW-MO Day\_3) - (PW+MO Day\_3) 5.20342620 0.2936731 48  
50 (PW-MO Day\_3) - (sterile-water Day\_5) 1.87788436 0.2936731 48  
51 (PW-MO Day\_3) - (PW-MO Day\_5) 0.87582540 0.2936731 48  
52 (PW-MO Day\_3) - (PW+MO Day\_5) 5.50487507 0.2936731 48  
53 (PW-MO Day\_3) - (sterile-water Day\_7) 2.74793039 0.2936731 48  
54 (PW-MO Day\_3) - (PW-MO Day\_7) 1.83320035 0.2936731 48  
55 (PW-MO Day\_3) - (PW+MO Day\_7) 6.70818435 0.2936731 48  
56 (PW+MO Day\_3) - (sterile-water Day\_5) -3.32554184 0.2936731 48  
57 (PW+MO Day\_3) - (PW-MO Day\_5) -4.32760080 0.2936731 48  
58 (PW+MO Day\_3) - (PW+MO Day\_5) 0.30144887 0.2936731 48  
59 (PW+MO Day\_3) - (sterile-water Day\_7) -2.45549581 0.2936731 48  
60 (PW+MO Day\_3) - (PW-MO Day\_7) -3.37022585 0.2936731 48  
61 (PW+MO Day\_3) - (PW+MO Day\_7) 1.50475815 0.2936731 48  
62 (sterile-water Day\_5) - (PW-MO Day\_5) -1.00205896 0.2936731 48  
63 (sterile-water Day\_5) - (PW+MO Day\_5) 3.62699071 0.2936731 48  
64 (sterile-water Day\_5) - (sterile-water Day\_7) 0.87004603 0.2936731 48  
65 (sterile-water Day\_5) - (PW-MO Day\_7) -0.04468401 0.2936731 48  
66 (sterile-water Day\_5) - (PW+MO Day\_7) 4.83029999 0.2936731 48  
67 (PW-MO Day\_5) - (PW+MO Day\_5) 4.62904968 0.2936731 48  
68 (PW-MO Day\_5) - (sterile-water Day\_7) 1.87210500 0.2936731 48  
69 (PW-MO Day\_5) - (PW-MO Day\_7) 0.95737495 0.2936731 48  
70 (PW-MO Day\_5) - (PW+MO Day\_7) 5.83235895 0.2936731 48  
71 (PW+MO Day\_5) - (sterile-water Day\_7) -2.75694468 0.2936731 48  
72 (PW+MO Day\_5) - (PW-MO Day\_7) -3.67167472 0.2936731 48  
73 (PW+MO Day\_5) - (PW+MO Day\_7) 1.20330928 0.2936731 48  
74 (sterile-water Day\_7) - (PW-MO Day\_7) -0.91473005 0.2936731 48  
75 (sterile-water Day\_7) - (PW+MO Day\_7) 3.96025396 0.2936731 48  
76 (PW-MO Day\_7) - (PW+MO Day\_7) 4.87498400 0.2936731 48  
77 n Day\_1 - y Day\_1 0.06776878 0.2397830 48  
78 n Day\_1 - n Day\_3 0.31984147 0.2397830 48  
79 n Day\_1 - y Day\_3 -1.82774990 0.2397830 48  
80 n Day\_1 - n Day\_5 0.89827967 0.2397830 48  
81 n Day\_1 - y Day\_5 -0.48749705 0.2397830 48  
82 n Day\_1 - n Day\_7 1.64257839 0.2397830 48  
83 n Day\_1 - y Day\_7 0.78869107 0.2397830 48  
84 y Day\_1 - n Day\_3 0.25207268 0.2397830 48  
85 y Day\_1 - y Day\_3 -1.89551868 0.2397830 48  
86 y Day\_1 - n Day\_5 0.83051089 0.2397830 48  
87 y Day\_1 - y Day\_5 -0.55526584 0.2397830 48  
88 y Day\_1 - n Day\_7 1.57480960 0.2397830 48  
89 y Day\_1 - y Day\_7 0.72092229 0.2397830 48  
90 n Day\_3 - y Day\_3 -2.14759136 0.2397830 48  
91 n Day\_3 - n Day\_5 0.57843820 0.2397830 48  
92 n Day\_3 - y Day\_5 -0.80733852 0.2397830 48  
93 n Day\_3 - n Day\_7 1.32273692 0.2397830 48  
94 n Day\_3 - y Day\_7 0.46884960 0.2397830 48  
95 y Day\_3 - n Day\_5 2.72602956 0.2397830 48  
96 y Day\_3 - y Day\_5 1.34025284 0.2397830 48  
97 y Day\_3 - n Day\_7 3.47032828 0.2397830 48  
98 y Day\_3 - y Day\_7 2.61644097 0.2397830 48  
99 n Day\_5 - y Day\_5 -1.38577672 0.2397830 48  
100 n Day\_5 - n Day\_7 0.74429872 0.2397830 48  
101 n Day\_5 - y Day\_7 -0.10958860 0.2397830 48  
102 y Day\_5 - n Day\_7 2.13007544 0.2397830 48  
103 y Day\_5 - y Day\_7 1.27618812 0.2397830 48  
104 n Day\_7 - y Day\_7 -0.85388732 0.2397830 48  
 t.ratio p.value factor  
1 -4.6465838 1.521359e-04 Day  
2 1.0115286 7.434984e-01 Day  
3 6.9698311 4.856333e-08 Day  
4 5.6581124 4.873649e-06 Day  
5 11.6164149 0.000000e+00 Day  
6 5.9583025 1.709576e-06 Day  
7 -9.0070725 6.923623e-12 TB  
8 -2.3174340 6.290873e-02 WTreat  
9 24.5190568 0.000000e+00 WTreat  
10 26.8364907 0.000000e+00 WTreat  
11 2.4952075 3.673389e-01 Day\*WTreat  
12 6.0871232 1.129690e-05 Day\*WTreat  
13 -5.3259891 1.540442e-04 Day\*WTreat  
14 -5.9291158 1.954465e-05 Day\*WTreat  
15 11.7893163 0.000000e+00 Day\*WTreat  
16 0.4653569 9.999983e-01 Day\*WTreat  
17 -2.9468014 1.573217e-01 Day\*WTreat  
18 12.8157941 0.000000e+00 Day\*WTreat  
19 3.4279917 5.073938e-02 Day\*WTreat  
20 0.3132012 1.000000e+00 Day\*WTreat  
21 16.9132393 0.000000e+00 Day\*WTreat  
22 3.5919157 3.304508e-02 Day\*WTreat  
23 -7.8211966 2.627077e-08 Day\*WTreat  
24 -8.4243233 3.262514e-09 Day\*WTreat  
25 9.2941088 1.677356e-10 Day\*WTreat  
26 -2.0298507 6.716810e-01 Day\*WTreat  
27 -5.4420089 1.040033e-04 Day\*WTreat  
28 10.3205866 2.958744e-12 Day\*WTreat  
29 0.9327842 9.983727e-01 Day\*WTreat  
30 -2.1820063 5.697876e-01 Day\*WTreat  
31 14.4180318 0.000000e+00 Day\*WTreat  
32 -11.4131123 0.000000e+00 Day\*WTreat  
33 -12.0162390 0.000000e+00 Day\*WTreat  
34 5.7021932 4.275279e-05 Day\*WTreat  
35 -5.6217663 5.633470e-05 Day\*WTreat  
36 -9.0339246 4.064197e-10 Day\*WTreat  
37 6.7286710 1.200472e-06 Day\*WTreat  
38 -2.6591315 2.775082e-01 Day\*WTreat  
39 -5.7739220 3.340389e-05 Day\*WTreat  
40 10.8261162 0.000000e+00 Day\*WTreat  
41 -0.6031267 9.999751e-01 Day\*WTreat  
42 17.1153055 0.000000e+00 Day\*WTreat  
43 5.7913460 3.145739e-05 Day\*WTreat  
44 2.3791877 4.388765e-01 Day\*WTreat  
45 18.1417832 0.000000e+00 Day\*WTreat  
46 8.7539808 1.054727e-09 Day\*WTreat  
47 5.6391903 5.307043e-05 Day\*WTreat  
48 22.2392285 0.000000e+00 Day\*WTreat  
49 17.7184322 0.000000e+00 Day\*WTreat  
50 6.3944727 3.868566e-06 Day\*WTreat  
51 2.9823144 1.457799e-01 Day\*WTreat  
52 18.7449099 0.000000e+00 Day\*WTreat  
53 9.3571075 1.353071e-10 Day\*WTreat  
54 6.2423170 6.580768e-06 Day\*WTreat  
55 22.8423552 0.000000e+00 Day\*WTreat  
56 -11.3239595 0.000000e+00 Day\*WTreat  
57 -14.7361178 0.000000e+00 Day\*WTreat  
58 1.0264778 9.962387e-01 Day\*WTreat  
59 -8.3613247 4.051934e-09 Day\*WTreat  
60 -11.4761151 0.000000e+00 Day\*WTreat  
61 5.1239230 3.033969e-04 Day\*WTreat  
62 -3.4121583 5.282930e-02 Day\*WTreat  
63 12.3504373 0.000000e+00 Day\*WTreat  
64 2.9626348 1.520910e-01 Day\*WTreat  
65 -0.1521556 1.000000e+00 Day\*WTreat  
66 16.4478825 0.000000e+00 Day\*WTreat  
67 15.7625955 0.000000e+00 Day\*WTreat  
68 6.3747931 4.144016e-06 Day\*WTreat  
69 3.2600026 7.707520e-02 Day\*WTreat  
70 19.8600408 0.000000e+00 Day\*WTreat  
71 -9.3878025 1.218505e-10 Day\*WTreat  
72 -12.5025929 0.000000e+00 Day\*WTreat  
73 4.0974452 7.896020e-03 Day\*WTreat  
74 -3.1147905 1.085209e-01 Day\*WTreat  
75 13.4852477 0.000000e+00 Day\*WTreat  
76 16.6000381 0.000000e+00 Day\*WTreat  
77 0.2826254 9.999917e-01 Day\*TB  
78 1.3338786 8.811923e-01 Day\*TB  
79 -7.6225150 2.254691e-08 Day\*TB  
80 3.7462184 1.049517e-02 Day\*TB  
81 -2.0330755 4.714340e-01 Day\*TB  
82 6.8502690 3.385799e-07 Day\*TB  
83 3.2891861 3.673700e-02 Day\*TB  
84 1.0512531 9.635870e-01 Day\*TB  
85 -7.9051404 8.416364e-09 Day\*TB  
86 3.4635930 2.312956e-02 Day\*TB  
87 -2.3157010 3.066017e-01 Day\*TB  
88 6.5676436 9.143272e-07 Day\*TB  
89 3.0065607 7.421067e-02 Day\*TB  
90 -8.9563936 2.244819e-10 Day\*TB  
91 2.4123398 2.589734e-01 Day\*TB  
92 -3.3669541 2.996437e-02 Day\*TB  
93 5.5163904 3.559339e-05 Day\*TB  
94 1.9553075 5.214920e-01 Day\*TB  
95 11.3687334 0.000000e+00 Day\*TB  
96 5.5894395 2.768988e-05 Day\*TB  
97 14.4727840 0.000000e+00 Day\*TB  
98 10.9117011 0.000000e+00 Day\*TB  
99 -5.7792939 1.437258e-05 Day\*TB  
100 3.1040506 5.863526e-02 Day\*TB  
101 -0.4570323 9.997851e-01 Day\*TB  
102 8.8833445 2.883955e-10 Day\*TB  
103 5.3222616 6.910324e-05 Day\*TB  
104 -3.5610829 1.770574e-02 Day\*TB

ph2b\_table <- f2b\_all\_tukey\_df %>%  
 dplyr::select(factor, contrast, estimate, SE, df, t.ratio, p.value) %>%  
 gt() %>%  
 # change column names  
 cols\_label(  
 factor = "Comparison",  
 contrast = "Group Comparison",  
 estimate = "Estimate",  
 SE = "Standard Error",  
 df = "Degrees of Freedom",  
 t.ratio = "t-Ratio",  
 p.value = "p-value"  
 ) %>%  
 # update header for table  
 tab\_header(  
 title = "4b Emmeans Post-hoc Test Results"  
 ) %>%  
 # 3 decimal places  
 fmt\_number(  
 columns = c(estimate, SE, t.ratio),  
 decimals = 3  
 ) %>%  
 # scientific number format for values <0.001 in p values  
 fmt\_scientific(  
 columns = c(p.value),  
 decimals = 1,  
 rows = p.value < 0.001  
 ) %>%  
 # 3 decimals for p values >=0.001  
 fmt\_number(  
 columns = c(p.value),  
 decimals = 3,  
 rows = p.value >= 0.001  
 ) %>%  
 #make the headers bold  
 tab\_style(  
 style = list(  
 cell\_text(weight = "bold")  
 ),  
 locations = cells\_column\_labels(everything()))  
  
ph2b\_table

Table 1: 4b Emmeans Post-hoc Test Results

| Comparison | Group Comparison | Estimate | Standard Error | Degrees of Freedom | t-Ratio | p-value |
| --- | --- | --- | --- | --- | --- | --- |
| Day | Day\_1 - Day\_3 | -0.788 | 0.170 | 48 | -4.647 | 1.5 × 10^-4 |
| Day | Day\_1 - Day\_5 | 0.172 | 0.170 | 48 | 1.012 | 0.743 |
| Day | Day\_1 - Day\_7 | 1.182 | 0.170 | 48 | 6.970 | 4.9 × 10^-8 |
| Day | Day\_3 - Day\_5 | 0.959 | 0.170 | 48 | 5.658 | 4.9 × 10^-6 |
| Day | Day\_3 - Day\_7 | 1.970 | 0.170 | 48 | 11.616 | 0.0 |
| Day | Day\_5 - Day\_7 | 1.010 | 0.170 | 48 | 5.958 | 1.7 × 10^-6 |
| TB | n - y | -1.080 | 0.120 | 48 | -9.007 | 6.9 × 10^-12 |
| WTreat | (sterile-water) - (PW-MO) | -0.340 | 0.147 | 48 | -2.317 | 0.063 |
| WTreat | (sterile-water) - (PW+MO) | 3.600 | 0.147 | 48 | 24.519 | 0.0 |
| WTreat | (PW-MO) - (PW+MO) | 3.941 | 0.147 | 48 | 26.836 | 0.0 |
| Day\*WTreat | (sterile-water Day\_1) - (PW-MO Day\_1) | 0.733 | 0.294 | 48 | 2.495 | 0.367 |
| Day\*WTreat | (sterile-water Day\_1) - (PW+MO Day\_1) | 1.788 | 0.294 | 48 | 6.087 | 1.1 × 10^-5 |
| Day\*WTreat | (sterile-water Day\_1) - (sterile-water Day\_3) | -1.564 | 0.294 | 48 | -5.326 | 1.5 × 10^-4 |
| Day\*WTreat | (sterile-water Day\_1) - (PW-MO Day\_3) | -1.741 | 0.294 | 48 | -5.929 | 2.0 × 10^-5 |
| Day\*WTreat | (sterile-water Day\_1) - (PW+MO Day\_3) | 3.462 | 0.294 | 48 | 11.789 | 0.0 |
| Day\*WTreat | (sterile-water Day\_1) - (sterile-water Day\_5) | 0.137 | 0.294 | 48 | 0.465 | 1.000 |
| Day\*WTreat | (sterile-water Day\_1) - (PW-MO Day\_5) | -0.865 | 0.294 | 48 | -2.947 | 0.157 |
| Day\*WTreat | (sterile-water Day\_1) - (PW+MO Day\_5) | 3.764 | 0.294 | 48 | 12.816 | 0.0 |
| Day\*WTreat | (sterile-water Day\_1) - (sterile-water Day\_7) | 1.007 | 0.294 | 48 | 3.428 | 0.051 |
| Day\*WTreat | (sterile-water Day\_1) - (PW-MO Day\_7) | 0.092 | 0.294 | 48 | 0.313 | 1.000 |
| Day\*WTreat | (sterile-water Day\_1) - (PW+MO Day\_7) | 4.967 | 0.294 | 48 | 16.913 | 0.0 |
| Day\*WTreat | (PW-MO Day\_1) - (PW+MO Day\_1) | 1.055 | 0.294 | 48 | 3.592 | 0.033 |
| Day\*WTreat | (PW-MO Day\_1) - (sterile-water Day\_3) | -2.297 | 0.294 | 48 | -7.821 | 2.6 × 10^-8 |
| Day\*WTreat | (PW-MO Day\_1) - (PW-MO Day\_3) | -2.474 | 0.294 | 48 | -8.424 | 3.3 × 10^-9 |
| Day\*WTreat | (PW-MO Day\_1) - (PW+MO Day\_3) | 2.729 | 0.294 | 48 | 9.294 | 1.7 × 10^-10 |
| Day\*WTreat | (PW-MO Day\_1) - (sterile-water Day\_5) | -0.596 | 0.294 | 48 | -2.030 | 0.672 |
| Day\*WTreat | (PW-MO Day\_1) - (PW-MO Day\_5) | -1.598 | 0.294 | 48 | -5.442 | 1.0 × 10^-4 |
| Day\*WTreat | (PW-MO Day\_1) - (PW+MO Day\_5) | 3.031 | 0.294 | 48 | 10.321 | 3.0 × 10^-12 |
| Day\*WTreat | (PW-MO Day\_1) - (sterile-water Day\_7) | 0.274 | 0.294 | 48 | 0.933 | 0.998 |
| Day\*WTreat | (PW-MO Day\_1) - (PW-MO Day\_7) | -0.641 | 0.294 | 48 | -2.182 | 0.570 |
| Day\*WTreat | (PW-MO Day\_1) - (PW+MO Day\_7) | 4.234 | 0.294 | 48 | 14.418 | 0.0 |
| Day\*WTreat | (PW+MO Day\_1) - (sterile-water Day\_3) | -3.352 | 0.294 | 48 | -11.413 | 0.0 |
| Day\*WTreat | (PW+MO Day\_1) - (PW-MO Day\_3) | -3.529 | 0.294 | 48 | -12.016 | 0.0 |
| Day\*WTreat | (PW+MO Day\_1) - (PW+MO Day\_3) | 1.675 | 0.294 | 48 | 5.702 | 4.3 × 10^-5 |
| Day\*WTreat | (PW+MO Day\_1) - (sterile-water Day\_5) | -1.651 | 0.294 | 48 | -5.622 | 5.6 × 10^-5 |
| Day\*WTreat | (PW+MO Day\_1) - (PW-MO Day\_5) | -2.653 | 0.294 | 48 | -9.034 | 4.1 × 10^-10 |
| Day\*WTreat | (PW+MO Day\_1) - (PW+MO Day\_5) | 1.976 | 0.294 | 48 | 6.729 | 1.2 × 10^-6 |
| Day\*WTreat | (PW+MO Day\_1) - (sterile-water Day\_7) | -0.781 | 0.294 | 48 | -2.659 | 0.278 |
| Day\*WTreat | (PW+MO Day\_1) - (PW-MO Day\_7) | -1.696 | 0.294 | 48 | -5.774 | 3.3 × 10^-5 |
| Day\*WTreat | (PW+MO Day\_1) - (PW+MO Day\_7) | 3.179 | 0.294 | 48 | 10.826 | 0.0 |
| Day\*WTreat | (sterile-water Day\_3) - (PW-MO Day\_3) | -0.177 | 0.294 | 48 | -0.603 | 1.000 |
| Day\*WTreat | (sterile-water Day\_3) - (PW+MO Day\_3) | 5.026 | 0.294 | 48 | 17.115 | 0.0 |
| Day\*WTreat | (sterile-water Day\_3) - (sterile-water Day\_5) | 1.701 | 0.294 | 48 | 5.791 | 3.1 × 10^-5 |
| Day\*WTreat | (sterile-water Day\_3) - (PW-MO Day\_5) | 0.699 | 0.294 | 48 | 2.379 | 0.439 |
| Day\*WTreat | (sterile-water Day\_3) - (PW+MO Day\_5) | 5.328 | 0.294 | 48 | 18.142 | 0.0 |
| Day\*WTreat | (sterile-water Day\_3) - (sterile-water Day\_7) | 2.571 | 0.294 | 48 | 8.754 | 1.1 × 10^-9 |
| Day\*WTreat | (sterile-water Day\_3) - (PW-MO Day\_7) | 1.656 | 0.294 | 48 | 5.639 | 5.3 × 10^-5 |
| Day\*WTreat | (sterile-water Day\_3) - (PW+MO Day\_7) | 6.531 | 0.294 | 48 | 22.239 | 0.0 |
| Day\*WTreat | (PW-MO Day\_3) - (PW+MO Day\_3) | 5.203 | 0.294 | 48 | 17.718 | 0.0 |
| Day\*WTreat | (PW-MO Day\_3) - (sterile-water Day\_5) | 1.878 | 0.294 | 48 | 6.394 | 3.9 × 10^-6 |
| Day\*WTreat | (PW-MO Day\_3) - (PW-MO Day\_5) | 0.876 | 0.294 | 48 | 2.982 | 0.146 |
| Day\*WTreat | (PW-MO Day\_3) - (PW+MO Day\_5) | 5.505 | 0.294 | 48 | 18.745 | 0.0 |
| Day\*WTreat | (PW-MO Day\_3) - (sterile-water Day\_7) | 2.748 | 0.294 | 48 | 9.357 | 1.4 × 10^-10 |
| Day\*WTreat | (PW-MO Day\_3) - (PW-MO Day\_7) | 1.833 | 0.294 | 48 | 6.242 | 6.6 × 10^-6 |
| Day\*WTreat | (PW-MO Day\_3) - (PW+MO Day\_7) | 6.708 | 0.294 | 48 | 22.842 | 0.0 |
| Day\*WTreat | (PW+MO Day\_3) - (sterile-water Day\_5) | -3.326 | 0.294 | 48 | -11.324 | 0.0 |
| Day\*WTreat | (PW+MO Day\_3) - (PW-MO Day\_5) | -4.328 | 0.294 | 48 | -14.736 | 0.0 |
| Day\*WTreat | (PW+MO Day\_3) - (PW+MO Day\_5) | 0.301 | 0.294 | 48 | 1.026 | 0.996 |
| Day\*WTreat | (PW+MO Day\_3) - (sterile-water Day\_7) | -2.455 | 0.294 | 48 | -8.361 | 4.1 × 10^-9 |
| Day\*WTreat | (PW+MO Day\_3) - (PW-MO Day\_7) | -3.370 | 0.294 | 48 | -11.476 | 0.0 |
| Day\*WTreat | (PW+MO Day\_3) - (PW+MO Day\_7) | 1.505 | 0.294 | 48 | 5.124 | 3.0 × 10^-4 |
| Day\*WTreat | (sterile-water Day\_5) - (PW-MO Day\_5) | -1.002 | 0.294 | 48 | -3.412 | 0.053 |
| Day\*WTreat | (sterile-water Day\_5) - (PW+MO Day\_5) | 3.627 | 0.294 | 48 | 12.350 | 0.0 |
| Day\*WTreat | (sterile-water Day\_5) - (sterile-water Day\_7) | 0.870 | 0.294 | 48 | 2.963 | 0.152 |
| Day\*WTreat | (sterile-water Day\_5) - (PW-MO Day\_7) | -0.045 | 0.294 | 48 | -0.152 | 1.000 |
| Day\*WTreat | (sterile-water Day\_5) - (PW+MO Day\_7) | 4.830 | 0.294 | 48 | 16.448 | 0.0 |
| Day\*WTreat | (PW-MO Day\_5) - (PW+MO Day\_5) | 4.629 | 0.294 | 48 | 15.763 | 0.0 |
| Day\*WTreat | (PW-MO Day\_5) - (sterile-water Day\_7) | 1.872 | 0.294 | 48 | 6.375 | 4.1 × 10^-6 |
| Day\*WTreat | (PW-MO Day\_5) - (PW-MO Day\_7) | 0.957 | 0.294 | 48 | 3.260 | 0.077 |
| Day\*WTreat | (PW-MO Day\_5) - (PW+MO Day\_7) | 5.832 | 0.294 | 48 | 19.860 | 0.0 |
| Day\*WTreat | (PW+MO Day\_5) - (sterile-water Day\_7) | -2.757 | 0.294 | 48 | -9.388 | 1.2 × 10^-10 |
| Day\*WTreat | (PW+MO Day\_5) - (PW-MO Day\_7) | -3.672 | 0.294 | 48 | -12.503 | 0.0 |
| Day\*WTreat | (PW+MO Day\_5) - (PW+MO Day\_7) | 1.203 | 0.294 | 48 | 4.097 | 0.008 |
| Day\*WTreat | (sterile-water Day\_7) - (PW-MO Day\_7) | -0.915 | 0.294 | 48 | -3.115 | 0.109 |
| Day\*WTreat | (sterile-water Day\_7) - (PW+MO Day\_7) | 3.960 | 0.294 | 48 | 13.485 | 0.0 |
| Day\*WTreat | (PW-MO Day\_7) - (PW+MO Day\_7) | 4.875 | 0.294 | 48 | 16.600 | 0.0 |
| Day\*TB | n Day\_1 - y Day\_1 | 0.068 | 0.240 | 48 | 0.283 | 1.000 |
| Day\*TB | n Day\_1 - n Day\_3 | 0.320 | 0.240 | 48 | 1.334 | 0.881 |
| Day\*TB | n Day\_1 - y Day\_3 | -1.828 | 0.240 | 48 | -7.623 | 2.3 × 10^-8 |
| Day\*TB | n Day\_1 - n Day\_5 | 0.898 | 0.240 | 48 | 3.746 | 0.010 |
| Day\*TB | n Day\_1 - y Day\_5 | -0.487 | 0.240 | 48 | -2.033 | 0.471 |
| Day\*TB | n Day\_1 - n Day\_7 | 1.643 | 0.240 | 48 | 6.850 | 3.4 × 10^-7 |
| Day\*TB | n Day\_1 - y Day\_7 | 0.789 | 0.240 | 48 | 3.289 | 0.037 |
| Day\*TB | y Day\_1 - n Day\_3 | 0.252 | 0.240 | 48 | 1.051 | 0.964 |
| Day\*TB | y Day\_1 - y Day\_3 | -1.896 | 0.240 | 48 | -7.905 | 8.4 × 10^-9 |
| Day\*TB | y Day\_1 - n Day\_5 | 0.831 | 0.240 | 48 | 3.464 | 0.023 |
| Day\*TB | y Day\_1 - y Day\_5 | -0.555 | 0.240 | 48 | -2.316 | 0.307 |
| Day\*TB | y Day\_1 - n Day\_7 | 1.575 | 0.240 | 48 | 6.568 | 9.1 × 10^-7 |
| Day\*TB | y Day\_1 - y Day\_7 | 0.721 | 0.240 | 48 | 3.007 | 0.074 |
| Day\*TB | n Day\_3 - y Day\_3 | -2.148 | 0.240 | 48 | -8.956 | 2.2 × 10^-10 |
| Day\*TB | n Day\_3 - n Day\_5 | 0.578 | 0.240 | 48 | 2.412 | 0.259 |
| Day\*TB | n Day\_3 - y Day\_5 | -0.807 | 0.240 | 48 | -3.367 | 0.030 |
| Day\*TB | n Day\_3 - n Day\_7 | 1.323 | 0.240 | 48 | 5.516 | 3.6 × 10^-5 |
| Day\*TB | n Day\_3 - y Day\_7 | 0.469 | 0.240 | 48 | 1.955 | 0.521 |
| Day\*TB | y Day\_3 - n Day\_5 | 2.726 | 0.240 | 48 | 11.369 | 0.0 |
| Day\*TB | y Day\_3 - y Day\_5 | 1.340 | 0.240 | 48 | 5.589 | 2.8 × 10^-5 |
| Day\*TB | y Day\_3 - n Day\_7 | 3.470 | 0.240 | 48 | 14.473 | 0.0 |
| Day\*TB | y Day\_3 - y Day\_7 | 2.616 | 0.240 | 48 | 10.912 | 0.0 |
| Day\*TB | n Day\_5 - y Day\_5 | -1.386 | 0.240 | 48 | -5.779 | 1.4 × 10^-5 |
| Day\*TB | n Day\_5 - n Day\_7 | 0.744 | 0.240 | 48 | 3.104 | 0.059 |
| Day\*TB | n Day\_5 - y Day\_7 | -0.110 | 0.240 | 48 | -0.457 | 1.000 |
| Day\*TB | y Day\_5 - n Day\_7 | 2.130 | 0.240 | 48 | 8.883 | 2.9 × 10^-10 |
| Day\*TB | y Day\_5 - y Day\_7 | 1.276 | 0.240 | 48 | 5.322 | 6.9 × 10^-5 |
| Day\*TB | n Day\_7 - y Day\_7 | -0.854 | 0.240 | 48 | -3.561 | 0.018 |