lakewatch lake template batch processing

```
#tinytex::tlmgr_update()
```

Florida LAKEWATCH Report for «Lake» in «County» County Using Data Downloaded 12/9/2022

Introduction for Lakes

This report summarizes data collected on systems that have been part of the LAKEWATCH program. Data are from the period of record for individual systems. Part one allows the comparison of data with Florida Department of Environmental Protection's Numeric Nutrient Criteria. Part two allows a comparison of the long-term mean nutrient concentrations with nutrient zone concentrations published by LAKEWATCH staff (Bachmann et al. 2012; https://lakewatch.ifas.ufl.edu/resources/bibliography/). Finally, this report examines data for long-term trends that may be occurring in individual systems but only for systems with **five or more years of data**. Step by step instructions on how to use the data tables are provided on page 4 of this report.

Florida Department of Environmental Protection (FDEP) Nutrient Criteria for Lakes (Table 1)

For lakes, the numeric interpretations of the nutrient criterion in paragraph 62-302.530(47)(b), F.A.C., based on chlorophyll are shown in Table 1. The applicable interpretations for TN and TP will vary on an annual basis, depending on the availability and concentration of chlorophyll data for the lake. The numeric interpretations for TN, TP, and chlorophyll shall not be exceeded more than once in any consecutive three year period.

a. If annual geometric mean chlorophyll does not exceed the chlorophyll value for one of three lake classification groups listed in the table below, then the TN and TP numeric interpretations for that calendar year shall be the annual geometric means of the maximum calculated numeric interpretation in Table 1.

b. If there are insufficient data to calculate the annual geometric mean chlorophyll for a given year or the annual geometric mean chlorophyll exceeds the values in Table 1 for the correct lake classification group, then the applicable numeric interpretations for TN and TP shall be the minimum values in Table 1.

Long-Term Data Summary for Lakes (Table 2): Definitions

- **Total Phosphorus (µg/L):** Nutrient most often limiting growth of plant/algae.
- **Total Nitrogen (µg/L):** Nutrient needed for aquatic plant/algae growth but only limiting when nitrogen to phosphorus ratios are generally less than 10 (by mass).
- **Chlorophyll-uncorrected (µg/L):** Chlorophyll concentrations are used to measure relative abundances of open water algae.
- **Secchi (ft), Secchi (m):** Secchi measurements are estimates of water clarity.

- **Color (Pt-Co Units):** LAKEWATCH measures true color, which is the color of the water after particles have been filtered out.
- **Specific Conductance (µS/cm @ 25 C):** Measurement of the ability of water to conduct electricity and can be used to estimate the amount of dissolved materials in water.
- **Lake Classification:** Numeric nutrient criteria for Florida require that lakes must first be classified into one of three group based on color and alkalinity or specific conductance; **colored lakes** (color greater than 40 Pt-Co units), **clear soft water lakes** (color less than or equal to 40 Pt-Co units and alkalinity less than or equal to 20 mg/L as CaCO3 or specific conductance less than or equal to 100 µs/cm @25 C), and **clear hard water lakes** (color less than 40 Pt-Co units and alkalinity greater than 20 mg/L as CaCO3 or specific conductance greater 100 µS/cm @ 25 C).

Table 1. Florida Department of Environmental Protection's Numeric Nutrient Criteria for lakes.

[1 For lakes with color > 40 PCU in the West Central Nutrient Watershed Region, the maximum TP limit shall be the 490 µg/L TP streams threshold for the region.]

```r
knitr::include_graphics("LW Reports Table 1 V.2.png")
```

Long Term Geometric Mean Lake Color and Long-Term Geometric Mean Color, Alkalinity and Specific Conductance	Annual Geometric Mean Chlorophyll-corrected
> 40 Platinum Cobalt Units **Colored Lakes**	20 µg/L
≤ 40 Platinum Cobalt Units and > 20 mg/L $CaCO_3$ or >100 µS/cm@25 C **Clear Hard Water Lakes**	20 µg/L
≤ 40 Platinum Cobalt Units and ≤ 20 mg/L $CaCO_3$ or < 100 µS/cm@25 C **Clear Soft Water Lakes**	6 µg/L

For the purpose of subparagraph 62-302.531(2)(b)1., F.A.C., color shall be assessed as true color and shall be free from turbidity. Lake color and alkalinity shall be the long-term geometric mean, based on a minimum of ten data points over at least three years with at least one data point in each year. If insufficient alkalinity data are available, long-term geometric mean specific conductance values shall be used, with a value of <100 µS/cm@25 C used to estimate the mg/L $CaCO_3$ alkalinity concentration until such time that alkalinity data are available.

```
knitr::include_graphics("output/output_table/table_2.png")
```

Table 2. Long-term trophic state data
variables color and specific conductanc
evaluate

Parameter	Minimu Annual
Total Phosphorus (μg/L)	60
Total Nitrogen (μg/L)	590
Chlorophyll- uncorrected (μg/L)	5
Secchi (ft)	0.5
Secchi (m)	0.15
Color (Pt-Co Units)	15
Specific Conductance (μS/cm@25 C)	110
Lake Classification	Clear H

```
### TABLE 3 CODE ###

#geometric means by year
byyr <- Lake_2 %>%
  group_by(Year) %>%
  summarize(gmean(TP), gmean(TN), gmean(CHL), gmean(SECCHI_ft))

#total geometric means means
ggtp <- gmean(byyr$`gmean(TP)`)
ggtn <- gmean(byyr$`gmean(TN)`)
ggchl <- gmean(byyr$`gmean(CHL)`)
ggsec <- gmean(byyr$`gmean(SECCHI_ft)`)

#calculate TSI
tsi_sd <- 60 -14.41*ln(ggsec)
tsi_chl <- 9.81* ln(ggchl) + 30.6
tsi_tp <- 14.42* ln(ggtp) + 4.15
tsi <- mean(tsi_sd, tsi_chl, tsi_tp)

#define variables
cnty <- Lake_2$County[1] #county
name <- Lake_2$Lake[1] #name
pr <- paste(min(Lake_2$Year), " to ", max(Lake_2$Year)) #period of record
lts <- ifelse(tsi < 40 , "Oligotrophic",
              (ifelse(tsi < 50 , "Mesotrophic",
               (ifelse(tsi < 70, "Eutrophic", "Hypereutrophic"))))) #lake trophic status
tpz <- Lake_1$`TP Zone`[1] #tp zone
gtp <- paste(ggtp, "(", min(byyr$`gmean(TP)`), " to ", max(byyr$`gmean(TP)`) , ")" ) #grand total phosp
tnz <- Lake_1$`TN Zone`[1]
gtn <- paste(ggtn, "(", min(byyr$`gmean(TN)`), " to ", max(byyr$`gmean(TN)`), ")") #grand tn geomean
gnis <- Lake_1$GNIS_ID[1]
lat <- Lake_1$Latitude[1]
long <- Lake_1$Longitude[1]
wbt <- Lake_1$`water type`[1]
sa <- paste(Lake_1$`SA (hectare)`[1], "ha, ", Lake_1$`SA (acres)`[1], "acres")


### IF Statements (Before I had access to the base file).  Will possible use later
# tpz <- ifelse(ggtp >= 355, "TP6",
#               (ifelse(ggtp >= 252, "TP5",
#                (ifelse(ggtp >= 93, "TP4",
#                 (ifelse(ggtp >= 45, "TP3",
#                  (ifelse(ggtp >= 21, "TP2","TP1")))))))) #tp zone
# tnz <- ifelse(ggtn >= 2701, "TN6",
#               (ifelse(ggtn >= 1369, "TN5",
#                (ifelse(ggtn >= 1087, "TN4",
#                 (ifelse(ggtn >= 642, "TN3",
#                  (ifelse(ggtn >= 450, "TN2","TN1")))))))) #tn zone


#add values to array
rowval <- c(cnty, name, gnis, lat, long, wbt, sa, pr, lts, tpz, gtp, tnz, gtn )
```

```r
#add row names to array
rowname <- c("County", "Name", "GNIS Number", "Latitude", "Longitude", "Water Body Type", "Surface Area

#make dataframe with rownames and row values
tbl3df <- data.frame(rowname, rowval)
#make gt table
table_three = gt(tbl3df) %>% tab_options(column_labels.hidden = TRUE) %>% fmt_number(
  decimals = 1
) %>% tab_header(
  title = md("**Table 3.** Base File Data, long-term nutrient grand geometric means and Nutrient Zone cl

gtsave(table_three, filename = "table_3.png", path = "output/output_table")
```

```r
knitr::include_graphics("output/output_table/table_3.png")
```

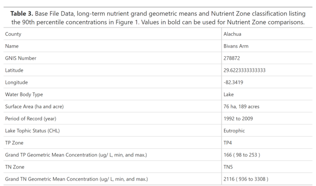


Table 3. Base File Data, long-term nutrient grand geometric means and Nutrient Zone classification listing the 90th percentile concentrations in Figure 1. Values in bold can be used for Nutrient Zone comparisons.

County	Alachua
Name	Bivans Arm
GNIS Number	278872
Latitude	29.6223333333333
Longitude	-82.3419
Water Body Type	Lake
Surface Area (ha and acre)	76 ha, 189 acres
Period of Record (year)	1992 to 2009
Lake Tophic Status (CHL)	Eutrophic
TP Zone	TP4
Grand TP Geometric Mean Concentration (ug/ L, min, and max.)	166 (98 to 253)
TN Zone	TN5
Grand TN Geometric Mean Concentration (ug/ L, min, and max.)	2116 (936 to 3308)

#graph example

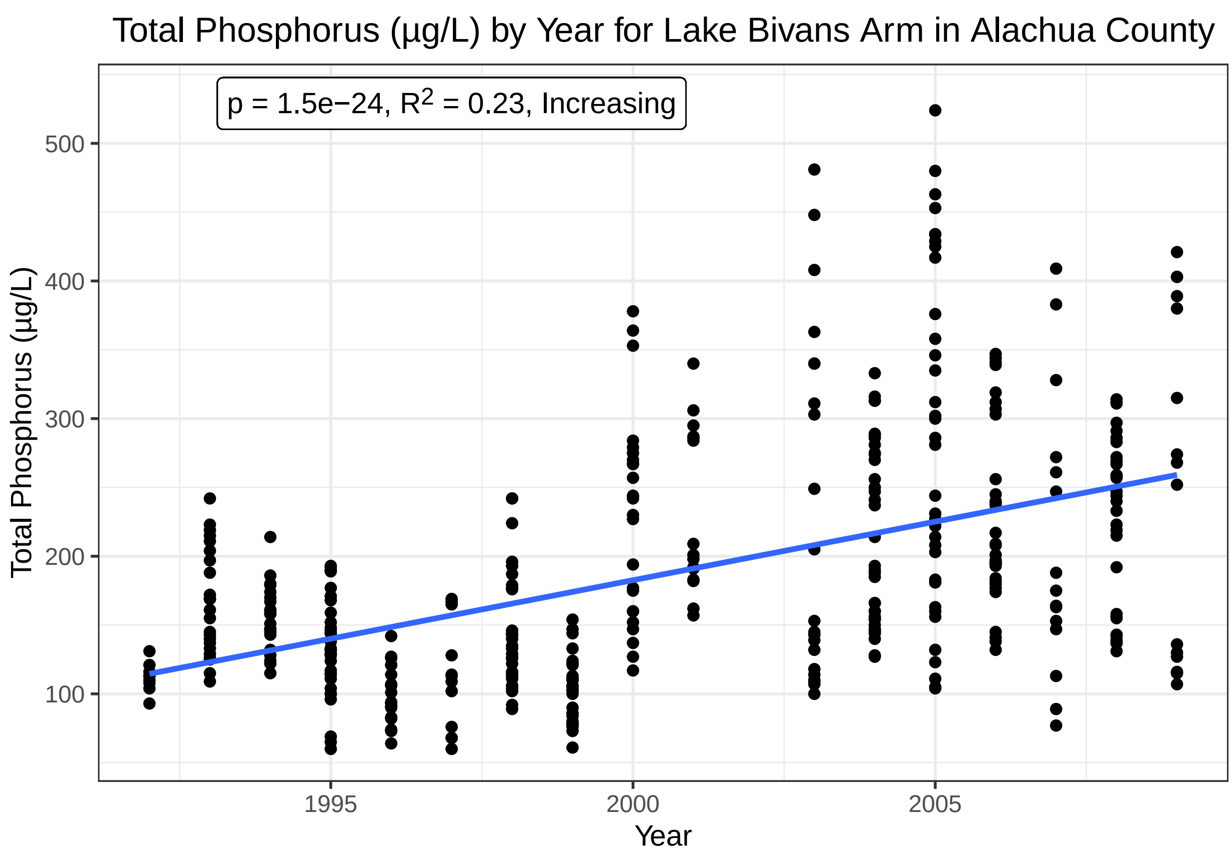
this is an example of the phosphorous graph, work in progress still

Figure 2 and Figure 3. Trend plots of annual average total phosphorus and annual average total nitrogen versus year. The R2 value indicates the strength of the relations (ranges from 0.0 to 1.0; higher the R2 the stronger the relation) and the p value indicates if the relation is significant ($p < 0.05$ is significant). Trend Status are reported on plots.

```r
#lm for graph to refer to

total_p_lm = lm(TP ~ Year, data = Lake_2)

total_p_table = glance(total_p_lm)

trend = if_else(total_p_table$p.value >= 0.5, true = "No trend", false = if_else(total_p_lm[["coefficie

plot_title = glue("Total Phosphorus (µg/L) by Year for Lake {Lake_2$Lake[1]} in {Lake_2$County[1]} Coun


label = (glue("p = {signif(total_p_table$p.value, digits = 2)}, R<sup>2</sup> = {signif(total_p_table$r

maxlim = max(Lake_2$TP)+10
minlim = min(Lake_2$TP)

total_p_graph = ggplot(data = Lake_2, aes(x = Year, y = TP)) +
  geom_point() +
  geom_smooth(
    method = "lm",
    se = FALSE,
    linetype = paste(
      if_else(total_p_table$p.value <= 0.5,true = "solid", false = "dashed" )
      )
```

```
  ) +
  labs(title = plot_title, x = "Year", y = "Total Phosphorus (µg/L)")+
  theme_bw() +
  theme(plot.title = element_text(hjust = 0.5)) + geom_richtext(
    label = label
    ,x = (min(Lake_2$Year, na.rm = TRUE)+5),
    y = (max(Lake_2$TP, na.rm = TRUE)+5),
    )+ylim(minlim, maxlim)


show(total_p_graph)
```

```
## `geom_smooth()` using formula = 'y ~ x'
```




```
total_n_lm = lm(TN ~ Year, data = Lake_2)

total_n_table = glance(total_n_lm)

trend = if_else(total_n_table$p.value >= 0.5, true = "No trend", false = if_else(total_n_lm[["coefficie

plot_title = glue("Total Nitrogen (µg/L) by Year for Lake {Lake_2$Lake[1]} in {Lake_2$County[1]} County


label = (glue("p = {signif(total_n_table$p.value, digits = 2)}, R<sup>2</sup> = {signif(total_n_table$r
```

```r
maxlim = max(Lake_2$TN)+10
minlim = min(Lake_2$TN)

total_n_graph = ggplot(data = Lake_2, aes(x = Year, y = TN)) +
  geom_point() +
  geom_smooth(
    method = "lm",
    se = FALSE,
    linetype = paste(
      if_else(total_n_table$p.value <= 0.5,true = "solid", false = "dashed" )
      )
    ) +
  labs(title = plot_title, x = "Year", y = "Total Nitrogen (µg/L)")+
  theme_bw() +
  theme(plot.title = element_text(hjust = 0.5)) + geom_richtext(
    label = label
    ,x = (min(Lake_2$Year, na.rm = TRUE)+5),
    y = (max(Lake_2$TN, na.rm = TRUE)+5),
    )+ylim(minlim, maxlim)


show(total_n_graph)
```

```
## `geom_smooth()` using formula = 'y ~ x'
```

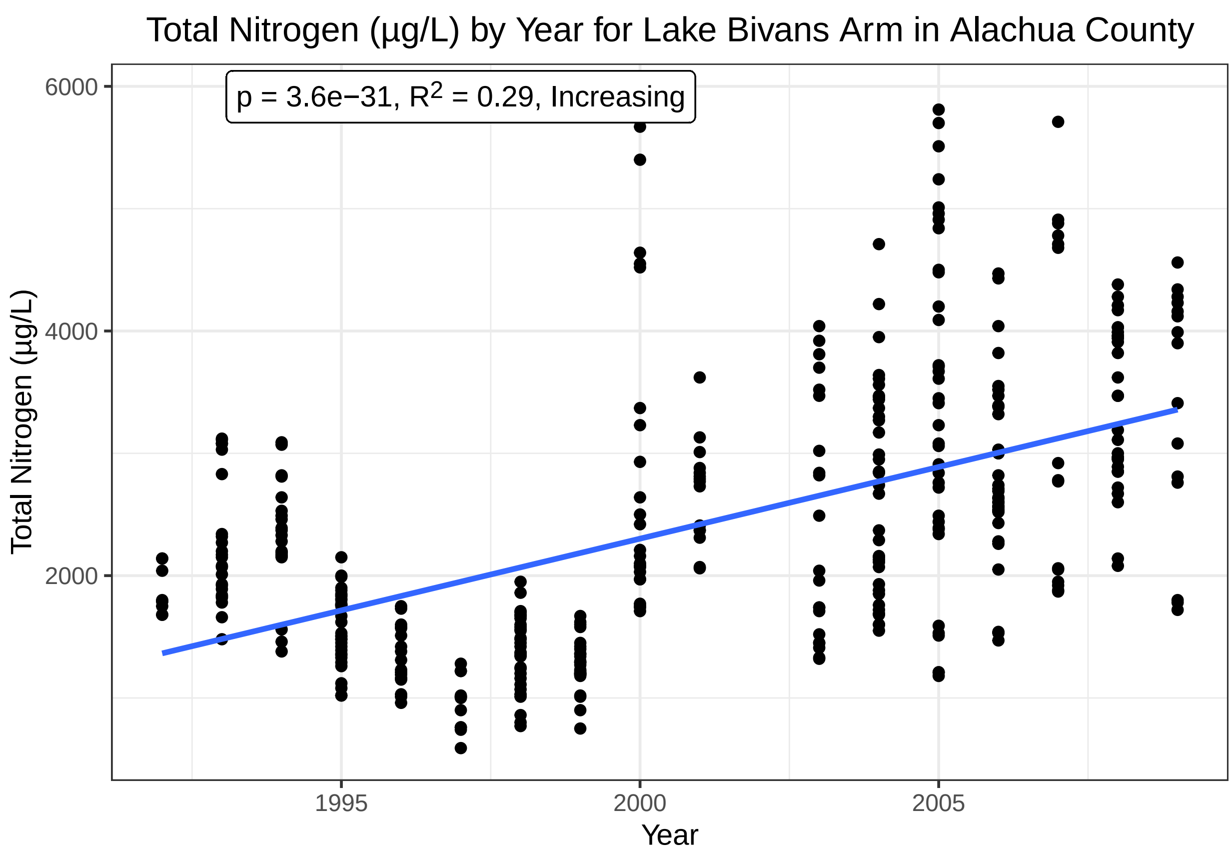
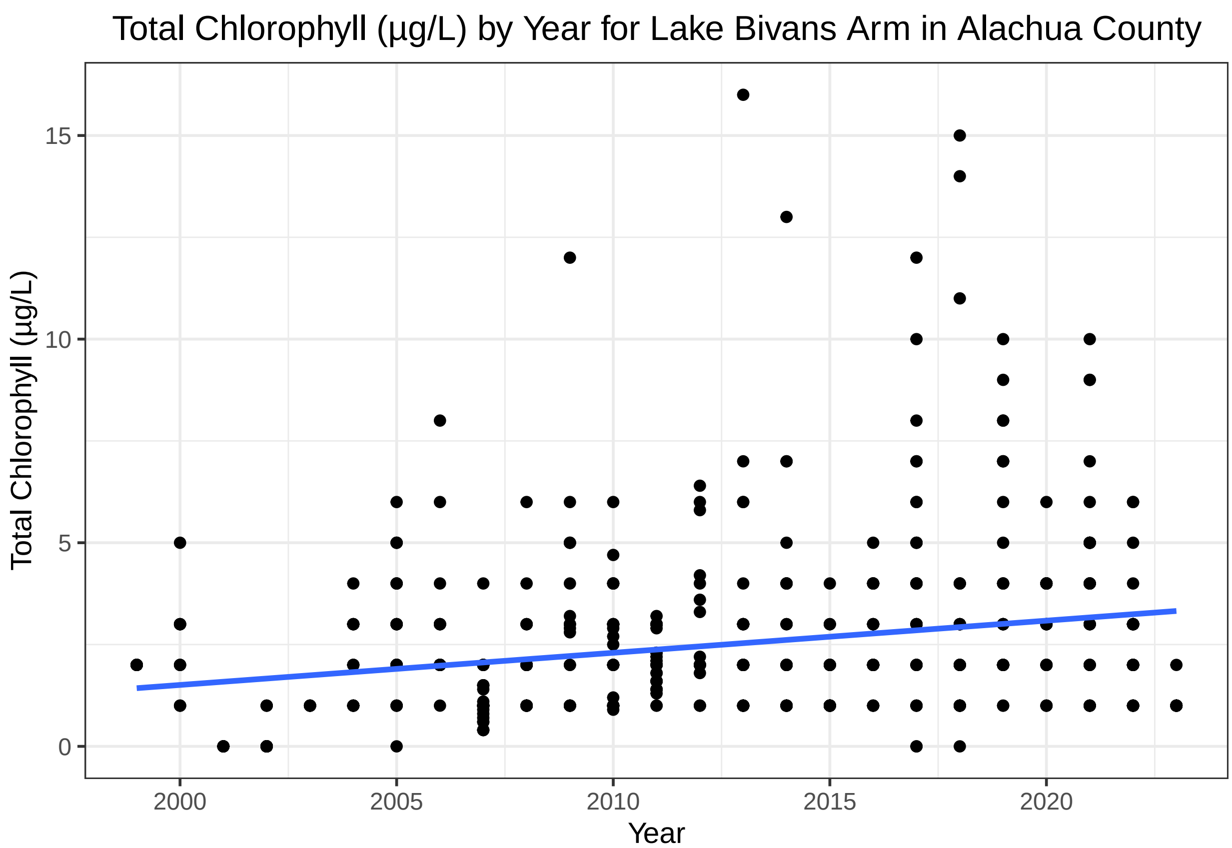


Figure 4 and Figure 5. Trend plots of annual average chlorophyll and annual average Secchi versus year. The R2 value indicates the strength of the relations (ranges from 0.0 to 1.0; higher the R2 the stronger the relations and the p value indicates if the relation is significant ($p < 0.05$ is significant). Trend status are reported on plots.

```
total_chl_lm = lm(CHL ~ Year, data = Lake_2)

total_chl_table = glance(total_chl_lm)

trend = if_else(total_chl_table$p.value >= 0.5, true = "No trend", false = if_else(total_chl_lm[["coeffi

plot_title = glue("Total Chlorophyll (µg/L) by Year for Lake {Lake_2$Lake[1]} in {Lake_2$County[1]} Cou


label = (glue("p = {signif(total_chl_table$p.value, digits = 2)}, R<sup>2</sup> = {signif(total_chl_tab

maxlim = max(Lake_2$CHL)+10
minlim = min(Lake_2$CHL)

total_chl_graph = ggplot(data = Lake, aes(x = Year, y = CHL)) +
  geom_point() +
  geom_smooth(
    method = "lm",
    se = FALSE,
    linetype = paste(
      if_else(total_chl_table$p.value <= 0.5,true = "solid", false = "dashed" )
      )
    ) +
  labs(title = plot_title, x = "Year", y = "Total Chlorophyll (µg/L)")+
  theme_bw() +
  theme(plot.title = element_text(hjust = 0.5)) + geom_richtext(
    label = label
    ,x = (min(Lake_2$Year,na.rm = TRUE)+5),
    y = (max(Lake_2$CHL, na.rm = TRUE)+5),
    )+ylim(minlim, maxlim)

show(total_chl_graph)
```

```
## `geom_smooth()` using formula = 'y ~ x'

## Warning: Removed 33 rows containing non-finite values (`stat_smooth()`).

## Warning: Removed 33 rows containing missing values (`geom_point()`).
```




```
total_secchi_lm = lm(SECCHI_ft ~ Year, data = Lake_2)

total_secchi_table = glance(total_secchi_lm)

trend = if_else(total_secchi_table$p.value >= 0.5, true = "No trend", false = if_else(total_secchi_lm[[

plot_title = glue("Secchi Depth (ft) by Year for Lake {Lake_2$Lake[1]} in {Lake_2$County[1]} County")


label = (glue("p = {signif(total_secchi_table$p.value, digits = 2)}, R<sup>2</sup> = {signif(total_secc

maxlim = max(Lake_2$SECCHI_ft, na.rm = TRUE)+10
minlim = min(Lake_2$SECCHI_ft, na.rm = TRUE)

total_secchi_graph = ggplot(data = Lake_2, aes(x = Year, y = SECCHI_ft)) +
  geom_point() +
  geom_smooth(
    method = "lm",
    se = FALSE,
    linetype = paste(
      if_else(total_secchi_table$p.value <= 0.5,true = "solid", false = "dashed" )
      )
    ) +
  labs(title = plot_title, x = "Year", y = "Secchi depth (ft)")+
  theme_bw() +
  theme(plot.title = element_text(hjust = 0.5)) + geom_richtext(
```

```
    label = label,
    x = (min(Lake_2$Year, na.rm = TRUE)+5),
    y = (max(Lake_2$SECCHI_ft, na.rm = TRUE)+5)
    )+ylim(minlim, maxlim)




show(total_secchi_graph)
```

```
## `geom_smooth()` using formula = 'y ~ x'
```

```
## Warning: Removed 12 rows containing non-finite values (`stat_smooth()`).
```

```
## Warning: Removed 12 rows containing missing values (`geom_point()`).
```