SEACAR Discrete Water Quality Analysis: Lab Surface Turbidity

Last compiled on 06 April, 2022

Contents

Purpose

The purpose of this script is to analyze the discrete surface turbidity data measured in the lab that is created from the SEACAR database, apply filtering criteria, create summary plots, and perform seasonal Kendall Tau analysis for each program location and summary statistics for values measured at the desired depth.

All scripts and outputs can be found on the SEACAR GitHub repository:

https://github.com/FloridaSEACAR/SEACAR_Panzik

Note: The top 2% of data is excluded when computing mean and standard deviations in plotting sections solely for the purpose of getting y-axis scales. The exclusion of the top 2% is not used in any statistics that are exported.

Adjustable Inputs

This is placed early so that is is easier to edit parameters that users may want to adjust.

The first variable is whether you want to create the summary plots in the appendices. If you want to see all appendix plots, set `APP_Plots` to `TRUE`. If you would like to only perform the analysis and export the data files with minimal plots, set `APP_Plots` to `FALSE`. This option is available because generating the plots in the appendices increases the processing time significantly.

Since the file names all have similar structure with only the parameter name being varied, the code below sets variables to include standard string information that is the same across all data files.

This includes: the raw data directory (`in_dir`), output file directory (`out_dit`), file prefix (`file_pref`), date the files were created from the database (`file_date`), the name of the parameter of interest (`param_name`), the relative depth of interest (`depth`), and where the data was measured (`activity`). The complete file name is created by pasting all of the strings together with the specific parameter name without spaces (`paste0` command).

```
APP_Plots <- TRUE
in_dir <- "data/"
out_dir <- "output/"
file_pref <- "Combined_WQ_WC_NUT_"
file_date <- "2022-Apr-05"
param_name <- "Turbidity"
depth <- "Surface"
activity <- "Sample"
```

Libraries

Loads libraries used in the script. The inclusion of `scipen` option limits how frequently R defaults to scientific notation.

```
library(knitr)
library(data.table)
library(dplyr)
library(lubridate)
library(ggplot2)
library(ggpubr)
library(scales)
library(EnvStats)
library(tidyr)
options(scipen = 999)
```

File Import

Creates file name from inputs above and read in the file from txt format with pipe delimiters.

The code creates output directories for the output files if they don't exist in the directory.

The command `fread` is used because of its improved speed while handling large data files. Only columns that are used by the script are imported from the file, and are designated in the `select` input.

The script then gets the units of the parameter, sets the `SampleDate` as a date object, and creates various scales of the date to be used by plotting functions.

```
if(!file.exists("output")){
   dir.create("output")}

file_in <- paste0(in_dir, file_pref, param_name, "-", file_date, ".txt")
data <-fread(file_in, sep = "|", header = TRUE, stringsAsFactors = FALSE,
             select = c("ManagedAreaName", "ProgramID", "ProgramName",
                        "ProgramLocationID", "SampleDate", "Year", "Month",
                        "RelativeDepth", "ActivityType", "ResultValue",
                        "ParameterUnits", "ValueQualifier",
                        "SEACAR_QAQCFlagCode", "Include"), na.strings = "")

unit <- unique(data$ParameterUnits)
data$SampleDate <- as.Date(data$SampleDate)
data$YearMonth <- paste0(data$Month, "-", data$Year)
data$YearMonthDec <- data$Year + ((data$Month-0.5) / 12)
data$DecDate <- decimal_date(data$SampleDate)
```

Data Filtering and Data Impacted by Specific Value Qualifiers

Most data filtering is performed on export from the database, and is indicated by the `Include` variable. `Include` values of 1 indicate the data should be used for analysis, values of 0 indicate the data should not be used for analysis. Documentation on the database filtering is provided here: SEACAR Documentation-Analysis Filters and Calculations.docx

The filtering that is performed by the script at this point removes rows that are missing values for `ResultValue`, and only keeps data that is measured at the relative depth (surface, bottom, etc.) and activity type (field or sample) of interest. This is partly handled on export with the `RelativeDepth` variable, but there are some measurements that are considered both surface and bottom based on measurement depth and total depth. By default, these are marked as `Surface` for `RelativeDepth` and receive a `SEACAR_QAQCFlag` indicator of `12Q`. Data passes the filtering the process if it is from the correct depth and has an `Include` value of 1. The script also only looks at data of the desired `ActivityType` which indicates whether it was measured in the field (`Field`) or in the lab (`Sample`).

After the initial filtering, a second filter variable is created to determine whether enough time is represented in the managed area, which is that each managed area has 10 year or more of unique year entries for observation that pass the initial filter. If data passes the first set of filtering criteria and the time criteria, they are used in the analysis.

After filtering, the amount of data impacted by the H (for dissolved oxygen & pH in program 476), I, Q, and U value qualifiers. A variable is also created that determines if scatter plot points should be a different color based on value qualifiers of interest.

```
if(depth=="Bottom"){
   data$RelativeDepth[grep("12Q", data$SEACAR_QAQCFlagCode[
      data$RelativeDepth == "Surface"])] <- "Bottom"
}

data$Include <- as.logical(data$Include)
data$ActivityType <- gsub("Field Msr/Obs", "Field", data$ActivityType)
data <- data[!is.na(data$ResultValue),]
data <- data[!is.na(data$RelativeDepth) & data$RelativeDepth==depth,]
data <- data[!is.na(data$ActivityType) & data$ActivityType==activity,]
if(param_name == "Water_Temperature"){
   data <- data[data$ResultValue>=-2,]
} else{
   data <- data[data$ResultValue>=0,]
}
data$Include[grep("H", data$ValueQualifier[data$ProgramID==476])] <- TRUE

MA_Years <- data[data$Include == TRUE, ] %>%
   group_by(ManagedAreaName) %>%
   summarize(N = length(unique(Year)))
MA_Years <- as.data.table(MA_Years[order(MA_Years$ManagedAreaName), ])
MA_Years$Enough_Time <- ifelse(MA_Years$N < 10, FALSE, TRUE)
data$Exclude_ManagedArea <- is.element(data$ManagedAreaName,
                                       MA_Years$ManagedAreaName[
                                          MA_Years$Enough_Time == FALSE])

data$Use_In_Analysis <- ifelse(data$Include == TRUE &
                                  data$Exclude_ManagedArea == FALSE,
                               TRUE, FALSE)
total <- length(data$Include)
pass_filter <- length(data$Include[data$Include==TRUE])

count_H <- length(grep("H", data$ValueQualifier[data$ProgramID==476]))
perc_H <- 100*count_H/length(data$ValueQualifier)

count_I <- length(grep("I", data$ValueQualifier))
perc_I <- 100*count_I/length(data$ValueQualifier)

count_Q <- length(grep("Q", data$ValueQualifier))
perc_Q <- 100*count_Q/length(data$ValueQualifier)

count_U <- length(grep("U", data$ValueQualifier))
perc_U <- 100*count_U/length(data$ValueQualifier)


data$VQ_Plot <- data$ValueQualifier

inc_H <- ifelse(param_name=="pH" | param_name=="Dissolved_Oxygen" |
                   param_name=="Dissolved_Oxygen_Saturation", TRUE, FALSE)

if (inc_H==TRUE){
   data$VQ_Plot <- gsub("[^HU]+", "", data$VQ_Plot)
   data$VQ_Plot <- gsub("UH", "HU", data$VQ_Plot)
```

```
    data$VQ_Plot[data$ProgramID!=476] <- gsub("[^U]+", "",
                                               data$VQ_Plot[data$ProgramID!=476])
    data$VQ_Plot[data$VQ_Plot==""] <- NA
    cat(paste0("Number of Measurements: ", total,
               ", Number Passed Filter: ", pass_filter, "\n",
               "Program 476 H Codes: ", count_H, " (", round(perc_H, 6), "%)\n",
               "I Codes: ", count_I, " (", round(perc_I, 6), "%)\n",
               "Q Codes: ", count_Q, " (", round(perc_Q, 6), "%)\n",
               "U Codes: ", count_U, " (", round(perc_U, 6), "%)"))
} else{
    data$VQ_Plot <- gsub("[^U]+", "", data$VQ_Plot)
    data$VQ_Plot[data$VQ_Plot==""] <- NA
    cat(paste0("Number of Measurements: ", total,
               ", Number Passed Filter: ", pass_filter, "\n",
               "I Codes: ", count_I, " (", round(perc_I, 6), "%)\n",
               "Q Codes: ", count_Q, " (", round(perc_Q, 6), "%)\n",
               "U Codes: ", count_U, " (", round(perc_U, 6), "%)"))
}
```

```
## Number of Measurements: 222957, Number Passed Filter: 222622
## I Codes: 3549 (1.591787%)
## Q Codes: 518 (0.232332%)
## U Codes: 238 (0.106747%)
```

Managed Area Statistics

Gets summary statistics for each managed area. Excluded managed areas are not included into whether the data should be used or not. Uses piping from dplyr package to feed into subsequent steps. The following steps are performed:

1. Take the `data` variable and only include rows that have a `Use_In_Analysis` value of TRUE
2. Group data that have the same `ManagedAreaName`, `Year`, and `Month`.
    - Second summary statistics do not use the `Month` grouping and are only for `ManagedAreaName` and `Year`.
    - Third summary statistics do not use `Year` grouping and are only for `ManagedAreaName` and `Month`
3. For each group, provide the following information: Number of Entries (N), Lowest Value (Min), Largest Value (Max), Median, Mean, Standard Deviation, and a list of all Program IDs included in these measurements.
4. Sort the data in ascending (A to Z and 0 to 9) order based on `ManagedAreaName` then `Year` then `Month`
5. Write summary stats to a pipe-delimited .txt file in the output directory
    - Click this text to open Git directory with output files

```
MA_names <- unique(data$ManagedAreaName[data$Use_In_Analysis == TRUE])
MA_names <- MA_names[order(MA_names)]
n <- length(MA_names)

MA_YM_Stats <- data[data$Use_In_Analysis == TRUE, ] %>%
```

```
  group_by(ManagedAreaName, Year, Month) %>%
  summarize(N = length(ResultValue),
            Min = min(ResultValue),
            Max = max(ResultValue),
            Median = median(ResultValue),
            Mean = mean(ResultValue),
            StandardDeviation = sd(ResultValue),
            ProgramIDs = paste(sort(unique(ProgramID), decreasing = FALSE),
                               collapse = ', '))
MA_YM_Stats <- as.data.table(MA_YM_Stats[order(MA_YM_Stats$ManagedAreaName,
                                               MA_YM_Stats$Year,
                                               MA_YM_Stats$Month), ])
fwrite(MA_YM_Stats, paste0(out_dir,"/", param_name, "_", file_date, "_",
                           activity, "-", depth,
                           "_ManagedArea_YearMonth_Stats.txt"), sep = "|")

MA_Y_Stats <- data[data$Use_In_Analysis == TRUE, ] %>%
  group_by(ManagedAreaName, Year) %>%
  summarize(N = length(ResultValue),
            Min = min(ResultValue),
            Max = max(ResultValue),
            Median = median(ResultValue),
            Mean = mean(ResultValue),
            StandardDeviation = sd(ResultValue),
            ProgramIDs = paste(sort(unique(ProgramID), decreasing = FALSE),
                               collapse = ', '))
MA_Y_Stats <- as.data.table(MA_Y_Stats[order(MA_Y_Stats$ManagedAreaName,
                                             MA_Y_Stats$Year), ])
fwrite(MA_Y_Stats, paste0(out_dir,"/", param_name, "_", file_date, "_",
                          activity, "-", depth,
                          "_ManagedArea_Year_Stats.txt"), sep = "|")

MA_M_Stats <- data[data$Use_In_Analysis == TRUE, ] %>%
  group_by(ManagedAreaName, Month) %>%
  summarize(N = length(ResultValue),
            Min = min(ResultValue),
            Max = max(ResultValue),
            Median = median(ResultValue),
            Mean = mean(ResultValue),
            StandardDeviation = sd(ResultValue),
            ProgramIDs = paste(sort(unique(ProgramID), decreasing = FALSE),
                               collapse = ', '))
MA_M_Stats <- as.data.table(MA_M_Stats[order(MA_M_Stats$ManagedAreaName,
                                             MA_M_Stats$Month), ])
fwrite(MA_M_Stats, paste0(out_dir,"/", param_name, "_", file_date, "_",
                          activity, "-", depth,
                          "_ManagedArea_Month_Stats.txt"), sep = "|")
```

Monitoring Location Statistics

Gets monitoring location statistics, which is defined as a unique combination of `ManagedAreaName`, `ProgramID`, `ProgramAreaName`, and `ProgramLocationID`, using piping from dplyr package. The following steps are performed:

1. Take the `data` variable and only include rows that have a `Use_In_Analysis` value of `TRUE`
2. Group data that have the same `ManagedAreaName`, `ProgramID`, `ProgramName`, and `ProgramLocationID`.
3. For each group, provide the following information: Earliest Sample Date (EarliestSampleDate), Latest Sample Date (LastSampleDate), Number of Entries (N), Lowest Value (Min), Largest Value (Max), Median, Mean, and Standard Deviation.
4. Sort the data in ascending (A to Z and 0 to 9) order based on `ManagedAreaName` then `ProgramName` then `ProgramID` then `ProgramLocationID`
5. Write summary stats to a pipe-delimited .txt file in the output directory

   - Click this text to open Git directory with output files

```
Mon_Stats <- data[data$Use_In_Analysis == TRUE, ] %>%
   group_by(ManagedAreaName, ProgramID, ProgramName, ProgramLocationID) %>%
   summarize(EarliestSampleDate = min(SampleDate),
             LastSampleDate = max(SampleDate),
             N = length(ResultValue),
             Min = min(ResultValue),
             Max = max(ResultValue),
             Median = median(ResultValue),
             Mean = mean(ResultValue),
             StandardDeviation = sd(ResultValue))

Mon_Stats <- as.data.table(Mon_Stats[order(Mon_Stats$ManagedAreaName,
                                              Mon_Stats$ProgramName,
                                              Mon_Stats$ProgramID,
                                              Mon_Stats$ProgramLocationID), ])
fwrite(Mon_Stats, paste0(out_dir,"/", param_name, "_", file_date, "_",
                           activity, "-", depth,
                          "_MonitoringLoc_Stats.txt"), sep = "|")
```

Seasonal Kendall Tau Analysis

Gets seasonal Kendall Tau statistics using the `kendallSeasonalTrendTest` from the `EnvStats` package. The `Trend` parameter is determined from a user-defined function based on the median, Senn slope, and p values from the data. Analysis modified from code created by Jason Scolaro that performed at The Water Atlas: https://sarasota.wateratlas.usf.edu/water-quality-trends/#analysis-overview

The following steps are performed:

1. Define the functions used in the analysis
2. Check to see if there are any groups to run analysis on.
3. Take the `data` variable and only include rows that have a `Use_In_Analysis` value of `TRUE`
4. Group data that have the same `ManagedAreaName`.

5. For each group, provides the following information: Earliest Sample Date (EarliestSampleDate), Latest Sample Date (LastSampleDate), Number of Entries (N), Lowest Value (Min), Largest Value (Max), Median, Mean, Standard Deviation, tau, Senn Slope (SennSlope), Senn Intercept (SennIntercept), and p.
   - The analysis is run with the `kendallSeasonalTrendTest` function using the `Year` values for year, and `Month` as the seasonal qualifier, and Trend.
   - An independent.obs value of `TRUE` indicates that the data should be treated as not being serially auto-correlated. An independent.obs value of `FALSE` indicates that it is treated as being serially auto-correlated, but also requires one observation per season per year for the full time of observation.
6. Reformat columns in the data frame from export.
7. Write summary stats to a pipe-delimited .txt file in the output directory
   - Click this text to open Git directory with output files

```
tauSeasonal <- function(data, independent, stats.median, stats.minYear,
                        stats.maxYear) {
  tau <- NULL
  tryCatch({
    ken <-
      kendallSeasonalTrendTest(
        y = data$ResultValue,
        season = data$Month,
        year = data$Year,
        independent.obs = independent
      )
    tau <- ken$estimate[1]
    p <- ken$p.value[2]
    slope <- ken$estimate[2]
    intercept <- ken$estimate[3]
    trend <- trend_calculator(slope, stats.median, p)
  }, warning = function(w) {
    print(w)
  }, error = function(e) {
    print(e)
  }, finally = {
    7
    if (!exists("tau")) {
      tau <- NULL
    }
    if (!exists("p")) {
      p <- NULL
    }
    if (!exists("slope")) {
      slope <- NULL
    }
    if (!exists("intercept")) {
      intercept <- NULL
    }
    if (!exists("trend")) {
      trend <- NULL
    }
  })
```

```
  KT <-c(unique(data$ManagedAreaName),
         independent,
         stats.median,
         nrow(data),
         stats.minYear,
         stats.maxYear,
         tau,
         p,
         slope,
         intercept,
         trend)
  return(KT)
}
runStats <- function(data) {
  data$Index <- as.Date(data$SampleDate) # , "%Y-%m-%d")
  data$ResultValue <- as.numeric(data$ResultValue)
  # Calculate basic stats
  stats.median <- median(data$ResultValue, na.rm = TRUE)
  stats.minYear <- min(data$Year, na.rm = TRUE)
  stats.maxYear <- max(data$Year, na.rm = TRUE)
  # Calculate Kendall Tau and Slope stats, then update appropriate columns and table
  KT <- tauSeasonal(data, TRUE, stats.median,
                    stats.minYear, stats.maxYear)
  if (is.null(KT[11])) {
    KT <- tauSeasonal(data, FALSE, stats.median,
                      stats.minYear, stats.maxYear)
  }
  if (is.null(KT.Stats) == TRUE) {
    KT.Stats <- KT
  } else{
    KT.Stats <- rbind(KT.Stats, KT)
  }
  return(KT.Stats)
}
trend_calculator <- function(slope, median_value, p) {
  trend <-
    if (p < .05 & abs(slope) > abs(median_value) / 10.) {
      if (slope > 0) {
        2
      }
      else {
        -2
      }
    }
  else if (p < .05 & abs(slope) < abs(median_value) / 10.) {
    if (slope > 0) {
      1
    }
    else {
      -1
    }
  }
  else
```

```
    0
  return(trend)
}
KT.Stats <- NULL
# Loop that goes through each managed area. List of managed areas stored in MA_Years$ManagedAreaName
c_names <- c("ManagedAreaName", "Independent", "Median", "N", "EarliestYear",
             "LatestYear", "tau", "p", "SennSlope", "SennIntercept", "Trend")
if(n==0){
  KT.Stats <- data.frame(matrix(ncol=11, nrow=0))
  colnames(KT.Stats) <- c_names
  fwrite(KT.Stats, paste0(out_dir,"/", param_name, "_", file_date, "_", depth,
                          "_KendallTau_Stats.txt"), sep = "|")
} else{
  for (i in 1:n) {
    values <- data[data$Use_In_Analysis == TRUE &
                     data$ManagedAreaName == MA_names[i], ]
    if (nrow(values) > 0) {
      KT.Stats <- runStats(values)
    }
  }
  KT.Stats <- as.data.frame(KT.Stats)
  c_names <- c("ManagedAreaName", "Independent", "Median", "N", "EarliestYear",
               "LatestYear", "tau", "p", "SennSlope", "SennIntercept", "Trend")
  if(dim(KT.Stats)[2]==1){
    KT.Stats <- as.data.frame(t(KT.Stats))
  }
  colnames(KT.Stats) <- c_names
  rownames(KT.Stats) <- seq(1:nrow(KT.Stats))
  KT.Stats$Median <- as.numeric(KT.Stats$Median)
  KT.Stats$N <- as.integer(KT.Stats$N)
  KT.Stats$EarliestYear <- as.integer(KT.Stats$EarliestYear)
  KT.Stats$LatestYear <- as.integer(KT.Stats$LatestYear)
  KT.Stats$tau <- round(as.numeric(KT.Stats$tau), digits=4)
  KT.Stats$p <- round(as.numeric(KT.Stats$p), digits=4)
  KT.Stats$SennSlope <- as.numeric(KT.Stats$SennSlope)
  KT.Stats$SennIntercept <- as.numeric(KT.Stats$SennIntercept)
  KT.Stats$Trend <- as.integer(KT.Stats$Trend)
  fwrite(KT.Stats, paste0(out_dir,"/", param_name, "_", file_date, "_", depth,
                          "_KendallTau_Stats.txt"), sep = "|")
}
```

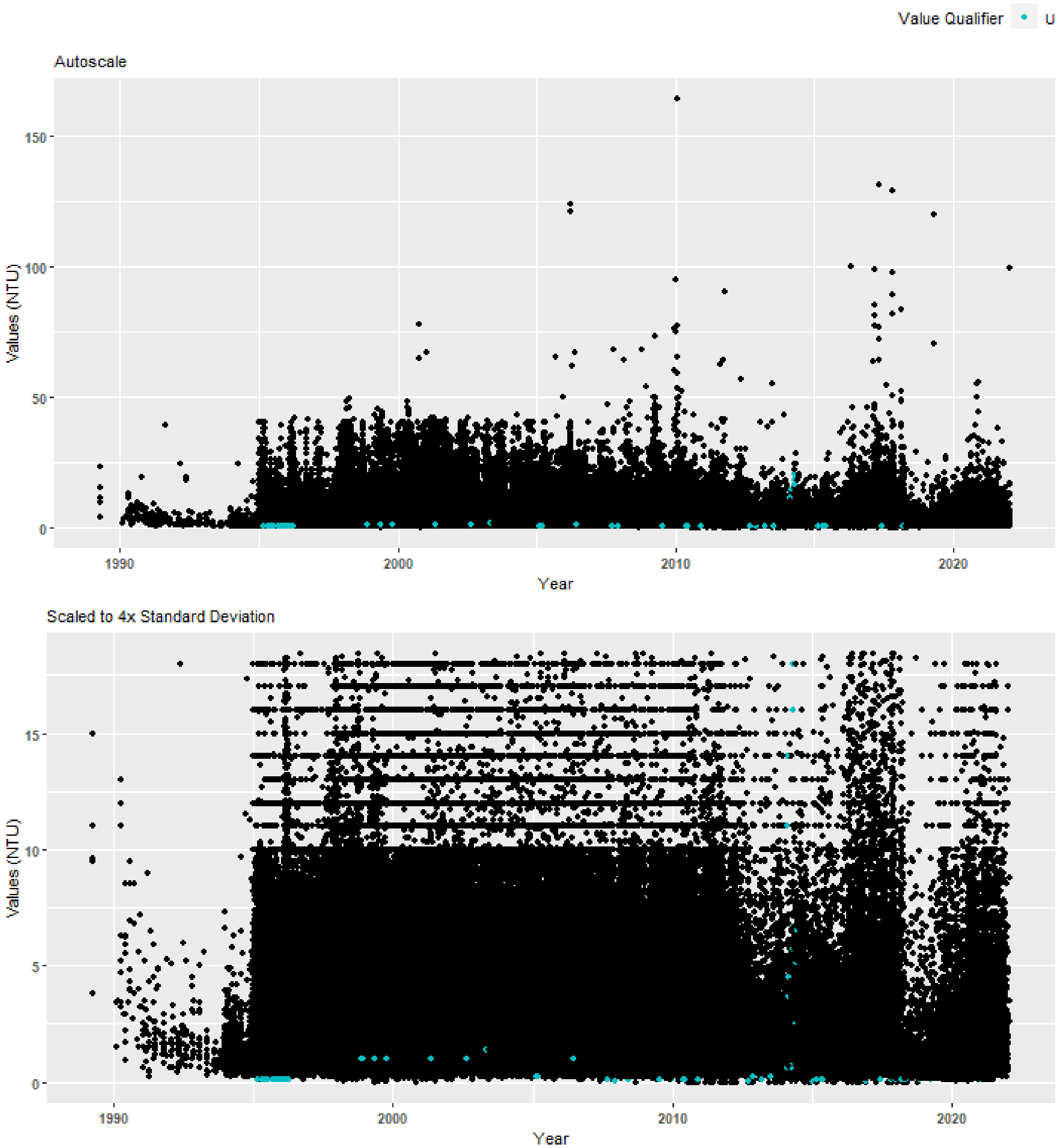
Appendix I: Scatter Plot of Entire Dataset

This part will create a scatter plot of the all data that passed initial filtering criteria with points colored based on specific value qualifiers. The values determined at the beginning (`year_lower`, `year_upper`, `min_RV`, `mn_RV`, `x_scale`, and `y_scale`) are solely for use by the plotting functions and are not output as part of the computed statistics.

```r
year_lower <- min(data$Year)
year_upper <- max(data$Year)
min_RV <- min(data$ResultValue)
mn_RV <- mean(data$ResultValue[data$ResultValue <
                                  quantile(data$ResultValue, 0.98)])
sd_RV <- sd(data$ResultValue[data$ResultValue <
                                quantile(data$ResultValue, 0.98)])
x_scale <- ifelse(year_upper - year_lower > 30, 10, 5)
y_scale <- mn_RV + 4 * sd_RV


p1 <- ggplot(data = data[data$Include==TRUE,],
             aes(x = SampleDate, y = ResultValue,
                 color=VQ_Plot)) +
   geom_point(size = 1.5) +
   labs(subtitle = "Autoscale",
        x = "Year", y = paste0("Values (", unit, ")"),
        color="Value Qualifier") +
   theme(legend.position = "top", legend.box = "horizontal",
         legend.justification = "right",
         axis.text.x = element_text(face = "bold"),
         axis.text.y = element_text(face="bold")) +
   scale_x_date(labels = date_format("%Y")) +
   {if(inc_H==TRUE){
      scale_color_manual(values = c("H"= "#F8766D", "U"= "#00BFC4",
                                    "HU" = "#7CAE00"), na.value="black")
   } else {
      scale_color_manual(values = c("U"= "#00BFC4"), na.value="black")
   }}


p2 <- ggplot(data = data[data$Include==TRUE,],
             aes(x = SampleDate, y = ResultValue,
                 color=VQ_Plot)) +
   geom_point(size = 1.5) +
   ylim(min_RV, y_scale) +
   labs(subtitle = "Scaled to 4x Standard Deviation",
        x = "Year", y = paste0("Values (", unit, ")")) +
   theme(legend.position = "none",
         axis.text.x = element_text(face = "bold"),
         axis.text.y = element_text(face = "bold")) +
   scale_x_date(labels = date_format("%Y")) +
   {if(inc_H==TRUE){
      scale_color_manual(values = c("H"= "#F8766D", "U"= "#00BFC4",
                                    "HU" = "#7CAE00"), na.value="black")
   } else {
      scale_color_manual(values = c("U"= "#00BFC4"), na.value="black")
   }}

leg <- get_legend(p1)
pset <- ggarrange(leg, p1 + theme(legend.position = "none"), p2,
                  ncol = 1, heights = c(0.1, 1, 1))
```

```r
p0 <- ggplot() + labs(title = "Scatter Plot for Entire Dataset") +
   theme_bw() + theme(plot.title = element_text(face="bold"),
                      panel.border = element_blank(),
                      panel.grid.major = element_blank(),
                      panel.grid.minor = element_blank(),
                      axis.line = element_blank())

ggarrange(p0, pset, ncol = 1, heights = c(0.1, 1))
```

Scatter Plot for Entire Dataset



Appendix II: Dataset Summary Box Plots

Box plots are created by using the entire data set and excludes any data that has been previously filtered out. The scripts that create plots follow this format

1. Use the data set that only has `Use_In_Analysis` of `TRUE`
2. Set what values are to be used for the x-axis, y-axis, and the variable that should determine groups for the box plots
3. Set the plot type as a box plot with the size of the outlier points
4. Create the title, x-axis, y-axis, and color fill labels
5. Set the y and x limits
6. Make the axis labels bold
7. Plot the arrangement as a set of panels

This set of box plots are grouped by year.

```
min_RV <- min(data$ResultValue[data$Include == TRUE])
mn_RV <- mean(data$ResultValue[data$Include == TRUE &
                                  data$ResultValue <
                                  quantile(data$ResultValue, 0.98)])
sd_RV <- sd(data$ResultValue[data$Include == TRUE &
                                data$ResultValue <
                                quantile(data$ResultValue, 0.98)])
y_scale <- mn_RV + 4 * sd_RV

p1 <- ggplot(data = data[data$Include == TRUE, ],
             aes(x = Year, y = ResultValue, group = Year)) +
   geom_boxplot(outlier.size = 0.5) +
   labs(subtitle = "Autoscale", x = "Year",
        y = paste0("Values (", unit, ")")) +
   theme(axis.text.x = element_text(face = "bold"),
         axis.text.y = element_text(face = "bold"))

p2 <- ggplot(data = data[data$Include == TRUE, ],
             aes(x = Year, y = ResultValue, group = Year)) +
   geom_boxplot(outlier.size = 0.5) +
   labs(subtitle = "Scaled to 4x Standard Deviation", x = "Year",
        y = paste0("Values (", unit, ")")) +
   ylim(min_RV, y_scale) +
   theme(axis.text.x = element_text(face = "bold"),
         axis.text.y = element_text(face = "bold"))

p3 <- ggplot(data = data[data$Include == TRUE, ],
             aes(x = as.integer(Year), y = ResultValue, group = Year)) +
   geom_boxplot(outlier.size = 0.5) +
   labs(subtitle = "Scaled to 4x Standard Deviation, Last 10 Years",
        x = "Year", y = paste0("Values (", unit, ")")) +
   ylim(min_RV, y_scale) +
   scale_x_continuous(limits = c(max(data$Year) - 10.5, max(data$Year)+1),
                      breaks = seq(max(data$Year) - 10, max(data$Year), 2)) +
   theme(axis.text.x = element_text(face = "bold"),
         axis.text.y = element_text(face = "bold"))
```

```
set <- ggarrange(p1, p2, p3, ncol = 1)

p0 <- ggplot() + labs(title = "Summary Box Plots for Entire Data",
                      subtitle = "By Year") + theme_bw() +
   theme(plot.title = element_text(face="bold"),
         panel.border = element_blank(), panel.grid.major = element_blank(),
         panel.grid.minor = element_blank(), axis.line = element_blank())

Yset <- ggarrange(p0, set, ncol=1, heights = c(0.07, 1))
```

This set of box plots are grouped by year and month with the color being related to the month.

```
p1 <- ggplot(data = data[data$Include == TRUE, ],
             aes(x = YearMonthDec, y = ResultValue,
                 group = YearMonth, color = as.factor(Month))) +
   geom_boxplot(outlier.size = 0.5) +
   labs(subtitle = "Autoscale", x = "Year",
        y = paste0("Values (", unit, ")"), color="Month") +
   theme(legend.position = "top", legend.box = "horizontal",
         axis.text.x = element_text(face = "bold"),
         axis.text.y = element_text(face = "bold")) +
   guides(color = guide_legend(nrow = 1))

p2 <- ggplot(data = data[data$Include == TRUE, ],
             aes(x = YearMonthDec, y = ResultValue,
                 group = YearMonth, color = as.factor(Month))) +
   geom_boxplot(outlier.size = 0.5) +
   labs(subtitle = "Scaled to 4x Standard Deviation",
        x = "Year", y = paste0("Values (", unit, ")")) +
   ylim(min_RV, y_scale) +
   theme(legend.position = "none", axis.text.x = element_text(face = "bold"),
         axis.text.y = element_text(face = "bold"))

p3 <- ggplot(data = data[data$Include == TRUE, ],
             aes(x = YearMonthDec, y = ResultValue,
                 group = YearMonth, color = as.factor(Month))) +
   geom_boxplot(outlier.size = 0.5) +
   labs(subtitle = "Scaled to 4x Standard Deviation, Last 10 Years",
        x = "Year", y = paste0("Values (", unit, ")")) +
   ylim(min_RV, y_scale) +
   scale_x_continuous(limits = c(max(data$Year) - 10.5, max(data$Year)+1),
                      breaks = seq(max(data$Year) - 10, max(data$Year), 2)) +
   theme(legend.position = "none", axis.text.x = element_text(face = "bold"),
         axis.text.y = element_text(face = "bold"))
leg <- get_legend(p1)
set <- ggarrange(leg, p1 + theme(legend.position = "none"), p2, p3, ncol = 1,
                 heights = c(0.1, 1, 1, 1))

p0 <- ggplot() + labs(title = "Summary Box Plots for Entire Data",
                      subtitle = "By Year & Month") + theme_bw() +
   theme(plot.title = element_text(face="bold"),
         panel.border = element_blank(), panel.grid.major = element_blank(),
         panel.grid.minor = element_blank(), axis.line = element_blank())
```

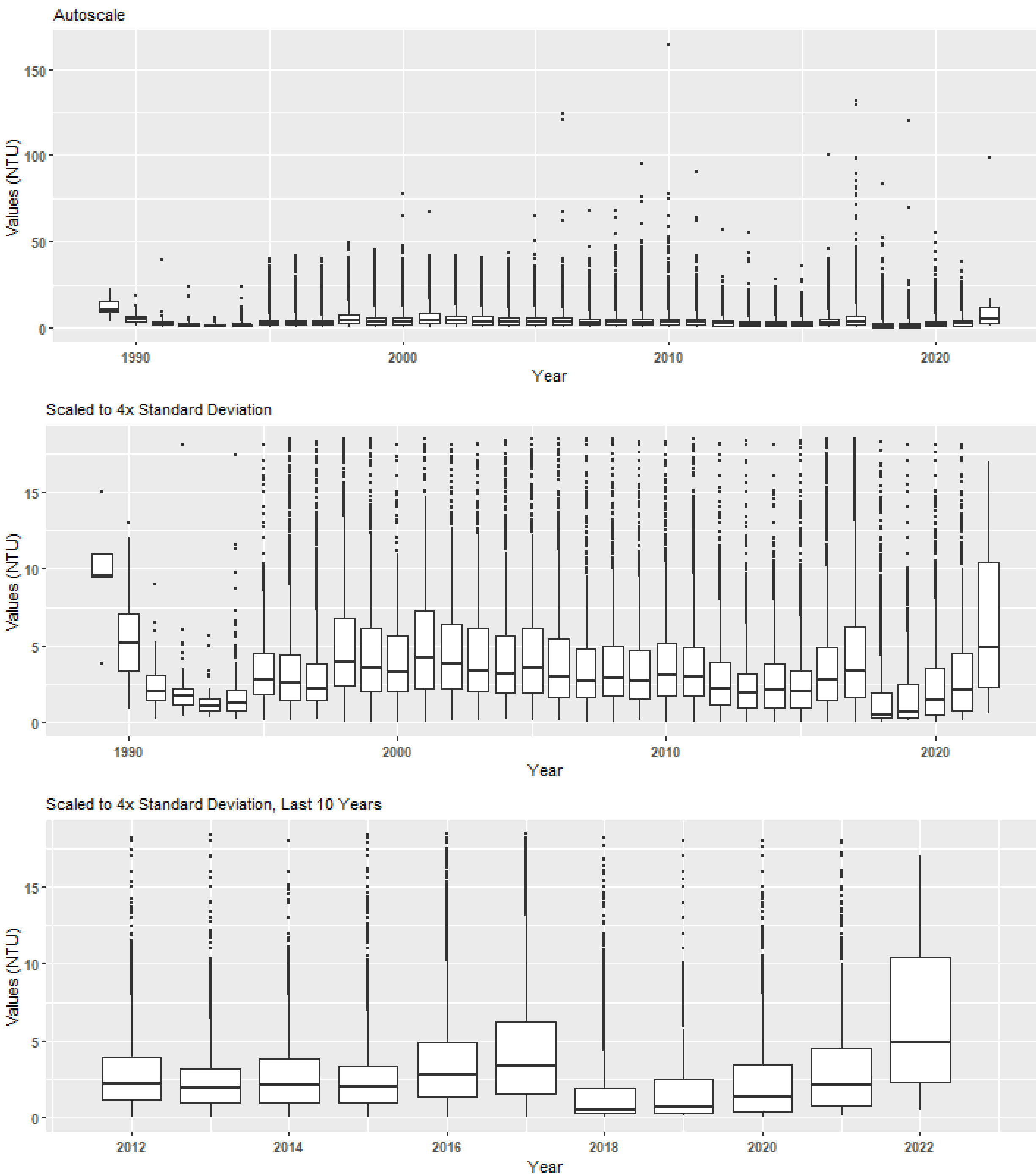
```
YMset <- ggarrange(p0, set, ncol=1, heights = c(0.07, 1))
```

The following box plots are grouped by month with fill color being related to the month. This is designed to view potential seasonal trends.

```
p1 <- ggplot(data = data[data$Include == TRUE, ],
             aes(x = Month, y = ResultValue,
                 group = Month, fill = as.factor(Month))) +
   geom_boxplot(outlier.size = 0.5) +
   labs(subtitle = "Autoscale", x = "Month",
        y = paste0("Values (", unit, ")"), fill="Month") +
   scale_x_continuous(limits = c(0, 13), breaks = seq(3, 12, 3)) +
   theme(legend.position = "top", legend.box = "horizontal",
         axis.text.x = element_text(face = "bold"),
         axis.text.y = element_text(face = "bold")) +
   guides(fill = guide_legend(nrow = 1))

p2 <- ggplot(data = data[data$Include == TRUE, ],
             aes(x = Month, y = ResultValue,
                 group = Month, fill = as.factor(Month))) +
   geom_boxplot(outlier.size = 0.5) +
   labs(subtitle = "Scaled to 4x Standard Deviation",
        x = "Month", y = paste0("Values (", unit, ")")) +
   ylim(min_RV, y_scale) +
   scale_x_continuous(limits = c(0, 13), breaks = seq(3, 12, 3)) +
   theme(legend.position = "none", axis.text.x = element_text(face = "bold"),
         axis.text.y = element_text(face = "bold"))

p3 <- ggplot(data = data[data$Include == TRUE &
                            data$Year >= max(data$Year) - 10, ],
             aes(x = Month, y = ResultValue,
                 group = Month, fill = as.factor(Month))) +
   geom_boxplot(outlier.size = 0.5) +
   labs(subtitle = "Scaled to 4x Standard Deviation, Last 10 Years",
        x = "Month", y = paste0("Values (", unit, ")")) +
   ylim(min_RV, y_scale) +
   scale_x_continuous(limits = c(0, 13), breaks = seq(3, 12, 3)) +
   theme(legend.position = "none", axis.text.x = element_text(face = "bold"),
         axis.text.y = element_text(face = "bold"))
leg <- get_legend(p1)
set <- ggarrange(leg, p1 + theme(legend.position = "none"), p2, p3, ncol = 1,
                 heights = c(0.1, 1, 1, 1))

p0 <- ggplot() + labs(title = "Summary Box Plots for Entire Data",
                      subtitle = "By Month") + theme_bw() +
   theme(plot.title = element_text(face="bold"),
         panel.border = element_blank(), panel.grid.major = element_blank(),
         panel.grid.minor = element_blank(), axis.line = element_blank())

Mset <- ggarrange(p0, set, ncol=1, heights = c(0.07, 1))
```

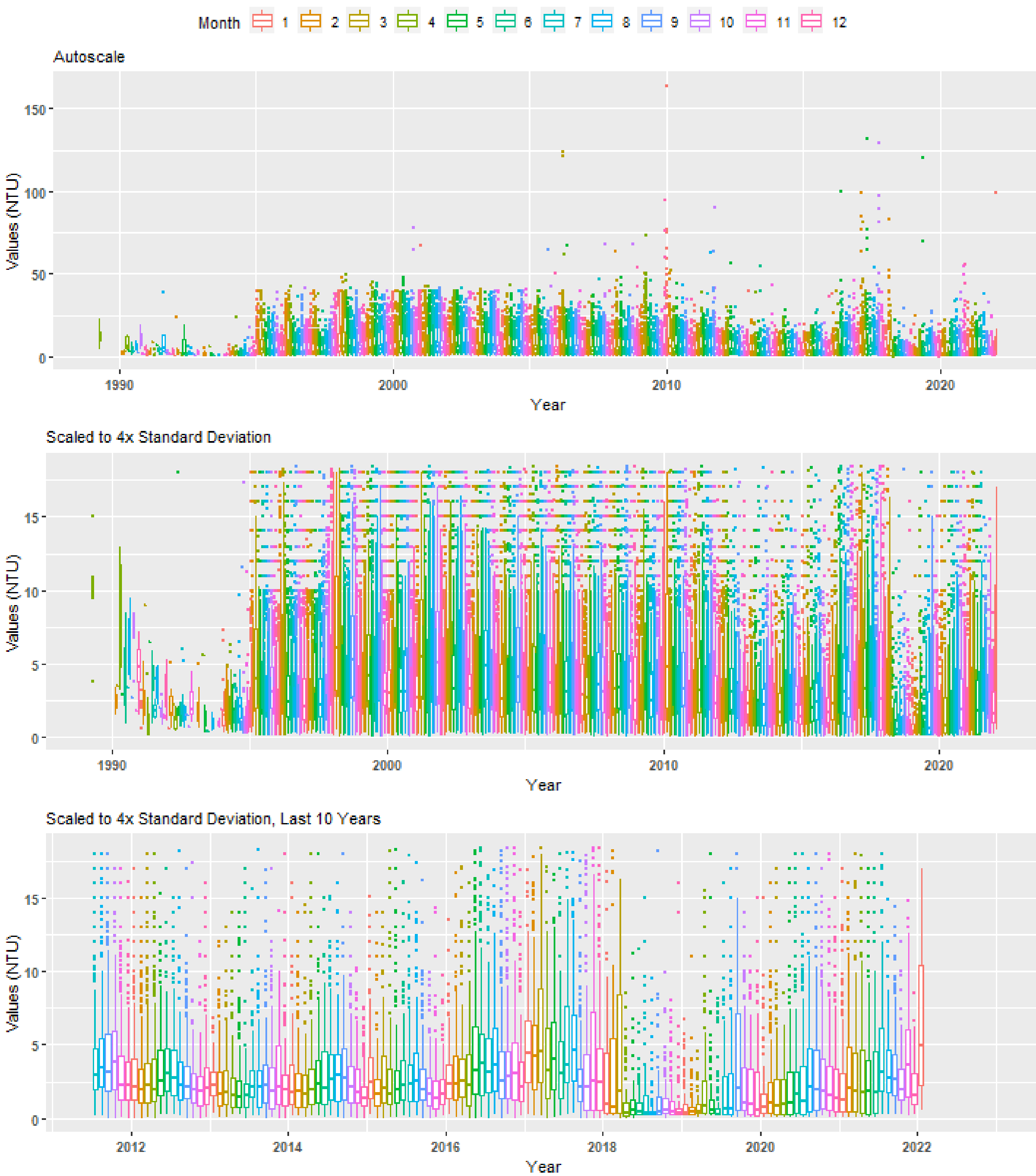
Summary Box Plots for Entire Data

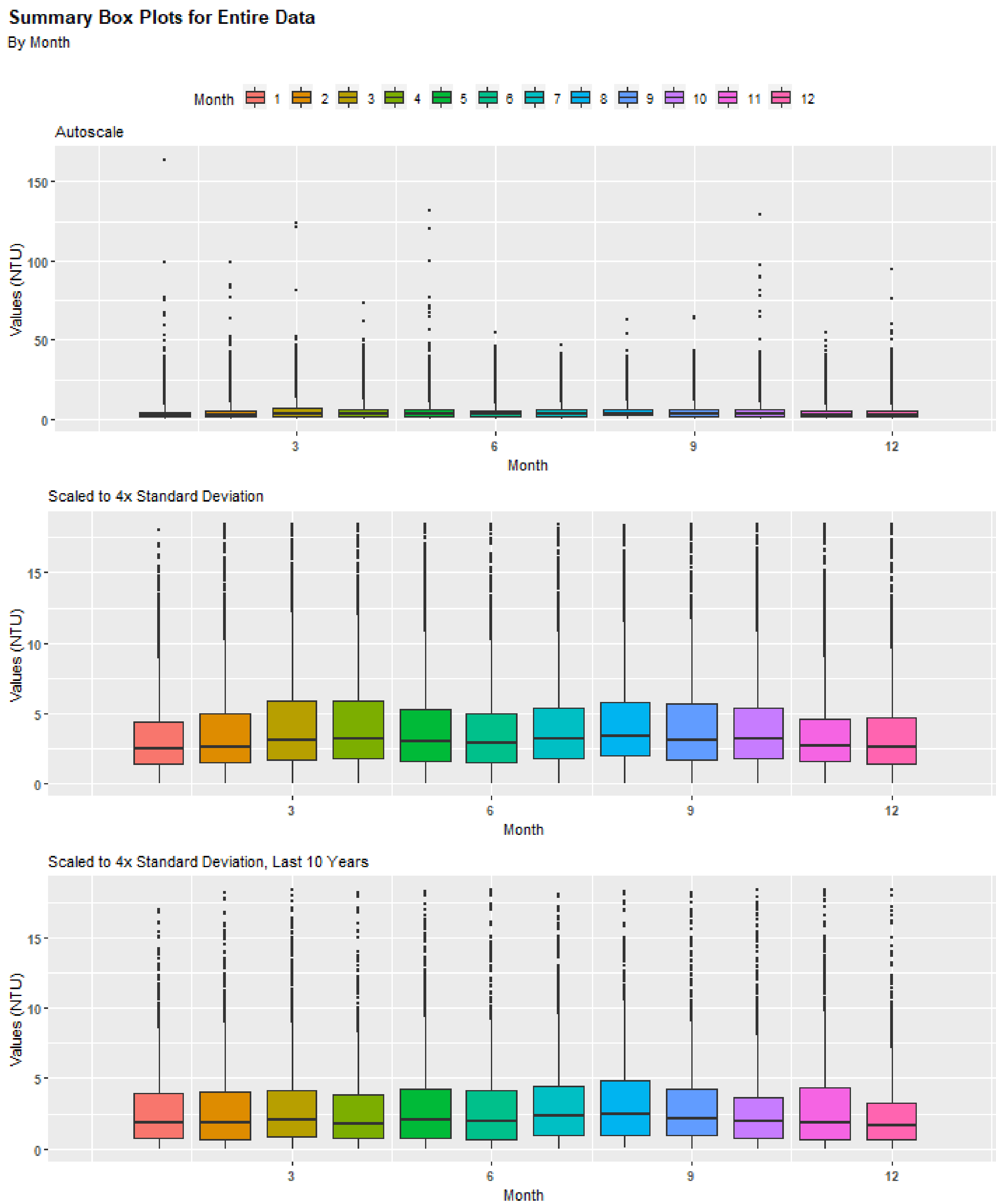
By Year



Summary Box Plots for Entire Data

By Year & Month

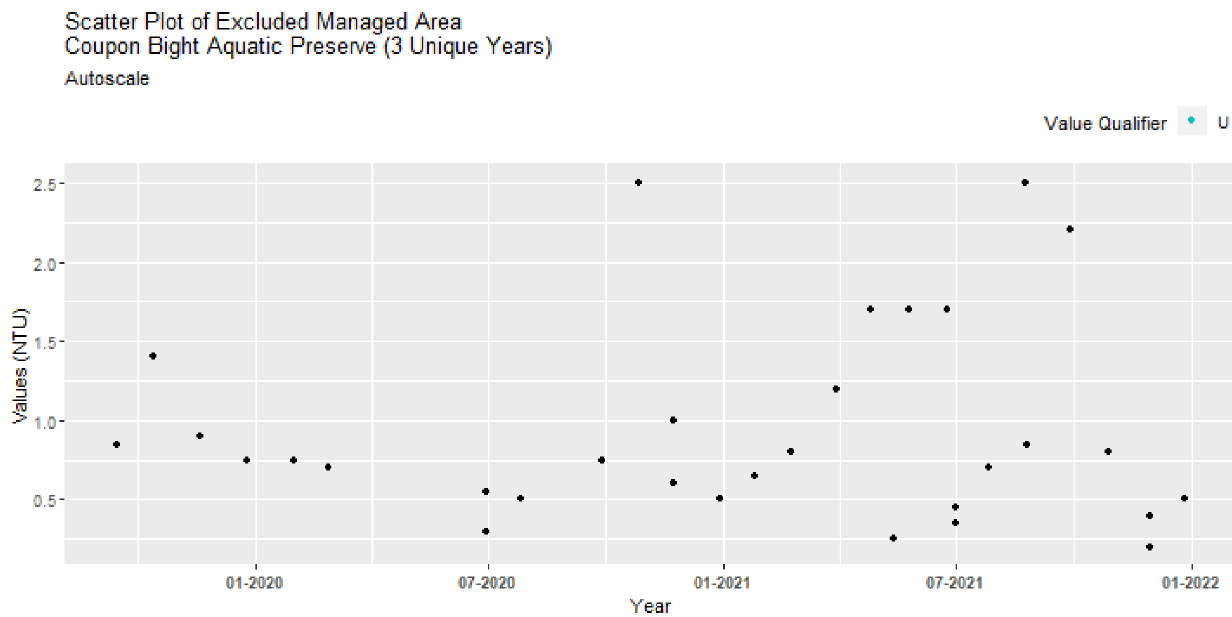


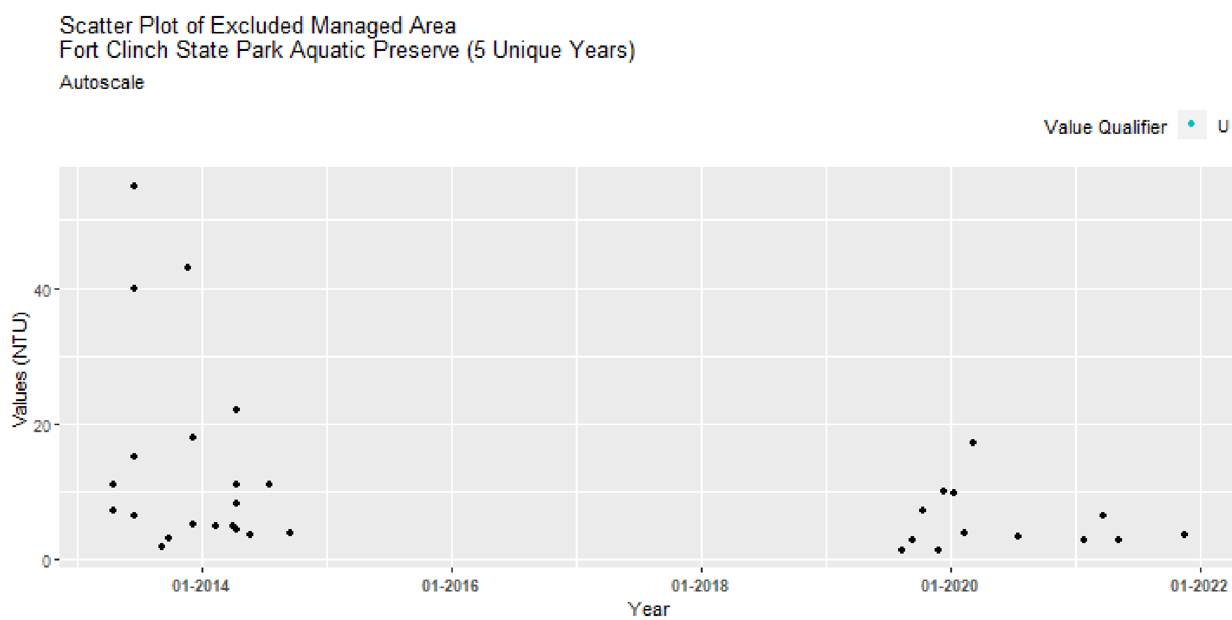

Summary Box Plots for Entire Data
By Month
Month 1 2 3 4 5 6 7 8 9 10 11 12
Autoscale
Values (NTU)
0
50
100
150
3
6
9
12
Month
Scaled to 4x Standard Deviation
Values (NTU)
0
5
10
15
3
6
9
12
Month
Scaled to 4x Standard Deviation, Last 10 Years
Values (NTU)
0
5
10
15
3
6
9
12
Month

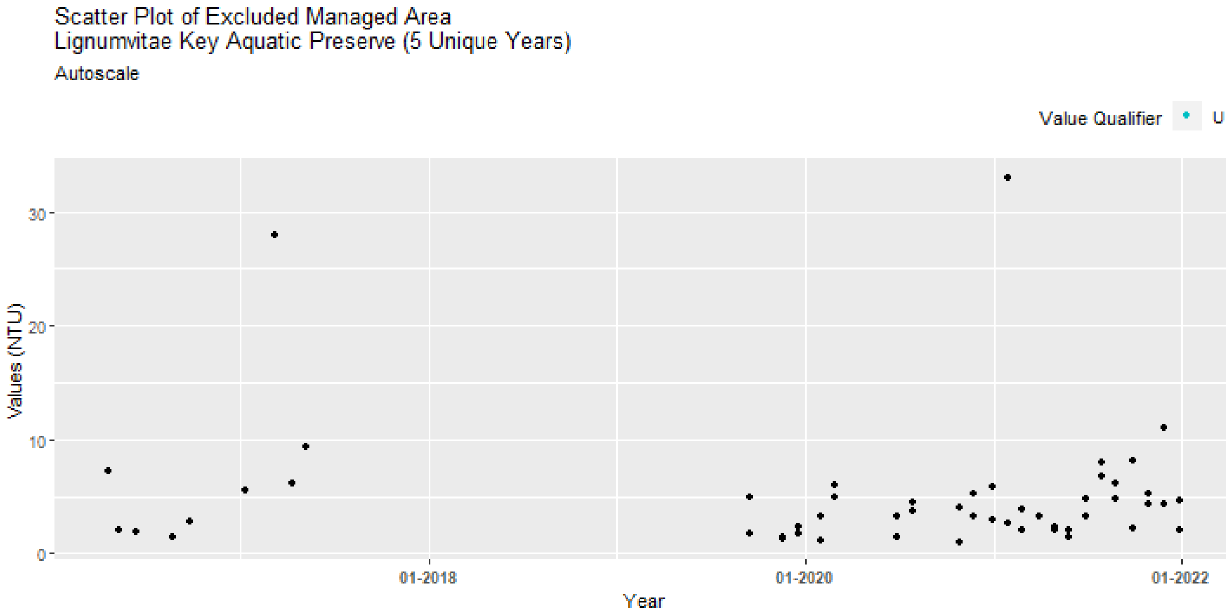
Appendix III: Excluded Managed Areas

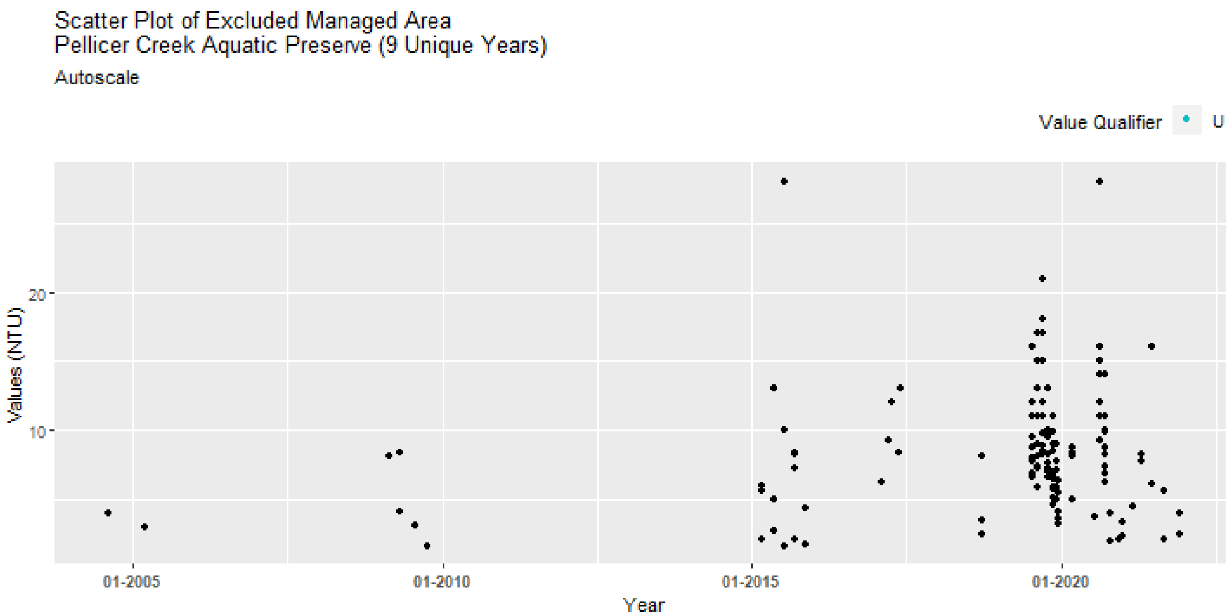
Scatter plots of data values are created for managed areas that have fewer than 10 separate years of data entries. Data points are colored based on specific value qualifiers of interest.

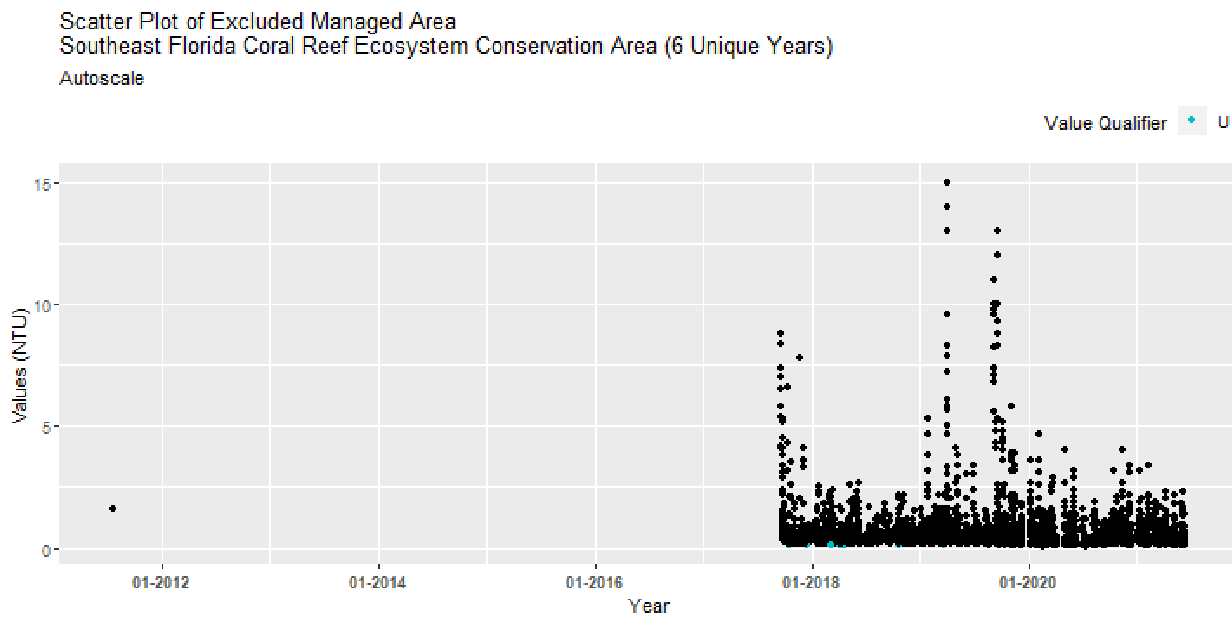
```
MA_Exclude <- MA_Years[MA_Years$Enough_Time==FALSE,]
MA_Exclude <- MA_Exclude[order(MA_Exclude$ManagedAreaName),]
z=length(MA_Exclude$ManagedAreaName)

if(z==0){
   print("There are no managed areas that qualify.")
} else {
   for(i in 1:z){

      p1<-ggplot(data=data[data$ManagedAreaName==MA_Exclude$ManagedAreaName[i]&
                              data$Include == TRUE, ],
                 aes(x = SampleDate, y = ResultValue, color=VQ_Plot)) +
         geom_point() +
         labs(title = paste0("Scatter Plot of Excluded Managed Area\n",
                             MA_Exclude$ManagedAreaName[i], " (",
                             MA_Exclude$N[i], " Unique Years)"),
              subtitle="Autoscale", x = "Year",
              y = paste0("Values (", unit, ")"), color="Value Qualifier") +
         theme(legend.position = "top", legend.box = "horizontal",
               legend.justification = "right",
               axis.text.x = element_text(face = "bold")) +
         scale_x_date(labels = date_format("%m-%Y")) +
         {if(inc_H==TRUE){
            scale_color_manual(values = c("H"= "#F8766D", "U"= "#00BFC4",
                                          "HU" = "#7CAE00"), na.value="black")
         } else {
            scale_color_manual(values = c("U"= "#00BFC4"), na.value="black")
         }}
      print(p1)
   }
}
```


Scatter Plot of Excluded Managed Area
Coupon Bight Aquatic Preserve (3 Unique Years)
Autoscale
Value Qualifier
U
2.5
2.0
1.5
1.0
0.5
Values (NTU)
01-2020
07-2020
01-2021
07-2021
01-2022
Year


Scatter Plot of Excluded Managed Area
Fort Clinch State Park Aquatic Preserve (5 Unique Years)
Autoscale
Value Qualifier
U
40
20
0
Values (NTU)
01-2014
01-2016
01-2018
01-2020
01-2022
Year


Scatter Plot of Excluded Managed Area
Lignumwitae Key Aquatic Preserve (5 Unique Years)
Autoscale
Value Qualifier
U
Values (NTU)
0
10
20
30
01-2018
01-2020
01-2022
Year


Scatter Plot of Excluded Managed Area
Pellicer Creek Aquatic Preserve (9 Unique Years)
Autoscale
Value Qualifier
U
Values (NTU)
10
20
01-2005
01-2010
01-2015
01-2020
Year



Appendix IV: Managed Area Trendlines

The plots created in this section are designed to show the general trend of the data. Data is taken and grouped by `ManagedAreaName`. The trendlines on the plots are created using the Senn slope and intercept from the seasonal Kendall Tau analysis. The scripts that create plots follow this format

1. Use the data set that only has `Use_In_Analysis` of `TRUE` for the desired managed area
2. Determine the earliest and latest year of the data to create x-axis scale and intervals
3. Determine the minimum, mean, and standard deviation for the data to be used for y-axis scales
   - Excludes the top 2% of values to reduce the impact of extreme outliers on the y-axis scale
4. Set what values are to be used for the x-axis, y-axis, and the variable that should determine groups for the plots
5. Set the plot type as a point plot with the size of the points
6. Add the linear trend
7. Create the title, x-axis, y-axis, and color fill labels
8. Set the y and x limits
9. Make the axis labels bold
10. Plot the arrangement as a set of panels

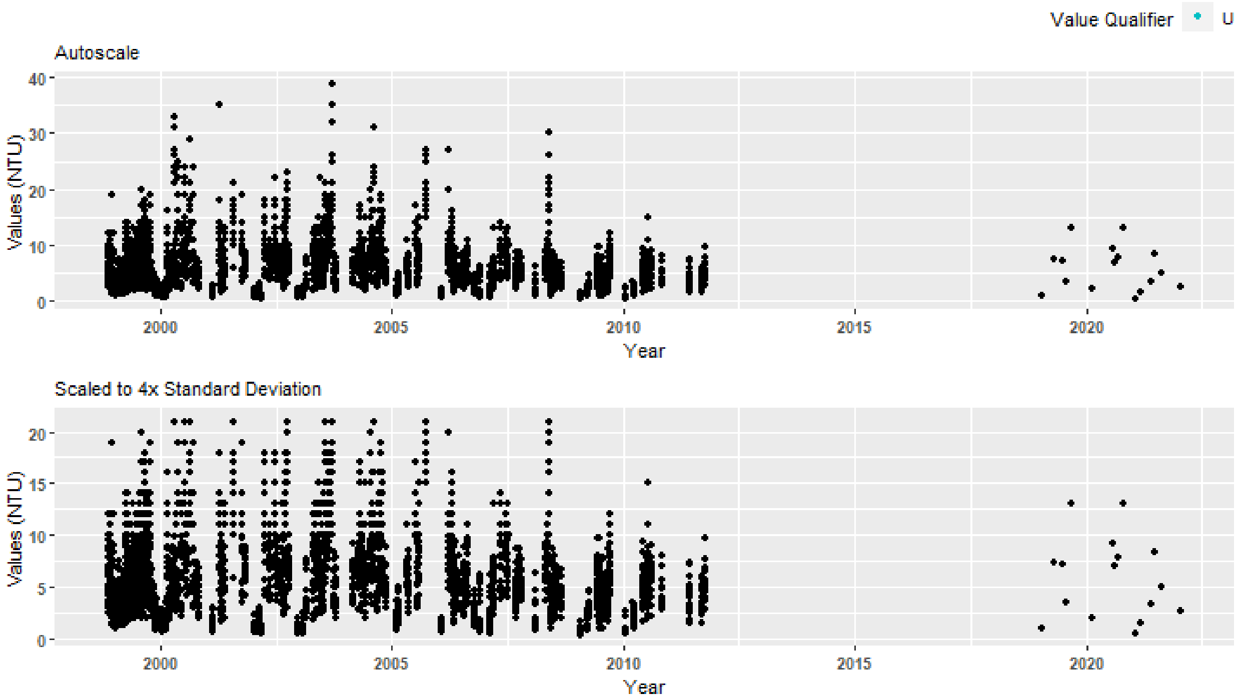
```
if(n==0){
   print("There are no managed areas that qualify.")
} else {
   for (i in 1:n) {
      year_lower <- min(data$Year[data$Use_In_Analysis == TRUE &
                                  data$ManagedAreaName ==
                                  MA_names[i]])
      year_upper <- max(data$Year[data$Use_In_Analysis == TRUE &
                                  data$ManagedAreaName ==
```

```
                                 MA_names[i]])
min_RV <- min(data$ResultValue[data$Use_In_Analysis == TRUE &
                                  data$ManagedAreaName == MA_names[i]])
mn_RV <- mean(data$ResultValue[data$Use_In_Analysis == TRUE &
                                  data$ManagedAreaName == MA_names[i] &
                                  data$ResultValue <
                                  quantile(data$ResultValue, 0.98)])
sd_RV <- sd(data$ResultValue[data$Use_In_Analysis == TRUE &
                                data$ManagedAreaName == MA_names[i] &
                                data$ResultValue <
                                quantile(data$ResultValue, 0.98)])
x_scale <- ifelse(year_upper - year_lower > 30, 10, 5)
y_scale <- mn_RV + 4 * sd_RV

tau <- KT.Stats$tau[KT.Stats$ManagedAreaName==MA_names[i]]
s_slope <- KT.Stats$SennSlope[KT.Stats$ManagedAreaName==MA_names[i]]
s_int <- KT.Stats$SennIntercept[KT.Stats$ManagedAreaName==MA_names[i]]
trend <- KT.Stats$Trend[KT.Stats$ManagedAreaName==MA_names[i]]
p <- KT.Stats$p[KT.Stats$ManagedAreaName==MA_names[i]]

model <- lm(ResultValue ~ DecDate,
            data = data[data$Use_In_Analysis == TRUE &
                           data$ManagedAreaName == MA_names[i]])
m_int <- coef(model)[[1]]
m_slope <- coef(model)[[2]]
p1 <- ggplot(data = data[data$Use_In_Analysis == TRUE &
                            data$ManagedAreaName == MA_names[i], ],
             aes(x = DecDate, y = ResultValue,
                 color=VQ_Plot)) +
   geom_point(size = 1.5) +
   geom_abline(aes(slope=s_slope, intercept=s_int),
               color="red", size=1.5) +
   labs(subtitle = "Autoscale",
        x = "Year", y = paste0("Values (", unit, ")"),
        color="Value Qualifier") +
   theme(legend.position = "top", legend.box = "horizontal",
         legend.justification = "right",
         axis.text.x = element_text(face = "bold"),
         axis.text.y = element_text(face="bold")) +
   {if(inc_H==TRUE){
      scale_color_manual(values = c("H"= "#F8766D", "U"= "#00BFC4",
                                    "HU" = "#7CAE00"), na.value="black")
   } else {
      scale_color_manual(values = c("U"= "#00BFC4"), na.value="black")
   }}

p2 <- ggplot(data = data[data$Use_In_Analysis == TRUE &
                            data$ManagedAreaName == MA_names[i], ],
             aes(x = DecDate, y = ResultValue,
                 color=VQ_Plot)) +
   geom_point(size = 1.5) +
   geom_abline(aes(slope=s_slope, intercept=s_int),
               color="red", size=1.5) +
```

```
        ylim(min_RV, y_scale) +
        labs(subtitle = "Scaled to 4x Standard Deviation",
             x = "Year", y = paste0("Values (", unit, ")")) +
        theme(legend.position = "none",
              axis.text.x = element_text(face = "bold"),
              axis.text.y = element_text(face="bold")) +
        {if(inc_H==TRUE){
           scale_color_manual(values = c("H"= "#F8766D", "U"= "#00BFC4",
                                         "HU" = "#7CAE00"), na.value="black")
        } else {
           scale_color_manual(values = c("U"= "#00BFC4"), na.value="black")
        }}
      leg <- get_legend(p1)
      KTset <- ggarrange(leg, p1 + theme(legend.position = "none"), p2,
                         ncol = 1, heights = c(0.1, 1, 1))

      p0 <- ggplot() + labs(title = paste0("Data Points with Trendlines for ",
                                           MA_names[i]),
                            subtitle =paste0("Senn Slope = ", s_slope,
                                             ",     Senn Intercept = ", s_int,
                                             "\nTrend = ", trend,
                                             ",     tau = ", tau,
                                             ",     p = ", p,
                                             "\nLinear Trendline: ",
                                             "y = ", m_slope,"x + ",m_int)) +
        theme_bw() + theme(plot.title = element_text(face="bold"),
                           panel.border = element_blank(),
                           panel.grid.major = element_blank(),
                           panel.grid.minor = element_blank(),
                           axis.line = element_blank())

      print(ggarrange(p0, KTset, ncol = 1, heights = c(0.15, 1)))
   }
}
```

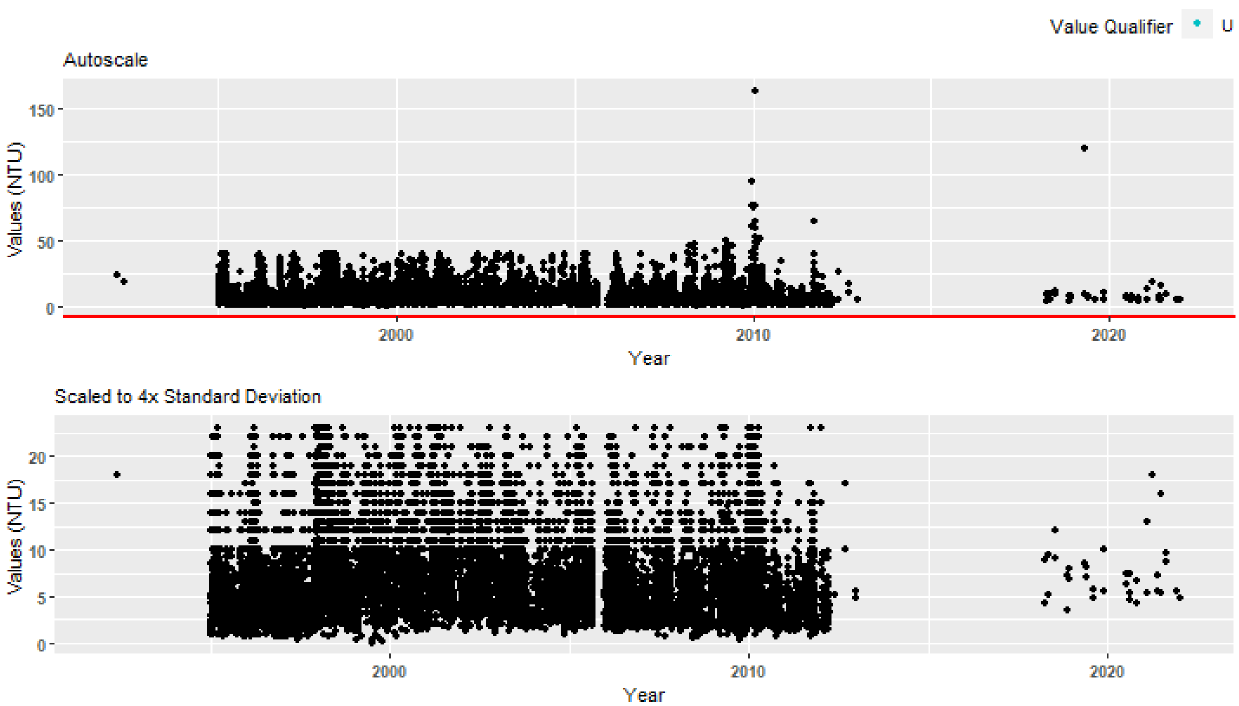
Data Points with Trendlines for Alligator Harbor Aquatic Preserve

Senn Slope = -0.15,   Senn Intercept = 264.0975
Trend = -1,   tau = -0.1436,   p = 0
Linear Trendline: y = -0.108153902079979x + 223.019559576797



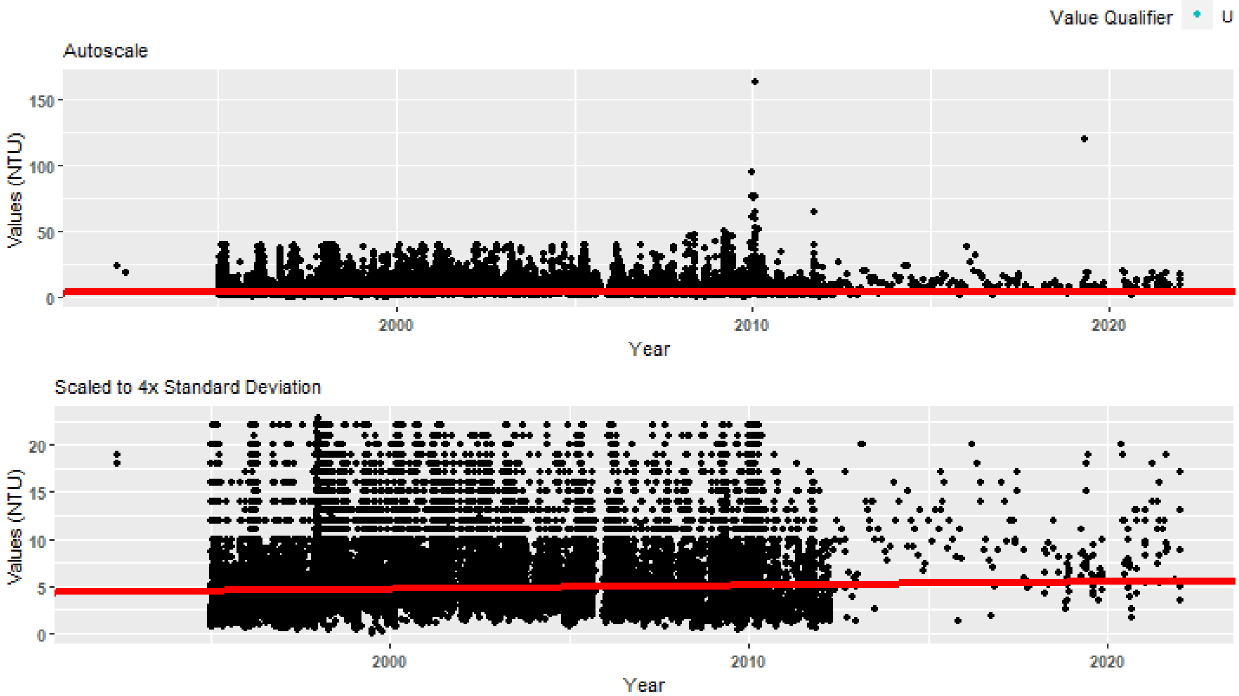
Data Points with Trendlines for Apalachicola Bay Aquatic Preserve

Senn Slope = 0.0111111111111111,   Senn Intercept = -31.315
Trend = 1,   tau = 0.0155,   p = 0.0047
Linear Trendline: y = -0.0434581610348609x + 94.7914491172399



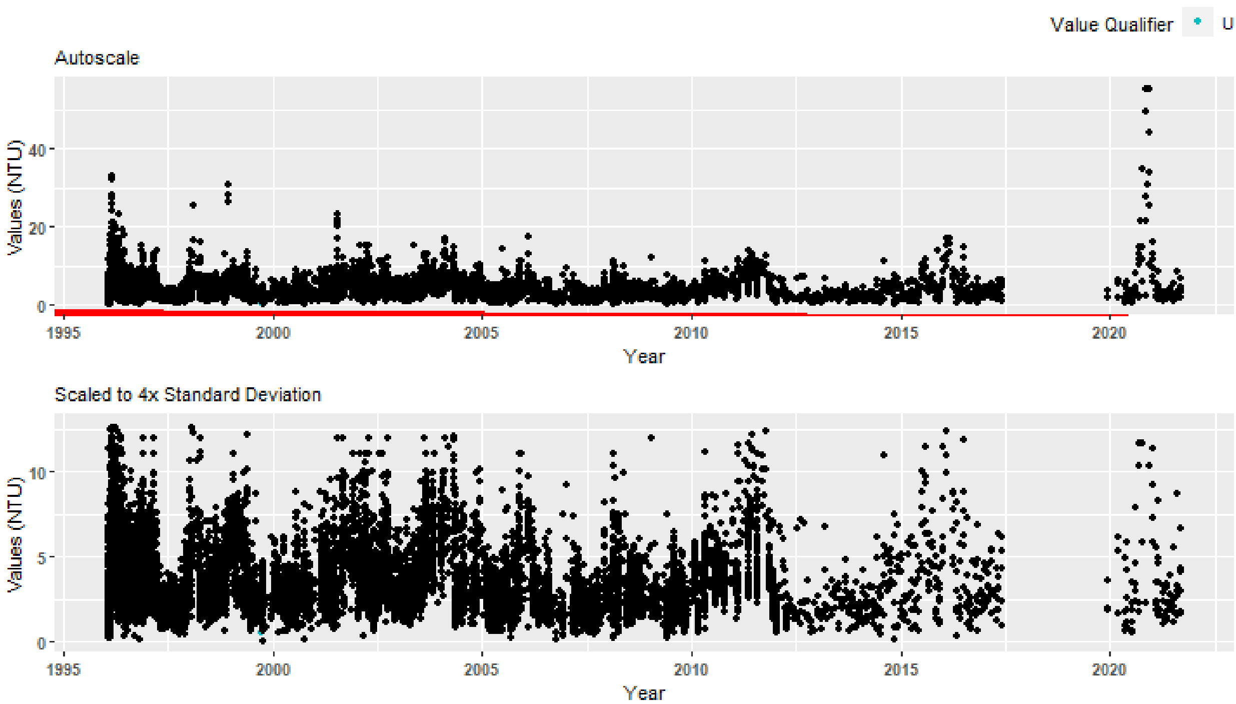
Data Points with Trendlines for Apalachicola National Estuarine Research Reserve

Senn Slope = 0.0384615384615385, Senn Intercept = -72.175
Trend = 1, tau = 0.0494, p = 0
Linear Trendline: y = 0.00814760618084332x + -9.10956095492196



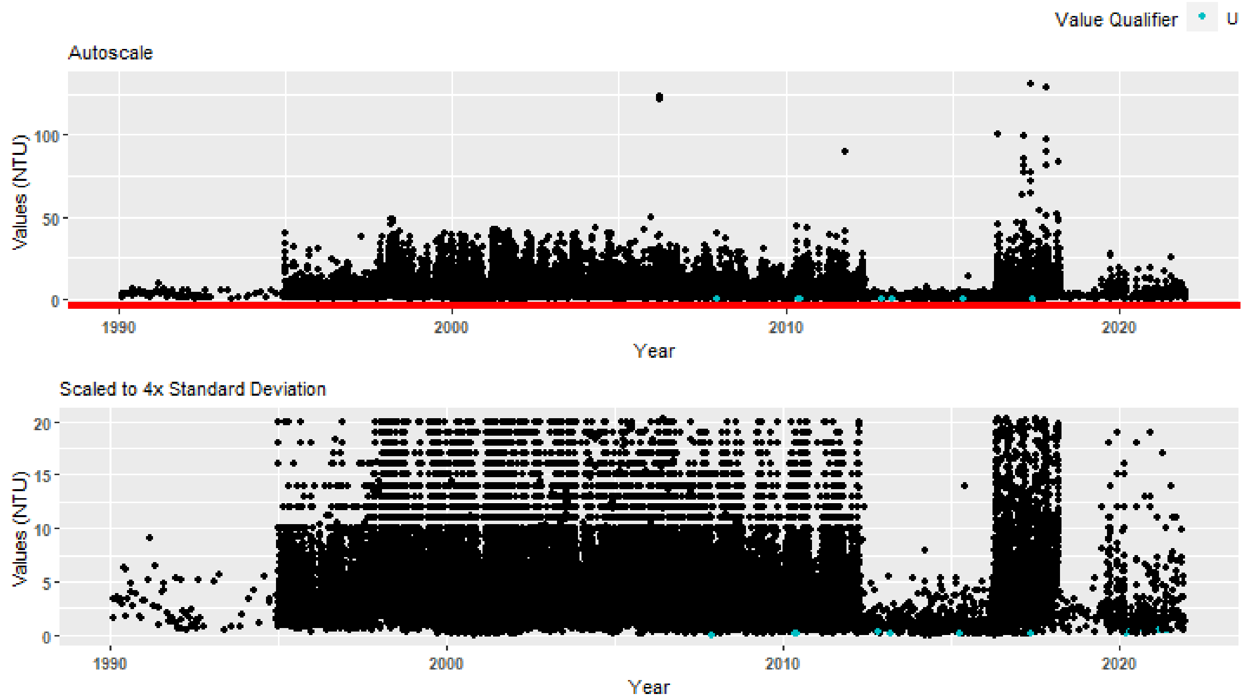
Data Points with Trendlines for Banana River Aquatic Preserve

Senn Slope = -0.0571428571428571, Senn Intercept = 112.03051
Trend = -1, tau = -0.1118, p = 0
Linear Trendline: y = -0.035666737180973x + 75.1543002439311



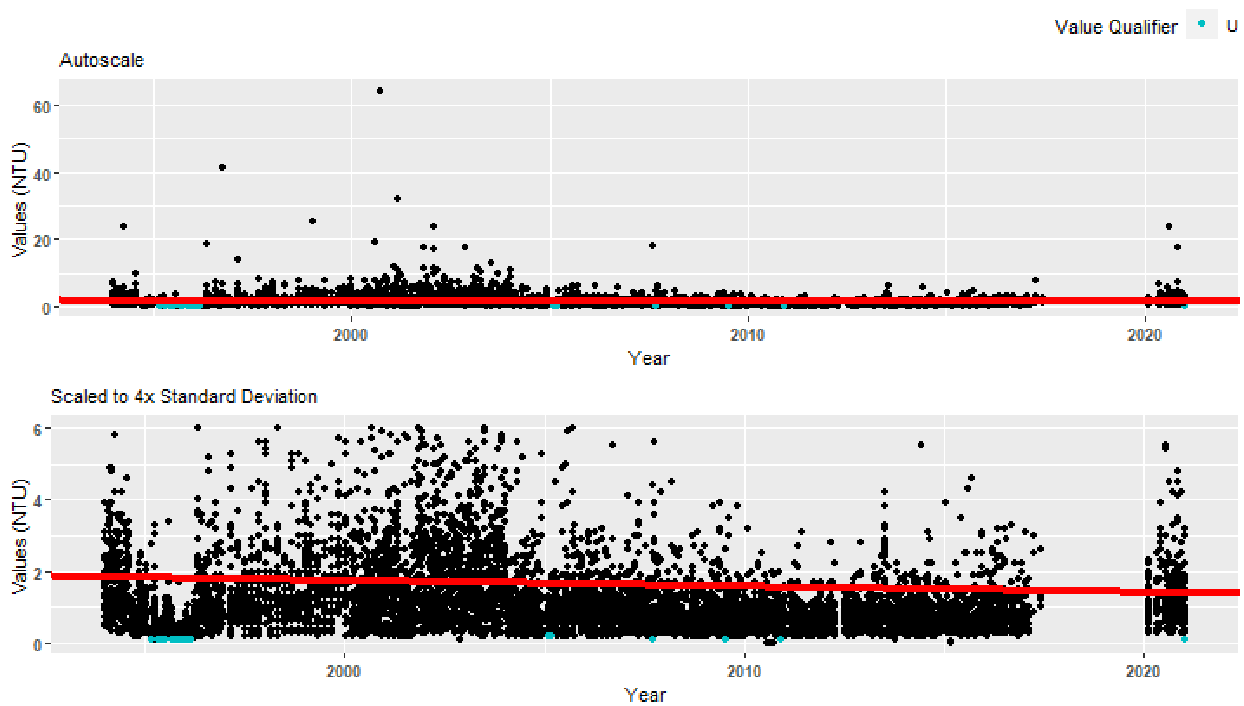
Data Points with Trendlines for Big Bend Seagrasses Aquatic Preserve

Senn Slope = 0,   Senn Intercept = -4.40714285714283
Trend = -1,   tau = 0.0098,   p = 0.0008
Linear Trendline: y = 0.0315529219215336x + -57.8665196765226



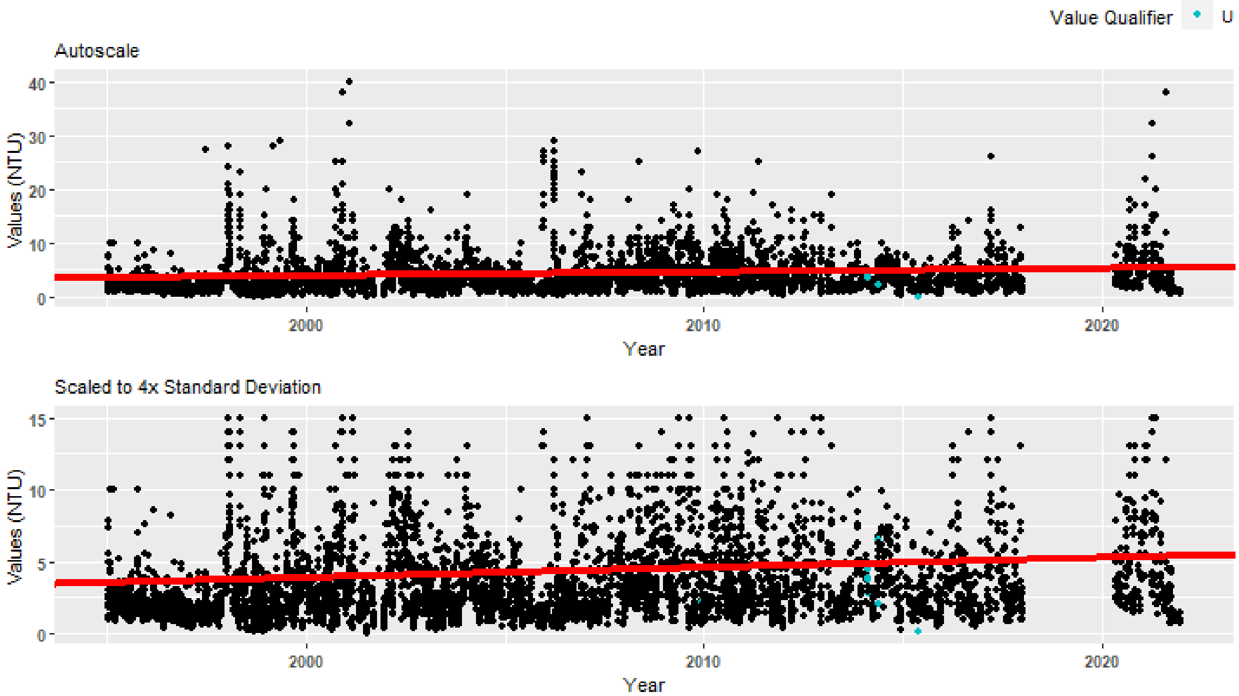
Data Points with Trendlines for Biscayne Bay Aquatic Preserve

Senn Slope = -0.0166666666666667,   Senn Intercept = 35.0885714285714
Trend = -1,   tau = -0.1249,   p = 0
Linear Trendline: y = -0.032672450071627x + 66.7170816360766



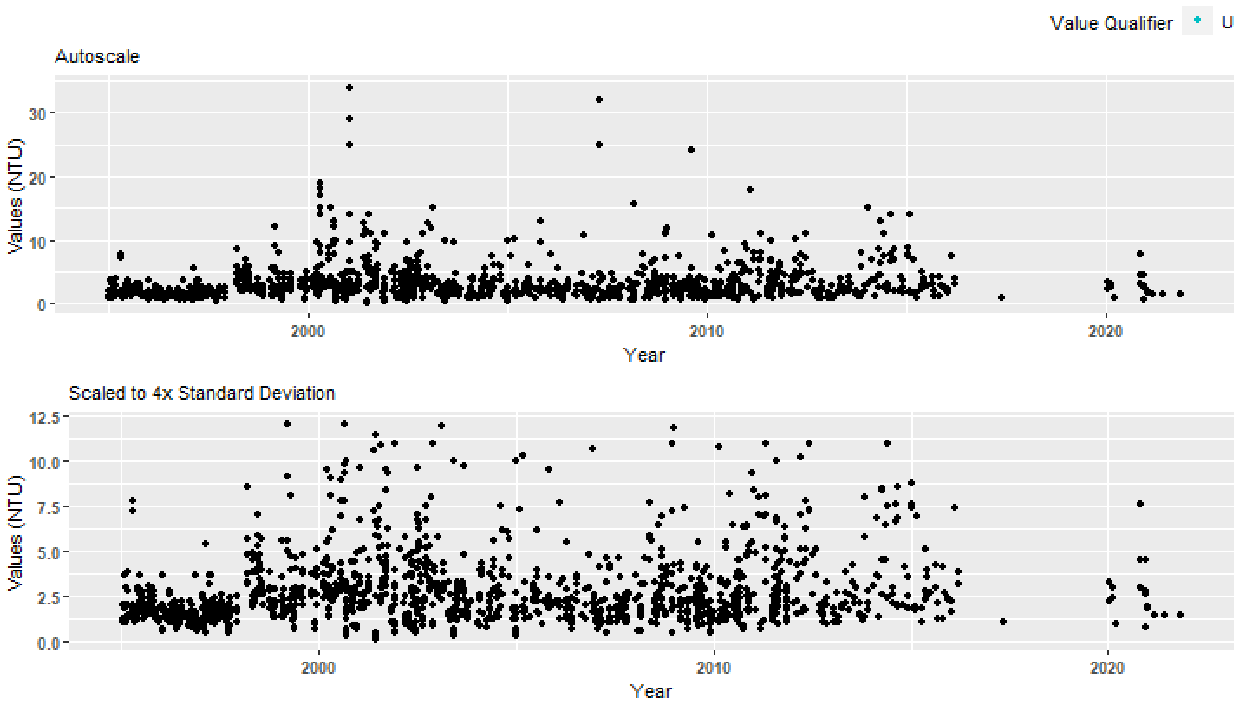
Data Points with Trendlines for Boca Ciega Bay Aquatic Preserve

Senn Slope = 0.06875,   Senn Intercept = -133.557142857143
Trend = 1,   tau = 0.1792,   p = 0
Linear Trendline: y = 0.090335142871446x + -177.715965419878



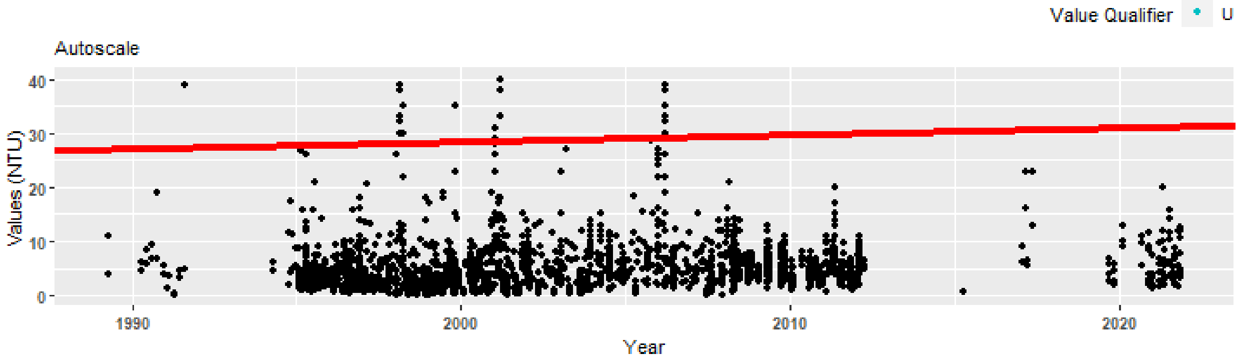
Data Points with Trendlines for Cape Haze Aquatic Preserve

Senn Slope = 0.0333333333333333,   Senn Intercept = -69.6835
Trend = 1,   tau = 0.1127,   p = 0
Linear Trendline: y = 0.0505532924642613x + -98.3973965693429



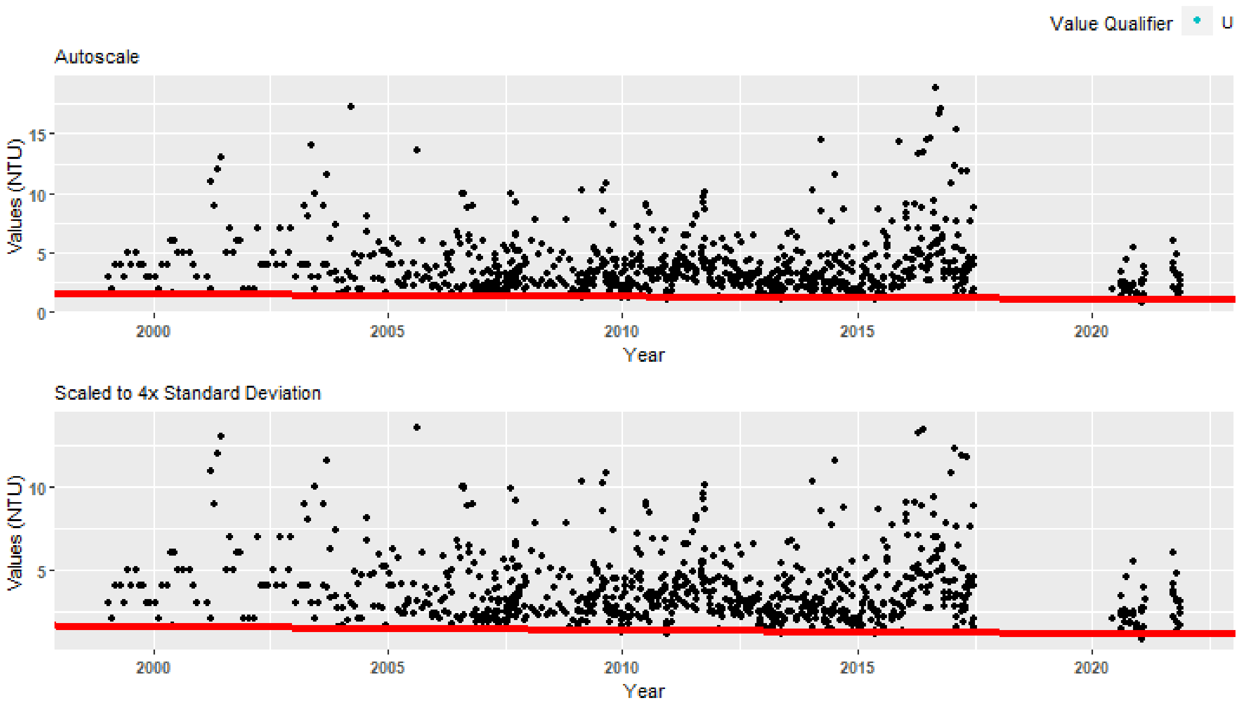
Data Points with Trendlines for Cape Romano-Ten Thousand Islands Aquatic Preserve

Senn Slope = 0.130769230769231, Senn Intercept = -233.181818181818
Trend = 1, tau = 0.1862, p = 0
Linear Trendline: y = 0.147544312098274x + -291.060538180018



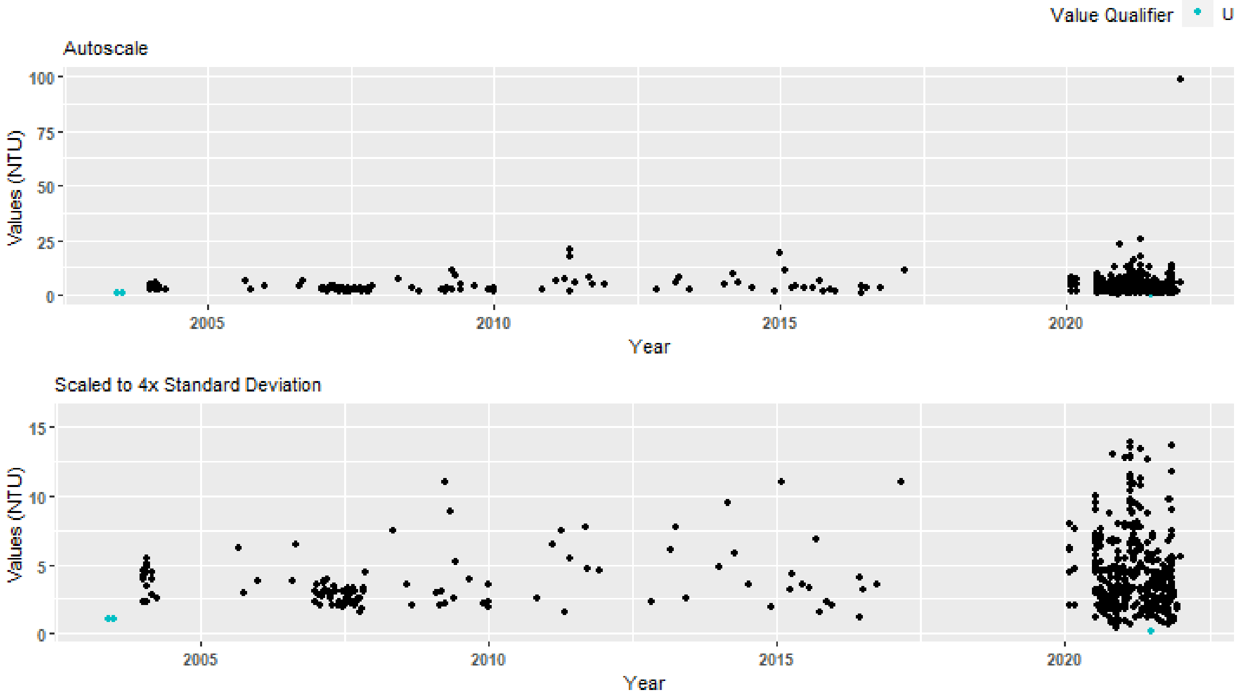
Data Points with Trendlines for Cockroach Bay Aquatic Preserve

Senn Slope = -0.02, Senn Intercept = 41.5540178571429
Trend = 0, tau = -0.0426, p = 0.0766
Linear Trendline: y = -0.0215881058914583x + 47.3515936288881



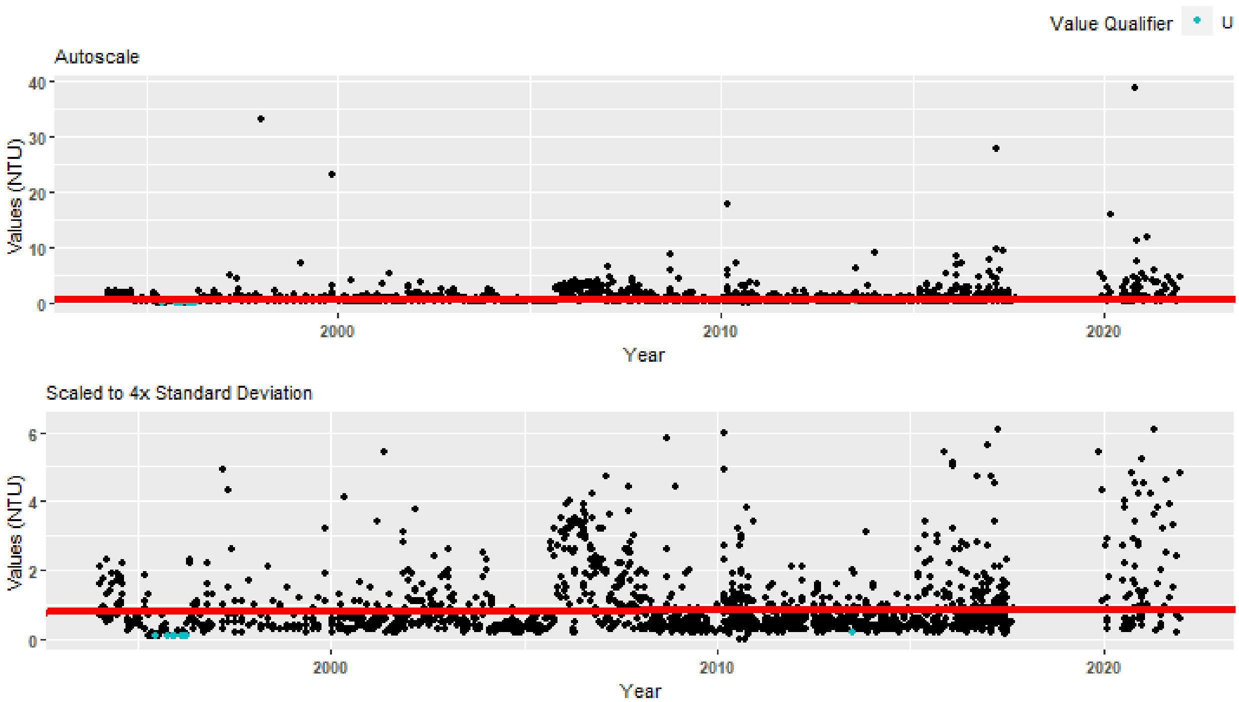
Data Points with Trendlines for Estero Bay Aquatic Preserve

Senn Slope = 0.0428571428571429,   Senn Intercept = -98.9354761904762
Trend = 1,   tau = 0.0694,   p = 0.0373
Linear Trendline: y = 0.0797987580949158x + -156.474052420528



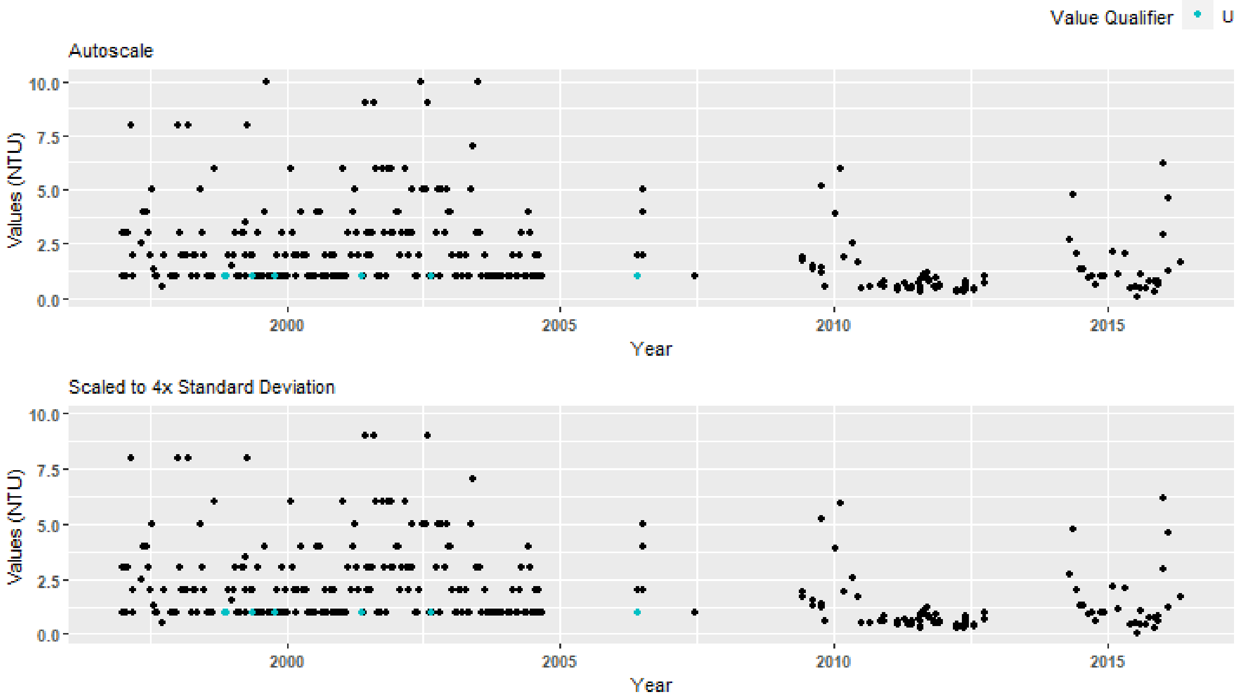
Data Points with Trendlines for Florida Keys National Marine Sanctuary

Senn Slope = 0.00357142857142857,   Senn Intercept = -6.33089498491704
Trend = 1,   tau = 0.068,   p = 0.0001
Linear Trendline: y = 0.0240158854018813x + -47.1485249289307



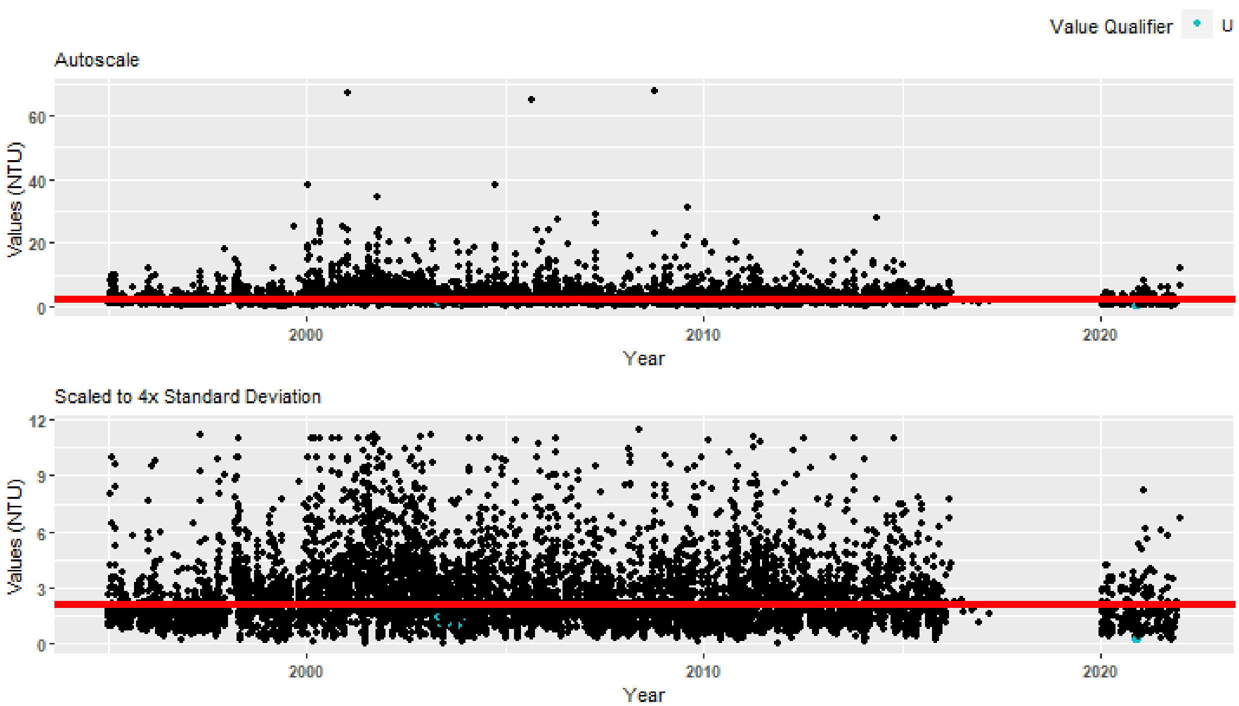
Data Points with Trendlines for Fort Pickens State Park Aquatic Preserve

Senn Slope = -0.0409090909090909,   Senn Intercept = 60.2005617857143
Trend = -1,   tau = -0.2587,   p = 0
Linear Trendline: y = -0.096996300576912x + 196.545158143212



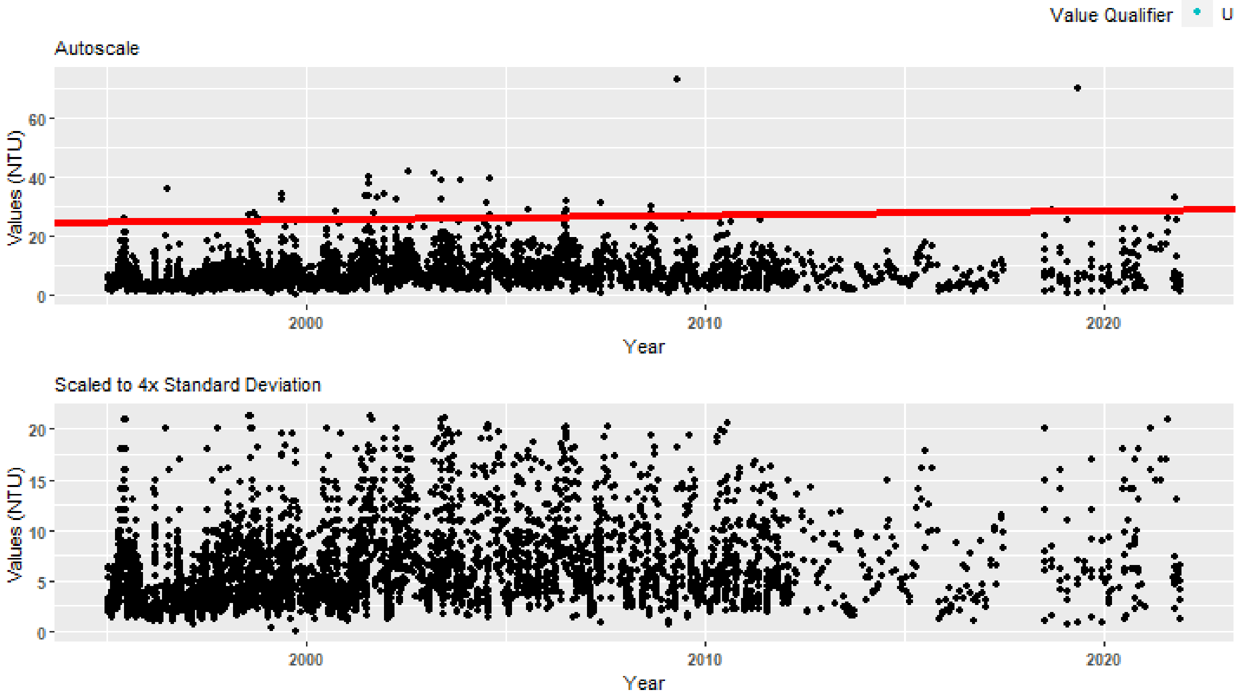
Data Points with Trendlines for Gasparilla Sound-Charlotte Harbor Aquatic Preserve

Senn Slope = 0,   Senn Intercept = 2.1
Trend = -1,   tau = -0.0149,   p = 0.0469
Linear Trendline: y = -0.0142143917028648x + 31.2118704893612



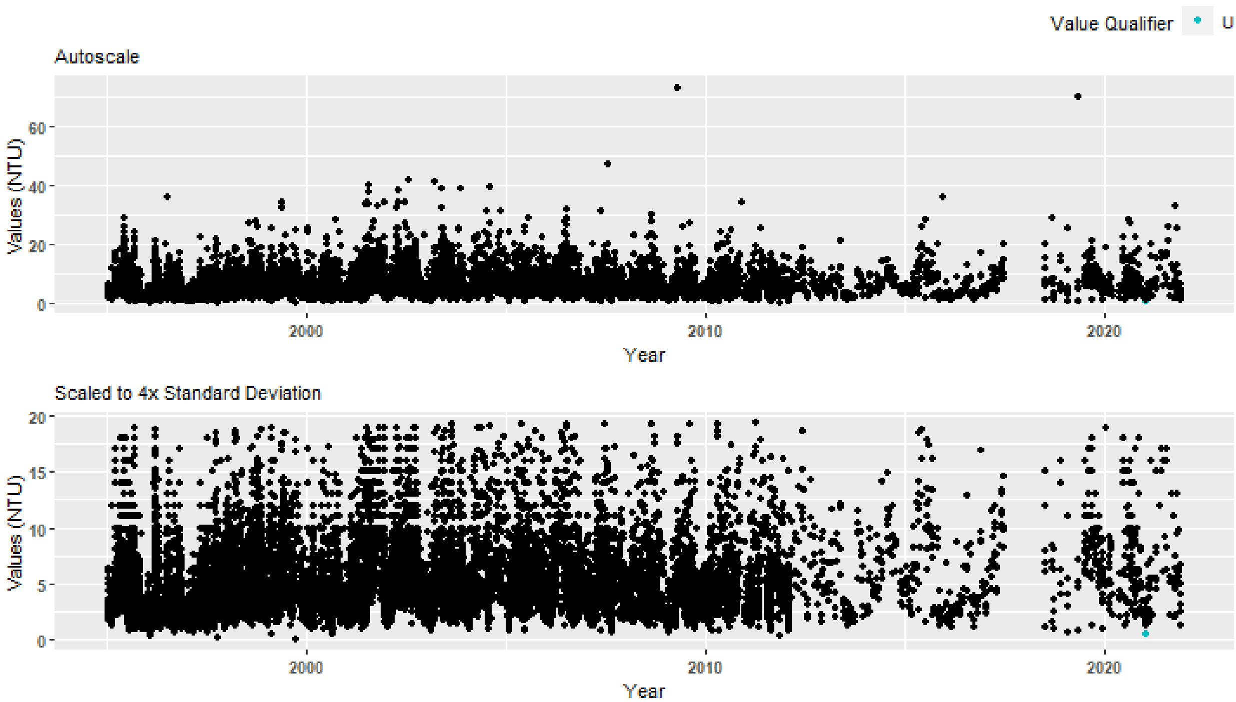
Data Points with Trendlines for Guana River Marsh Aquatic Preserve

Senn Slope = 0.153333333333333,   Senn Intercept = -281.25
Trend = 1,   tau = 0.1941,   p = 0
Linear Trendline: y = 0.162236319170157x + -318.428746246893



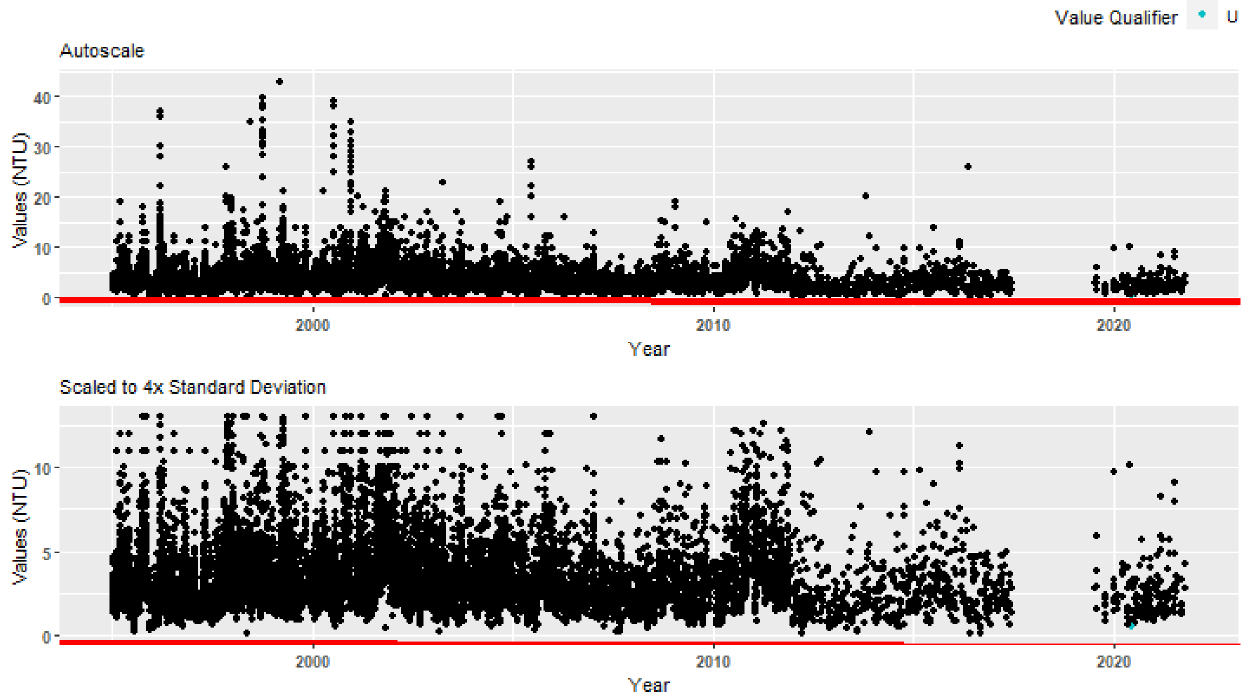
Data Points with Trendlines for Guana Tolomato Matanzas National Estuarine Research Reserve

Senn Slope = 0.0666666666666667,   Senn Intercept = -174.417974666667
Trend = 1,   tau = 0.1021,   p = 0
Linear Trendline: y = 0.0774942035130711x + -149.697182325529



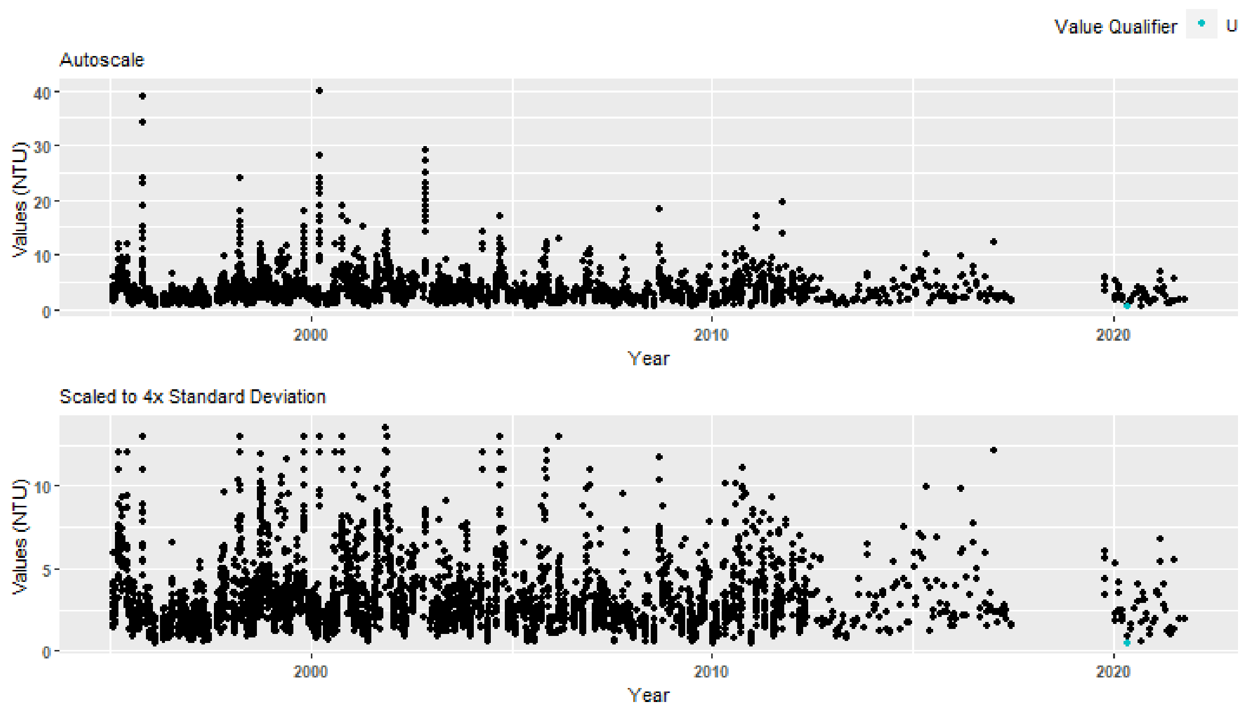
Data Points with Trendlines for Indian River-Malabar to Vero Beach Aquatic Preserve

Senn Slope = -0.00833333333333334, Senn Intercept = 16.1057953571429
Trend = -1, tau = -0.0207, p = 0
Linear Trendline: y = -0.0259699659480143x + 55.5541310443137



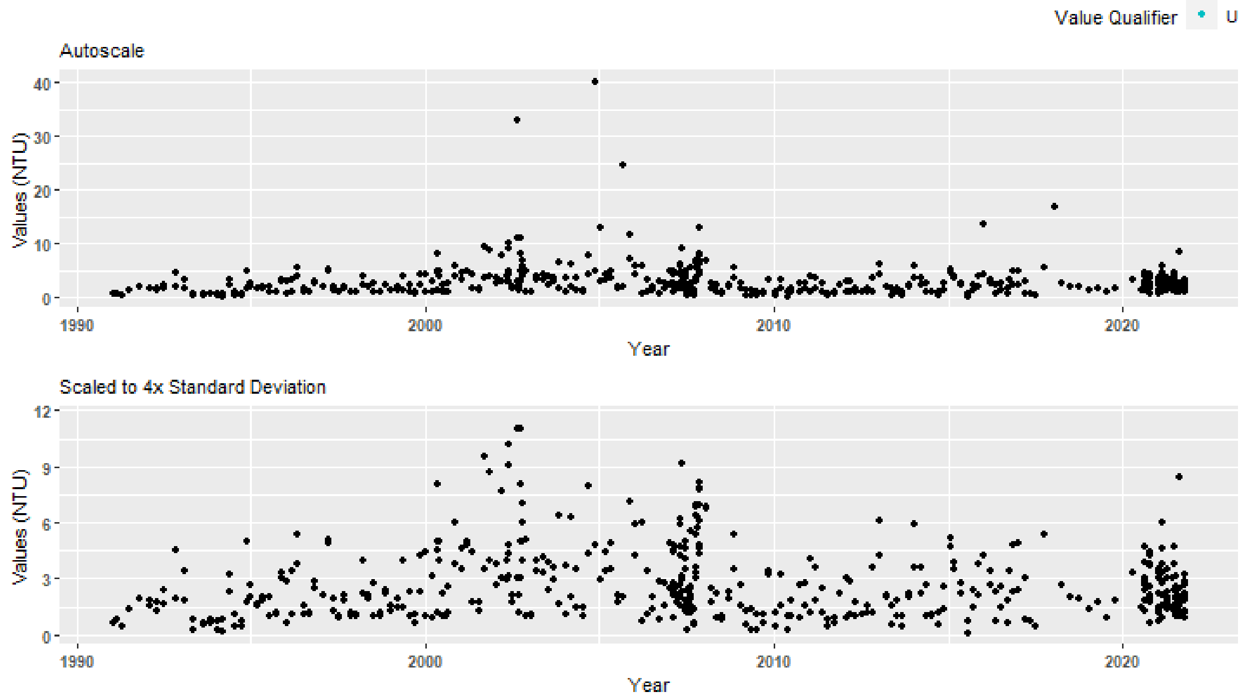
Data Points with Trendlines for Indian River-Vero Beach to Ft. Pierce Aquatic Preserve

Senn Slope = 0, Senn Intercept = -39.1855555555555
Trend = 0, tau = -0.0009, p = 0.2552
Linear Trendline: y = -0.0301558384520004x + 63.8950545385719



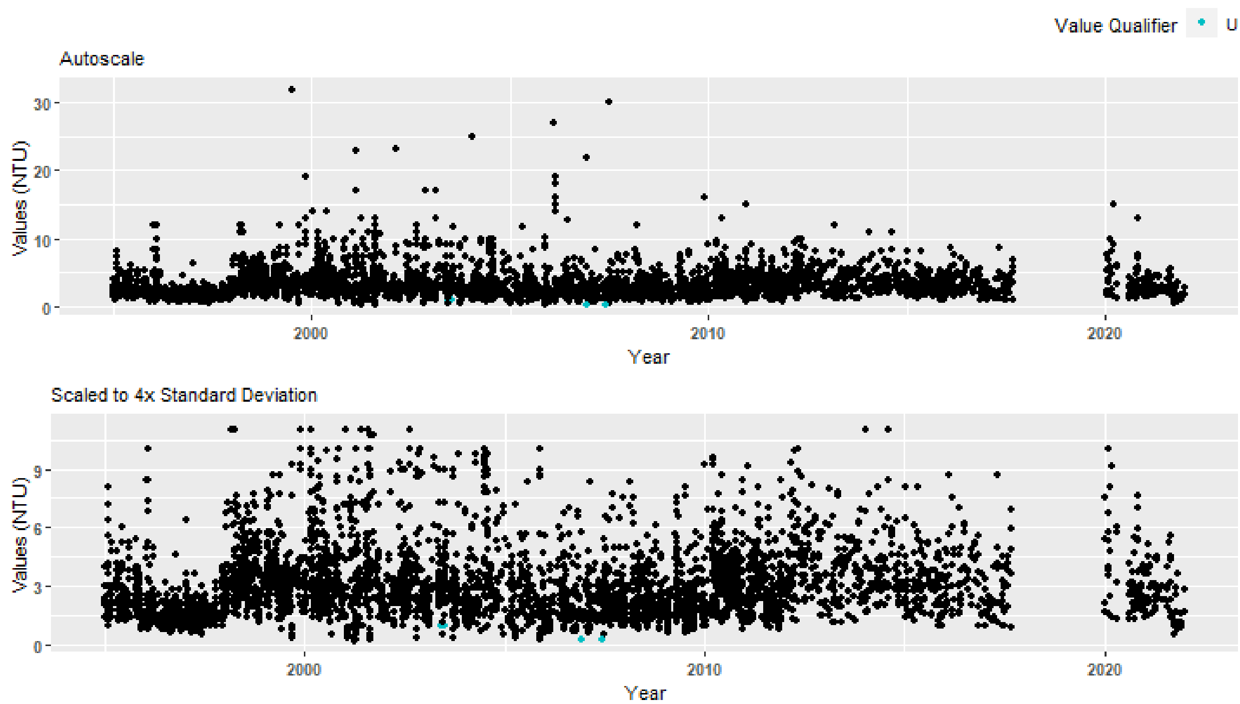
Data Points with Trendlines for Jensen Beach to Jupiter Inlet Aquatic Preserve

Senn Slope = -0.00714285714285715,   Senn Intercept = 2
Trend = 0,   tau = -0.0412,   p = 0.3248
Linear Trendline: y = -0.0124989209984614x + 28.0955397536613



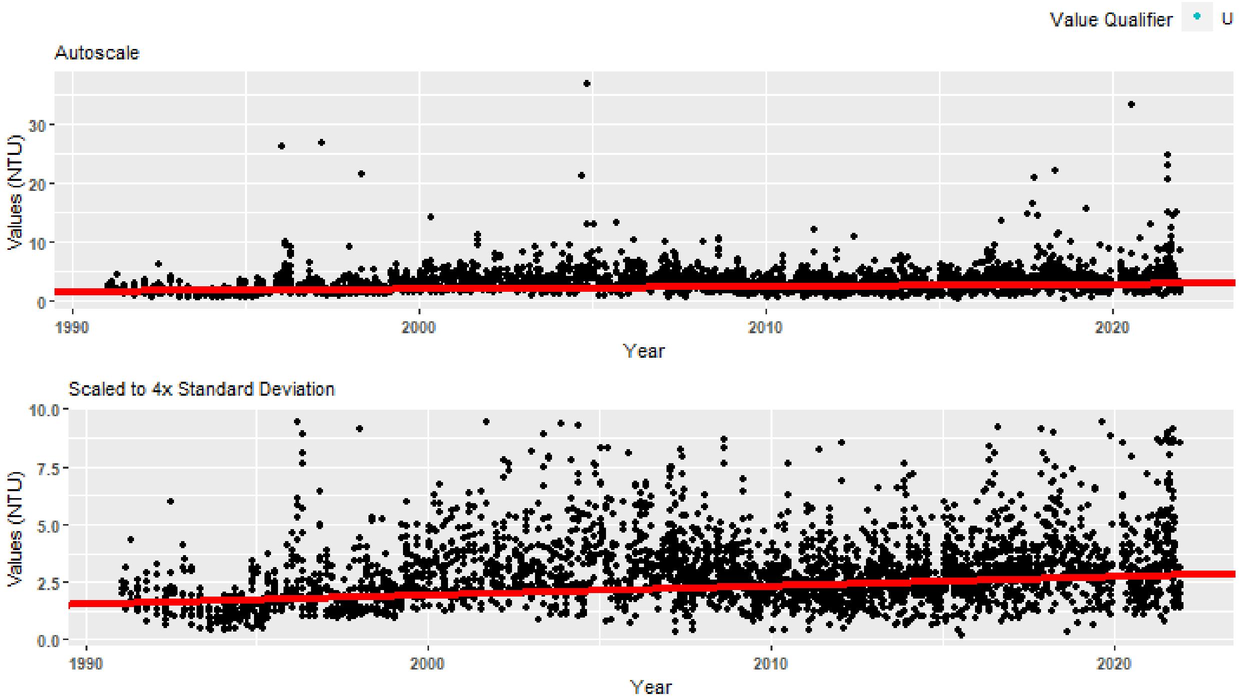
Data Points with Trendlines for Lemon Bay Aquatic Preserve

Senn Slope = 0.025,   Senn Intercept = -69.8336466165413
Trend = 1,   tau = 0.0758,   p = 0
Linear Trendline: y = 0.00968652942642578x + -16.2775802021289



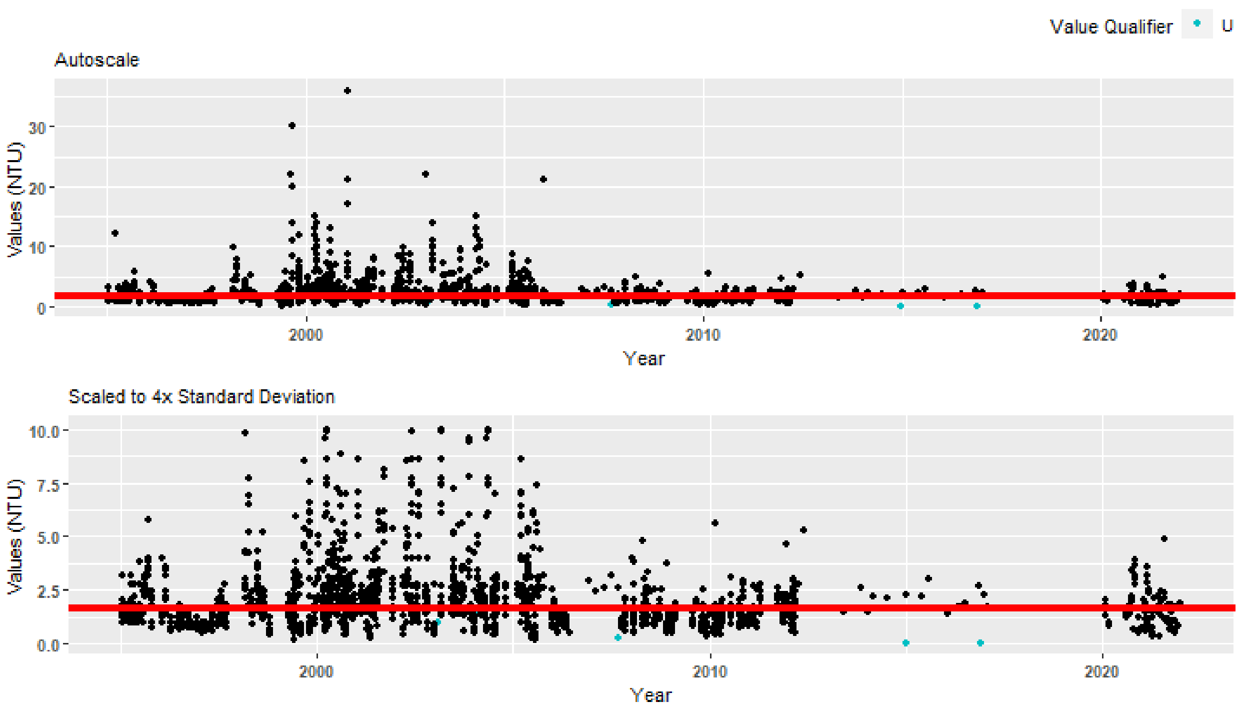
Data Points with Trendlines for Loxahatchee River-Lake Worth Creek Aquatic Preserve

Senn Slope = 0.04, Senn Intercept = -78.0430158730159
Trend = 1, tau = 0.169, p = 0
Linear Trendline: y = 0.0463472112412088x + -90.09029953015



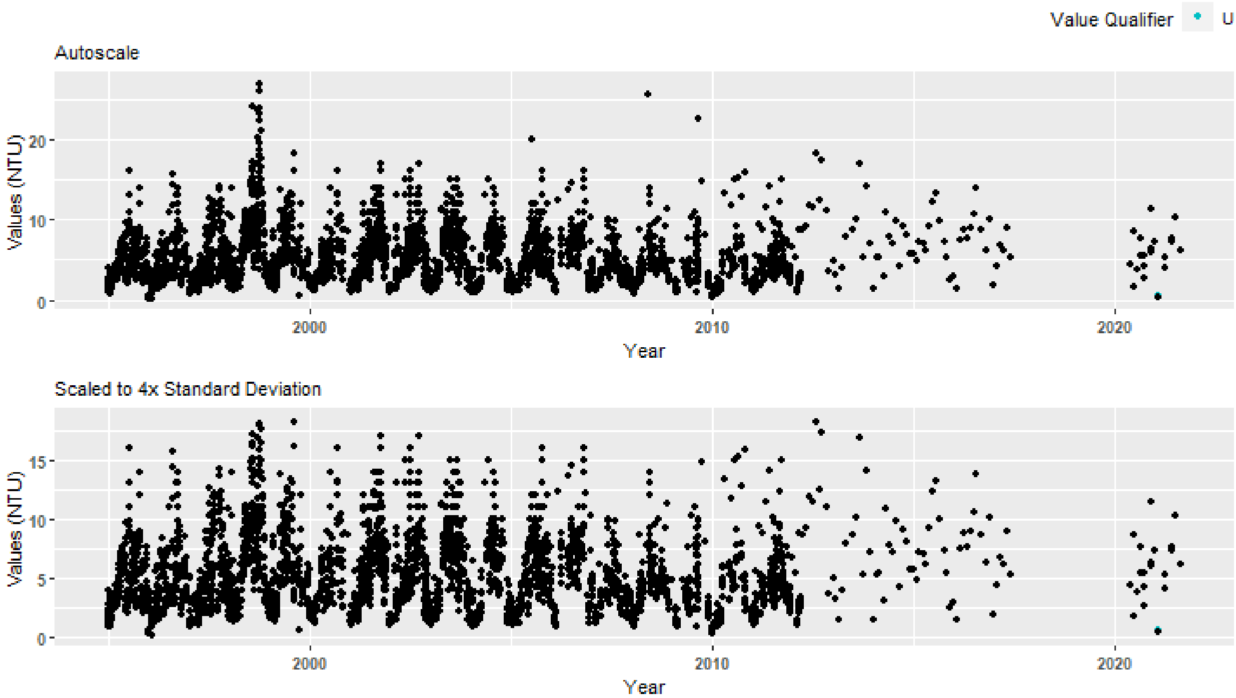
Data Points with Trendlines for Matlacha Pass Aquatic Preserve

Senn Slope = 0, Senn Intercept = 1.6
Trend = 0, tau = 0.0015, p = 0.8667
Linear Trendline: y = -0.0407856503392324x + 84.0052330550508



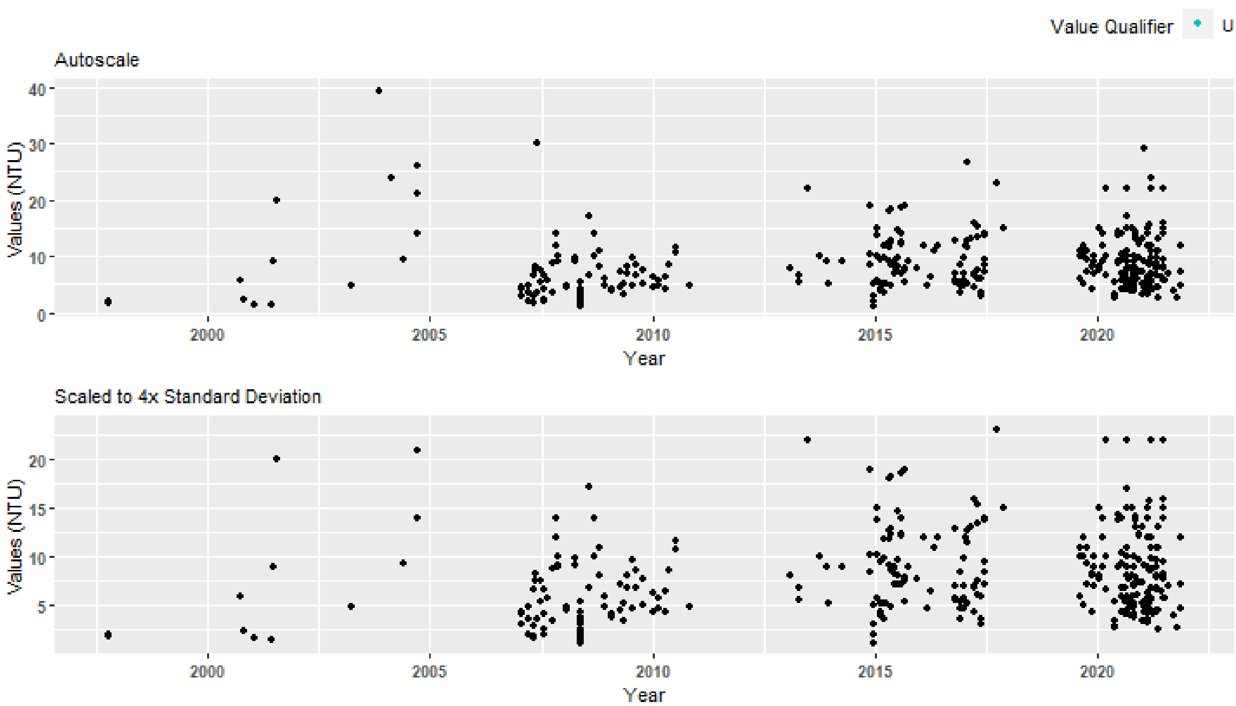
Data Points with Trendlines for Mosquito Lagoon Aquatic Preserve

Senn Slope = -0.0307692307692308,   Senn Intercept = 30.4
Trend = -1,   tau = -0.0585,   p = 0
Linear Trendline: y = -0.026201220653158x + 57.8503478301553



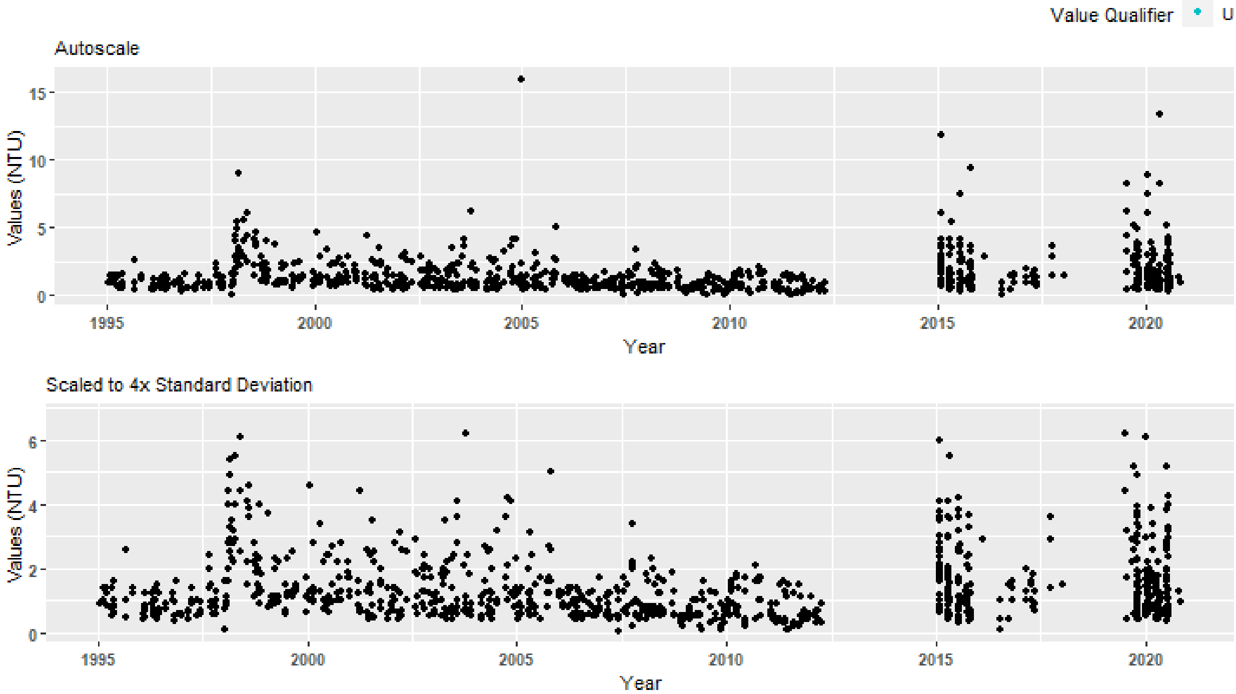
Data Points with Trendlines for Nassau River-St. Johns River Marshes Aquatic Preserve

Senn Slope = 0.106376363636364,   Senn Intercept = -107.132885048077
Trend = 1,   tau = 0.0908,   p = 0.0054
Linear Trendline: y = 0.103529810208316x + -200.163380713177



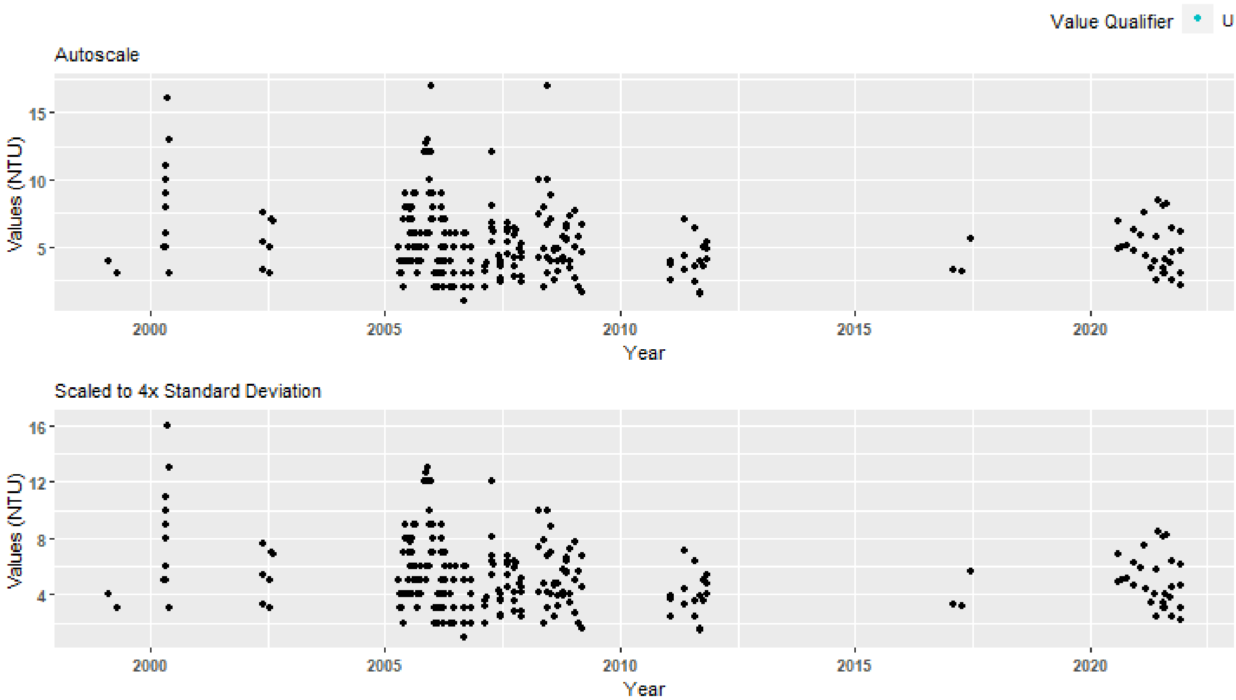
Data Points with Trendlines for Nature Coast Aquatic Preserve

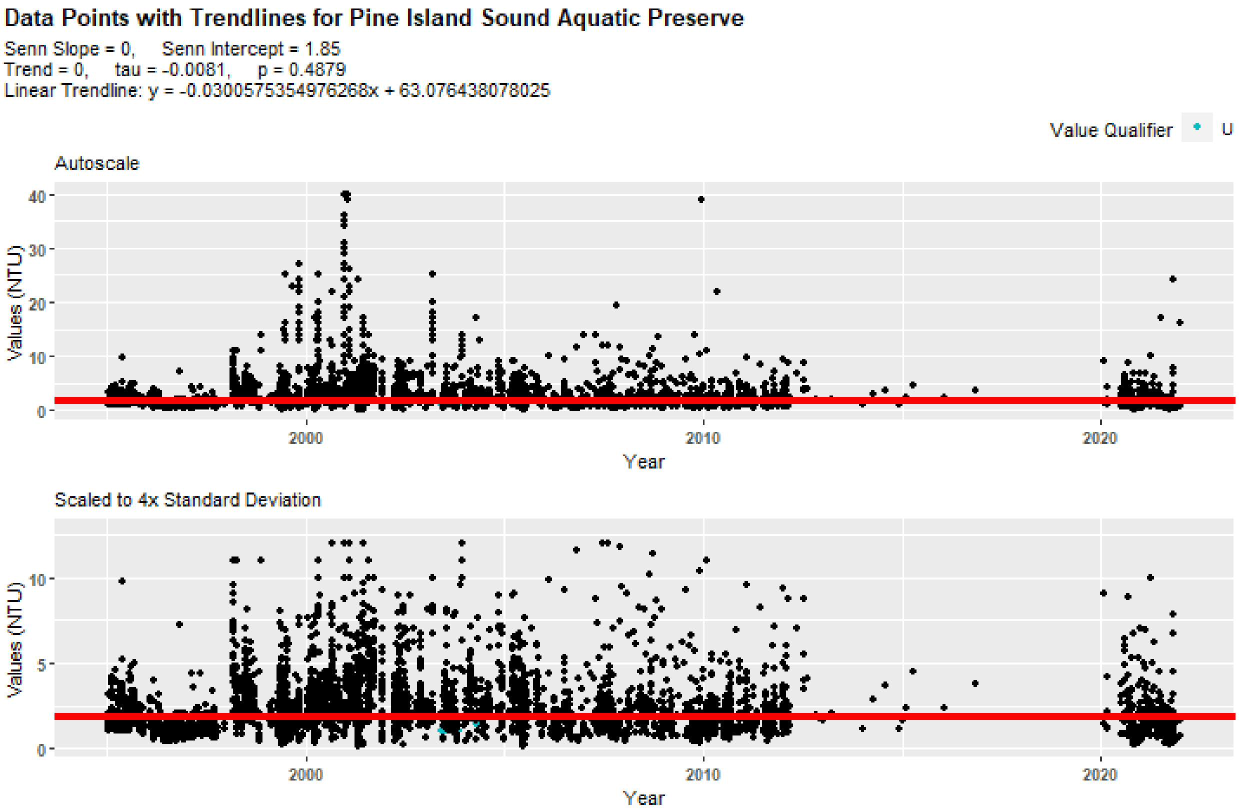
Senn Slope = -0.005, Senn Intercept = 28.4670833333333
Trend = -1, tau = -0.0687, p = 0.0303
Linear Trendline: y = 0.00994621499180507x + -18.5783913947786

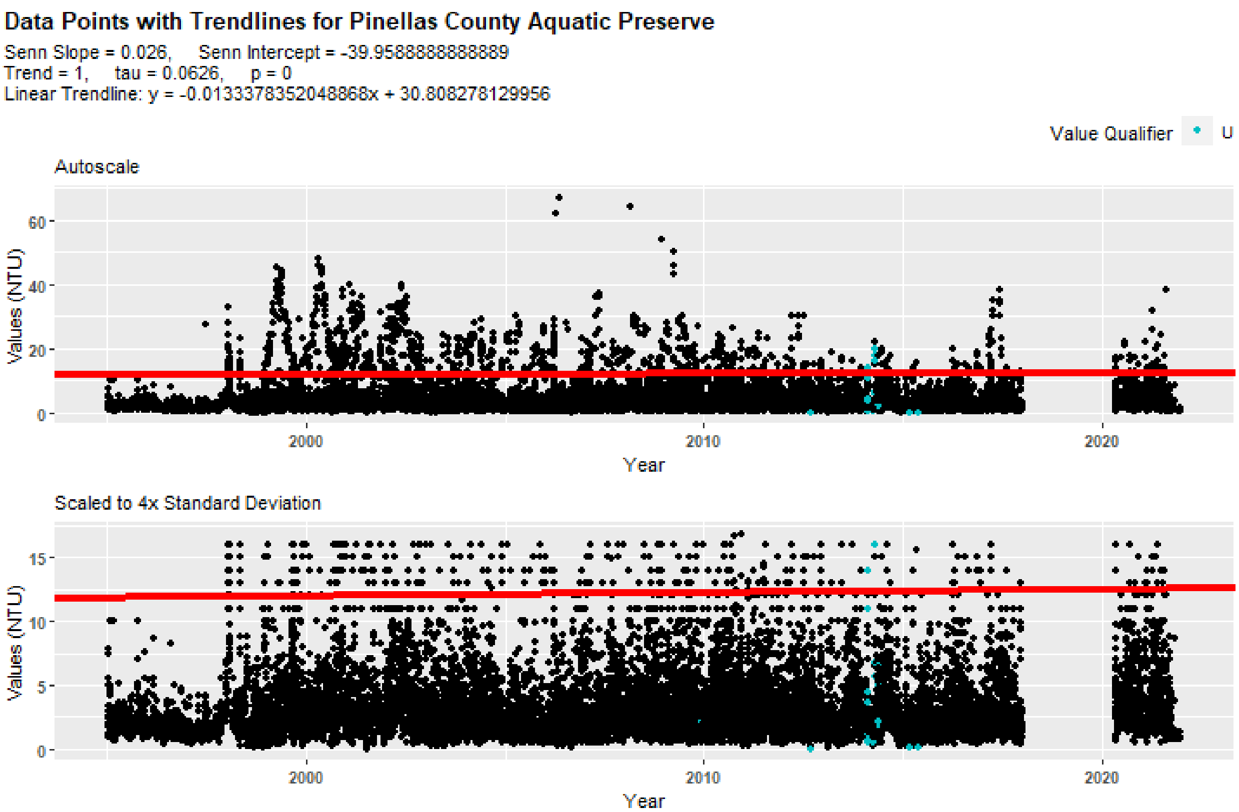


Data Points with Trendlines for North Fork St. Lucie Aquatic Preserve

Senn Slope = -0.1, Senn Intercept = 171.666666666667
Trend = -1, tau = -0.1248, p = 0.0009
Linear Trendline: y = -0.089956940378287 1x + 186.020405818697

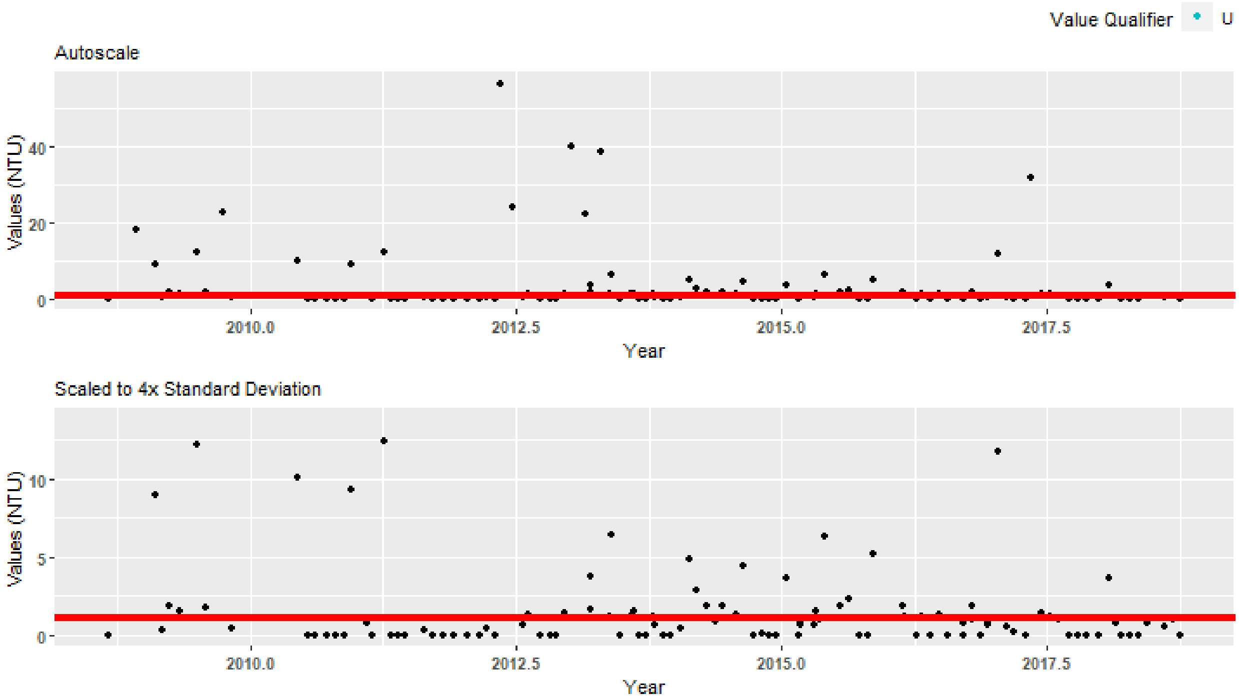



Data Points with Trendlines for Pine Island Sound Aquatic Preserve
Senn Slope = 0, Senn Intercept = 1.85
Trend = 0, tau = -0.0081, p = 0.4879
Linear Trendline: y = -0.0300575354976268x + 63.076438078025
Value Qualifier
U
Autoscale
Values (NTU)
Year
Scaled to 4x Standard Deviation
Values (NTU)
Year


Data Points with Trendlines for Pinellas County Aquatic Preserve
Senn Slope = 0.026, Senn Intercept = -39.9588888888889
Trend = 1, tau = 0.0626, p = 0
Linear Trendline: y = -0.0133378352048868x + 30.808278129956
Value Qualifier
U
Autoscale
Values (NTU)
Year
Scaled to 4x Standard Deviation
Values (NTU)
Year

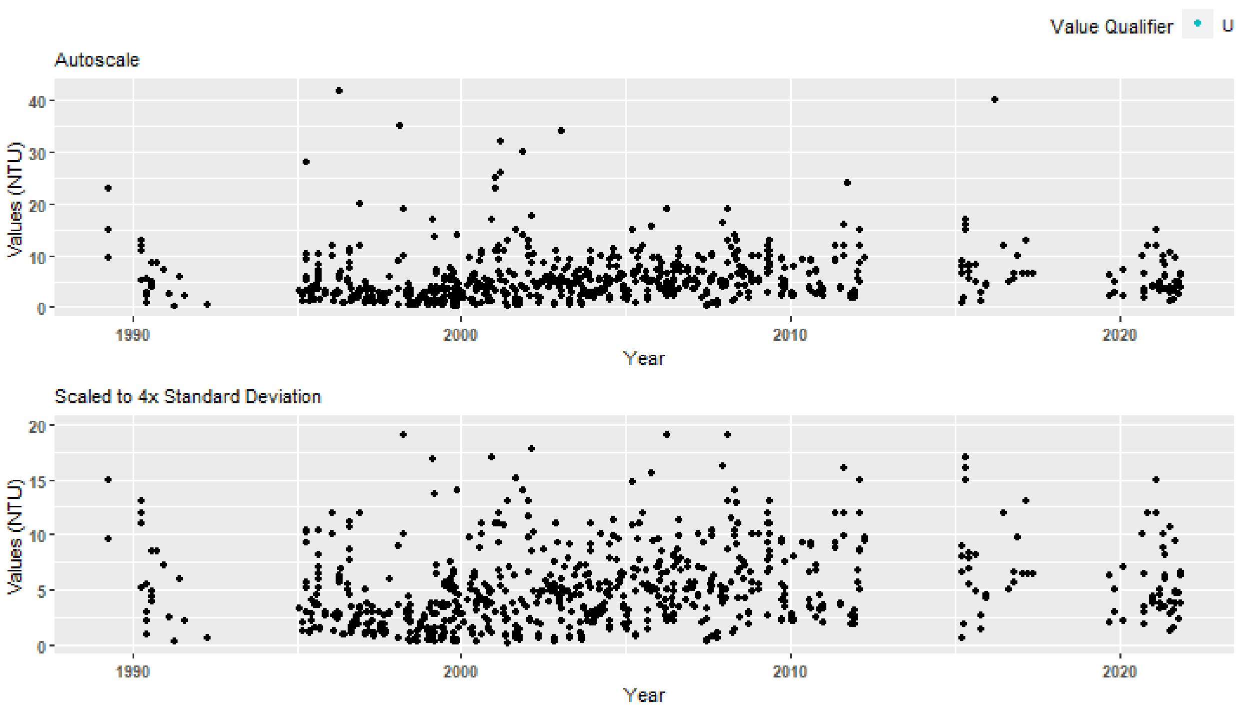
Data Points with Trendlines for Rocky Bayou State Park Aquatic Preserve

Senn Slope = 0,   Senn Intercept = 1.1
Trend = 0,   tau = -0.0763,   p = 0.2264
Linear Trendline: y = -0.567161181860835x + 1145.88362677768



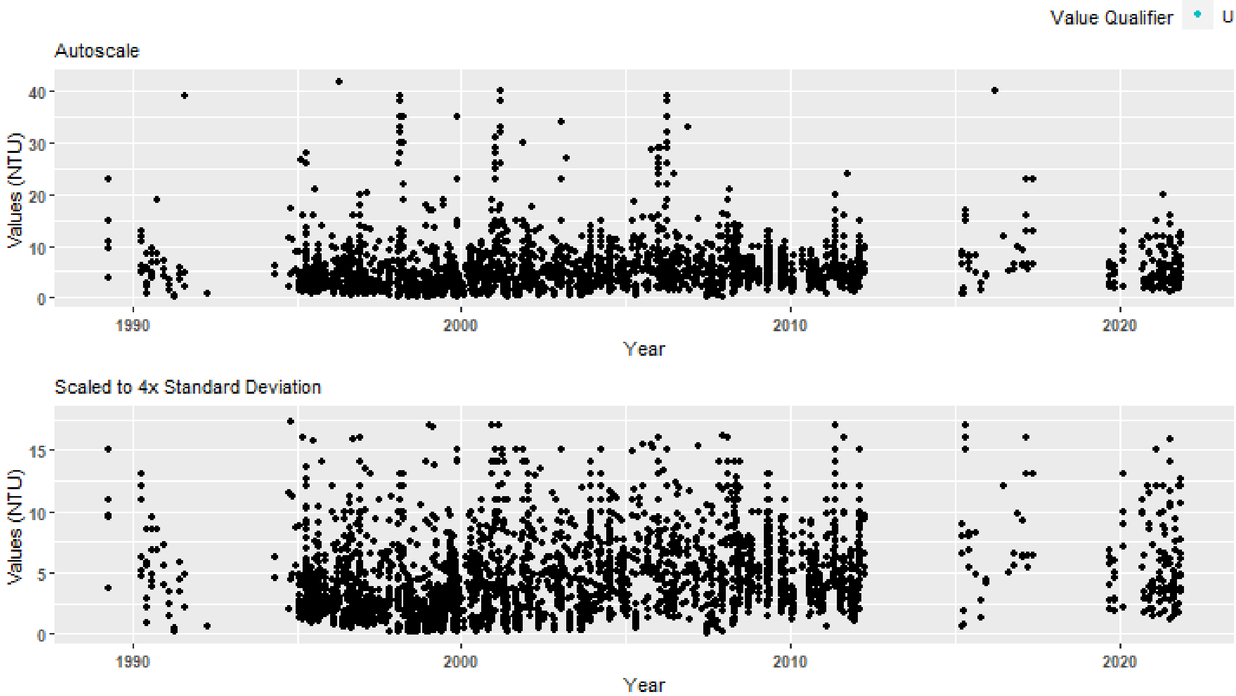
Data Points with Trendlines for Rookery Bay Aquatic Preserve

Senn Slope = 0.133333333333333,   Senn Intercept = -196.8435
Trend = 1,   tau = 0.1802,   p = 0
Linear Trendline: y = 0.079531771201861x + -153.87610253619



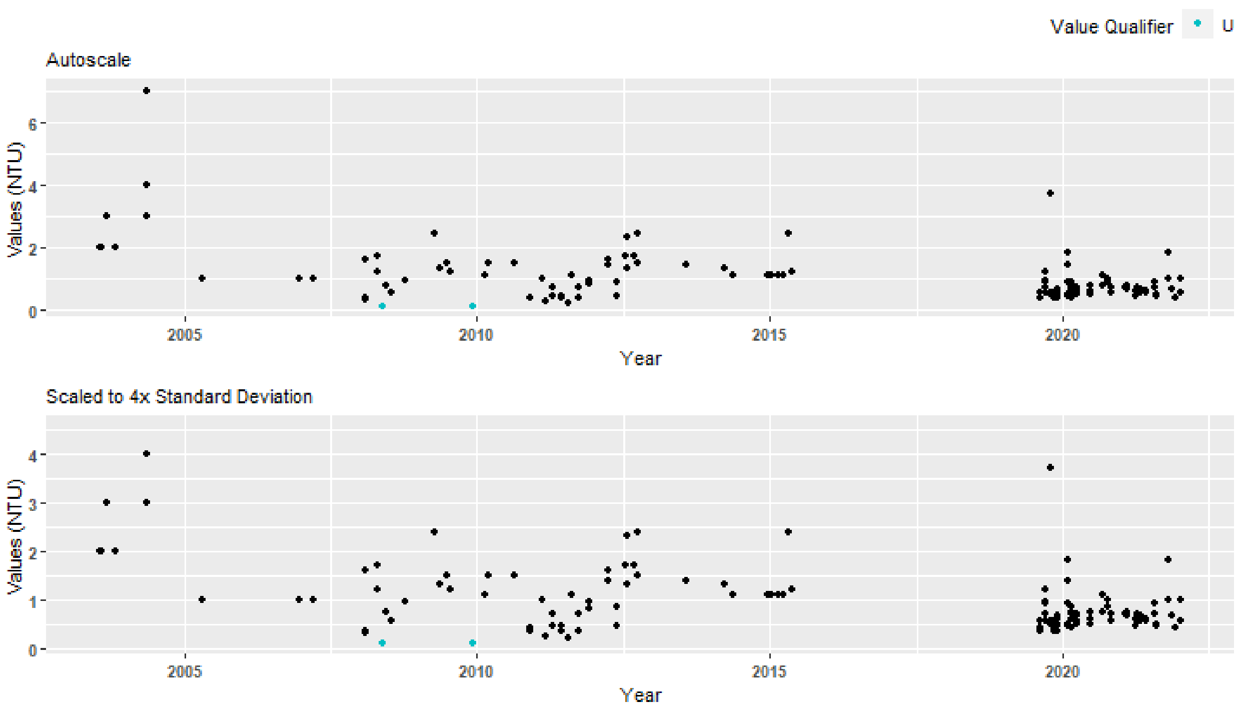
Data Points with Trendlines for Rookery Bay National Estuarine Research Reserve

Senn Slope = 0.135714285714286,   Senn Intercept = -212.74756127451
Trend = 1,   tau = 0.1908,   p = 0
Linear Trendline: y = 0.137023852911446x + -269.804569767504



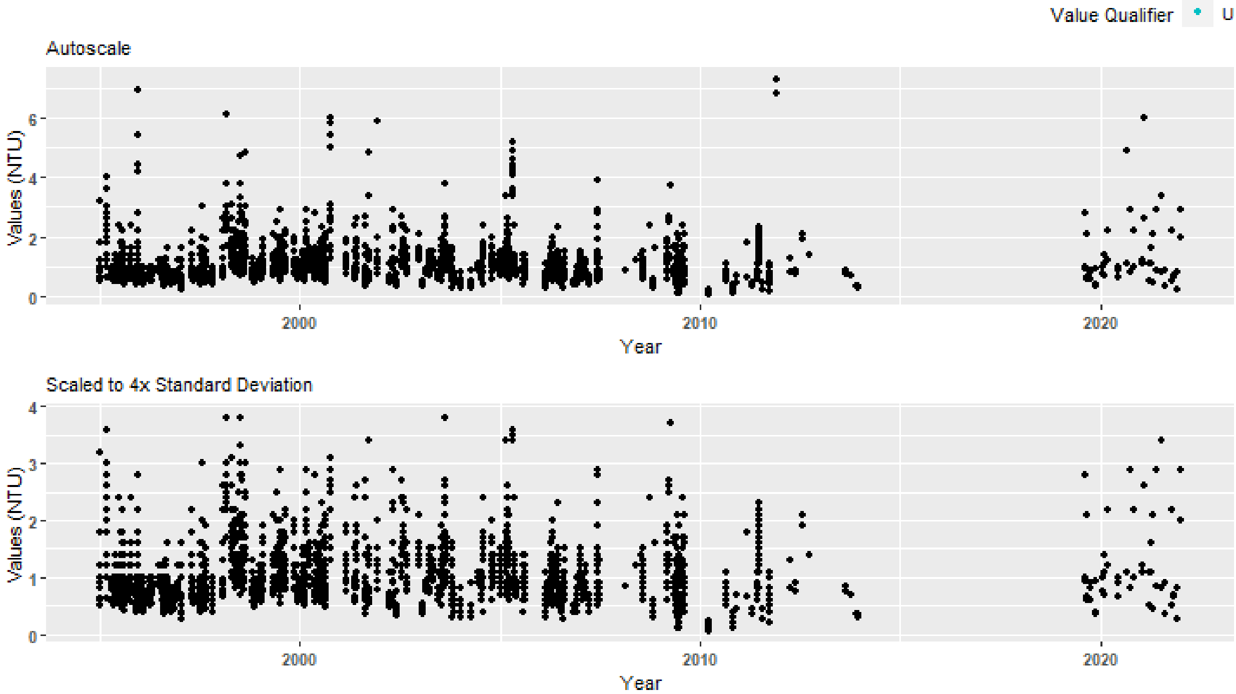
Data Points with Trendlines for St. Andrews State Park Aquatic Preserve

Senn Slope = -0.0384615384615385,   Senn Intercept = 71.0884595959596
Trend = -1,   tau = -0.1358,   p = 0.0246
Linear Trendline: y = -0.069406983711939x + 140.881472570329



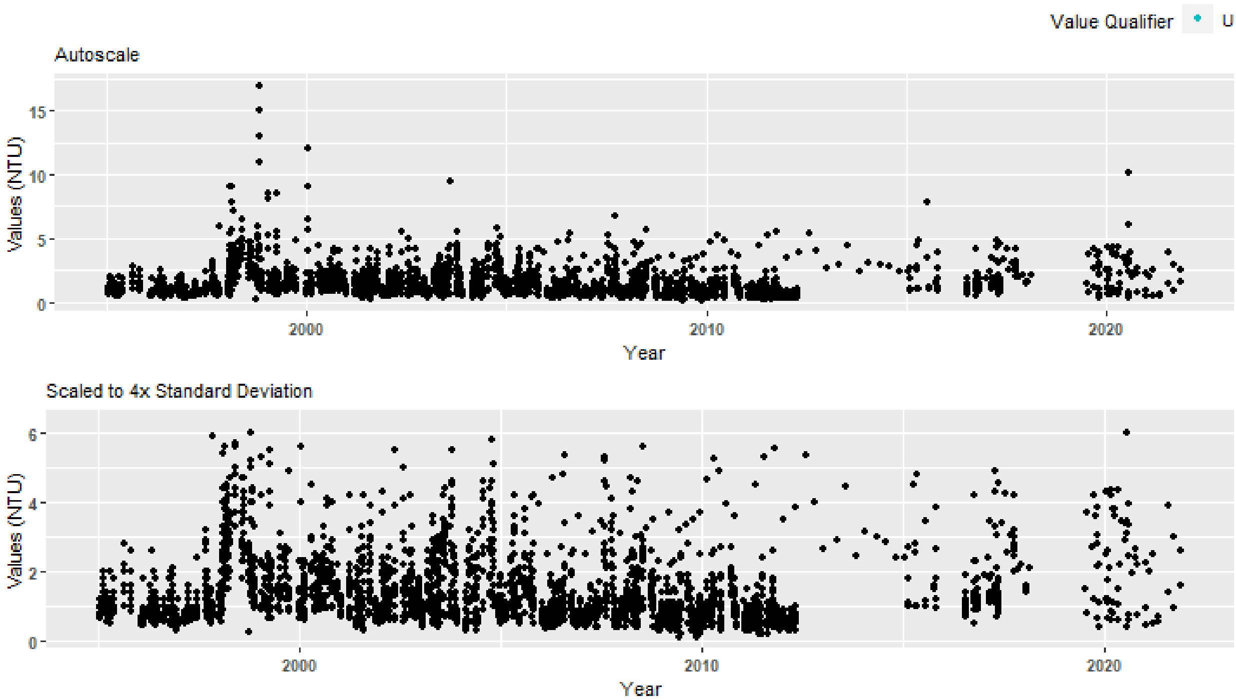
Data Points with Trendlines for St. Joseph Bay Aquatic Preserve

Senn Slope = -0.00166666666666665,   Senn Intercept = 0.86
Trend = -1,   tau = -0.0307,   p = 0.023
Linear Trendline: y = -0.0028171829911677x + 6.69615732384561



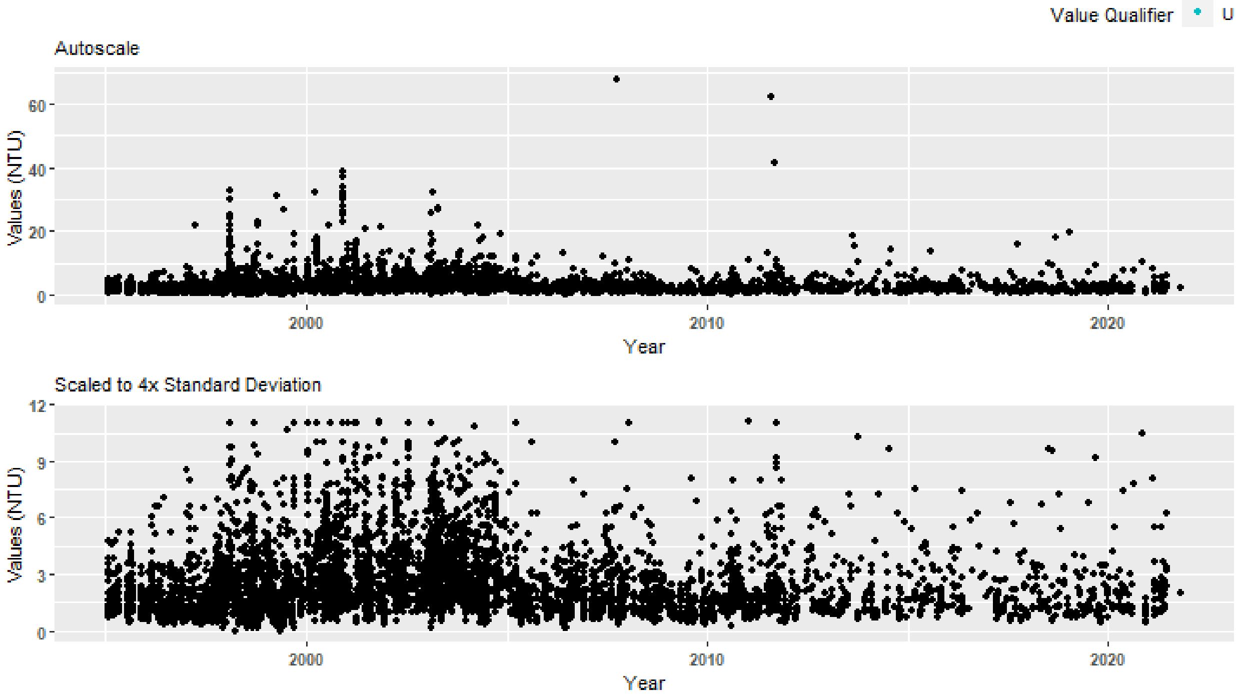
Data Points with Trendlines for St. Martins Marsh Aquatic Preserve

Senn Slope = -0.0166666666666667,   Senn Intercept = 18.2357142857143
Trend = -1,   tau = -0.1074,   p = 0
Linear Trendline: y = -0.014825809583821x + 31.1915030652823



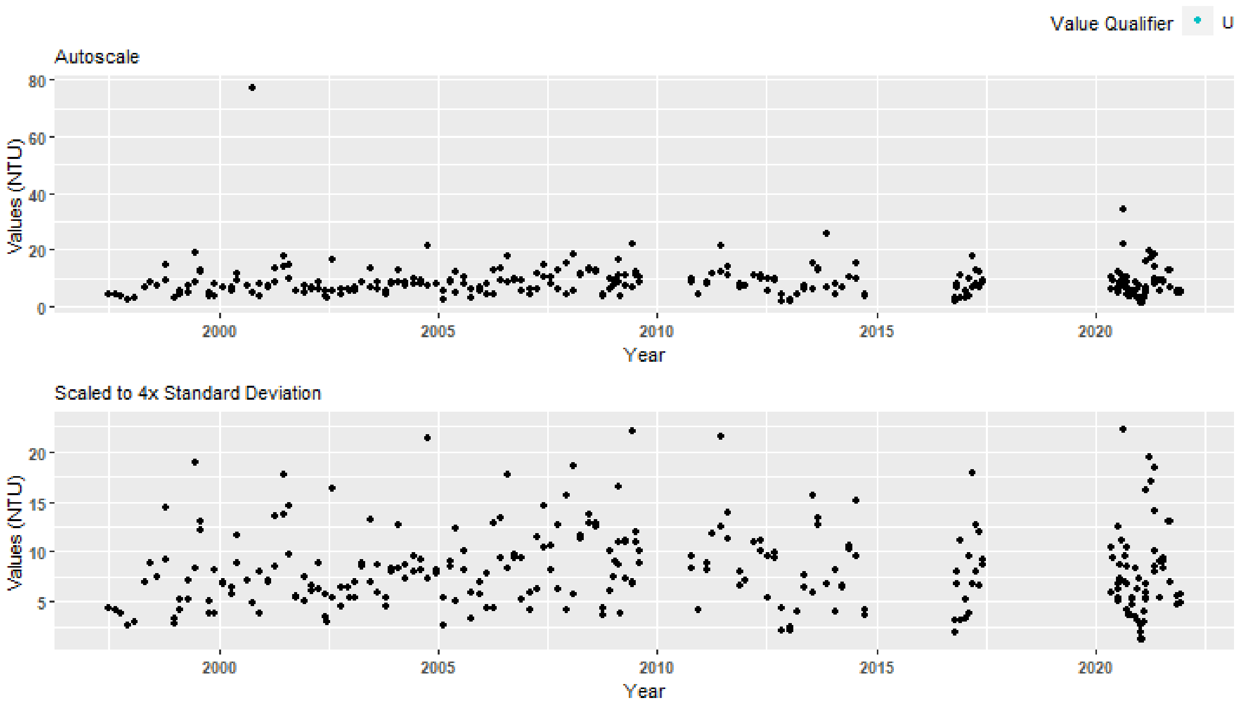
Data Points with Trendlines for Terra Ceia Aquatic Preserve

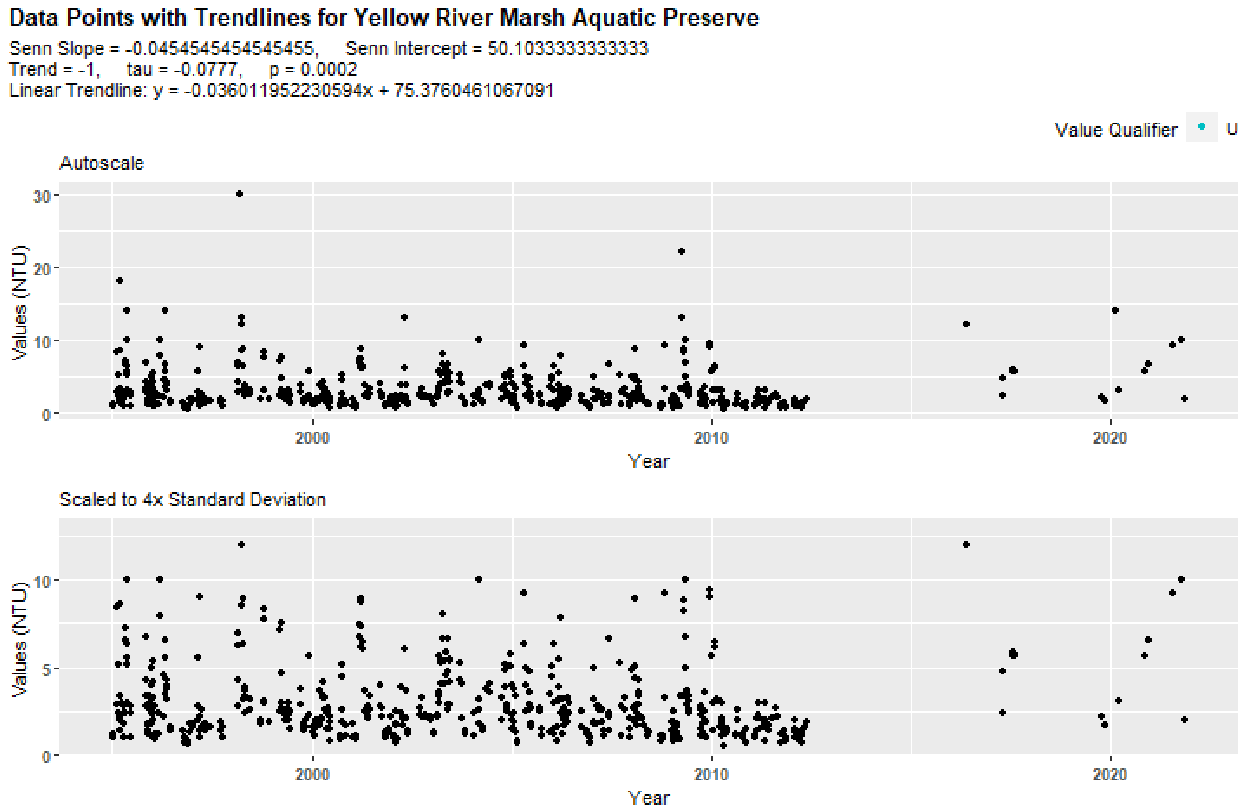
Senn Slope = 0, Senn Intercept = -6.83428571428571
Trend = 0, tau = 0.0051, p = 0.3915
Linear Trendline: y = -0.0185741386966849x + 39.8362123822804



Data Points with Trendlines for Tomoka Marsh Aquatic Preserve

Senn Slope = 0.0740581818181819, Senn Intercept = -50.2816102573529
Trend = 0, tau = 0.0645, p = 0.066
Linear Trendline: y = -0.023937187505941 4x + 56.7048271887543





Appendix V: Managed Area Summary Box Plots

Data is taken and grouped by `ManagedAreaName`. The scripts that create plots follow this format

1. Use the data set that only has `Use_In_Analysis` of `TRUE` for the desired managed area
2. Determine the earliest and latest year of the data to create x-axis scale and intervals
3. Determine the minimum, mean, and standard deviation for the data to be used for y-axis scales
   - Excludes the top 2% of values to reduce the impact of extreme outliers on the y-axis scale
4. Set what values are to be used for the x-axis, y-axis, and the variable that should determine groups for the box plots
5. Set the plot type as a box plot with the size of the outlier points
6. Create the title, x-axis, y-axis, and color fill labels
7. Set the y and x limits
8. Make the axis labels bold
9. Plot the arrangement as a set of panels

The following plots are arranged by `ManagedAreaName` with data grouped by `Year`, then `Year` and `Month`, then finally `Month` only. Each managed area will have 3 sets of plots, each with 3 panels in them. Each panel goes as follows:

1. Y-axis autoscaled
2. Y-axis set to be mean + 5 time the standard deviation

3. Y-axis set to be mean + 5 time the standard deviation for most recent 10 years of data

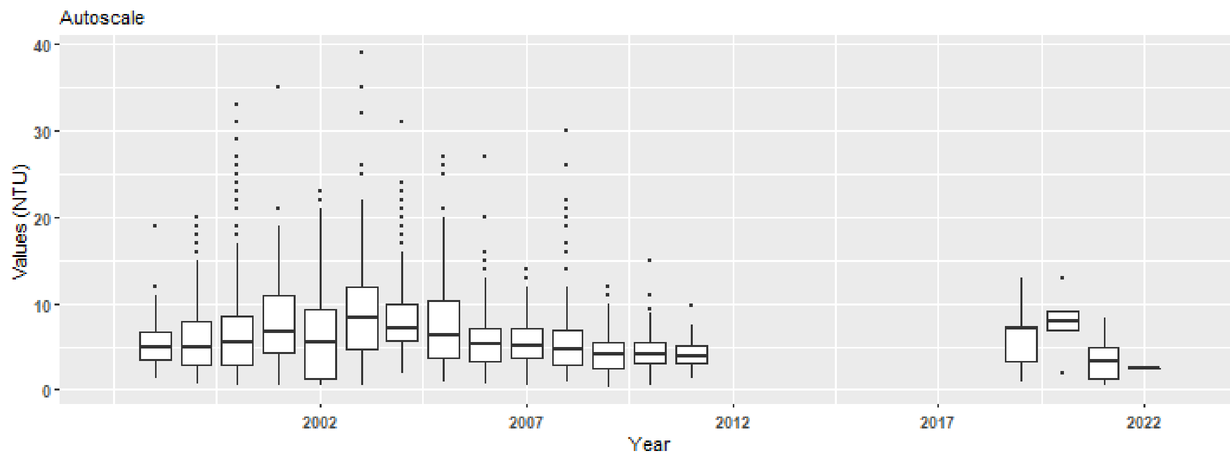
```
if(n==0){
   print("There are no managed areas that qualify.")
} else {
   for (i in 1:n) {
      year_lower <- min(data$Year[data$Use_In_Analysis == TRUE &
                                 data$ManagedAreaName == MA_names[i]])
      year_upper <- max(data$Year[data$Use_In_Analysis == TRUE &
                                 data$ManagedAreaName == MA_names[i]])
      min_RV <- min(data$ResultValue[data$Use_In_Analysis == TRUE &
                                    data$ManagedAreaName == MA_names[i]])
      mn_RV <- mean(data$ResultValue[data$Use_In_Analysis == TRUE &
                                    data$ManagedAreaName == MA_names[i] &
                                    data$ResultValue <
                                    quantile(data$ResultValue, 0.98)])
      sd_RV <- sd(data$ResultValue[data$Use_In_Analysis == TRUE &
                                  data$ManagedAreaName == MA_names[i] &
                                  data$ResultValue <
                                  quantile(data$ResultValue, 0.98)])
      x_scale <- ifelse(year_upper - year_lower > 30, 10, 5)
      y_scale <- mn_RV + 4 * sd_RV

      ##Year plots
      p1 <- ggplot(data = data[data$Use_In_Analysis == TRUE &
                              data$ManagedAreaName == MA_names[i], ],
                  aes(x = Year, y = ResultValue, group = Year)) +
         geom_boxplot(outlier.size = 0.5) +
         labs(subtitle = "Autoscale",
              x = "Year", y = paste0("Values (", unit, ")")) +
         scale_x_continuous(limits = c(year_lower - 1, year_upper + 1),
                            breaks = rev(seq(year_upper,
                                             year_lower, -x_scale))) +
         theme(axis.text.x = element_text(face = "bold"),
               axis.text.y = element_text(face = "bold"))

      p2 <- ggplot(data = data[data$Use_In_Analysis == TRUE &
                              data$ManagedAreaName == MA_names[i], ],
                  aes(x = Year, y = ResultValue, group = Year)) +
         geom_boxplot(outlier.size = 0.5) +
         labs(subtitle = "Scaled to 4x Standard Deviation",
              x = "Year", y = paste0("Values (", unit, ")")) +
         ylim(min_RV, y_scale) +
         scale_x_continuous(limits = c(year_lower - 1, year_upper + 1),
                            breaks = rev(seq(year_upper,
                                             year_lower, -x_scale))) +
         theme(axis.text.x = element_text(face = "bold"),
               axis.text.y = element_text(face = "bold"))

      p3 <- ggplot(data = data[data$Use_In_Analysis == TRUE &
                              data$ManagedAreaName == MA_names[i] &
                              data$Year>=year_upper-10, ],
                  aes(x = Year, y = ResultValue, group = Year)) +
         geom_boxplot(outlier.size = 0.5) +
```

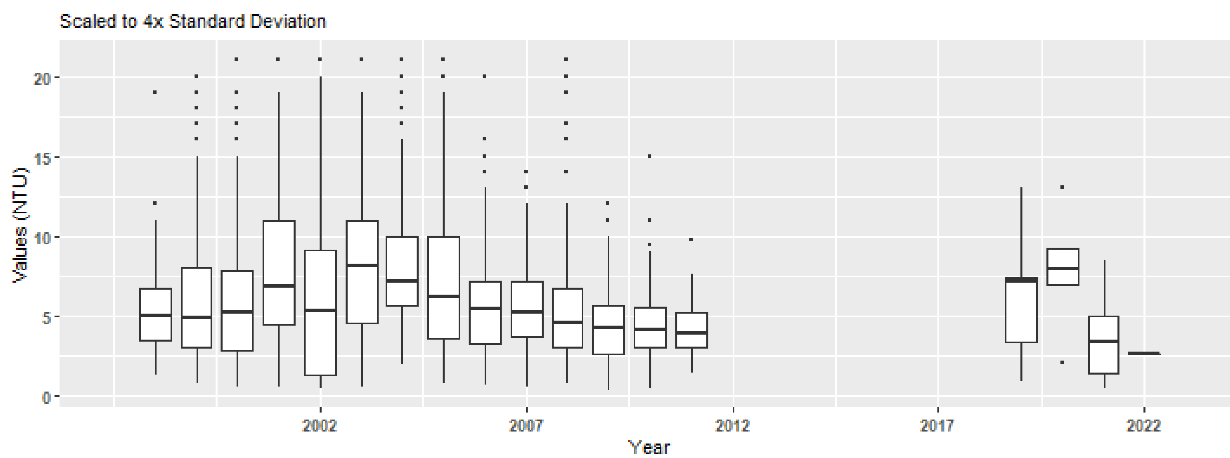
```r
   labs(subtitle = "Scaled to 4x Standard Deviation, Last 10 Years",
        x = "Year", y = paste0("Values (", unit, ")")) +
   ylim(min_RV, y_scale) +
   scale_x_continuous(limits = c(year_upper - 10.5, year_upper + 1),
                      breaks = rev(seq(year_upper, year_upper - 10,-2))) +
   theme(axis.text.x = element_text(face = "bold"),
         axis.text.y = element_text(face = "bold"))

Yset <- ggarrange(p1, p2, p3, ncol = 1)

p0 <- ggplot() + labs(title = paste0("Summary Box Plots for ",
                                     MA_names[i]), subtitle = "By Year") +
   theme_bw() + theme(plot.title = element_text(face="bold"),
                      panel.border = element_blank(),
                      panel.grid.major = element_blank(),
                      panel.grid.minor = element_blank(), axis.line = element_blank())


## Year & Month Plots
p4 <- ggplot(data = data[data$Use_In_Analysis == TRUE &
                            data$ManagedAreaName == MA_names[i], ],
             aes(x = YearMonthDec, y = ResultValue,
                 group = YearMonth, color = as.factor(Month))) +
   geom_boxplot(outlier.size = 0.5) +
   labs(subtitle = "Autoscale",
        x = "Year", y = paste0("Values (", unit, ")"), color = "Month") +
   scale_x_continuous(limits = c(year_lower - 1, year_upper + 1),
                      breaks = rev(seq(year_upper,
                                       year_lower, -x_scale))) +
   theme(legend.position = "none",
         axis.text.x = element_text(face = "bold"),
         axis.text.y = element_text(face = "bold"))

p5 <- ggplot(data = data[data$Use_In_Analysis == TRUE &
                            data$ManagedAreaName == MA_names[i], ],
             aes(x = YearMonthDec, y = ResultValue,
                 group = YearMonth, color = as.factor(Month))) +
   geom_boxplot(outlier.size = 0.5) +
   labs(subtitle = "Scaled to 4x Standard Deviation",
        x = "Year", y = paste0("Values (", unit, ")"), color = "Month") +
   ylim(min_RV, y_scale) +
   scale_x_continuous(limits = c(year_lower - 1, year_upper + 1),
                      breaks = rev(seq(year_upper,
                                       year_lower, -x_scale))) +
   theme(legend.position = "top", legend.box = "horizontal",
         axis.text.x = element_text(face = "bold"),
         axis.text.y = element_text(face = "bold")) +
   guides(color = guide_legend(nrow = 1))

p6 <- ggplot(data = data[data$Use_In_Analysis == TRUE &
                            data$ManagedAreaName == MA_names[i], ],
             aes(x = YearMonthDec, y = ResultValue,
                 group = YearMonth, color = as.factor(Month)
```

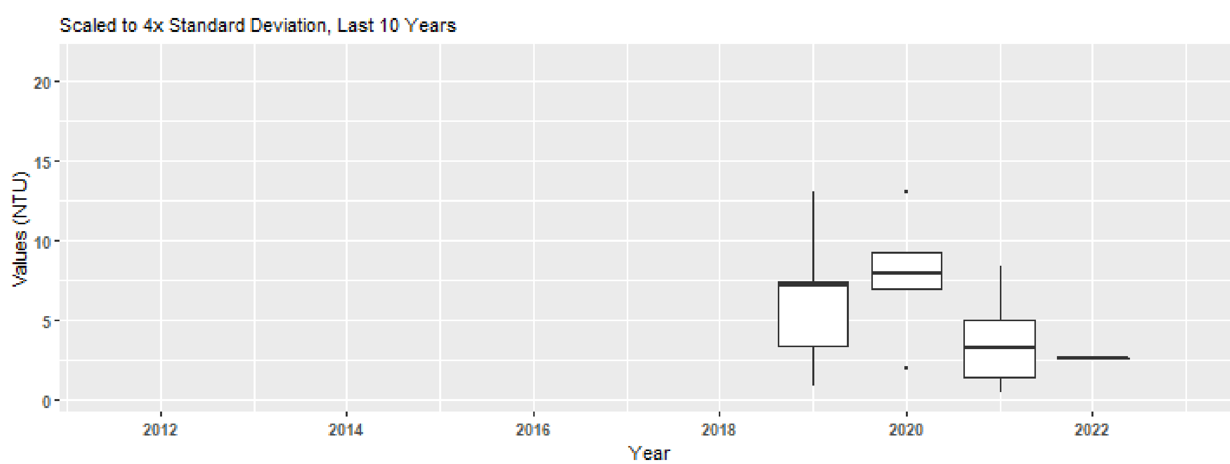
```r
          )) +
   geom_boxplot(outlier.size = 0.5) +
   labs(subtitle = "Scaled to 4x Standard Deviation, Last 10 Years",
        x = "Year", y = paste0("Values (", unit, ")"), color = "Month") +
   ylim(min_RV, y_scale) +
   scale_x_continuous(limits = c(year_upper - 10.5, year_upper + 1),
                      breaks = rev(seq(year_upper, year_upper - 10,-2))) +
   theme(legend.position = "none",
         axis.text.x = element_text(face = "bold"),
         axis.text.y = element_text(face = "bold"))

leg1 <- get_legend(p5)
YMset <- ggarrange(leg1, p4, p5 + theme(legend.position = "none"), p6,
                   ncol = 1, heights = c(0.1, 1, 1, 1))

p00 <- ggplot() + labs(title = paste0("Summary Box Plots for ",
                                      MA_names[i]),
                       subtitle = "By Year & Month") + theme_bw() +
   theme(plot.title = element_text(face="bold"),
         panel.border = element_blank(),
         panel.grid.major = element_blank(),
         panel.grid.minor = element_blank(), axis.line = element_blank())

## Month Plots
p7 <- ggplot(data = data[data$Use_In_Analysis == TRUE &
                            data$ManagedAreaName == MA_names[i], ],
             aes(x = Month, y = ResultValue,
                 group = Month, fill = as.factor(Month))) +
   geom_boxplot(outlier.size = 0.5) +
   labs(subtitle = "Autoscale",
        x = "Month", y = paste0("Values (", unit, ")"), fill = "Month") +
   scale_x_continuous(limits = c(0, 13), breaks = seq(3, 12, 3)) +
   theme(legend.position = "none",
         axis.text.x = element_text(face = "bold"),
         axis.text.y = element_text(face = "bold"))

p8 <- ggplot(data = data[data$Use_In_Analysis == TRUE &
                            data$ManagedAreaName == MA_names[i], ],
             aes(x = Month, y = ResultValue,
                 group = Month, fill = as.factor(Month))) +
   geom_boxplot(outlier.size = 0.5) +
   labs(subtitle = "Scaled to 4x Standard Deviation",
        x = "Month", y = paste0("Values (", unit, ")"), fill = "Month") +
   ylim(min_RV, y_scale) +
   scale_x_continuous(limits = c(0, 13), breaks = seq(3, 12, 3)) +
   theme(legend.position = "top", legend.box = "horizontal",
         axis.text.x = element_text(face = "bold"),
         axis.text.y = element_text(face = "bold")) +
   guides(fill = guide_legend(nrow = 1))

p9 <- ggplot(data = data[data$Use_In_Analysis == TRUE &
                            data$ManagedAreaName == MA_names[i] &
                            data$Year >= year_upper - 10, ],
```

```r
                   aes(x = Month, y = ResultValue,
                       group = Month, fill = as.factor(Month))) +
         geom_boxplot(outlier.size = 0.5) +
         labs(subtitle = "Scaled to 4x Standard Deviation, Last 10 Years",
              x = "Month", y = paste0("Values (", unit, ")"), fill = "Month") +
         ylim(min_RV, y_scale) +
         scale_x_continuous(limits = c(0, 13), breaks = seq(3, 12, 3)) +
         theme(legend.position = "none",
               axis.text.x = element_text(face = "bold"),
               axis.text.y = element_text(face = "bold"))

      leg2 <- get_legend(p8)
      Mset <- ggarrange(leg2, p7, p8 + theme(legend.position = "none"), p9,
                        ncol = 1, heights = c(0.1, 1, 1, 1))

      p000 <- ggplot() + labs(title = paste0("Summary Box Plots for ",
                                             MA_names[i]),
                              subtitle = "By Month") + theme_bw() +
         theme(plot.title = element_text(face="bold"),
               panel.border = element_blank(),
               panel.grid.major = element_blank(),
               panel.grid.minor = element_blank(), axis.line = element_blank())

      print(ggarrange(p0, Yset, ncol = 1, heights = c(0.07, 1)))
      print(ggarrange(p00, YMset, ncol = 1, heights = c(0.07, 1)))
      print(ggarrange(p000, Mset, ncol = 1, heights = c(0.07, 1, 0.7)))
   }
}
```

Summary Box Plots for Alligator Harbor Aquatic Preserve
By Year

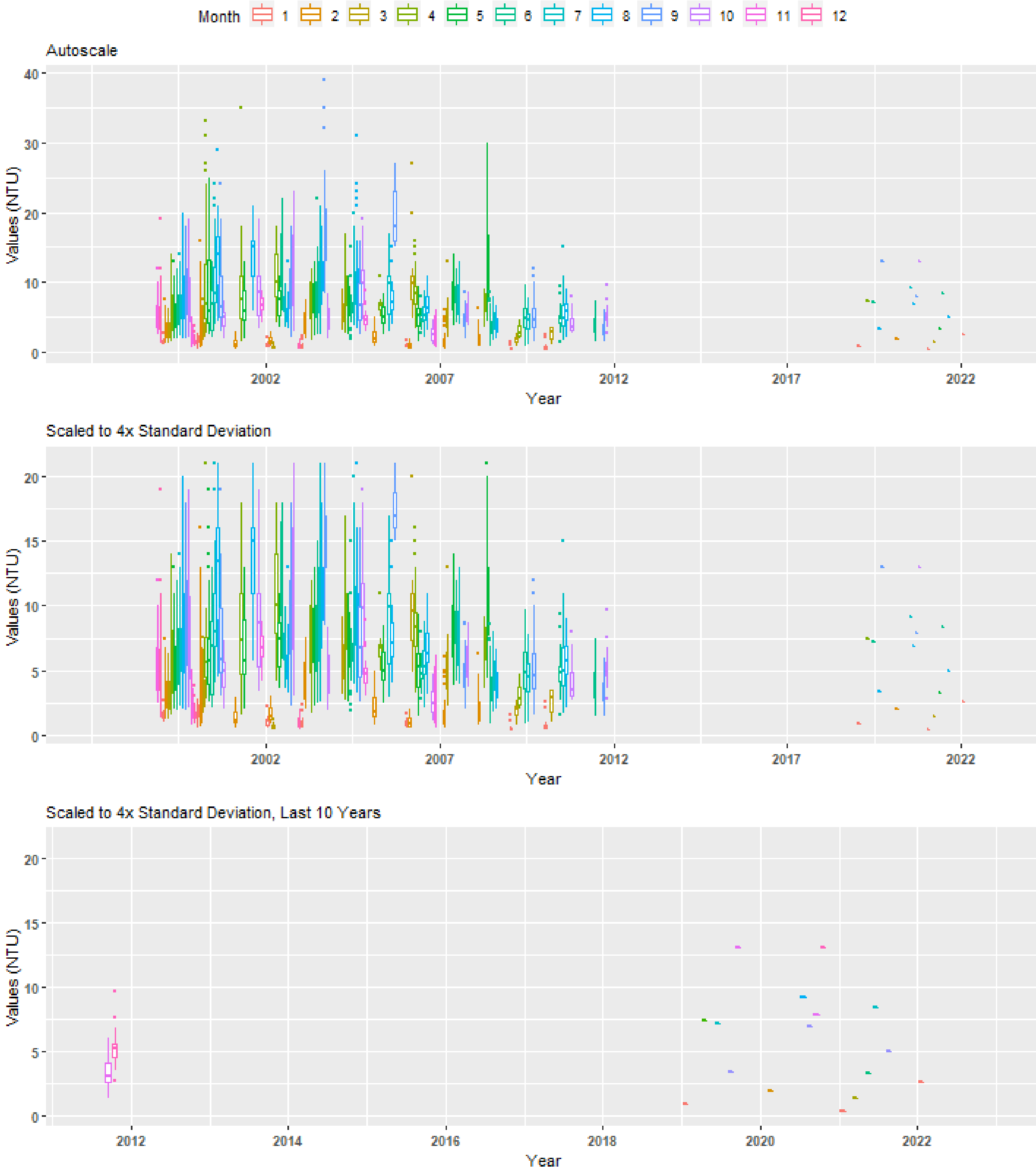




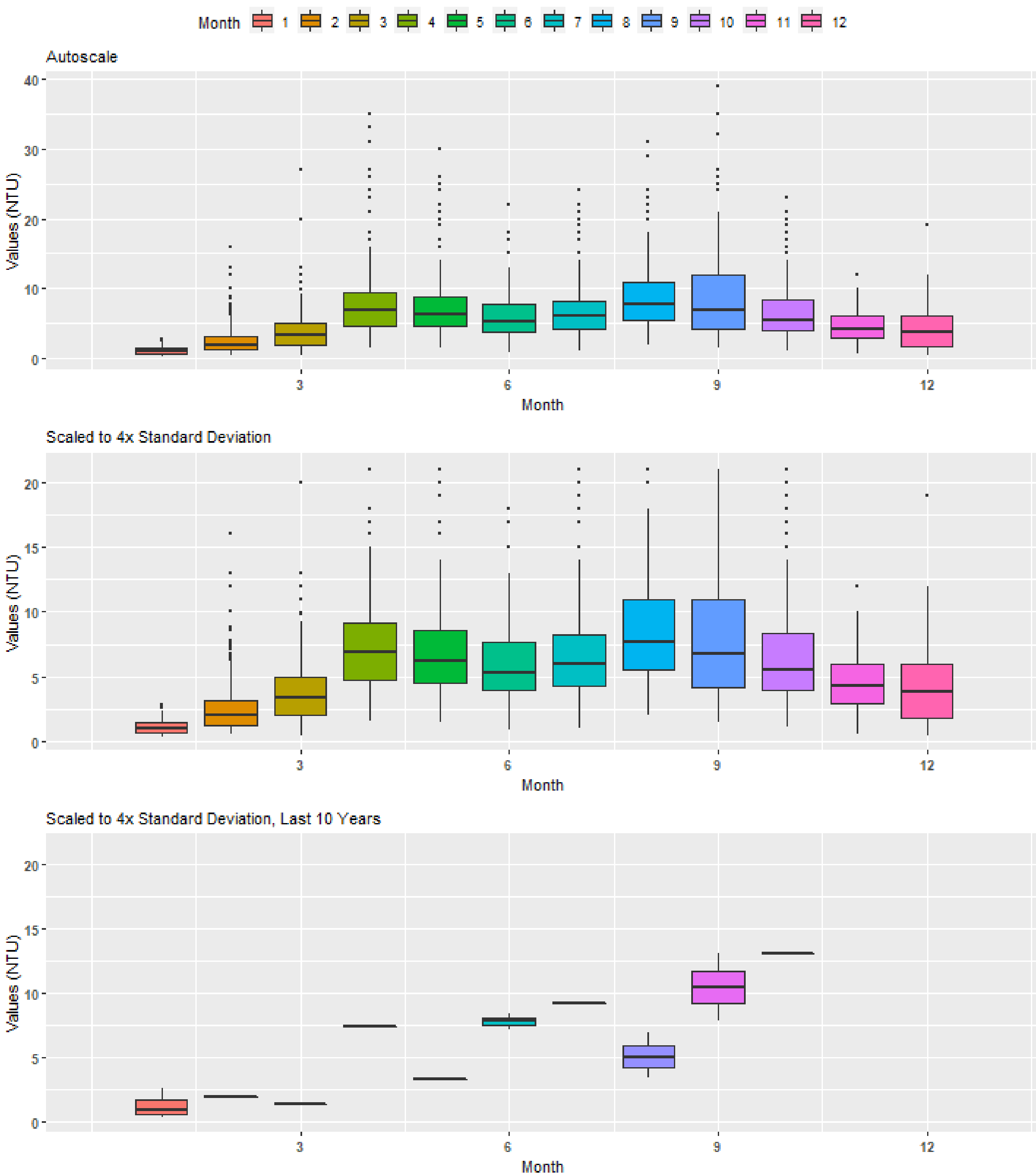


Summary Box Plots for Alligator Harbor Aquatic Preserve

By Year & Month

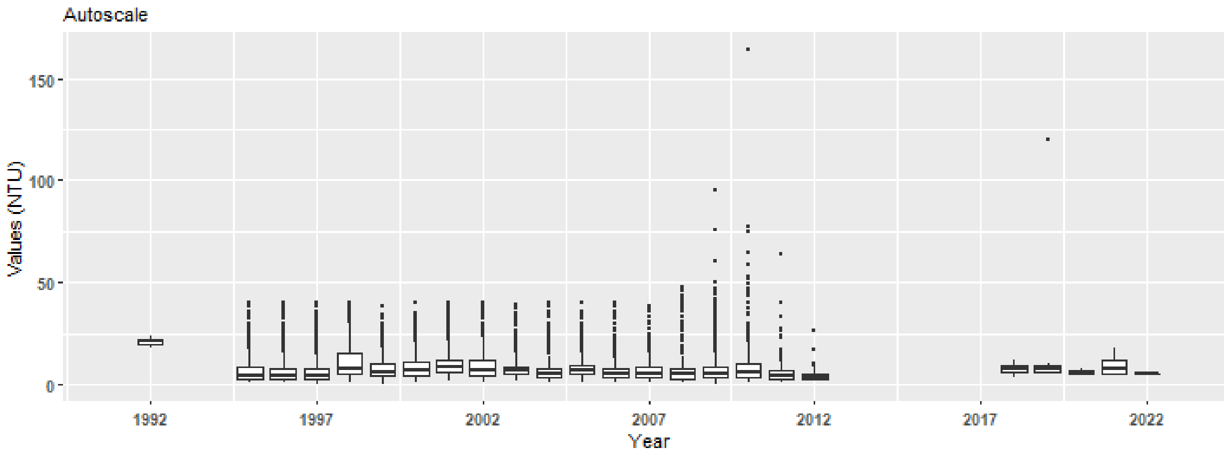


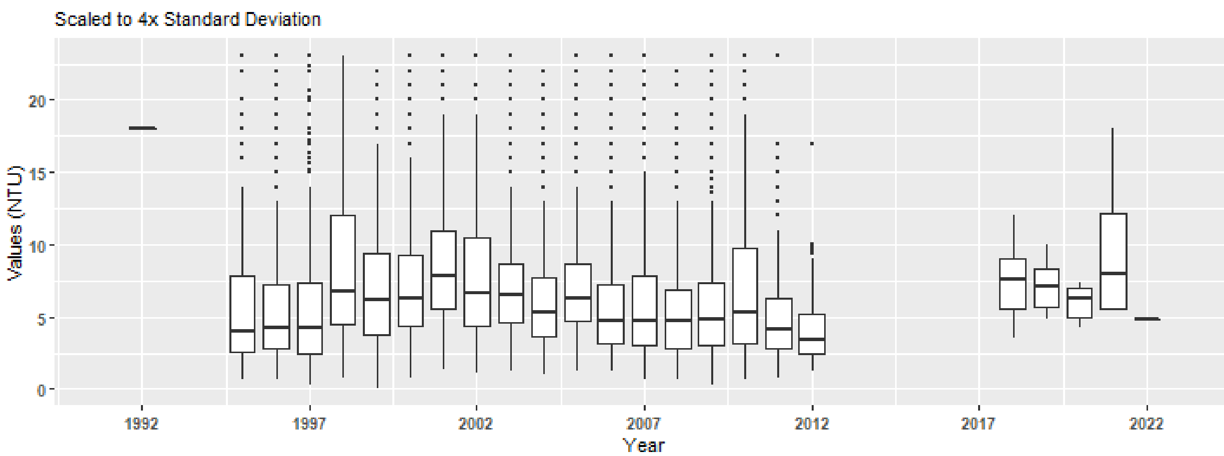
Summary Box Plots for Alligator Harbor Aquatic Preserve
By Month

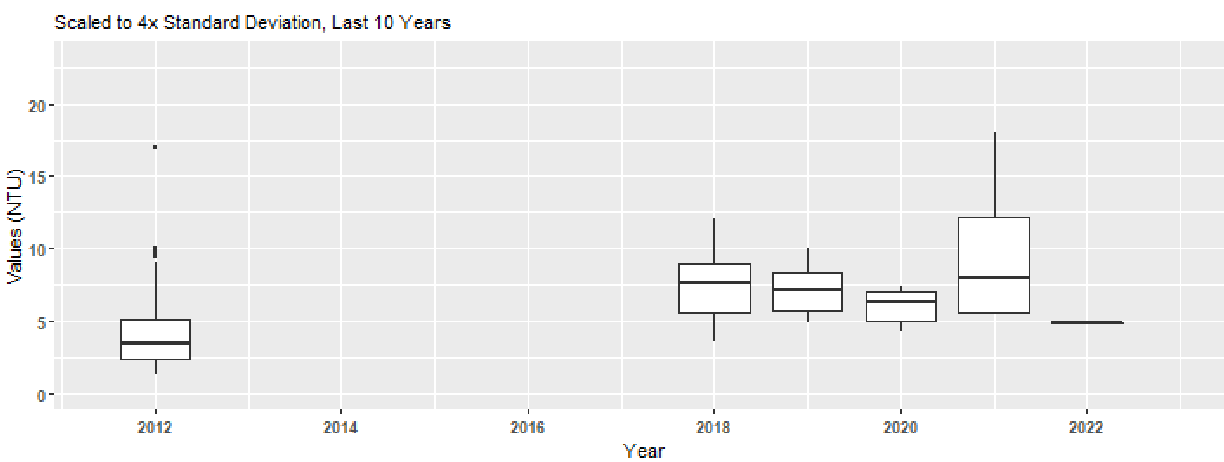


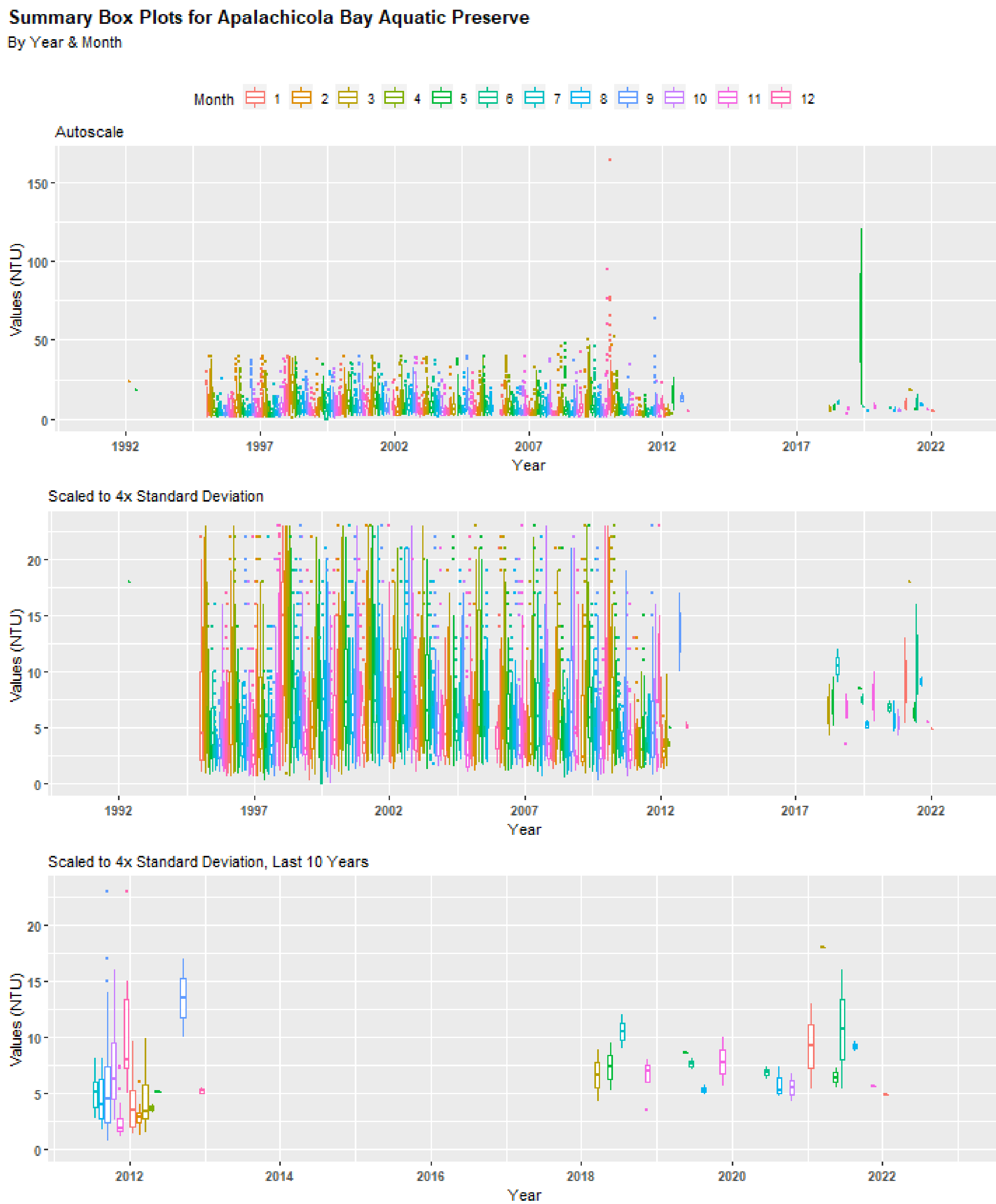
Summary Box Plots for Apalachicola Bay Aquatic Preserve

By Year



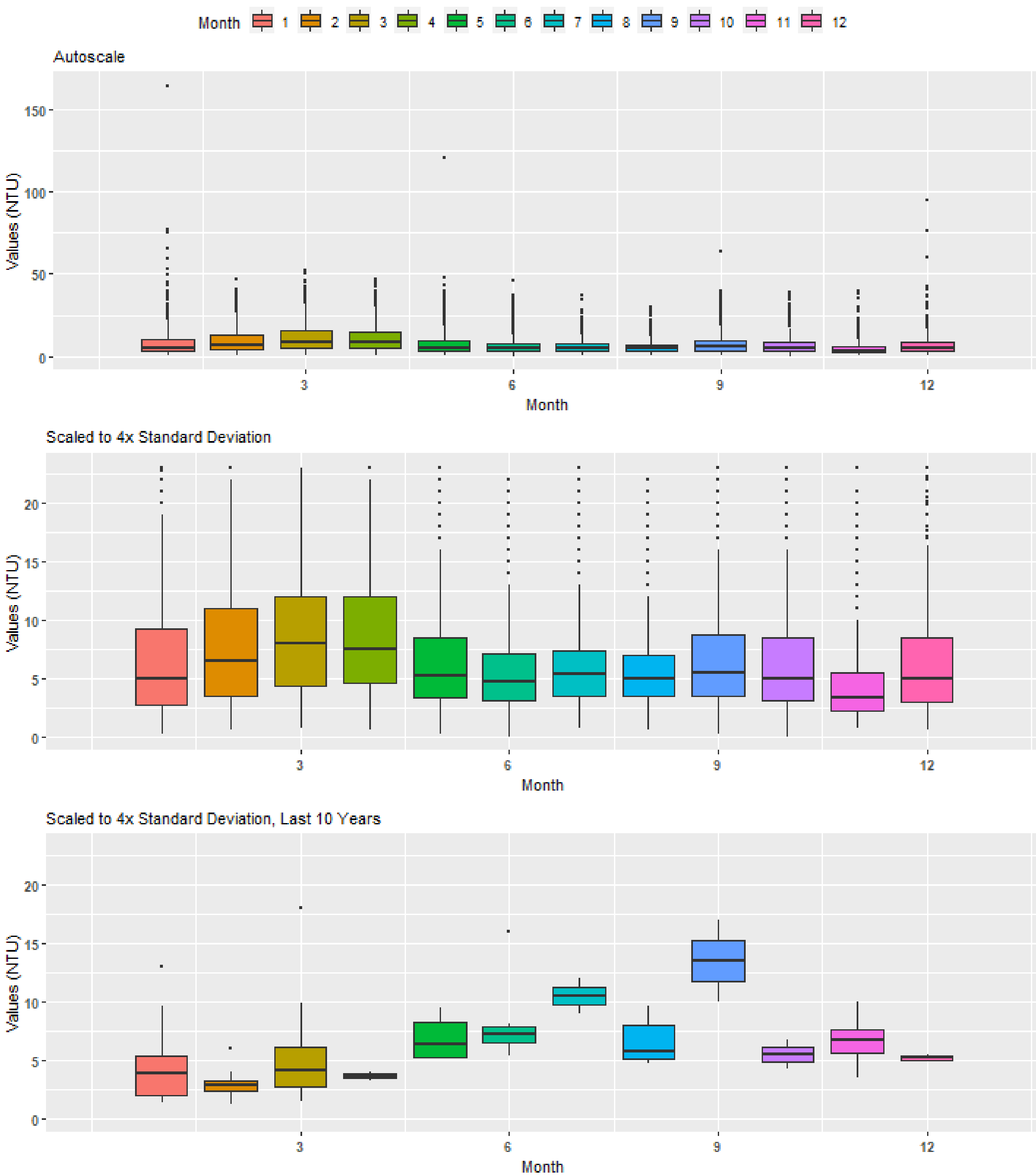






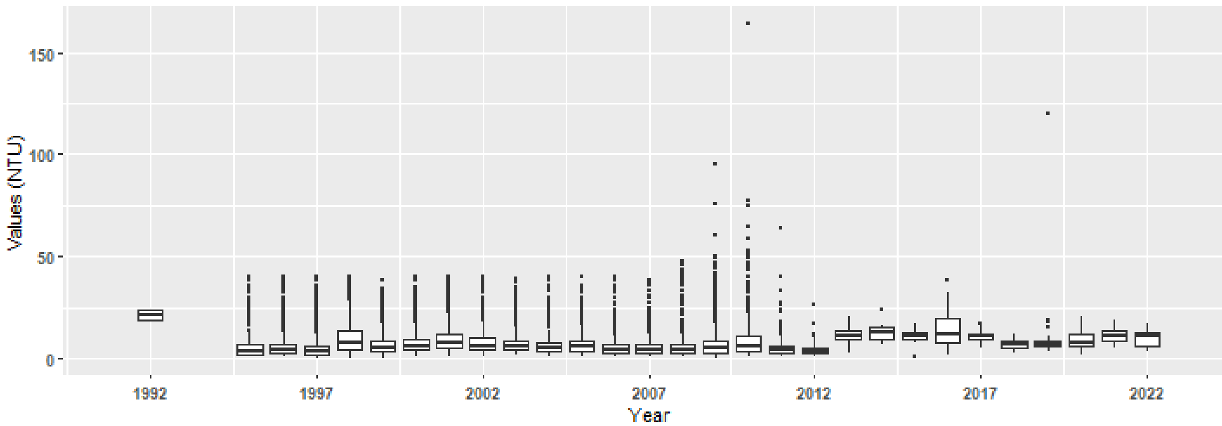
Summary Box Plots for Apalachicola Bay Aquatic Preserve
By Year & Month
Month 1 2 3 4 5 6 7 8 9 10 11 12
Autoscale
Values (NTU)
150
100
50
0
1992 1997 2002 2007 2012 2017 2022
Year
Scaled to 4x Standard Deviation
Values (NTU)
20
15
10
5
0
1992 1997 2002 2007 2012 2017 2022
Year
Scaled to 4x Standard Deviation, Last 10 Years
Values (NTU)
20
15
10
5
0
2012 2014 2016 2018 2020 2022
Year

Summary Box Plots for Apalachicola Bay Aquatic Preserve
By Month

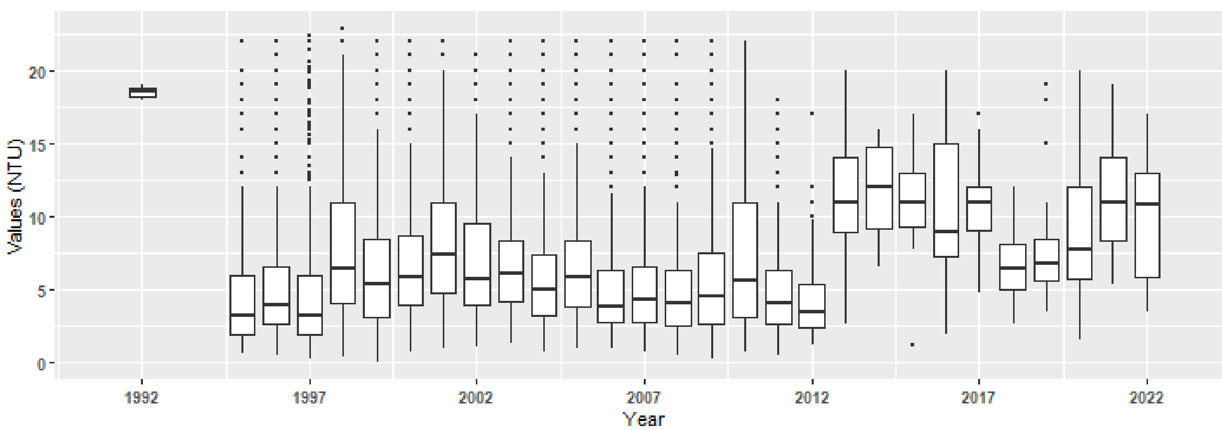


Summary Box Plots for Apalachicola National Estuarine Research Reserve
By Year

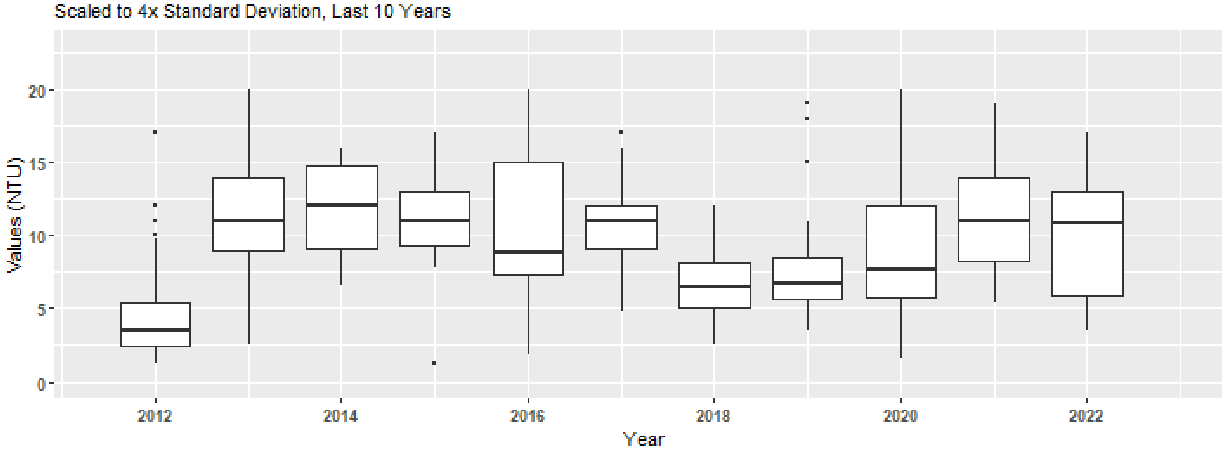
Autoscale



Scaled to 4x Standard Deviation

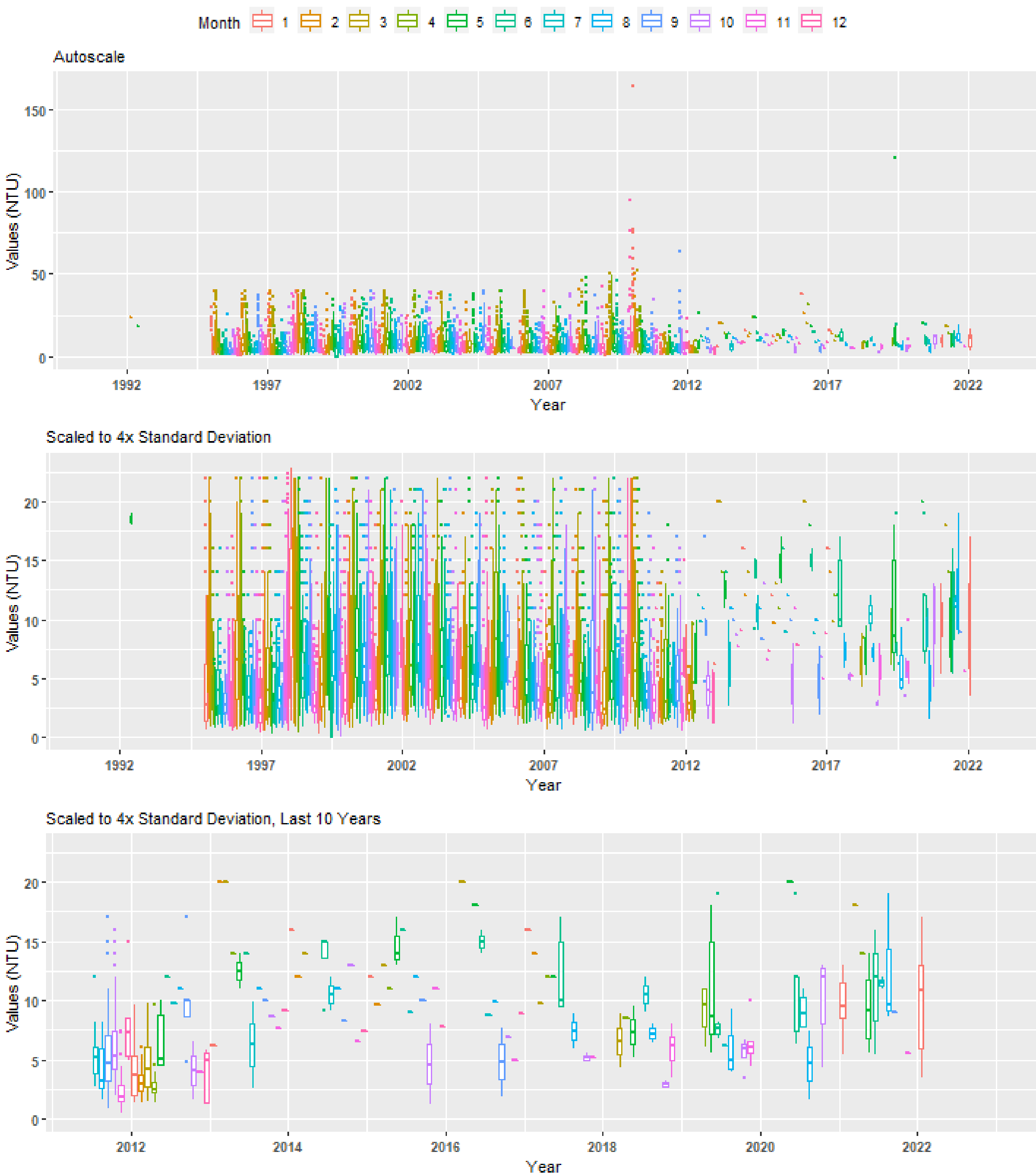


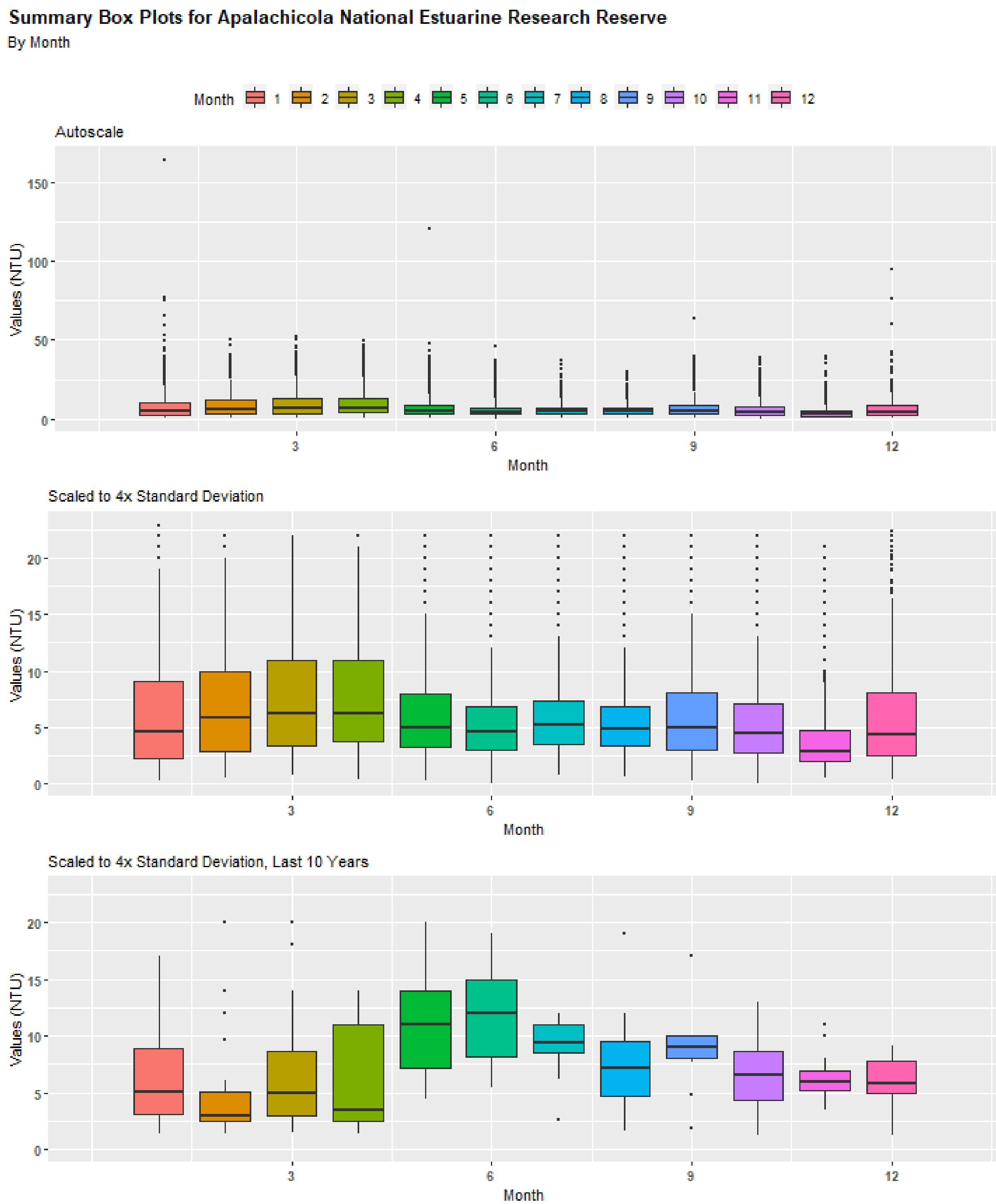
Scaled to 4x Standard Deviation, Last 10 Years



Summary Box Plots for Apalachicola National Estuarine Research Reserve

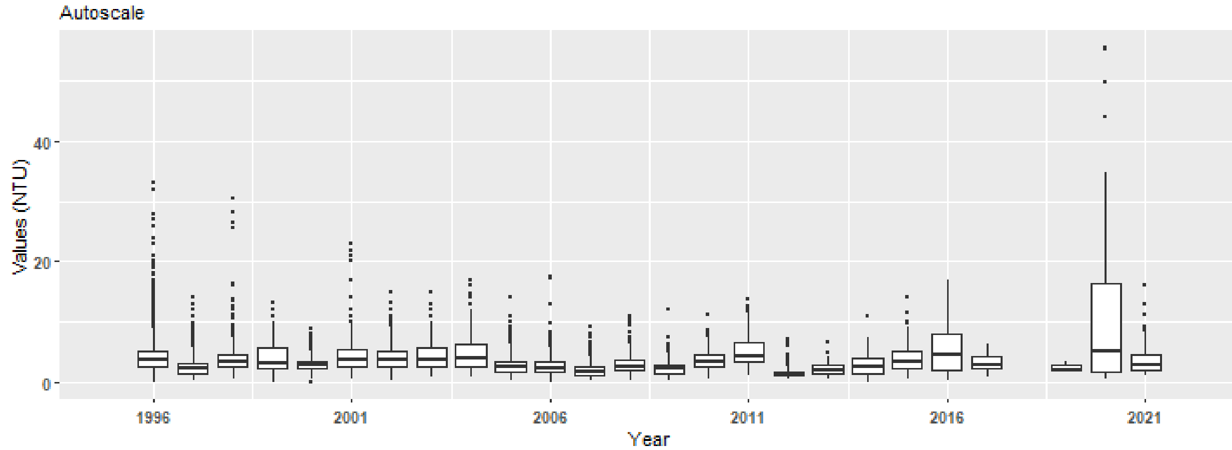
By Year & Month

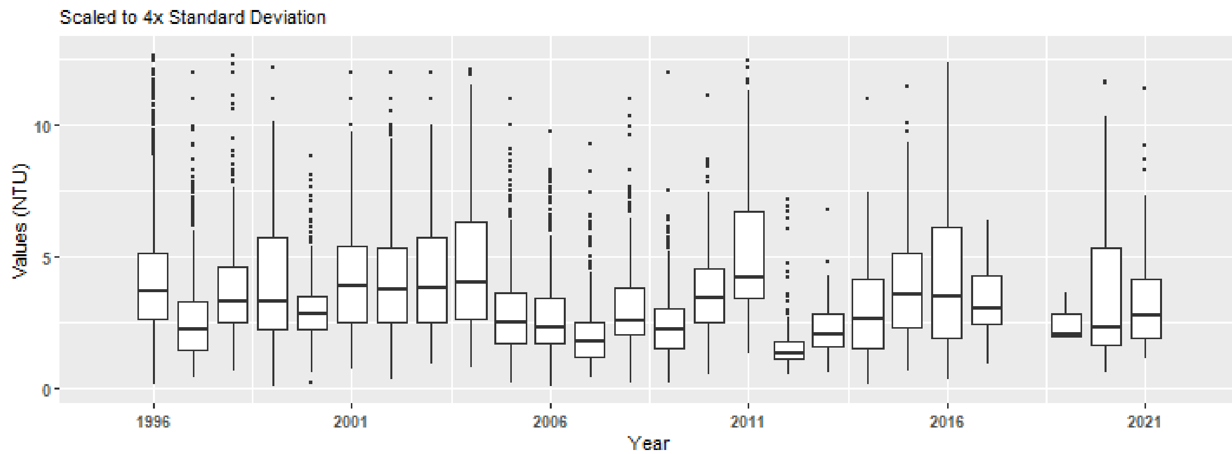


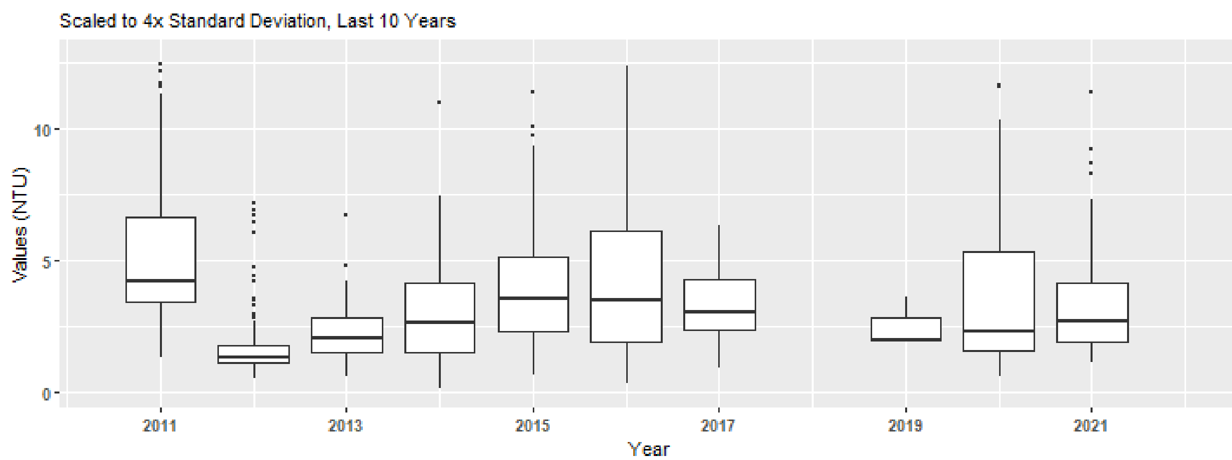

Summary Box Plots for Apalachicola National Estuarine Research Reserve
By Month
Month 1 2 3 4 5 6 7 8 9 10 11 12
Autoscale
Values (NTU)
Month
Scaled to 4x Standard Deviation
Values (NTU)
Month
Scaled to 4x Standard Deviation, Last 10 Years
Values (NTU)
Month

Summary Box Plots for Banana River Aquatic Preserve

By Year

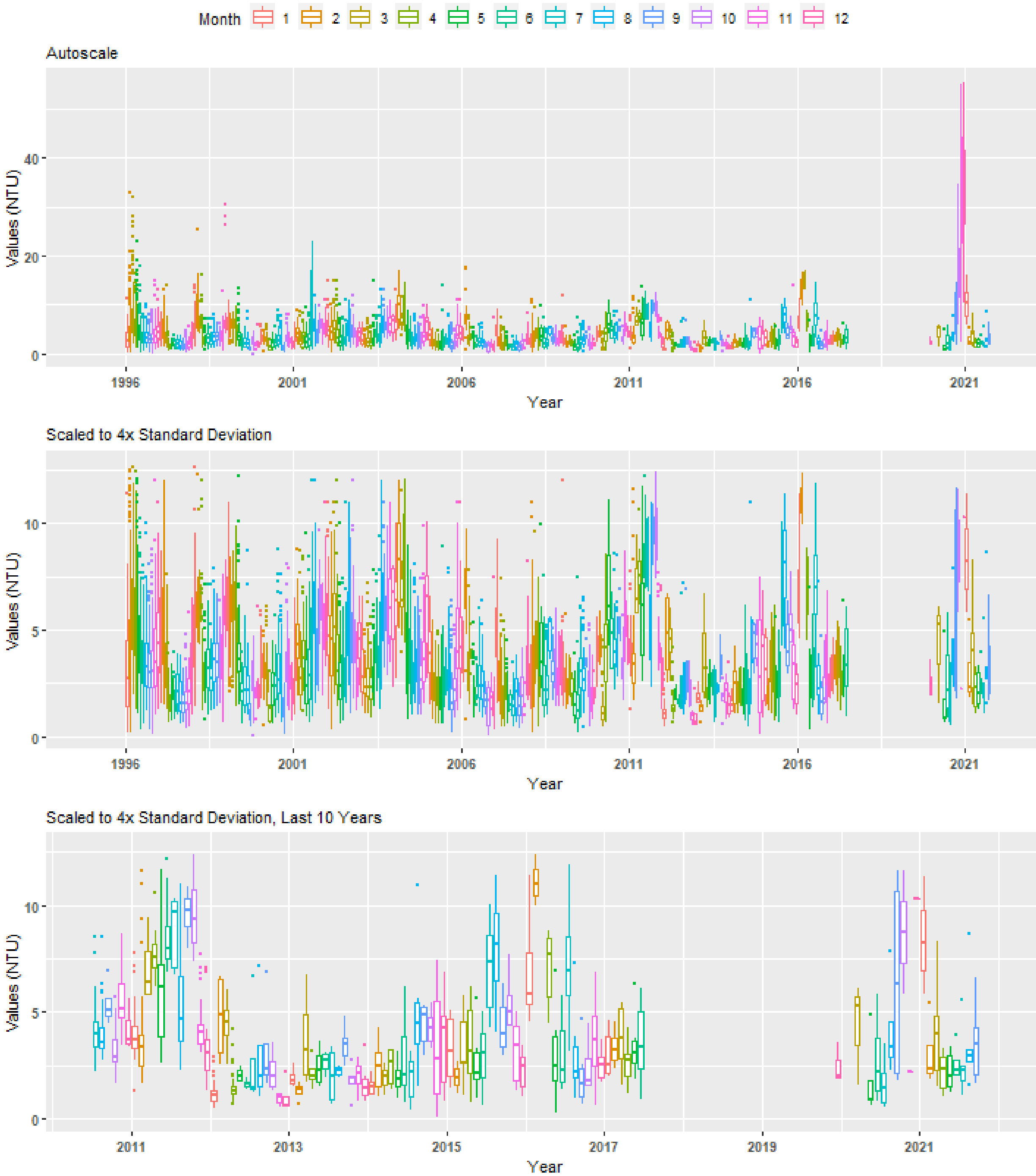




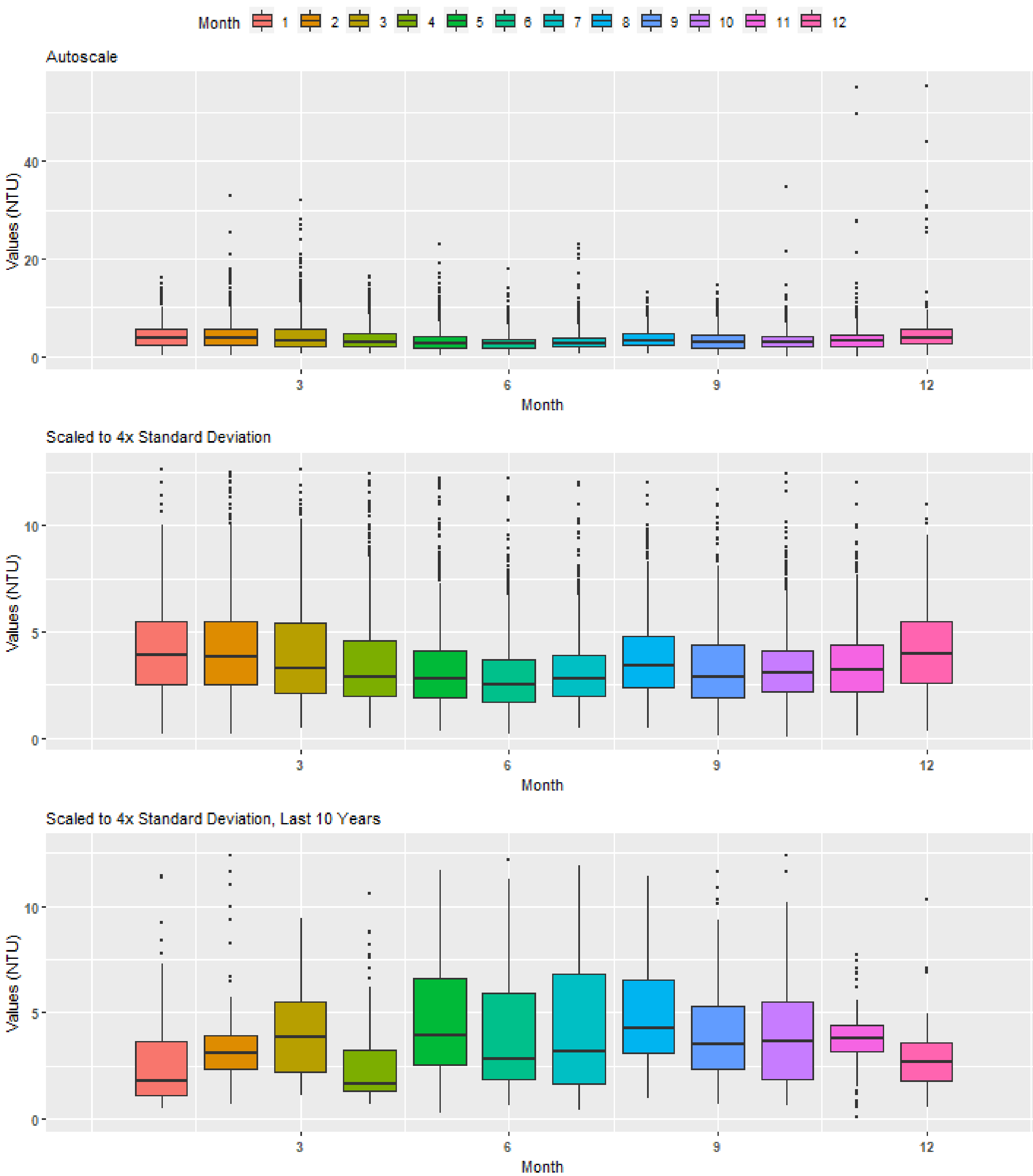


Summary Box Plots for Banana River Aquatic Preserve

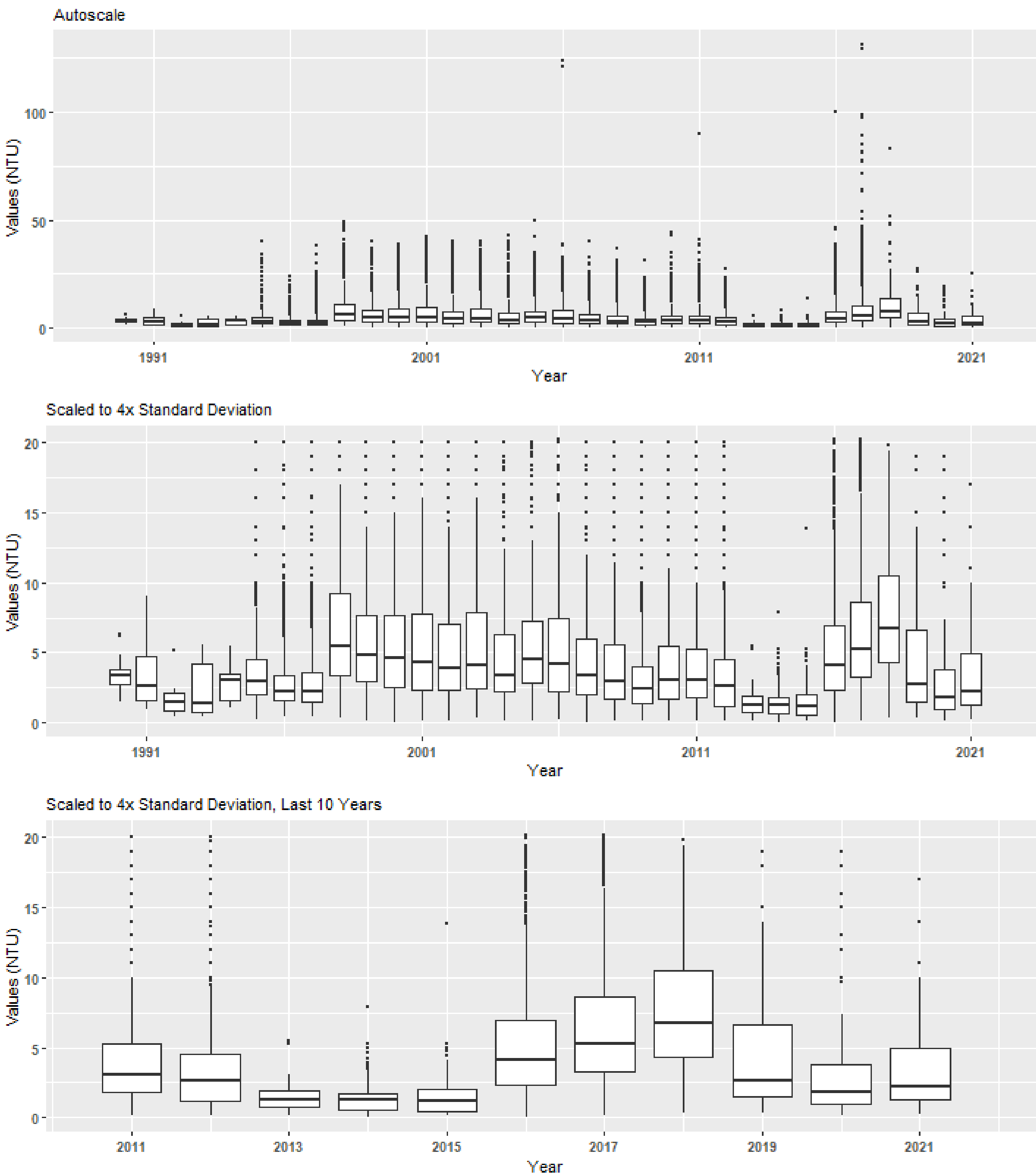
By Year & Month

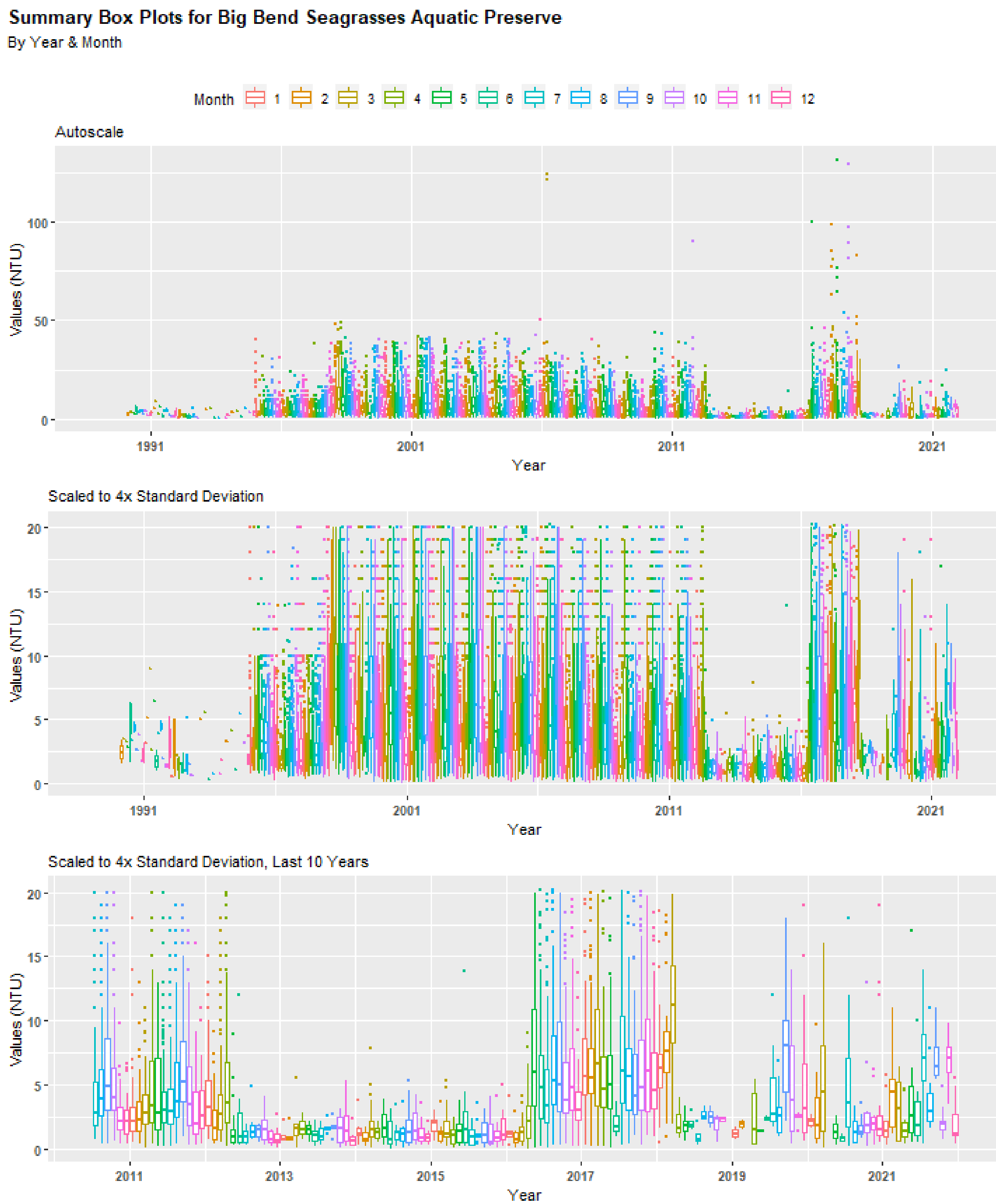


Summary Box Plots for Banana River Aquatic Preserve
By Month



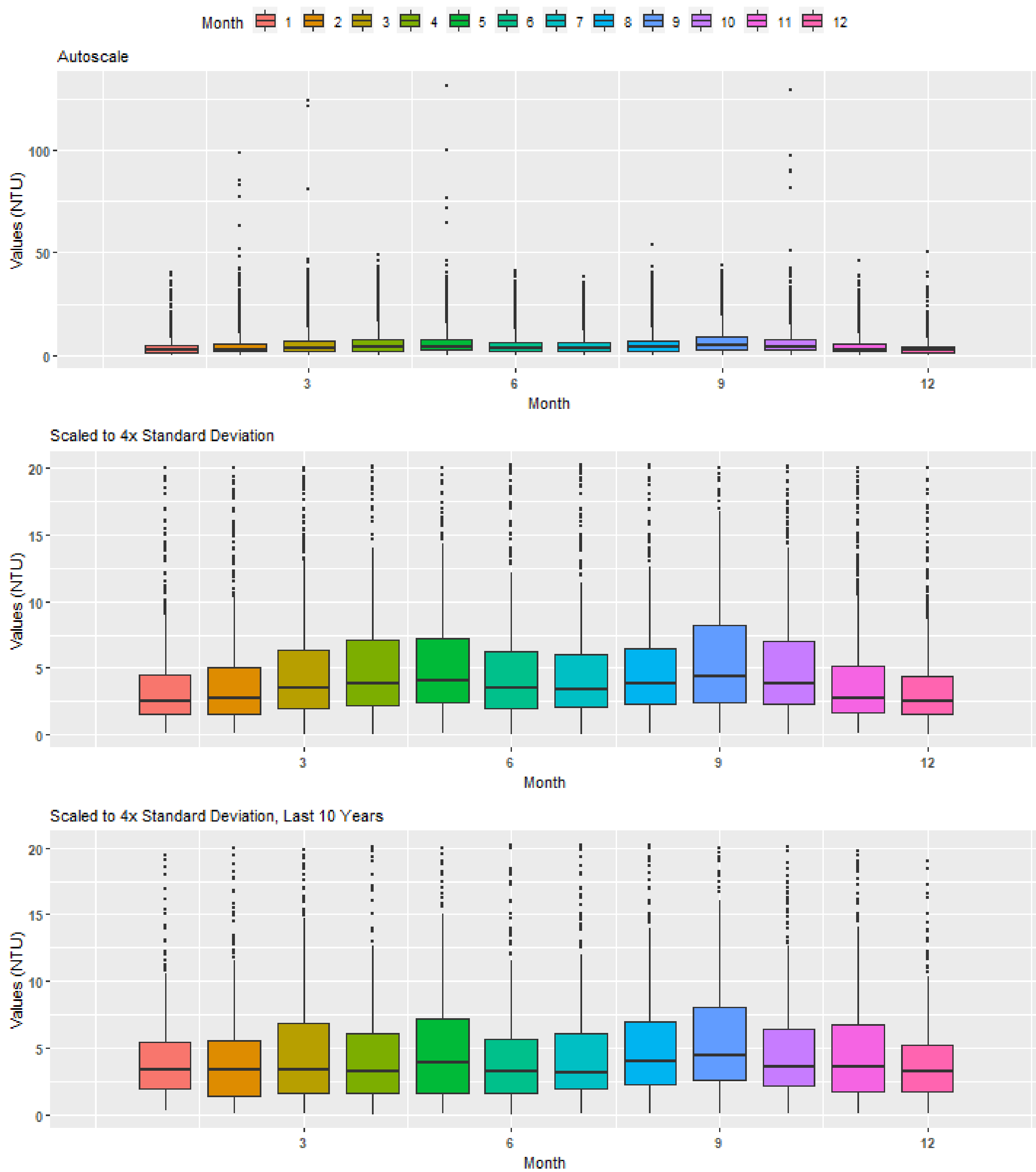
Summary Box Plots for Big Bend Seagrasses Aquatic Preserve
By Year



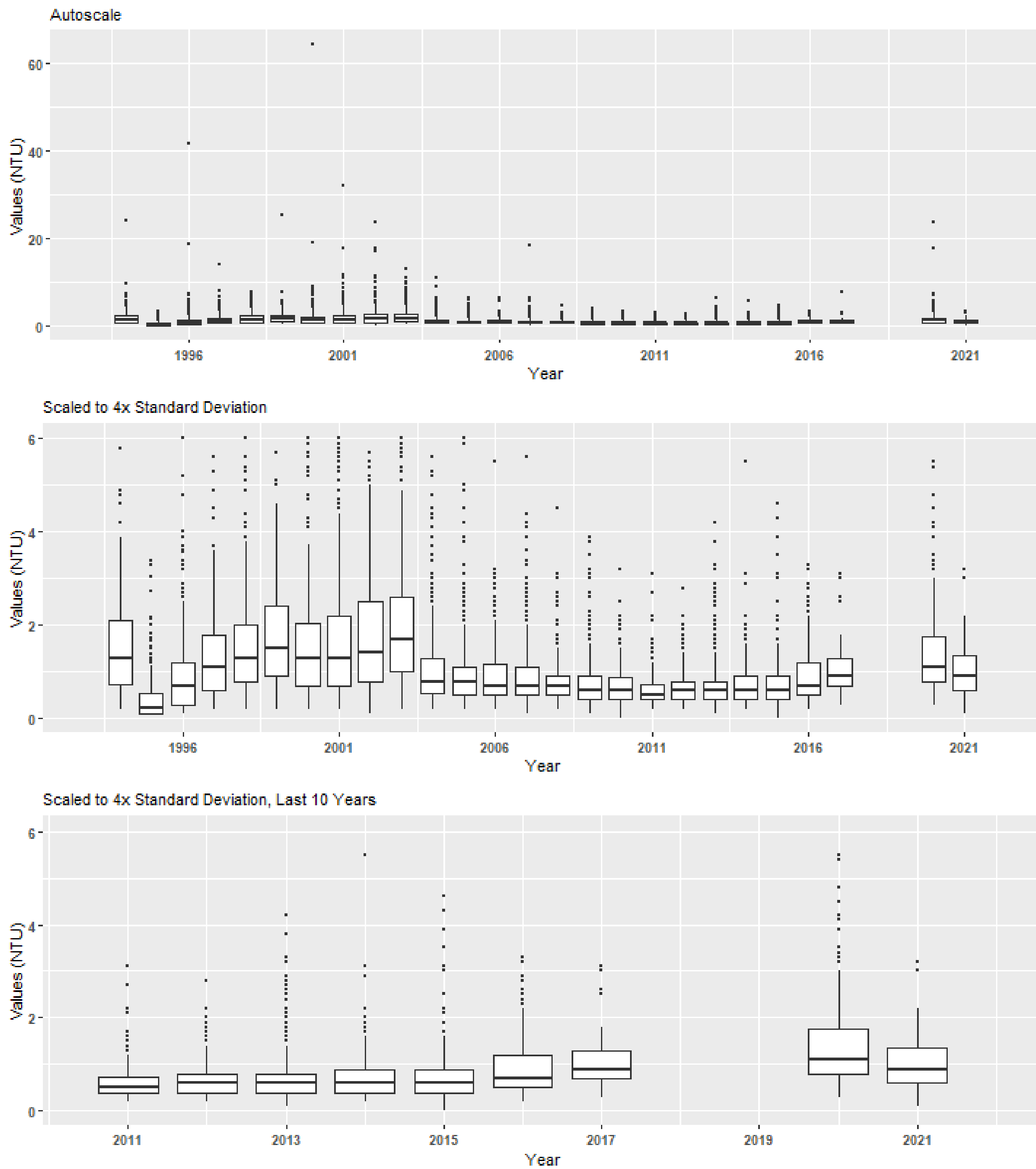

Summary Box Plots for Big Bend Seagrasses Aquatic Preserve
By Year & Month
Month 1 2 3 4 5 6 7 8 9 10 11 12
Autoscale
Values (NTU)
100
50
0
1991
2001
2011
2021
Year
Scaled to 4x Standard Deviation
Values (NTU)
20
15
10
5
0
1991
2001
2011
2021
Year
Scaled to 4x Standard Deviation, Last 10 Years
Values (NTU)
20
15
10
5
0
2011
2013
2015
2017
2019
2021
Year

Summary Box Plots for Big Bend Seagrasses Aquatic Preserve

By Month

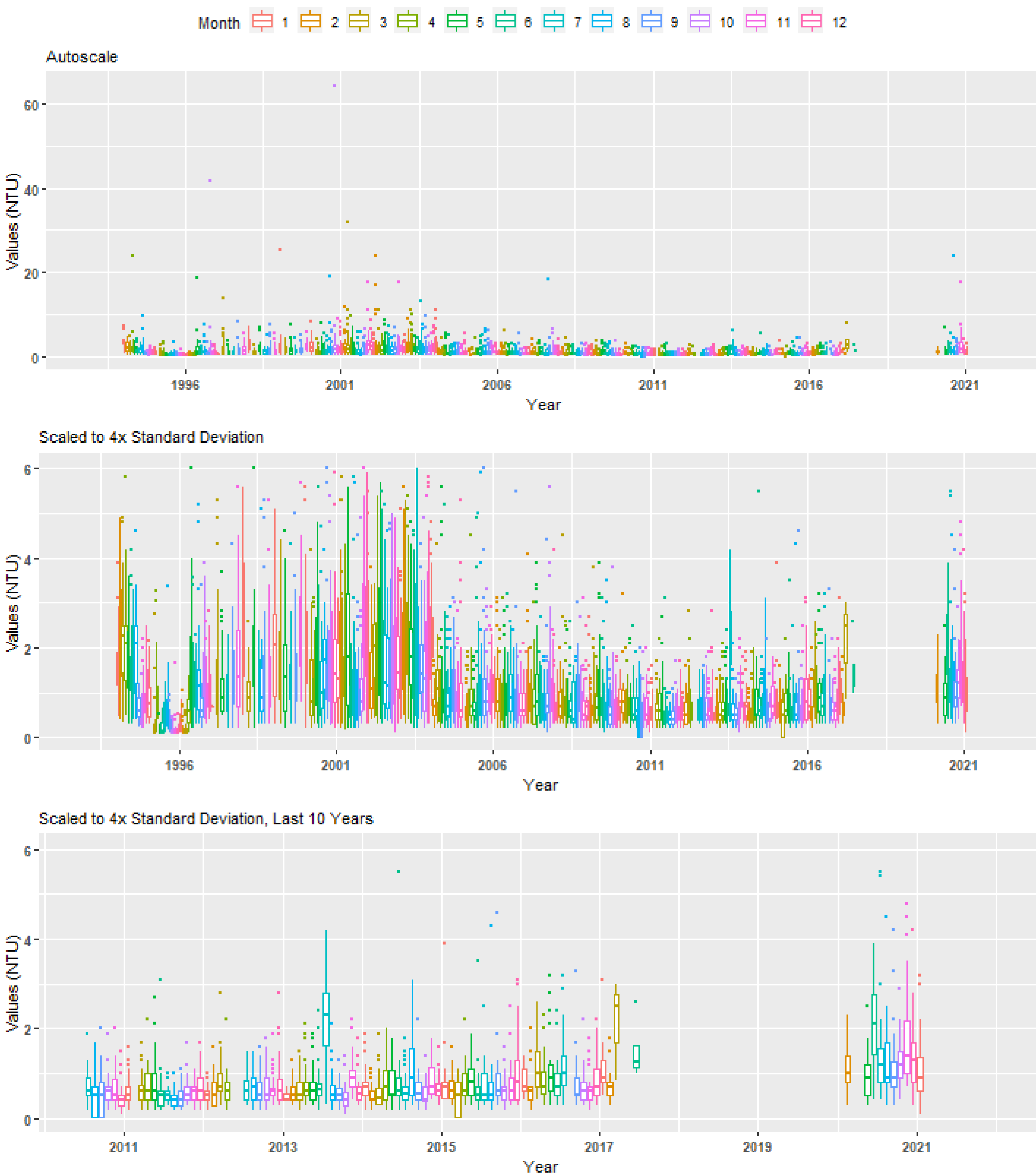


Summary Box Plots for Biscayne Bay Aquatic Preserve
By Year

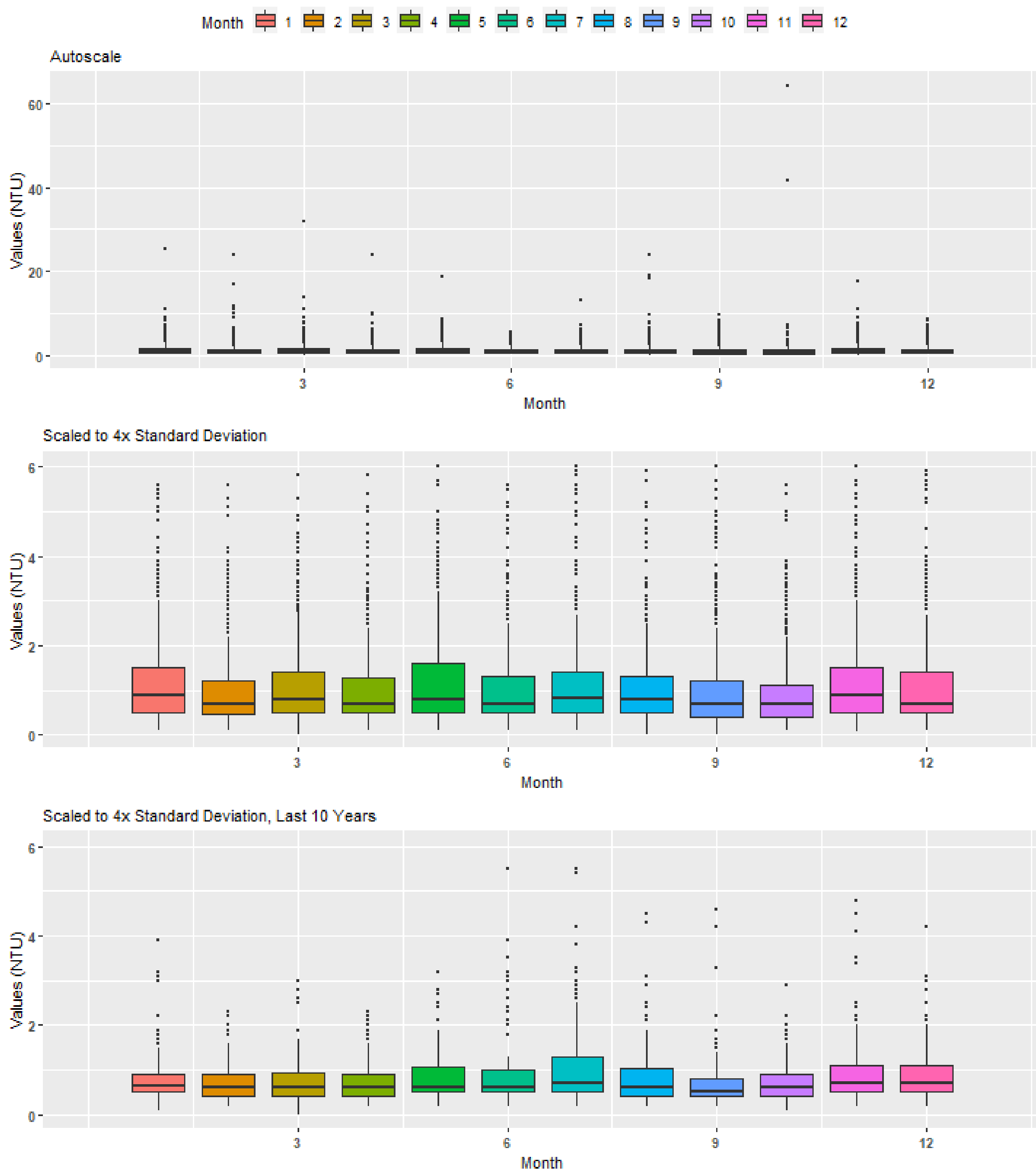


Summary Box Plots for Biscayne Bay Aquatic Preserve

By Year & Month

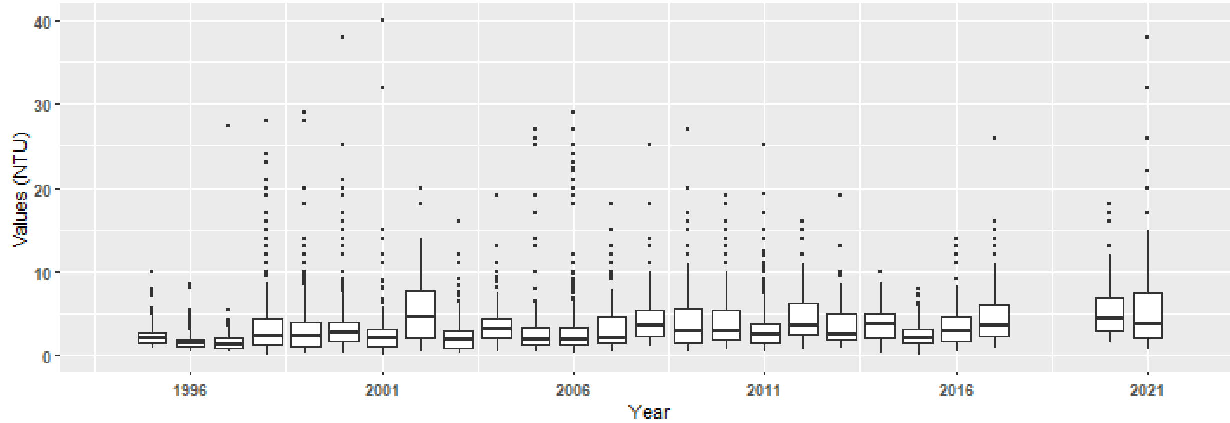


Summary Box Plots for Biscayne Bay Aquatic Preserve
By Month

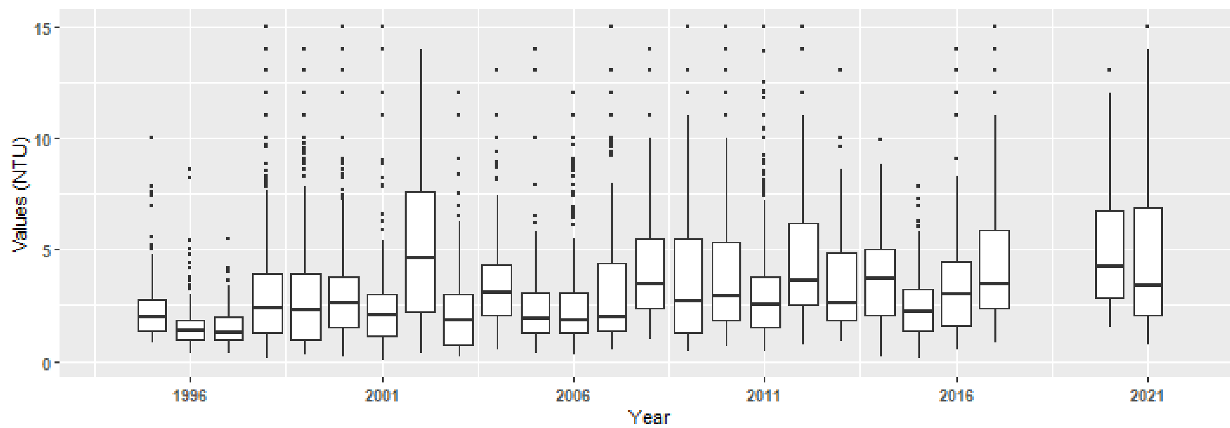


Summary Box Plots for Boca Ciega Bay Aquatic Preserve
By Year

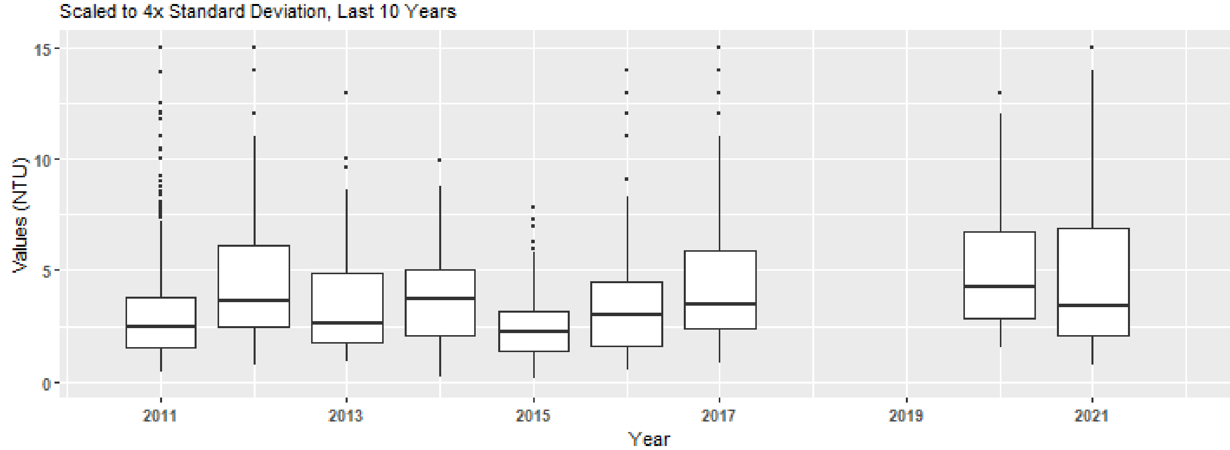
Autoscale

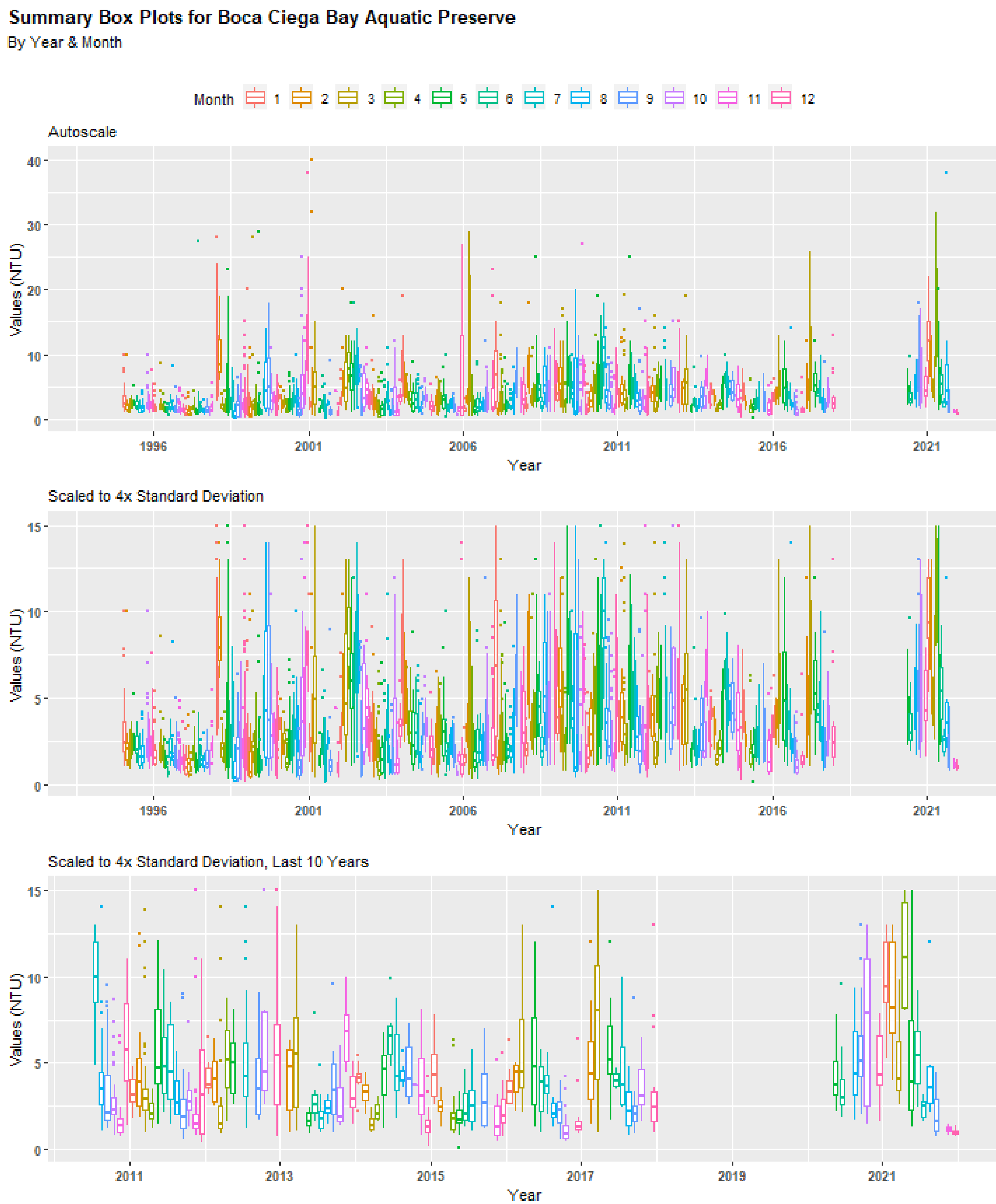


Scaled to 4x Standard Deviation



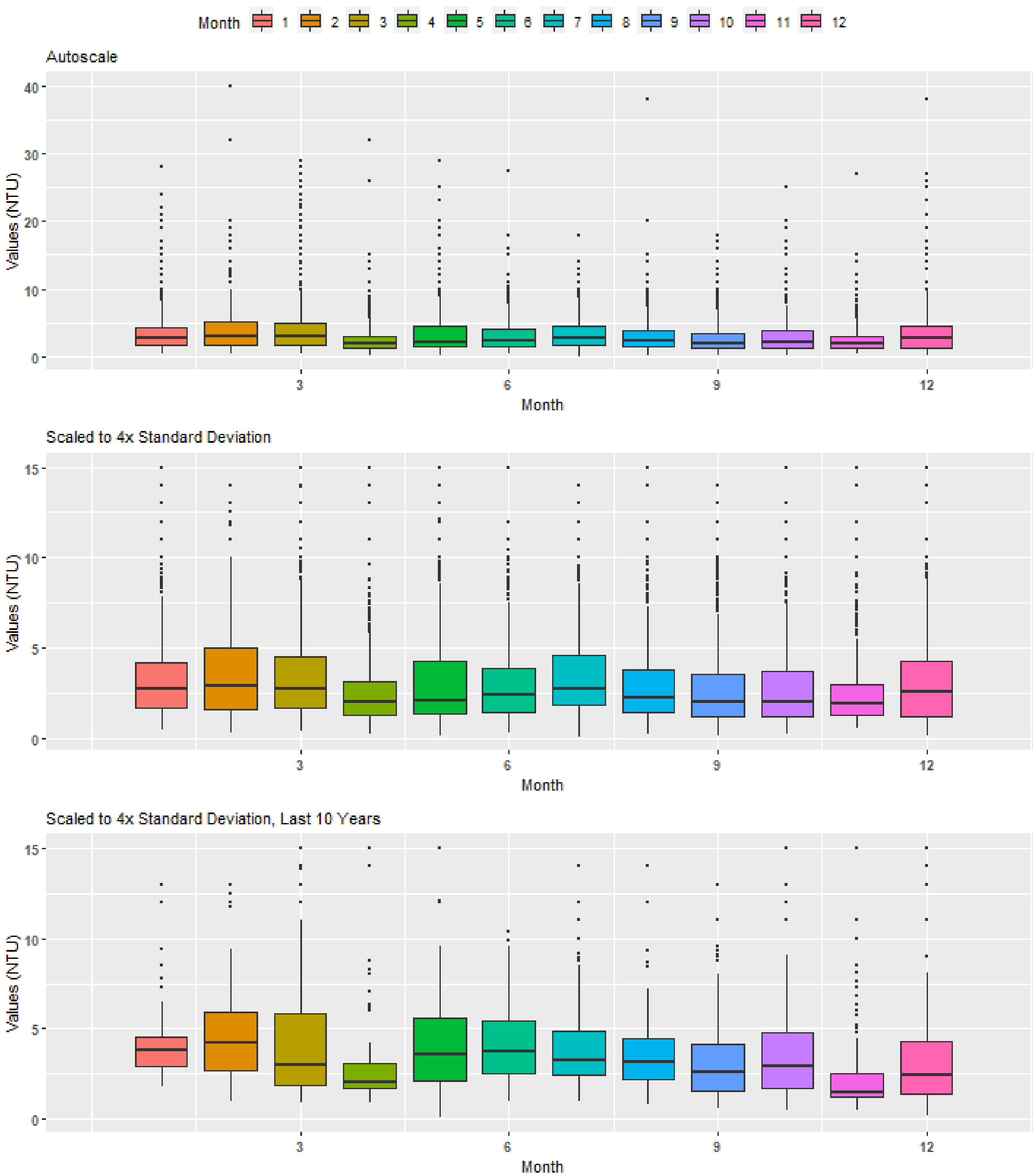
Scaled to 4x Standard Deviation, Last 10 Years



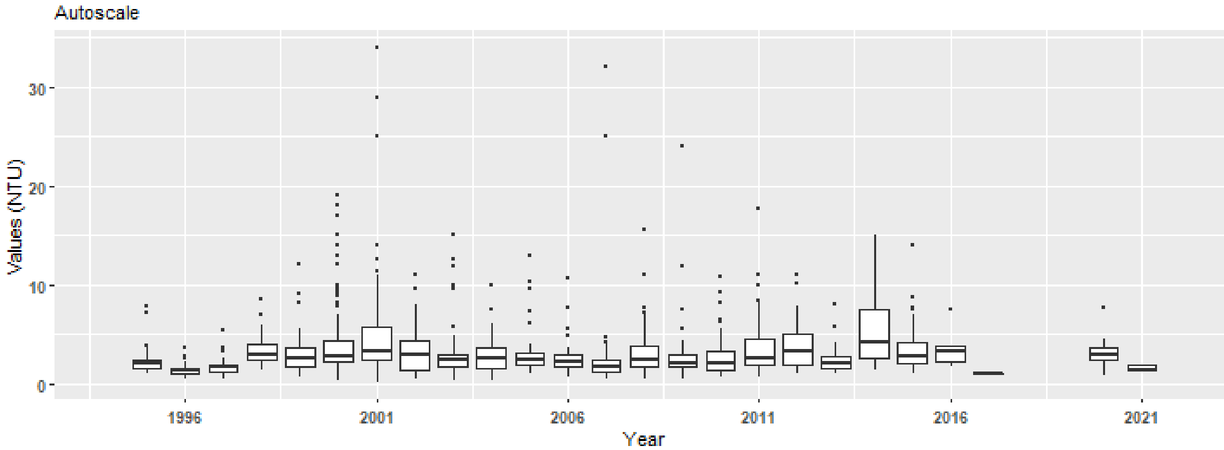


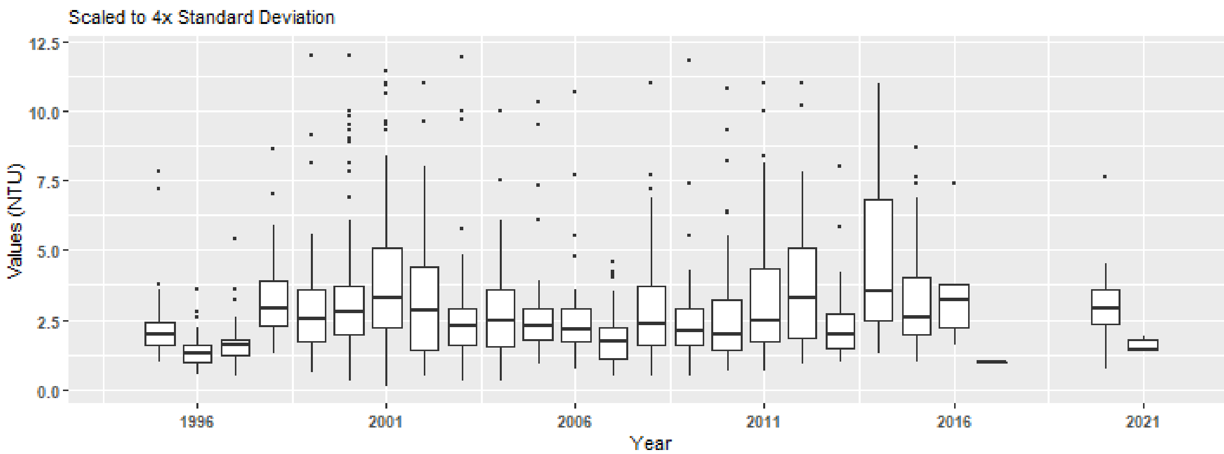
Summary Box Plots for Boca Ciega Bay Aquatic Preserve
By Year & Month
Month 1 2 3 4 5 6 7 8 9 10 11 12
Autoscale
Values (NTU)
0
10
20
30
40
1996
2001
2006
2011
2016
2021
Year
Scaled to 4x Standard Deviation
Values (NTU)
0
5
10
15
1996
2001
2006
2011
2016
2021
Year
Scaled to 4x Standard Deviation, Last 10 Years
Values (NTU)
0
5
10
15
2011
2013
2015
2017
2019
2021
Year

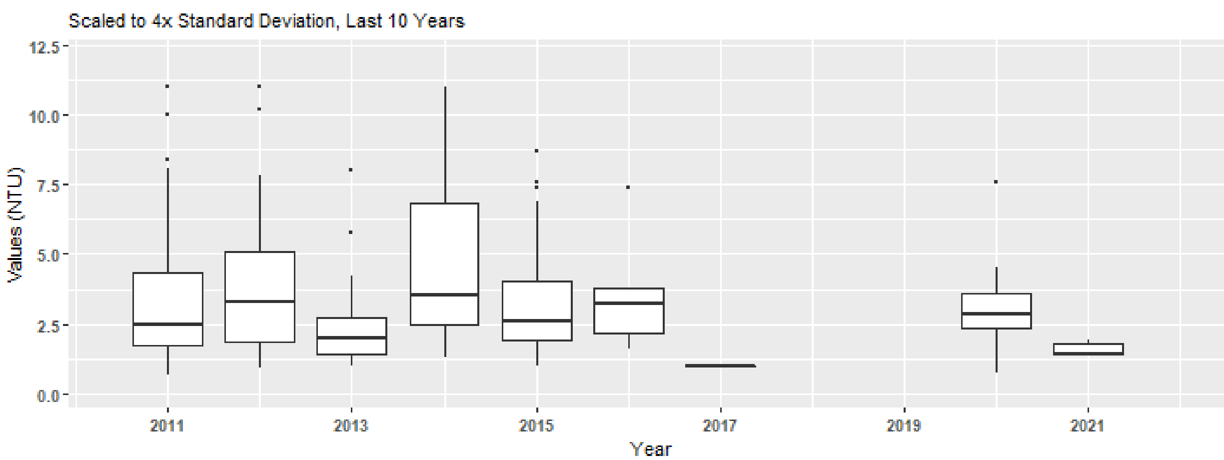
Summary Box Plots for Boca Ciega Bay Aquatic Preserve
By Month



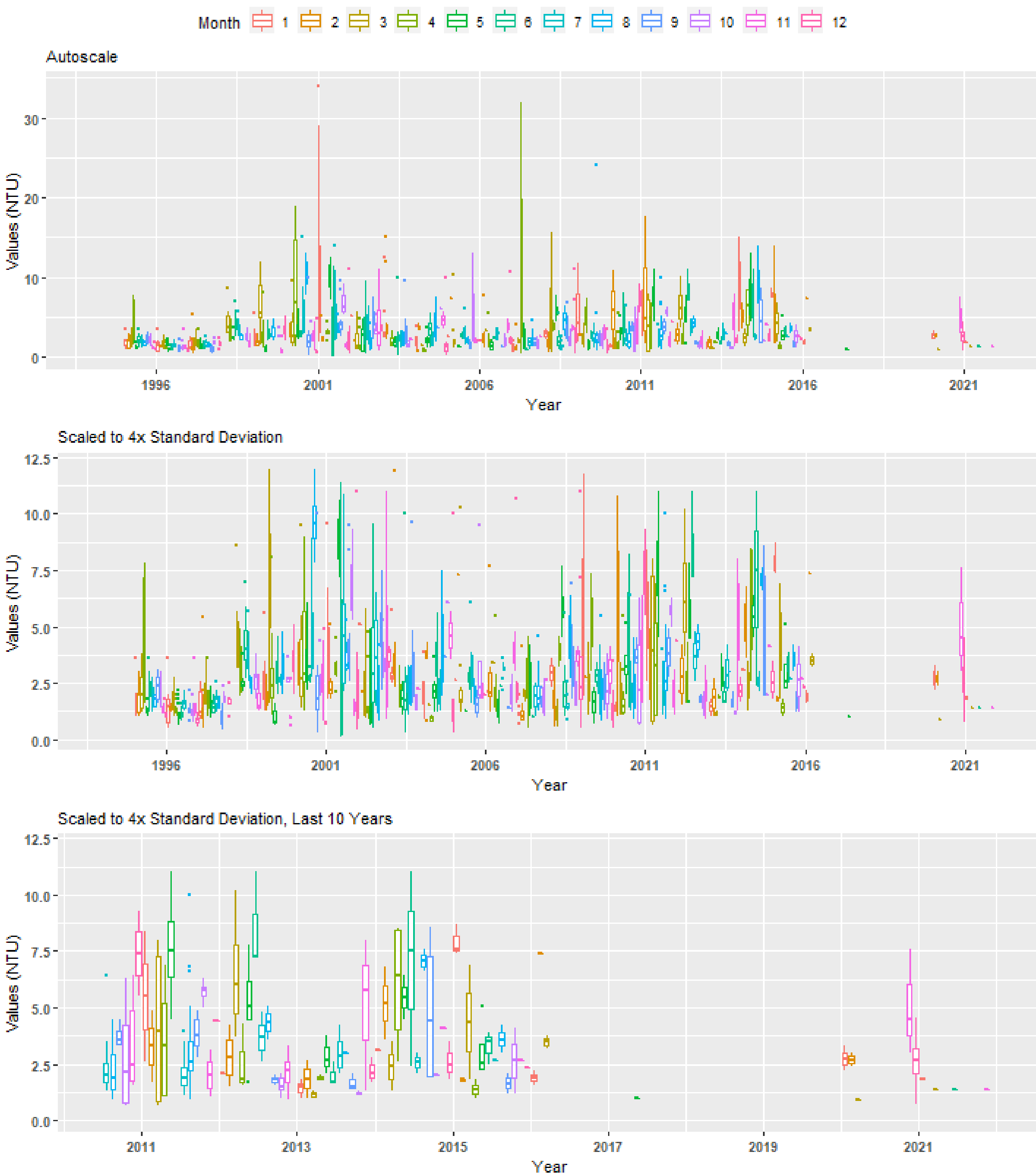
Summary Box Plots for Cape Haze Aquatic Preserve
By Year



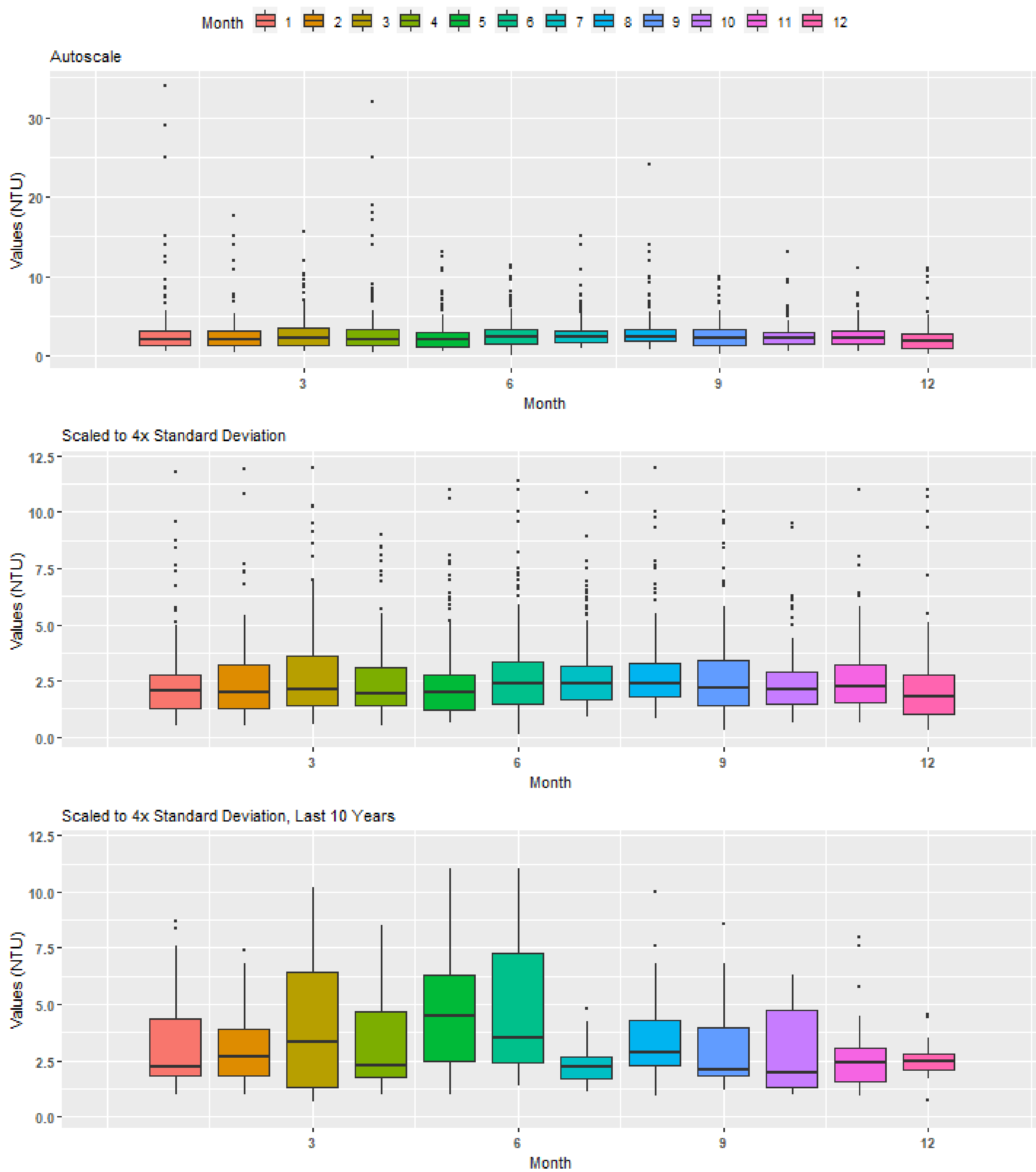




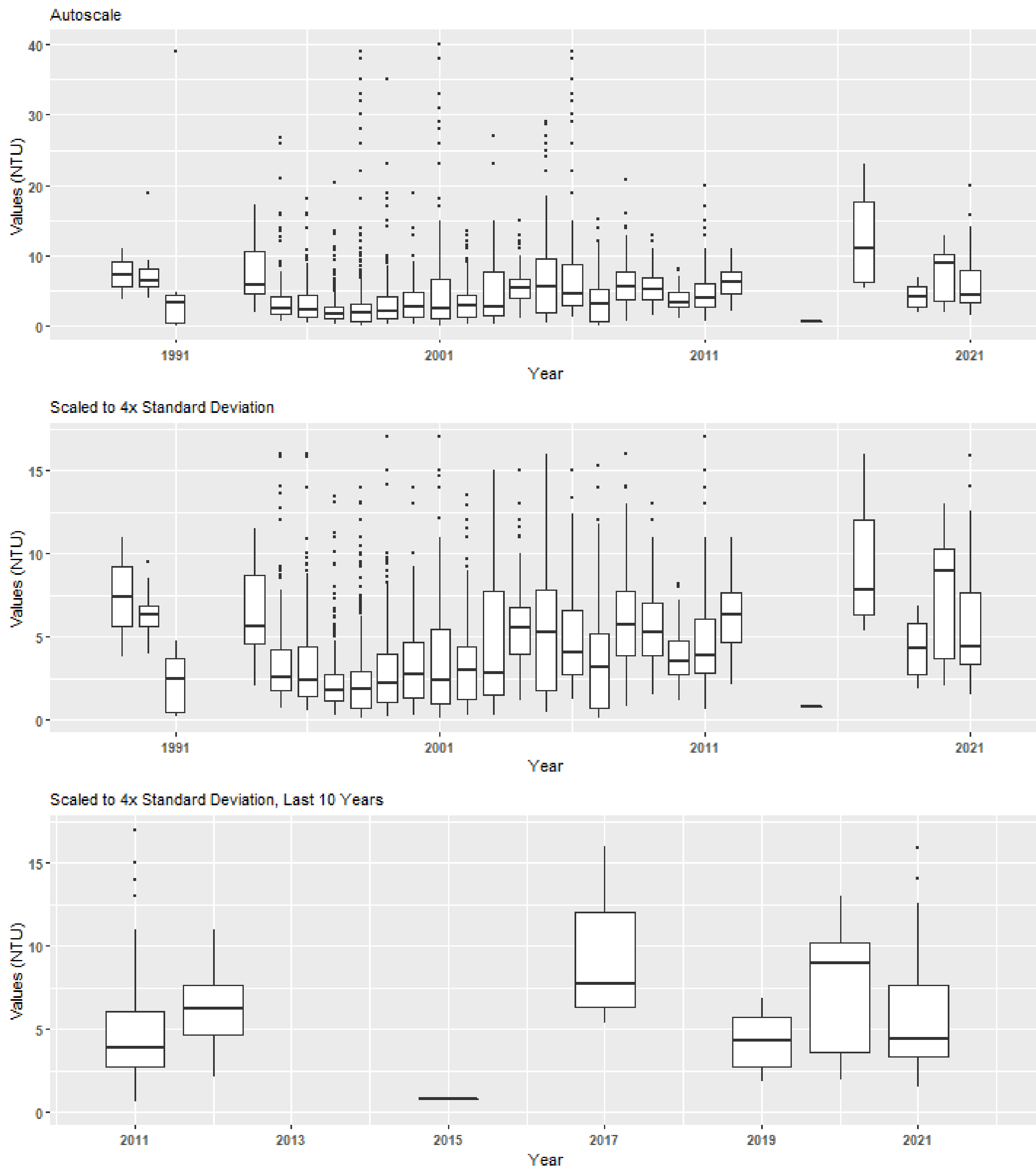
Summary Box Plots for Cape Haze Aquatic Preserve
By Year & Month



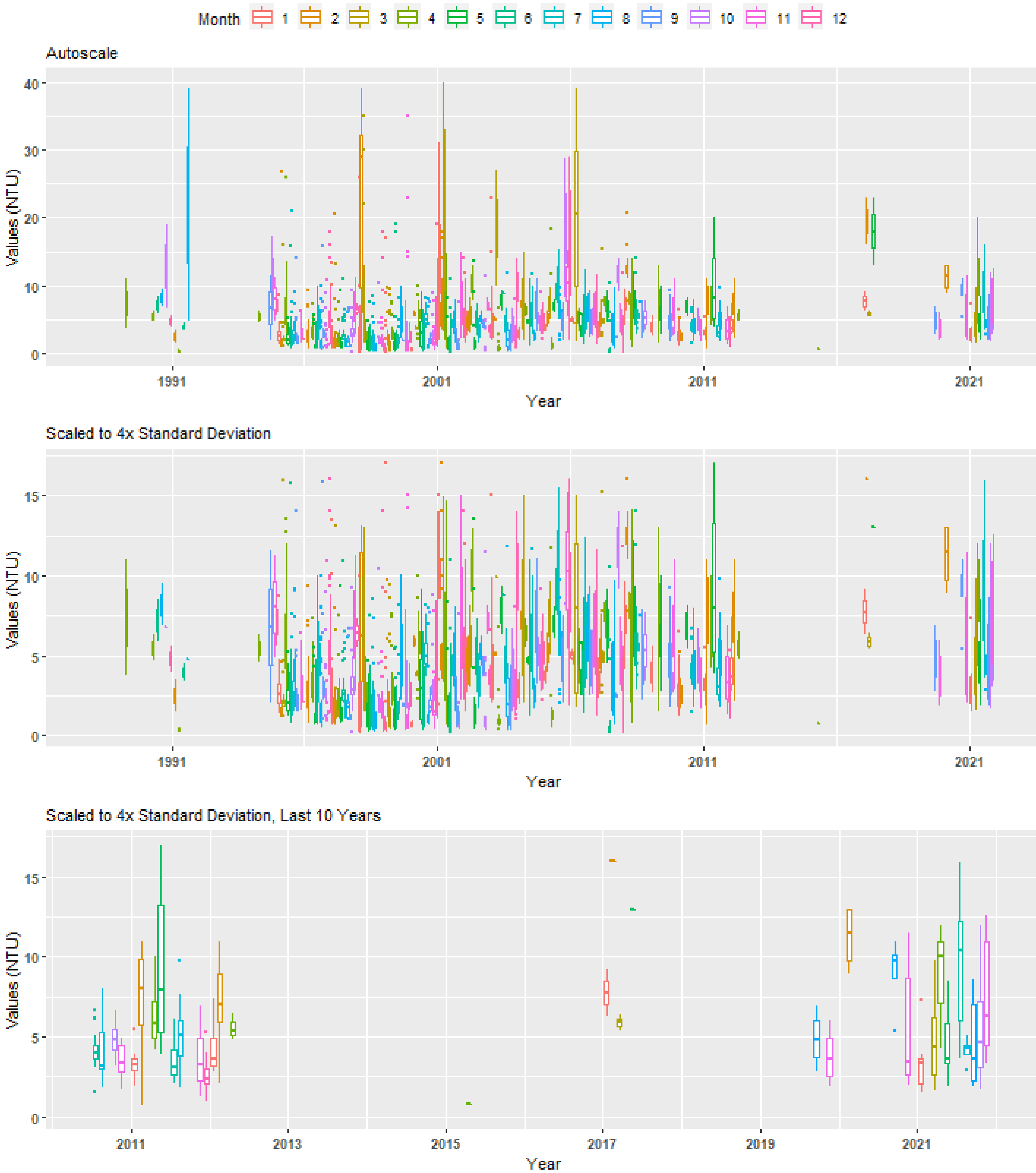
Summary Box Plots for Cape Haze Aquatic Preserve
By Month



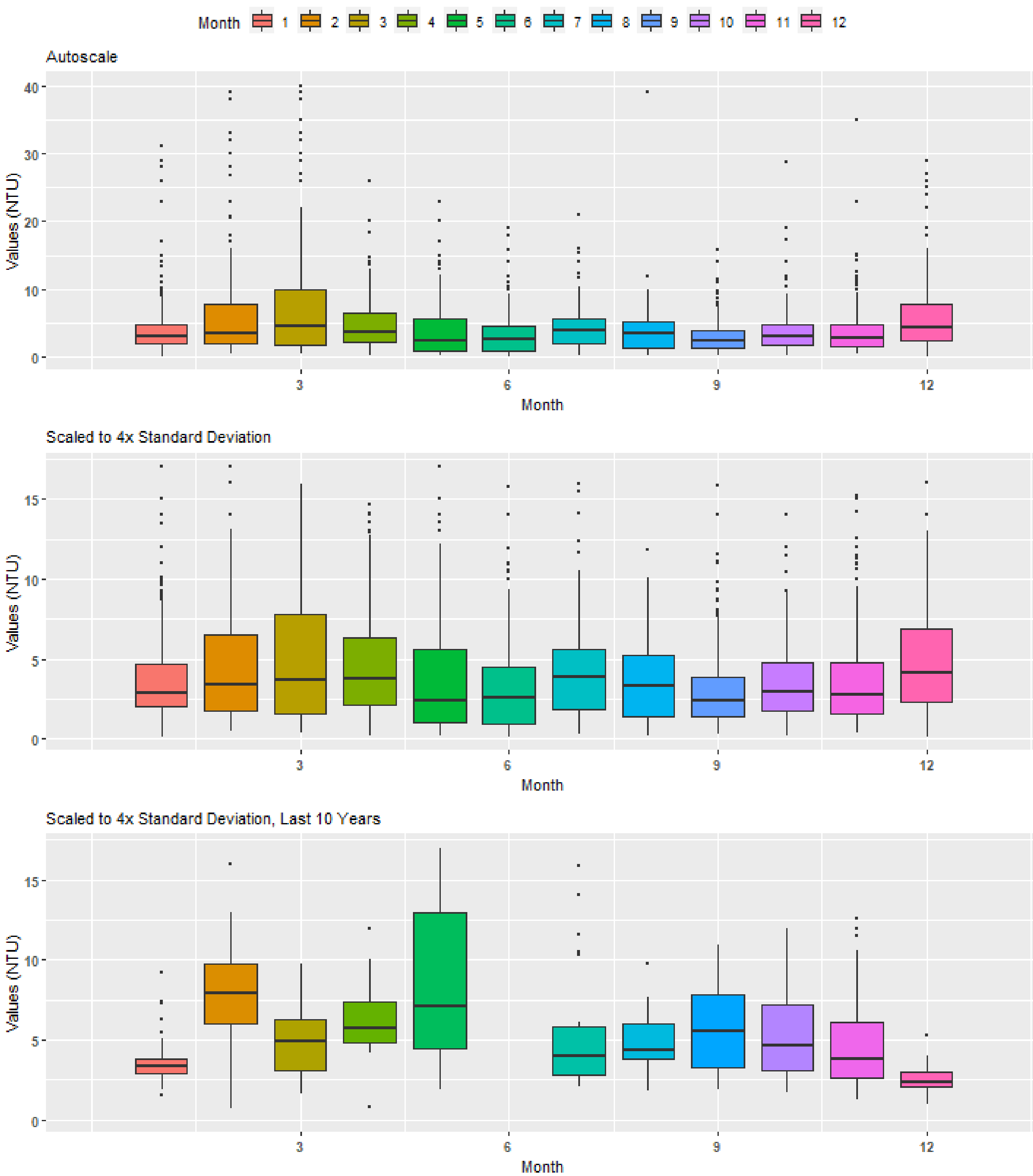
Summary Box Plots for Cape Romano-Ten Thousand Islands Aquatic Preserve
By Year



Summary Box Plots for Cape Romano-Ten Thousand Islands Aquatic Preserve
By Year & Month



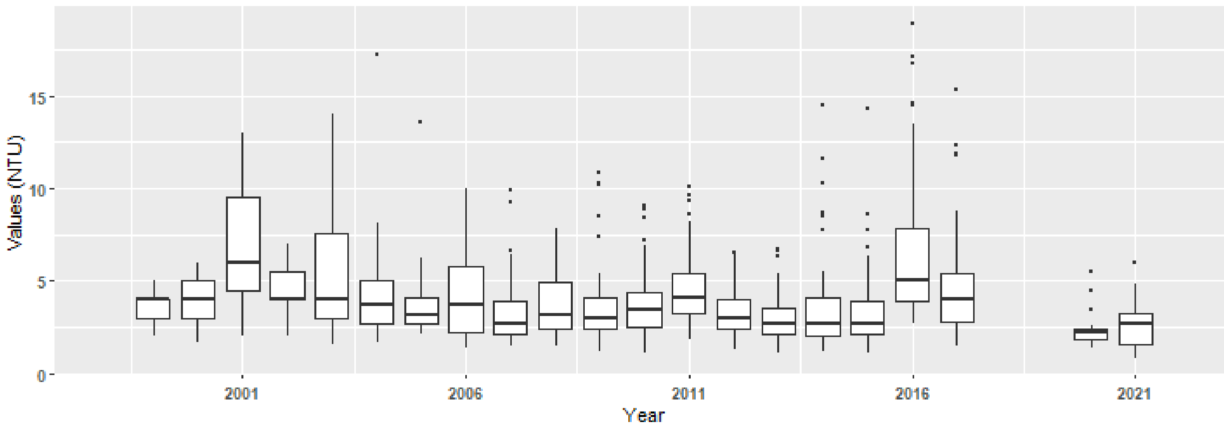
Summary Box Plots for Cape Romano-Ten Thousand Islands Aquatic Preserve
By Month



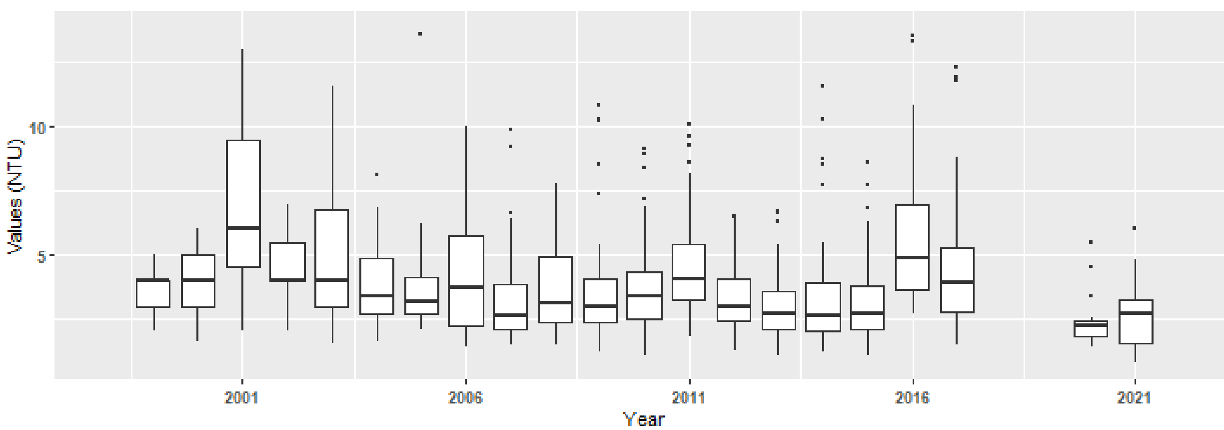
Summary Box Plots for Cockroach Bay Aquatic Preserve

By Year

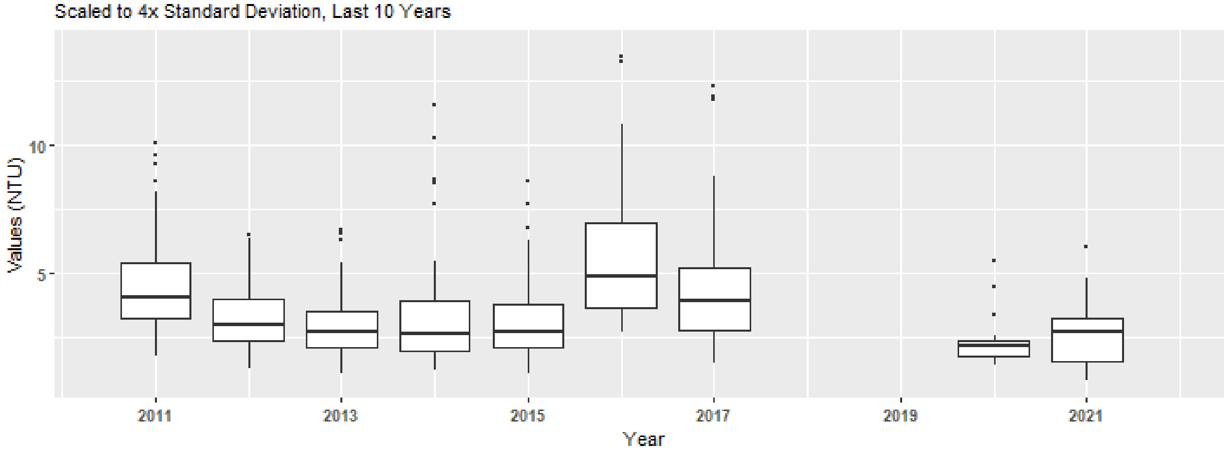
Autoscale



Scaled to 4x Standard Deviation

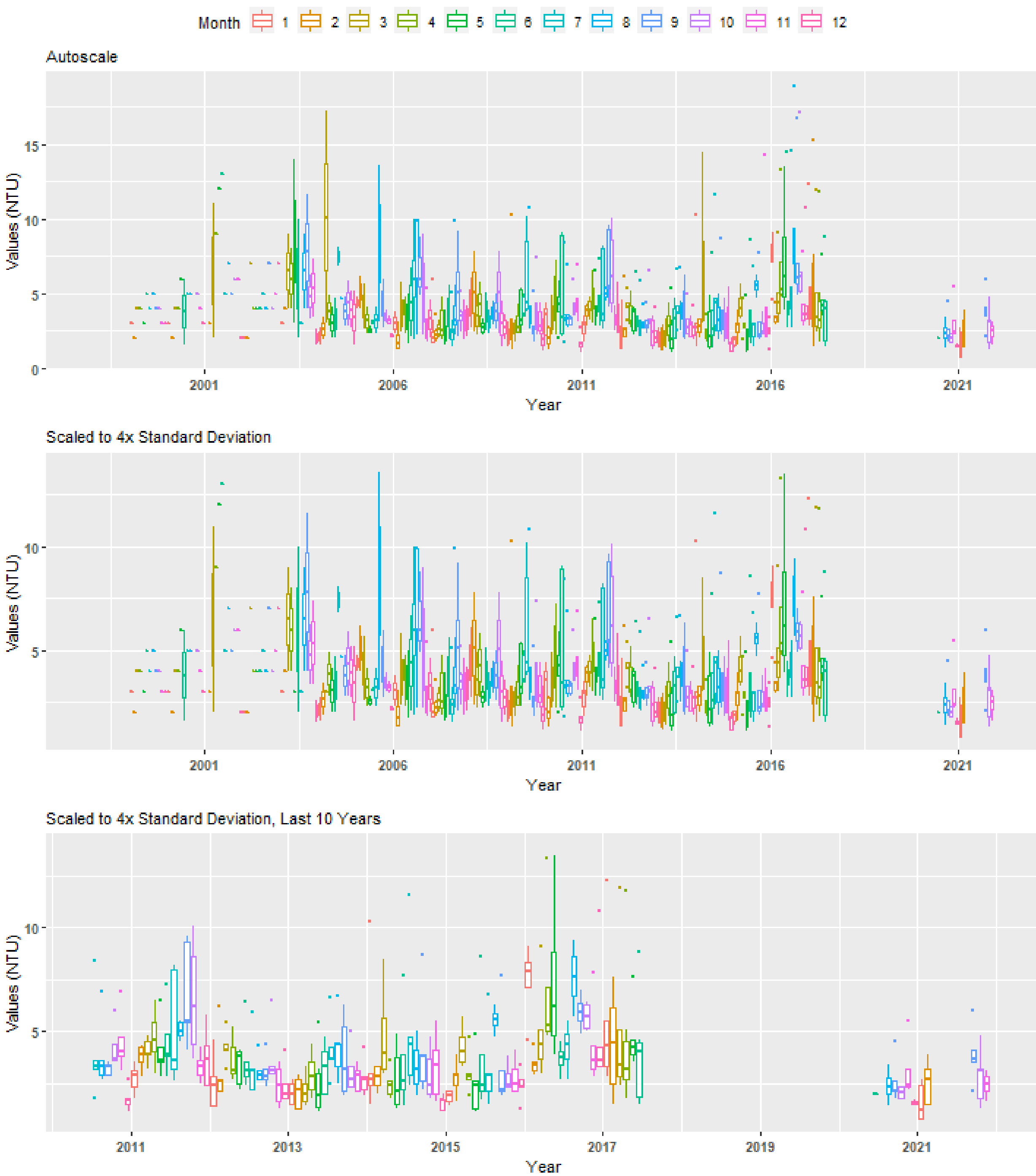


Scaled to 4x Standard Deviation, Last 10 Years

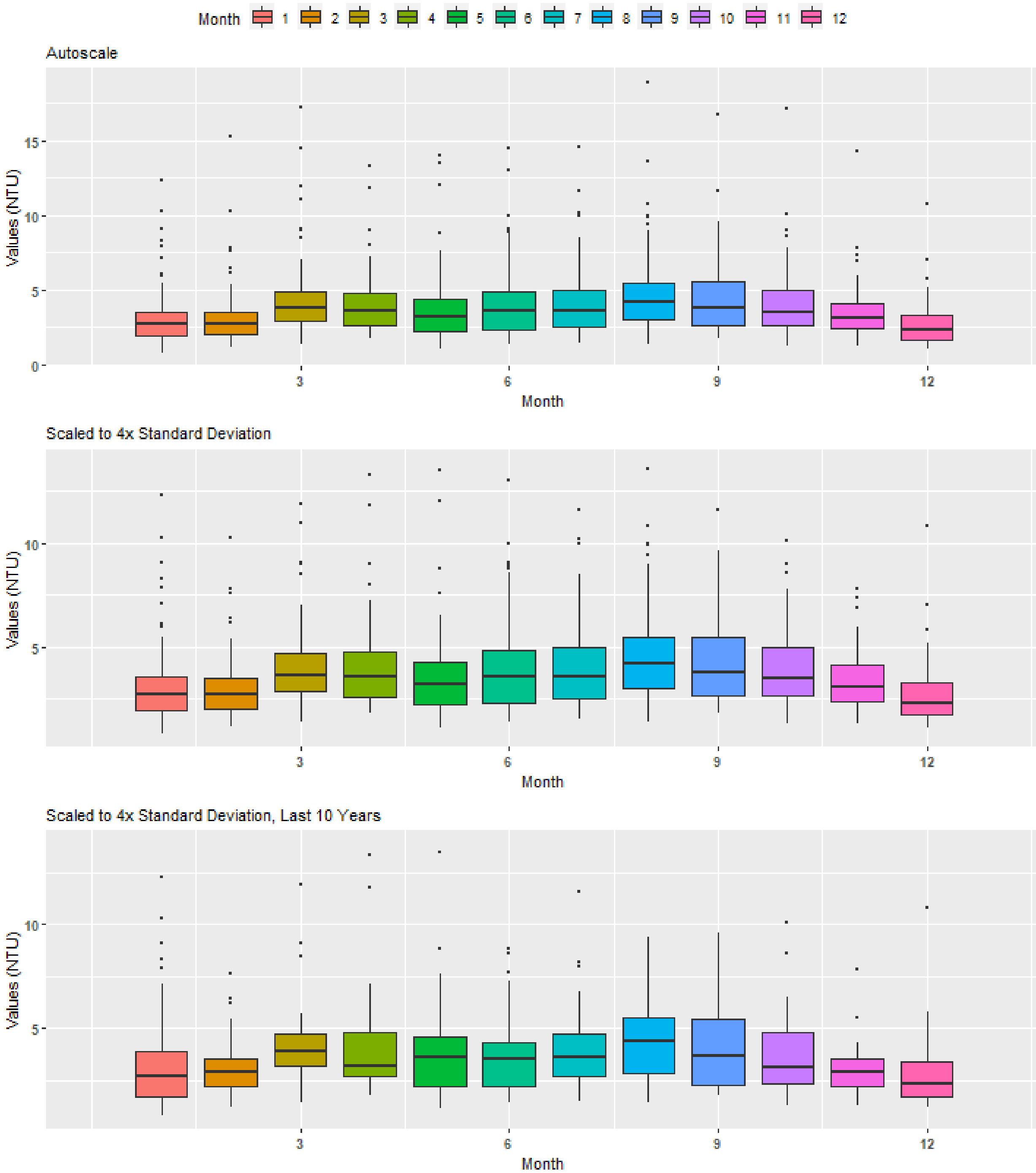


Summary Box Plots for Cockroach Bay Aquatic Preserve

By Year & Month

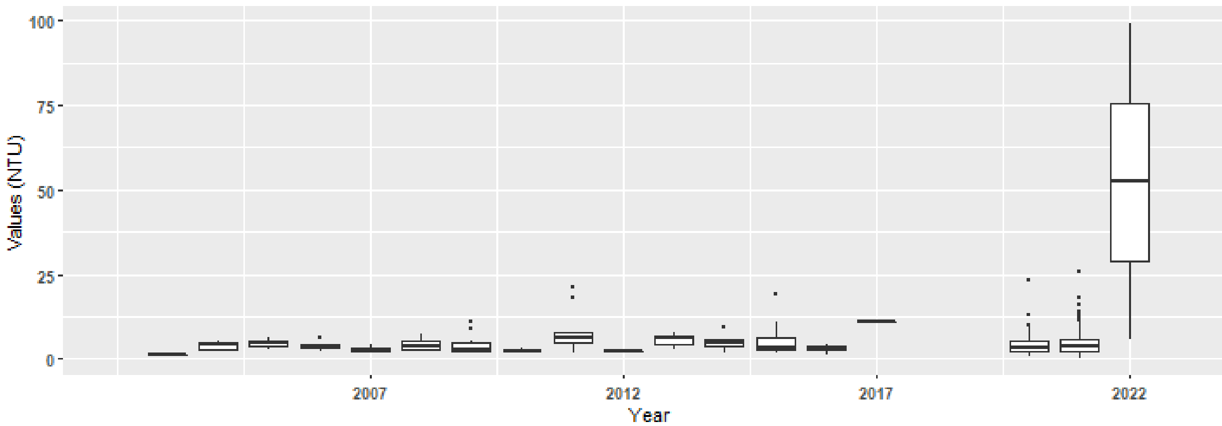


Summary Box Plots for Cockroach Bay Aquatic Preserve
By Month

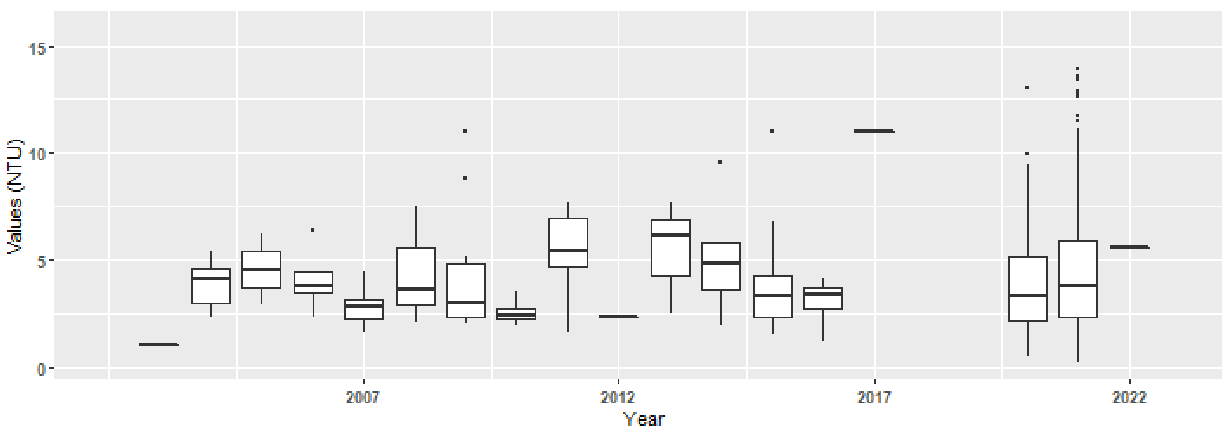


Summary Box Plots for Estero Bay Aquatic Preserve
By Year

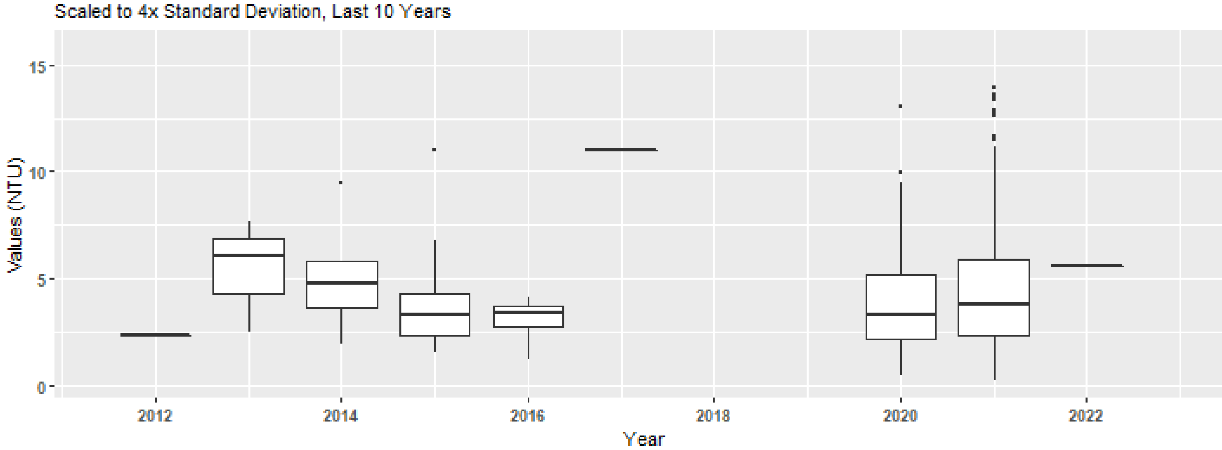
Autoscale

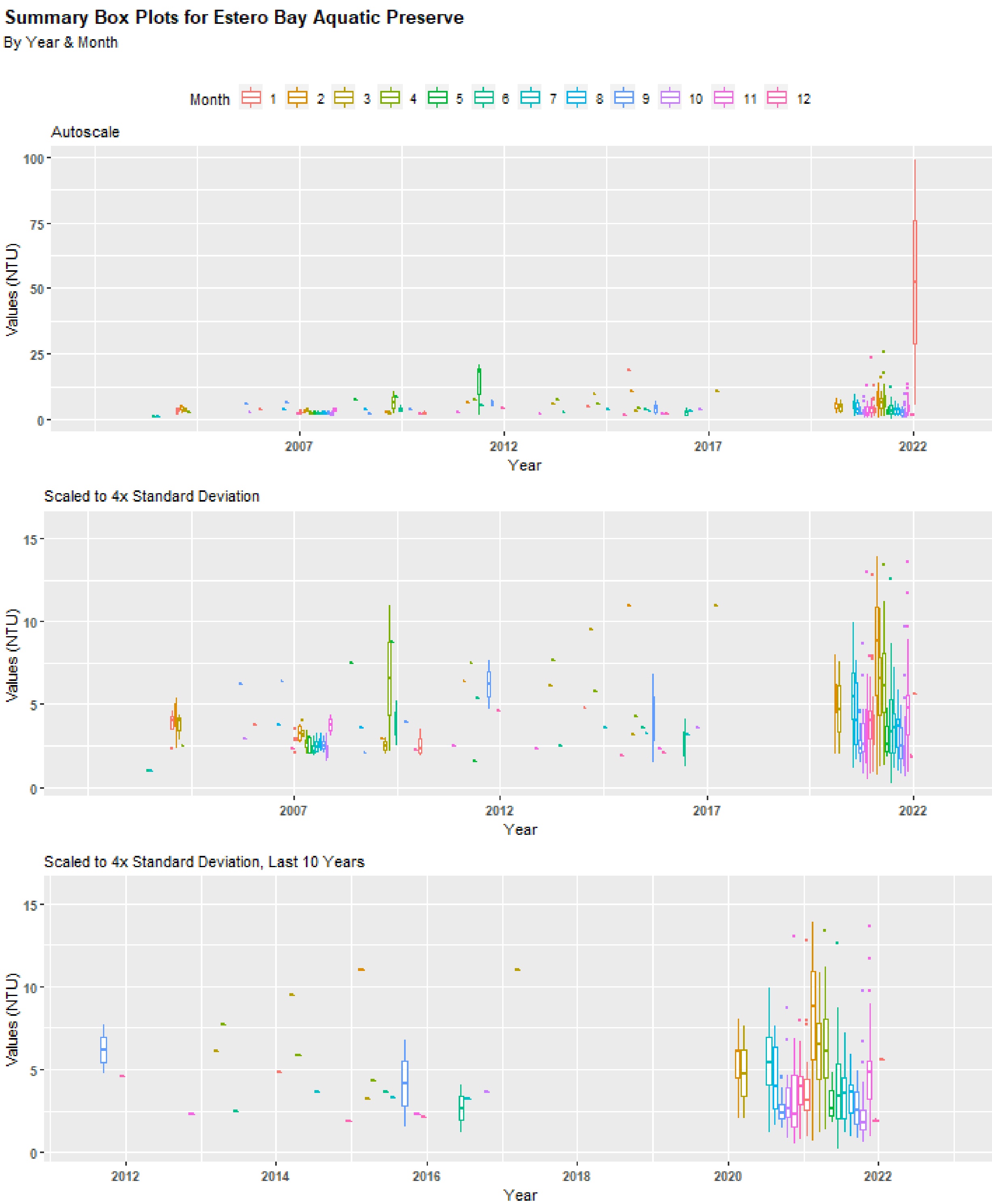


Scaled to 4x Standard Deviation



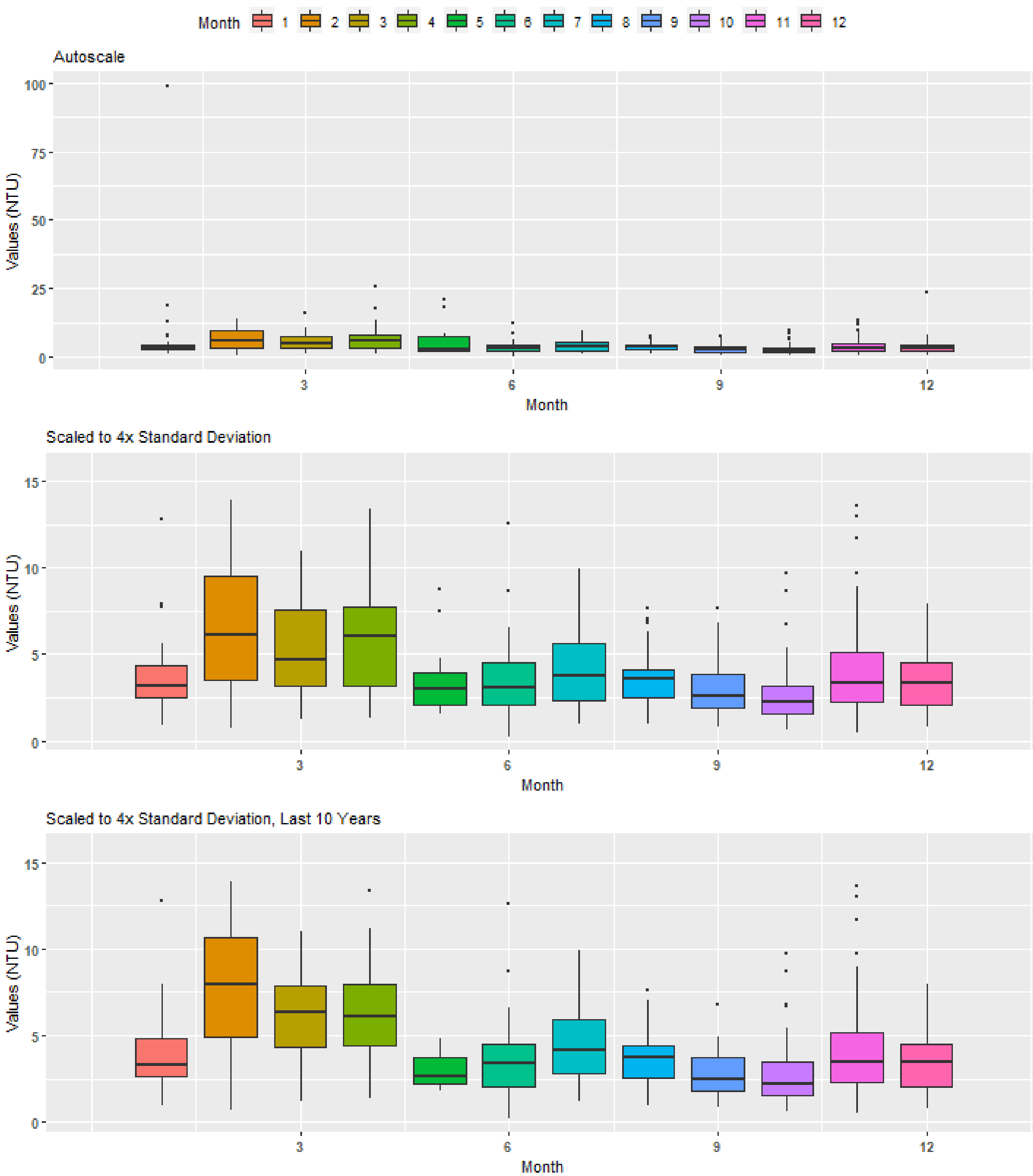
Scaled to 4x Standard Deviation, Last 10 Years



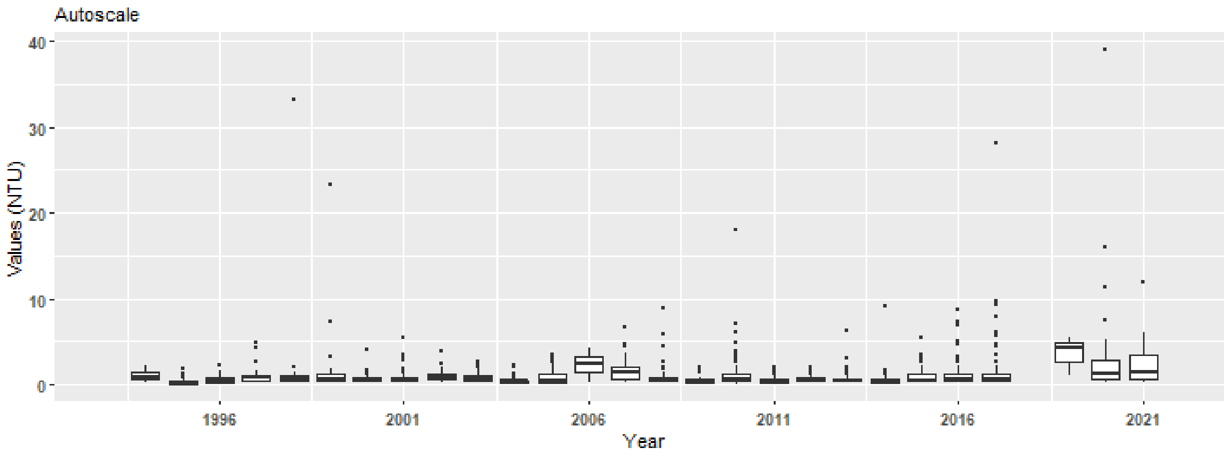

Summary Box Plots for Estero Bay Aquatic Preserve
By Year & Month
Month 1 2 3 4 5 6 7 8 9 10 11 12
Autoscale
Values (NTU)
100
75
50
25
0
2007
2012
2017
2022
Year
Scaled to 4x Standard Deviation
Values (NTU)
15
10
5
0
2007
2012
2017
2022
Year
Scaled to 4x Standard Deviation, Last 10 Years
Values (NTU)
15
10
5
0
2012
2014
2016
2018
2020
2022
Year

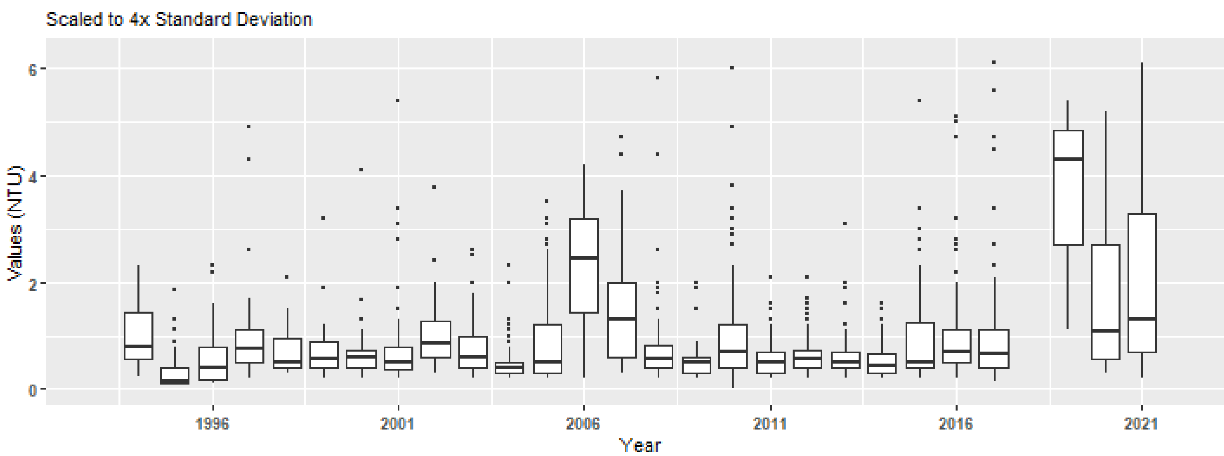
Summary Box Plots for Estero Bay Aquatic Preserve

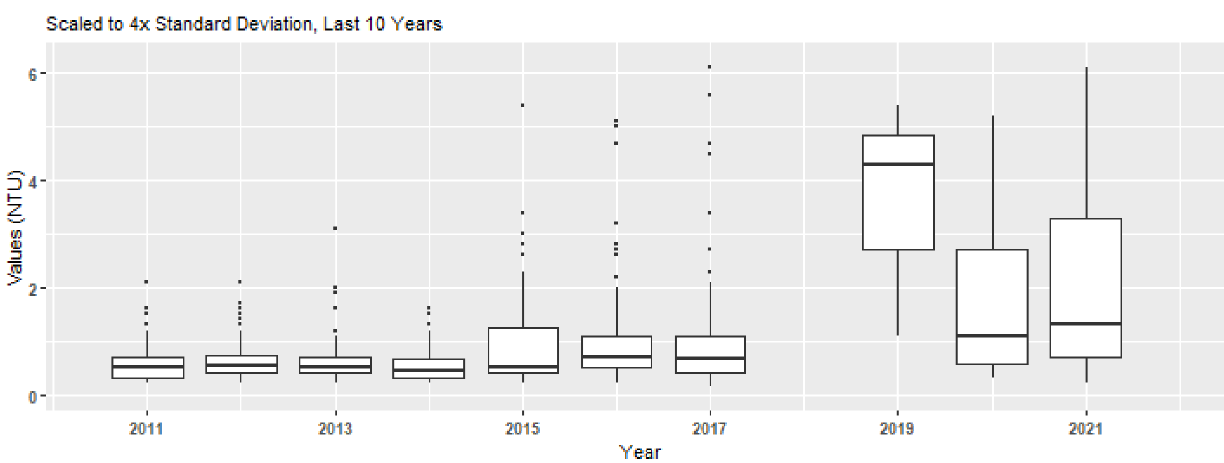
By Month



Summary Box Plots for Florida Keys National Marine Sanctuary
By Year

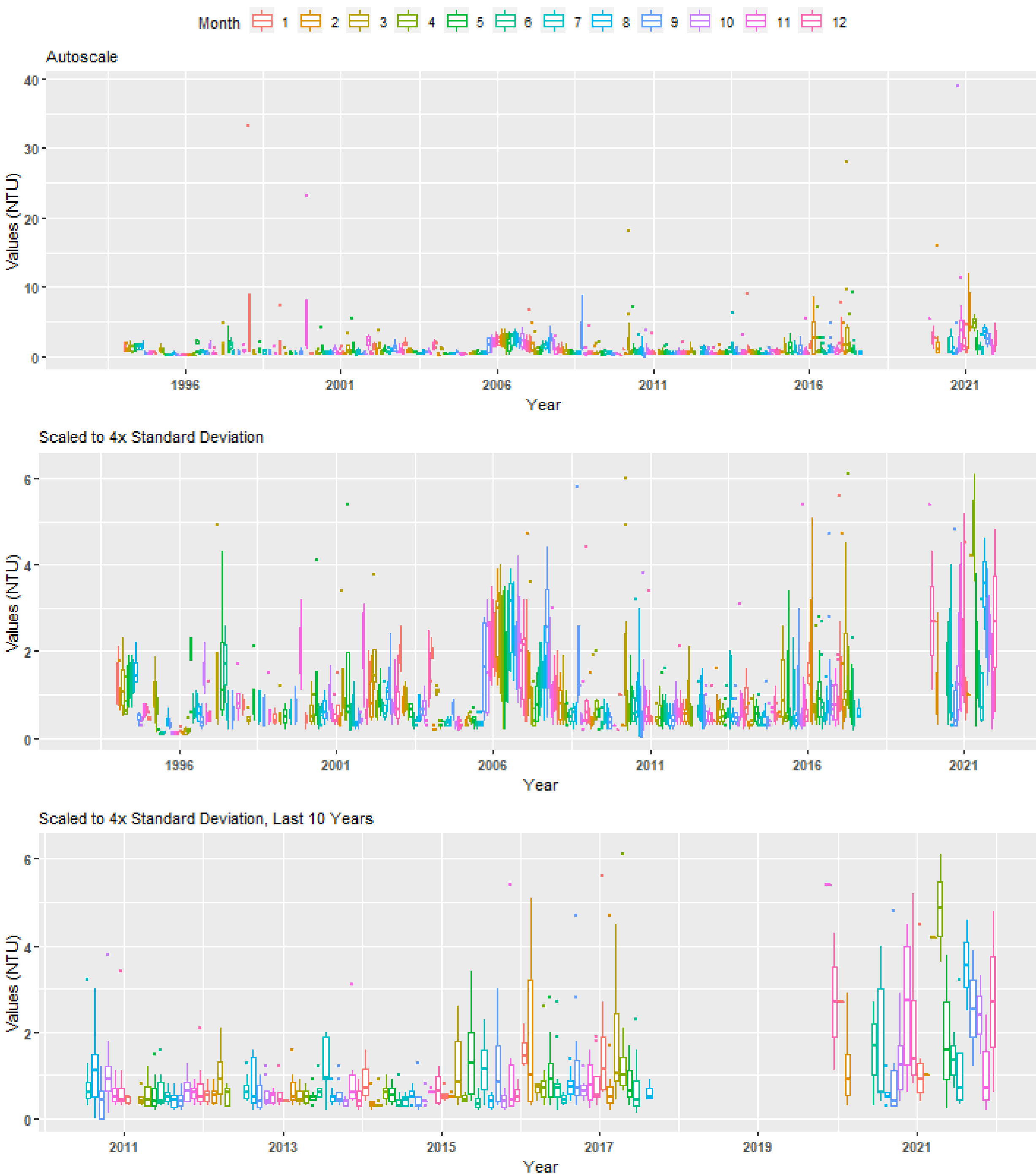




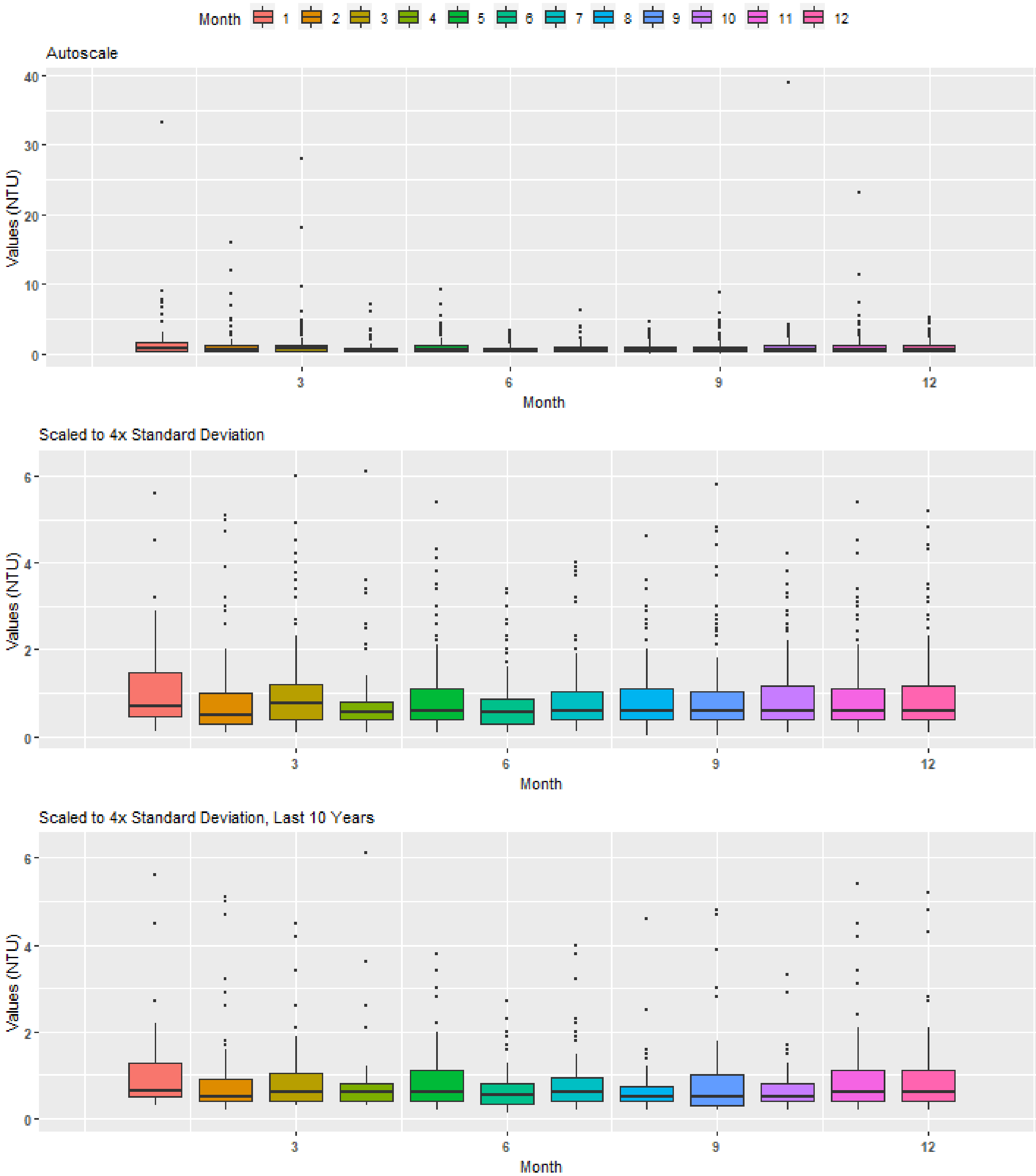


Summary Box Plots for Florida Keys National Marine Sanctuary

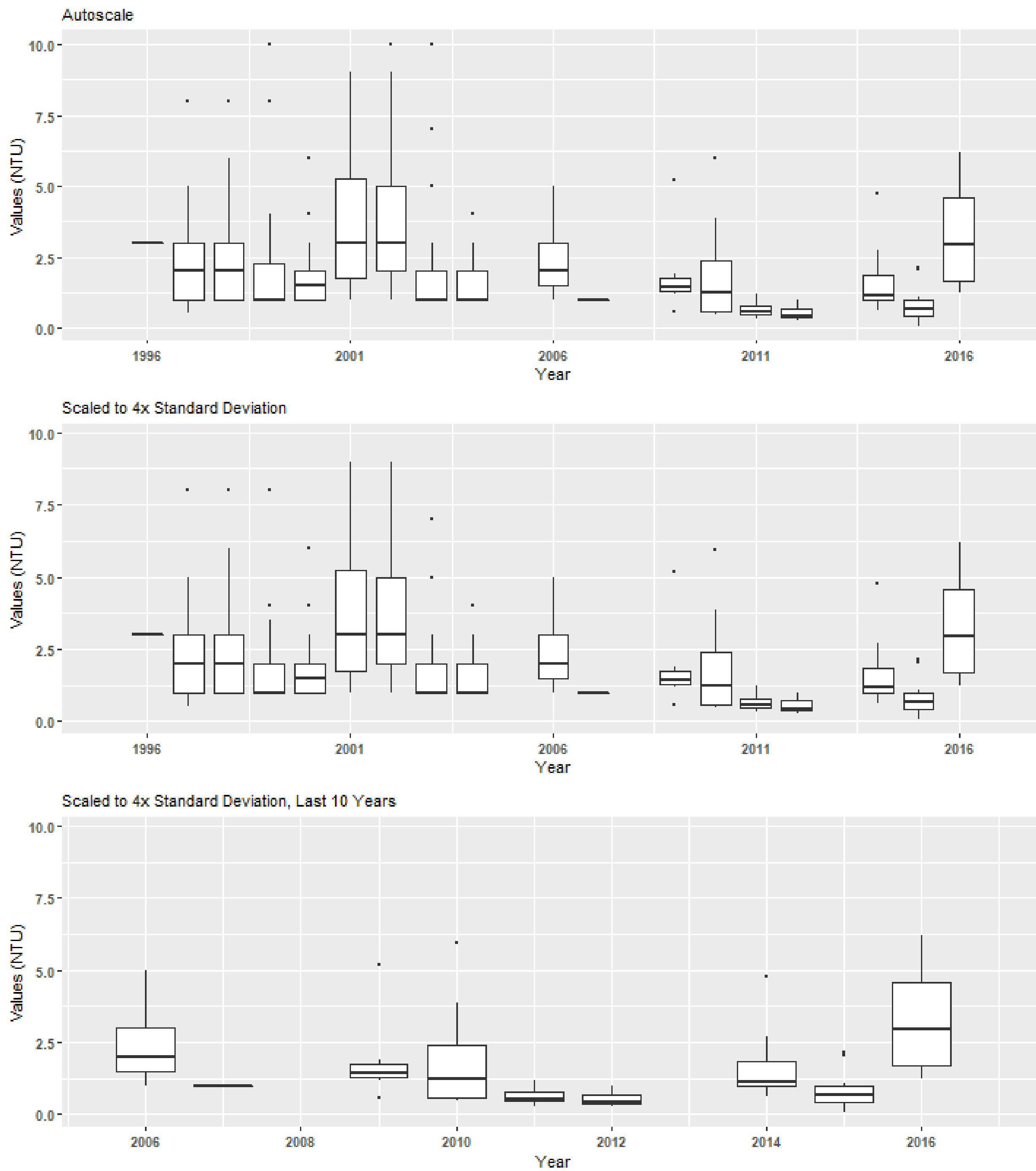
By Year & Month



Summary Box Plots for Florida Keys National Marine Sanctuary
By Month



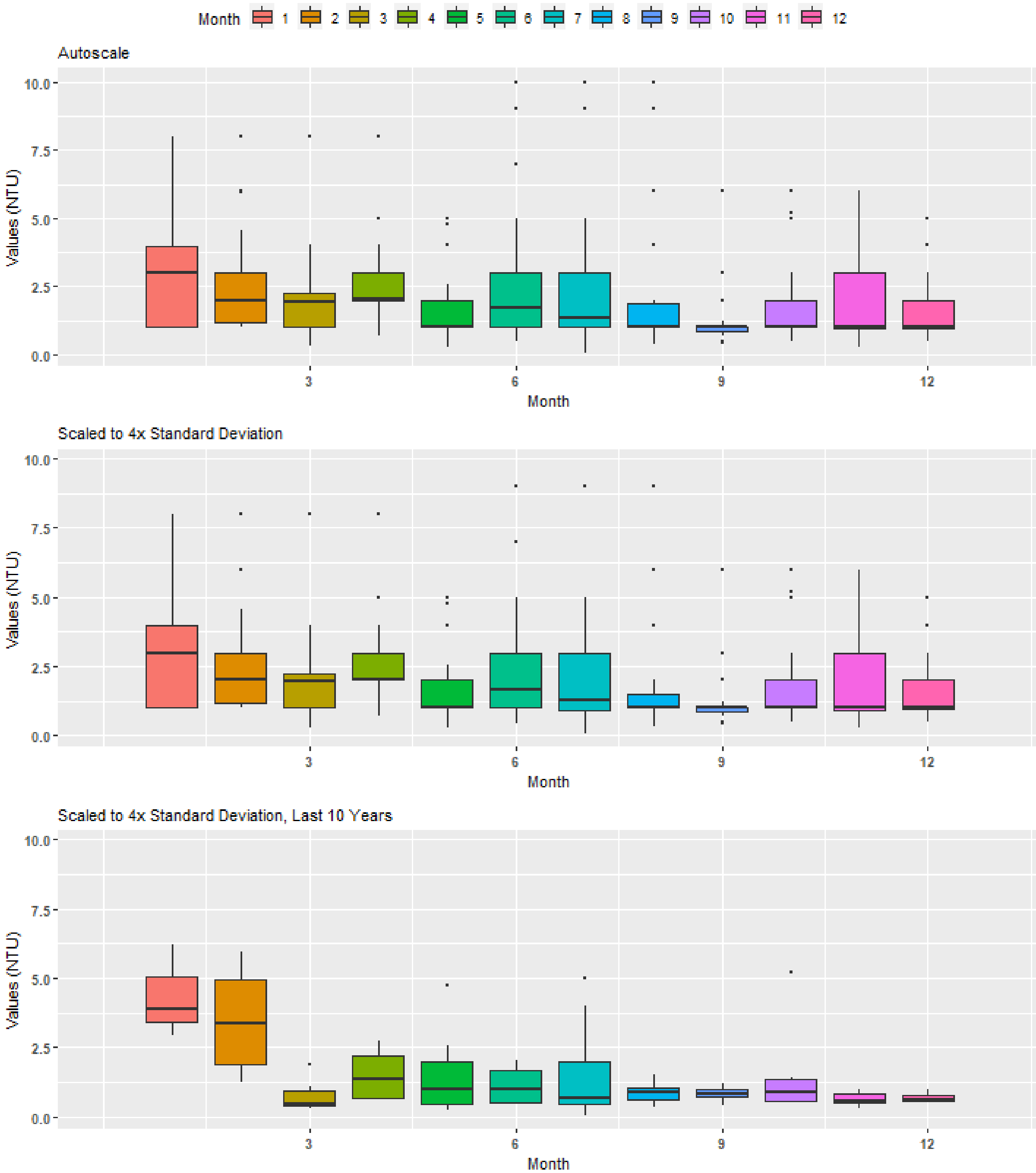
Summary Box Plots for Fort Pickens State Park Aquatic Preserve
By Year



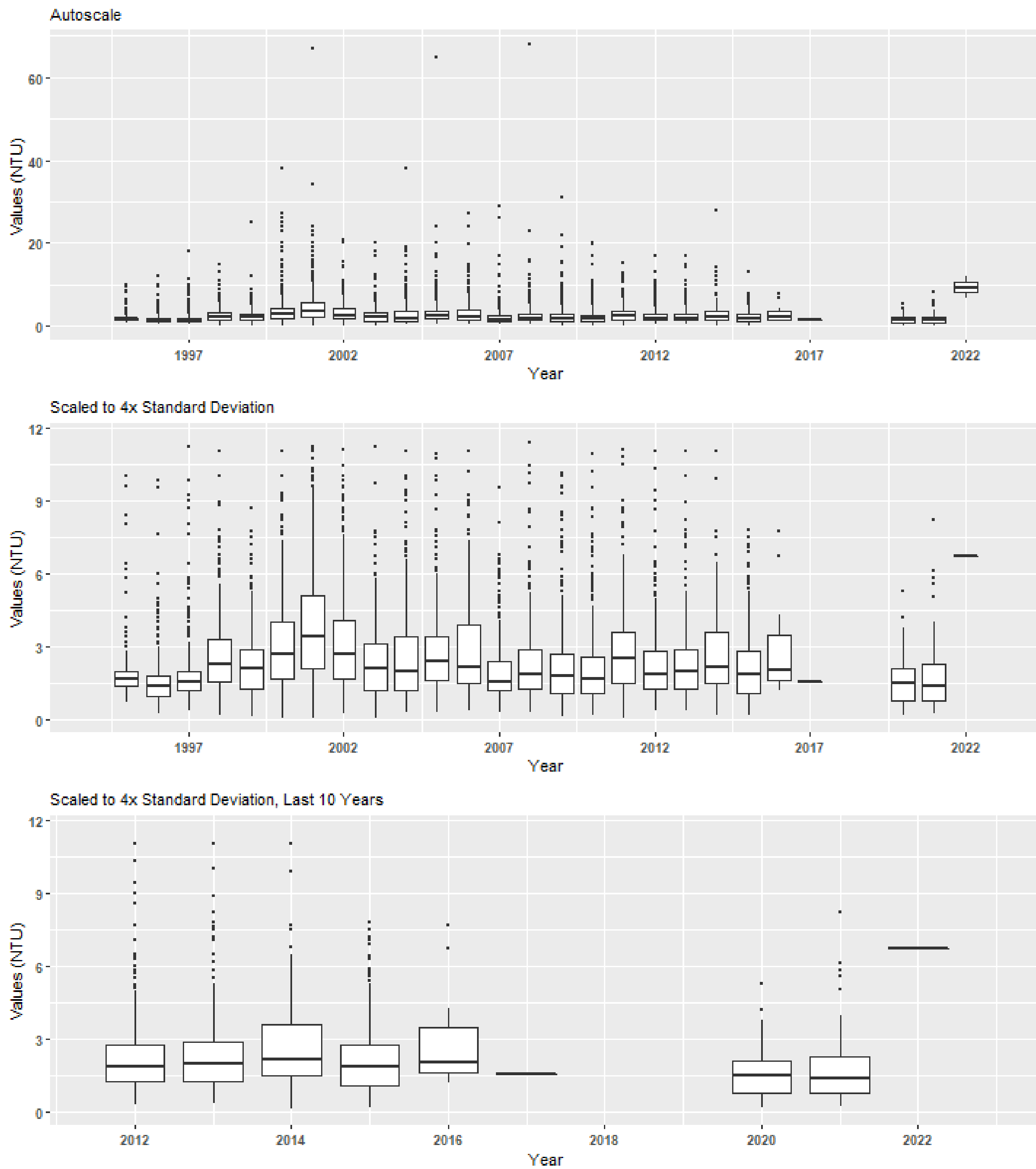
Summary Box Plots for Fort Pickens State Park Aquatic Preserve

By Year & Month

Summary Box Plots for Fort Pickens State Park Aquatic Preserve
By Month

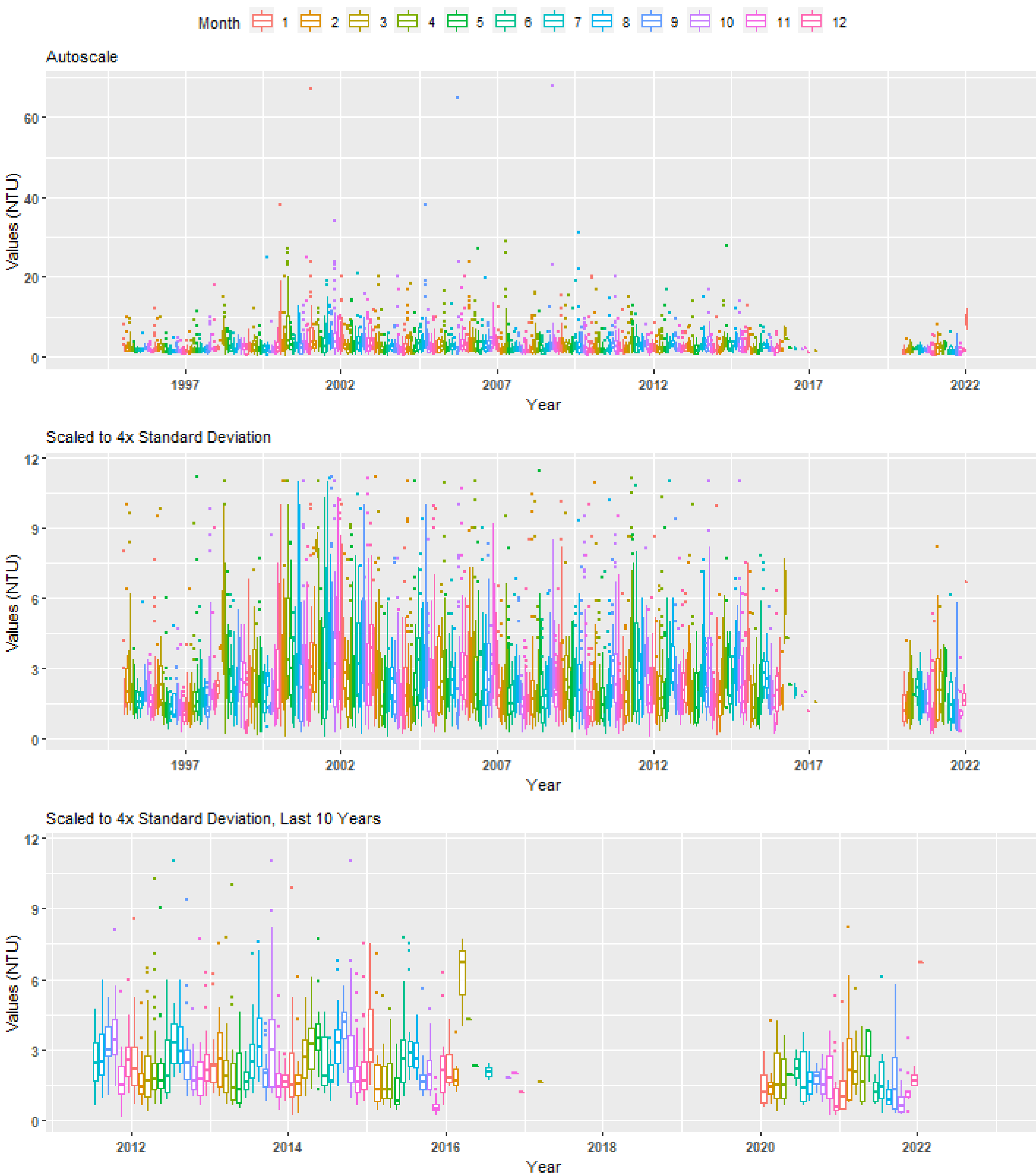


Summary Box Plots for Gasparilla Sound-Charlotte Harbor Aquatic Preserve
By Year

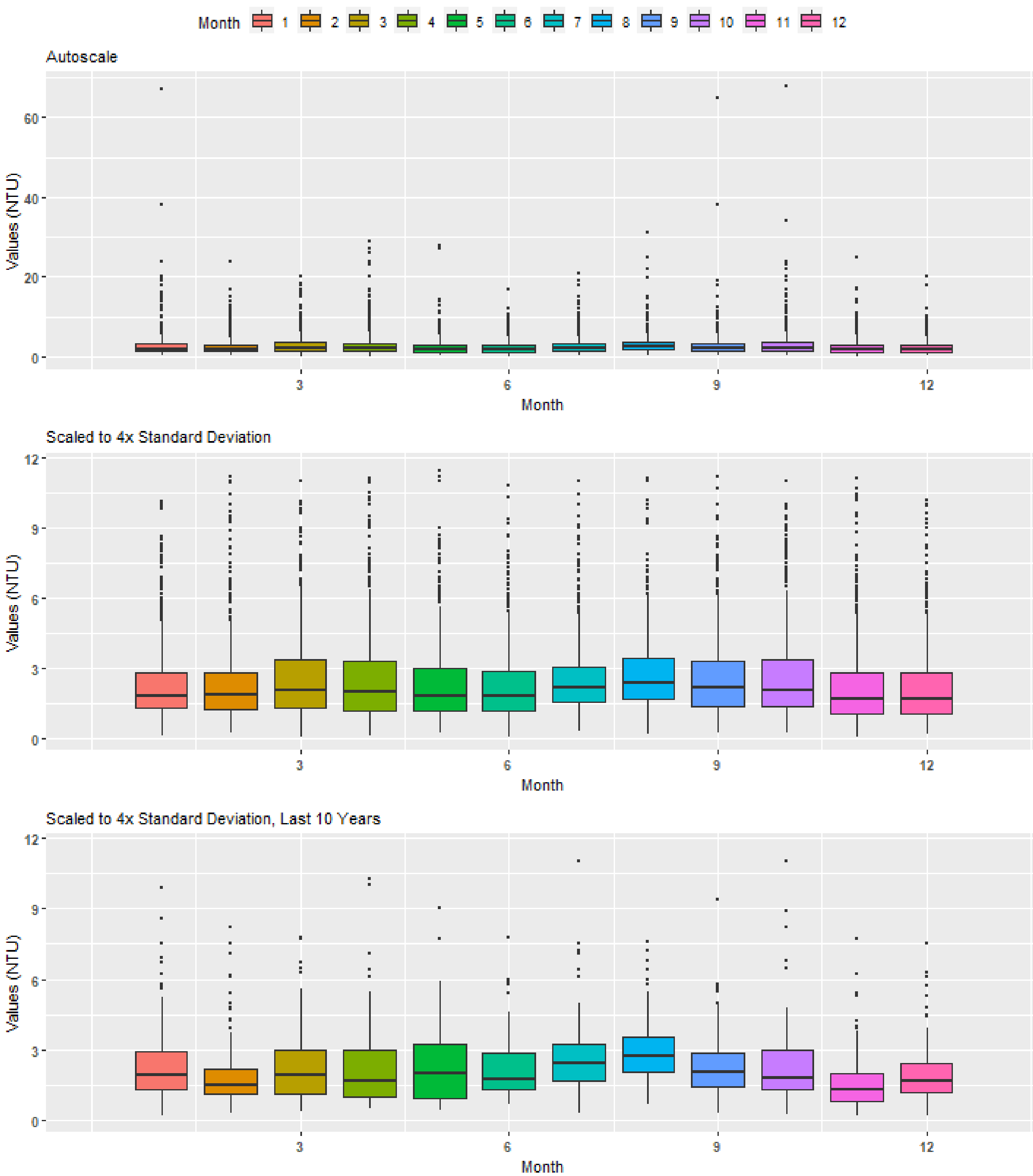


Summary Box Plots for Gasparilla Sound-Charlotte Harbor Aquatic Preserve

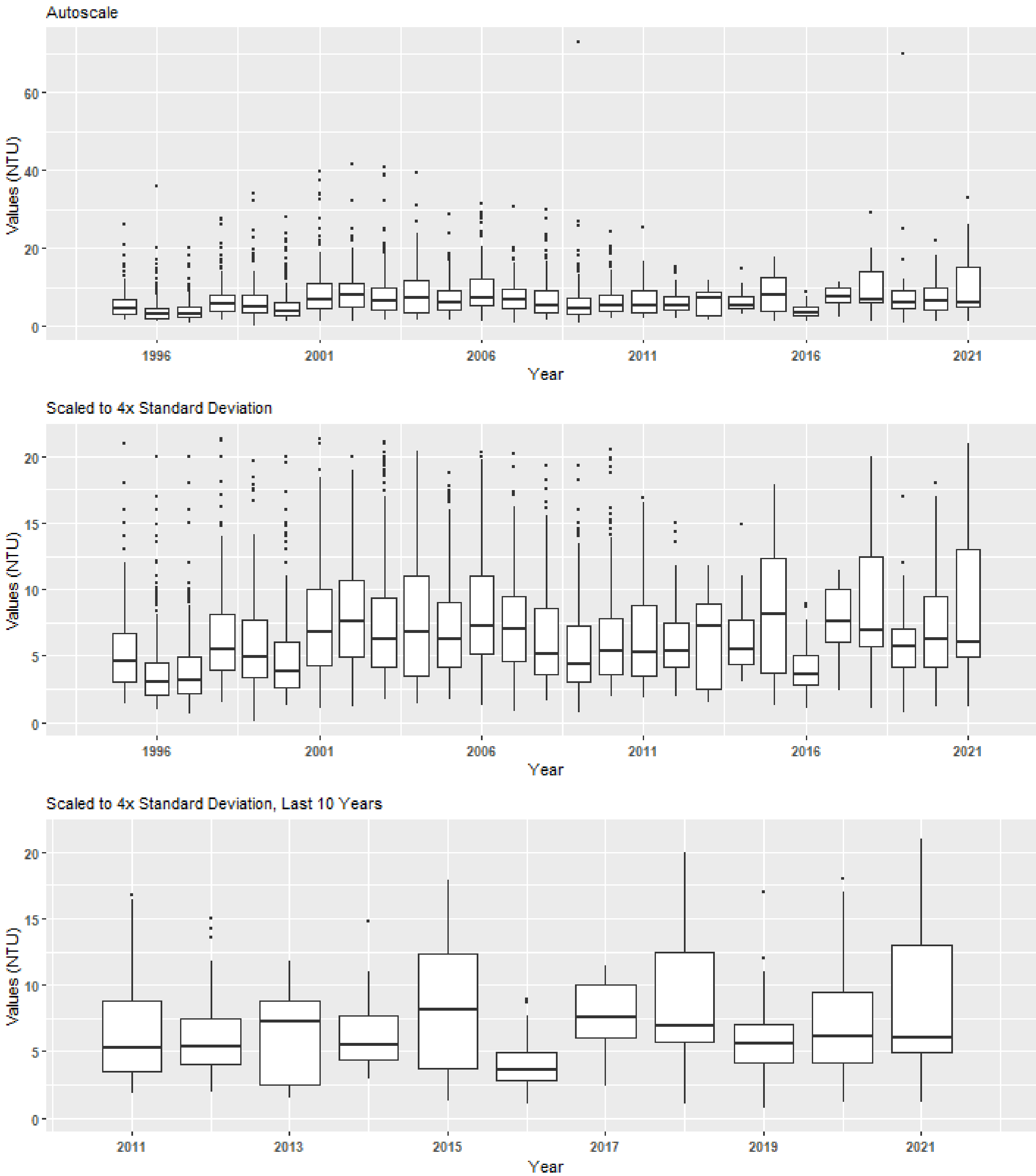
By Year & Month

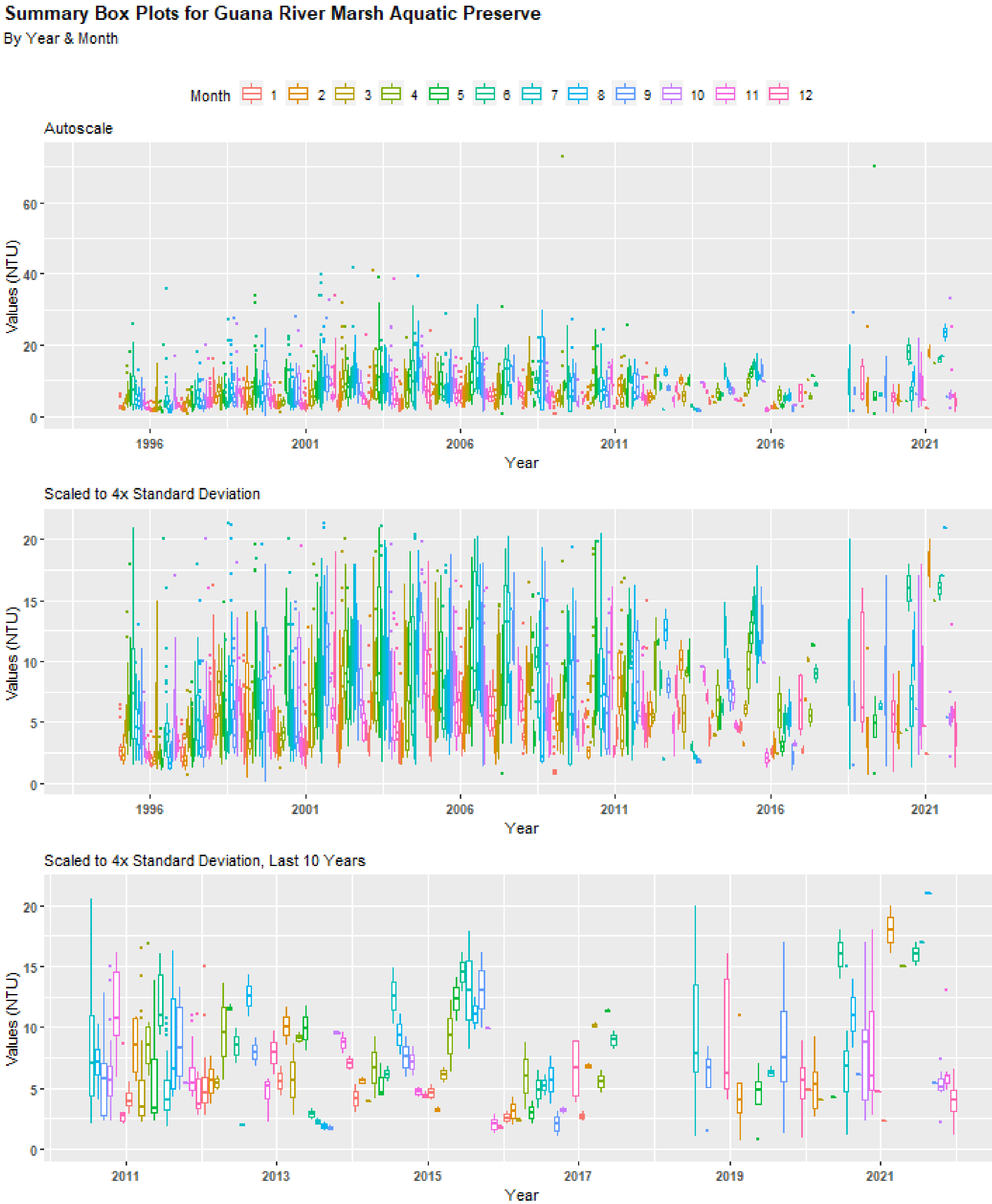


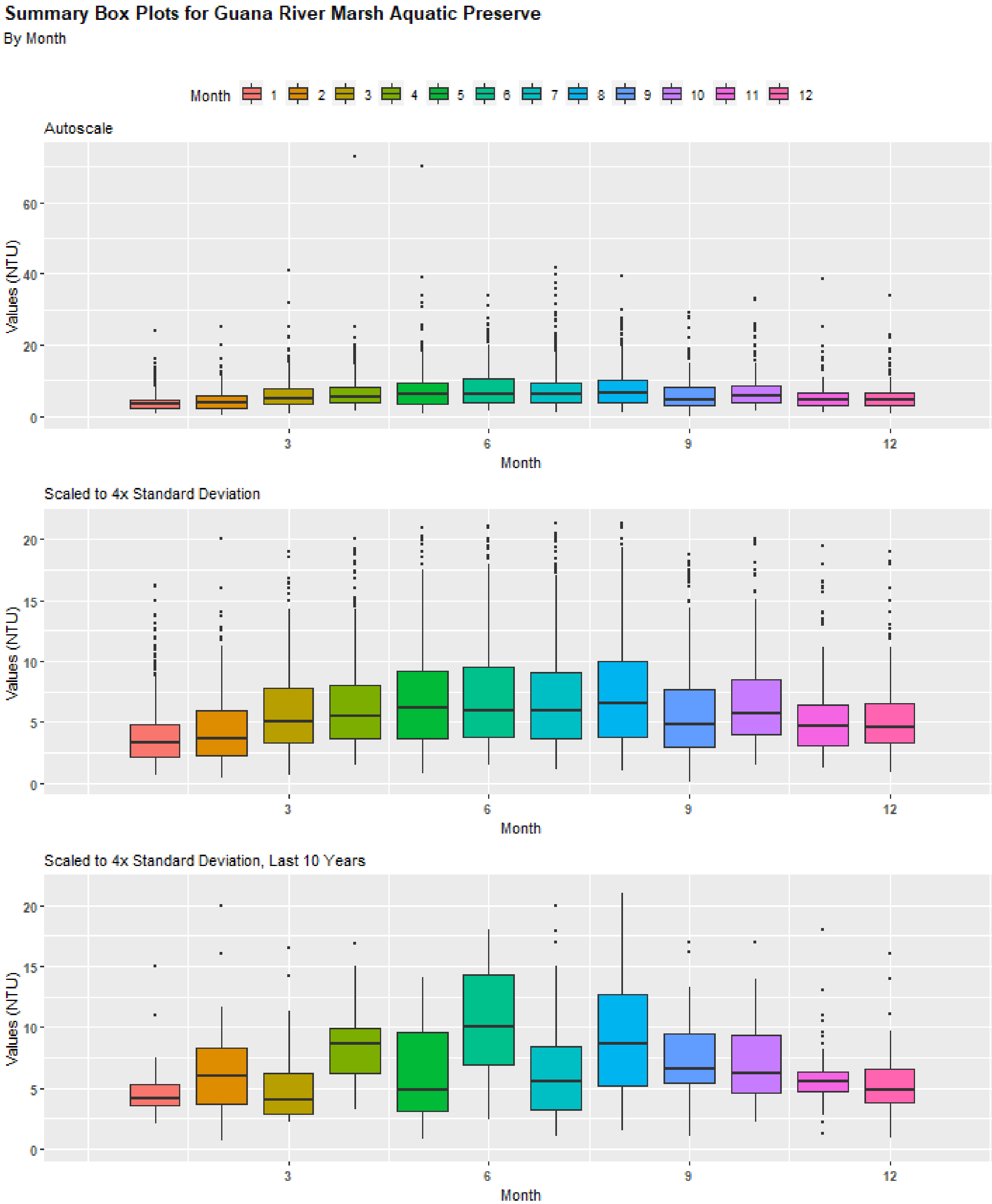
Summary Box Plots for Gasparilla Sound-Charlotte Harbor Aquatic Preserve
By Month



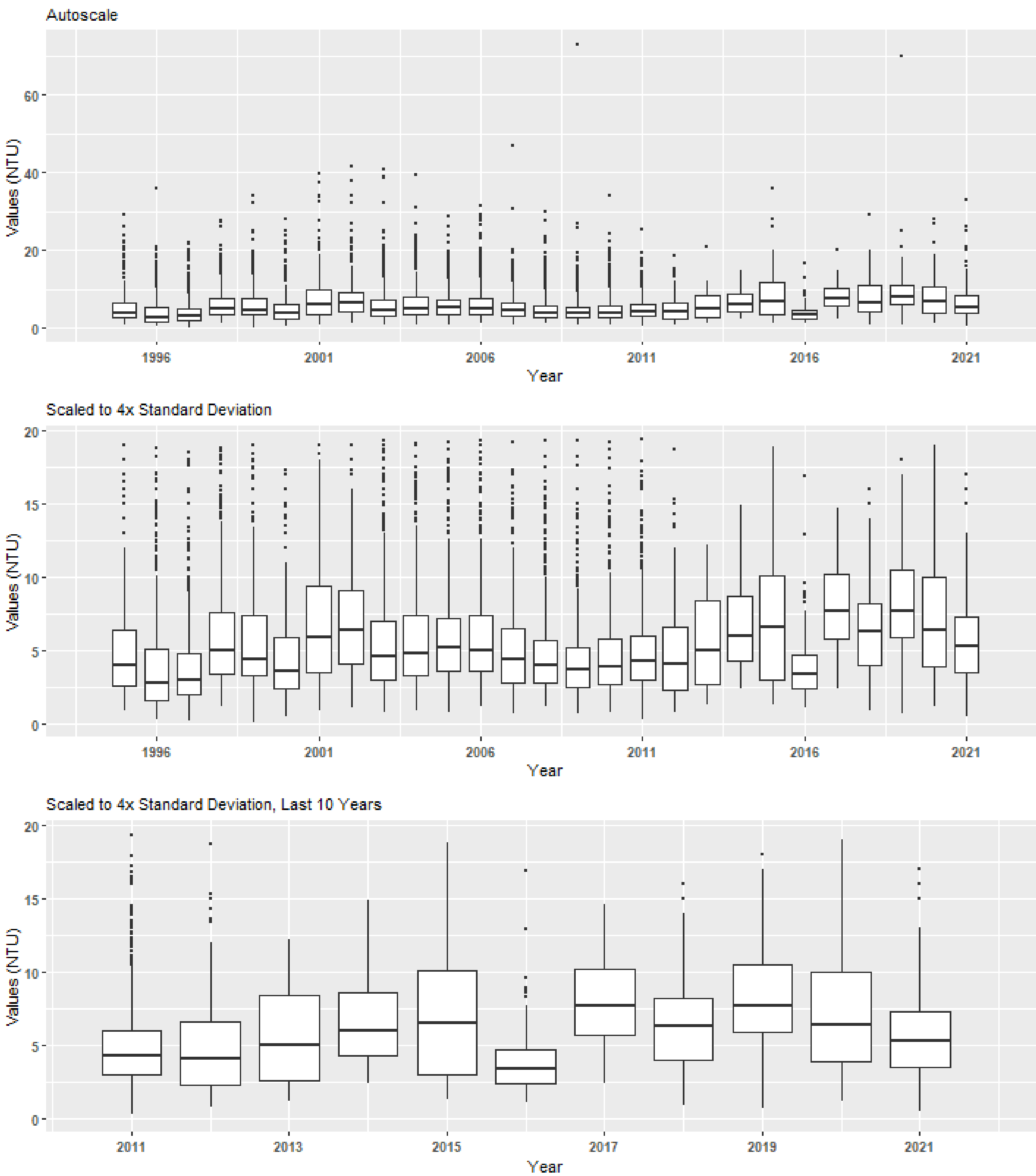
Summary Box Plots for Guana River Marsh Aquatic Preserve
By Year

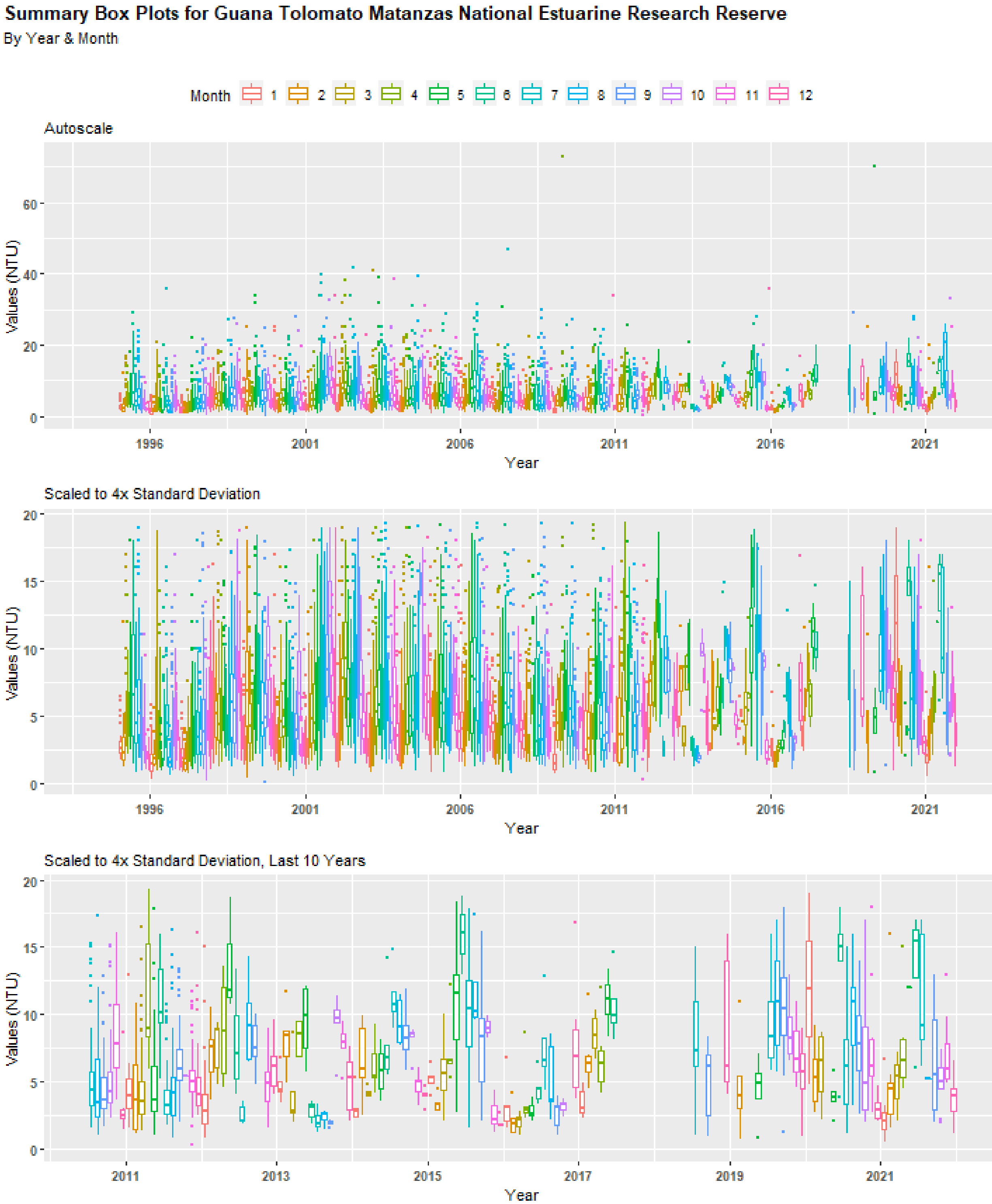



Summary Box Plots for Guana River Marsh Aquatic Preserve
By Year & Month
Month 1 2 3 4 5 6 7 8 9 10 11 12
Autoscale
Values (NTU)
0
20
40
60
1996
2001
2006
2011
2016
2021
Year
Scaled to 4x Standard Deviation
Values (NTU)
0
5
10
15
20
1996
2001
2006
2011
2016
2021
Year
Scaled to 4x Standard Deviation, Last 10 Years
Values (NTU)
0
5
10
15
20
2011
2013
2015
2017
2019
2021
Year

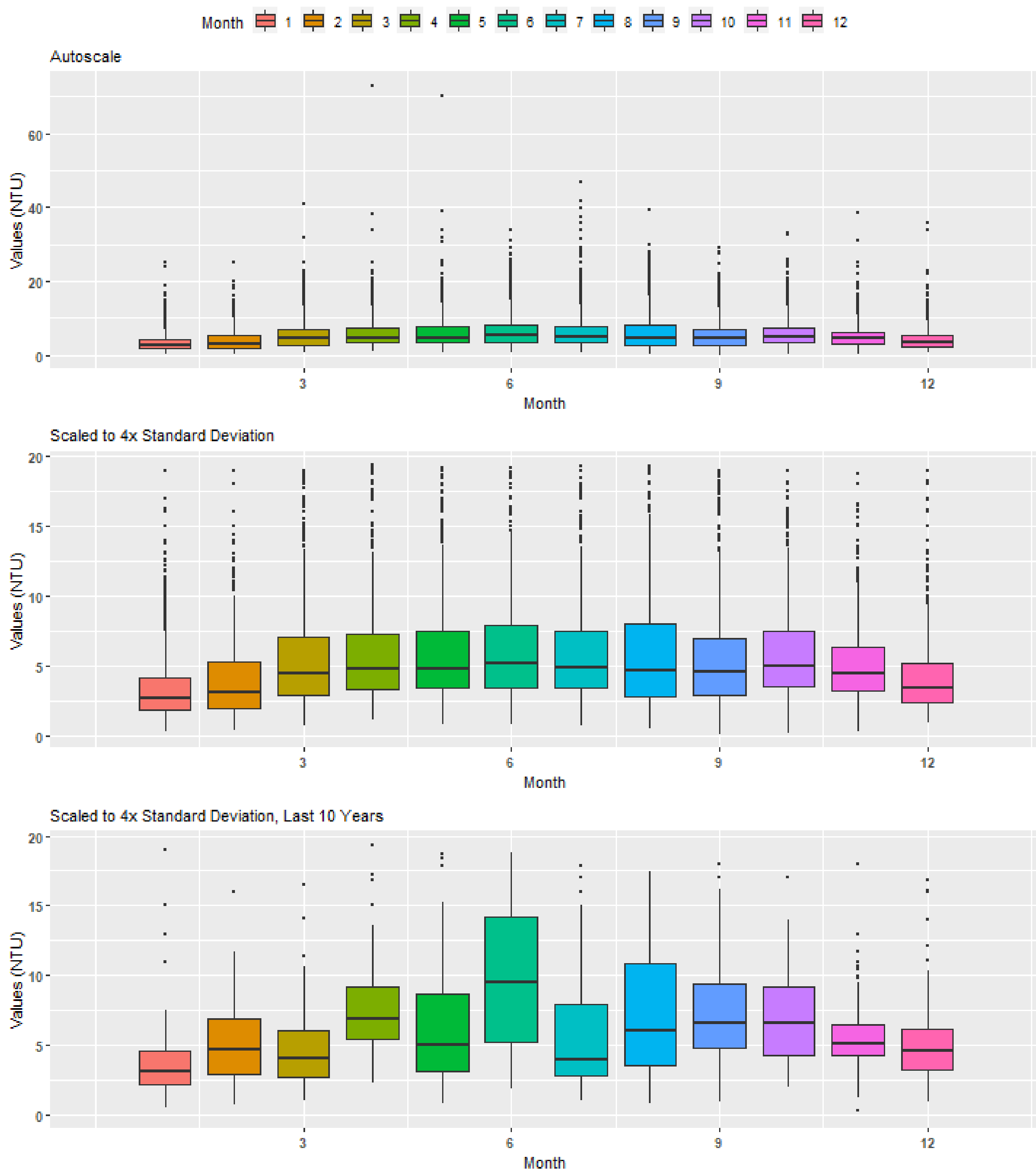

Summary Box Plots for Guana River Marsh Aquatic Preserve
By Month
Month 1 2 3 4 5 6 7 8 9 10 11 12
Autoscale
Values (NTU)
0
20
40
60
3
6
9
12
Month
Scaled to 4x Standard Deviation
Values (NTU)
0
5
10
15
20
3
6
9
12
Month
Scaled to 4x Standard Deviation, Last 10 Years
Values (NTU)
0
5
10
15
20
3
6
9
12
Month

Summary Box Plots for Guana Tolomato Matanzas National Estuarine Research Reserve
By Year



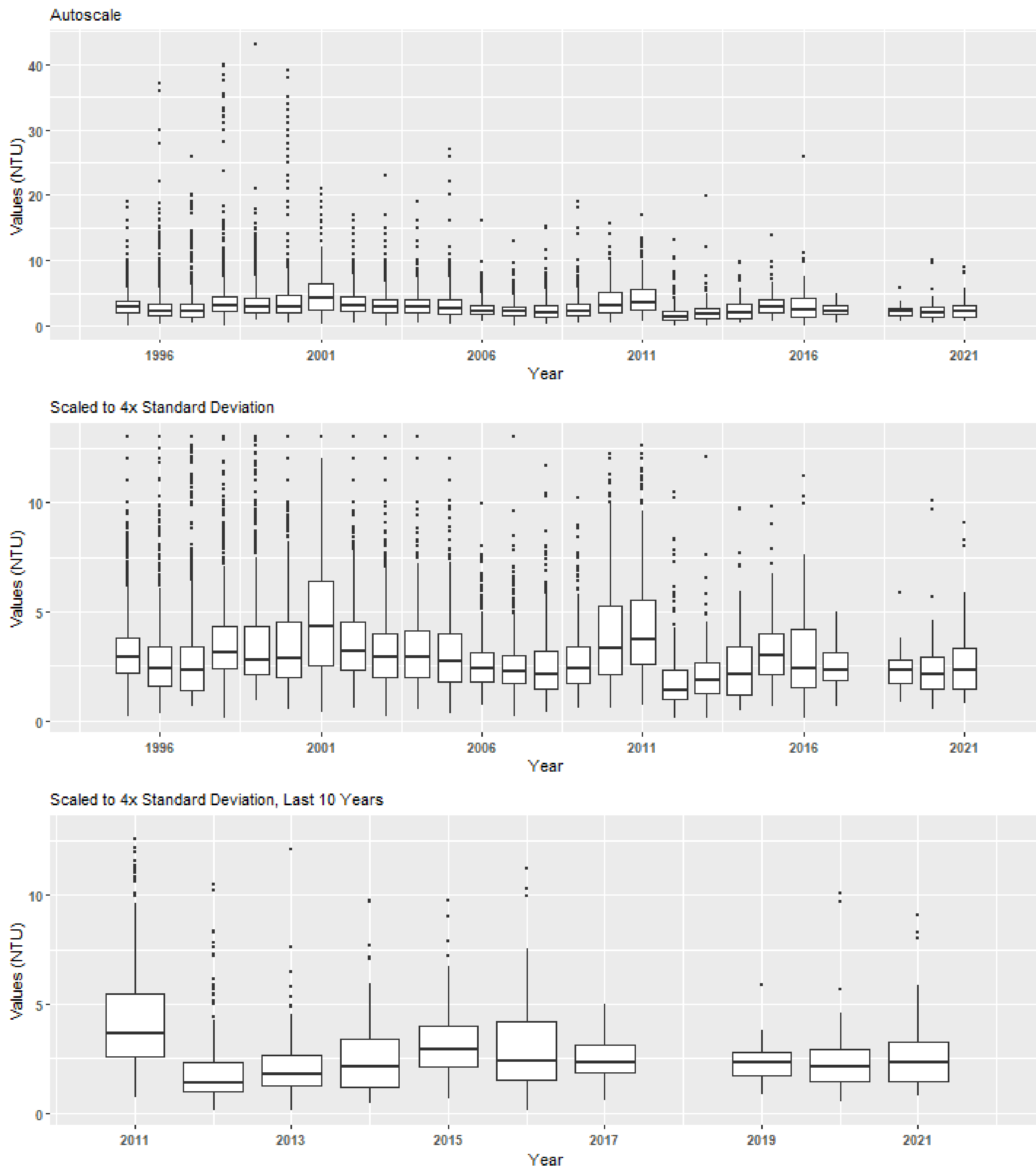

Summary Box Plots for Guana Tolomato Matanzas National Estuarine Research Reserve
By Year & Month
Month 1 2 3 4 5 6 7 8 9 10 11 12
Autoscale
Values (NTU)
0
20
40
60
1996
2001
2006
2011
2016
2021
Year
Scaled to 4x Standard Deviation
Values (NTU)
0
5
10
15
20
1996
2001
2006
2011
2016
2021
Year
Scaled to 4x Standard Deviation, Last 10 Years
Values (NTU)
0
5
10
15
20
2011
2013
2015
2017
2019
2021
Year

Summary Box Plots for Guana Tolomato Matanzas National Estuarine Research Reserve
By Month



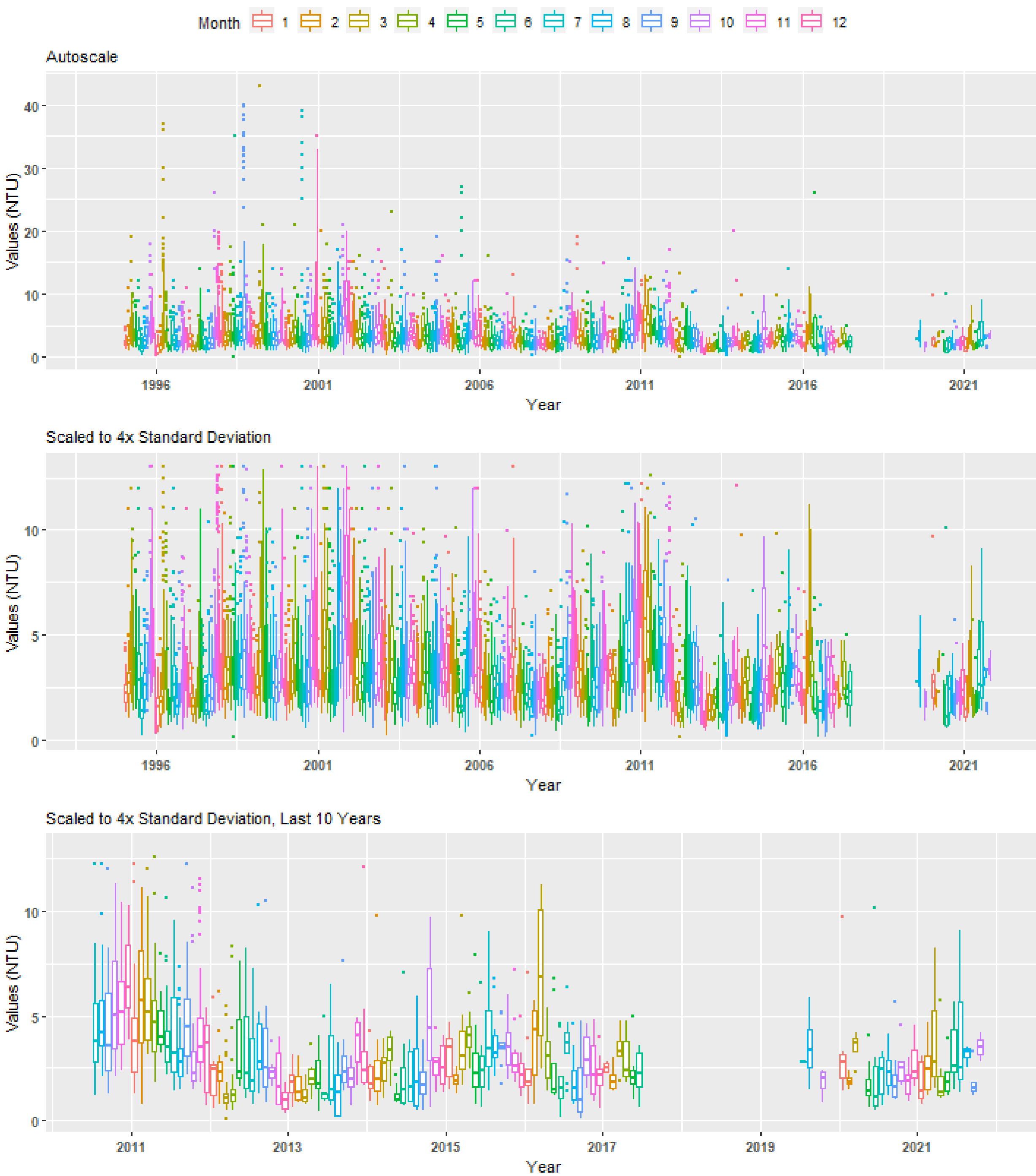
Summary Box Plots for Indian River-Malabar to Vero Beach Aquatic Preserve

By Year

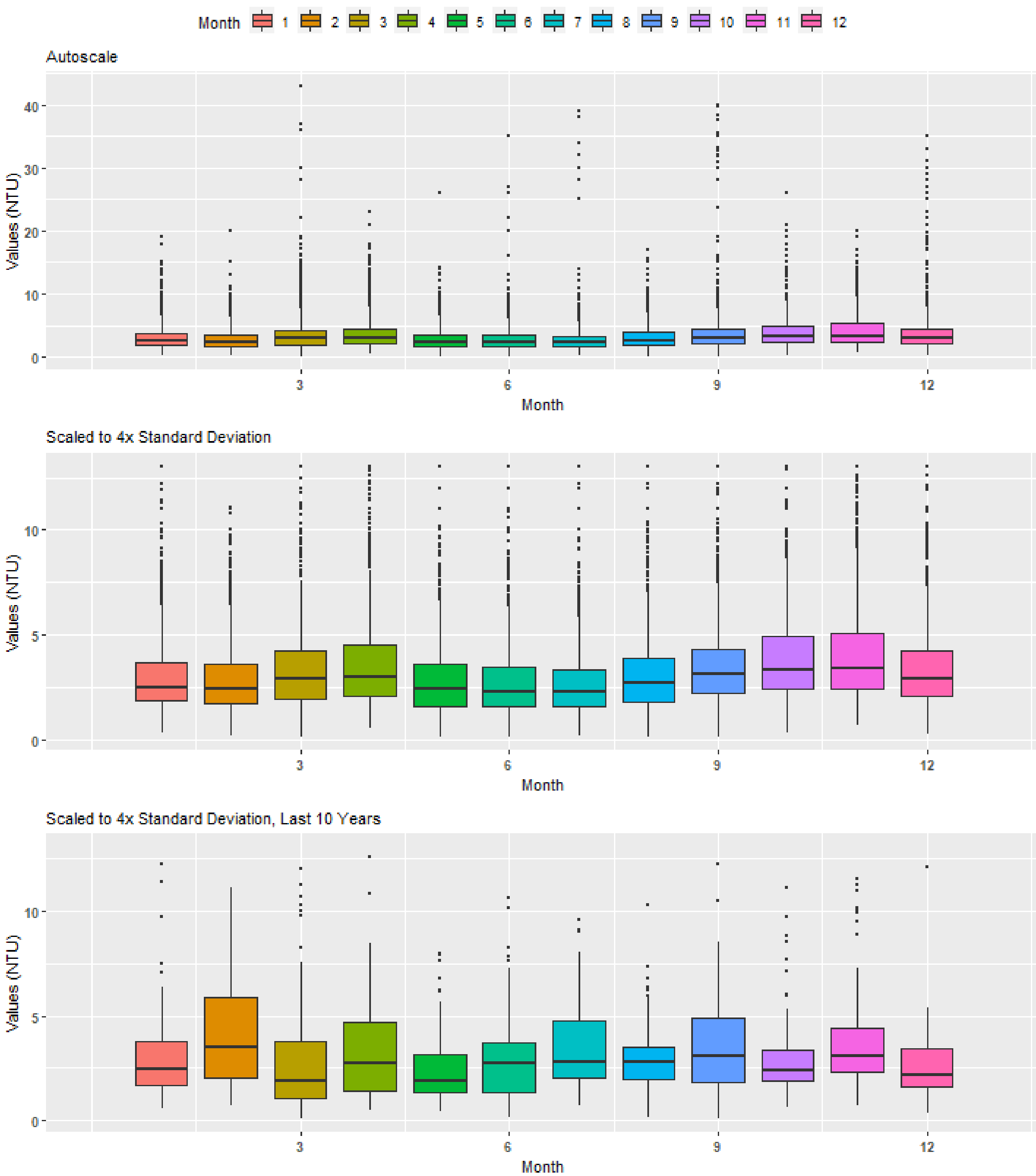


Summary Box Plots for Indian River-Malabar to Vero Beach Aquatic Preserve

By Year & Month

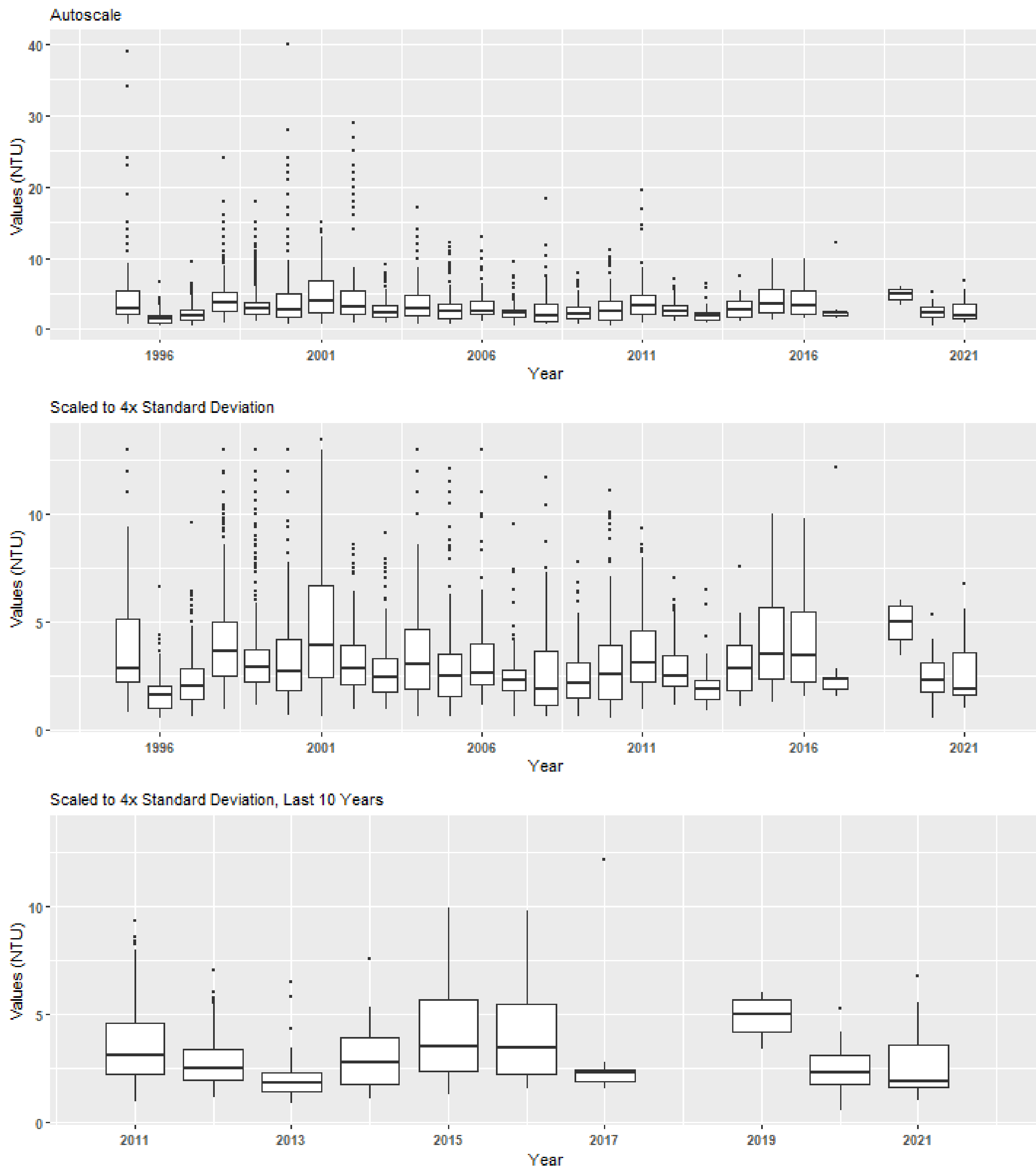


Summary Box Plots for Indian River-Malabar to Vero Beach Aquatic Preserve
By Month



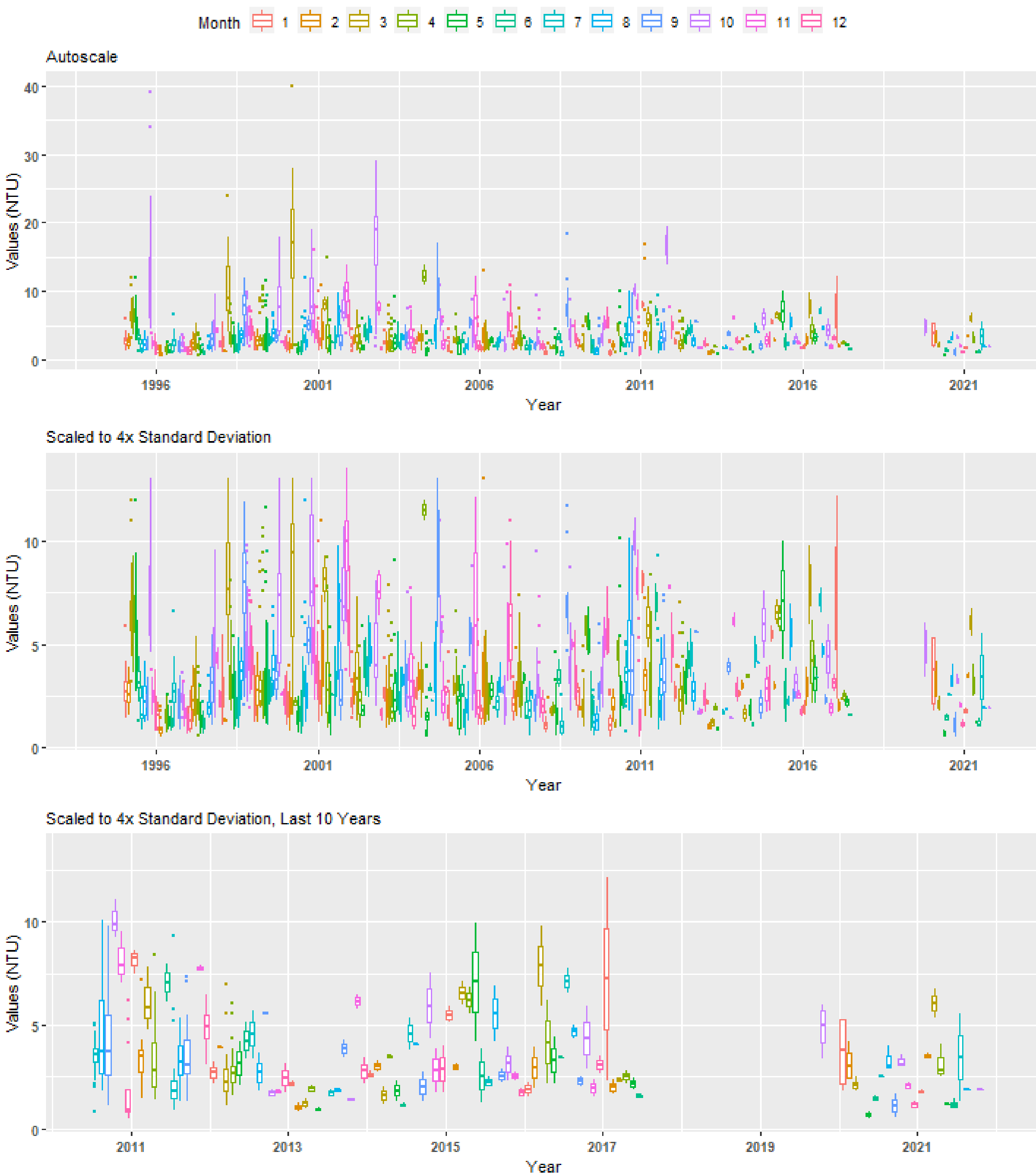
Summary Box Plots for Indian River-Vero Beach to Ft. Pierce Aquatic Preserve

By Year

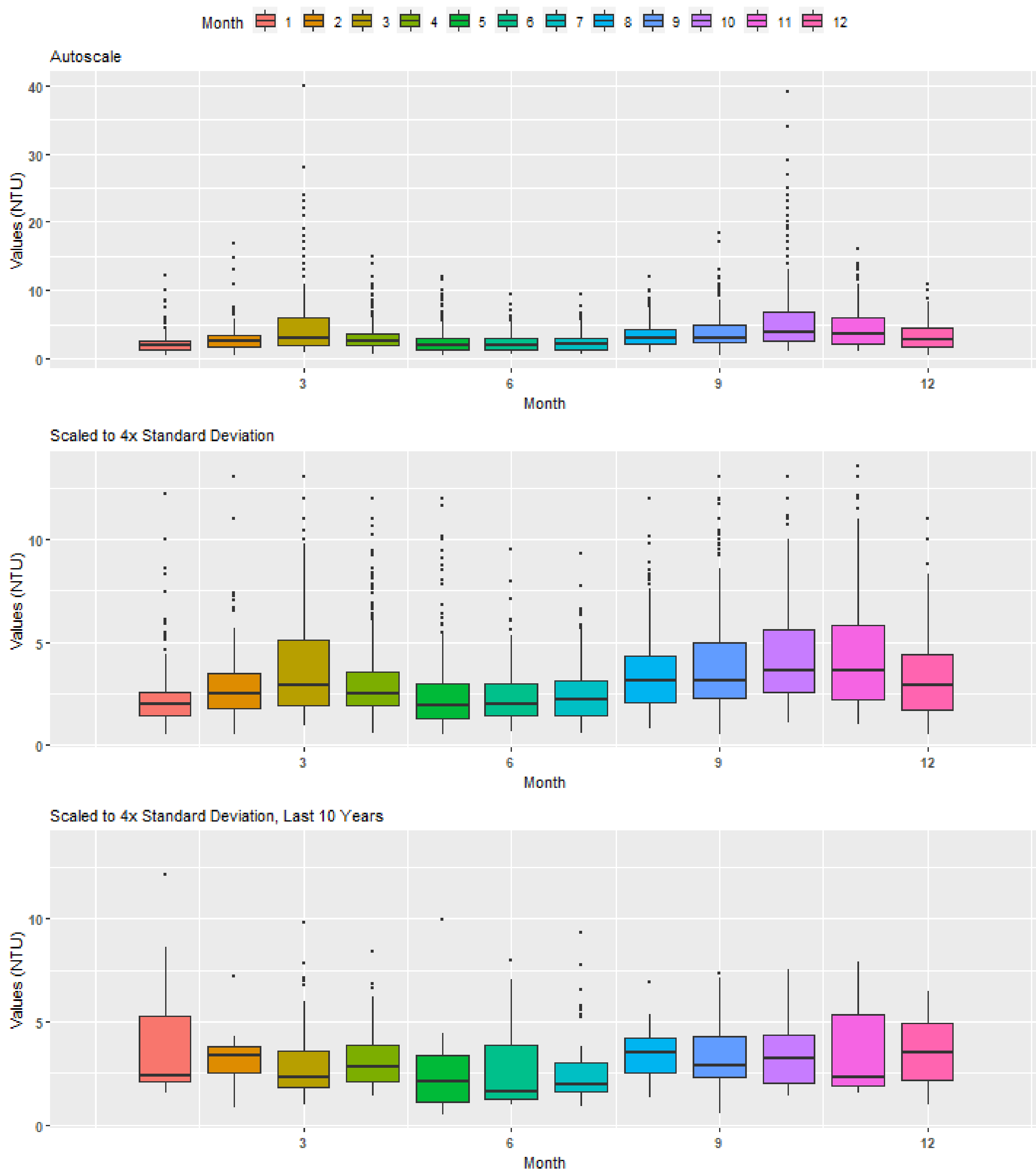


Summary Box Plots for Indian River-Vero Beach to Ft. Pierce Aquatic Preserve

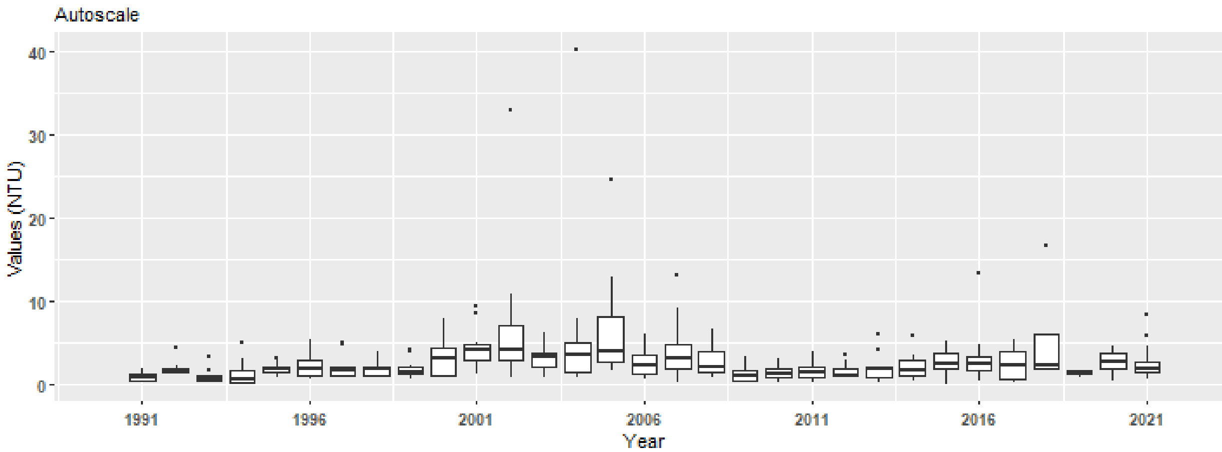
By Year & Month

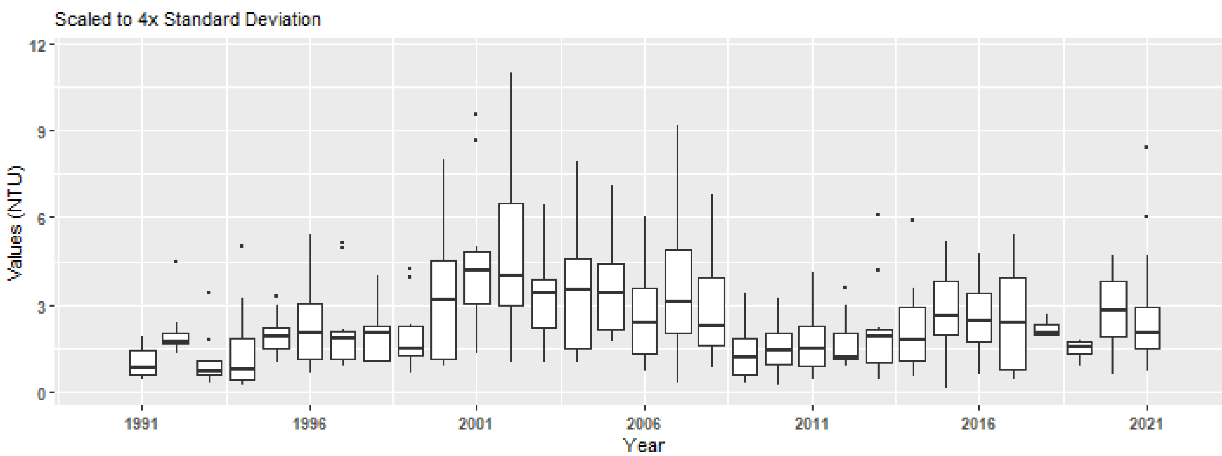


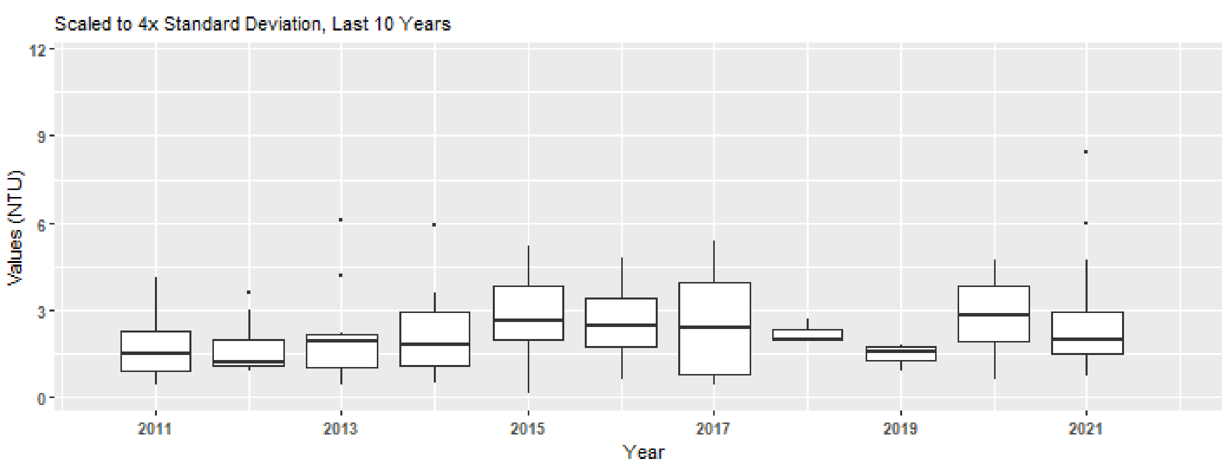
Summary Box Plots for Indian River-Vero Beach to Ft. Pierce Aquatic Preserve
By Month



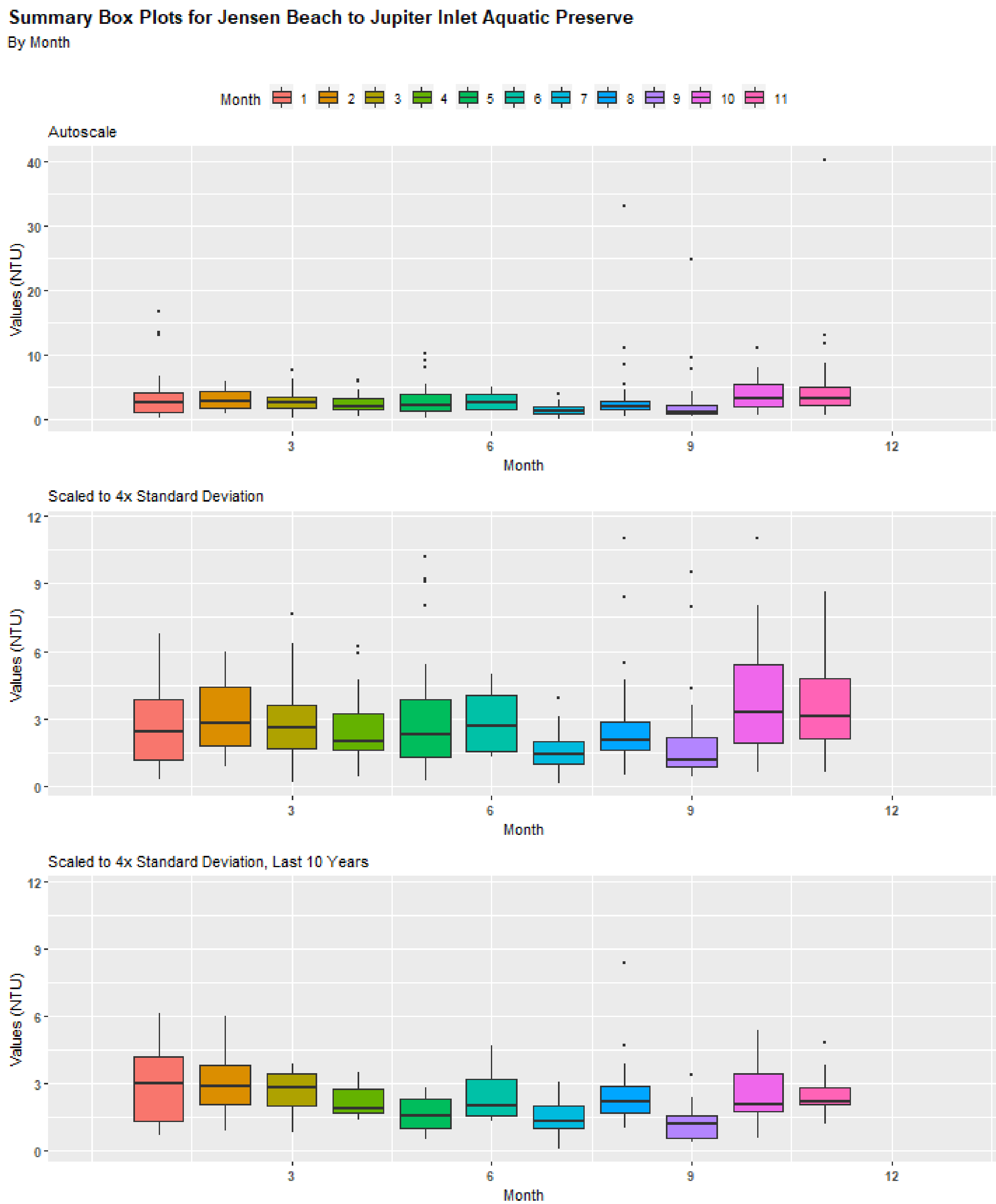
Summary Box Plots for Jensen Beach to Jupiter Inlet Aquatic Preserve
By Year



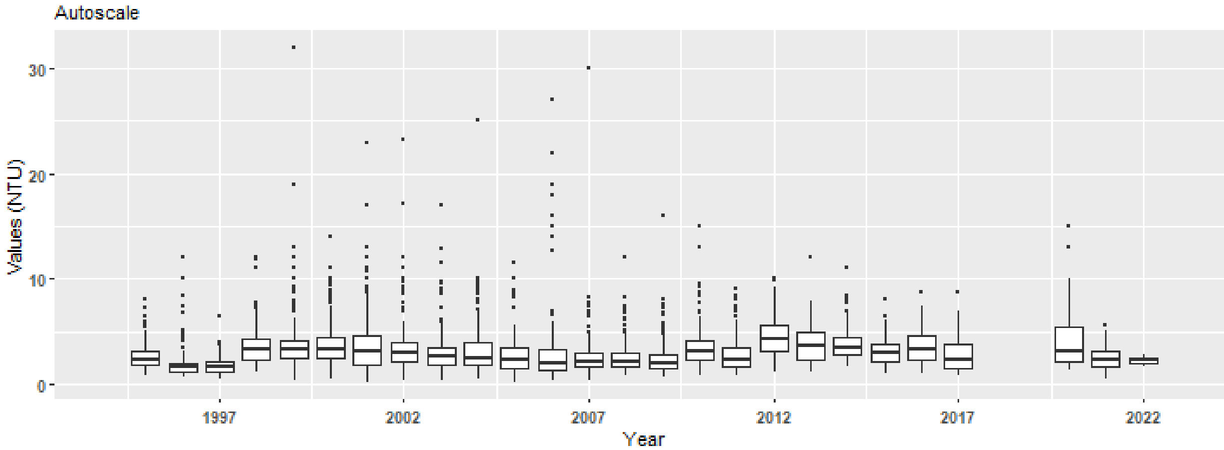


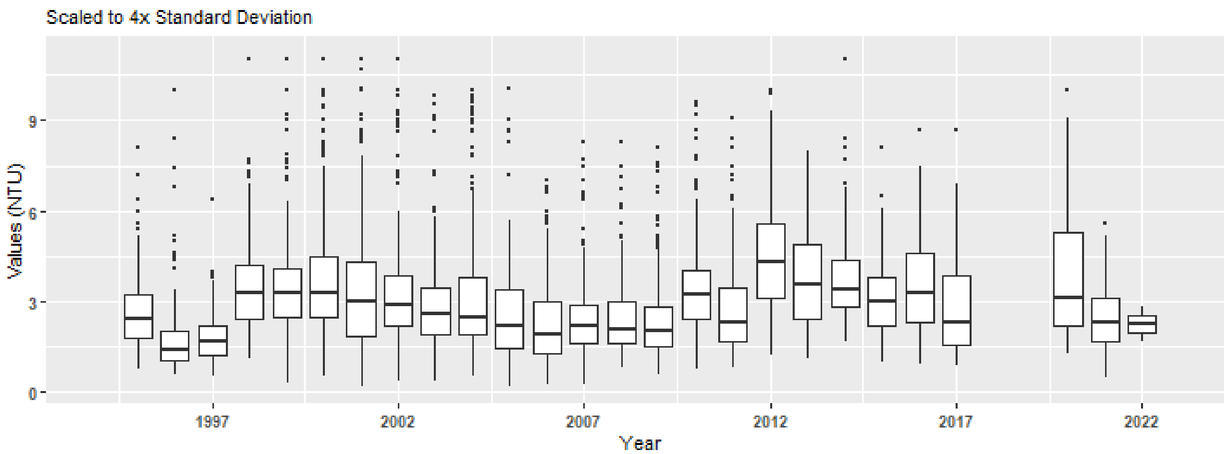


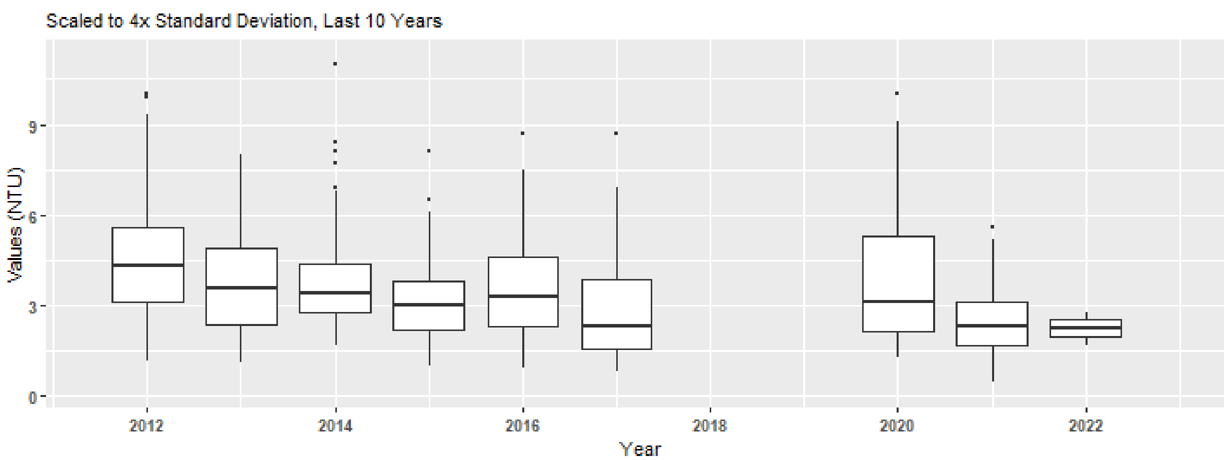
Summary Box Plots for Jensen Beach to Jupiter Inlet Aquatic Preserve
By Year & Month


Summary Box Plots for Jensen Beach to Jupiter Inlet Aquatic Preserve
By Month
Month 1 2 3 4 5 6 7 8 9 10 11
Autoscale
Values (NTU)
Month
Scaled to 4x Standard Deviation
Values (NTU)
Month
Scaled to 4x Standard Deviation, Last 10 Years
Values (NTU)
Month

Summary Box Plots for Lemon Bay Aquatic Preserve
By Year

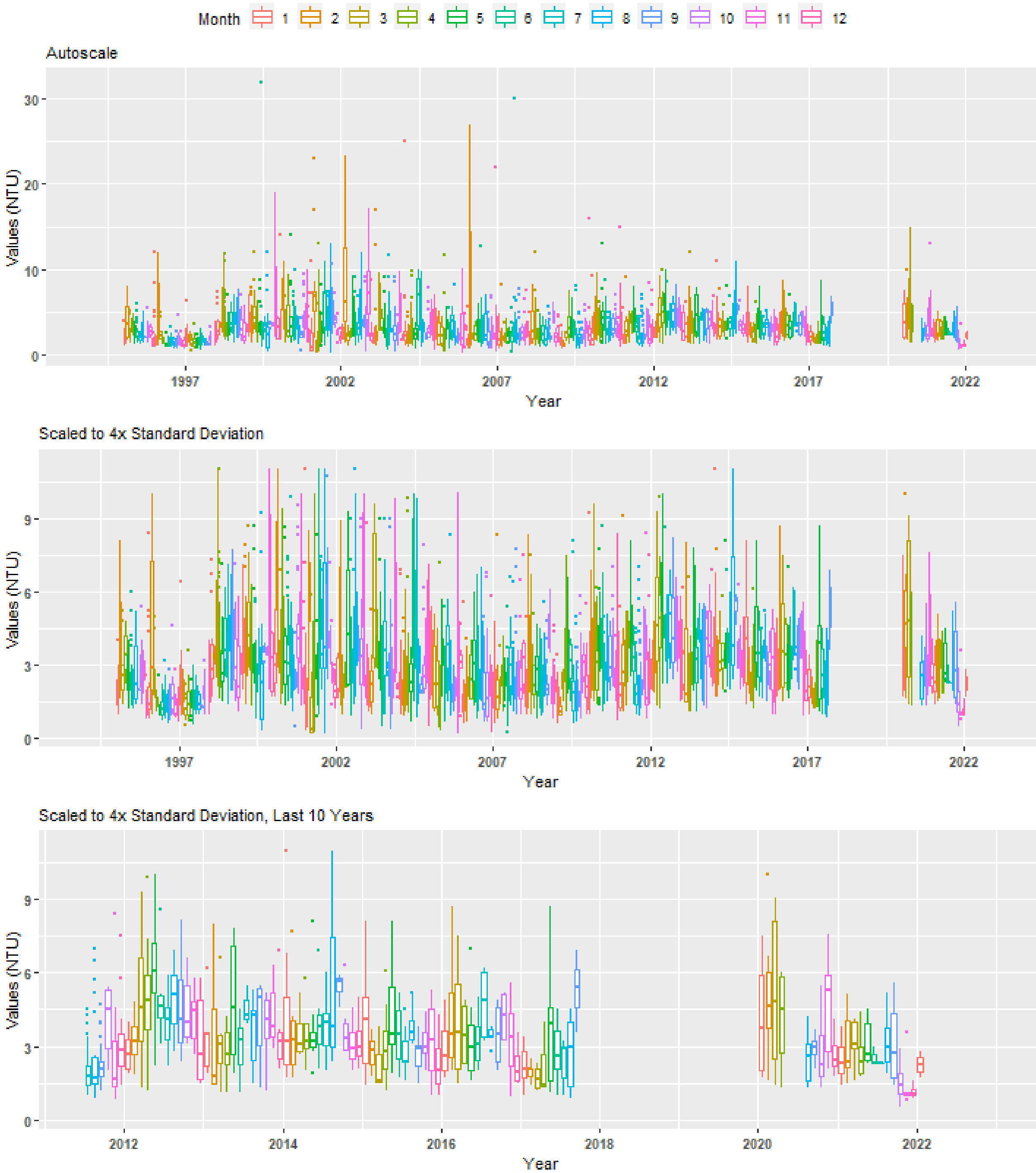




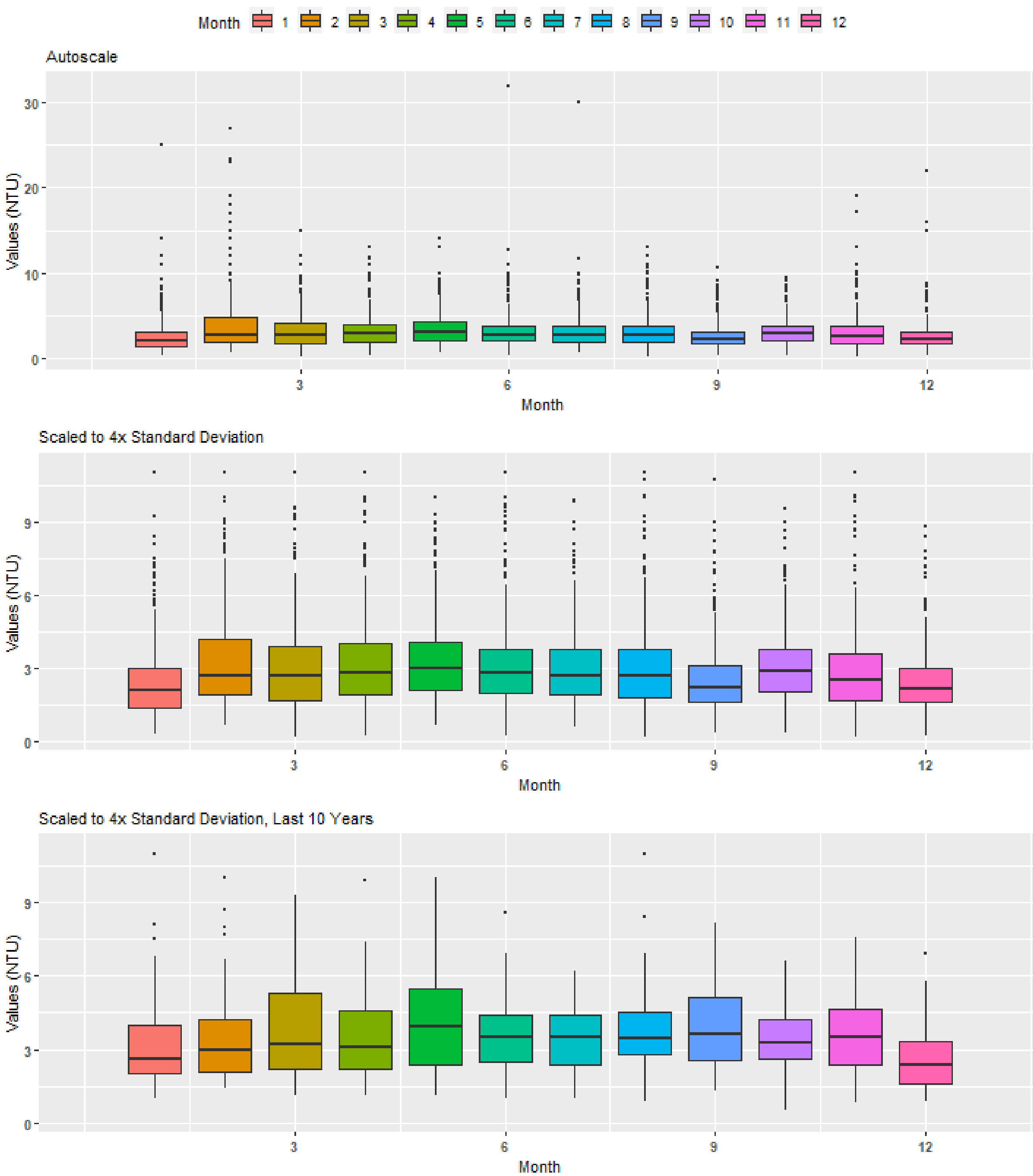


Summary Box Plots for Lemon Bay Aquatic Preserve

By Year & Month

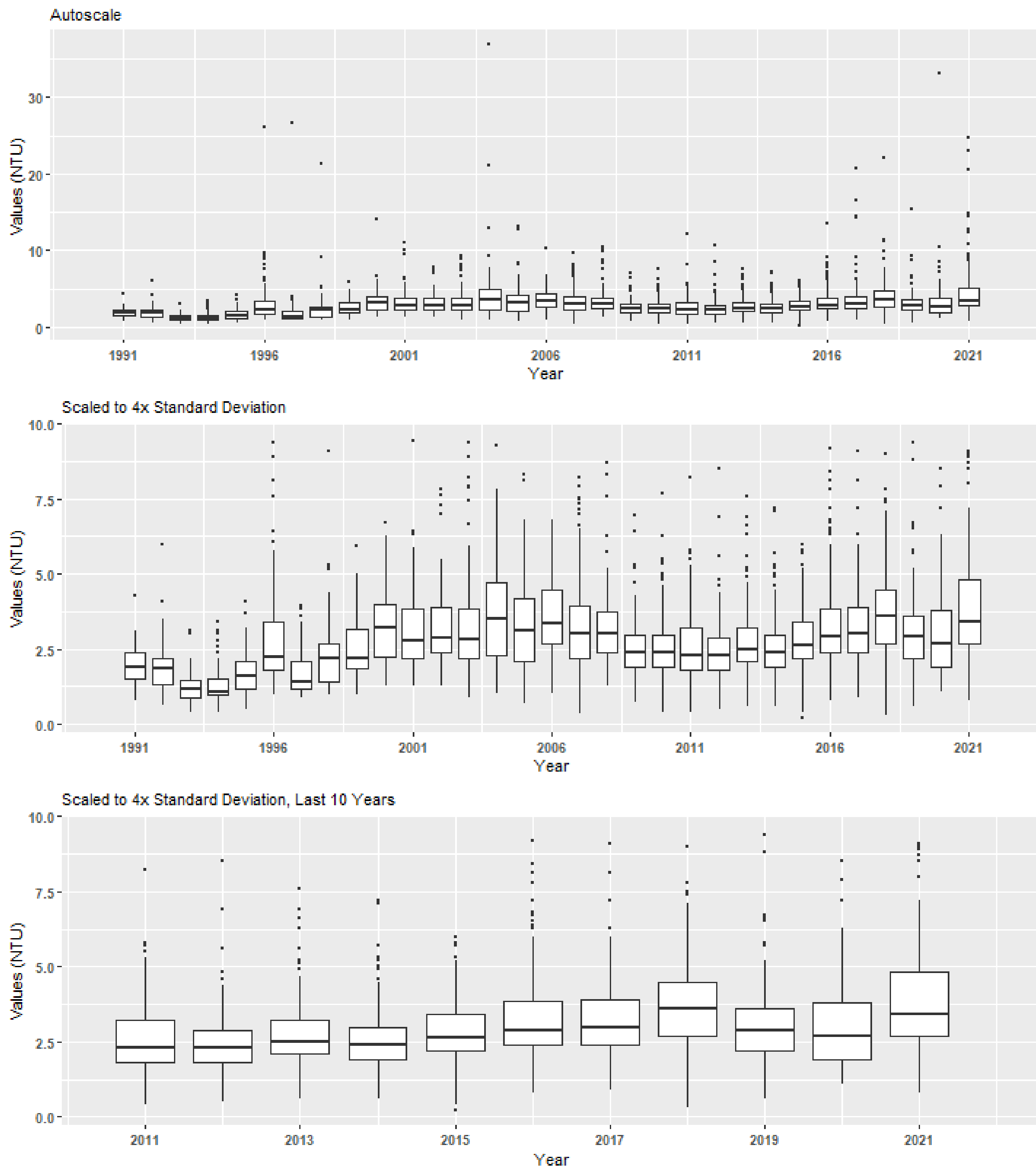


Summary Box Plots for Lemon Bay Aquatic Preserve
By Month

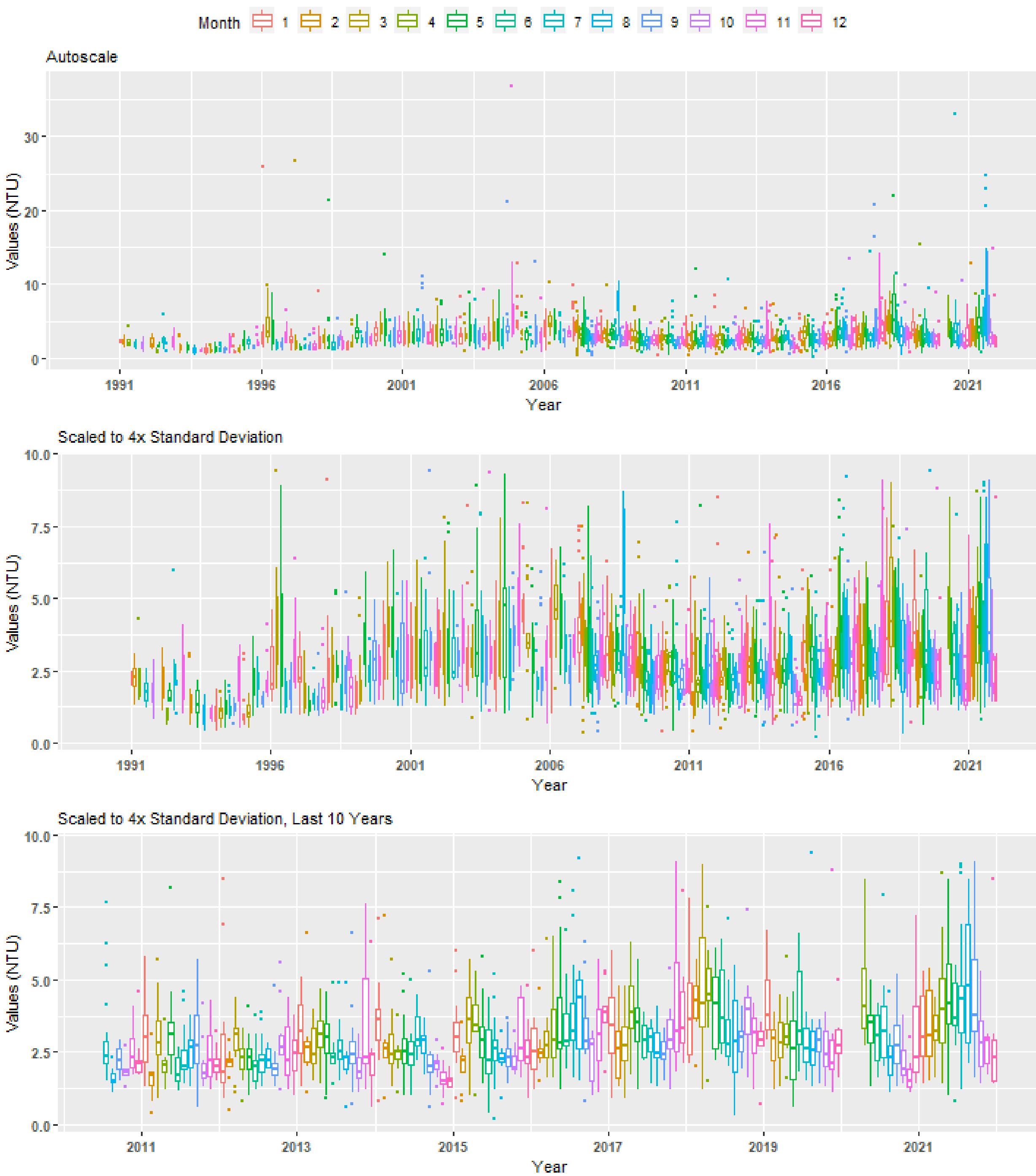


Summary Box Plots for Loxahatchee River-Lake Worth Creek Aquatic Preserve

By Year

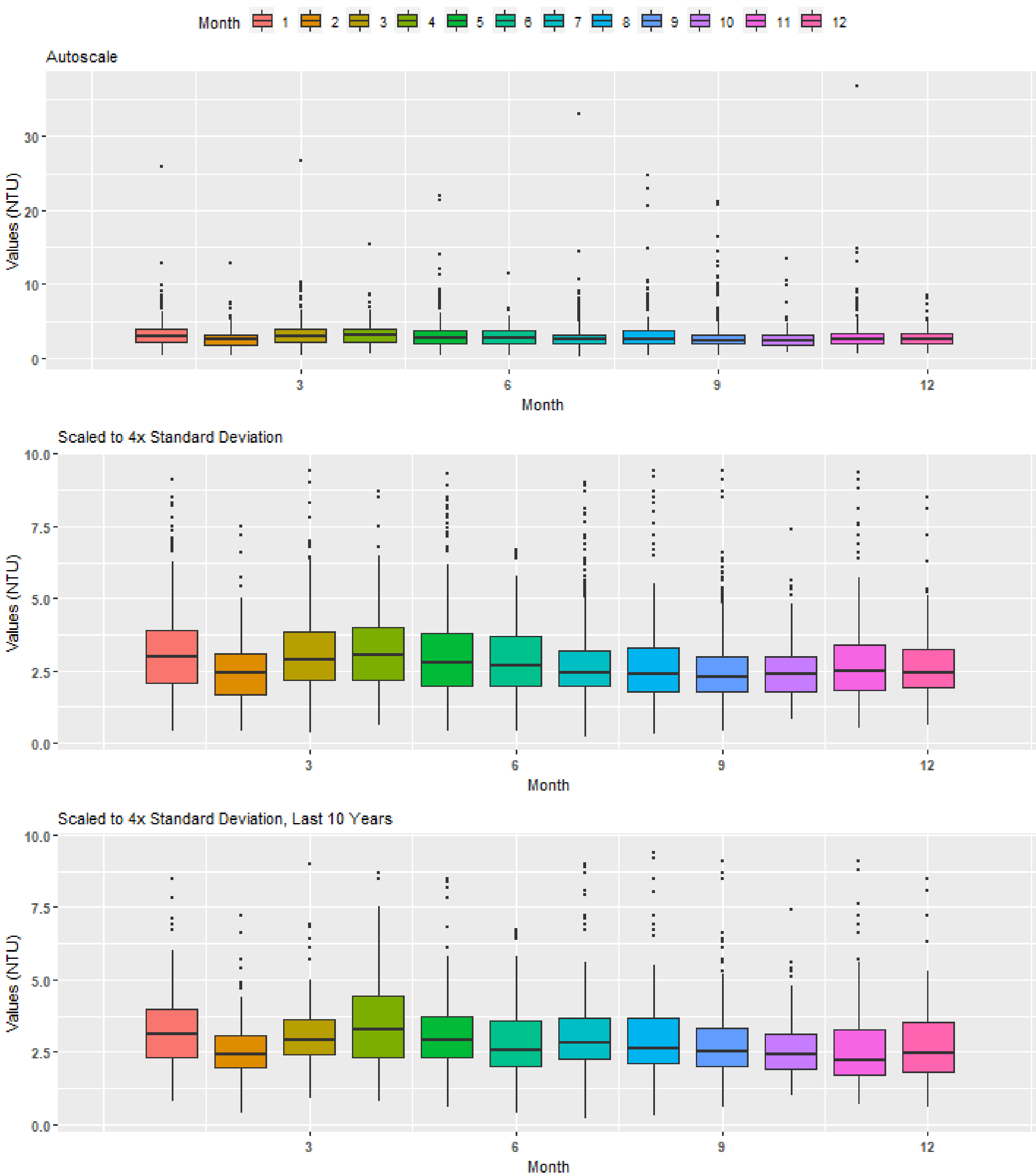


Summary Box Plots for Loxahatchee River-Lake Worth Creek Aquatic Preserve
By Year & Month

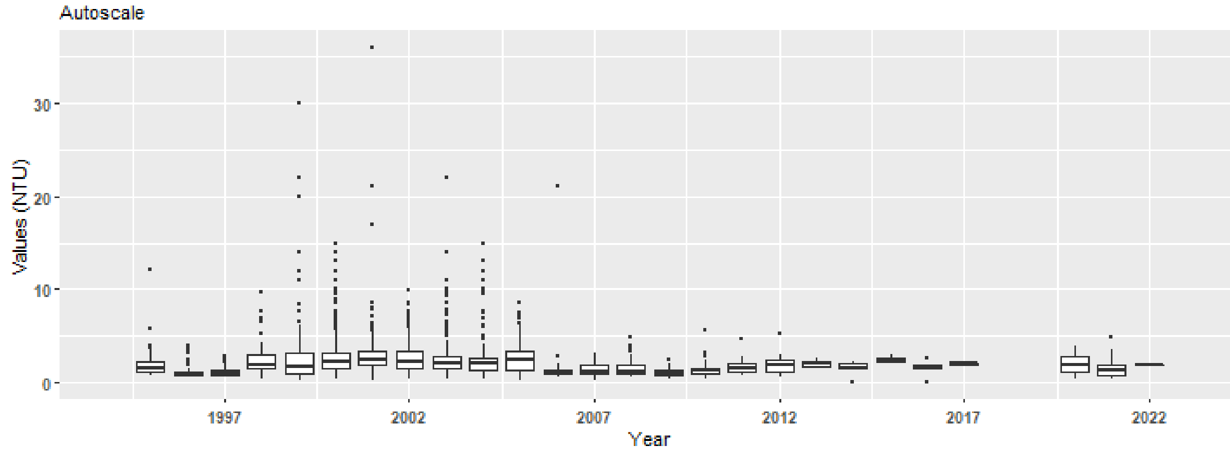


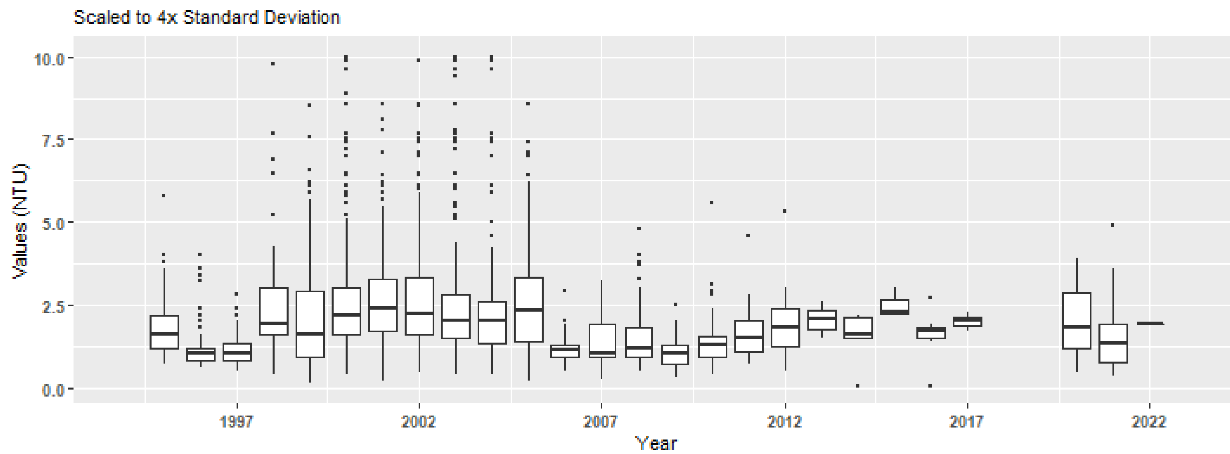
Summary Box Plots for Loxahatchee River-Lake Worth Creek Aquatic Preserve

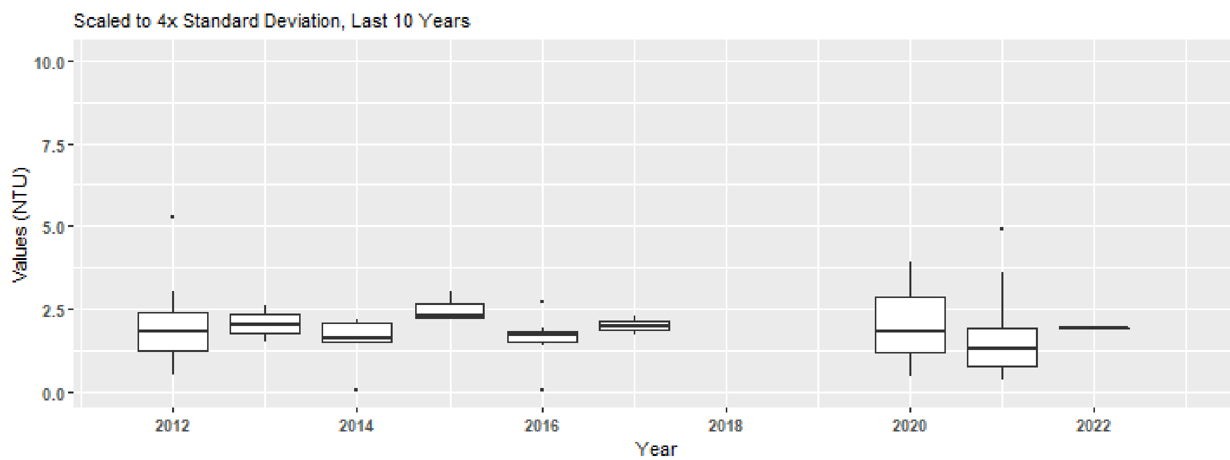
By Month



Summary Box Plots for Matlacha Pass Aquatic Preserve
By Year



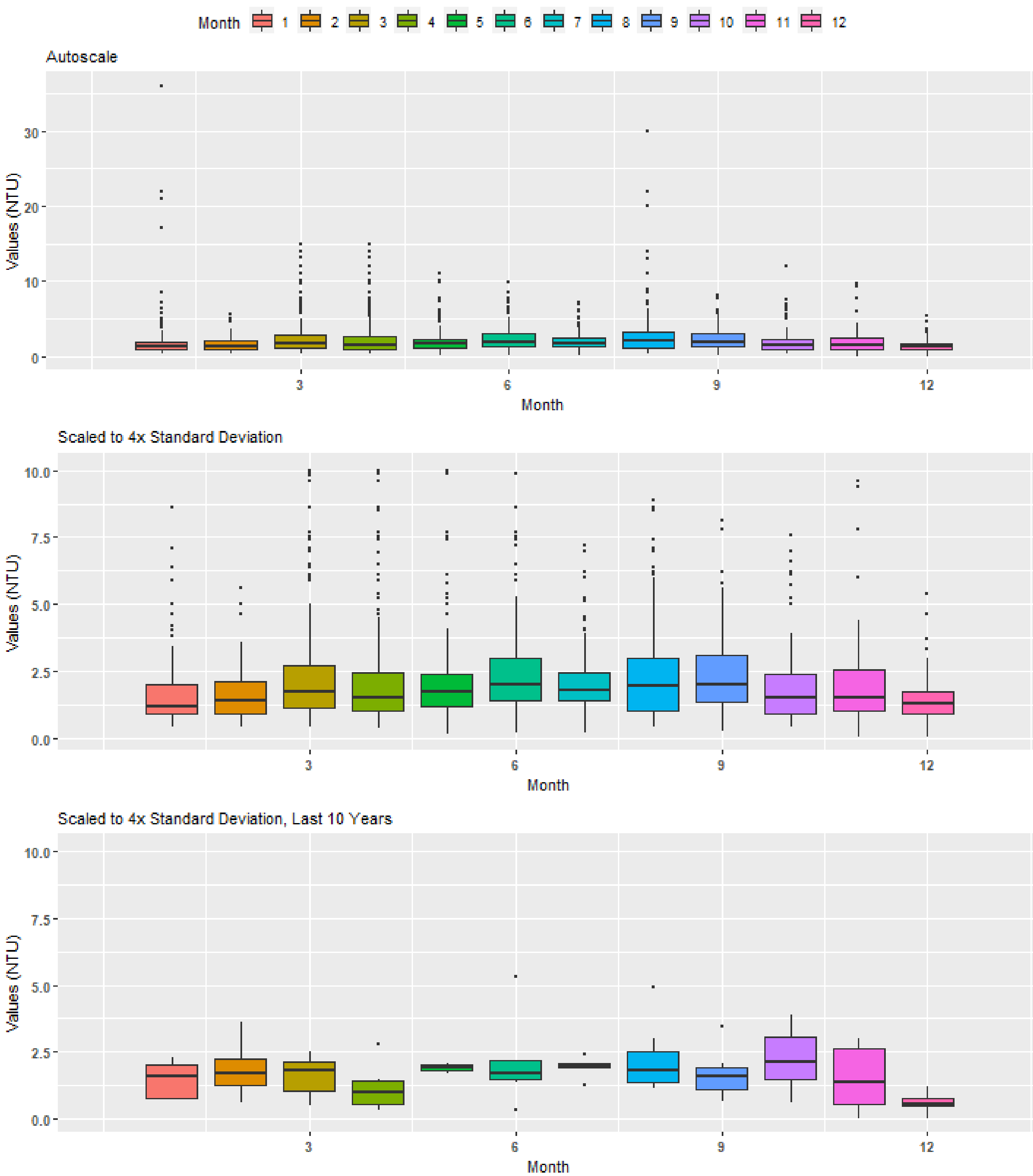




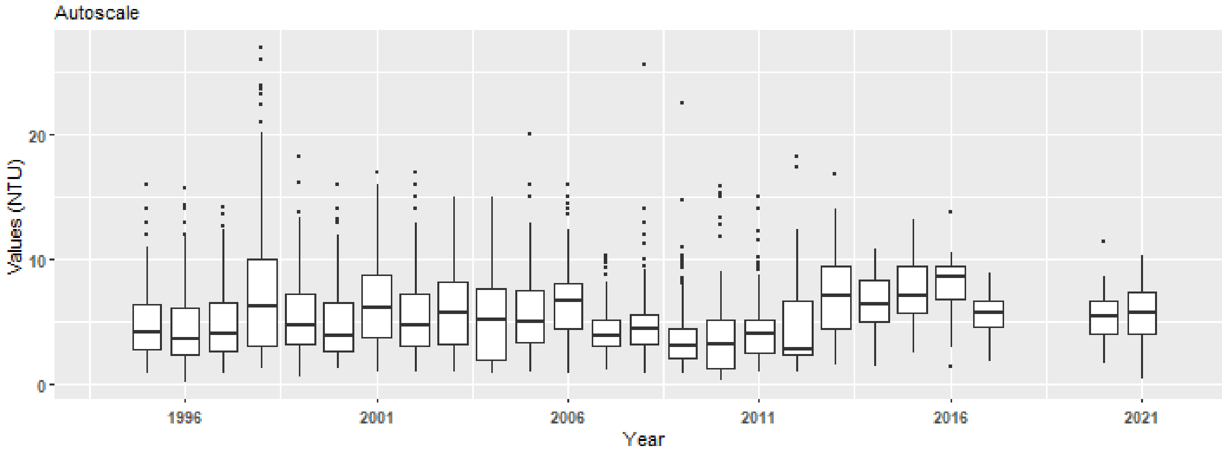
Summary Box Plots for Matlacha Pass Aquatic Preserve

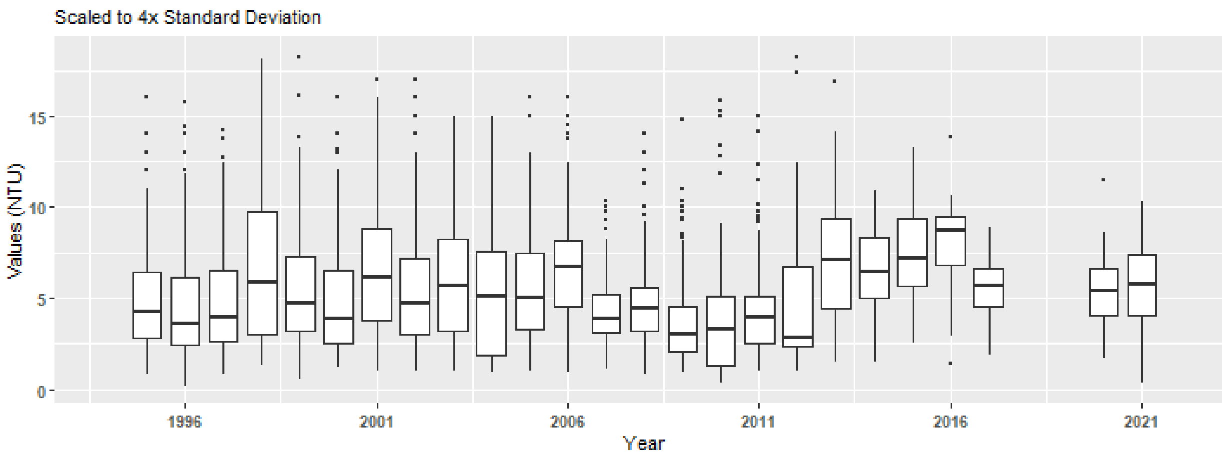
By Year & Month

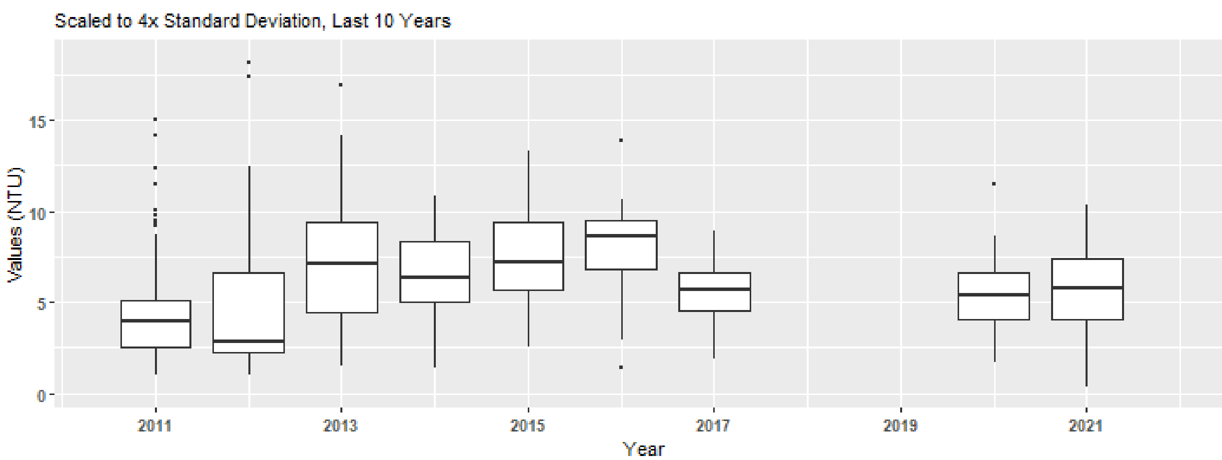
Summary Box Plots for Matlacha Pass Aquatic Preserve
By Month



Summary Box Plots for Mosquito Lagoon Aquatic Preserve
By Year

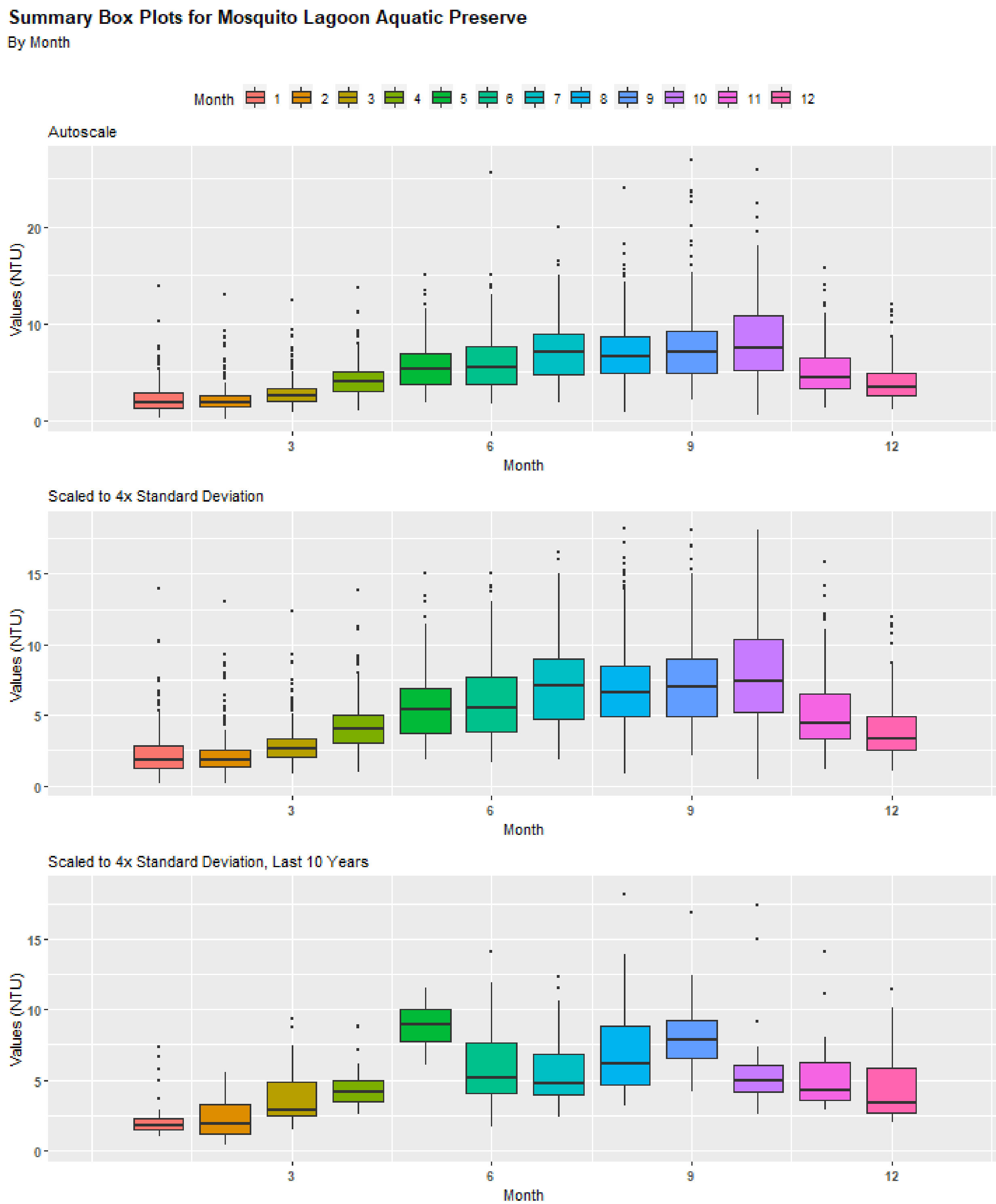






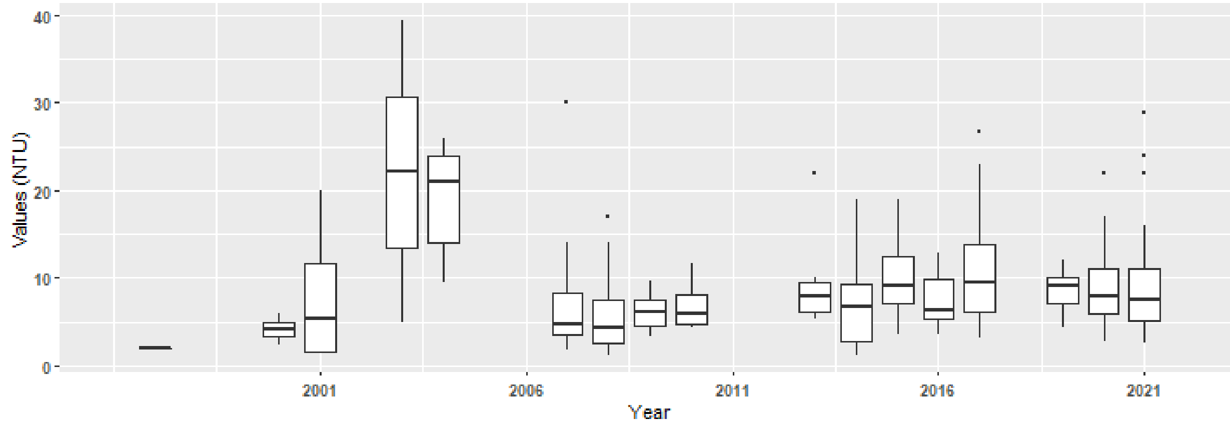
Summary Box Plots for Mosquito Lagoon Aquatic Preserve

By Year & Month

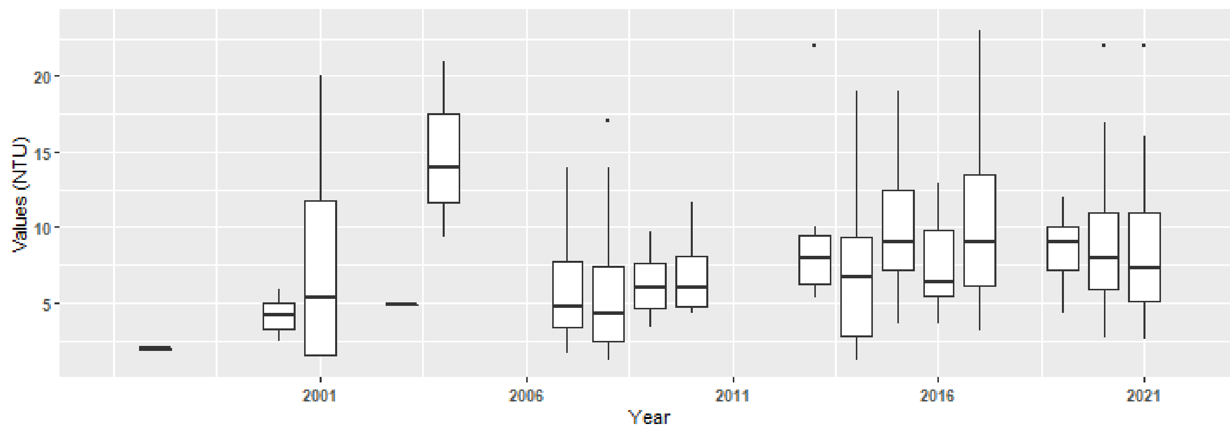

Summary Box Plots for Mosquito Lagoon Aquatic Preserve
By Month
Month 1 2 3 4 5 6 7 8 9 10 11 12
Autoscale
Values (NTU)
Month
Scaled to 4x Standard Deviation
Values (NTU)
Month
Scaled to 4x Standard Deviation, Last 10 Years
Values (NTU)
Month

Summary Box Plots for Nassau River-St. Johns River Marshes Aquatic Preserve
By Year

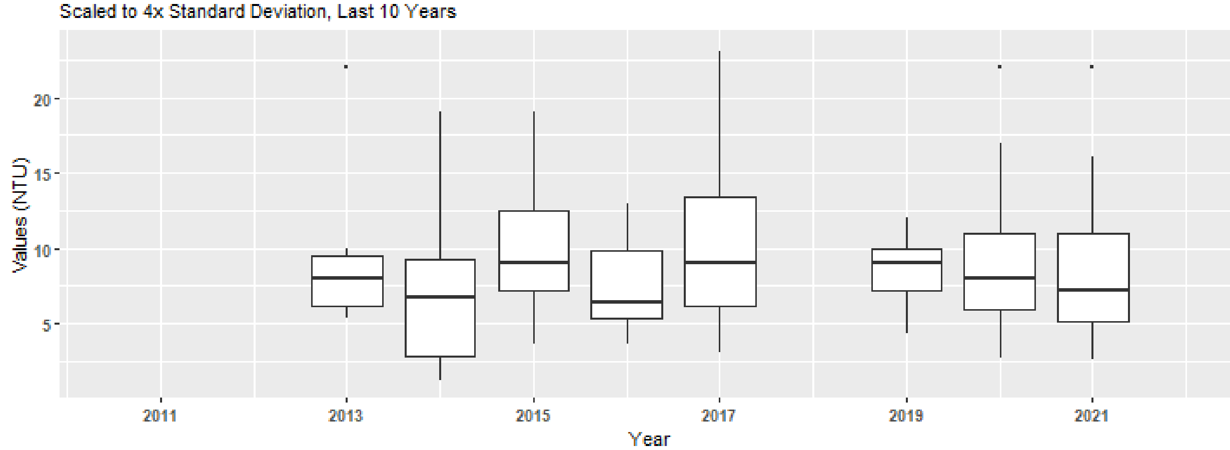
Autoscale



Scaled to 4x Standard Deviation

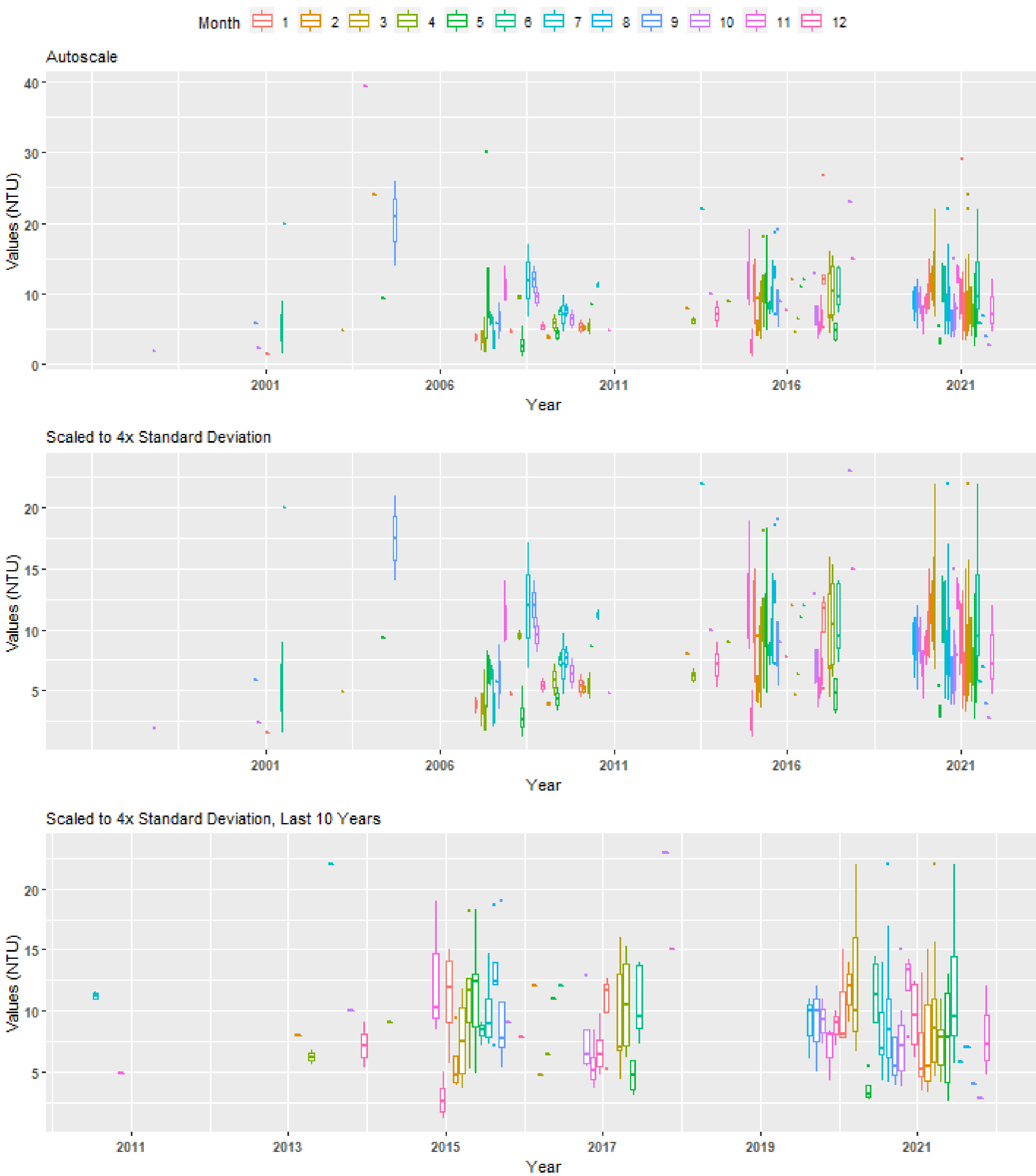


Scaled to 4x Standard Deviation, Last 10 Years



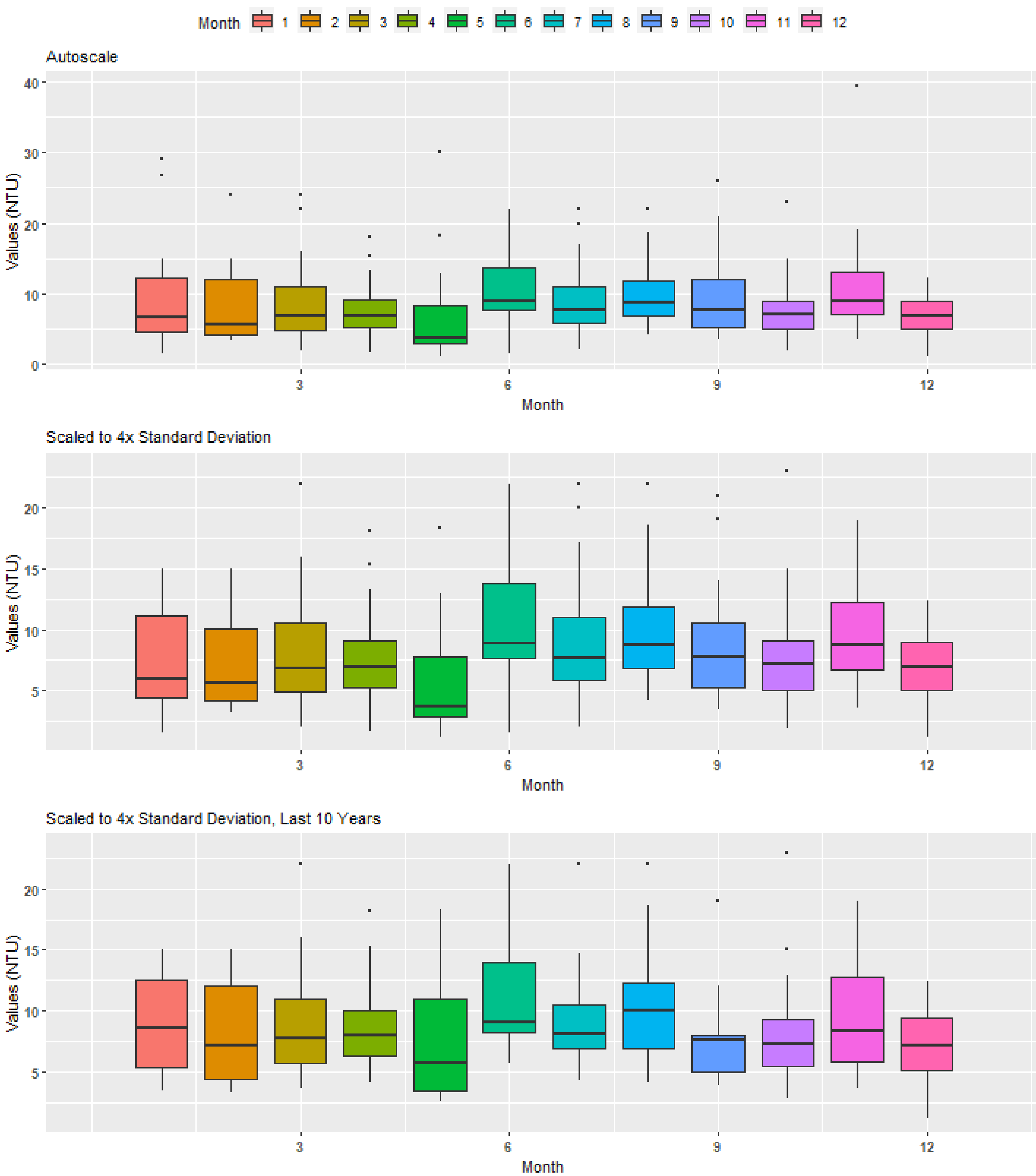
Summary Box Plots for Nassau River-St. Johns River Marshes Aquatic Preserve

By Year & Month



Summary Box Plots for Nassau River-St. Johns River Marshes Aquatic Preserve

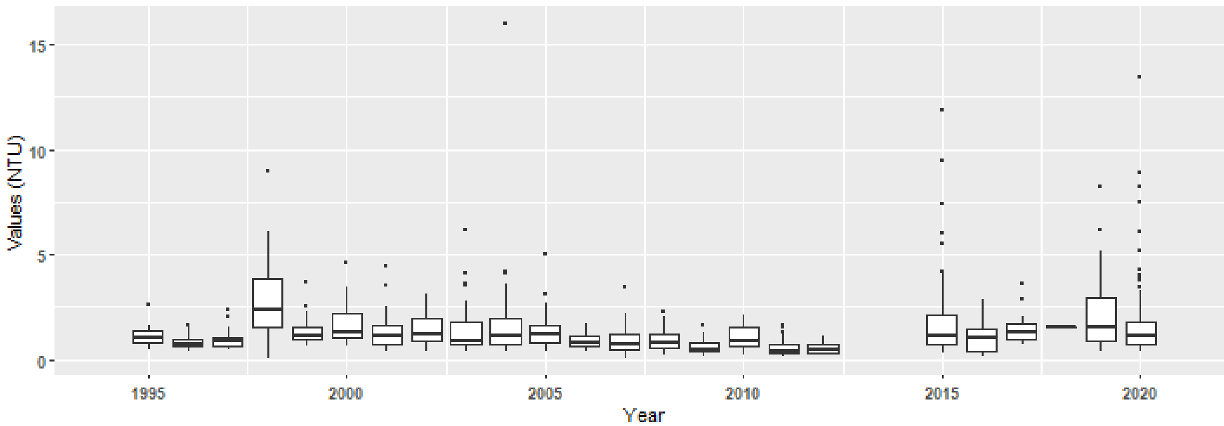
By Month



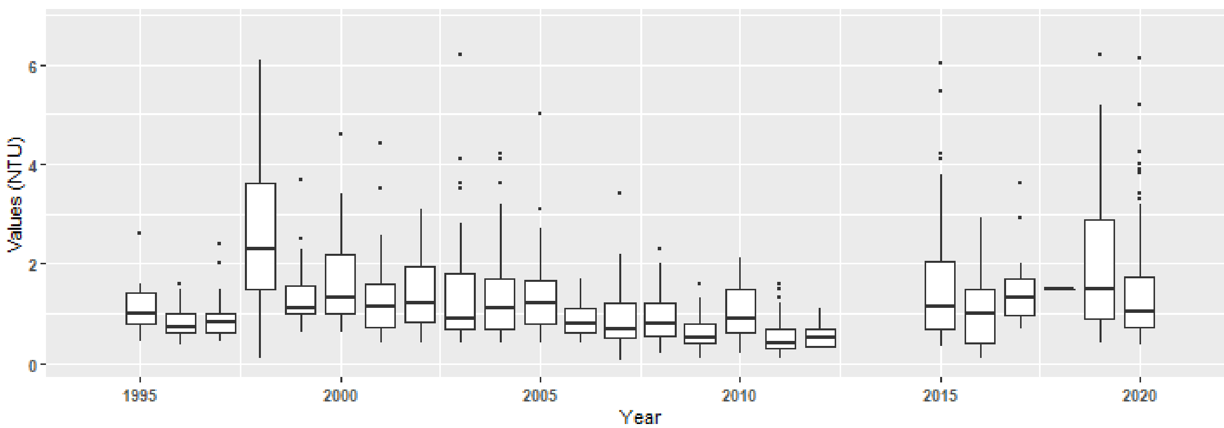
Summary Box Plots for Nature Coast Aquatic Preserve

By Year

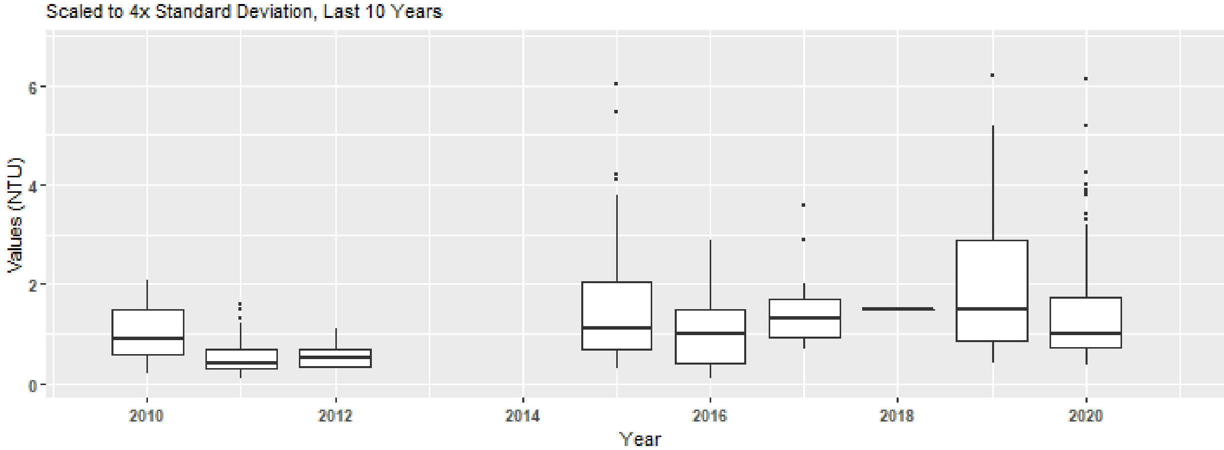
Autoscale



Scaled to 4x Standard Deviation

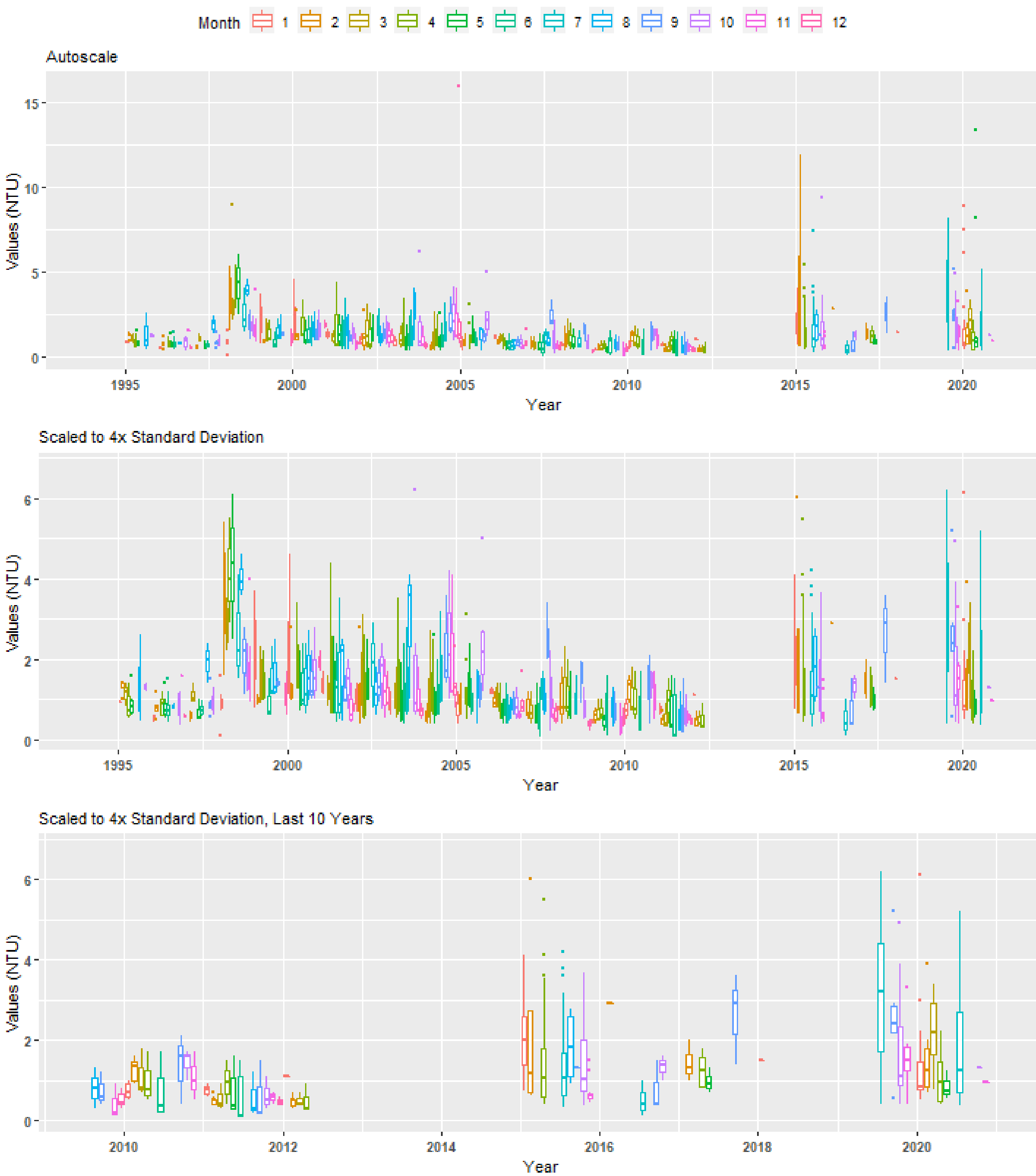


Scaled to 4x Standard Deviation, Last 10 Years

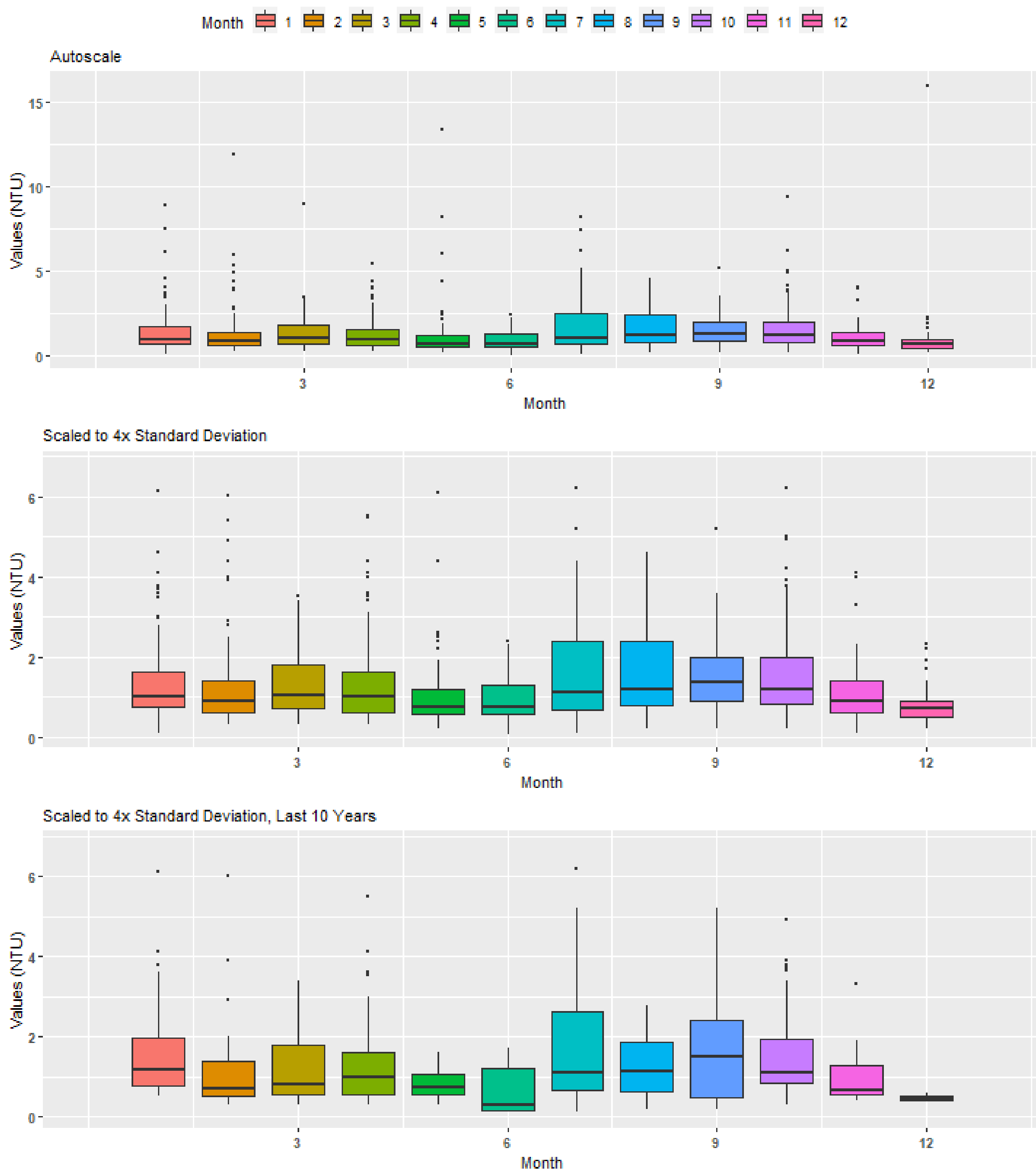


Summary Box Plots for Nature Coast Aquatic Preserve

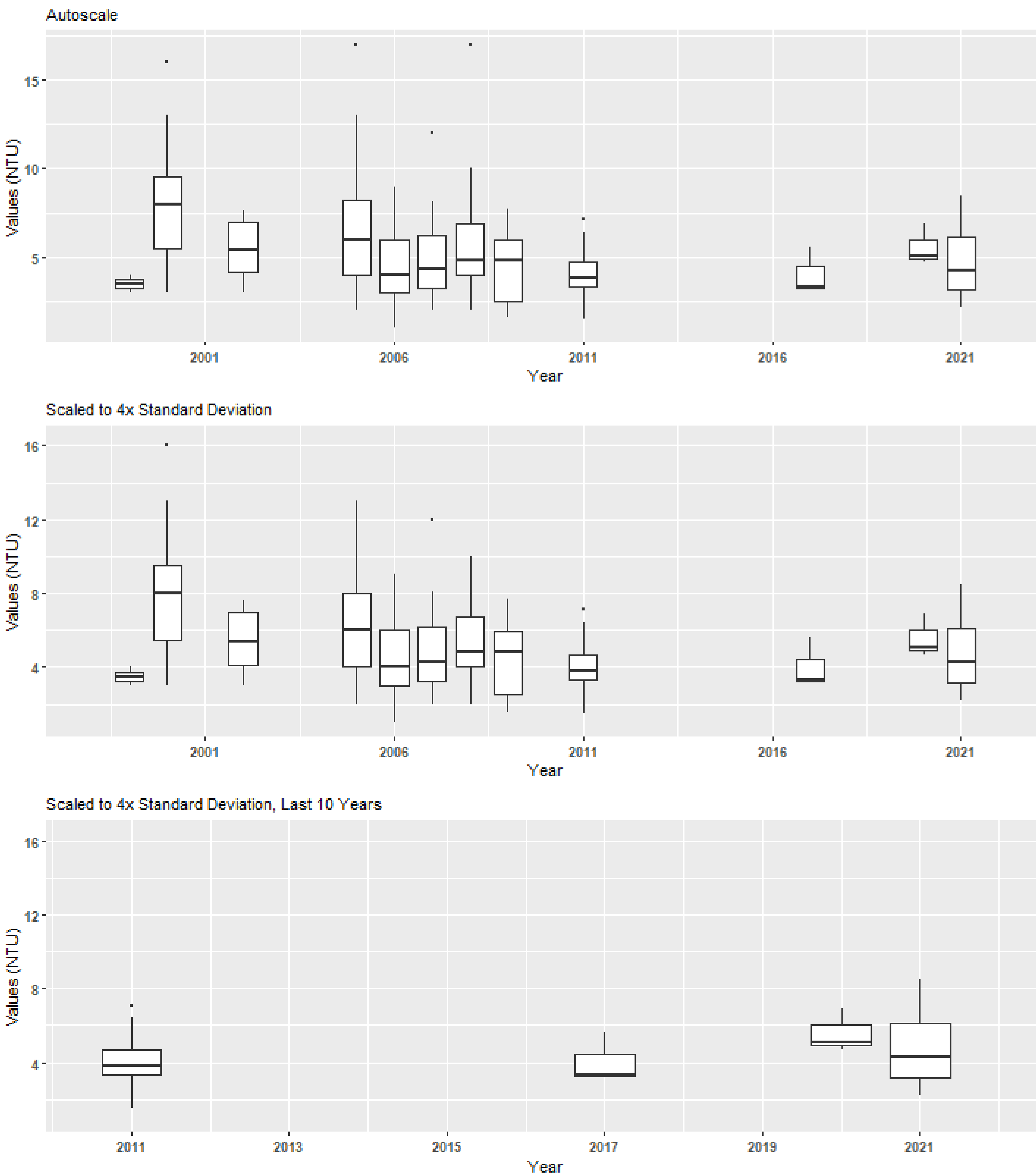
By Year & Month



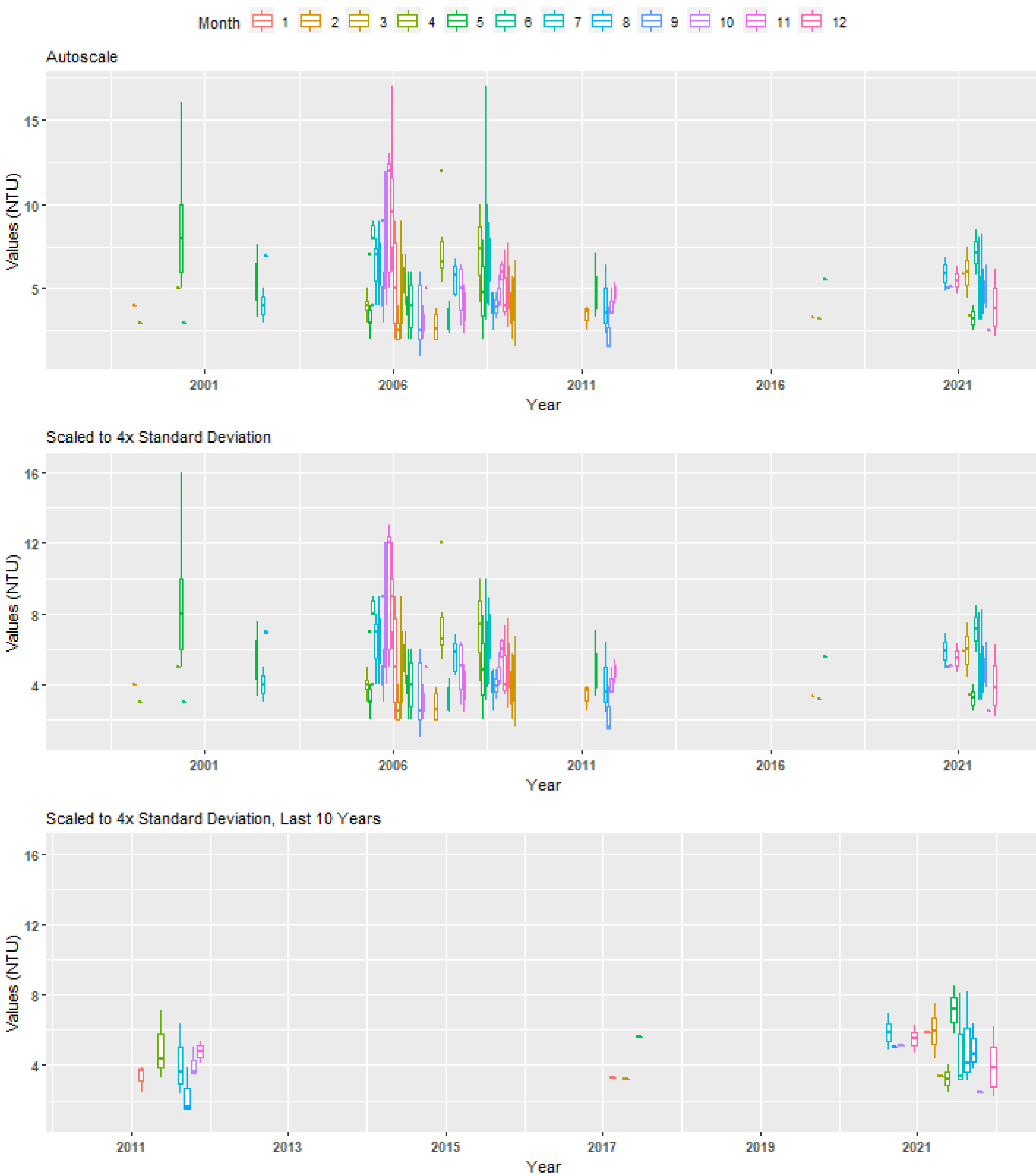
Summary Box Plots for Nature Coast Aquatic Preserve
By Month

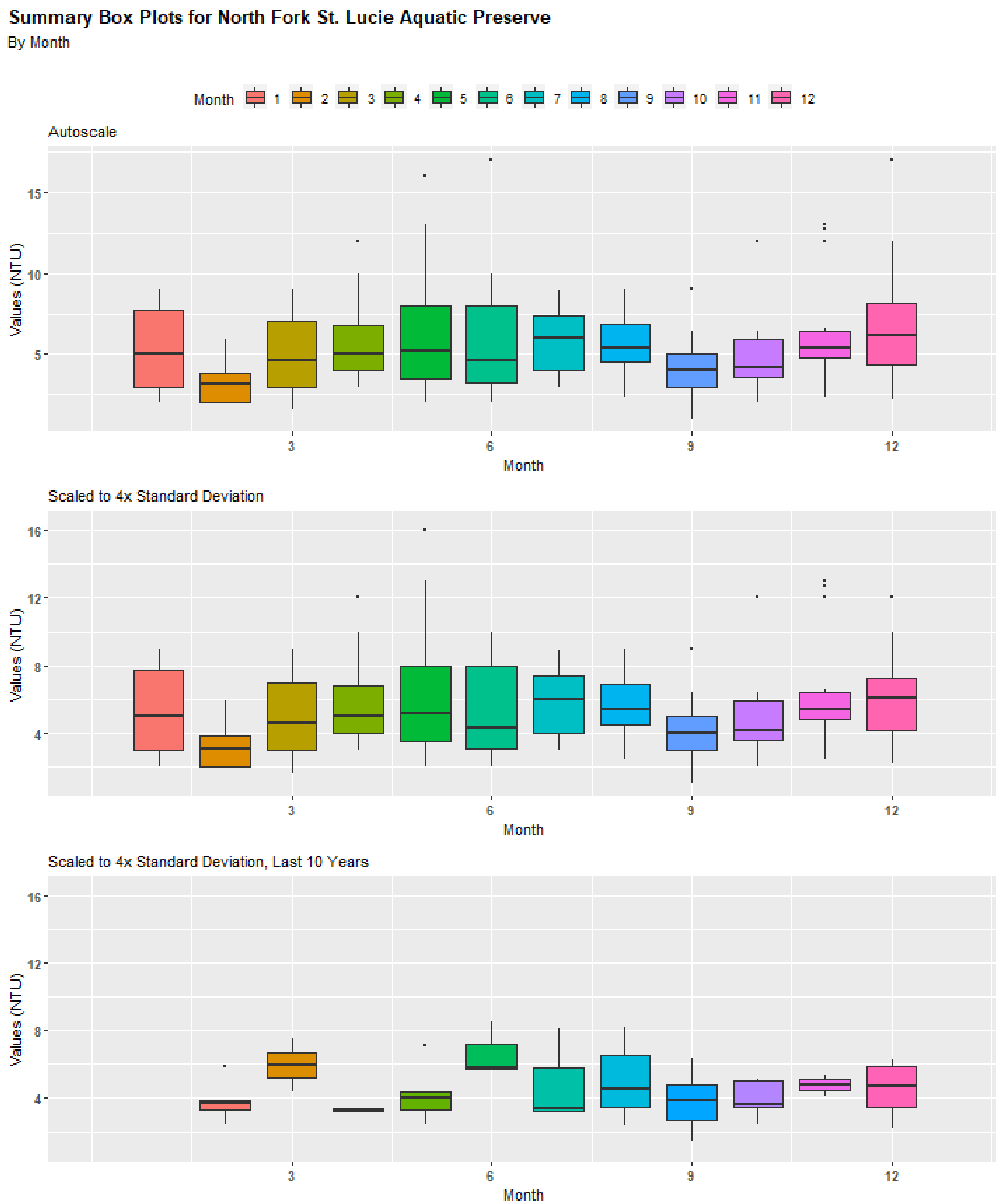


Summary Box Plots for North Fork St. Lucie Aquatic Preserve
By Year

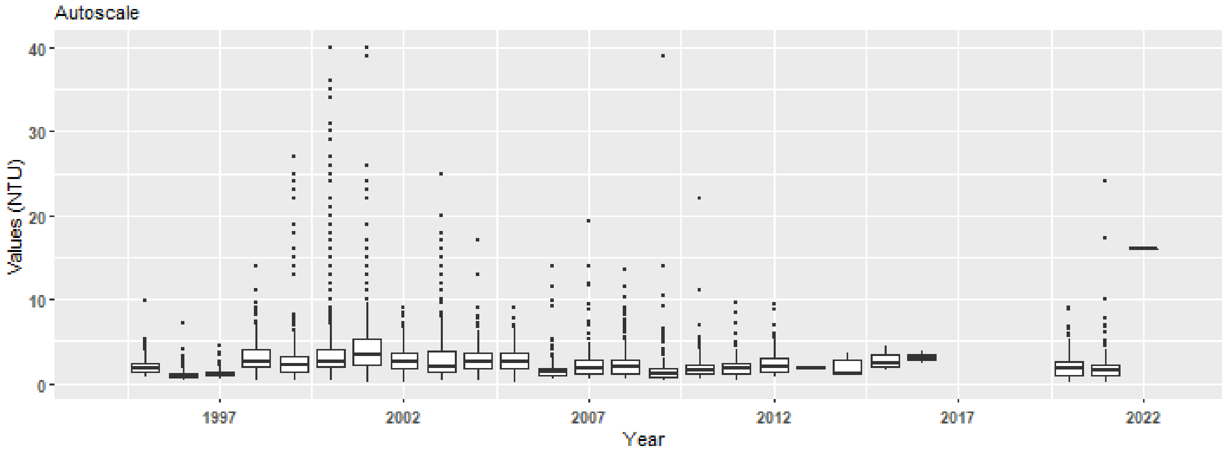


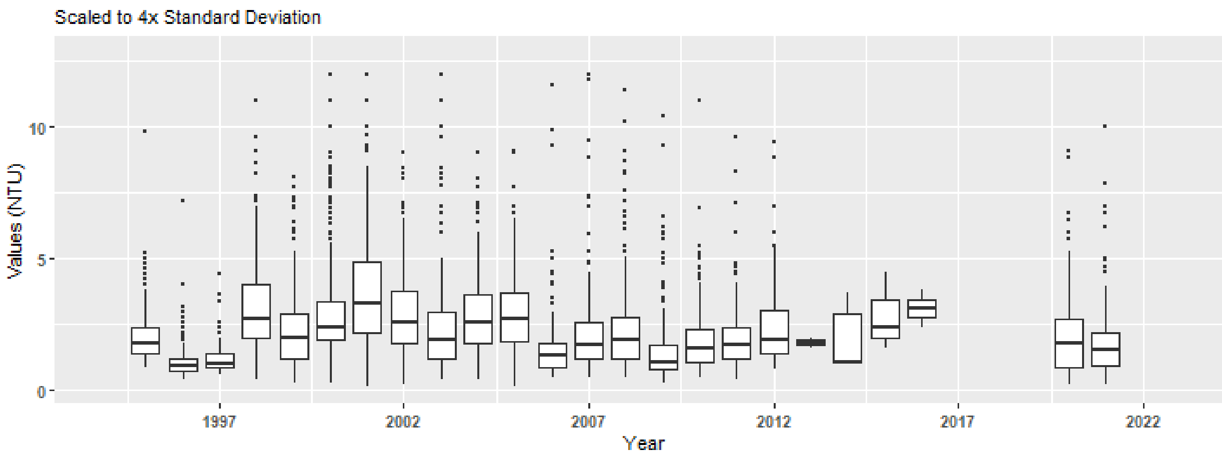
Summary Box Plots for North Fork St. Lucie Aquatic Preserve
By Year & Month

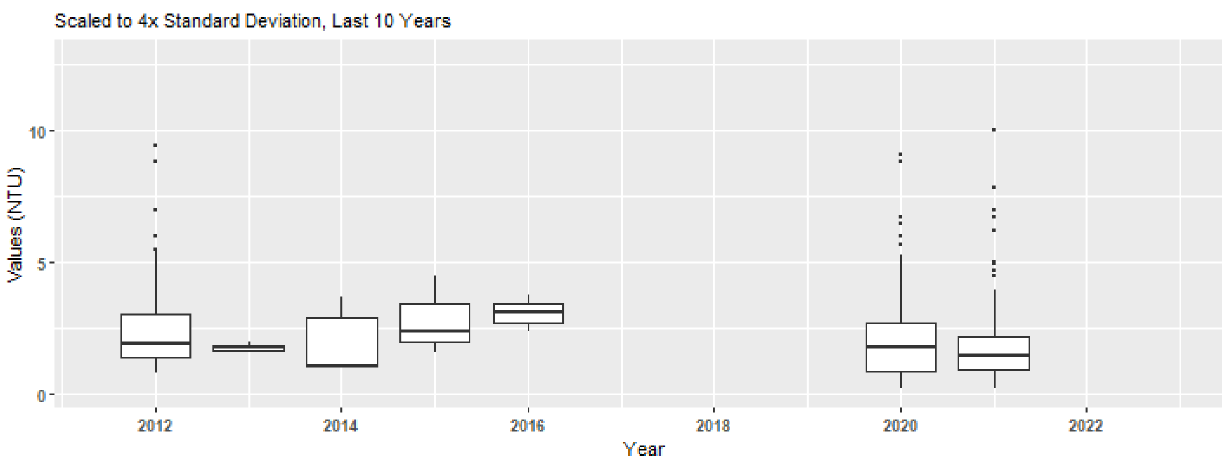



Summary Box Plots for North Fork St. Lucie Aquatic Preserve
By Month
Month 1 2 3 4 5 6 7 8 9 10 11 12
Autoscale
Values (NTU)
15
10
5
3
6
9
12
Month
Scaled to 4x Standard Deviation
Values (NTU)
16
12
8
4
3
6
9
12
Month
Scaled to 4x Standard Deviation, Last 10 Years
Values (NTU)
16
12
8
4
3
6
9
12
Month

Summary Box Plots for Pine Island Sound Aquatic Preserve
By Year

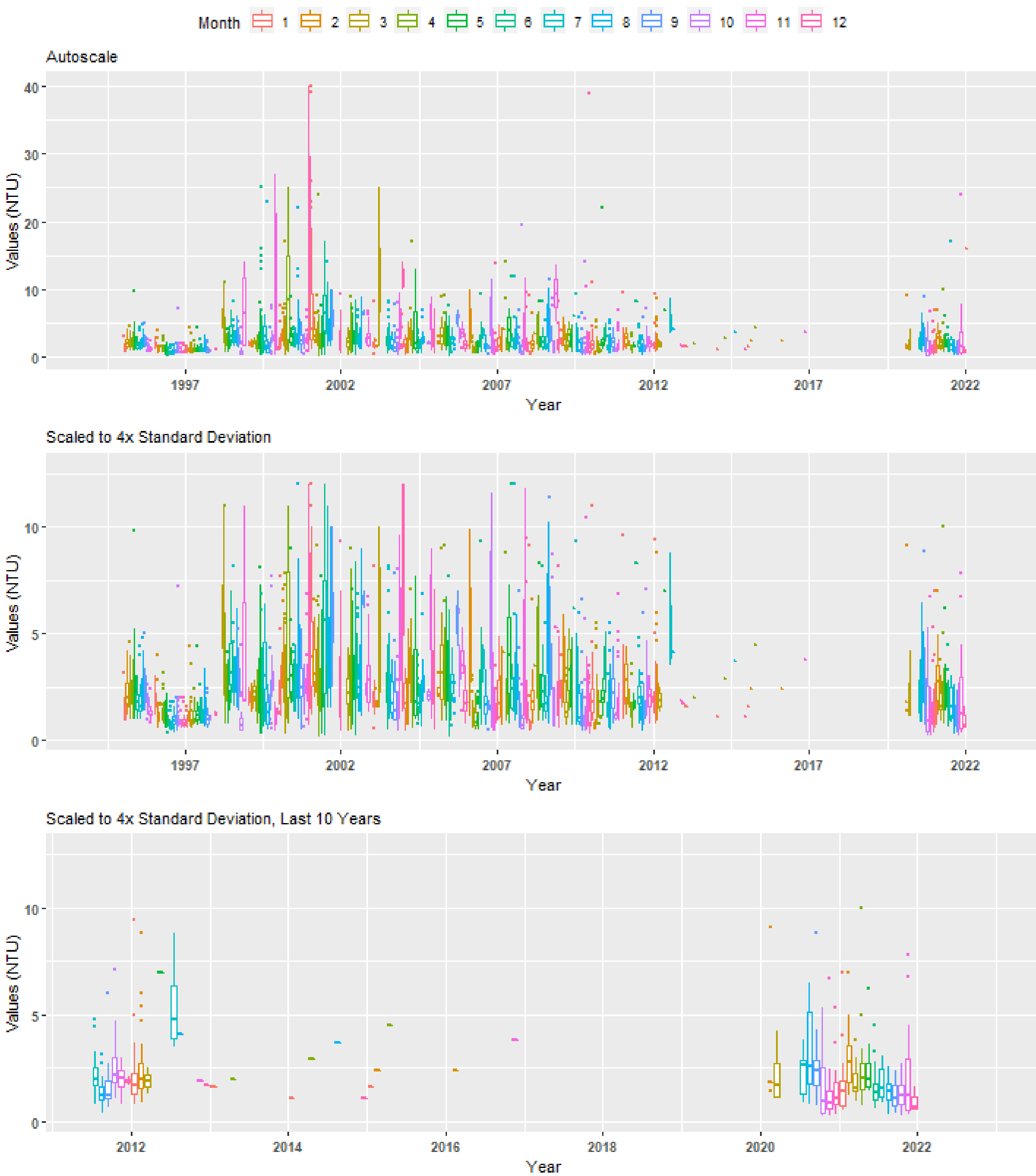




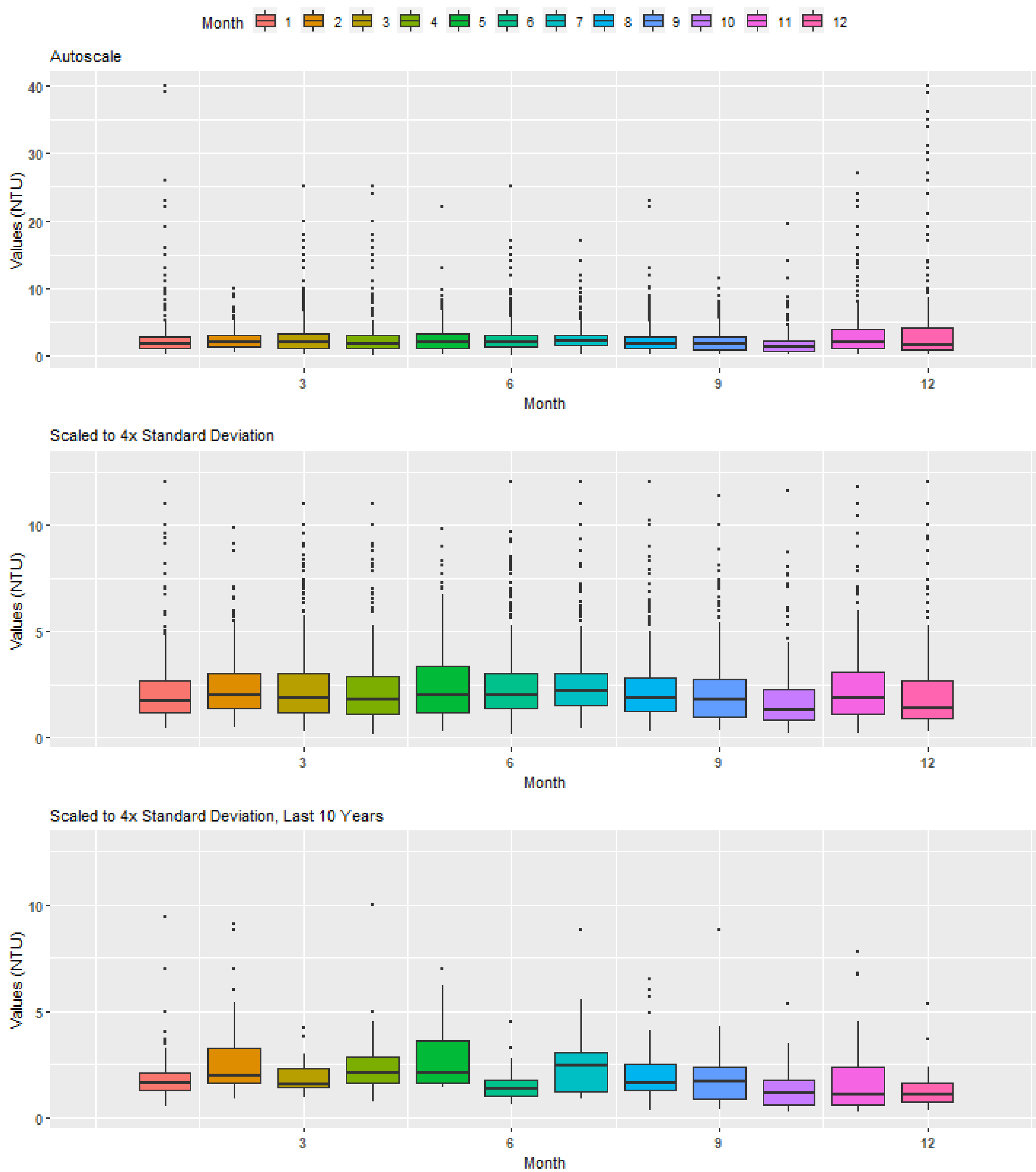


Summary Box Plots for Pine Island Sound Aquatic Preserve

By Year & Month



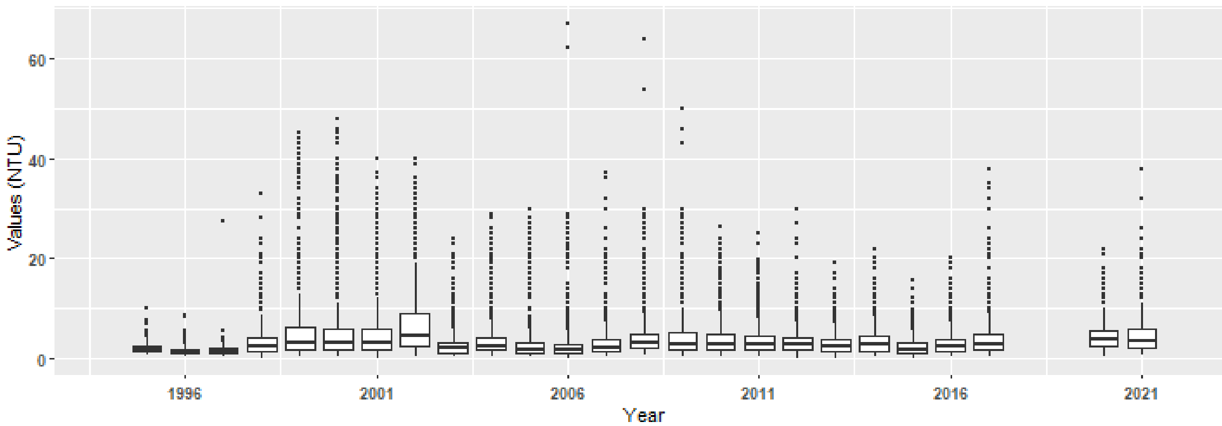
Summary Box Plots for Pine Island Sound Aquatic Preserve
By Month



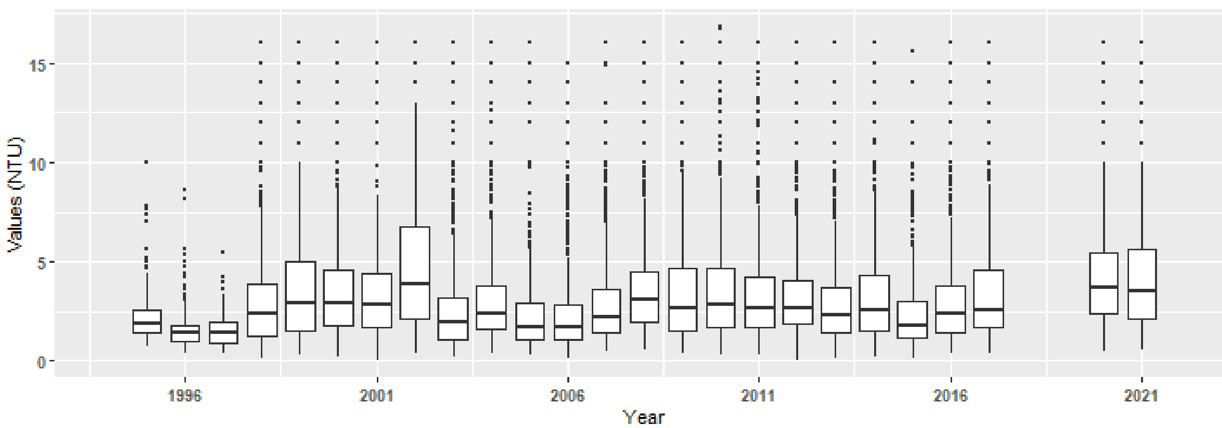
Summary Box Plots for Pinellas County Aquatic Preserve

By Year

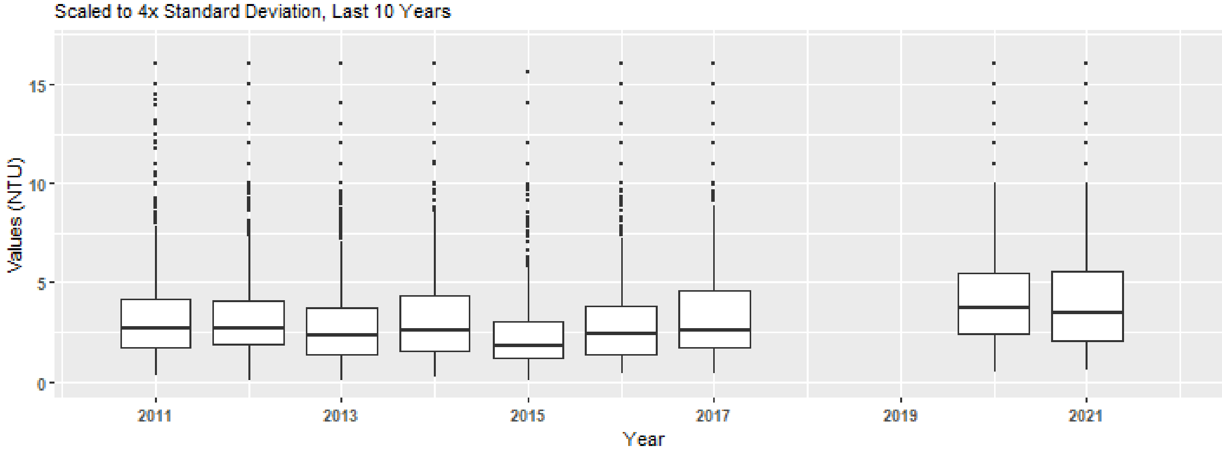
Autoscale



Scaled to 4x Standard Deviation

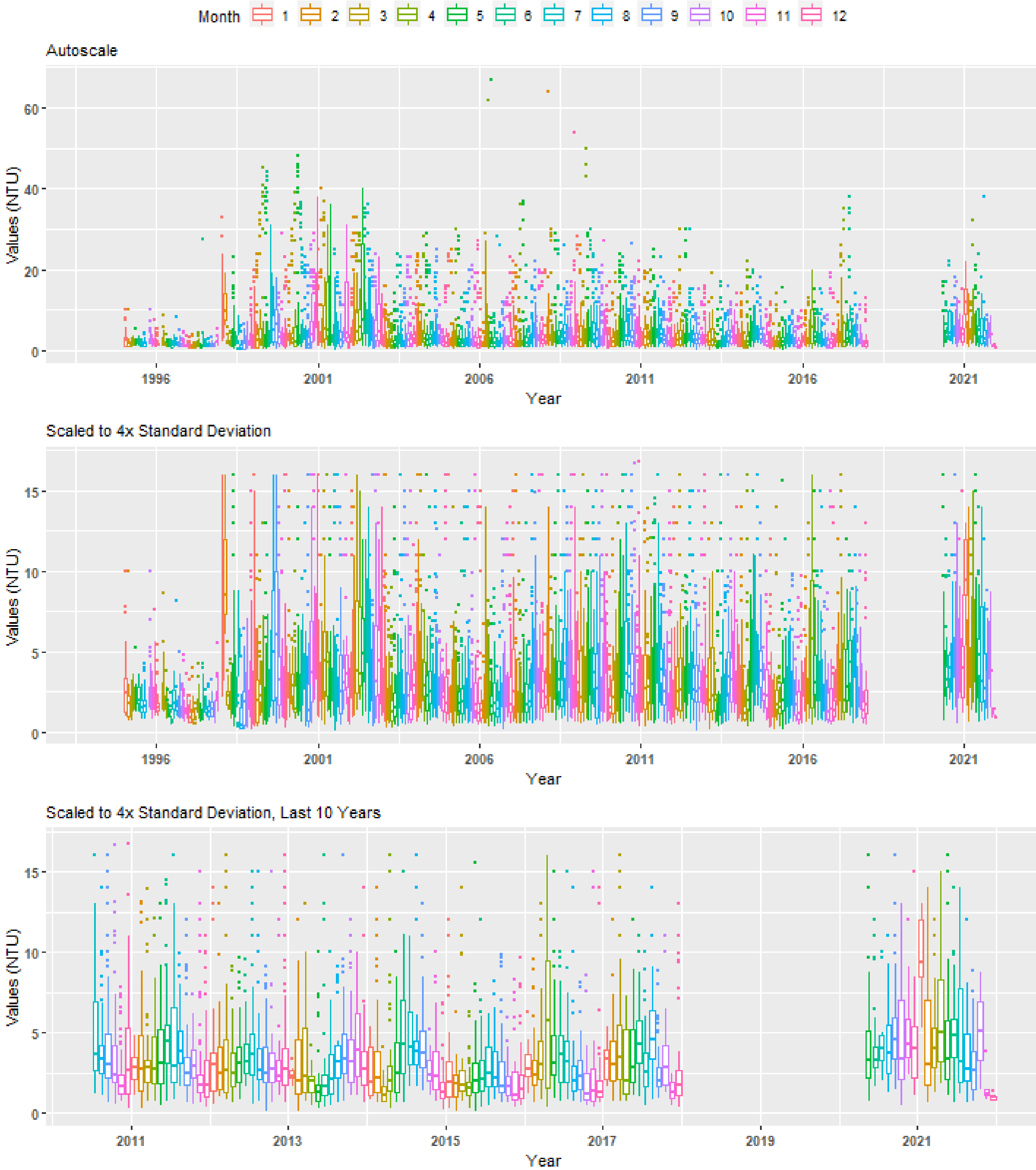


Scaled to 4x Standard Deviation, Last 10 Years



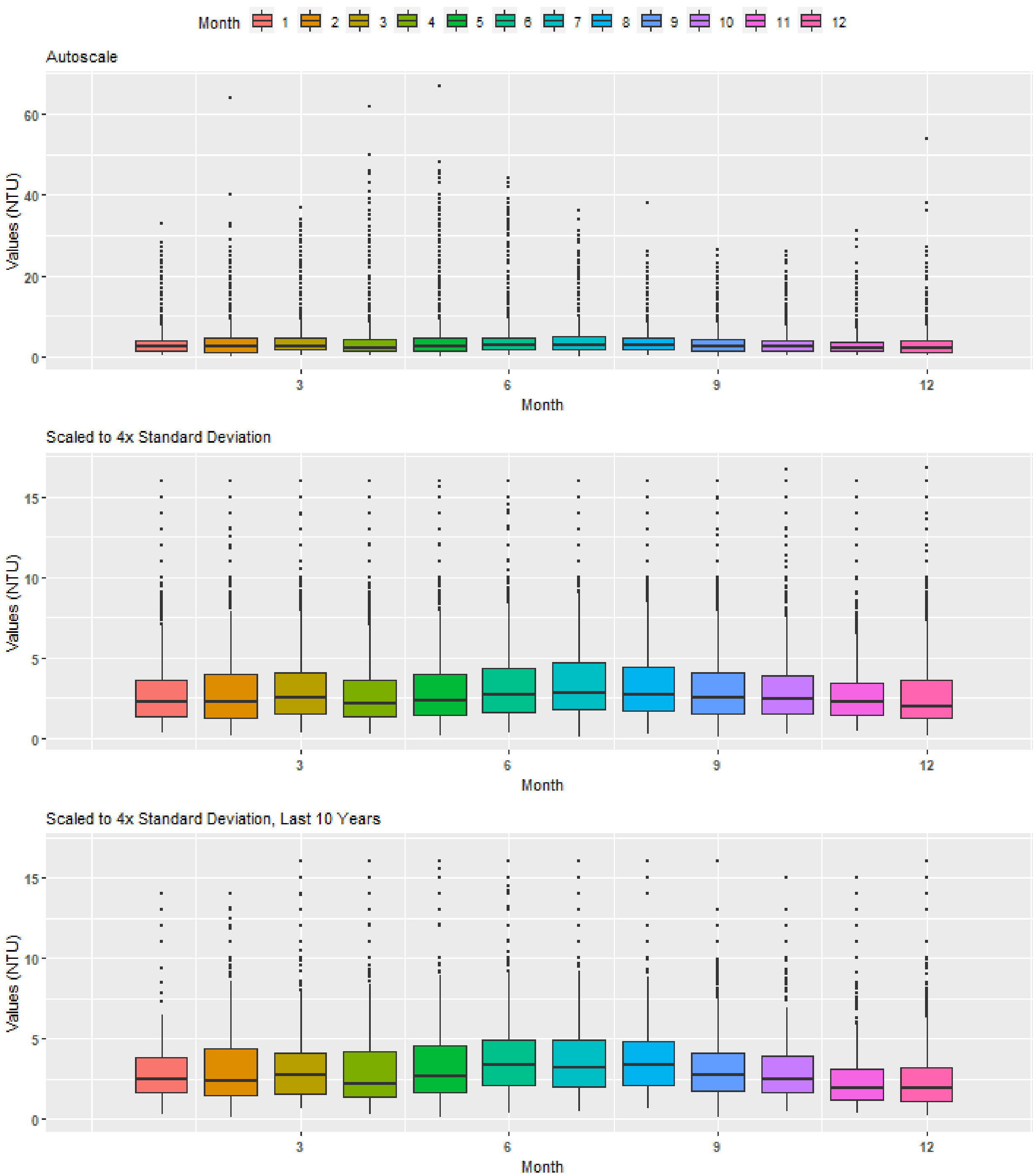
Summary Box Plots for Pinellas County Aquatic Preserve

By Year & Month

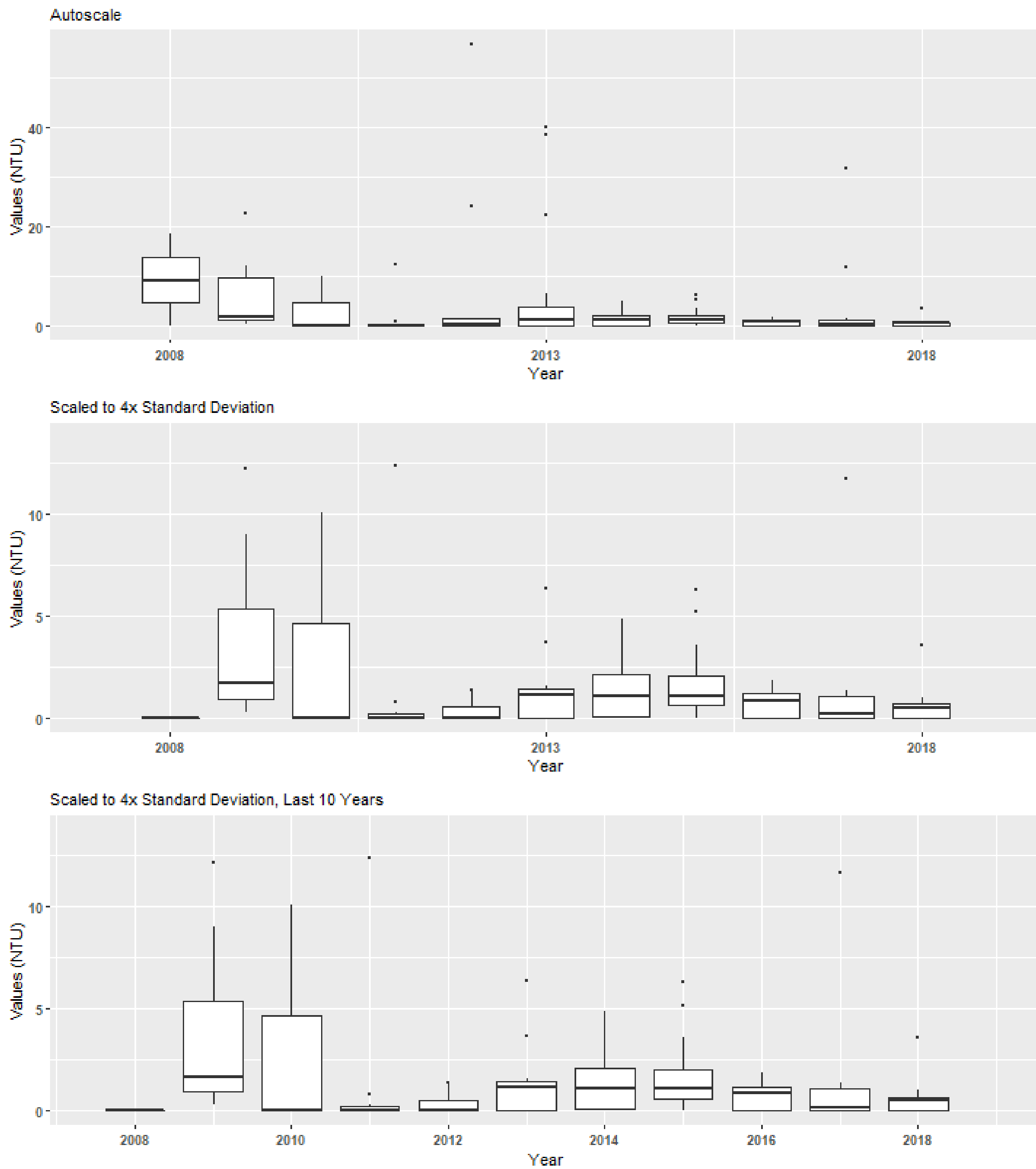


Summary Box Plots for Pinellas County Aquatic Preserve

By Month



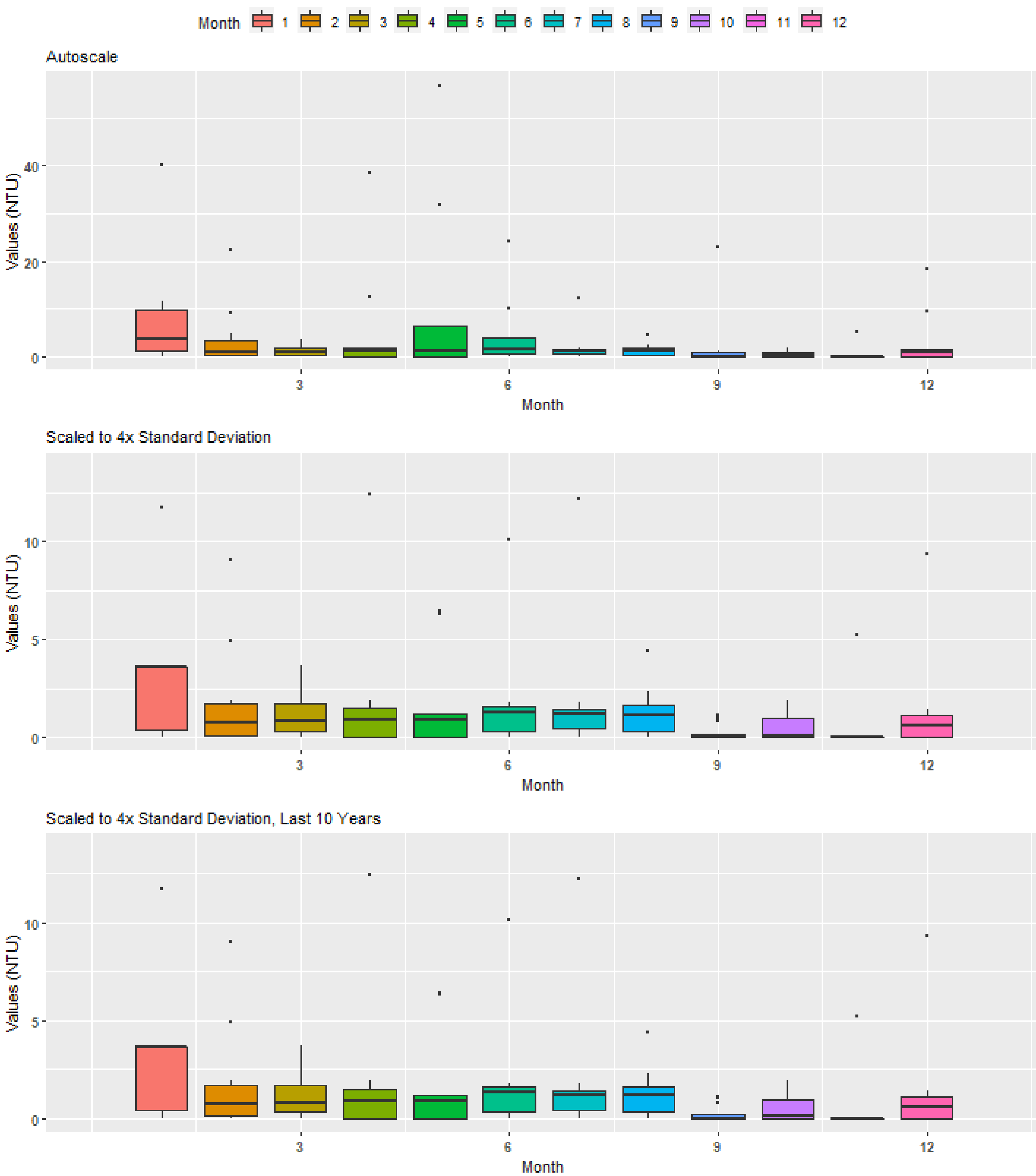
Summary Box Plots for Rocky Bayou State Park Aquatic Preserve
By Year



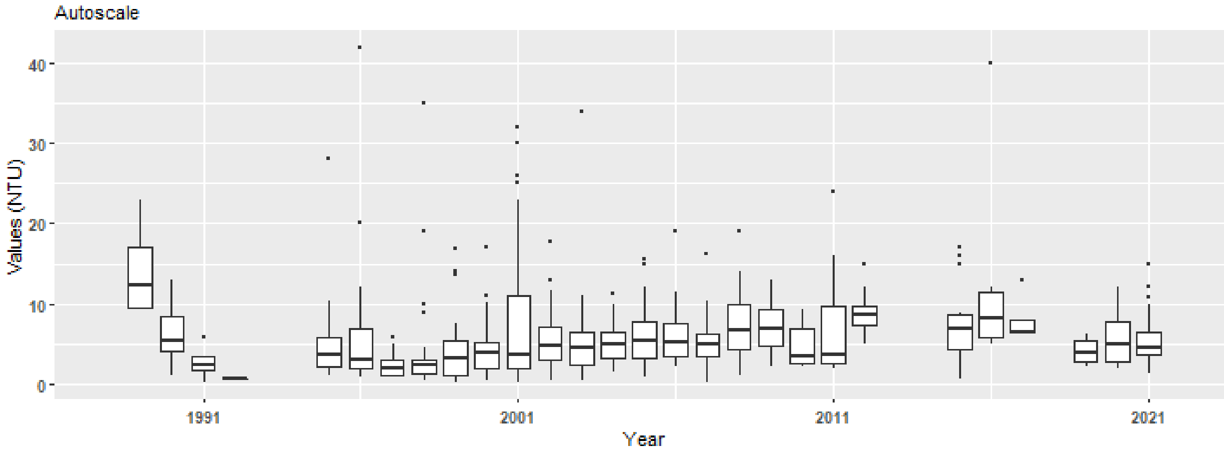
Summary Box Plots for Rocky Bayou State Park Aquatic Preserve

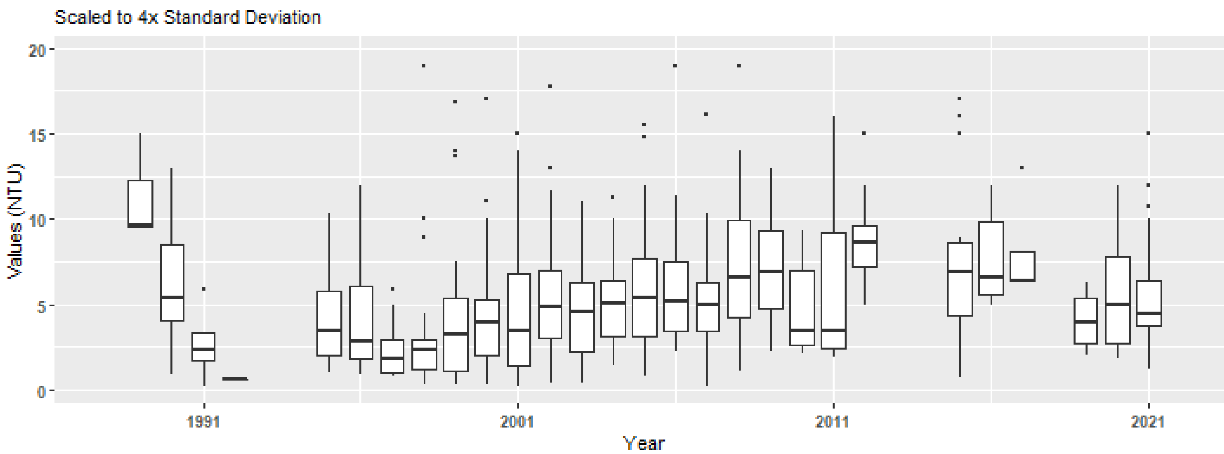
By Year & Month

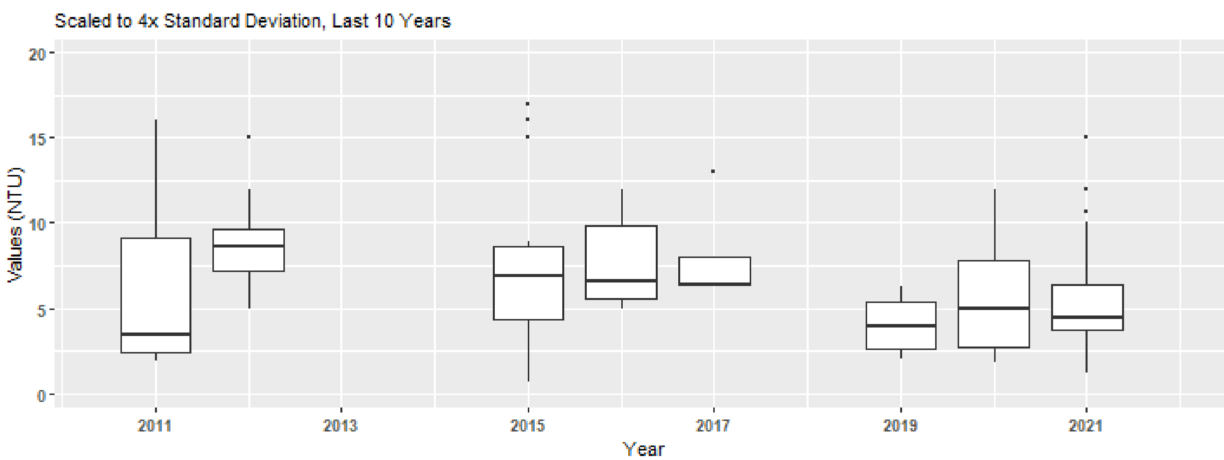
Summary Box Plots for Rocky Bayou State Park Aquatic Preserve
By Month



Summary Box Plots for Rookery Bay Aquatic Preserve
By Year

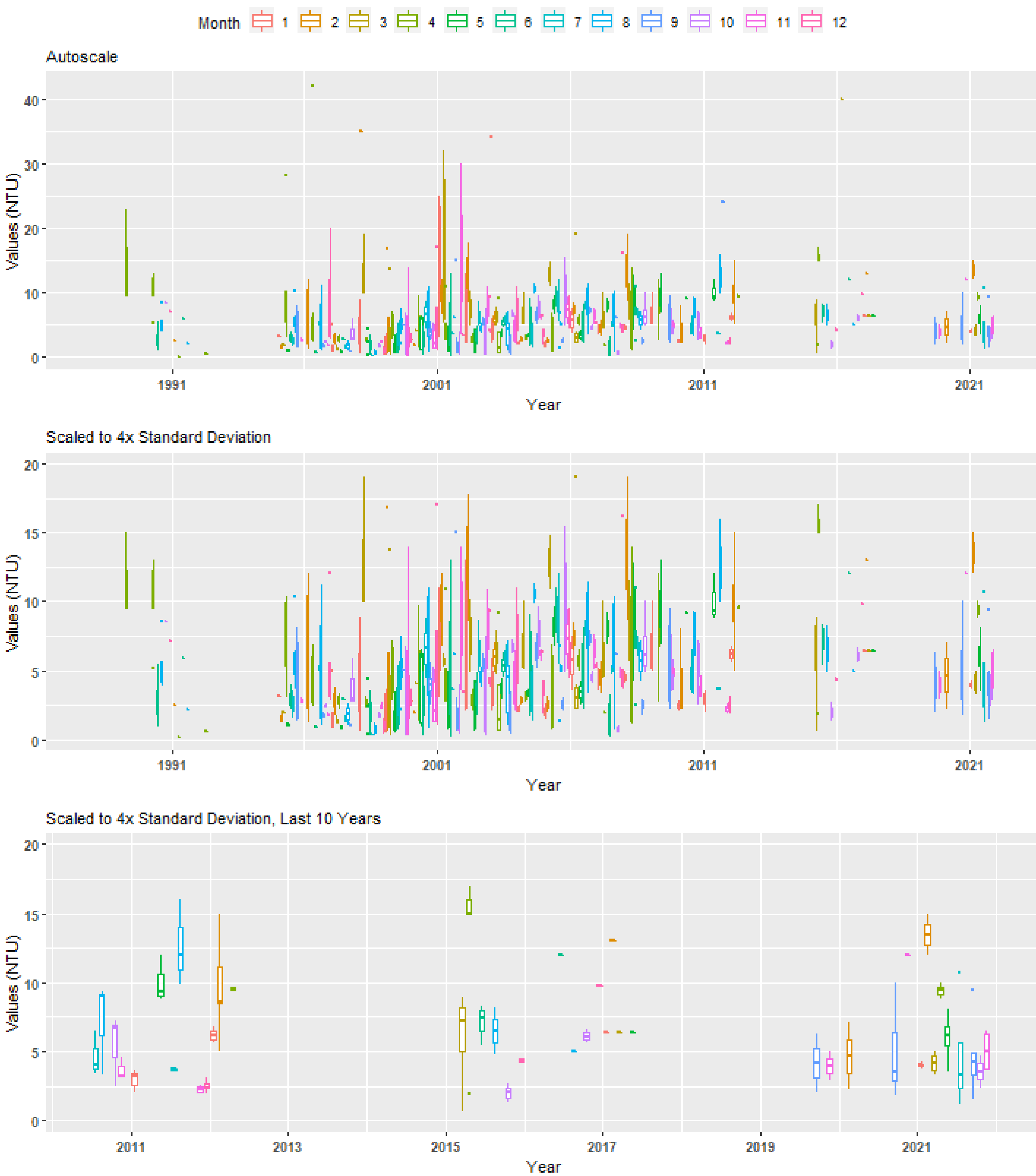






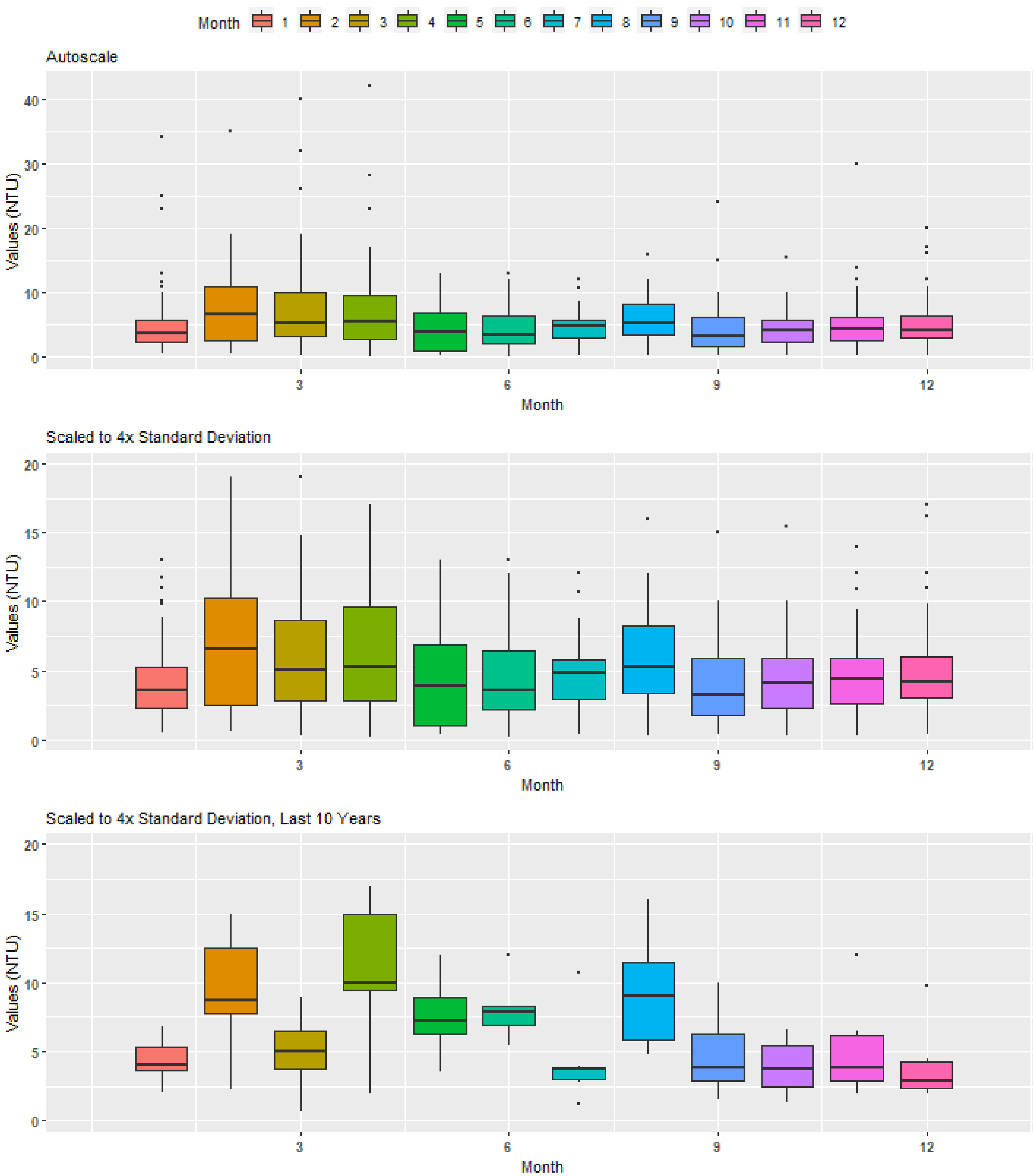
Summary Box Plots for Rookery Bay Aquatic Preserve

By Year & Month



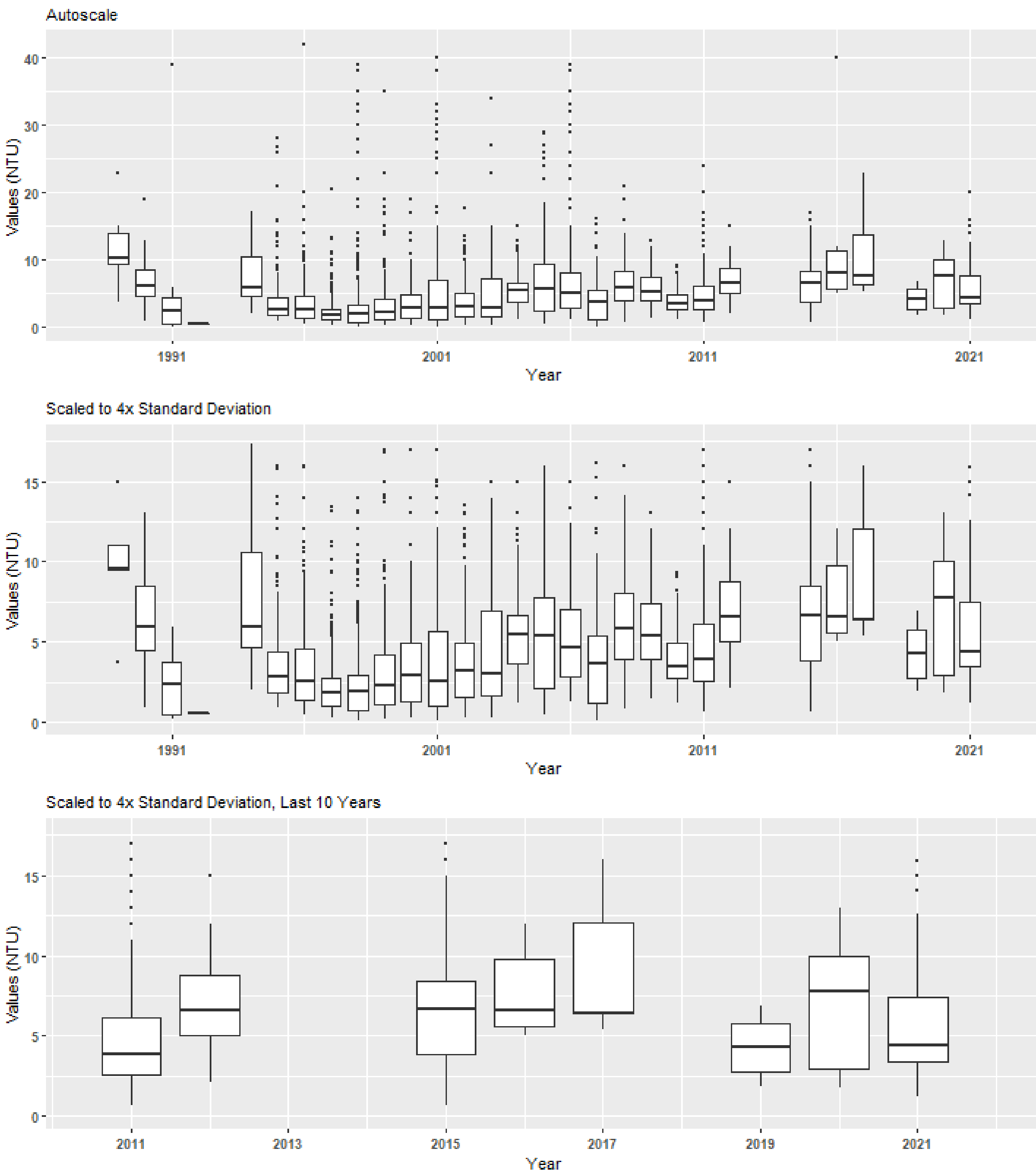
Summary Box Plots for Rookery Bay Aquatic Preserve

By Month



Summary Box Plots for Rookery Bay National Estuarine Research Reserve

By Year

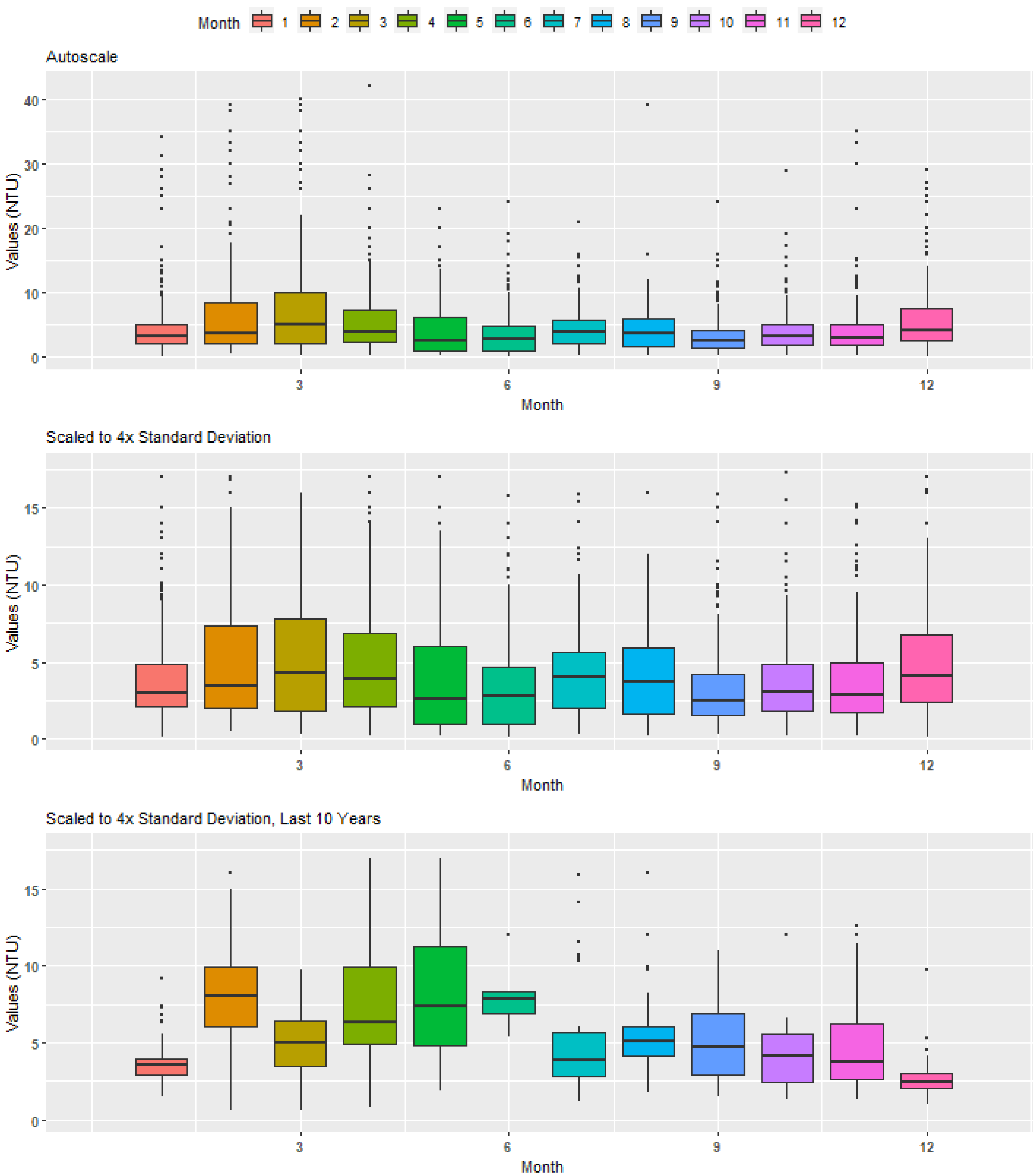


Summary Box Plots for Rookery Bay National Estuarine Research Reserve

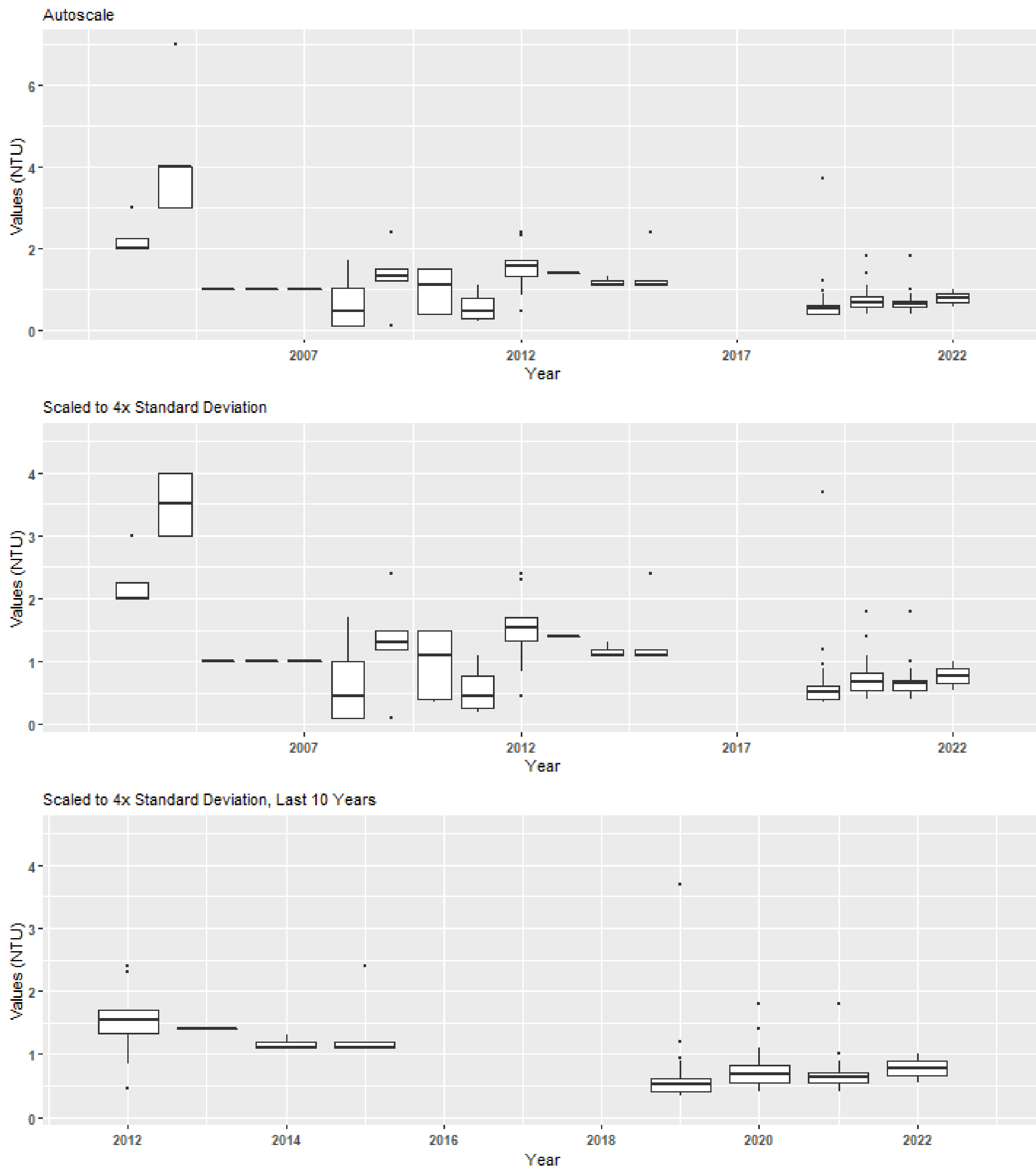
By Year & Month

Summary Box Plots for Rookery Bay National Estuarine Research Reserve

By Month



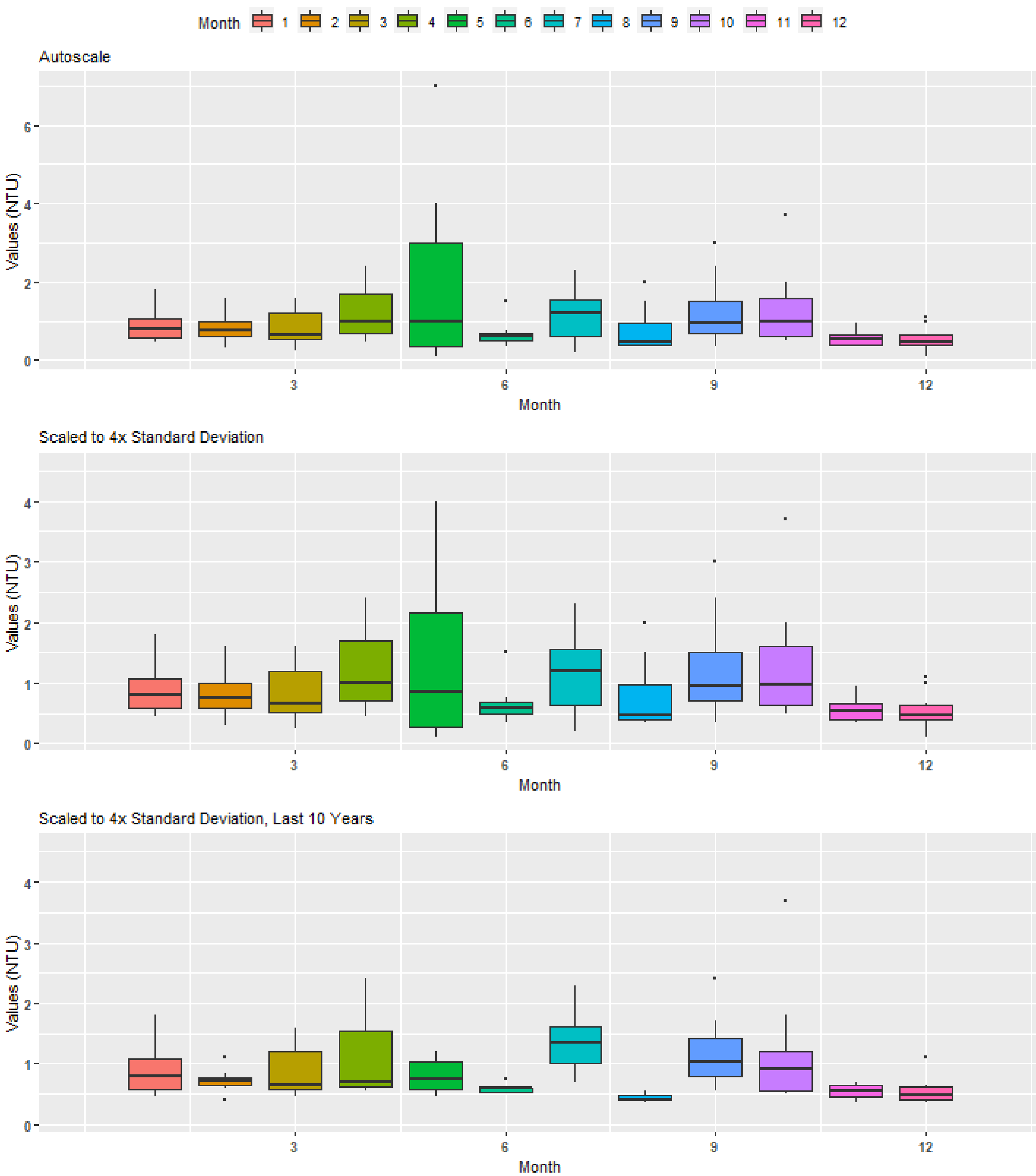
Summary Box Plots for St. Andrews State Park Aquatic Preserve
By Year



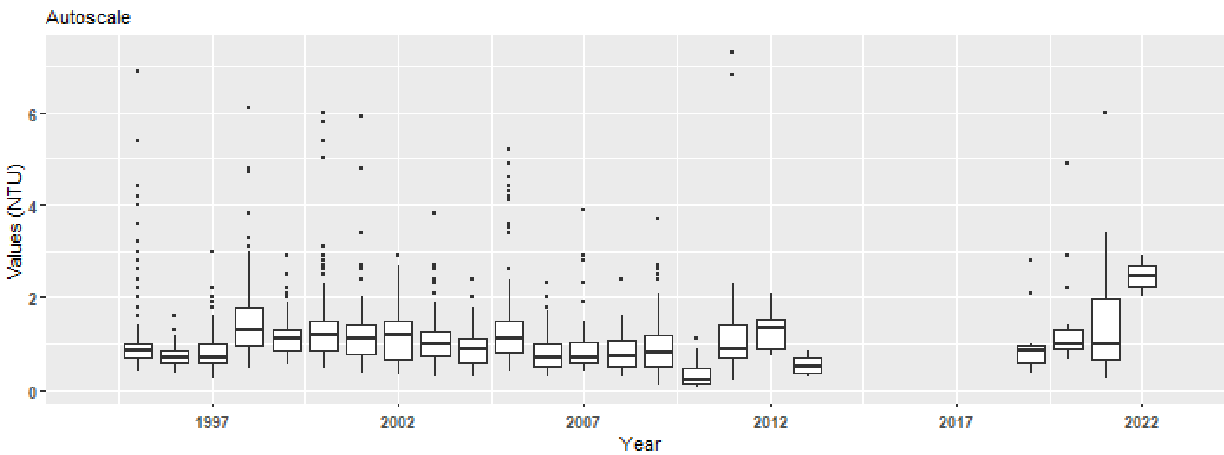
Summary Box Plots for St. Andrews State Park Aquatic Preserve

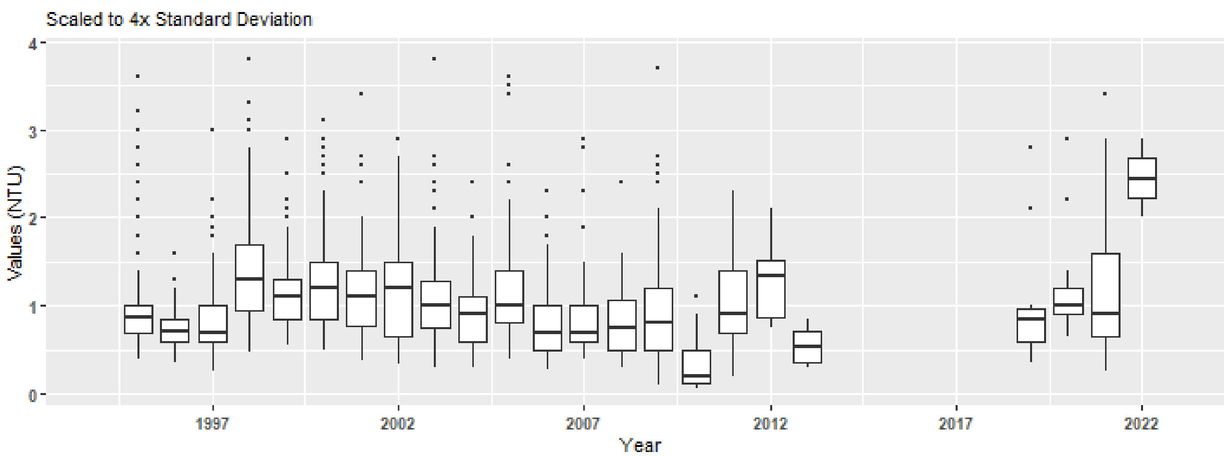
By Year & Month

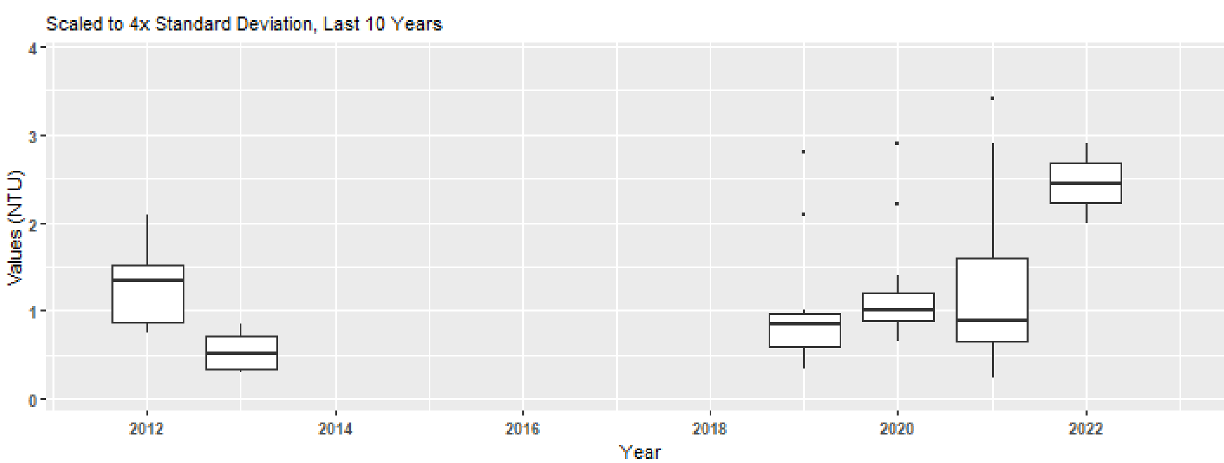
Summary Box Plots for St. Andrews State Park Aquatic Preserve
By Month



Summary Box Plots for St. Joseph Bay Aquatic Preserve
By Year

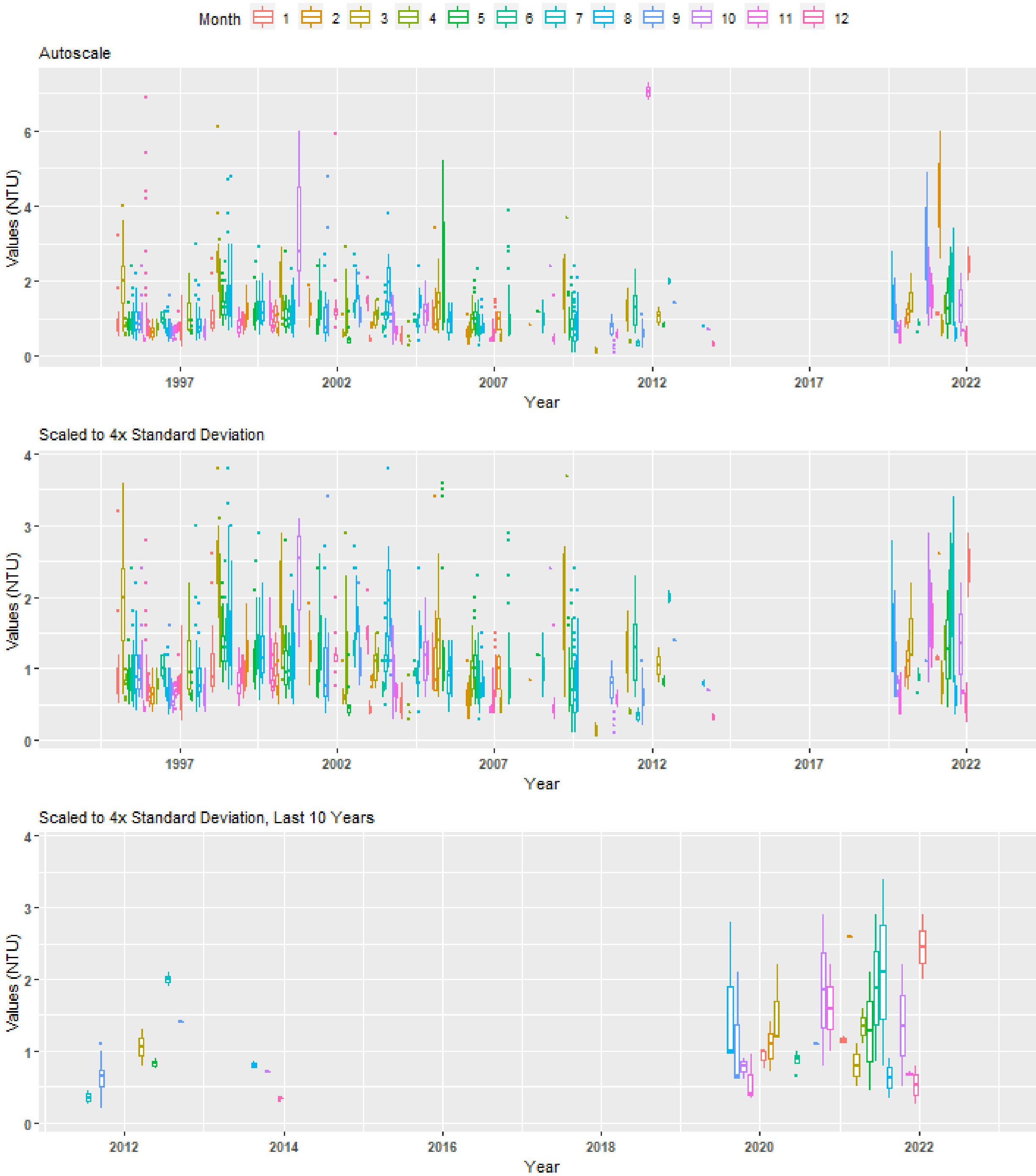




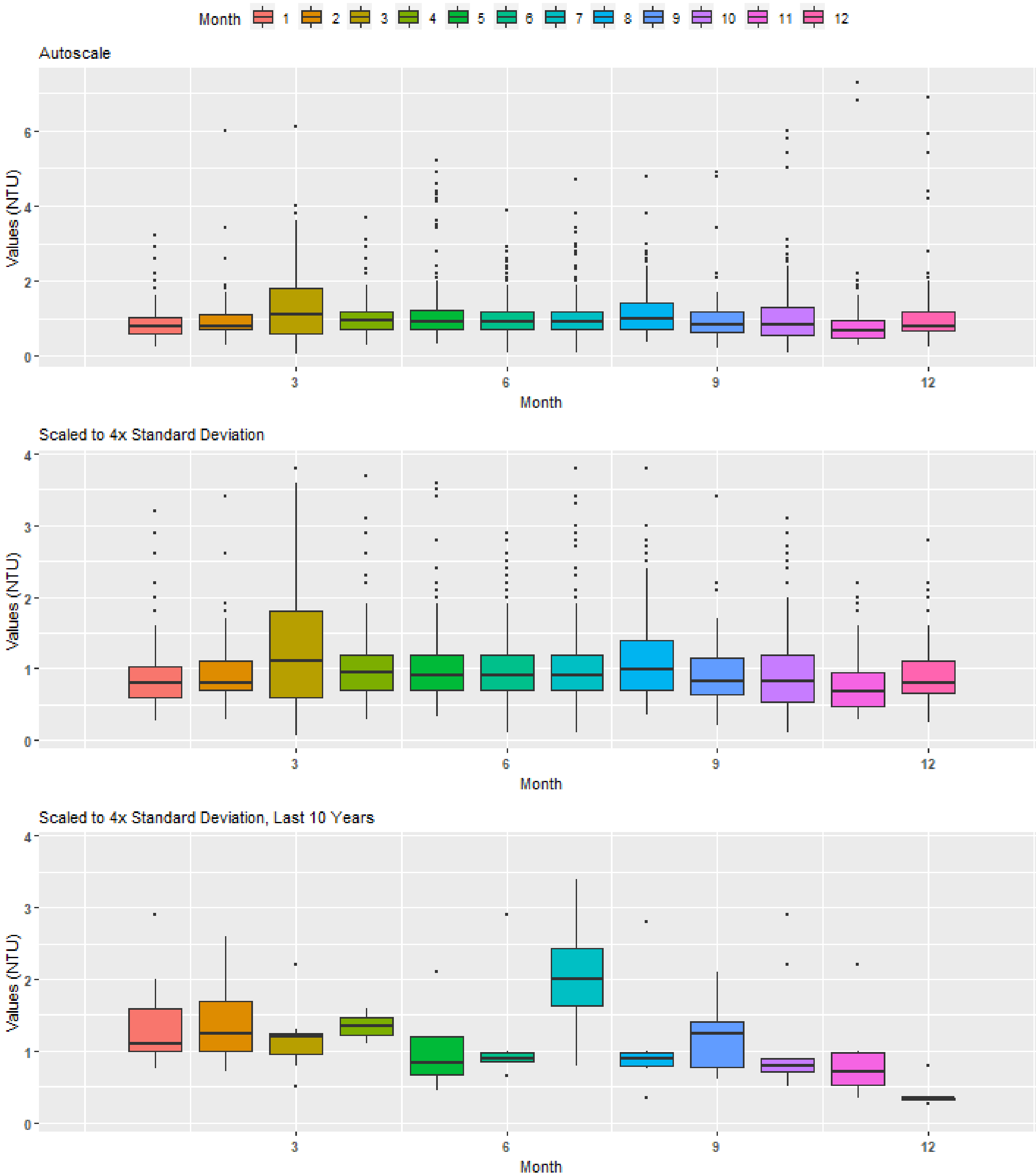


Summary Box Plots for St. Joseph Bay Aquatic Preserve

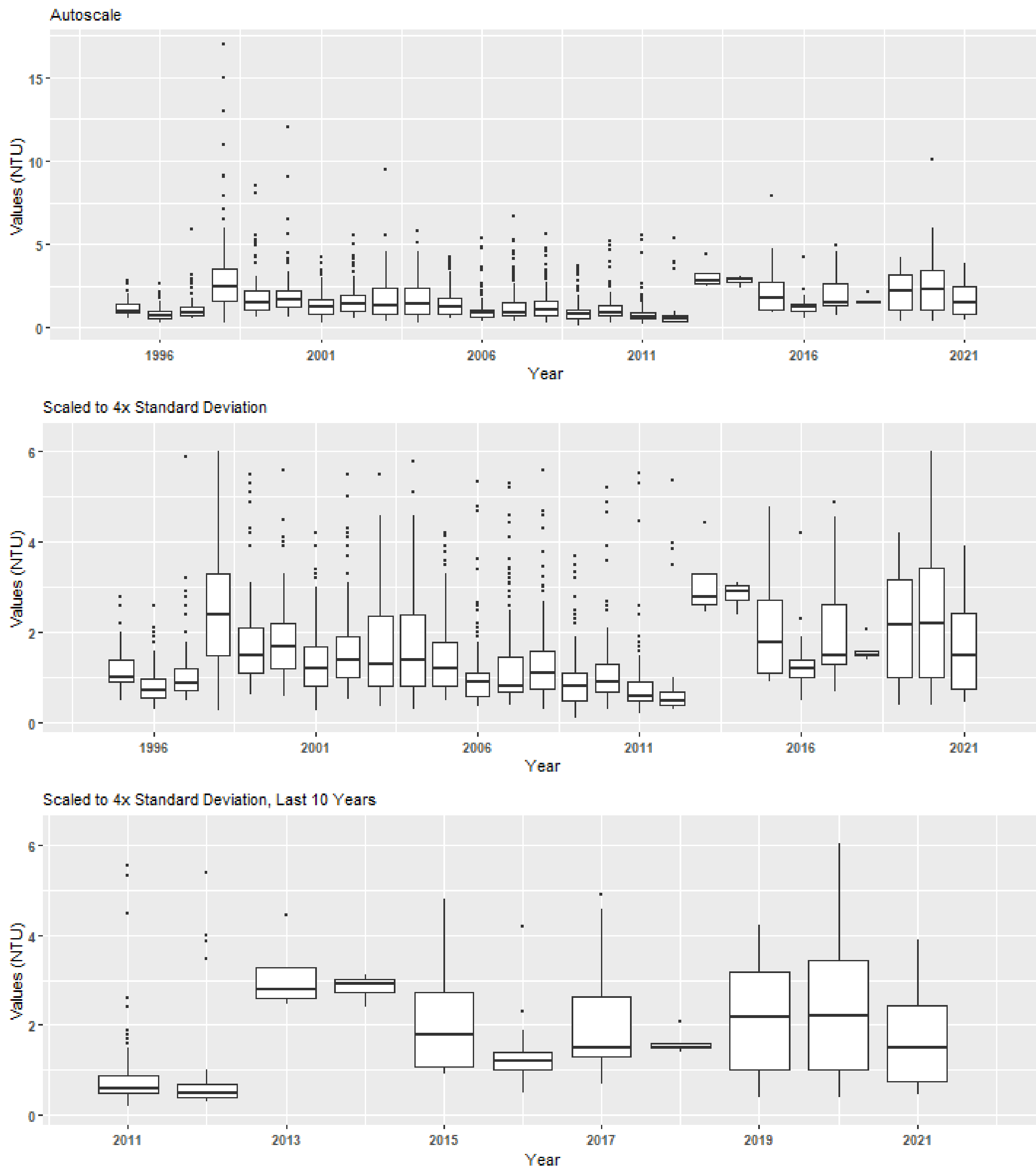
By Year & Month



Summary Box Plots for St. Joseph Bay Aquatic Preserve
By Month

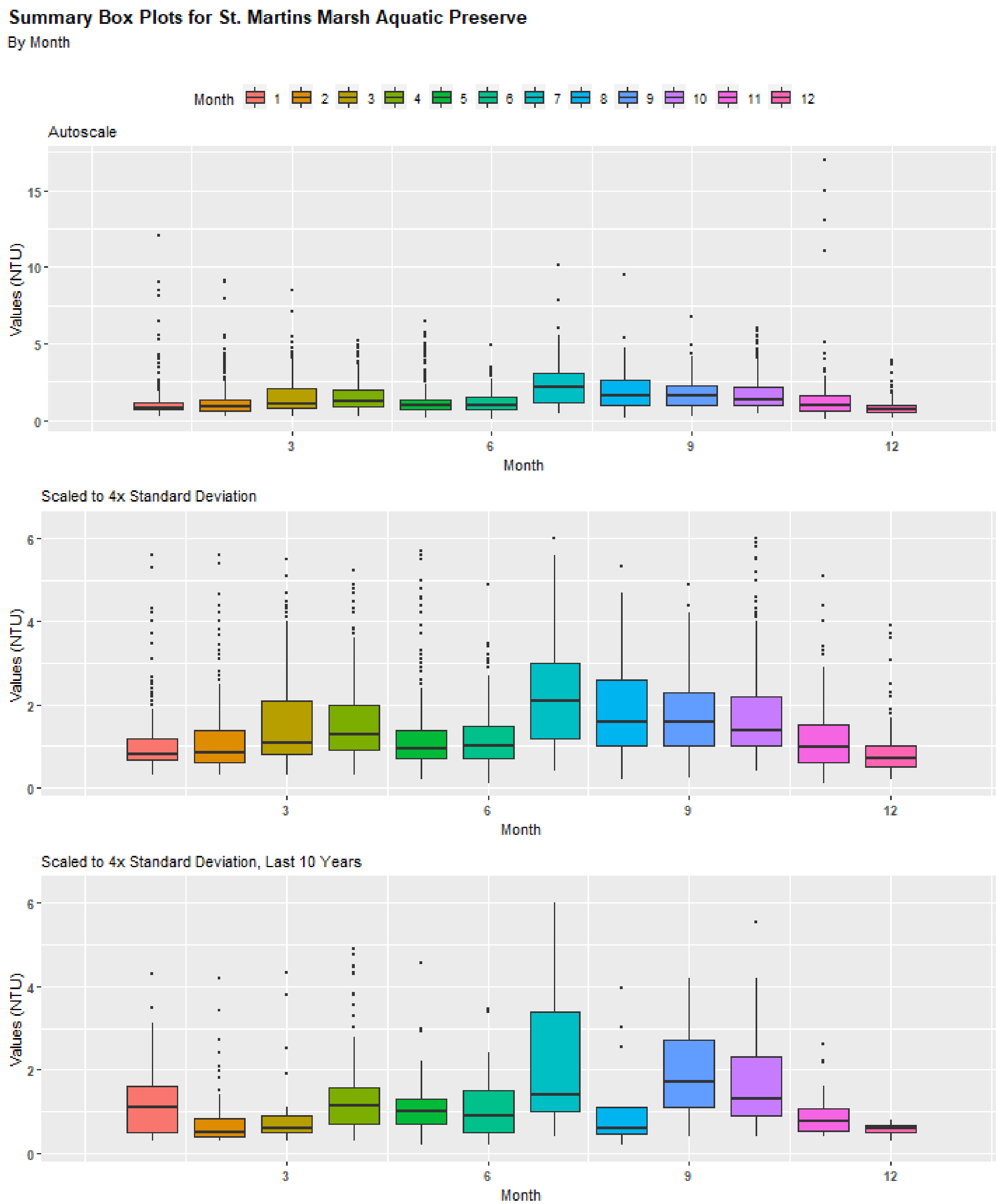


Summary Box Plots for St. Martins Marsh Aquatic Preserve
By Year

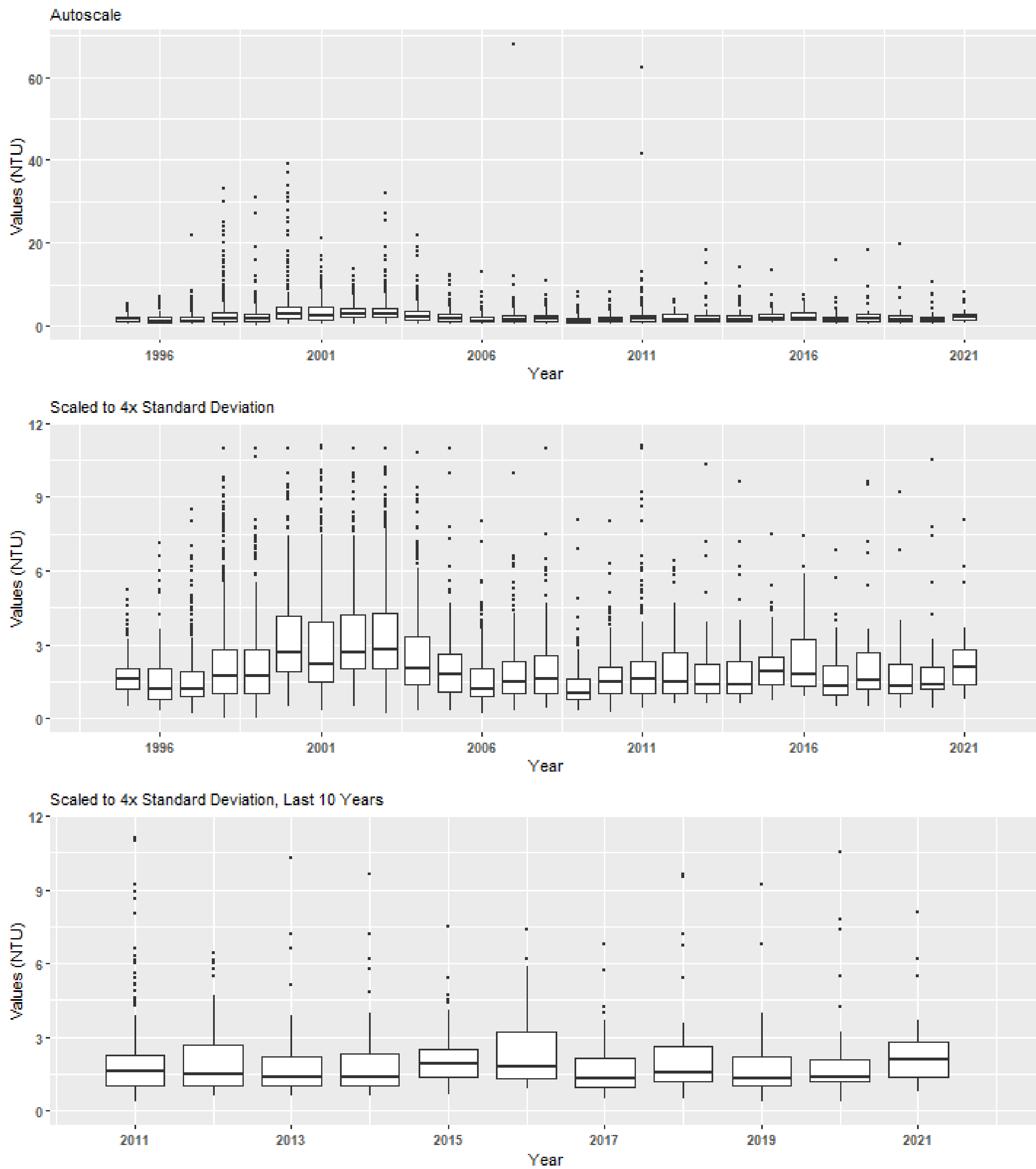


Summary Box Plots for St. Martins Marsh Aquatic Preserve

By Year & Month

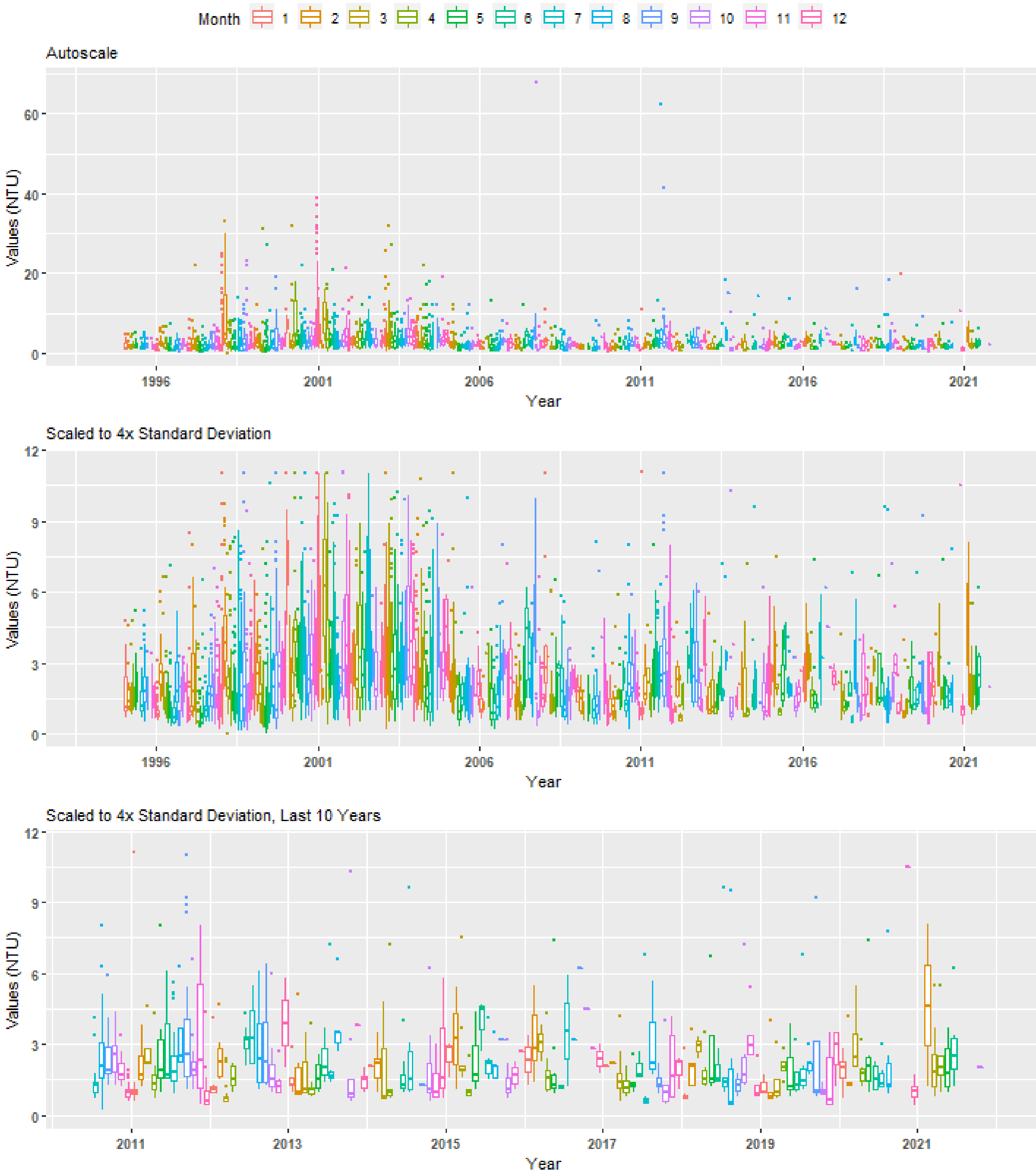

Summary Box Plots for St. Martins Marsh Aquatic Preserve
By Month
Month 1 2 3 4 5 6 7 8 9 10 11 12
Autoscale
Values (NTU)
0
5
10
15
3
6
9
12
Month
Scaled to 4x Standard Deviation
Values (NTU)
0
2
4
6
3
6
9
12
Month
Scaled to 4x Standard Deviation, Last 10 Years
Values (NTU)
0
2
4
6
3
6
9
12
Month

Summary Box Plots for Terra Ceia Aquatic Preserve
By Year

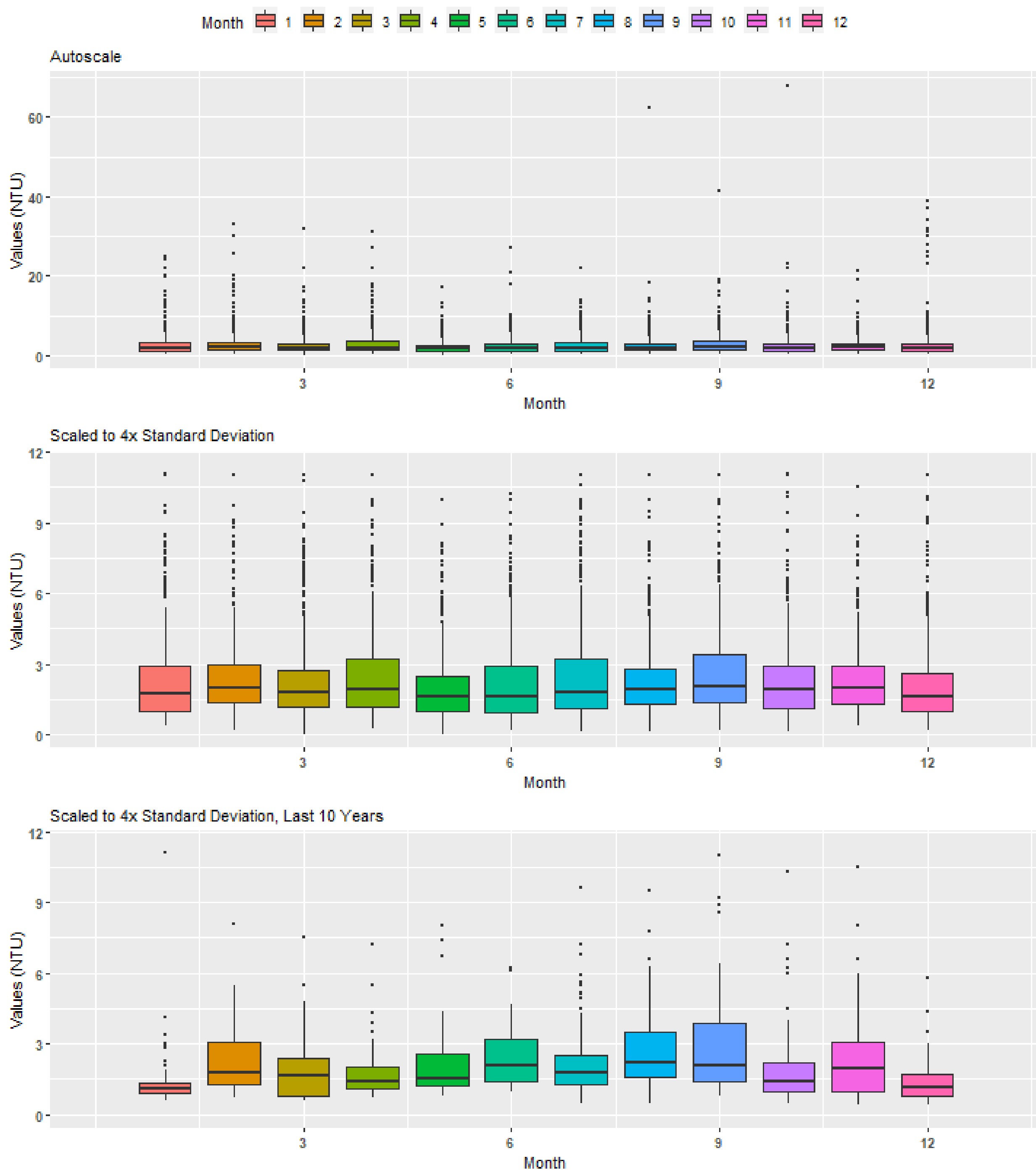


Summary Box Plots for Terra Ceia Aquatic Preserve

By Year & Month

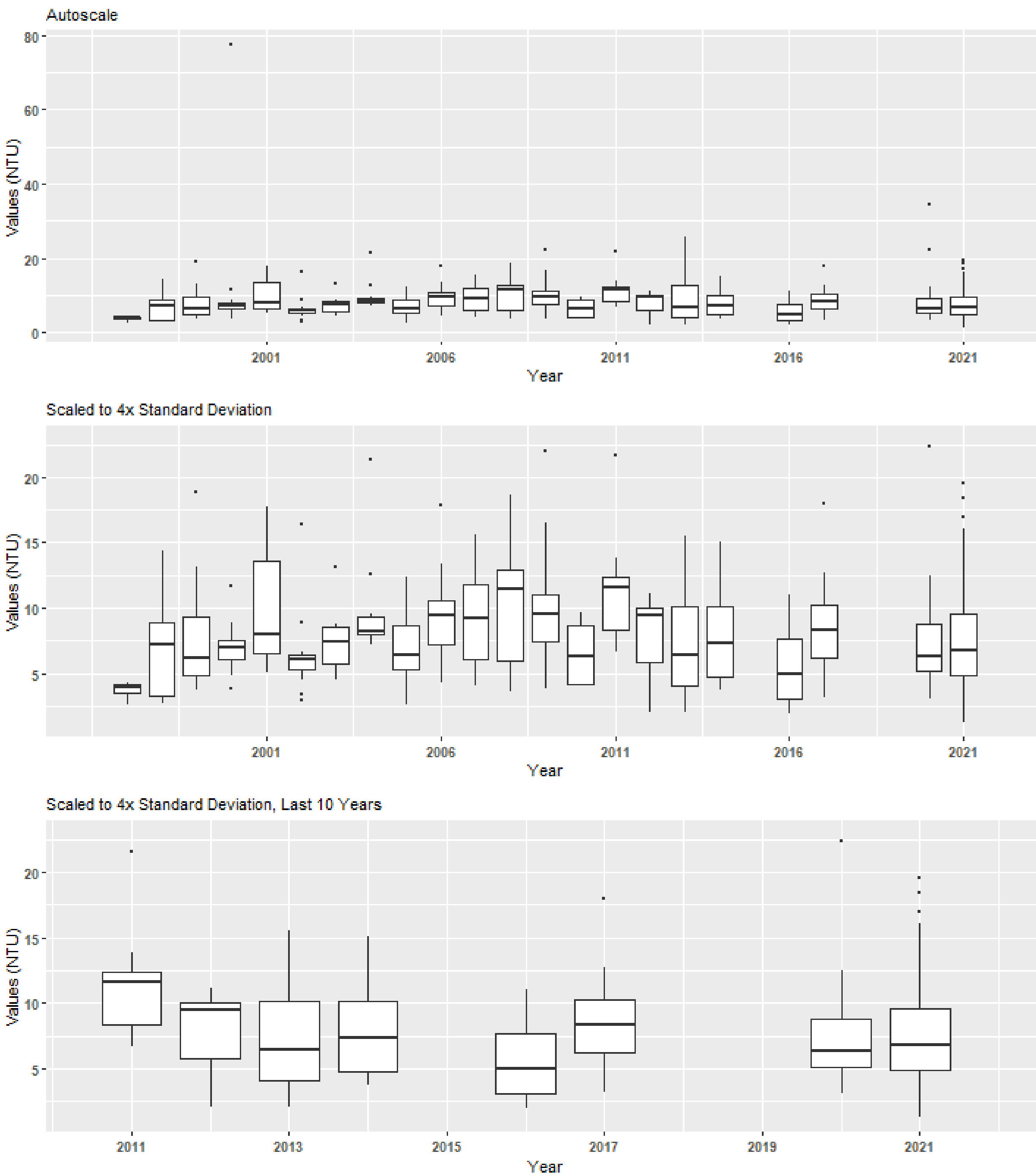


Summary Box Plots for Terra Ceia Aquatic Preserve
By Month



Summary Box Plots for Tomoka Marsh Aquatic Preserve

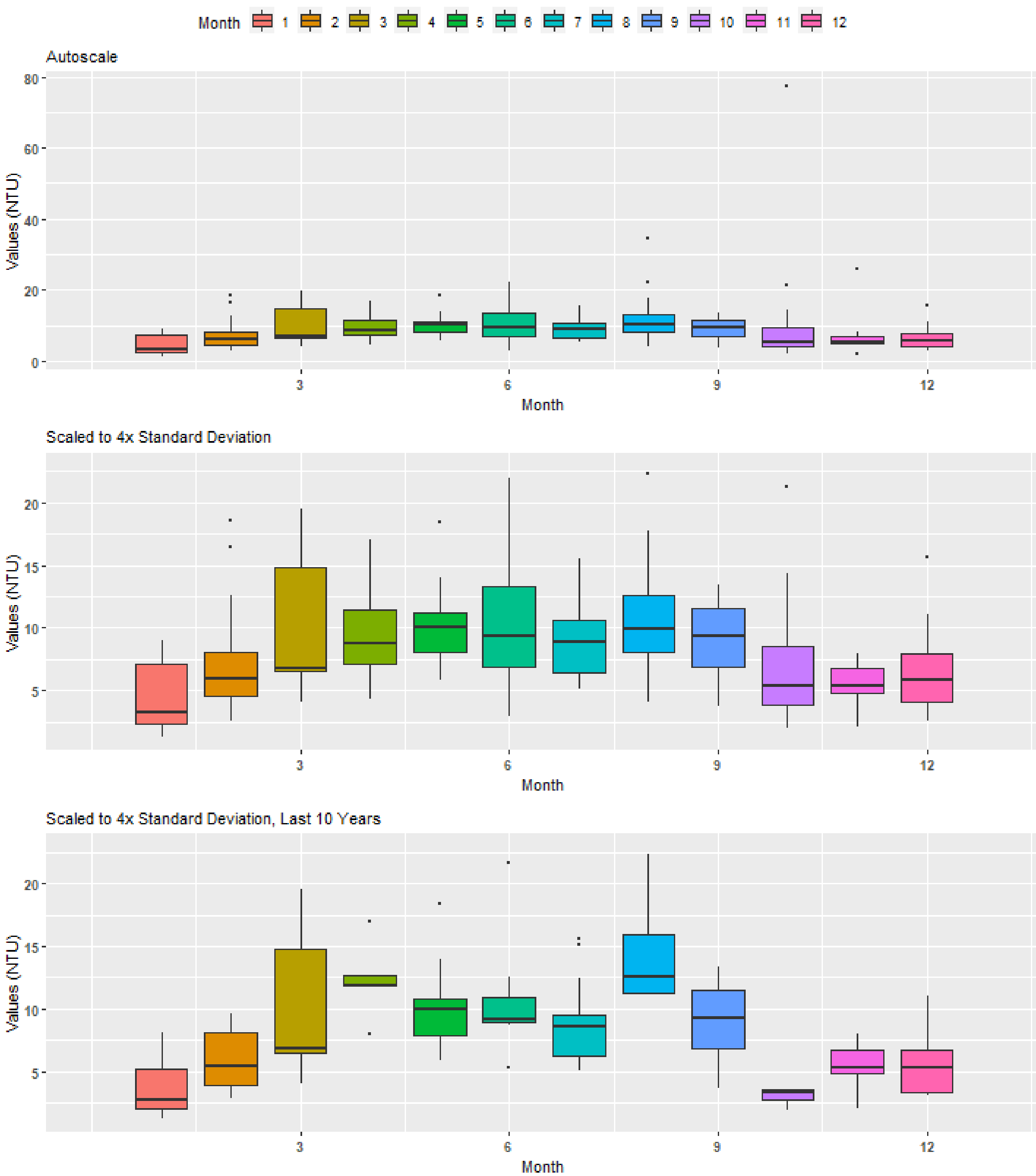
By Year



Summary Box Plots for Tomoka Marsh Aquatic Preserve

By Year & Month

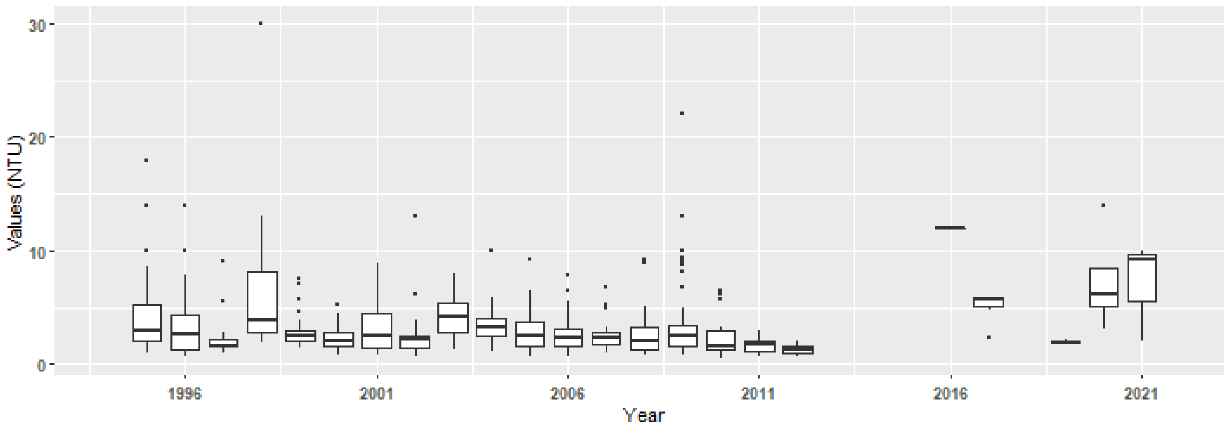
Summary Box Plots for Tomoka Marsh Aquatic Preserve
By Month



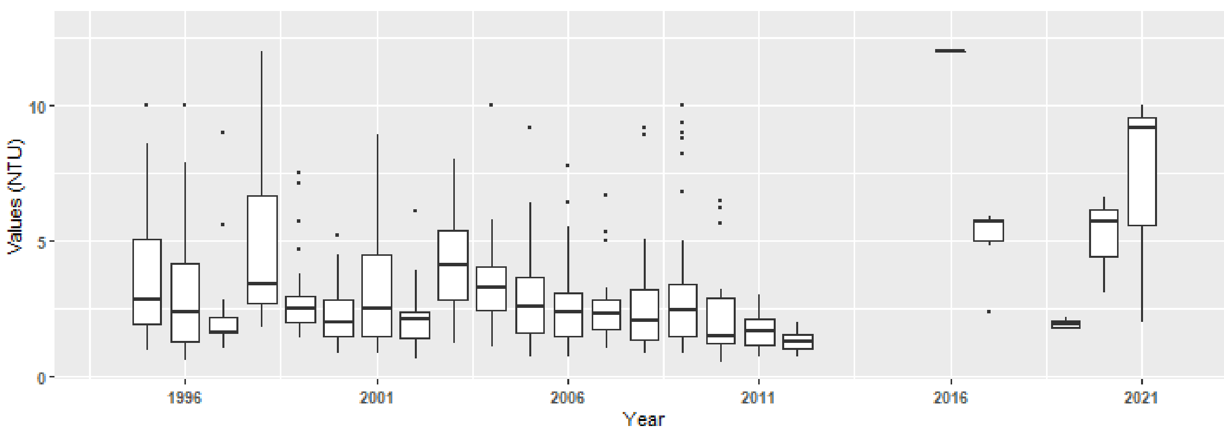
Summary Box Plots for Yellow River Marsh Aquatic Preserve

By Year

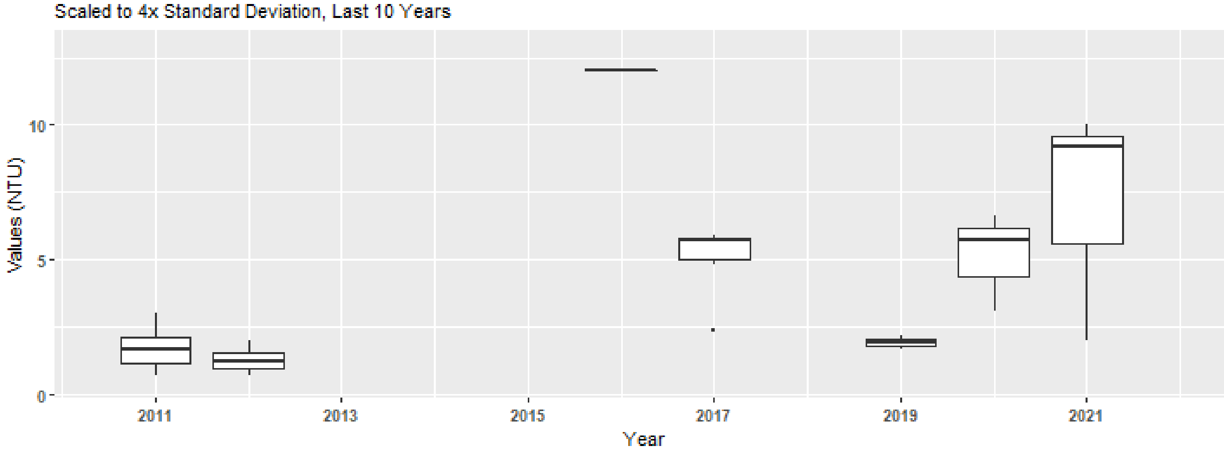
Autoscale



Scaled to 4x Standard Deviation



Scaled to 4x Standard Deviation, Last 10 Years



Summary Box Plots for Yellow River Marsh Aquatic Preserve

By Year & Month

Summary Box Plots for Yellow River Marsh Aquatic Preserve
By Month