Appendix C: Statistical/Bayesian Lake Model

Section 1: Introduction

The main lake modeling report summarizes development of the UNRBA statistical/Bayesian lake model. This appendix provides additional detail on the development in the following sections:

1. This section describes **data preparation** and how raw data were gathered, formatted, screened, and quality assured. There is a separate file for each source of data that may include multiple model variables.
2. This section describes the **merging** of the formatted data sets for each model variable.
3. This section provides **data summaries** for merged data sets as distributions and as time series shaded by model bins
4. This section describes defining the **model nodes** and assignment of model bins
5. This section describes creation of the **conditional probability tables** for the modeled bins
6. This section summarizes the results of the **sensitivity analysis**

This appendix represents the compilation of model code and script outputs to document the modeling. Other than formatting section headers for organization, no additional formatting has been conducted. Due to the length of this appendix, it has been created in Microsoft Word in three parts and then compiled as a single pdf.

Section 2: Data Preparation

2.1 Falls Lake CAAE Data

2.1.1 Raw Data

This file prepares CAAE data provided by L. Strader and A. Matos **CAAE_Durham_2002to2018_FORMATTED_v2.xlsx.** The Excel spreadsheet contains multiple worksheets. We use the **2014 to 2018 Photic Data** worksheet. This file is only used to prepare CAAE data because all Durham data were received and processed from other source files.

```
openxlsx::getSheetNames(here::here(rawFile))

## [1] "2014 to 2018 Photic Data" "DurhamData_Historic"
## [3] "CAAE_Profile"             "Durham Profile"
## [5] "CAAESites"                "CAAESiteTypes"
## [7] "DurhamSites"

caae <- readxl::read_excel(here::here(rawFile),
  sheet = "2014 to 2018 Photic Data", na = c("NA", ""))


names(caae)

##  [1] "station_name"    "m_date"         "Secchi depth, m" "depth_m"
##  [5] "depth_type"      "c_depth_1"      "c_depth_2"       "parameter"
##  [9] "value"           "qcode"          "max_rl"          "MonOrg"
```

2.1.1.1 Drop NA value records

There are 15 records with no measurement data. These are dropped from the analysis.

```
caae <- dplyr::filter(caae, !is.na(value))
```

2.1.1.2 Drop Unused Columns

We removed the qcode column. This column may contain information relevant to data qaqc and may have useful information to filter out bad rows, but we did not have a data dictionary to interpret codes.

```
cat(paste0("- ", paste0(sort(unique(caae$qcode)), " (N = ", table(caae$qcode), ")"), collapse = "\n"))

## - A (N = 119)
## - A, (N = 445)
## - J,A (N = 6)
## - J,J7,A (N = 3)
## - J2 (N = 8)
## - J2, J2, A (N = 1)
## - J4 (N = 13)
## - J4,Q (N = 2)
## - J7,A (N = 1)
## - L,U (N = 52)
## - L,U, A (N = 3)
## - Q (N = 10)
## - Q, A (N = 1)
## - R,A (N = 1)
## - U (N = 203)
## - U, A (N = 96)
## - U, A, (N = 1)
## - U, U, A (N = 6)
## - U,A (N = 52)
## - U,L, A (N = 7)

caae <- caae %>% dplyr::select(-qcode)
```

2.1.1.3 Data Source

The CAAE file includes data sourced from both CAAE and Durham, but only the CAAE data are prepared here.

```
cat(paste0("- ", paste0(sort(unique(caae$MonOrg)), " (N = ", table(caae$MonOrg), ")"), collapse = "\n"))

## - CAAE (N = 3125)
## - Durham (N = 1706)

# Remove Durham data (because received elsewhere)
caae <- caae %>%
  dplyr::filter(MonOrg != "Durham")
```

We removed all Durham data, after confirming these are received and processed elsewhere (**dataPrep_durmCity.rmd**).

2.1.1.4 Stations

The data have been collected from 17 stations. Coordinates for the station were provided in the worksheet **CAAESites**.

```
cat(paste0("- ", paste0(sort(unique(caae$station_name)), " (N = ", table(caae$station_name), ")"), colla
pse = "\n"))
```

```
## - FL1 (N = 220)
## - FL10C (N = 49)
## - FL11C (N = 50)
## - FL1C (N = 50)
## - FL2 (N = 220)
## - FL3 (N = 225)
## - FL4 (N = 216)
## - FL5 (N = 193)
## - FL50C (N = 516)
## - FL6 (N = 252)
## - FL6C (N = 48)
## - FL7C (N = 49)
## - FL85C (N = 451)
## - FL8C (N = 50)
## - FL9C (N = 50)
## - FLINC (N = 471)
## - LC1 (N = 15)
```

```
gisCAAE <- readxl::read_excel(here::here(rawFile),
  sheet = "CAAESites") %>%
  dplyr::select(STATIONID = Name, STATION = LongName, LAT = Lat, LONG = Long) %>%
  sf::st_as_sf(coords = c("LONG", "LAT")) %>%
  sf::st_set_crs(4326)

leaflet() %>%
  addTiles() %>%
  addCircleMarkers(data = gisCAAE, label = ~htmltools::htmlEscape(STATIONID),
                   labelOptions = labelOptions(noHide = T))
```

2.1.1.5 Variables

The data include measurements for 13 variable:

```
cat(paste0("- ", paste0(sort(unique(caae$parameter)), " (N = ", table(caae$parameter), ")"), collapse = "
\n"))
```

```
## - Ammonia Nitrogen as N, mg/l (N = 279)
## - Chlorophyll-a, ug/l (N = 875)
## - Dissolved Oxygen, mg/l (N = 5)
## - Nitrate-Nitrite as N, mg/l (N = 278)
## - Organic N - calculated, mg/l (N = 278)
## - pH (N = 6)
## - Specific Conductivity, uS/cm (N = 6)
## - Total Kjeldahl Nitrogen as N, mg/l (N = 278)
## - Total N - calculated, mg/l (N = 278)
```

```
## - Total Organic Carbon, mg/l (N = 279)
## - Total Phosphorus as P, mg/l (N = 278)
## - Total Suspended Solids, mg/l (N = 279)
## - Water Temperature, C (N = 6)
```

2.1.1.6 Standardize SOURCE and STATION information

We tested and confirmed that there are NOT multiple samples per site-day-depth. We also confirmed that there are NOT multiple samples from the same site-day and multiple depths.

We assigned the SOURCE as "caae" and created a unique SOURCEID from the STATIONID + MonOrg + m_date + depth_m columns.

```
# confirm that there are NOT multiple samples per site-day-depth
test1 <- caae %>%
  dplyr::group_by(station_name, m_date, depth_m, parameter) %>%
  dplyr::summarize(N = n(), .groups = "drop")
# sum(test1$N > 1) # zero sites

# confirm that there are NOT multiple samples per site-day - collected from different depths
test2 <- caae %>%
  dplyr::group_by(station_name, m_date, parameter) %>%
  dplyr::summarize(N = n(), MinDepth = min(depth_m), MaxDepth = max(depth_m), .groups = "drop")
# sum(test2$N > 1) # zero sites

caae <- caae %>%
  dplyr::rename(STATIONID = station_name) %>%
  dplyr::mutate(SOURCE = "caae",
                SOURCEID = paste(STATIONID, MonOrg, m_date, depth_m, sep = "_"),
                SOURCETYPE = "Empirical")

caae <- dplyr::left_join(caae, st_drop_geometry(gisCAAE), by = c("STATIONID"))

rm(test1, test2)
```

2.1.1.7 Standardize DATE information

```
caae$m_date <- format(caae$m_date, format = "%Y-%m-%d %H:%m") #converts m_date(POSIXct) to ch
aracter
caae$m_date <- as.Date(caae$m_date, "%Y-%m-%d") #converts m_date to Date

# original
caae <- caae %>%
  dplyr::mutate(DATE = m_date,
                MONTH = lubridate::month(DATE, label = TRUE, abbr = TRUE),
                YEAR = lubridate::year(DATE)) %>%
  dplyr::select(-m_date)

table(caae$YEAR, caae$MONTH)
```

```
##
##       Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##   2014   0   0   0   0   0   0   0  20  16  16  15  19
##   2015  20  13  16  20  16  16  16  16  16  16  16  16
##   2016   9  16  16 100 100 109 118 109 109  55 113 109
##   2017 100 109  82  82 109 108 100 105  97  72  63  27
##   2018  62  60  81  91 109 109 100 100  55  58   0   0
```

The data include samples from 138 dates spread across 5 years.

2.1.1.8 Apply lake unit and location classification

```
# Create the LAKEUNIT column
# Make sure all site names in the lookup list source_setupDictionaries
# all(caae$STATIONID %in% names(lakeUnitList))
caae <- assignLAKEUNIT(df = caae, siteNameColumn = "STATIONID", lakeUnitList = lakeUnitList)

# Create the LOCATE column
# Make sure all site names in the lookup list source_setupDictionaries
# all(caae$STATIONID %in% names(locateList))
caae <- assignLOCATE(df = caae, siteNameColumn = "STATIONID", locateList = locateList)
```

2.1.1.9 Handling Non-Detects

```
caae <- caae %>%
  dplyr::mutate(belowRL = if_else(value >= max_rl, FALSE, TRUE))
```

The data provide information about reporting limits:

0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 278, 0, 0, 0, 0, 0, 278, 0, 0, 0, 0, 0, 0, 0, 0, 0, 279, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 278, 0, 0, 278, 278, 0, 0, 0, 0, 0, 875, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 279, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 279, 0

Most measures were consistently above reporting limits (FALSE = Above limits; TRUE = Below limits):

99, 875, 0, 104, 278, 0, 0, 278, 278, 279, 278, 278, 0, 180, 0, 0, 174, 0, 0, 0, 0, 0, 0, 0, 1, 0

```
Test <- caae %>% dplyr::filter(belowRL == TRUE)
#nrow(Test)
#sum((2*Test$value)-Test$max_rl) # zero because all ND values appropriately entered as halve of limits

# remove the limit data because not needed
caae <- caae %>% dplyr::select(-max_rl, -belowRL)
```

All of the non-detect (below reporting) values appear to have been correctly entered as half of the parameter reporting limit. No changes were necessary.

2.1.1.10 Excluding Non-Photic Zone

There were many samples deeper than the photic zone, if “photic zone” is defined as 2x the secchi depth. We removed all these records and confirmed that all remaining samples were photic zone. We then removed the composite depth columns (c_depth_1 and c_depth_2) and standardized the depth column names.

After tidying the depth data, we pulled the Secchi depth column out from the dataframe and restructured the data so secchi depth would be an additional parameter. We appended the secchi data as additional row observations.

```
# sum(is.na(caae$depth_m)) # 10
# sum(is.na(caae$`Secchi depth, m`)) # 10
caae <- caae %>%
  # TRUE if sample from photic zone
  dplyr::mutate(Test = depth_m <= (2* `Secchi depth, m`)) %>%
  # Exclude all non-photic
  dplyr::filter(Test == TRUE) %>%
  dplyr::select(-c_depth_1, -c_depth_2, -Test) %>%
  dplyr::rename(DEPTHM = depth_m,
                DEPTHTYPE = depth_type)
# table(caae$Test) # put test back in above code to test tally of T/F values
table(caae$DEPTHTYPE)

##
##  calculated value composite- photic
##              554              2561

# Restructure data so secchi is a parameter rather than a column.

# remove parameter and value, then move secchi into those columns
secchi <- caae %>%
  dplyr::select(-parameter, -value) %>%
  dplyr::mutate(parameter = "Secchi Depth, m",
                value = `Secchi depth, m`) %>%
  dplyr::select(-`Secchi depth, m`) %>%
  dplyr::distinct()
# all but secchi data
caae <- caae %>% dplyr::select(-`Secchi depth, m`)
# rbind the new secchi structure to the caae data as an additional parameter
caae <- rbind(caae, secchi)
```

2.1.1.11 Remove the “Other Lake” Records

The data include records from Beaverdam Lake (FL3) which is excluded from our study.

```
table(caae$LAKEUNIT)

##
##      Upper     Middle      Lower Other Lake
##       1519       1181       1295        275

caae <- caae %>%
 dplyr::filter(!LAKEUNIT == "Other Lake")
```

2.1.1.12 Tidy parameter labels

We standardized labeling of some parameters, as follows:

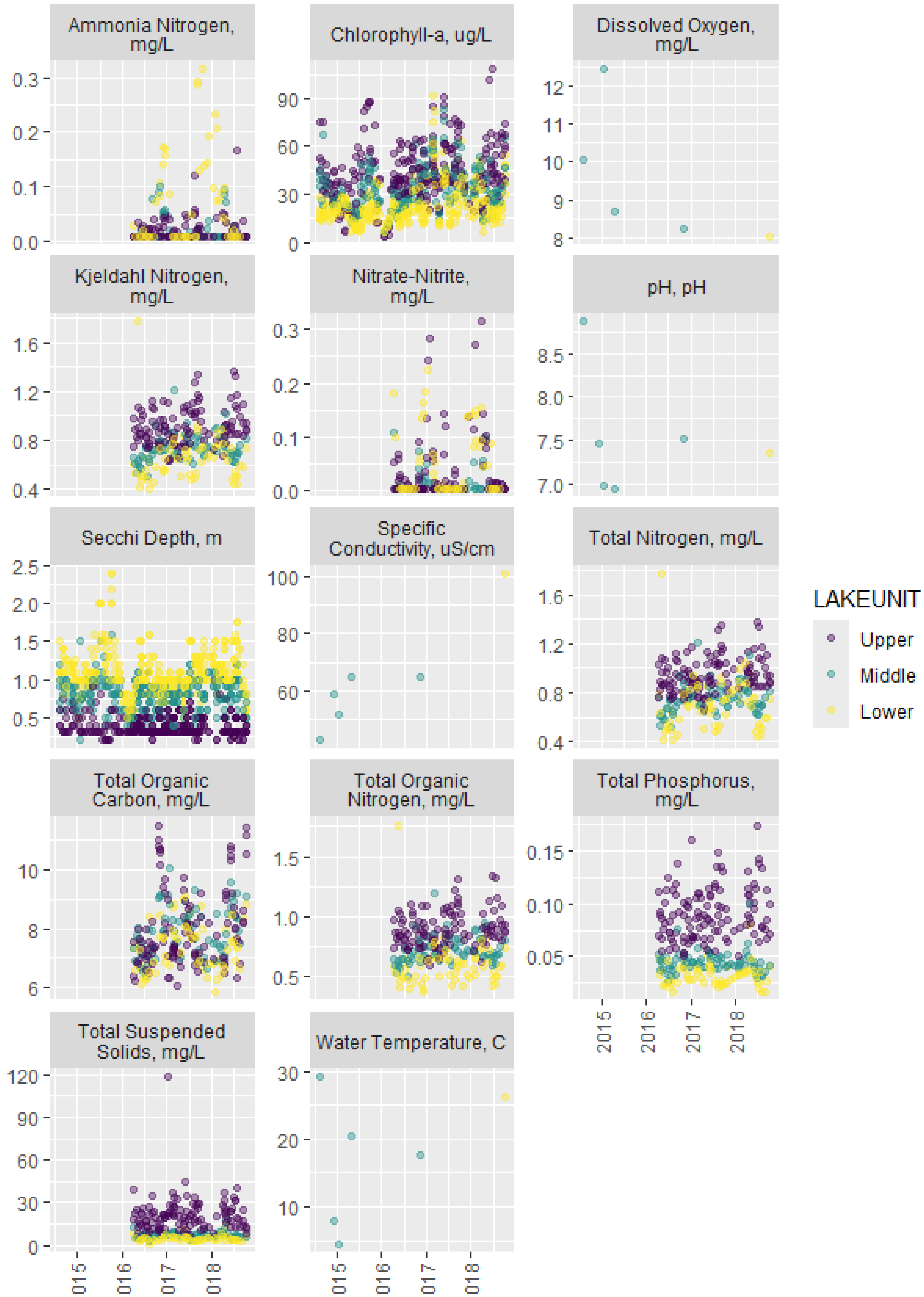
- “Nitrate-Nitrite as N” to “Nitrate-Nitrite”
- “Ammonia Nitrogen as N” to “Ammonia Nitrogen”
- “Total Kjeldahl Nitrogen as N” to “Kjeldahl Nitrogen”
- “Total Phosphorus as P” to “Total Phosphorus”
- “Organic N - calculated” to “Total Organic Nitrogen”
- “Total N - calculated” to “Total Nitrogen”
- “Total Ortho-Phosphate as P” to “Total Orthophosphate”

Measurements are recorded as “composite-photic” samples or “calculated values”. We labeled all records as DEPTHTYPE == “Photic Composite” and used the VARTYPE column to distinguish “Empirical” from “Calculated” values.

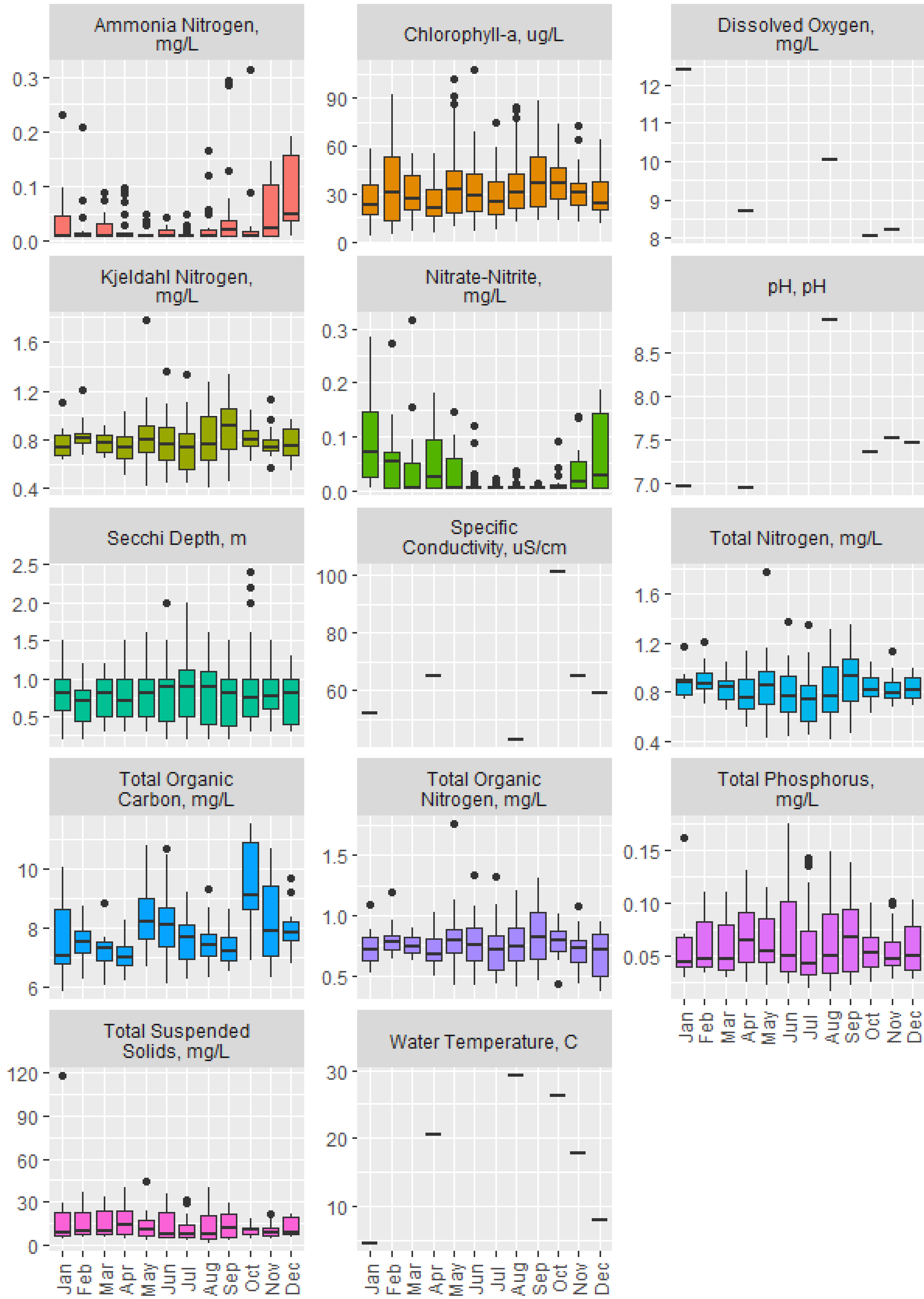
```
caae <- caae %>%
  dplyr::rename(VALUE = value) %>%
  dplyr::mutate(MEASUNIT = gsub("^.*,\\s", "", parameter),
         MEASUNIT = gsub("/l", "/L", MEASUNIT),
                VARIABLE = gsub(",\\s.*$", "", parameter),
                VARIABLE = gsub(" as N$", "", VARIABLE),
                VARIABLE = gsub(" as P$", "", VARIABLE),
                VARIABLE = gsub(" N - calculated$", " Nitrogen", VARIABLE),
                VARIABLE = gsub("Organic Nitrogen", "Total Organic Nitrogen", VARIABLE),
                VARIABLE = gsub("Ortho-Phosphate", "Orthophosphate", VARIABLE),
                VARIABLE = gsub("Total Kjeldahl", "Kjeldahl", VARIABLE),
                DEPTHTYPE = stringr::str_replace(DEPTHTYPE, "- ", "-"),
                VARTYPE = if_else(DEPTHTYPE == "calculated value", "Calculated", "Empirical"),
                DEPTHTYPE = "Photic Composite",
                VARLABEL = sprintf("%s, %s", VARIABLE, MEASUNIT)) %>%
  dplyr::select(SOURCE,   SOURCEID,   SOURCETYPE, DATE,   STATIONID,  STATION,    DEPTHM, DEPTHTY
PE, VARIABLE, VALUE, VARTYPE,    VARLABEL,   MEASUNIT,   YEAR,   MONTH,  LAKEUNIT,   LOCATE)
```

2.1.1.13 Quick Data Inspection

```
byDate <- ggplot() +
  geom_point(data = caae, aes(x = DATE, y = VALUE, color = LAKEUNIT, group = str_wrap(VARLABEL, 20)
), alpha = 0.4) +
  labs(x = "", y = "") +
  facet_wrap(~str_wrap(VARLABEL, 20), scales = "free_y", ncol = 3) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byDate
```

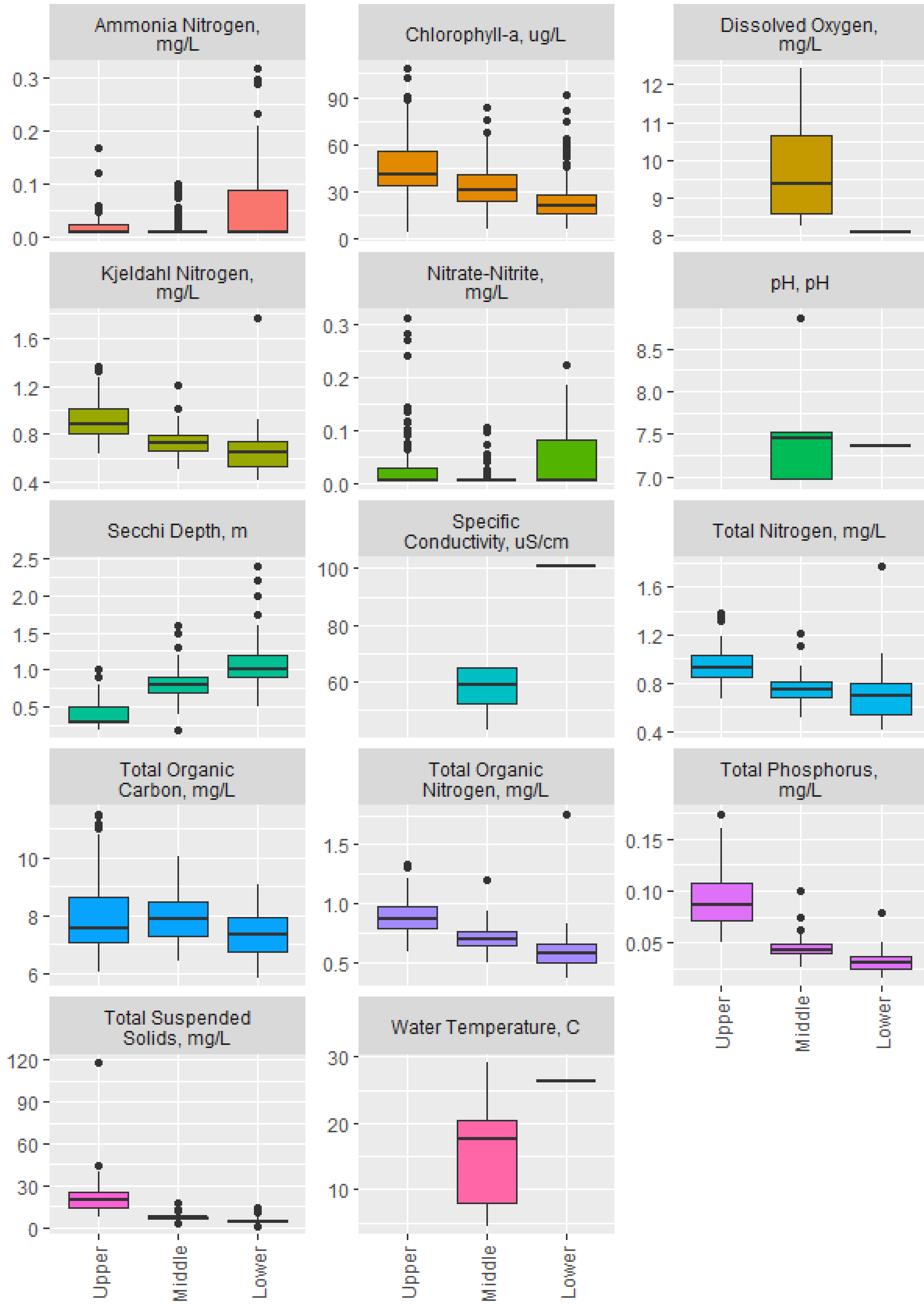

Ammonia Nitrogen, mg/L
Chlorophyll-a, ug/L
Dissolved Oxygen, mg/L
Kjeldahl Nitrogen, mg/L
Nitrate-Nitrite, mg/L
pH, pH
Secchi Depth, m
Specific Conductivity, uS/cm
Total Nitrogen, mg/L
Total Organic Carbon, mg/L
Total Organic Nitrogen, mg/L
Total Phosphorus, mg/L
Total Suspended Solids, mg/L
Water Temperature, C
2015
2016
2017
2018
LAKEUNIT
Upper
Middle
Lower

```
#ggsave(plot = byDate, filename = here::here("Data/Tidy/dataPrep/Figures", "caae_byDate.png"), width
= 6.5, height = 8)

byMonth<- ggplot() +
  geom_boxplot(data = caae, aes(x = MONTH, y = VALUE, fill = str_wrap(VARLABEL, 20)), show.legend =
F) +
  labs(x = "", y = "") +
  facet_wrap(~str_wrap(VARLABEL, 20), scales = "free_y", ncol = 3) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byMonth
```



Ammonia Nitrogen, mg/L
Chlorophyll-a, ug/L
Dissolved Oxygen, mg/L
Kjeldahl Nitrogen, mg/L
Nitrate-Nitrite, mg/L
pH, pH
Secchi Depth, m
Specific Conductivity, uS/cm
Total Nitrogen, mg/L
Total Organic Carbon, mg/L
Total Organic Nitrogen, mg/L
Total Phosphorus, mg/L
Total Suspended Solids, mg/L
Water Temperature, C
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

```
#ggsave(plot = byMonth, filename = here::here("Data/Tidy/dataPrep/Figures", "caae_byMonth.png"), wi
dth = 6.5, height = 8)

byLakeunit<- ggplot() +
  geom_boxplot(data = caae, aes(x = LAKEUNIT, y = VALUE, fill = str_wrap(VARLABEL, 20)), show.legend
= F) +
  labs(x = "", y = "") +
  facet_wrap(~str_wrap(VARLABEL, 20), scales = "free_y", ncol = 3) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byLakeunit
```


Ammonia Nitrogen, mg/L
Chlorophyll-a, ug/L
Dissolved Oxygen, mg/L
Kjeldahl Nitrogen, mg/L
Nitrate-Nitrite, mg/L
pH, pH
Secchi Depth, m
Specific Conductivity, uS/cm
Total Nitrogen, mg/L
Total Organic Carbon, mg/L
Total Organic Nitrogen, mg/L
Total Phosphorus, mg/L
Total Suspended Solids, mg/L
Water Temperature, C
Upper
Middle
Lower

```
#ggsave(plot = byLakeunit, filename = here::here("Data/Tidy/dataPrep/Figures", "caae_byLakeunit.png")
, width = 6.5, height = 8)
```

2.1.1.14 Export tidy data

Originally exported the CAAE data as **caae_data.rds** and then each variable as it's own **caae_[variable].rds** file.

The data were originally saved to the Data/Tidy/dataPrep folder, but have been redirected to an appendix folder for final documentation and saved as csv

```
# Save complete prepped data
# saveRDS(caae, here::here("Data/Tidy/dataPrep", "caae_data.rds"))
# openxlsx::write.xlsx(caae, file = here::here("Data/Tidy/dataPrep", "caae_data.xlsx"))
readr::write_csv(caae, here::here("Data/Tidy/AppendixC", "caae_data.csv"))

# Save by variable to pass to the dataMerge files
wtemp <- caae %>%
  dplyr::filter(VARIABLE == "Water Temperature")
# saveRDS(wtemp, here::here("Data/Tidy/dataPrep", "caae_wtemp.rds"))
readr::write_csv(wtemp, here::here("Data/Tidy/AppendixC", "caae_wtemp.csv"))

toc <- caae %>%
  dplyr::filter(VARIABLE == "Total Organic Carbon")
# saveRDS(toc, here::here("Data/Tidy/dataPrep", "caae_toc.rds"))
readr::write_csv(toc, here::here("Data/Tidy/AppendixC", "caae_toc.csv"))

chla <- caae %>%
  dplyr::filter(VARIABLE == "Chlorophyll-a")
# saveRDS(chla, here::here("Data/Tidy/dataPrep", "caae_chla.rds"))
readr::write_csv(chla, here::here("Data/Tidy/AppendixC", "caae_chla.csv"))

do <- caae %>%
  dplyr::filter(VARIABLE == "Dissolved Oxygen")
# saveRDS(do, here::here("Data/Tidy/dataPrep", "caae_do.rds"))
readr::write_csv(do, here::here("Data/Tidy/AppendixC", "caae_do.csv"))

ammonia <- caae %>%
  dplyr::filter(VARIABLE == "Ammonia Nitrogen")
# saveRDS(ammonia, here::here("Data/Tidy/dataPrep", "caae_ammonia.rds"))
readr::write_csv(ammonia, here::here("Data/Tidy/AppendixC", "caae_ammonia.csv"))

ph <- caae %>%
  dplyr::filter(VARIABLE == "pH")
# saveRDS(ph, here::here("Data/Tidy/dataPrep", "caae_ph.rds"))
readr::write_csv(ph, here::here("Data/Tidy/AppendixC", "caae_ph.csv"))

tss <- caae %>%
```

```
  dplyr::filter(VARIABLE == "Total Suspended Solids")
# saveRDS(tss, here::here("Data/Tidy/dataPrep", "caae_tss.rds"))
readr::write_csv(tss, here::here("Data/Tidy/AppendixC", "caae_tss.csv"))

secchi <- caae %>%
  dplyr::filter(VARIABLE == "Secchi Depth")
# saveRDS(secchi, here::here("Data/Tidy/dataPrep", "caae_secchi.rds"))
readr::write_csv(secchi, here::here("Data/Tidy/AppendixC", "caae_secchi.csv"))

nkjeld <- caae %>%
  dplyr::filter(VARIABLE == "Kjeldahl Nitrogen")
# saveRDS(nkjeld, here::here("Data/Tidy/dataPrep", "caae_nkjeld.rds"))
readr::write_csv(nkjeld, here::here("Data/Tidy/AppendixC", "caae_nkjeld.csv"))

cond <- caae %>%
  dplyr::filter(VARIABLE == "Specific Conductivity")
# saveRDS(cond, here::here("Data/Tidy/dataPrep", "caae_cond.rds"))
readr::write_csv(cond, here::here("Data/Tidy/AppendixC", "caae_cond.csv"))

nitnit <- caae %>%
  dplyr::filter(VARIABLE == "Nitrate-Nitrite")
# saveRDS(nitnit, here::here("Data/Tidy/dataPrep", "caae_nitnit.rds"))
readr::write_csv(nitnit, here::here("Data/Tidy/AppendixC", "caae_nitnit.csv"))

orthotot <- caae %>%
  dplyr::filter(VARIABLE == "Total Orthophosphate")
# saveRDS(orthotot, here::here("Data/Tidy/dataPrep", "caae_orthotot.rds"))
readr::write_csv(orthotot, here::here("Data/Tidy/AppendixC", "caae_orthotot.csv"))

totaln <- caae %>%
  dplyr::filter(VARIABLE == "Total Nitrogen")
saveRDS(totaln, here::here("Data/Tidy/dataPrep", "caae_totaln.rds"))
readr::write_csv(totaln, here::here("Data/Tidy/AppendixC", "caae_totaln.csv"))

totalp <- caae %>%
  dplyr::filter(VARIABLE == "Total Phosphorus")
# saveRDS(totalp, here::here("Data/Tidy/dataPrep", "caae_totalp.rds"))
readr::write_csv(totalp, here::here("Data/Tidy/AppendixC", "caae_totalp.csv"))

ton <- caae %>%
  dplyr::filter(VARIABLE == "Total Organic Nitrogen")
# saveRDS(ton, here::here("Data/Tidy/dataPrep", "caae_ton.rds"))
readr::write_csv(ton, here::here("Data/Tidy/AppendixC", "caae_ton.csv"))
```

Code created by KDV Decision Analysis LLC and last run 2024-08-30 with R version 4.4.1 (2024-06-14 ucrt).

2.2 NC DEQ Algae and Chlorophyl-a

2.2.1 Major Data Revisions

In April 2023, we received updated data and had to completely redo these analysis, discarding the original data which had errors. The original analysis can be found on github in March/April 2023. The updates were pushed May/June 2023. Then a new algal classification was received late June and applied early July.

2.2.2 Data Sources

Daniel Wiltsie of DEQ (daniel.wiltsie@ncdenr.gov) originally (October 2021) provided algal data in two Excel worksheets: Blooms data and All algal data in the file **Falls Lake algal bloom data.xlsx** (now renamed with prefix **DONOTUSE**). These data contained columns:

- NCDWQTSN: agency's internal classification of algal species (code)
- Cells: the number of individual cells counted in the sample
- Units: the total number of algal units (colonies or filaments) counted in the sample

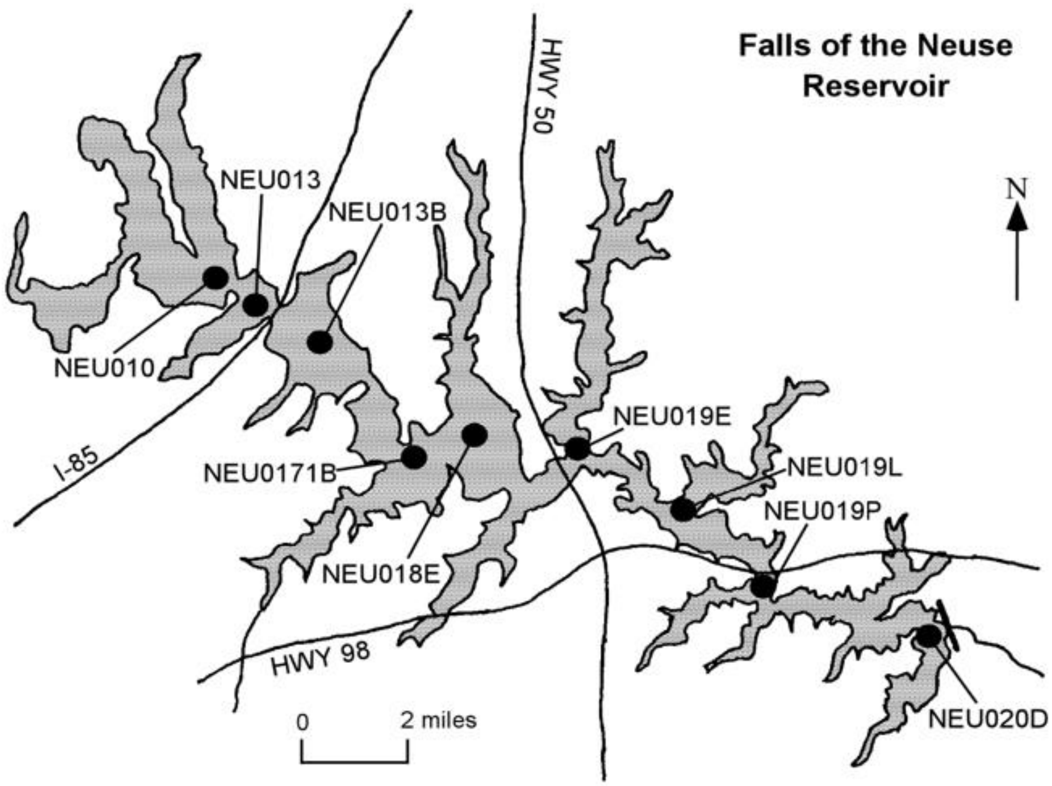
Noting differences between these data and data previously received from Elizabeth (2011-2018 routine sampling data), we received an updated version of the DEQ algal data and redeveloped the data prep code. The new data, in file **Falls of the Neuse algal data.xlsx** had a additional column (biovolume) which is the standardized measure that should be used for our work. The new data also included an additional worksheet with chlorophyll-a data.

- Biovolume: the volume of algae (mm3/m3) as calculated according to the agency's internal SOP documentation (included in the data folder on OneDrive)

We assigned each algal group to an algal type: Diatom, Green, Blue Green, Euglenophyte, Prymnesiophyte, and Other.

The NCDWR definition of a bloom is: >10,000 algal units/mL (unit density) OR >5,000 mm3/m3 (biovolume). Per D. Wiltsie, these are thresholds derived by local experts. These values may soon change based on more recent research from Duke (see notes in data folder on OneDrive).

D. Wiltsie provided this map of the sample sites:



Additional info about state sampling can be found at the DEQ Algal site

2.2.3 Algal Data

Immediately after reading in the data, we removed columns with constant data (*Waterbody*) or values which would not be immediately relevant to our analysis (*AsmtType* = Routine, Episodic, NA; *County*; *Basin*). We also assigned a *SOURCE* column a value "deqAlgae" and a uniquely valued SOURCEID column with pasted SiteCode + DateCollected + Row Number.

We also immediately removed any data missing the Genus, SiteCode, or DateCollected information.

We found records for a station "YAD178F3" which appears to be a Yadkin River site, so we removed all records for this site.

We found records for a site "NEU018B" and determined it was a non-existent site - a data entry error. D. Wiltsie reviewed the data and recommended these sites be relabelled as NEU013B. Per email to A. Drew 2023-01-06:

NEU018B only has this one sample collection date in 2006 and no associated description or lat/lon. I compared the other stations that were sampled that year and found that NEU013B was sampled during every other monitoring trip. So my best guess is that this was simply a typo when inputting the data into the database. Feel free to change NEU018B to NEU013B.

After inspection of the *ChemLabID* and *Smplid*, we also decided to remove these columns as we would not be using them.

We renamed StationDesc as **STATION** and SiteCode as **STATIONID**.

```
algae <- readxl::read_excel(here::here(rawFile), sheet = "All algal data", guess_max = 5000) %>%
  dplyr::mutate(SOURCE = "deqAlgae",
                SOURCEID = paste(dplyr::row_number(), SiteCode, DateCollected, sep = "_"))
```

```
# Quickly Inspect
# summary(algae)
# table(algae$Waterbody)
# dplyr::n_distinct(algae$SiteCode) # 14
# dplyr::n_distinct(algae$DateCollected) # 180
# sum(is.na(algae$Smplid)) # 0
# dplyr::n_distinct(algae$Smplid) # 493
# sum(is.na(algae$Smplid)) # 0
# dplyr::n_distinct(algae$ChemLabID) # 471
# sum(is.na(algae$ChemLabID)) # 155

algae <- algae %>%
   dplyr::select(-Waterbody, -AsmtType, -County, -Basin) %>%
   dplyr::filter(!is.na(Genus), !is.na(SiteCode), !is.na(DateCollected)) %>%
   dplyr::filter(SiteCode != "YAD178F3") %>%
  dplyr::mutate(SiteCode = if_else(SiteCode == "NEU018B", "NEU013B", SiteCode)) %>%
   dplyr::select(-Smplid, -ChemLabID) %>%
   dplyr::rename(STATION = StationDesc, STATIONID = SiteCode, GENUS = Genus)
```

After removing the few rows that had missing values for date, location, or genus values and the Yadkin River sites, 11597 rows remained. There are some 0 measures in the biovolume column - but we confirmed these are accurate, given the next highest measures are 1 etc (zeros sort as expected for true zero values.)

The data structure is as follows:

STATIONID	STATION	DateCollected	GENUS	Species	Cell Density (cells/mL)	Unit Density (units/mL)	Biovolume (mm3/m3)	SOURCE	SOURCEID
NEU019L	Falls of Neuse Res at Marker #6 nr Bayleaf	2001-08-27	Achnanthidium	sp p.	1878	1878	94	deqAlgae	1_NEU019L_2001-08-27
NEU019L	Falls of Neuse Res at Marker #6 nr Bayleaf	2001-08-27	Anabaena	circinalis	6418	313	417	deqAlgae	2_NEU019L_2001-08-27
NEU0	Falls of Neuse Res at Marker #6 nr Bayleaf	2001-	Ankistrodesmus	falcatus	313	313	9	deq	3_NEU019L_20

STATIONID	STATION	Date Collected	GENUS	Species	Cell Density (cells/mL)	Unit Density (units/mL)	Biovolume (mm3/m3)	SOURCE	SOURCE ID
19L		08-27						Algae	01-08-27
NEU019L	Falls of Neuse Res at Marker #6 nr Bayleaf	2001-08-27	Chlorella	sp p.	783	783	11	deqAlgae	4_NEU019L_2001-08-27
NEU019L	Falls of Neuse Res at Marker #6 nr Bayleaf	2001-08-27	Chromulina	sp p.	783	783	12	deqAlgae	5_NEU019L_2001-08-27
NEU019L	Falls of Neuse Res at Marker #6 nr Bayleaf	2001-08-27	Chroococcus	dispersus	17218	1565	9	deqAlgae	6_NEU019L_2001-08-27

2.2.3.1 Old vs New Data

The old data have quite different data and data structure and there was confusion in July 2023 about why older figures showed many Upper Lake data points but the new data showed very few. This was traced back to an earlier misclassification of site NEU013B as “Upper” instead of “Middle”. This site is the most upstream of the regular monthly sampling, but it is downstream of I85, our split point between upper and lower lake units.

New data Site-Year observations (NB, numbers reflect multiple observations per date-time sample) and site assignment to lake units:

```
new <- algae %>%
  dplyr::mutate(YEAR = lubridate::year(DateCollected))
lakeUnitList[names(lakeUnitList) %in% algae$STATIONID]

##          LC01          LI01        NEU013       NEU013B       NEU018E
##      "Middle"      "Middle"       "Upper"       "Upper"      "Middle"
##       NEU019L       NEU019P       NEU020D Sandling Beach         ELL10
##       "Lower"       "Lower"       "Lower"      "Middle"       "Upper"

table(new$YEAR, new$STATIONID)
```

```
##
##        ELL10 LC01 LI01 NEU013 NEU013B NEU018E NEU019L NEU019P NEU020D
##   2001     0    0    0      0       0       0      23       0       0
##   2005     0    0    0    121       0     107       0     109       0
##   2006   220    0    0     10     289     265       0     190       0
##   2007   128    0    0      0     178     207       0     199       0
##   2008     0    0    0      0       0       0       0       0       0
##   2010     0    0    0      0      21      18       0      30       0
##   2011     0    0    0      0     257     206       0     203      24
##   2012     0    0    0      0     233     281       0     290       0
##   2013     0    0    0      0     259     298       0     286       0
##   2014     0    0    0      0     293     329       0     302       0
##   2015     0    0    0      0     335     326       0     318      43
##   2016     0    0    0      0     310     305       0     291       0
##   2017     0    0    0      0     362     284       0     360       0
##   2018     0    0    0      0     224     279       0     287      45
##   2019     0    0    0      0     244     253       0     240       0
##   2020     0   28    0      0     217     252      13     231      39
##   2021     0    0   10      0     219     212       0     205       0
##   2022     0    0    0      0      76      76       0      89       0
##
##        Sandling Beach
##   2001              0
##   2005              0
##   2006              0
##   2007              0
##   2008             48
##   2010              0
##   2011              0
##   2012              0
##   2013              0
##   2014              0
##   2015              0
##   2016              0
##   2017              0
##   2018              0
##   2019              0
##   2020              0
##   2021              0
##   2022              0
```

Old data Site-Year observations (NB, numbers reflect multiple observations per date-time sample).

```
old <- readxl::read_xlsx(here::here(oldFile))
table(old$Year, old$SiteCode)
```

```
##
##       NEU013B NEU018E NEU019P NEU020D
##   2011    257     206     203       0
##   2012    233     281     290       0
##   2013    259     298     286       0
##   2014    293     329     302       0
##   2015    335     306     301       0
##   2016    300     284     246       0
##   2017    336     284     315       0
##   2018    224     262     287      45
```

```
sppList <- algae %>%
  dplyr::group_by(GENUS) %>%
  dplyr::summarize(N = n(),
                   N_species = dplyr::n_distinct(Species),
                   N_sites = dplyr::n_distinct(STATIONID),
                   N_dates = dplyr::n_distinct(DateCollected), .groups = "drop")
# sppList
# openxlsx::write.xlsx(sppList, file = here::here("Data/Tidy/dataPrep/Excel", "deqAlgae_RawGenera_summary.xlsx"), overwrite = TRUE)
```

The data provide measures for 93 genera.

Genera with the most observations:

- Centritractus, Chlorella, Cymbella, Ebria, Elakatothrix, Melosira, Phacotus, Tabellaria, Woronichinia, Chaetoceros, Cylindrotheca, Gyrodinium, Pyramimonas, Eunotia, Eudorina, Chroomonas, Closteriopsis, Pandorina, Sphaerocystis, Carteria

Genera observed at the most sites:

- Centritractus, Chaetoceros, Chlorella, Cymbella, Ebria, Elakatothrix, Melosira, Phacotus, Tabellaria, Woronichinia, Cylindrotheca, Eunotia, Gyrodinium, Pandorina, Pyramimonas, Acanthoceras, Closteriopsis, Eudorina, Gloeactinium, Golenkinia

Genera observed on the most dates:

- Centritractus, Chlorella, Cylindrotheca, Cymbella, Ebria, Elakatothrix, Melosira, Phacotus, Tabellaria, Woronichinia, Chaetoceros, Gyrodinium, Pyramimonas, Eudorina, Eunotia, Carteria, Chroomonas, Closteriopsis, Sphaerocystis, Pandorina

2.2.3.2 Tidy date and location information

```
rm(sppList)
#unique(algae$SiteCode)

algae <- algae %>%
  dplyr::rename(DATE = DateCollected) %>%
  dplyr::mutate(DATE = lubridate::as_date(DATE),
                MONTH = lubridate::month(DATE, label = TRUE, abbr = TRUE),
                YEAR = lubridate::year(DATE))
```

```
# Create the LAKEUNIT column
# Make sure all site names in the lookup list source_setupDictionaries
# all(algae$STATION %in% names(lakeUnitList))
algae <- assignLAKEUNIT(df = algae, siteNameColumn = "STATIONID", lakeUnitList = lakeUnitList)

# Create the LOCATE column
# Make sure all site names in the lookup list source_setupDictionaries
# all(algae$STATION %in% names(locateList))
algae <- assignLOCATE(df = algae, siteNameColumn = "STATIONID", locateList = locateList)

table(algae$YEAR, algae$LAKEUNIT)

##
##       Upper Middle Lower Other Lake
##   2001     0      0    23          0
##   2005   121    107   109          0
##   2006   519    265   190          0
##   2007   306    207   199          0
##   2008     0     48     0          0
##   2010    21     18    30          0
##   2011   257    206   227          0
##   2012   233    281   290          0
##   2013   259    298   286          0
##   2014   293    329   302          0
##   2015   335    326   361          0
##   2016   310    305   291          0
##   2017   362    284   360          0
##   2018   224    279   332          0
##   2019   244    253   240          0
##   2020   217    280   283          0
##   2021   219    222   205          0
##   2022    76     76    89          0

# upper <- dplyr::filter(algae, LAKEUNIT == "Upper", `Biovolume (mm3/m3)` != 0)
# table(upper$DATE, upper$LAKEUNIT)

algaeByYearSite <- algae %>%
  dplyr::group_by(YEAR, STATIONID) %>%
  dplyr::summarize(N_dates = dplyr::n_distinct(DATE), .groups = "drop") %>%
  tidyr::pivot_wider(id_cols = YEAR, names_from = STATIONID, values_from = N_dates)

# openxlsx::write.xlsx(algaeByYearSite, file = here::here("Data/Tidy/dataPrep/Excel", "deqAlgae_Sample
SitesYears_summary.xlsx"), overwrite = TRUE)

knitr::kable(algaeByYearSite)
```

YEAR	NEU019L	NEU013	NEU018E	NEU019P	ELL10	NEU013B	Sandling Beach	NEU020D	LC01	LI01
2001	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
2005	NA	4	4	4	NA	NA	NA	NA	NA	NA
2006	NA	1	7	8	6	8	NA	NA	NA	NA
2007	NA	NA	5	5	5	5	NA	NA	NA	NA
2008	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
2010	NA	NA	1	1	NA	1	NA	NA	NA	NA
2011	NA	NA	11	11	NA	12	NA	1	NA	NA
2012	NA	NA	12	12	NA	11	NA	NA	NA	NA
2013	NA	NA	12	12	NA	12	NA	NA	NA	NA
2014	NA	NA	12	12	NA	13	NA	NA	NA	NA
2015	NA	NA	12	12	NA	11	NA	1	NA	NA
2016	NA	NA	12	11	NA	12	NA	NA	NA	NA
2017	NA	NA	12	12	NA	12	NA	NA	NA	NA
2018	NA	NA	12	11	NA	10	NA	2	NA	NA
2019	NA	NA	12	11	NA	12	NA	NA	NA	NA
2020	1	NA	11	11	NA	11	NA	2	1	NA
2021	NA	NA	10	10	NA	10	NA	NA	NA	1
2022	NA	NA	3	3	NA	3	NA	NA	NA	NA

```
rm(algaeByYearSite)
```

There are 177 collection dates and 10 collection sites. However, in any given year, only a few sites were sampled.

2.2.3.3 Assign algae groups and types

The first dataset had a column algal group, but the new data do not. We created a lookup table from the original data to assist classification of the genera in these new data - but not all genera were easily classed based on other data. In email 2022-06-27, A. Matos suggested use of Group assignments as found in: **Phyto 2011 to 2018.xls**. Per A. Matos:

"I'm just seeing that Daniel gave you Genus only. I went back to the Phyto 2011 to 2018 xls and added a tab called GroupGenus. That data set had AlgalGroup and Genus so I made a look up table to map Genus -> Groups in Cells K:M. Still in the scientific names but we can change to Diatoms, Greens, etc. We probably should keep the Euglenoids and Prymnesiophytes as their own group and not lump those into Other."

The proposed classification ("FallsPhyto2011 to 2018.xlsx" in sheet "GroupGenus") unfortunately only labelled 71 of the 93 unique Genera found in the data. After pooling all algae data from all sources, we created and used an amended lookup table (**CurrentAlgaeChecklist_Reference.xlsx**).

```
# old incomplete file
# groupLu <- readxl::read_excel(here::here("Data/Raw/NC_DEQ/deqAlgae", "FallsPhyto2011 to 2018.xls
x"), sheet = "GroupGenus", range = "K1:M72")

# New complete file
groupLu <- readxl::read_excel(here::here(algaeLU))

# Join the groups
algae <- algae %>%
  dplyr::mutate(GENUS = stringr::str_to_title(GENUS)) %>%
  dplyr::left_join(groupLu, by = c("GENUS" = "GENUS")) %>%
  dplyr::rename(SPECIES = Species)

table(algae$ALGALGROUP)

##
## Bacillariophyta     Chlorophyta     Chrysophyta     Cryptophyta   Cyanobacteria
##            1741            4961             462             638            2574
##        Ebriidae    Euglenophyta  Prymnesiophyta     Pyrrhophyta    Raphidophyta
##               1             519             449             241              10
##     Xanthophyta
##               1

# Which genera remain unclassified?
# These are exported, compared to lists from other algae data and manually classified if possible
# The classified data are then read in and applied (DEQ_Algae/UnassignedGenera_Classified.xlsx)
# This was repeated until all had been assigned
unclassified <- dplyr::filter(algae, is.na(ALGALGROUP)) %>%
  dplyr::select(ALGALGROUP, GENUS) %>%
  dplyr::distinct()

rm(groupLu, unclassified)
```

2.2.3.4 Check measurement data and standardize names

```
# summary(algae) # No missing data in the measurement columns.

# Standardize names, pivot, and capture label and unit information.
algae <- algae %>%
  dplyr::rename(CellDens = `Cell Density (cells/mL)`,
                UnitDens = `Unit Density (units/mL)`,
                Biovolume = `Biovolume (mm3/m3)`) %>%
  tidyr::pivot_longer(cols = CellDens:Biovolume, names_to = "VARIABLE", values_to = "VALUE")

# Add columns to store description data about each observation.

units <- c("CellDens" = "cells/mL", "UnitDens" = "units/mL", "Biovolume" = "mm3/m3")
label <- c("CellDens" = "Algal Density (cells/mL)", "UnitDens" = "Algal Density (units/mL)", "Biovolume" =
"Biovolume (mm3/m3)")
vartype <- c("CellDens" = "Empirical", "UnitDens" = "Empirical", "Biovolume" = "Calculated")
variable <- c("CellDens" = "Cell Density", "UnitDens" = "Unit Density")

algae <- algae %>%
    dplyr::mutate(MEASUNIT = dplyr::recode(VARIABLE, !!!units),
                  VARLABEL = dplyr::recode(VARIABLE, !!!label),
                  VARTYPE = dplyr::recode(VARIABLE, !!!vartype),
                  VARIABLE = dplyr::recode(VARIABLE, !!!variable))
```

The algae data contain 34791 records covering 177 distinct event dates from 2001 to 2022. These data were collected at 10 stations. Within the bloom data, there are 11 distinct algal groups and 93 distinct algal genera.

2.2.3.5 Sample Method and Depth

Specific details of sample method or depth were not included in the spreadsheet. However, the SOP describes photic zone composite and surface grab sample methods. We labelled these data as “Photic, Composite” and left the actual depth as NA (because photic depth is unknown).

The variable type is assigned as “Count” for unit density and “Calculated” for cell density and biovolume. Specific calculation methods are described in the SOP.

```
# add standard columns
algae <- algae %>%
  dplyr::mutate(DEPTHM = NA_real_,
                DEPTHTYPE = "Photic Composite", # or grab?
                VARTYPE = if_else(stringr::str_detect(VARIABLE, "Unit"), "Count", "Calculated"),
                SOURCETYPE = "Empirical")
```

2.2.4 Chlorophyll-a Data

Some of the algae collections dates and sites also had chlorophyll-a data. We prepared these data in the same way.

Immediately after reading in the data, we removed columns which would not be relevant to our analysis (*Qualifier Code* = NA, J2, Q1, P, J4; *ChemLabId*; *StationDesc*). We also assigned a *SOURCE* column a value "deqAlgae" and a uniquely valued SOURCEID column with pasted SiteCode + DateCollected + Row Number.

We also immediately removed any data missing the Genus, SiteCode, or DateCollected information.

We found records for a station "YAD178F3" which appears to be a Yadkin River site, so we removed all the records for this site.

```
chla <- readxl::read_excel(here::here(rawFile),
                           sheet = "Chl a data", guess_max = 5000) %>%
  dplyr::filter(SiteCode != "YAD178F3") %>%
  dplyr::rename(STATIONID = SiteCode,
                STATION = StationDesc) %>%
  dplyr::mutate(DATE = lubridate::as_date(DateCollected),
                MONTH = lubridate::month(DATE, label = TRUE, abbr = TRUE),
                YEAR = lubridate::year(DATE),
                SOURCE = "deqAlgae",
                SOURCEID = paste(dplyr::row_number(), STATIONID, DATE, sep = "_")) %>%
  dplyr::select(-all_of(c("Qualifier Code", "ChemLabID", "DateCollected")))
```

2.2.4.1 Assign LAKEUNIT and LOCATE

```
# Create the LAKEUNIT column
# Make sure all site names in the lookup list source_setupDictionaries
# all(chla$STATION %in% names(lakeUnitList))
chla <- assignLAKEUNIT(df = chla, siteNameColumn = "STATIONID", lakeUnitList = lakeUnitList)

table(chla$LAKEUNIT)

##
##     Upper     Middle      Lower Other Lake
##       147        140        141          0

# Create the LOCATE column
# Make sure all site names in the lookup list source_setupDictionaries
# all(chla$STATION %in% names(locateList))
chla <- assignLOCATE(df = chla, siteNameColumn = "STATIONID", locateList = locateList)

table(chla$LOCATE)

##
##       Lake        Arm  Tributary  Watershed Other Lake
##        417         11          0          0          0
```

2.2.4.2 Assign VARIABLE with units, labels, etc

```
chla <- chla %>%
  dplyr::mutate(VARIABLE = "Chlorophyll-a",
                VARLABEL = "Chlorophyll-a, ug/L") %>%
  dplyr::rename(VALUE = Result, MEASUNIT = Units) %>%
  dplyr::select(-Lat, -Lon, -Parameter)
```

2.2.4.3 Assign Sample Method and Depth

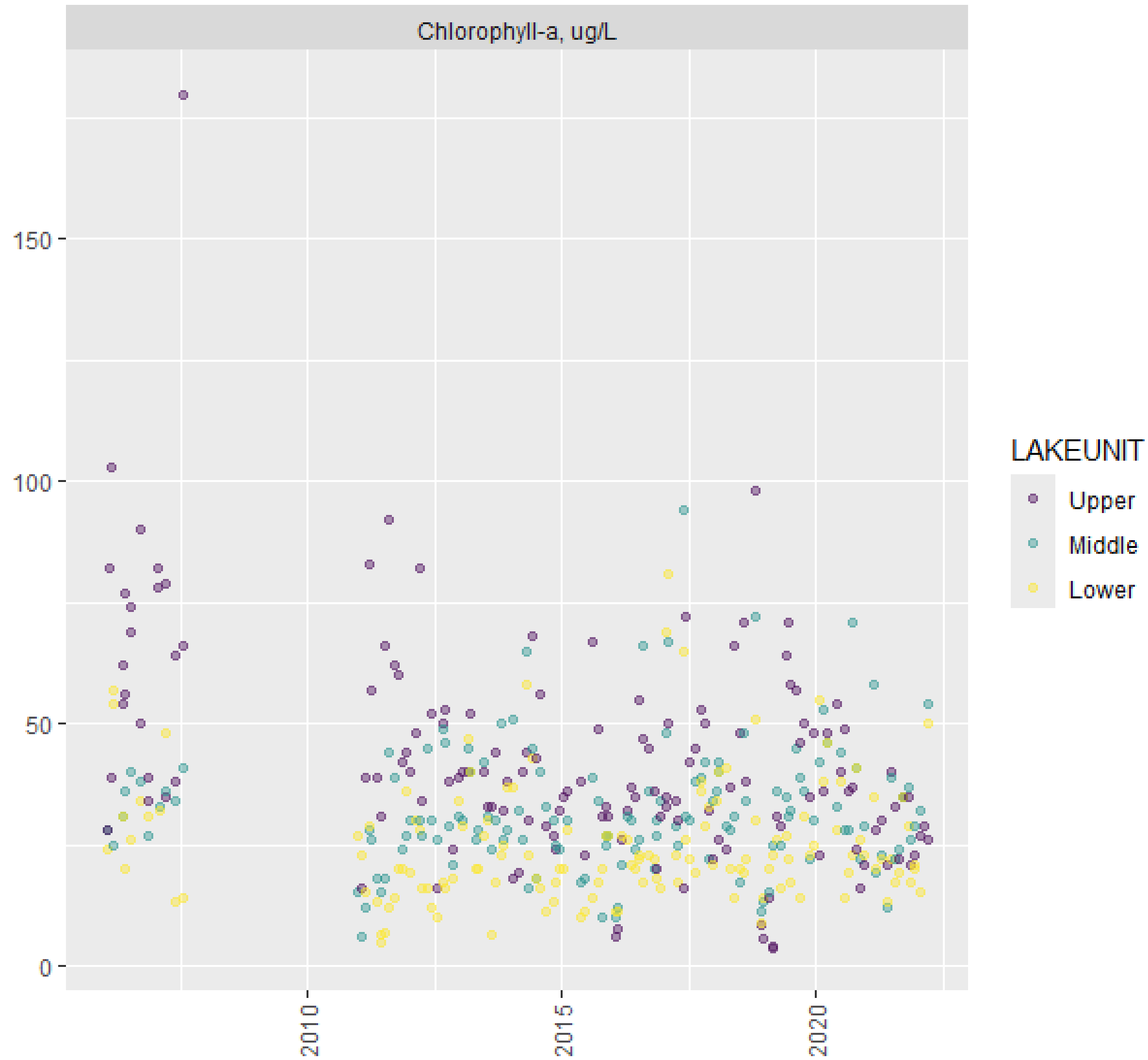
Specific details were not provided with the data, but based on the SOP we assigned:

- depth as “Photic, Composite” with measured depth of NA
- variable type as “Fluorometer, SM 445”

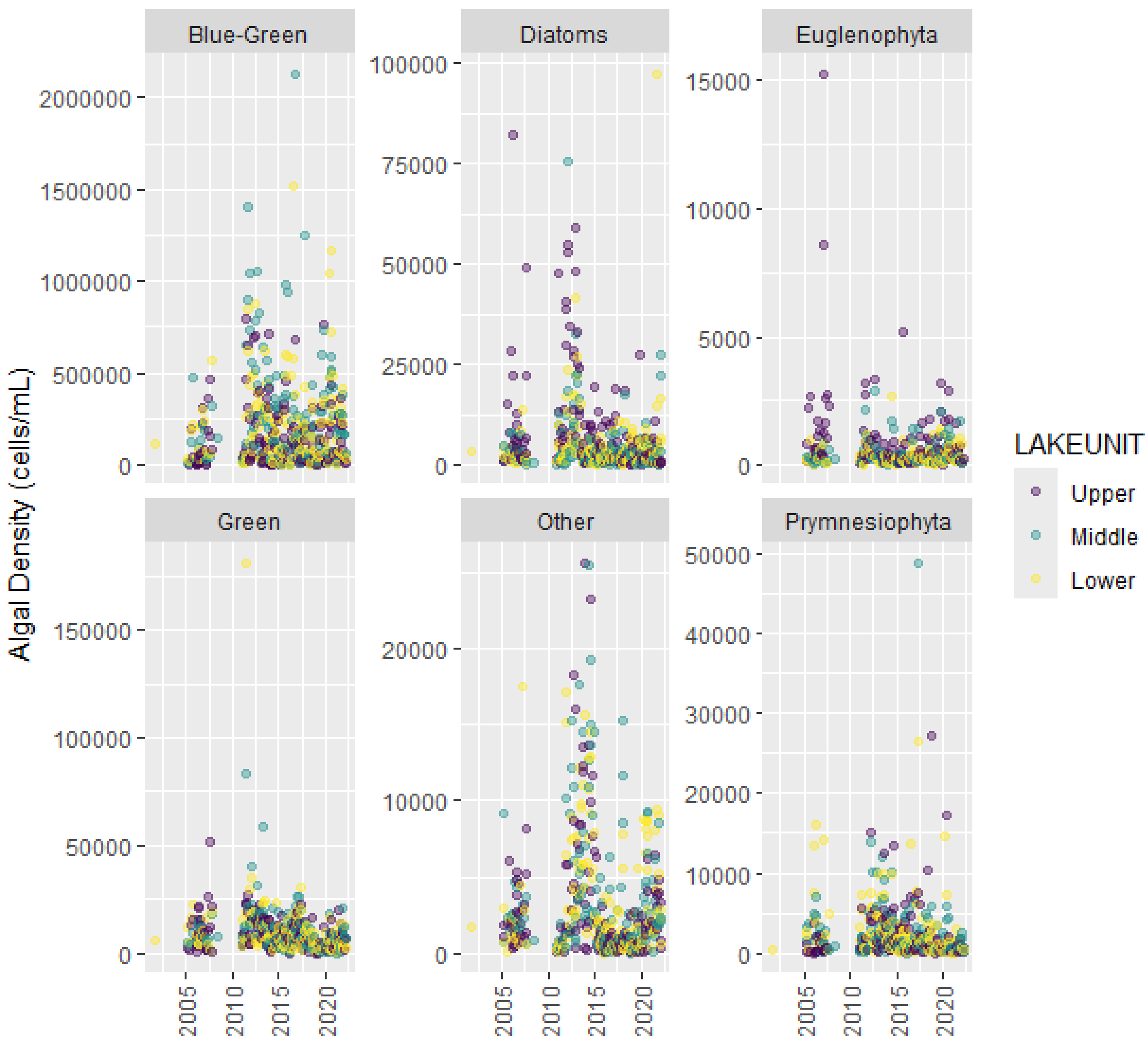
```
#final tidy to standard columns
chla <- chla %>%
  dplyr::mutate(DEPTHM = NA_real_,
                DEPTHTYPE = "Photic Composite", # or grab?
                VARTYPE = "Fluoromter, SM 445",
                SOURCETYPE = "Empirical") %>%
  dplyr::select(SOURCE, SOURCEID, SOURCETYPE, DATE, STATIONID, STATION, DEPTHM, DEPTHTY
PE, VARIABLE, VALUE, VARTYPE, VARLABEL, MEASUNIT, YEAR, MONTH, LAKEUNIT, LOCATE)
```

2.2.4.4 Quick Data Inspection

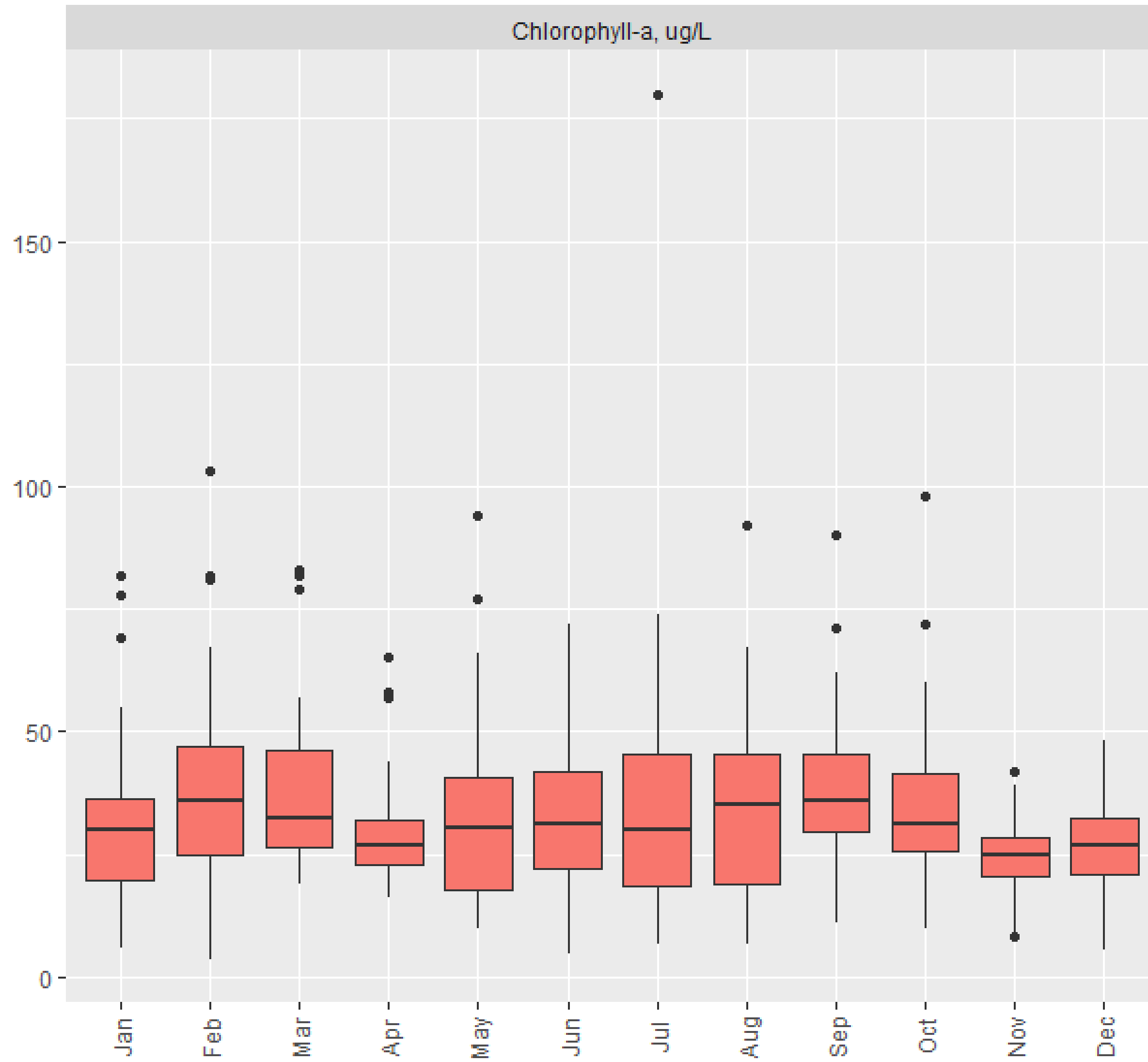
```
byDateChla <- ggplot() +
  geom_point(data = chla, aes(x = DATE, y = VALUE, color = LAKEUNIT, group = str_wrap(VARLABEL, 20)
), alpha = 0.4) +
  labs(x = "", y = "") +
  facet_wrap(~str_wrap(VARLABEL, 20), scales = "free_y", ncol = 3) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byDateChla
```



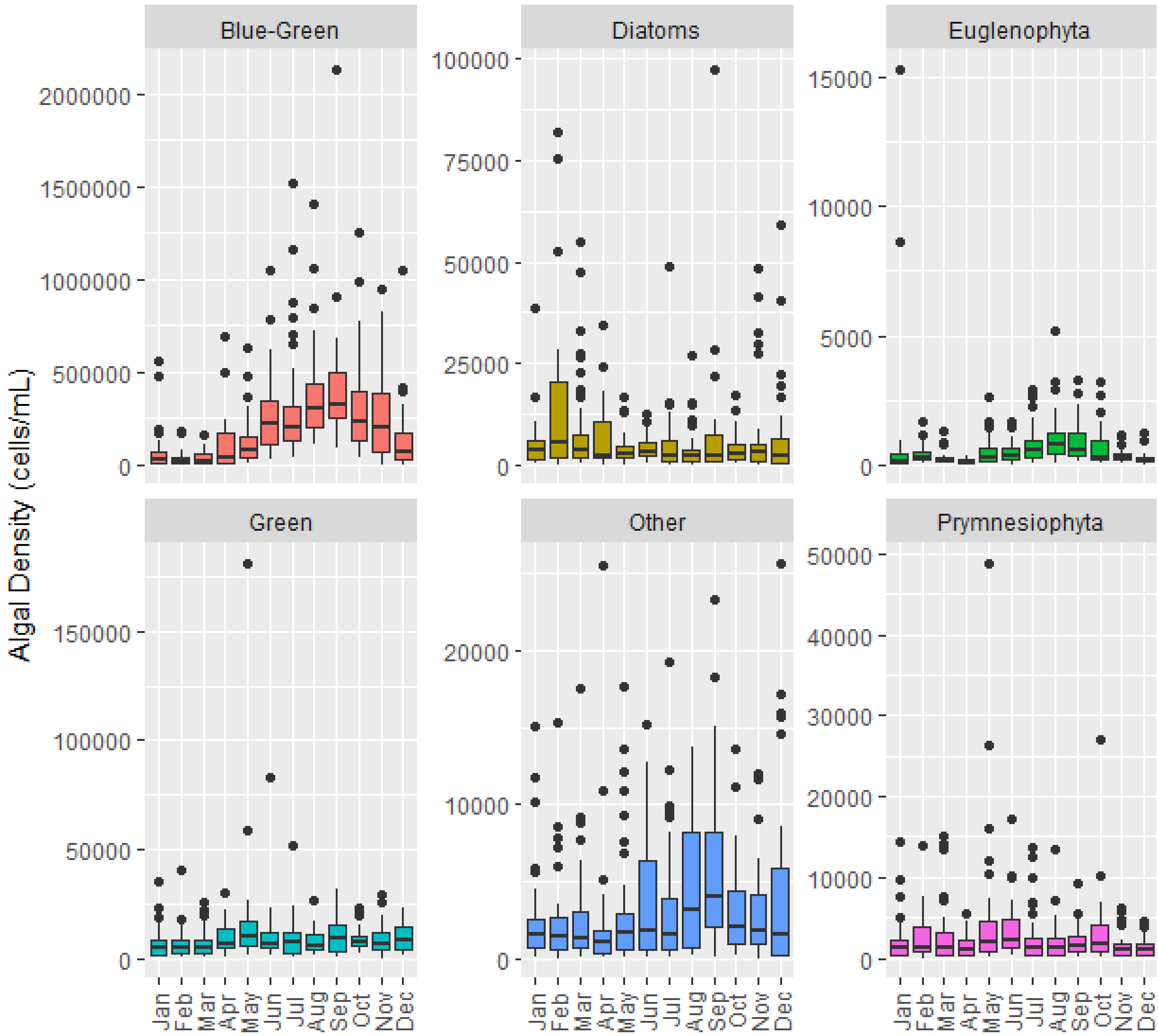

```
#ggsave(plot = byDateChla, filename = here::here("Data/Tidy/dataPrep/Figures", "deqAlgae_byDateChla
.png"), width = 6.5, height = 4)

byDateAlgae <- algae %>%
  dplyr::filter(VARIABLE == "Cell Density") %>%
  dplyr::group_by(DATE, STATIONID, LAKEUNIT, ALGALTYPE) %>%
  dplyr::summarize(Total = sum(VALUE, na.rm = T), .groups = "drop") %>%
  ggplot() +
  geom_point(aes(x = DATE, y = Total, color = LAKEUNIT, group = str_wrap(ALGALTYPE, 20)), alpha = 0.4
) +
  labs(x = "", y = "Algal Density (cells/mL)") +
  facet_wrap(~str_wrap(ALGALTYPE, 20), scales = "free_y", ncol = 3) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byDateAlgae
```



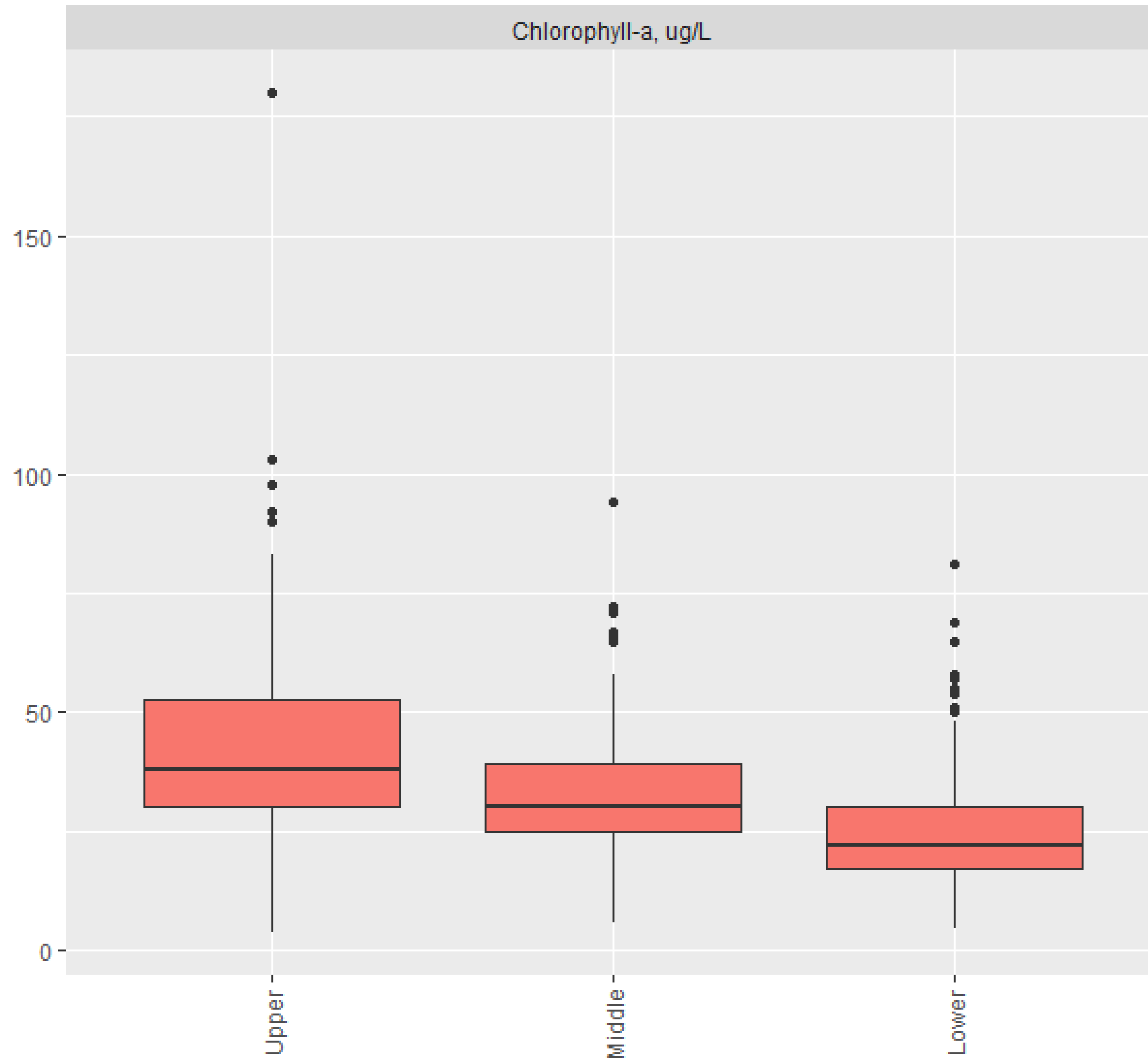

```
#ggsave(plot = byDateAlgae, filename = here::here("Data/Tidy/dataPrep/Figures", "deqAlgae_byDateAlgae.png"), width = 6.5, height = 6)

byMonthChla<- ggplot() +
  geom_boxplot(data = chla, aes(x = MONTH, y = VALUE, fill = str_wrap(VARLABEL, 20)), show.legend = F) +
  labs(x = "", y = "") +
  facet_wrap(~str_wrap(VARLABEL, 20), scales = "free_y", ncol = 3) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byMonthChla
```



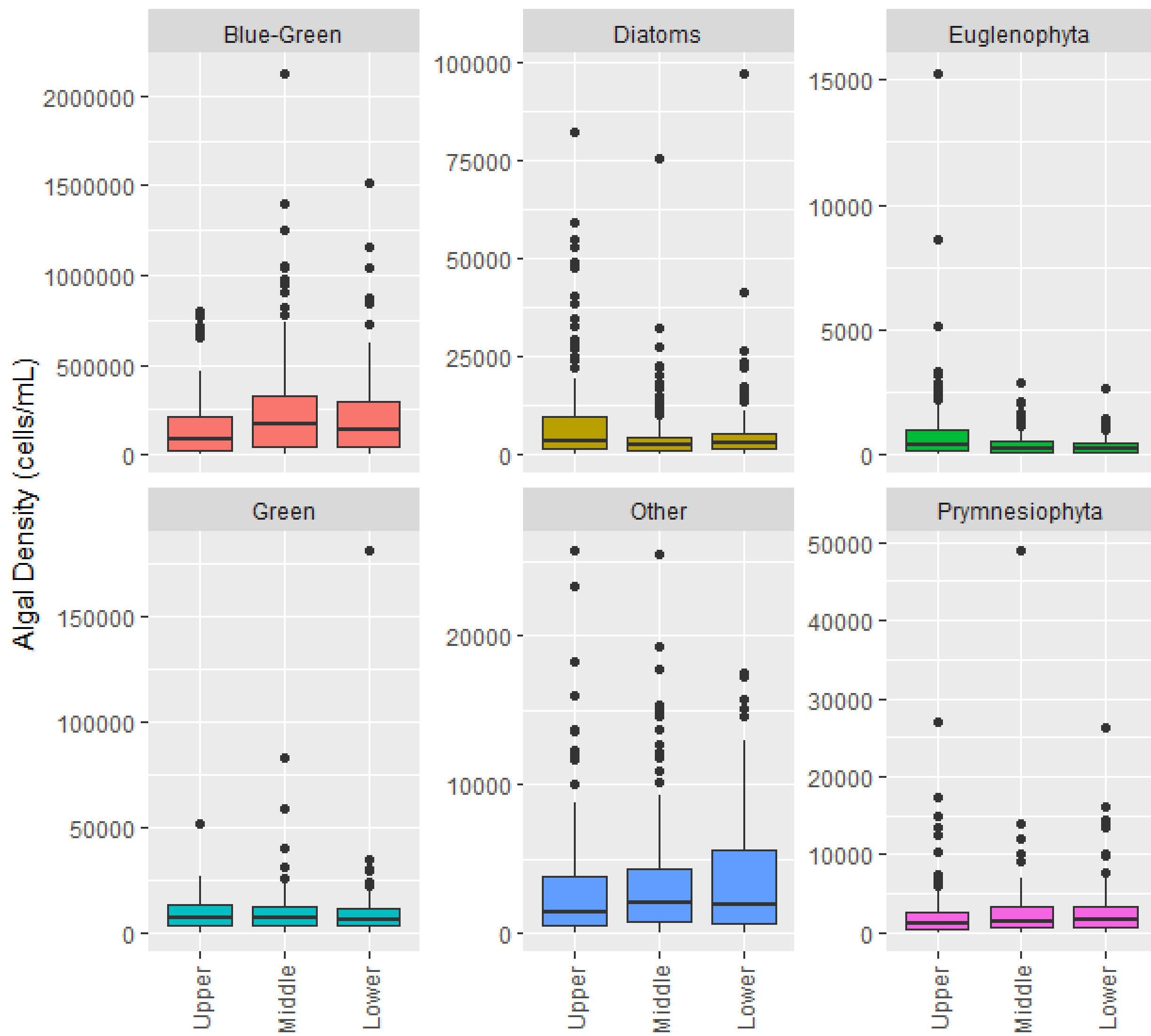

```r
#ggsave(plot = byMonthChla, filename = here::here("Data/Tidy/dataPrep/Figures", "deqAlgae_byMonth
Chla.png"), width = 6.5, height = 4)

byMonthAlgae <- algae %>%
  dplyr::filter(VARIABLE == "Cell Density") %>%
  dplyr::group_by(DATE, MONTH, STATIONID, LAKEUNIT, ALGALTYPE) %>%
  dplyr::summarize(Total = sum(VALUE, na.rm = T), .groups = "drop") %>%
  ggplot() +
  geom_boxplot(aes(x = MONTH, y = Total, fill = str_wrap(ALGALTYPE, 20)), show.legend = F) +
  labs(x = "", y = "Algal Density (cells/mL)") +
  facet_wrap(~str_wrap(ALGALTYPE, 20), scales = "free_y", ncol = 3) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byMonthAlgae
```




```
#ggsave(plot = byMonthAlgae, filename = here::here("Data/Tidy/dataPrep/Figures", "deqAlgae_byMont
hAlgae.png"), width = 6.5, height = 6)

byLakeunitChla <- ggplot() +
  geom_boxplot(data = chla, aes(x = LAKEUNIT, y = VALUE, fill = str_wrap(VARLABEL, 20)), show.legend
= F) +
  labs(x = "", y = "") +
  facet_wrap(~str_wrap(VARLABEL, 20), scales = "free_y", ncol = 3) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byLakeunitChla
```




```
#ggsave(plot = byLakeunitChla, filename = here::here("Data/Tidy/dataPrep/Figures", "deqAlgae_byLake
unitChla.png"), width = 6.5, height = 4)


byLakeunitAlgae<-  algae %>%
  dplyr::filter(VARIABLE == "Cell Density") %>%
  dplyr::group_by(DATE, STATIONID, LAKEUNIT, ALGALTYPE) %>%
  dplyr::summarize(Total = sum(VALUE, na.rm = T), .groups = "drop") %>%
  ggplot() +
  geom_boxplot(aes(x = LAKEUNIT, y = Total, fill = str_wrap(ALGALTYPE, 20)), show.legend = F) +
  labs(x = "", y = "Algal Density (cells/mL)") +
  facet_wrap(~str_wrap(ALGALTYPE, 20), scales = "free_y", ncol = 3) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byLakeunitAlgae
```




```
#ggsave(plot = byLakeunitAlgae, filename = here::here("Data/Tidy/dataPrep/Figures", "ecAlgae_byLakeunitAlgae.png"), width = 6.5, height = 6)
```

2.2.5 Export data

The full algae data are saved as **deqAlgae_data.rds.** Individual variables are saved as **deqAlgae_[].rds**.

The data were originally saved to the Data/Tidy/dataPrep folder, but have been redirected to an appendix folder for final documentation and saved as csv

```
# save chlorophyll-a
# saveRDS(chla, here::here("Data/Tidy/dataPrep", "deqAlgae_chla.rds"))
readr::write_csv(chla, here::here("Data/Tidy/AppendixC", "deqAlgae_chla.csv"))

# combine data
chlaPlus <- chla %>%
  dplyr::mutate(GENUS = NA_character_,
```

```
                            SPECIES = NA_character_,
                            ALGALTYPE = NA_character_,
                            ALGALGROUP = NA_character_)
algae <- rbind(algae, chlaPlus)

# save algae data (including the chla for same dates)
# saveRDS(algae, here::here("Data/Tidy/dataPrep", "deqAlgae_data.rds"))
# openxlsx::write.xlsx(algae, file = here::here("Data/Tidy/dataPrep/Excel", "deqAlgae_data.xlsx"), overwr
ite = TRUE)
readr::write_csv(algae, here::here("Data/Tidy/AppendixC", "deqAlgae_data.csv"))

# Then each algae metric is also saved separately:

bv <- dplyr::filter(algae, VARIABLE == "Biovolume")
# saveRDS(bv, here::here("Data/Tidy/dataPrep", "deqAlgae_biovolume.rds"))
readr::write_csv(bv, here::here("Data/Tidy/AppendixC", "deqAlgae_biovolume.csv"))

cd <- dplyr::filter(algae, VARIABLE == "Cell Density")
# saveRDS(cd, here::here("Data/Tidy/dataPrep", "deqAlgae_celldens.rds"))
readr::write_csv(cd, here::here("Data/Tidy/AppendixC", "deqAlgae_celldens.csv"))

ud <- dplyr::filter(algae, VARIABLE == "Unit Density")
# saveRDS(ud, here::here("Data/Tidy/dataPrep", "deqAlgae_unitdens.rds"))
readr::write_csv(ud, here::here("Data/Tidy/AppendixC", "deqAlgae_unitdens.csv"))
```

Code prepared by KDV Decision Analysis LLC. Code last run 2024-08-29 with R version 4.4.1 (2024-06-14 ucrt).

2.3 City of Durham (durmAlgae)

2.3.1 Data Source

Durham data were provided in the file **CompiledAlgalData_Durham.xlsx** with additional notes found in **Falls Lake Data- Phyto 2013_2022.xlsx**

```
raw <- readxl::read_xlsx(here::here(rawFile))

notes <- readxl::read_xlsx(here::here(notesFile))
```

2.3.2 Data Prep by UNRBA

The City of Durham Falls Lake algae data (**CompiledAlgalData_Durham.xlsx**) was prepared by BC (L. Strader). These data contain 1127 records from 2014 to 2021. The data were collected from 5 stations in the upper and middle lake units. We assigned lake unit to the stations as follows:

```
table(raw$`Corrected Station Name`)

##
##     D3-1    FL-ATS    FL-DS3    FL-DS4 FL-SR1801
##       33        24        52       166       852
```

```
lakeUnitList[names(lakeUnitList) %in% raw$`Corrected Station Name`]

##   FL-DS4 FL-SR1801     D3-1   FL-ATS   FL-DS3
##  "Upper"  "Upper"  "Upper"  "Upper"  "Upper"
```

2.3.2.1 UNRBA Data Prep Notes

L. Strader's notes (**Falls Lake Data- Phyto 2013_2022.xlsx**) from her preliminary preparations:

```
| Year|Site       |File Name
|----:|:----------|:--------------------------------------------------------------
| 2013|-          |-
| 2014|FL-DS3     |2014.06.16_Enco FallsLakeStudy10.016_Phytoplankton_AlgalBloom
| 2014|FL-SR1801  |NA
| 2014|FL-DS4     |NA
| 2014|FL-SR1801  |NA
| 2015|FL-DS4     |Phytoplankton 5-04-2015 mew revised
| 2015|FL-SR1801  |Phytoplankton 5-04-2015 mew revised
| 2015|FL-SR1801  |NA
| 2016|FL-DS4     |NA
| 2016|FL-SR1801  |NA
| 2016|FL-SR1801  |MAYBE_05301769 - 05301770- Phyto Plankton Data
| 2016|FL-DS4     |NA
| 2017|FL-DS4     |05301769 - 05301770- Phyto Plankton Data
| 2017|FL-SR1801  |05301769 - 05301770- Phyto Plankton Data
| 2017|FL-SR1801  |06121724- Falls Lake- Phyto Plankton- LMC
| 2017|FL-SR1801  |09051734- PhytoPlankton
| 2018|FL-SR1801  |05211819- Phyto Plankton
| 2018|FL-SR1801  |07021818- Phyto Plankton
| 2018|FL-DS4     |08061810- Phyto Plankton- LMC
| 2018|FL-SR1801  |08061810- Phyto Plankton- LMC
| 2018|FL-SR1801  |08271832- Phyto Plankton- LMC
| 2018|FL-SR1801  |09051887- Phyto Plankton
| 2019|-          |-
| 2020|-          |-
| 2021|FL-DS4     |CE04537 BSA PHYTOS - OUTPUT
| 2021|FL-ATS     |CE04537 BSA PHYTOS - OUTPUT
| 2021|FL-DS4     |20210816 City of Durham Phytos - OUTPUT
| 2021|FL-ATS     |20210816 City of Durham Phytos - OUTPUT
```

2.3.2.2 KDV Data Review

The raw data (prior to L. Strader compilation) included classification to the level of genera. The data as compiled by L. Strader are classified to a coarser "Algal Type" level (N types = 11). For a given site and day, there are multiple measures (rows) for a given type, giving the appearance of duplicated measures for what are in fact counts for multiple unique genera of that type that must be aggregated.

The biovolume data are incomplete with many NA values even though density measures are present. The site-date sample events where there are algae data for density but NOT for biovolume are shown below. Count value indicates unique genera observed on that site-date event.

```
test <- dplyr::filter(raw, is.na(`Biovolume (um3/mL)`))
table(test$`Sample Date`, test$`Corrected Station Name`)

##
##             FL-DS3 FL-DS4 FL-SR1801
##   2014-06-16     52      0         0
##   2015-05-04      0     20        22
##   2016-10-17      0      0        92
```

The site-date sample events where there ARE biovolume data are (count value indicates unique genera observed on that site-date event):

```
test <- dplyr::filter(raw, !is.na(`Biovolume (um3/mL)`))
table(test$`Sample Date`, test$`Corrected Station Name`)

##
##            D3-1 FL-ATS FL-DS4 FL-SR1801
##   2017-05-30    0      0    106        92
##   2017-06-12    0      0      0       119
##   2017-09-05    0      0      0       112
##   2018-05-21    0      0      0        94
##   2018-07-02    0      0      0       123
##   2018-08-27    0      0      0        97
##   2018-09-05    0      0      0       101
##   2021-04-05    0      0     16         0
##   2021-08-09   33     24     24         0
```

Within each parameter (density or biovolume), we summed the values for a given type within a date-site sample event.

```
tidy <- raw %>%
  dplyr::group_by(`Corrected Station Name`, `Sample Date`, `Algal Type`) %>%
  # Only retain units closest matching other resoures
  dplyr::mutate(Density = sum(`Density (cells/mL)`, na.rm = TRUE),
                Biovolume = sum(`Biovolume (um3/mL)`, na.rm = TRUE)) %>%
  dplyr::ungroup() %>%
  # sum introduced 0's where should be NA for "no data reported"
  # because this is an introduced value, we can use equality to 0 test
  dplyr::mutate(Biovolume = if_else(Biovolume == 0, NA_real_, Biovolume)) %>%
  # Remove columns with genera level data
  dplyr::select(-(`Density (cells/L)`:`Biovolume (um3/mL)`)) %>%
  # Without genera measure, there will be duplicate records we can now remove
  # leaving just the type level sums
  dplyr::distinct()
```

After grouping and summing data for the same taxonomic groups (on the same date and site), there are 118 unique records.

2.3.3 Data Standardization

2.3.3.1 Algal Type and Algal Group

The “Algal Type” column in these data corresponds to our “Algal Group” column (eg Chlorophyta, Haptophyta, etc). We adjust this column name, then add our project “Algal Type” column which uses the descriptive names (eg, Green, Diatom, etc).

These data do not have genus and species data, but the columns are added with NA values to match other algal data resources.

2.3.3.2 Biovolume Units

The raw data for biovolume are recorded as um3/mL, but our other data are in mm3/m3. We therefore divide these biovolume values by 1000 to convert them from um3/mL to mm3/m3.

We also found and corrected some typographic errors and we changed Haptophyta to Prymnesiophyta.

To align with other algae data:

- We added the columns GENUS and SPECIES. Both columns were filled with “Unassigned” so these could be easily distinguished from the various methods of entering “unknown” or “unidentified”.
- We renamed the column “Algal Type” to be “ALGALGROUP” matching other data structures.
- Based on the more dteailed data in ALGALGROUP, we then assigned each row to one of the study ALGALTYPE categories.

```
corrections <- c("Pyrrophyta" = "Pyrrhophyta",
                 "Raphidiophyta" = "Raphidophyta",
                 "Haptophyta" = "Prymnesiophyta")

tidy <- tidy %>%
  dplyr::mutate(ALGALGROUP = `Algal Type`,
                Biovolume = Biovolume/1000,
                ALGALGROUP = dplyr::recode(ALGALGROUP, !!!corrections),
                GENUS = "Unassigned",
                SPECIES = "Unassigned") %>%
  dplyr::select(-`Algal Type`)

# Assign the algal classification (BlueGreen, Diatom, NotBGorD, etc)

# Create the ALGALTYPE column based on the values in the group column
# Make sure all group names in the lookup list source_setupDictionaries
# all(tidy$ALGALGROUP %in% names(algalTypeList))
tidy <- assignALGALTYPE(df = tidy, algalGrpColumn = "ALGALGROUP", algalTypeList = algalTypeList)

# If there are still some species with missing assignments, label these as "Unassigned"
if (sum(is.na(tidy$ALGALTYPE)) > 0) {
  tidy$ALGALTYPE[is.na(tidy$ALGALTYPE)] <- "Unassigned"
}
```

2.3.3.3 Add/Drop Columns and Standardize Names

- Add source information (“durmAlgae”), clean column names, and drop unnecessary columns.
- SOURCEID is a concatenated version of ALGALGROUP, Corrected Station Name, and Sample Date

```
# add new columns SOURCE and SOURCEID
tidy <- tidy %>%
  dplyr::mutate(SOURCE = "durmAlgae") %>%
```

```
  tidyr::unite("SOURCEID", all_of(c("ALGALGROUP", "Corrected Station Name", "Sample Date")), sep = '
_', remove = FALSE) %>%
  dplyr::mutate(SOURCEID = stringr::str_replace_all(SOURCEID, " ", ""))

# Confirm SOURCEID is unique
# test <- dplyr::group_by(tidy, SOURCEID) %>%
#   summarize(N = n(), .groups = "drop")
# sum(test$N > 1) == 0 # should be true

# Remove unused columns and update column names

# standardize column names
original <- names(tidy)
standard <- stringr::str_replace_all(original, " ", "")
standard <- stringr::str_replace_all(standard, "[[:punct:]]", "")
standard <- toupper(standard)
names(tidy) <- standard

tidy <- tidy %>%
  dplyr::select(-HWY50, -SEGMENTNUMBER, -SEGMENT, -WATERBODYTYPE, -ORIGINALSTATIONNAME,
-NOTES) %>%
  dplyr::rename(STATIONID = CORRECTEDSTATIONNAME)
```

- Add the standard sample date and location information.

```
# Create the LAKEUNIT column
# Make sure all site names in the lookup list source_setupDictionaries
# all(tidy$STATIONID %in% names(lakeUnitList))
tidy <- assignLAKEUNIT(df = tidy, siteNameColumn = "STATIONID", lakeUnitList = lakeUnitList)

# Create the LOCATE column
# Make sure all site names in the lookup list source_setupDictionaries
# all(tidy$STATIONID %in% names(locateList))
tidy <- assignLOCATE(df = tidy, siteNameColumn = "STATIONID", locateList = locateList)

# Standardize date and station information
tidy <- tidy %>%
  dplyr::mutate(DATE = as.Date(SAMPLEDATE),
                MONTH = lubridate::month(DATE, label = TRUE),
                YEAR = lubridate::year(DATE),
                SOURCETYPE = "Empirical",
                STATION = STATIONID, # use station id again for now
                DEPTHM = NA_real_, # TODO: is there depth info?
                DEPTHTYPE = NA_character_) %>% # TODO: is there depth info?
dplyr::select(-SAMPLEDATE)
```

- Restructure the data to long format.

```
# Restructure variable data (biovolume and cells)
tidy <- tidy %>%
  tidyr::pivot_longer(cols = DENSITY:BIOVOLUME, names_to = "VARIABLE", values_to = "VALUE") %>%
  dplyr::mutate(MEASUNIT = if_else(VARIABLE == "DENSITY", "cells/mL", "mm3/m3"),
                VARIABLE = stringr::str_replace_all(VARIABLE, c("DENSITY" = "Cell Density", "BIOVOLU
ME" = "Biovolume")),
                VARTYPE = if_else(VARIABLE == "Biovolume", "Calculated", "Empirical"),
                VARLABEL = sprintf("Algal Density (%s)", MEASUNIT)) %>%
  dplyr::select(SOURCE,   SOURCEID,   SOURCETYPE, DATE,   STATIONID,  STATION,    DEPTHM, DEPTHTY
PE, GENUS, SPECIES, ALGALGROUP, ALGALTYPE, VARIABLE, VALUE, VARTYPE, VARLABEL,   MEASUNIT,   Y
EAR,   MONTH,  LAKEUNIT,   LOCATE)
```

2.3.3.4 Quick Data Inspection

The biovolume data are the data that we will focus on for UNRBA. Record tallies for the prepared Durham data are:

```
biov <- dplyr::filter(tidy, VARIABLE == "Biovolume")
table(biov$YEAR, biov$STATIONID)

##
##       D3-1 FL-ATS FL-DS3 FL-DS4 FL-SR1801
##   2014    0      0      7      0         0
##   2015    0      0      0      4         6
##   2016    0      0      0      0         9
##   2017    0      0      0      9        27
##   2018    0      0      0      0        33
##   2021    7      4      0     12         0

table(biov$YEAR, biov$LAKEUNIT)

##
##       Upper Middle Lower Other Lake
##   2014     7      0     0          0
##   2015    10      0     0          0
##   2016     9      0     0          0
##   2017    36      0     0          0
##   2018    33      0     0          0
##   2021    23      0     0          0

table(biov$DATE, biov$LAKEUNIT)

##
##             Upper Middle Lower Other Lake
##   2014-06-16     7      0     0          0
##   2015-05-04    10      0     0          0
##   2016-10-17     9      0     0          0
```

```
## 2017-05-30 18 0 0 0
## 2017-06-12 9 0 0 0
## 2017-09-05 9 0 0 0
## 2018-05-21 9 0 0 0
## 2018-07-02 9 0 0 0
## 2018-08-27 8 0 0 0
## 2018-09-05 7 0 0 0
## 2021-04-05 5 0 0 0
## 2021-08-09 18 0 0 0
```

```
table(biov$ALGALGROUP, biov$LAKEUNIT)
```

```
##
## Upper Middle Lower Other Lake
## Bacillariophyta 16 0 0 0
## Chlorophyta 16 0 0 0
## Chrysophyta 6 0 0 0
## Cryptophyta 15 0 0 0
## Cyanobacteria 16 0 0 0
## Euglenophyta 12 0 0 0
## Ochrophyta 6 0 0 0
## Prymnesiophyta 10 0 0 0
## Pyrrhophyta 11 0 0 0
## Raphidophyta 8 0 0 0
## Xanthophyta 2 0 0 0
```

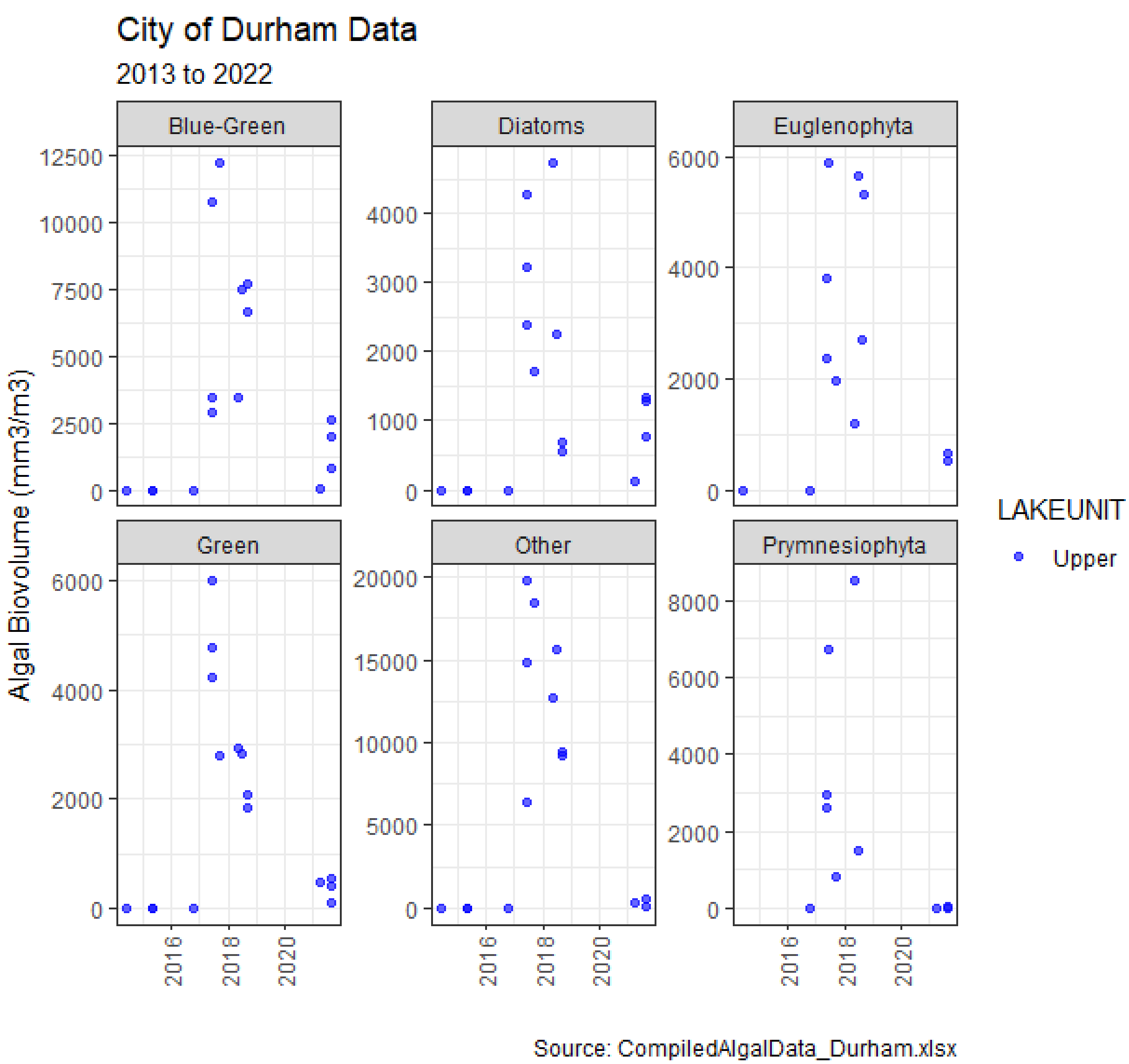
```
table(biov$ALGALTYPE, biov$LAKEUNIT)
```

```
##
## Upper Middle Lower Other Lake
## Diatoms 16 0 0 0
## Green 16 0 0 0
## Blue-Green 16 0 0 0
## Euglenophyta 12 0 0 0
## Prymnesiophyta 10 0 0 0
## Other 48 0 0 0
## Unassigned 0 0 0 0
```

Remember: Tallies are not for the number of sample events, but the number of observations (Date-Site-AlgalType)

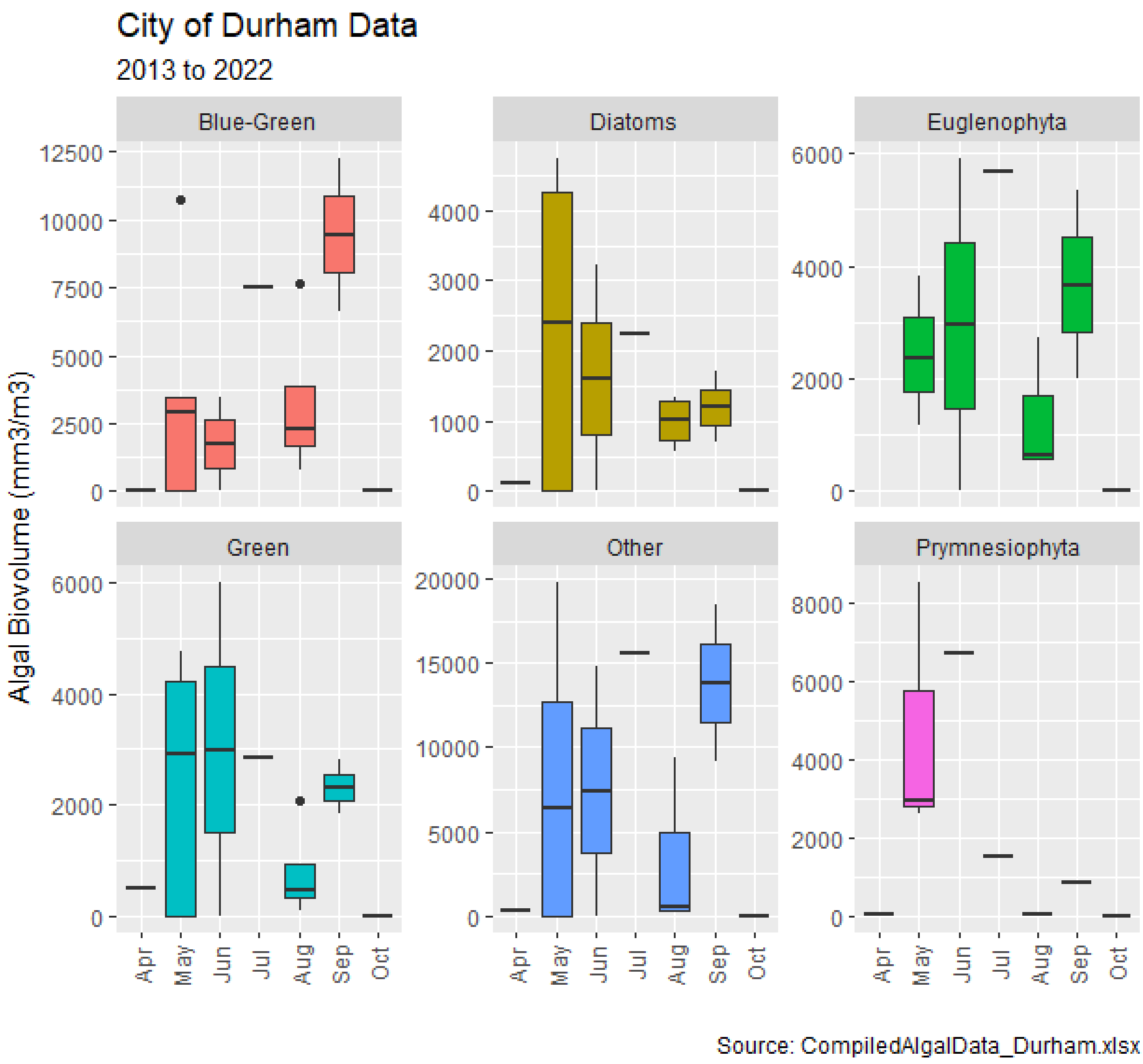
```
byDate <- tidy %>%
  dplyr::filter(VARIABLE == "Biovolume") %>%
  dplyr::group_by(DATE, STATIONID, LAKEUNIT, ALGALTYPE) %>%
  dplyr::summarize(Total = sum(VALUE, na.rm = T), .groups = "drop") %>%
  ggplot() +
  geom_point(aes(x = DATE, y = Total, color = LAKEUNIT, group = str_wrap(ALGALTYPE, 20)), alpha = 0.6
) +
```

```
 scale_color_manual(values = c("Upper" = "blue", "Middle" = "darkcyan", "Lower" = "purple")) +
  labs(title = "City of Durham Data", subtitle = "2013 to 2022", caption = "Source: CompiledAlgalData_D
urham.xlsx",
      x = "", y = "Algal Biovolume (mm3/m3)") +
  facet_wrap(~str_wrap(ALGALTYPE, 20), scales = "free_y", ncol = 3) +
  theme_bw() +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byDate
```



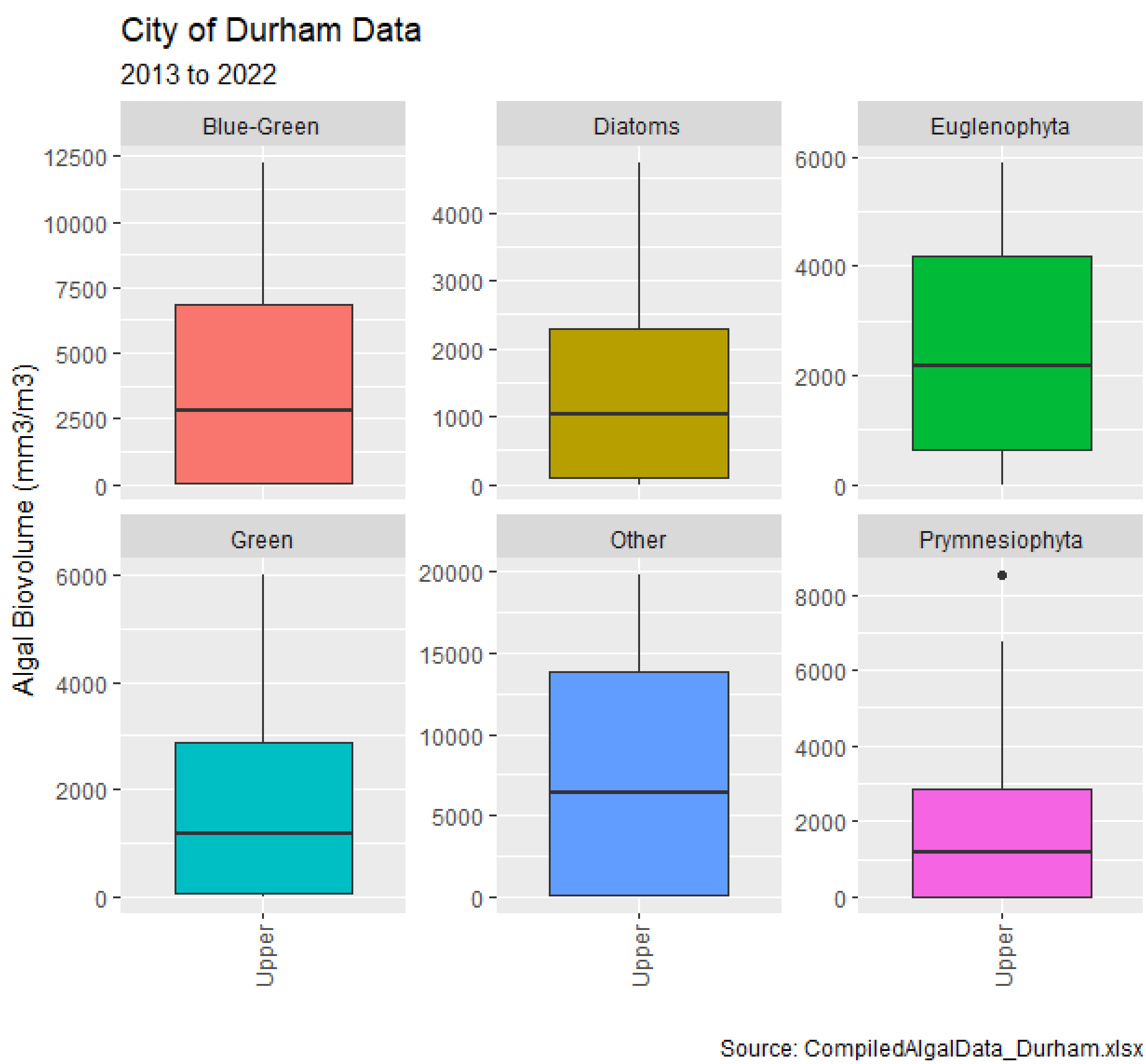

```
#ggsave(plot = byDate, filename = here::here("Data/Tidy/dataPrep/Figures", "durmAlgae_biov_byDate.p
ng"), width = 6.5, height = 6)

byMonth <- tidy %>%
  dplyr::filter(VARIABLE == "Biovolume") %>%
  dplyr::group_by(DATE, MONTH, STATIONID, LAKEUNIT, ALGALTYPE) %>%
```

```
  dplyr::summarize(Total = sum(VALUE, na.rm = T), .groups = "drop") %>%
  ggplot() +
  geom_boxplot(aes(x = MONTH, y = Total, fill = str_wrap(ALGALTYPE, 20)), show.legend = F) +
  labs(title = "City of Durham Data", subtitle = "2013 to 2022", caption = "Source: CompiledAlgalData_D
urham.xlsx",
       x = "", y = "Algal Biovolume (mm3/m3)") +
  facet_wrap(~str_wrap(ALGALTYPE, 20), scales = "free_y", ncol = 3) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byMonth
```




```
#ggsave(plot = byMonth, filename = here::here("Data/Tidy/dataPrep/Figures", "durmAlgae_biov_byMon
th.png"), width = 6.5, height = 6)

byLakeunit <-  tidy %>%
  dplyr::filter(VARIABLE == "Biovolume") %>%
```

```
  dplyr::group_by(DATE, STATIONID, LAKEUNIT, ALGALTYPE) %>%
  dplyr::summarize(Total = sum(VALUE, na.rm = T), .groups = "drop") %>%
  ggplot() +
  geom_boxplot(aes(x = LAKEUNIT, y = Total, fill = str_wrap(ALGALTYPE, 20)), show.legend = F) +
  labs(title = "City of Durham Data", subtitle = "2013 to 2022", caption = "Source: CompiledAlgalData_D
urham.xlsx",
      x = "", y = "Algal Biovolume (mm3/m3)") +
  facet_wrap(~str_wrap(ALGALTYPE, 20), scales = "free_y", ncol = 3) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byLakeunit
```




```
#ggsave(plot = byLakeunit, filename = here::here("Data/Tidy/dataPrep/Figures", "durmAlgae_biov_byLa
keunit.png"), width = 6.5, height = 6)
```

2.3.4 Save Tidy Data

Exported the data to **durmAlgae_data.rds** and individual variables to **durmAlgae_[variable name].rds**.

The data were originally saved to the Data/Tidy/dataPrep folder, but have been redirected to an appendix folder for final documentation and saved as csv

```
# Save prepped data
# saveRDS(tidy, here::here("Data/Tidy/dataPrep", "durmAlgae_data.rds"))
# openxlsx::write.xlsx(tidy, here::here("Data/Tidy/dataPrep/Excel", "durmAlgae_data.xlsx"))
readr::write_csv(tidy,
          here::here("Data/Tidy/AppendixC", "durmAlgae_data.csv"))

# Algal Biovolume
biov <- tidy %>%
  dplyr::filter(VARIABLE == "Biovolume")
# saveRDS(biov, here::here("Data/Tidy/dataPrep", "durmAlgae_biovolume.rds"))
readr::write_csv(biov,
          here::here("Data/Tidy/AppendixC", "durmAlgae_biovolume.csv"))

# Algal Cell Density
dens <- tidy %>%
  dplyr::filter(VARIABLE == "Cell Density")
# saveRDS(dens, here::here("Data/Tidy/dataPrep", "durmAlgae_celldens.rds"))
readr::write_csv(dens,
          here::here("Data/Tidy/AppendixC", "durmAlgae_celldens.csv"))
```

Code created by KDV Decision Analysis LLC and last run 2024-08-29 with R version 4.4.1 (2024-06-14 ucrt).

2.4 City of Durham Data (durmCity)

2.4.1 Data Description

City of Durham data received from A. Matos, originally sent by Susan along with these caveats and notes for 2018.

Based on City notes:

- Of 29 field blanks from Falls 2018 monitoring, 21 blanks (72%) had reportable levels of TKN. Reporting limit was 0.2 mg/L. For all blanks, median was 0.29 mg/L, mean was 0.46 mg/L, range was 0.2 – 1.76 mg/L.
- The majority of TKN results (environmental samples) for Falls were flagged last year due to blank contamination: 47 had a QA code of R or J7, while only 15 were not flagged.
- Student t-test and Wilcoxon comparisons show a significant difference in concentrations between flagged and unflagged results from environmental samples (though note very uneven sample sizes). In other words, TKN concentrations in environmental samples that were taken the same day as contaminated field blanks were higher than concentrations in environmental samples taken on days when blanks came back clean.

- I reviewed our contract lab's QC reports as we got each set of results back, and their internal blanks and other QC samples were generally fine – sometimes matrix spikes, etc. were a little high/low on % recovery, but nothing egregious. (But, of course, their spikes and duplicates were generally in the wastewater range, not the lower concentrations seen in surface water.)

Corrective actions by City – extensive cleaning of our facilities and equipment, retraining field staff, instituting additional QC checks in the field, a field audit, changing our DI water source to an ACS reagent grade source. None of these alleviated the situation. No relationships were found between hits in blanks and the location where the blank was prepared, field staff, DI lot number, DI age, or weather at the time of sampling. We also did not see these issues for other projects whose samples were run by our City lab. Additional QC samples (duplicates analyzed by the contract lab and a City lab) that were taken later in the season consistently showed higher levels of TKN reported by the contract lab.

Based on this information, I have to recommend that you be very thoughtful about the use of our TKN data for 2018, and would recommend further comparisons to other available in-lake data before use.

Based on these notes, we excluded:

_ TKN from 2018 _ all records with q_code == "R" for rejected - all "blank" entries

```
d15 <- read_csv(here::here(rawFile_2015), show_col_types = FALSE) %>%
  dplyr::select(station_name, sample_date, sample_type, medium, comp_depth, depth_m, parameter, v
alue, unit, lab_qcode)
d16 <- read_csv(here::here(rawFile_2016), show_col_types = FALSE) %>%
  dplyr::select(station_name, sample_date, sample_type, medium, comp_depth, depth_m, parameter, v
alue, unit, lab_qcode)
d17 <- read_csv(here::here(rawFile_2017), show_col_types = FALSE) %>%
  dplyr::select(station_name, sample_date, sample_type, medium, comp_depth, depth_m, parameter, v
alue, unit, lab_qcode)
d18 <- read_csv(here::here(rawFile_2018), show_col_types = FALSE) %>%
  dplyr::select(station_name, sample_date, sample_type, medium, comp_depth, depth_m, parameter, v
alue, unit, lab_qcode)

raw <- rbind(d15, d16, d17, d18) %>%
  dplyr::filter(lab_qcode != "R" | is.na(lab_qcode)) %>%
  dplyr::filter(!stringr::str_detect(station_name, "Blank")) %>%
  dplyr::select(-lab_qcode)
```

There are some duplicated data within these records (N = 60) which we remove.

```
raw <- distinct(raw)
head(raw)

## # A tibble: 6 × 9
##   station_name sample_date sample_type medium comp_depth depth_m parameter value
##   <chr>        <chr>       <chr>       <chr>  <chr>        <dbl> <chr>     <dbl>
## 1 FL-DS4       07/20/2015… Duplicate,… Water  composite…      NA Total Kj…  1.3
## 2 FL-DS4       05/18/2015… Duplicate,… Water  composite…      NA Ammonia …  0.02
```

```
## 3 FL-DS4      07/20/2015… Duplicate,… Water  composite…      NA Ammonia … 0.045
## 4 FL-SR1801    06/15/2015… Duplicate,… Water  composite…      NA Ammonia … 0.045
## 5 FL-SR1801    08/24/2015… Duplicate,… Water  composite…      NA Ammonia … 0.045
## 6 FL-DS4      05/18/2015… Duplicate,… Water  composite…      NA Nitrate … 0.1
## # ℹ 1 more variable: unit <chr>
```

2.4.2 Assign SOURCE Information

Source code is “durmCity”. We found one duplicate value, which we deleted.

```
raw <- raw %>%
  dplyr::mutate(SOURCE = "durmCity",
         SOURCEID = paste(station_name, sample_date, depth_m, parameter, value),
         SOURCETYPE = "Empirical")

janitor::get_dupes(raw, SOURCEID)

## # A tibble: 0 × 13
## # ℹ 13 variables: SOURCEID <chr>, dupe_count <int>, station_name <chr>,
## #   sample_date <chr>, sample_type <chr>, medium <chr>, comp_depth <chr>,
## #   depth_m <dbl>, parameter <chr>, value <dbl>, unit <chr>, SOURCE <chr>,
## #   SOURCETYPE <chr>

raw <- distinct(raw)

assertthat::assert_that(dplyr::n_distinct(raw$SOURCEID) == nrow(raw), msg = "SOURCEID values must be unique per observation.")

## [1] TRUE
```

2.4.3 Check Data

Confirm that all are water samples, all are < 4.4 m depth or labeled as photic (or surface) samples. Drop unused columns: sample_type and medium.

```
table(raw$medium, useNA = "ifany") # all water

##
## Water
##  7743

summary(raw$depth_m)

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##   0.100   1.000   2.000   2.002   3.000   6.000    1777

table(raw$comp_depth)

##
## composite- photic          discrete
##              1554              6189

table(raw$comp_depth, raw$depth_m > 4.4, useNA = "ifany")
```

```
##
##                    FALSE TRUE <NA>
##   composite- photic    0    0 1554
##   discrete          5776  190  223

raw <- raw %>%
  dplyr::select(-sample_type, -medium)
```

We removed the NA samples taken from depths greater than 4.4 m.

```
raw <- raw %>%
dplyr::filter(depth_m < 4.4 | is.na(depth_m))
```

2.4.4 Standardize DATE Informtaion

Add the DATE, YEAR and mONTH columns. Confirm all data have an assigned date.

```
tidy <- raw %>%
  dplyr::rename(DATE = sample_date) %>%
  dplyr::mutate(DATE = as.Date(lubridate::mdy_hm(DATE)),
         YEAR = lubridate::year(DATE),
         MONTH = lubridate::month(DATE, label = T, abbr = T))

table(tidy$YEAR)

##
## 2015 2016 2017 2018
## 1993 1894 1651 1955

assertthat::assert_that(sum(is.na(tidy$DATE)) < 1, msg = "NA values are not allowed in the DATE colum
n")

## [1] TRUE
```

2.4.5 Standardize DEPTH Information

Add DEPTHM and DEPTHTYPE columns

```
tidy <- tidy %>%
  dplyr::rename(DEPTHM = depth_m,
         DEPTHTYPE = comp_depth)

table(tidy$DEPTHTYPE, useNA = "ifany")

##
## composite- photic        discrete
##            1554            5939
```

2.4.6 Standardise STATION Information

Add STATION, STATIONID, LAKEUNIT, and LOCATE columns.

```
assertthat::assert_that(sum(is.na(tidy$station_name)) < 1, msg = "NA values are not allowed for station
name and id.")
```

```
## [1] TRUE

tidy <- tidy %>%
  dplyr::rename(STATIONID = station_name) %>%
  dplyr::mutate(STATIONID = if_else(stringr::str_detect(STATIONID, "Blank"), "Unnamed Durham Station
", STATIONID),
         STATION = STATIONID)

assertthat::assert_that(all(tidy$STATIONID %in% names(lakeUnitList)), msg = "Some station names in fil
e are not found in the LAKEUNIT assignment list.")

## [1] TRUE

tidy <- assignLAKEUNIT(df = tidy, siteNameColumn = "STATIONID", lakeUnitList = lakeUnitList)

assertthat::assert_that(all(tidy$STATIONID %in% names(locateList)), msg = "Some station names in file
are not found in the LOCATE assignment list.")

## [1] TRUE

tidy <- assignLOCATE(df = tidy, siteNameColumn = "STATIONID", locateList = locateList)
```

2.4.7 Standardize VARIABLE Information

Add VARIABLE, VARTYPE, MEASUNIT and VARLABEL columns.

```
table(tidy$parameter, tidy$STATIONID)

##
##                              FL-DS4 FL-SR1801
##   Ammonia Nitrogen              105       107
##   Chlorophyll a                 122       122
##   Conductivity                  151       138
##   Dissolved Oxygen              568       528
##   Dissolved Oxygen Saturation   569       528
##   Nitrate + Nitrite as N        108       107
##   Organic Carbon                117       118
##   Orthophosphorus               111       107
##   pH                            569       528
##   Secchi Depth                  113       110
##   Specific conductance          418       390
##   Temperature                   569       528
##   Total Kjeldahl Nitrogen        99       102
##   Total Nitrogen                  7         9
##   Total Phosphorus              104       109
##   Turbidity                     121       111

table(tidy$parameter, tidy$unit)
```

```
##
##                          %    C deg C    m mg/L  NTU   SU ug/L   uS
##   Ammonia Nitrogen            0    0     0    0  212    0    0    0    0
##   Chlorophyll a               0    0     0    0    0    0    0  244    0
##   Conductivity                0    0     0    0    0    0    0    0  289
##   Dissolved Oxygen            0    0     0    0 1096    0    0    0    0
##   Dissolved Oxygen Saturation 1097    0     0    0    0    0    0    0    0
##   Nitrate + Nitrite as N      0    0     0    0  215    0    0    0    0
##   Organic Carbon              0    0     0    0  235    0    0    0    0
##   Orthophosphorus             0    0     0    0  218    0    0    0    0
##   pH                          0    0     0    0    0    0 1097    0    0
##   Secchi Depth                0    0     0  223    0    0    0    0    0
##   Specific conductance        0    0     0    0    0    0    0    0    0
##   Temperature                 0  289   808    0    0    0    0    0    0
##   Total Kjeldahl Nitrogen     0    0     0    0  201    0    0    0    0
##   Total Nitrogen              0    0     0    0   16    0    0    0    0
##   Total Phosphorus            0    0     0    0  213    0    0    0    0
##   Turbidity                   0    0     0    0    0  232    0    0    0
##
##                            uS/cm at 25 deg C
##   Ammonia Nitrogen                           0
##   Chlorophyll a                              0
##   Conductivity                               0
##   Dissolved Oxygen                           0
##   Dissolved Oxygen Saturation                0
##   Nitrate + Nitrite as N                     0
##   Organic Carbon                             0
##   Orthophosphorus                            0
##   pH                                         0
##   Secchi Depth                               0
##   Specific conductance                     808
##   Temperature                                0
##   Total Kjeldahl Nitrogen                    0
##   Total Nitrogen                             0
##   Total Phosphorus                           0
##   Turbidity                                  0
```

Separated out the parameter name and measurement units, then recreated label. Also trimmed extra white spaces and checked for other typographic errors. Several variable names needed to be standardized:

- “Chlorophyll a” to “Chlorophyll-a”
- “Nitrate + Nitrite as N” to “Nitrate-Nitrite”
- “Total Kjeldahl Nitrogen” to “Kjeldahl Nitrogen”

- “Organic Carbon” to “Total Organic Carbon”
- “Conductivity” to “Specific Conductivity”
- “Specific conductance” to “Specific Conductivity”
- “Temperature” to “Water Temperature”

We also standardized some units:

- “SU” to “pH”
- “deg C” to “C”
- “uS/cm at 25 C” to “uS”

```
tidy <- tidy %>%
  dplyr::rename(VARIABLE = parameter,
           MEASUNIT = unit,
           VALUE = value) %>%
   dplyr::mutate(VARIABLE = gsub(" as N$", "", VARIABLE),
                    VARIABLE = gsub("^Total Kjeldahl", "Kjeldahl", VARIABLE),
                    VARIABLE = if_else(VARIABLE == "Nitrate + Nitrite", "Nitrate-Nitrite", VARIABLE),
                    VARIABLE = if_else(VARIABLE == "Conductivity", "Specific Conductivity", VARIABLE),
                    VARIABLE = if_else(VARIABLE == "Specific conductance", "Specific Conductivity", VARI
ABLE),
                    VARIABLE = if_else(VARIABLE == "Temperature", "Water Temperature", VARIABLE),
                    VARIABLE = gsub("phyll a", "phyll-a", VARIABLE),
                    VARIABLE = gsub("^Organic Carbon$", "Total Organic Carbon", VARIABLE),
                    MEASUNIT = gsub("SU", "pH", MEASUNIT),
                    MEASUNIT = gsub("deg C", "C", MEASUNIT),
                    MEASUNIT = if_else(MEASUNIT == "uS/cm at 25 C", "uS", MEASUNIT),
                    VARLABEL = sprintf("%s, %s", VARIABLE, MEASUNIT),
                    VARTYPE = NA_character_)

table(tidy$VARIABLE, tidy$STATIONID)

##
##                            FL-DS4 FL-SR1801
##   Ammonia Nitrogen              105       107
##   Chlorophyll-a                 122       122
##   Dissolved Oxygen              568       528
##   Dissolved Oxygen Saturation   569       528
##   Kjeldahl Nitrogen              99       102
##   Nitrate-Nitrite               108       107
##   Orthophosphorus               111       107
##   pH                            569       528
##   Secchi Depth                  113       110
##   Specific Conductivity         569       528
```

```
##   Total Nitrogen               7        9
##   Total Organic Carbon         117      118
##   Total Phosphorus             104      109
##   Turbidity                    121      111
##   Water Temperature            569      528
```

```
table(tidy$VARIABLE, tidy$MEASUNIT)
```

```
##
##                                   %    C    m mg/L  NTU   pH ug/L   uS
##   Ammonia Nitrogen                0    0    0  212    0    0    0    0
##   Chlorophyll-a                   0    0    0    0    0    0  244    0
##   Dissolved Oxygen                0    0    0 1096    0    0    0    0
##   Dissolved Oxygen Saturation  1097    0    0    0    0    0    0    0
##   Kjeldahl Nitrogen               0    0    0  201    0    0    0    0
##   Nitrate-Nitrite                 0    0    0  215    0    0    0    0
##   Orthophosphorus                 0    0    0  218    0    0    0    0
##   pH                              0    0    0    0    0 1097    0    0
##   Secchi Depth                    0    0  223    0    0    0    0    0
##   Specific Conductivity           0    0    0    0    0    0    0 1097
##   Total Nitrogen                  0    0    0   16    0    0    0    0
##   Total Organic Carbon            0    0    0  235    0    0    0    0
##   Total Phosphorus                0    0    0  213    0    0    0    0
##   Turbidity                       0    0    0    0  232    0    0    0
##   Water Temperature               0 1097    0    0    0    0    0    0
```

```
table(tidy$VARIABLE, tidy$YEAR)
```

```
##
##                               2015 2016 2017 2018
##   Ammonia Nitrogen              55   52   48   57
##   Chlorophyll-a                 61   69   52   62
##   Dissolved Oxygen             288  274  242  292
##   Dissolved Oxygen Saturation  289  274  242  292
##   Kjeldahl Nitrogen             62   58   50   31
##   Nitrate-Nitrite               58   53   48   56
##   Orthophosphorus               57   52   50   59
##   pH                           289  274  242  292
##   Secchi Depth                  57   62   47   57
##   Specific Conductivity        289  274  242  292
##   Total Nitrogen                16    0    0    0
##   Total Organic Carbon          63   58   52   62
##   Total Phosphorus              61   58   40   54
##   Turbidity                     59   62   54   57
##   Water Temperature            289  274  242  292
```

```
table(tidy$VARIABLE)
```

```
##
##        Ammonia Nitrogen            Chlorophyll-a
##                     212                      244
##        Dissolved Oxygen Dissolved Oxygen Saturation
##                    1096                     1097
##       Kjeldahl Nitrogen           Nitrate-Nitrite
##                     201                      215
##         Orthophosphorus                        pH
##                     218                     1097
##           Secchi Depth      Specific Conductivity
##                     223                     1097
##          Total Nitrogen      Total Organic Carbon
##                      16                      235
##        Total Phosphorus                 Turbidity
##                     213                      232
##       Water Temperature
##                    1097
```

2.4.8 Export Tidy Data

The full City of Durham data are saved as **durmCity_data.rds** (with copy saved also to Excel) and individual variables are saved as **durhCity_[abbrev].rds.**

```
# all sites all data
# saveRDS(tidy, here::here("Data/Tidy/dataPrep", "durmCity_data.rds"))
# openxlsx::write.xlsx(tidy, file = here::here("Data/Tidy/dataPrep/Excel", "durmCity_data.xlsx"), overwrit
e = TRUE)
readr::write_csv(tidy, here::here("Data/Tidy/AppendixC", "durmCity_data.csv"))

# Individual variables

vars <- c("ammonia" = "Ammonia Nitrogen",
        "chla" = "Chlorophyll-a",
        "cond" = "Specific Conductivity",
        "do" = "Dissolved Oxygen",
        "dosat" = "Dissolved Oxygen Saturation",
        "nitnit" = "Nitrate-Nitrite",
        "nkjeld" = "Kjeldahl Nitrogen",
        "ph" = "pH",
        "secchi" = "Secchi Depth",
        "wtemp" = "Water Temperature",
        "toc" = "Total Organic Carbon",
        "totaln" = "Total Nitrogen",
        "totalp" = "Total Phosphorus",
        "turbid" = "Turbidity",
        "orthop" = "Orthophosphorus")
```

```
assertthat::assert_that(all(tidy$VARIABLE %in% vars), msg = "The list of variables for the save loop is inc
omplete.")
```

```
## [1] TRUE
```

```
assertthat::assert_that(dplyr::n_distinct(tidy$VARIABLE) == length(vars), msg = "The set of variable nam
es does not match the set in the data.  Check the code.")
```

```
## [1] TRUE
```

```
# If not true, check and correct
# unique(falls$VARIABLE)[!unique(falls$VARIABLE) %in% vars] # find things to add to vars
# vars[!vars %in% unique(falls$VARIABLE)] # find things to remove from vars

# for (i in seq(vars)) {
#   print(names(vars[i]))
#   sub <- dplyr::filter(tidy, VARIABLE == vars[[i]])
#   saveRDS(sub, here::here(sprintf("Data/Tidy/dataPrep/durmCity_%s.rds", names(vars[i]))))
# }

for (i in seq(vars)) {
  print(names(vars[i]))
  sub <- dplyr::filter(tidy, VARIABLE == vars[[i]])
  readr::write_csv(sub, here::here(sprintf("Data/Tidy/AppendixC/durmCity_%s.csv", names(vars[i]))))
}
```

```
## [1] "ammonia"
## [1] "chla"
## [1] "cond"
## [1] "do"
## [1] "dosat"
## [1] "nitnit"
## [1] "nkjeld"
## [1] "ph"
## [1] "secchi"
## [1] "wtemp"
## [1] "toc"
## [1] "totaln"
## [1] "totalp"
## [1] "turbid"
## [1] "orthop"
```

Code created by KDV Decision Analysis LLC and last run 2024-08-29 with R version 4.4.1 (2024-06-14 ucrt).

2.5 City of Raleigh Falls Lake EC Algae Data 2007-2001 (ecAlgae)

2.5.1 Raw Data

The file *ECAlgae Falls and Johnson 2007-11_Modified.xlsx* appears to contain algae data sampled at the Falls Lake and Lake Johnson intakes. These data only provide cell and unit counts, not biovolume as provided in other files.

Ensure to use the file *ECAlgae Falls and Johnson 2007-11_Modified.xlsx*. The following modifications were made to this file:

- Converted from .xls to .xlsx
- Removed first row containing units (Units/mL & Cells/mL) for the two species columns and two group total columns and appended to respective column names within header.
- Only reading in columns main data columns (1:9) and two group total columns (11,12).
- Drop the first row as it only contains NAs, and rename columns.

```
path <- here::here(rawFile)
rawData <- openxlsx::read.xlsx(path, cols = c((1:9), 11, 12))[-1,]
# Here I drop the first row in which units for the two species columns are specified
# add the units to the species columns
# Also removed period characters which replaced spaces in 'Algal Group', 'Counting Unit', etc.
names(rawData) <- c("Sample", "SamplingDate", "Genus", "Species", "AlgalGroup",
          "CountingUnit", "Cells/Unit", "Species(Units/mL)", "Species(Cells/mL)",
          "GroupTotal(Units/mL)", "GroupTotal(Cells/mL)")
```

Some dates within this data set use a 2 digit year for like ‘08’. I correct this while dates are still stored as strings below. The follow code works by checking how many digits the year is, and appending ‘20’ if it’s < 4 digits.

There are some inconsistencies within the day and month formats but they seem to be handled by the as_date().

After mending the date strings, I convert them to date objects and store withing the *DATE* column, and drop the original *SamplingDate* column.

```
# Check dateformat, rebuild date string with 4 digit year if in 2 digit form
rebuildDate <- function(date){
 splitDate <- str_split(date, "/") %>%
  unlist
 if(str_length(splitDate[3]) <  4){
  splitDate[3] <- paste0("20", splitDate[3])
  return(paste(splitDate, collapse = "/"))
 } else {
  return(date)
 }
}



# Apply function to SamplingDate column
```

```
rawData <- rawData %>%
  dplyr::mutate(DATE = vapply(SamplingDate, rebuildDate, character(1), USE.NAMES = FALSE),
                DATE = as_date(DATE, format = "%m/%d/%Y"),
                YEAR = lubridate::year(DATE),
                        MONTH = lubridate::month(DATE, label = TRUE, abbr = TRUE)) %>%
  dplyr::select(-c("SamplingDate"))
```

2.5.1.1 Assign location information

We split the *Sample* variable into two columns, *LOCATION* and *DEPTHTYPE*. Within the majority of observations for the *Sample* column, the Depth is provided as the 3rd item, separated by dashes '-' (example: 'Epi', 'Hypo', etc.).

We dropped all observations for Hypolimnium, as our project focuses on surface waters. Then add a DEPTHM column and populate it with NAs as we don't have numeric depth measurements.

```
# Split sample column up into the depth and location
splitSample <- str_split(rawData$Sample, "-") %>%
 lapply(function(x){
  if(length(x) > 1){
   return(data.frame(LOCATION = paste0(x[1], "-", x[2]), DEPTHTYPE = x[3]))
  } else{
   return(data.frame(LOCATION = x, DEPTHTYPE = NA_character_))
  }
 }) %>%
 bind_rows()

# Add depth and location columns back to data.frame, drop Sample and Species column and
# group summary columns
algaeData <- cbind(splitSample, rawData) %>%
 dplyr::select(-c("Sample")) %>%
  # drop the hypo but include the NA values
 dplyr::filter(DEPTHTYPE != "Hypo" | is.na(DEPTHTYPE)) %>%
 dplyr::mutate(DEPTHM = NA_real_, LAKEUNIT = "Lower", LOCATE = "Lake", STATION = "Intake Surface"
, STATIONID = "Intake Surface")
```

2.5.1.2 Assign source information

The purpose of the source information is to create a unique identifier for debugging of the prepped data.

Add the source information columns. *SOURCE* is "ECAlgae". *SOURCEID* is the merged DATE, STATIONID, GENUS, SPECIES, and row number.

```
algaeData <- dplyr::mutate(algaeData,
                        SOURCE = "ecAlgae",
                        SOURCETYPE = "Empirical",
                        SOURCEID = paste0(DATE, STATIONID, Genus, Species, "_", dplyr::row_nu
mber()))
# Confirm ll SOURCEID unique
# test <- dplyr::group_by(algaeData, SOURCE, SOURCEID) %>%
```

```
#   summarize(N = n(), .groups = "drop")
# sum(test$N > 1) == 0 # should be true
```

2.5.1.3 Assign Algae Type

ALGALGROUP is a coarse level taxonomic category while ALGALTYPE is an ecological class (green, blue-green, diatom, etc)

We standarized the column names to GENUS and SPECIES, then tidied some assumed typographic errors within the data.

- Replaced occurrences of ‘Pyrrophyta’ with ‘Pyrrhophyta’.
- Replace Euglenophtya and Bacillariophtya with Euglenophyta and Bacillariophyta, respectively.
- Replaced occurrences of ‘Miscellaneous’ with ‘Unassigned’.
- Replaced occurrences of ‘Haptophyta’ with ‘Prymnesiophyta’.

```
table(algaeData$AlgalGroup) # this will be what we refer to as ALGALGROUP

##
## Bacillariophtya Bacillariophyta     Chlorophyta     Chrysophyta     Cryptophyta
##              10             634            2278             107             200
##   Cyanobacteria    Euglenophtya    Euglenophyta      Haptophyta   Miscellaneous
##            1078               6             336              64             132
##     Pyrrhophyta      Pyrrophyta    Raphidophyta     Xanthophyta
##              27              72              32             106

algaeData <- algaeData %>%
  dplyr::rename(GENUS = Genus, SPECIES = Species) %>%
  dplyr::mutate(ALGALGROUP = dplyr::recode(AlgalGroup,
                                           "Pyrrophyta" = "Pyrrhophyta",
                                           "Euglenophtya" = "Euglenophyta",
                                           "Bacillariophtya" = "Bacillariophyta",
                                           "Miscellaneous" = "Unassigned",
                                           "Haptophyta" = "Prymnesiophyta"
  ))

table(algaeData$ALGALGROUP)

##
## Bacillariophyta     Chlorophyta     Chrysophyta     Cryptophyta   Cyanobacteria
##             644            2278             107             200            1078
##    Euglenophyta  Prymnesiophyta     Pyrrhophyta    Raphidophyta      Unassigned
##             342              64              99              32             132
##     Xanthophyta
##             106

sum(is.na(algaeData$ALGALGROUP))
```

```
## [1] 0
```

We binned the *ALGALGROUP* column values within a column titled *ALGALTYPE*. Algal groups present in these data are: Bacillariophyta, Chlorophyta, Chrysophyta, Cryptophyta, Cyanobacteria, Euglenophyta, Prymnesiophyta, Unassigned, Pyrrhophyta, Raphidophyta, and Xanthophyta.

The bins within the *ALGALTYPE* column are based on a lookup table provided by A. Matos with the DEQ data. These EC data contained several algal groups not present in the lookup table, so we added these manually prior to the assignment:

- Xanthophyta: Other
- Haptophyta: Other
- Chrysophyta: Other
- Raphidophyta: Other
- Bacillariophyta: Diatom

```
# Assign the algal TYPE classification (BlueGreen, Diatom, NotBGorD, etc)

# Create the ALGALTYPE column based on the values in the group column
# Make sure all group names in the lookup list source_setupDictionaries
# all(algaeData$AlgalGroup %in% names(algalTypeList))
algaeData <- assignALGALTYPE(df = algaeData, algalGrpColumn = "ALGALGROUP", algalTypeList = algalT
ypeList)

# If there are still some species with missing assignments, label these as "Unassigned"
algaeData$ALGALTYPE[is.na(algaeData$ALGALTYPE)] <- "Unassigned"
# these will be corrected later in the merge
```

2.5.1.4 Handle Group Total Columns

Separate the two *GroupTotal* columns and store within a separate data.frame. This will be used later to compare sums of the tidied set vs the original sums.

```
groupSums <- algaeData %>%
  dplyr::select(`GroupTotal(Units/mL)`,`GroupTotal(Cells/mL)`, `DEPTHTYPE`, `DATE`,
      `AlgalGroup`) %>%
  dplyr::filter(!is.na(`GroupTotal(Units/mL)`) & !is.na(`GroupTotal(Cells/mL)`)) %>%
  dplyr::mutate(`GroupTotal(Units/mL)` = as.numeric(`GroupTotal(Units/mL)`),
      `GroupTotal(Cells/mL)` = as.numeric(`GroupTotal(Cells/mL)`))
```

2.5.1.5 Pivot to VARIABLE and VALUE columns

Algae are counted by multiple methods and reported as cells/mL or units/mL.

```
kable(dplyr::group_by(algaeData, ALGALGROUP, ALGALTYPE) %>%
  dplyr::summarise(CountingUnits = paste(unique(CountingUnit), collapse = ", "), .groups = "drop"))
```

ALGALGROUP	ALGALTYPE	CountingUnits
Bacillariophyta	Diatoms	cell, chain, colony
Chlorophyta	Green	cell, colony, filament

ALGALGROUP	ALGALTYPE	CountingUnits
Chrysophyta	Other	cell, colony
Cryptophyta	Other	cell
Cyanobacteria	Blue-Green	filament, cell, colony, cell pair
Euglenophyta	Euglenophyta	cell
Prymnesiophyta	Prymnesiophyta	cell
Pyrrhophyta	Other	cell
Raphidophyta	Other	cell
Unassigned	Unassigned	cell, colony
Xanthophyta	Other	cell

We piviot the data over these two measurement units and add the following other columns: * MEASUNIT * Specifies unit of measurement for VARIABLE * VARLABEL * Specifies the label to be used VARIABLE in visualizations * VARTYPE * Specifies the kind of measurement within VARIABLE

The column *AlgalType* is then renamed as *VARIABLE* to specify what we are measuring.

```
longData <- algaeData %>%
  tidyr::pivot_longer(cols = c("Species(Units/mL)", "Species(Cells/mL)"), names_to = "Set", values_to = "
VALUE") %>%
  dplyr::mutate(MEASUNIT = ifelse(grepl("Cells/mL", Set), "cells/mL", "units/mL"),
                VARIABLE = ifelse(grepl("Cells/mL", Set), "Cell Density", "Unit Density"),
                VARLABEL = paste0("Algal Density, ", MEASUNIT),
                VARTYPE = ifelse(grepl("Cells/mL", Set), "Empirical", "Calculated")) %>%
  dplyr::select(SOURCE,  SOURCEID,  SOURCETYPE, DATE,  STATIONID, STATION, DEPTHM, DEPTHTYPE,
GENUS, SPECIES, ALGALGROUP, ALGALTYPE, VARIABLE, VALUE, VARTYPE, VARLABEL,  MEASUNIT,  YEAR
,  MONTH,  LAKEUNIT,  LOCATE)
```

2.5.2 Check Data

Below I show the code I used to verify my final data structure. (It is not run by default within this document.) I compare the sums of each group (grouped by DATE, DEPTHTYPE, and ALGALGROUP) to the summations within the groupSums, which are the summation columns from the original document, appended to the other grouping columns.

Note: I round these number before comparing to account for differences < 1. There are three occurrences in which the summations from the tidied data set don't match the summations from the original sum columns:

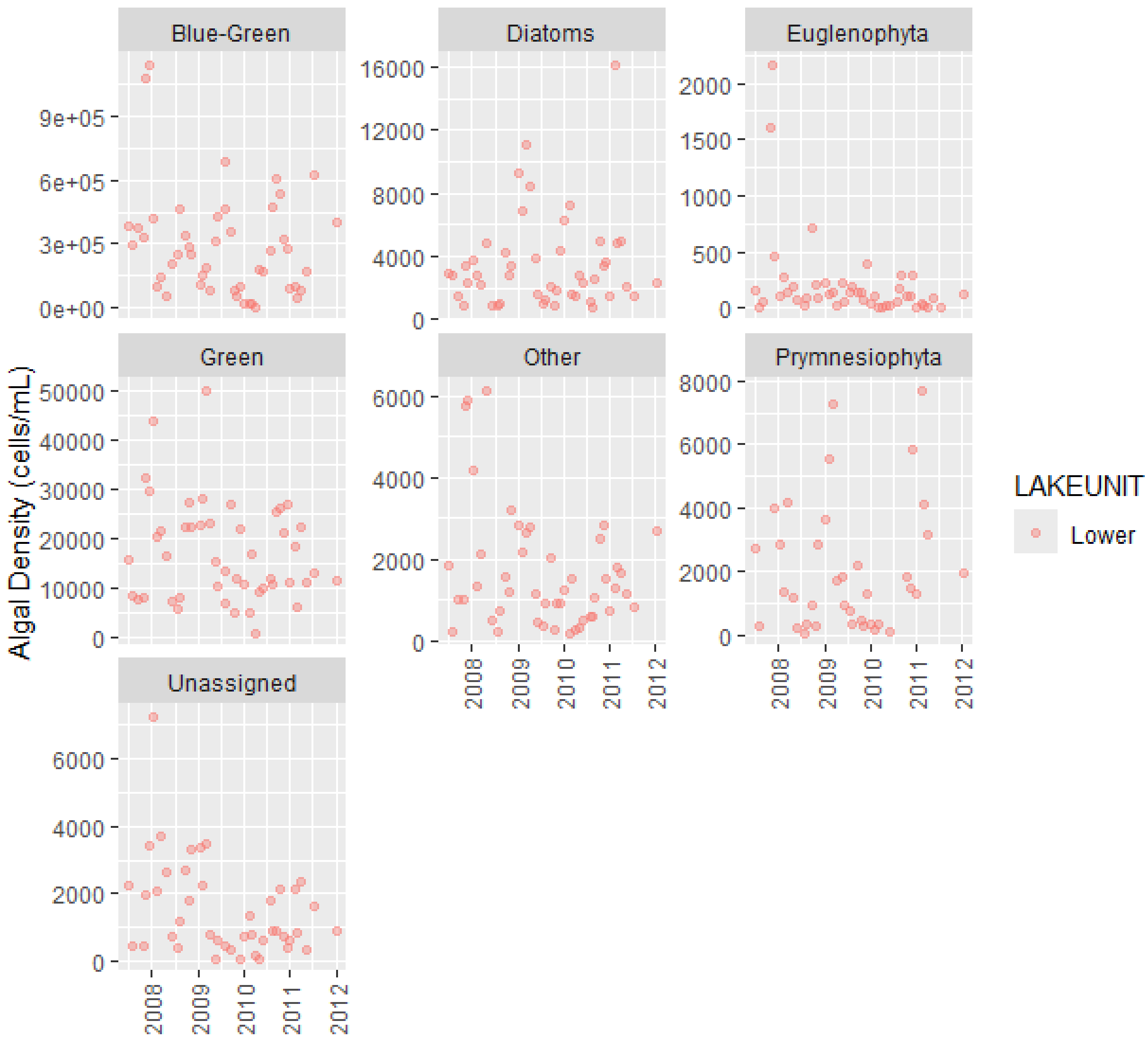
- Issue on 2007-07-05 for chrysophyta with Hypo DEPTHTYPE:
  - The original document mixed totals for Chysophyta and Cryptophyta
- Issue on 2007-07-05 for Euglenophyta with epi DEPTHTYPE:
  - Not significantly different, I don't think this should be a concern
- Issue on 2007-10-30 for Cyanobacteria with Mixed DEPTHTYPE:
  - Looks like document creator printed multiple sums, one for all of this group and one for a subset.

```
for(i in 1:NROW(groupSums)){
 thisSum <- groupSums[i,]

 if(is.na(thisSum$DEPTHTYPE)){
  thisData <- filter(longData, is.na(DEPTHTYPE), DATE == thisSum$DATE,
              ALGALGROUP == thisSum$AlgalGroup)
 } else {
   thisData <- filter(longData, DEPTHTYPE == thisSum$DEPTHTYPE, DATE == thisSum$DATE,
       ALGALGROUP == thisSum$AlgalGroup)
 }



 thisUnitSum <- sum(filter(thisData, MEASUNIT == "Units/mL")$VALUE) %>%
  round()

 thisCellSum <- sum(filter(thisData, MEASUNIT == "Cells/mL")$VALUE) %>%
  round()

 unitCheck <- thisUnitSum == round(thisSum$`GroupTotal(Units/mL)`)
 cellCheck <-  thisCellSum == round(thisSum$`GroupTotal(Cells/mL)`)

 if(!unitCheck){
  print("-----unit issue-----")
  print(sum(filter(thisData, MEASUNIT == "Units/mL")$VALUE))
  print(thisSum)
  print("------------------------")
 }

 if(!cellCheck){
  print("----Celll issue---")
  print(thisCellSum)
  print(thisSum)
  print("-----------------------")
 }
}
```

2.5.3 Quick Data Inspection

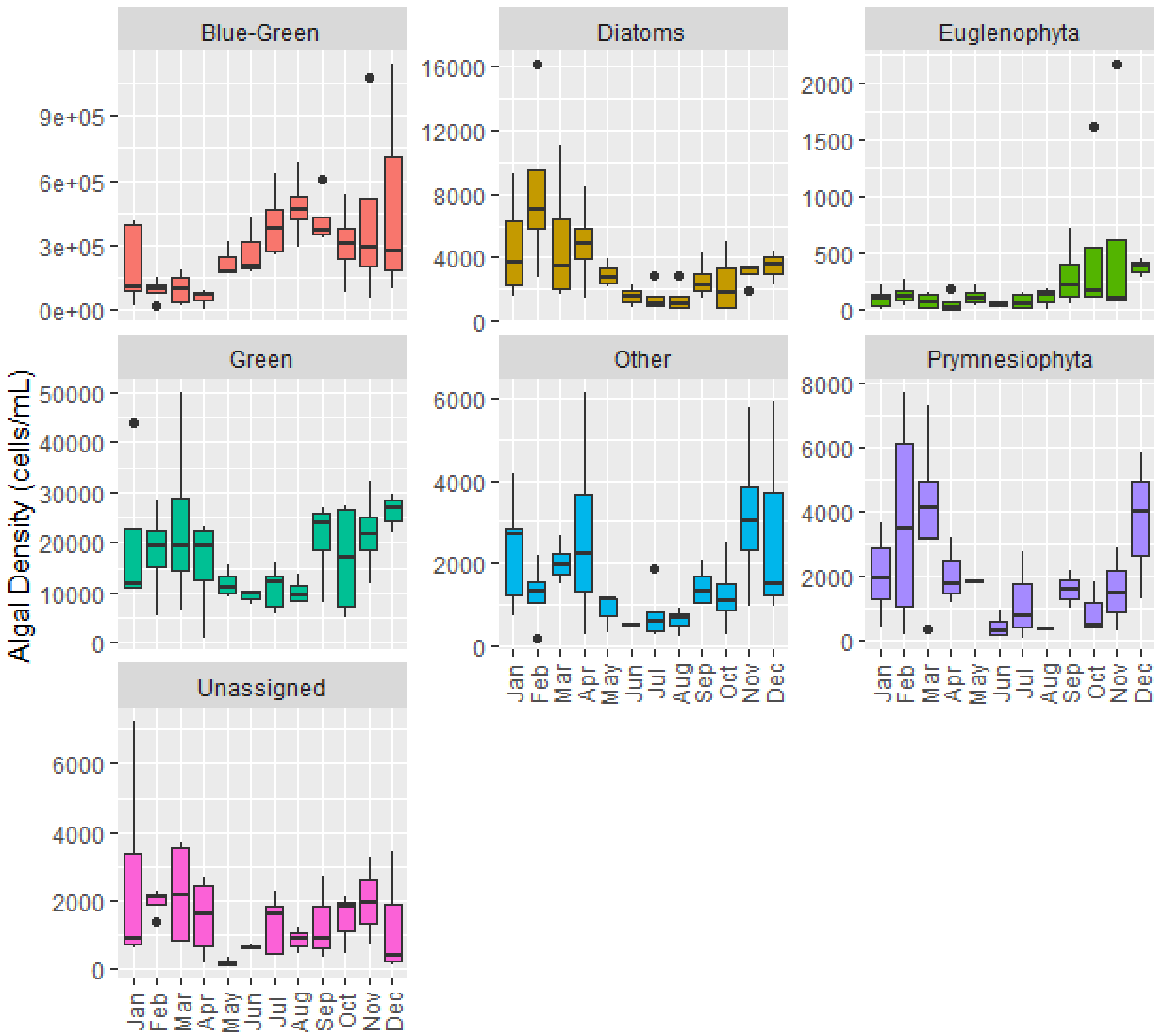
```
byDate <- longData %>%
  dplyr::filter(VARLABEL == "Algal Density, cells/mL") %>%
  dplyr::group_by(DATE, STATIONID, LAKEUNIT, ALGALTYPE) %>%
  dplyr::summarize(Total = sum(VALUE, na.rm = T), .groups = "drop") %>%
  ggplot() +
  geom_point(aes(x = DATE, y = Total, color = LAKEUNIT, group = str_wrap(ALGALTYPE, 20)), alpha = 0.4
) +
```

```
  labs(x = "", y = "Algal Density (cells/mL)") +
  facet_wrap(~str_wrap(ALGALTYPE, 20), scales = "free_y", ncol = 3) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byDate
```



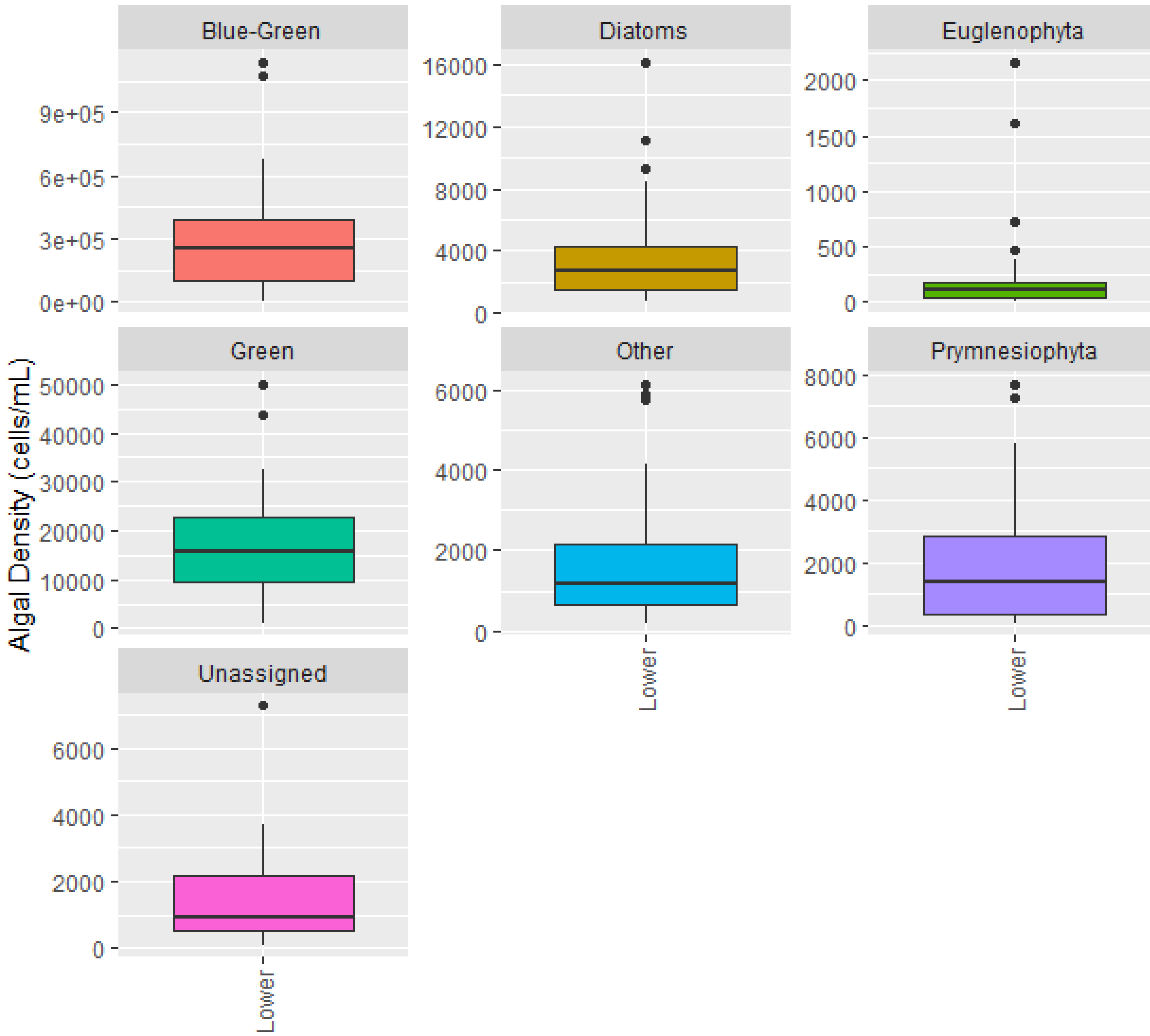

```
#ggsave(plot = byDate, filename = here::here("Data/Tidy/dataPrep/Figures", "ecAlgae_byDate.png"), wi
dth = 6.5, height = 6)

byMonth <- longData %>%
  dplyr::filter(VARLABEL == "Algal Density, cells/mL") %>%
  dplyr::group_by(DATE, MONTH, STATIONID, LAKEUNIT, ALGALTYPE) %>%
  dplyr::summarize(Total = sum(VALUE, na.rm = T), .groups = "drop") %>%
  ggplot() +
  geom_boxplot(aes(x = MONTH, y = Total, fill = str_wrap(ALGALTYPE, 20)), show.legend = F) +
  labs(x = "", y = "Algal Density (cells/mL)") +
```

```
  facet_wrap(~str_wrap(ALGALTYPE, 20), scales = "free_y", ncol = 3) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byMonth
```




```
#ggsave(plot = byMonth, filename = here::here("Data/Tidy/dataPrep/Figures", "ecAlgae_byMonth.png")
, width = 6.5, height = 6)

byLakeunit<-  longData %>%
  dplyr::filter(VARLABEL == "Algal Density, cells/mL") %>%
  dplyr::group_by(DATE, STATIONID, LAKEUNIT, ALGALTYPE) %>%
  dplyr::summarize(Total = sum(VALUE, na.rm = T), .groups = "drop") %>%
  ggplot() +
  geom_boxplot(aes(x = LAKEUNIT, y = Total, fill = str_wrap(ALGALTYPE, 20)), show.legend = F) +
  labs(x = "", y = "Algal Density (cells/mL)") +
  facet_wrap(~str_wrap(ALGALTYPE, 20), scales = "free_y", ncol = 3) +
```

```
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byLakeunit
```




```
#ggsave(plot = byLakeunit, filename = here::here("Data/Tidy/dataPrep/Figures", "ecAlgae_byLakeunit.p
ng"), width = 6.5, height = 6)
```

2.5.4 Export Tidy Data

The full algae data are saved as **ecAlgae_data.rds**

```
# saveRDS(longData, here::here("Data/Tidy/dataPrep", "ecAlgae_data.rds"))
# openxlsx::write.xlsx(longData, file = here::here("Data/Tidy/dataPrep/Excel", "ecAlgae_data.xlsx"), over
write = TRUE)
readr::write_csv(longData, here::here("Data/Tidy/AppendixC", "ecAlgae_data.csv"))
```

Then each metric is also saved separately:

- *ecAlgae_celldens*

- *ecAlgae_unitdens*

```
cd <- dplyr::filter(longData, VARIABLE == "Cell Density")
# saveRDS(cd, here::here("Data/Tidy/dataPrep", "ecAlgae_celldens.rds"))
readr::write_csv(cd, here::here("Data/Tidy/AppendixC", "ecAlgae_celldens.csv"))

ud <- dplyr::filter(longData, VARIABLE == "Unit Density")
# saveRDS(ud, here::here("Data/Tidy/dataPrep", "ecAlgae_unitdens.rds"))
readr::write_csv(ud, here::here("Data/Tidy/AppendixC", "ecAlgae_unitdens.csv"))
```

Code prepared by KDV Decision Analysis LLC. Code last run 2024-08-29 with R version 4.4.1 (2024-06-14 ucrt)

2.6 City of Raleigh EC Toxin Data 2007 to 2011 (ecToxins)

2.6.1 Data Source Prep

The Raleigh Toxin folder contained a file **ECToxins Falls and Johnson 2007-12.xls** which contained the toxin measures at the Falls Lake and Lake Johnson intakes. Three toxins were measured: Anatoxin-a, Cylindrospermopsin, and Microcystin from 2007 to 2012.

The majority of measures were Non Detects ("ND"). Although we had notes (**RaleighToxin_EMJ_MeasuresAndLimits_20220503.pdf**) suggesting higher detection limits in City of Raleigh samples, these data contained values lower than the detection limit (and even lower than half the detection limit). We used half of the minimum observed value as the detection limit. All values are below critical values, so this assumption will not impact model results.

We replaced ND values with these values as roughly half the detection limit:

- Anatoxin-a: 0.025
- Cylindrospermopsin: 0.05
- Microcystin: 0.05

Multiple Anatoxin-a measures were also recorded as "0.05-0.1" and we changed these to numeric value 0.075.

We assigned SOURCE as "ecToxin" and SOURCEID by concatenating values Sample + Date

```
rawFalls <- readxl::read_xls(here::here(rawFile), sheet = "Falls", col_types = c("text", "date", "text", "text
", "text")) %>%
  dplyr::mutate(SOURCE = "ecToxin",
                SOURCEID = paste(Sample, Date, sep = "_"))

names(rawFalls)

## [1] "Sample"                 "Date"
## [3] "Anatoxin-a (µg/L)"       "Cylindrospermopsin (µg/L)"
## [5] "Microcystin (µg/L)"      "SOURCE"
## [7] "SOURCEID"
```

There are 65 records in the raw data, but these include samples from all depths.

2.6.2 CPivot and create tidy VARIABLE and VALUE columns

```
  # convert data to values that can be coerced to numeric
tidy <- rawFalls %>%
  dplyr::mutate(`Anatoxin-a` = ifelse(`Anatoxin-a (μg/L)`=="ND", "0.025", `Anatoxin-a (μg/L)`),
                `Anatoxin-a` = ifelse(`Anatoxin-a`=="0.05-0.1", "0.075", `Anatoxin-a`),
                `Cylindrospermopsin` = ifelse(`Cylindrospermopsin (μg/L)`=="ND", "0.05", `Cylindrospe
rmopsin (μg/L)`),
                `Microcystin` = ifelse(`Microcystin (μg/L)`=="ND", "0.05", `Microcystin (μg/L)`)) %>%
  # coerce values to numeric and round; remove raw columns
  dplyr::mutate(across(`Anatoxin-a`:`Microcystin`, ~round(as.numeric(.), 3))) %>%
  dplyr::select(-(`Anatoxin-a (μg/L)`:`Microcystin (μg/L)`)) %>%
  # pivot longer for standard VARIABLE and VALUE structure
  tidyr::pivot_longer(cols = `Anatoxin-a`:`Microcystin`, names_to = "VARIABLE", values_to = "VALUE") %
>%
  dplyr::mutate(MEASUNIT = "ug/L",
                VARTYPE = NA_character_,
                SOURCETYPE = "Empirical",
                VARLABEL = sprintf("%s (%s)", VARIABLE, MEASUNIT))
```

2.6.3 Retain only surface measures

The data include samples designated as “Epi”, “Mixed”, “Hypo”, and “Surface”. For this study we are focused on surface. After confirming with A. Matos that any “Hypo” or “Mixed” measurements were NOT surface measures, we removed these values. Given lake depth is variable, we do not assign a default depth or depth method type.

```
tidy  <- tidy %>%
  tidyr::separate(Sample, into = c("STATIONID", "DEPTHM")) %>%
  dplyr::filter(DEPTHM %in% c("Surface", "Epi")) %>%
  dplyr::mutate(STATIONID = "Intake Surface",
                STATION = "Intake Surface",
                DEPTHM = NA_real_,
                DEPTHTYPE = NA_character_)
```

2.6.4 Assign Dates and Location

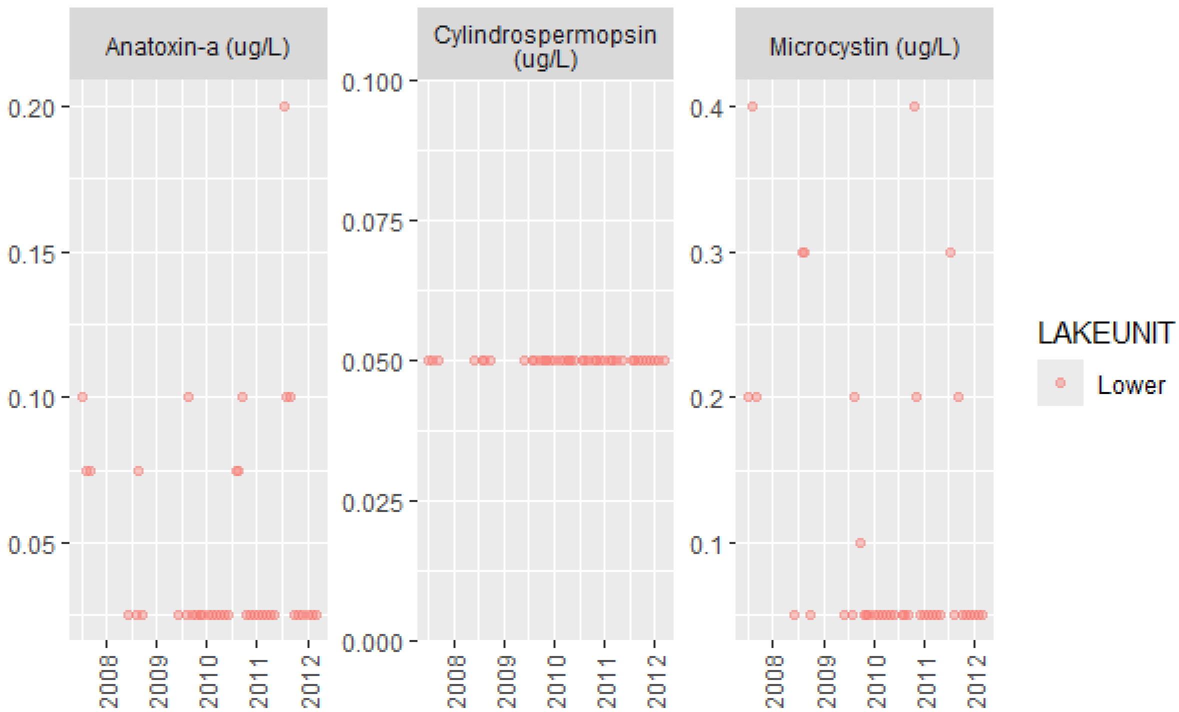
All samples are assumed to be taken from the intake location.

```
tidy <- tidy %>%
  dplyr::rename(DATE = Date) %>%
  dplyr::mutate(LAKEUNIT = "Lower",
                LOCATE = "Lake",
                MONTH = lubridate::month(DATE, label = TRUE, abbr = TRUE),
                YEAR = lubridate::year(DATE))
```

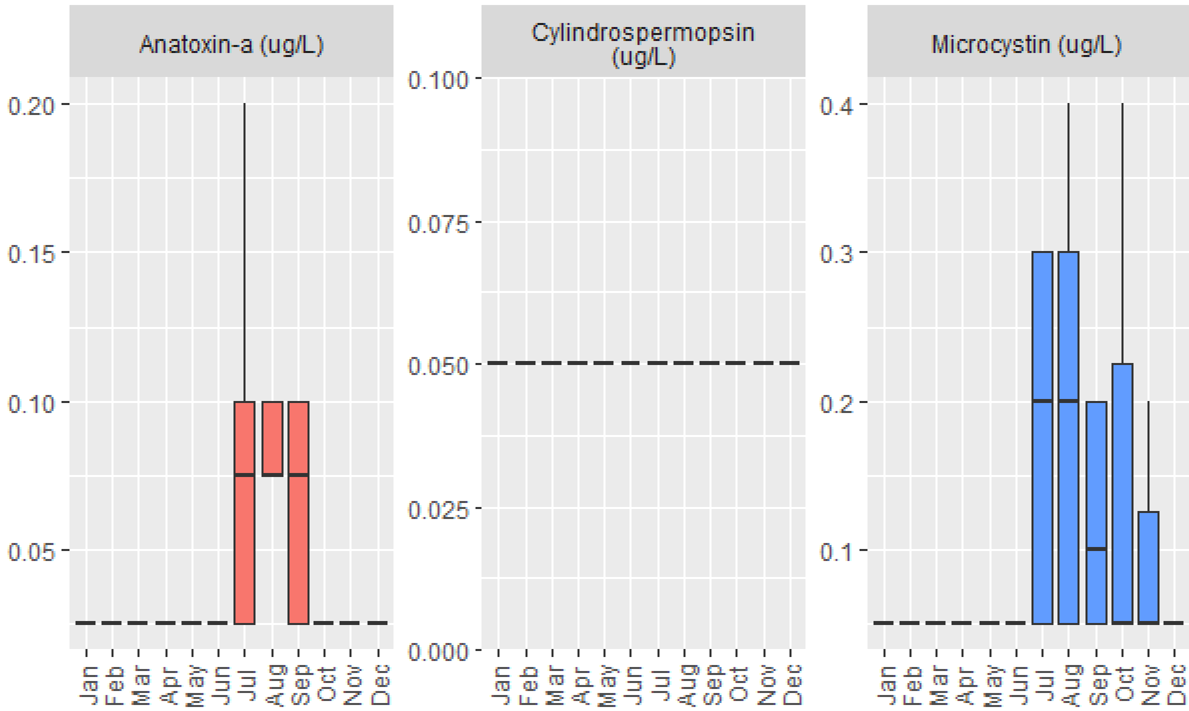
The tidy data contain 120 surface water toxin measurement events. The dates for surface and epilimnion samples range from 2007 to 2007. There are 40 sample dates.

2.6.5 Quick Data Inspection

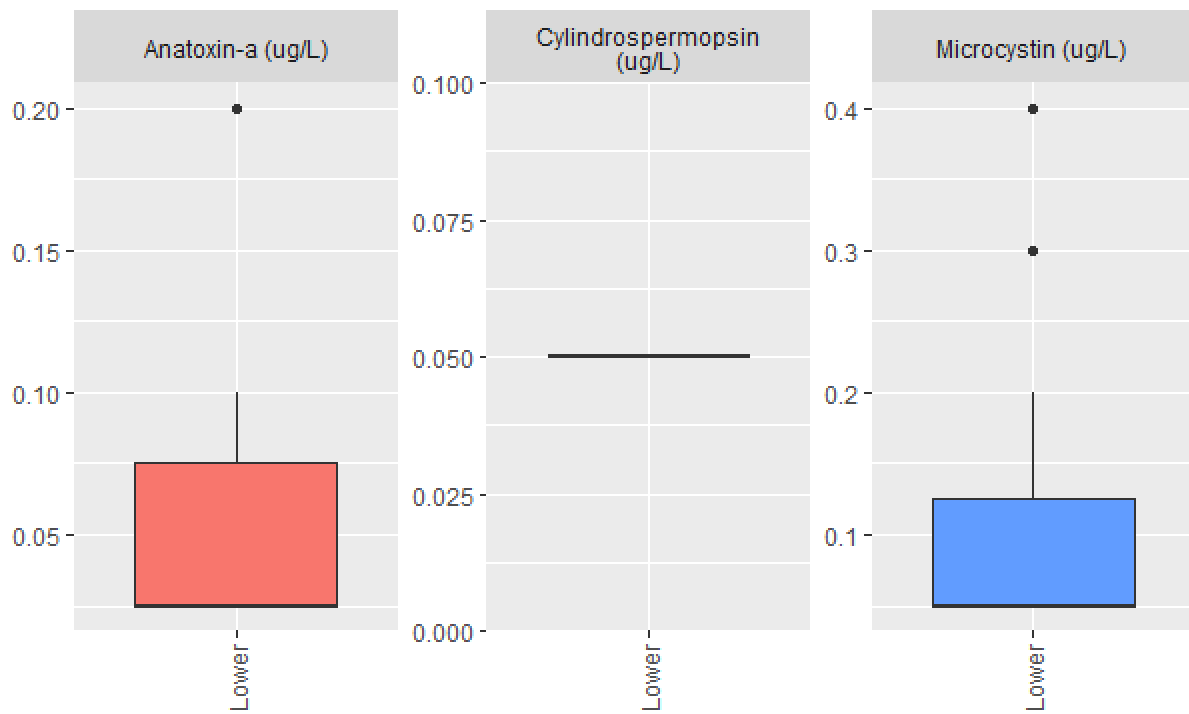
```
byDate <- ggplot() +
  geom_point(data = tidy, aes(x = DATE, y = VALUE, color = LAKEUNIT, group = str_wrap(VARLABEL, 20))
, alpha = 0.4) +
  labs(x = "", y = "") +
  facet_wrap(~str_wrap(VARLABEL, 20), scales = "free_y", ncol = 3) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byDate
```




```
#ggsave(plot = byDate, filename = here::here("Data/Tidy/dataPrep/Figures", "ecToxin_byDate.png"), wi
dth = 6.5, height = 4)

byMonth<- ggplot() +
  geom_boxplot(data = tidy, aes(x = MONTH, y = VALUE, fill = str_wrap(VARLABEL, 20)), show.legend =
F) +
  labs(x = "", y = "") +
  facet_wrap(~str_wrap(VARLABEL, 20), scales = "free_y", ncol = 3) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byMonth
```




```
#ggsave(plot = byMonth, filename = here::here("Data/Tidy/dataPrep/Figures", "ecToxins_byMonth.png"
), width = 6.5, height = 4)

byLakeunit<- ggplot() +
  geom_boxplot(data = tidy, aes(x = LAKEUNIT, y = VALUE, fill = str_wrap(VARLABEL, 20)), show.legend
= F) +
  labs(x = "", y = "") +
  facet_wrap(~str_wrap(VARLABEL, 20), scales = "free_y", ncol = 3) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byLakeunit
```




```
#ggsave(plot = byLakeunit, filename = here::here("Data/Tidy/dataPrep/Figures", "ecToxins_byLakeunit.png"), width = 6.5, height = 4)
```

2.6.6 Export tidy data

```
tidyData <- tidy %>%
    dplyr::select(SOURCE, SOURCEID, SOURCETYPE, DATE, STATIONID, STATION, DEPTHM, DEPTHTYPE, VARIABLE, VALUE, VARTYPE, VARLABEL, MEASUNIT, YEAR, MONTH, LAKEUNIT, LOCATE)

# Save prepped data
# saveRDS(tidyData, here::here("Data/Tidy/dataPrep", "ecToxins_data.rds"))
# openxlsx::write.xlsx(tidyData, file = here::here("Data/Tidy/dataPrep/Excel", "ecToxins_data.xlsx"))
readr::write_csv(tidyData, here::here("Data/Tidy/AppendixC", "ecToxins_data.csv"))

# Anatoxin-a
anatot <- tidyData %>%
  dplyr::filter(VARIABLE == "Anatoxin-a")
# saveRDS(anatot, here::here("Data/Tidy/dataPrep", "ecToxins_anatot.rds"))
readr::write_csv(anatot, here::here("Data/Tidy/AppendixC", "ecToxins_anatot.csv"))

# Microcystin
mictot <- tidyData %>%
  dplyr::filter(VARIABLE == "Microcystin")
# saveRDS(mictot, here::here("Data/Tidy/dataPrep", "ecToxins_mictot.rds"))
readr::write_csv(mictot, here::here("Data/Tidy/AppendixC", "ecToxins_mictot.csv"))
```

```
# Cylindrospermopsin
cyltot <- tidyData %>%
  dplyr::filter(VARIABLE == "Cylindrospermopsin")
# saveRDS(cyltot, here::here("Data/Tidy/dataPrep", "ecToxins_cyltot.rds"))
readr::write_csv(cyltot, here::here("Data/Tidy/AppendixC", "ecToxins_cyltot.csv"))
```

Code prepared by KDV Decision Analysis LLC. Code last run 2024-08-29 with R version 4.4.1 (2024-06-14 ucrt).

2.7 Toxin Data 2016-2018 (raltoxin)

2.7.1 Data Source Prep

2.7.1.1 2016to2018ToxinData.csv

The **2016to2018ToxinData.csv** file came in **ToxinData_2021Mar23.zip**

Falls Lake algal toxin data collected by the City of Raleigh (2016-2018). The spreadsheets contain data for three toxins (Cylindrospermopsin, Microcystin, Anatoxin-a) from six locations. As noted in UNRBA 2019 report:

- "The World Health Organization (WHO) microcystin guideline for drinking water is 1 µg/L, and the EPA draft recreational guideline is 4 µg/L."
- "For many sampling events, toxins were not detected. From a total of some 180 samples, microcystin and cylindrospermopsin were each detected in about 13 to 30 percent of the samples across the six monitored stations, and anatoxin was found in 10 to 20 percent of the samples across stations."
- "Algal toxin concentrations in lake arms tend to be higher than in the main channel. No samples of microcystin exceeded either the draft EPA recreational guideline nor the WHO drinking water guideline. Cylindrospermopsin was generally lower than microcystin, and anatoxin-a was sometimes higher than microcystin."

Alix Matos (B&C) provided access to Dropbox account (https://www.dropbox.com/sh/kalhhp9jf86x355/AADGq8GjMrlswI8MqAzg6mS1a?dl=0) on 2021-03-23 and a spreadsheet documenting data resources and past reports that she regularly updates (StudiesRelevantToFLmodels). The Dropbox contained a folder, **FL_SummaryOfStudies**, which contained the zipped folder **ToxinData_2021Mar23.zip**

More information about these data is available in the UNRBA 2019 Annual Report in Section 5.10.

- 2016to2017ToxinData.csv
- 2016to2018ToxinData.csv
- 2017to2018ToxinData.csv
- Delivery Email.txt
- RaleighToxin_EMJ_MeasuresAndLimits_20220503.pdf ## Inspecting Raw Files

```
# Read in the raw data
# A few dates will fail to parse
toxin1617 <- readr::read_csv(here::here(rawFile1617),
                             show_col_types = FALSE) %>%
```

```
  dplyr::mutate(`Visit DateTime` = lubridate::date(lubridate::mdy_hm(`Visit DateTime`)))

toxin1718 <- readr::read_csv(here::here(rawFile1718),
                             show_col_types = FALSE) %>%
  dplyr::mutate(`Date Collected` = lubridate::mdy(`Date Collected`))

toxin1618 <- readr::read_csv(here::here(rawFile1618),
                             show_col_types = FALSE) %>%
  dplyr::mutate(`Date Collected` = lubridate::mdy(`Date Collected`))

# Examine mis-matched data structures
# Identify extra columns in the 16-17 data
mainCols <- names(toxin1718)
extraCols <- names(toxin1617)[!names(toxin1617) %in% names(toxin1718)]

# Check if dates align (do number days in 16-17 file equal number of 16-17 records in the 16-18 file)
date <- lubridate::ymd(toxin1618$`Date Collected`)
firstYr <- sum(date < lubridate::mdy("9/28/2017")) # expected 366, got 327
secondYr <- sum(date > lubridate::mdy("9/27/2017")) # expected 327 got 213
# Further investigation confirmed that the dates are overlapping
range(toxin1617$`Visit DateTime`, na.rm = TRUE)

## [1] "2016-01-26" "2017-12-19"

range(toxin1718$`Date Collected`, na.rm = TRUE)

## [1] "2017-02-22" "2018-10-30"

# Compare grab and discrete data
grab1617 <- toxin1617[toxin1617$`Depth Type`=="Grab", ]
discrete1617 <- toxin1617[toxin1617$`Depth Type`=="Discrete", ]

# Create df to inspect for duplicate records
toxin1617 <- toxin1617 %>%
  dplyr::select(Parameter, Site = `# Station ID`, `Date Collected` = `Visit DateTime`, Result, Units = Unit, `
Sample Type` = `Depth Type`, Method = `Analysis Method`)
merge1618 <- rbind(toxin1617, toxin1718, toxin1618)

merge1618 <- dplyr::arrange(merge1618, Parameter, Site, `Date Collected`)
# duplicate records visible
# appears that discrete value  == grab value
exampleDups <- merge1618[c(19:32), ]

# keep only the grab data... does that make the merged data match?
merge1618 <- merge1618 %>%
  dplyr::filter(`Sample Type` != "Discrete") %>% # 1017 rows
```

```
  dplyr::distinct() %>% # 867 rows
  dplyr::arrange(`Date Collected`, Parameter)
# still too many rows, so examined sorted data visually.  Discovered
# sites had been renamed in toxin1618, so removing duplicate
# records programmatically did not remove true duplicates
merge1618[418:429, ]

## # A tibble: 12 × 7
##   Parameter  Site         `Date Collected` Result Units `Sample Type` Method
##   <chr>      <chr>        <date>           <chr>  <chr> <chr>         <chr>
##  1 Microcystin Honeycutt Cre… 2017-07-25       ND     ug/L  Grab          ELISA
##  2 Microcystin Honeycutt Cre… 2017-07-25       ND     ug/L  Grab          ELISA
##  3 Microcystin Intake Surface 2017-07-25       0.15   ug/L  Grab          ELISA
##  4 Microcystin Lake at Intak… 2017-07-25       0.15   ug/L  Grab          ELISA
##  5 Microcystin Lake at US Hw… 2017-07-25       ND     ug/L  Grab          ELISA
##  6 Microcystin Lower Barton … 2017-07-25       ND     ug/L  Grab          ELISA
##  7 Microcystin Lower Barton … 2017-07-25       ND     ug/L  Grab          ELISA
##  8 Microcystin New Light Cre… 2017-07-25       0.17   ug/L  Grab          ELISA
##  9 Microcystin New Light Cre… 2017-07-25       0.17   ug/L  Grab          ELISA
## 10 Microcystin US Hwy 98      2017-07-25       ND     ug/L  Grab          ELISA
## 11 Microcystin Upper Barton … 2017-07-25       0.23   ug/L  Grab          ELISA
## 12 Microcystin Upper Barton … 2017-07-25       0.23   ug/L  Grab          ELISA

merge1618 <- merge1618 %>%
  dplyr::filter(stringr::str_detect(Site, "Arm") | stringr::str_detect(Site, "Lake"))
# 540 same as toxin1618

# after evaluating the merge file, I chose to continue with the 2016-2018 file (toxin1618).
rm(merge1618, toxin1617, toxin1718, grab1617)
```

The three files have inconsistent structure and contain factor variables with different values. There are multiple columns with no values or a single constant value.

All three files contain the columns: Parameter, Site, Date Collected, Result, Units, Sample Type, Method.

The earliest file has an additional 28 columns: # Station ID, Visit DateTime, Sample DateTime, Matrix, Sample Collection Method, Depth Type, Depth (m), Composite Depth 1 (m), Composite Depth 2 (m), Filtered Location, Unit, Flag, Path Length, Analysis Method, High Limit, High Limit Type, Low Limit, Low Limit Type, Receipt Lab, Receipt Date, Analysis Lab, Analysis DateTime, Sample Delivery Group, COC ID, Monitoring Organization, QAPP ID, Project Description, Comments. These include potentially important information relevant to censured data (high and/or low limits?). All of the depth data columns (Depth Type, Depth (m), Composite Depth 1 (m) and Composite Depth 2 (m)) are empty (NA), as are the columns Flag, Path Length, Analysis DateTime, Sample Delivery Group and Comments.

At first the 2016-2018 file appeared to be a partial merge of the 2016-2017 and 2017-2018 files; it contained less records than expected if simply a sum of the two individual years. It was unclear what criteria were used to reduce the set. The 2016-2017 file has a column Depth Type with values

"Grab" and "Discrete" and a column Sample Type with the values "Primary" and NA. The files 2017-2018 and 2016-2018 have a column Sample Type with only values "Grab". Eventually we discovered the two single partial files contain overlapping dates. Furthermore, sites were renamed in the 2016-2018 data.

As far as I can tell, the Discrete samples are duplicates of the Grab sample. Discrete values are never documented on dates without grab values. Discrete results on a given date are always equal to the grab results on the same date.

Site names appear modified in the merged set, with the extension "Arm" added to creek sites and Lake added to other sites. We confirmed these have identical toxin values as sites without the "Arm" and "Lake" additions.

2.7.2 Define detection limits

The limit of detection (LOD) and a limit of quantitation (LOQ) are undefined in the data. However, a later email from Samantha Dillan at City of Raleigh (**RaleighToxin_EMJ_MeasuresAndLimits_20220503.pdf**) noted these limits on the bottom of a table from 2022 samples:

- ANTX-A (Anatoxin-a) detection limit 0.150-5.000
- CYN (Cylindrospermopsin) detection limit 0.010-2.000
- MC (Mycrocystin) detection limit 0.300-5.000

However, sometimes the data had measured values lower than these detection limits (but not half the limit as common in data prep steps), so I assume a different lab or method may have been used to prepare these data. For the purposes of this data analysis, I used the lower of two values to replace "non detect values".

- half of the lower limit referenced in City of Raleigh table
- half of the minimum value reported in the measured data

In all cases, the lower limits were well below any level of concern and would be classed in the category "Low" for the Bayesian model regardless.

```
#The NDVALUE should be half of whatever is lower: LOWLIMIT or NDVALUE
ndValues <- data.frame(TOXIN = c("ANA", "CYL", "MIC"),
                       LOWLIMIT = c(0.15, 0.01, 0.30),
                       UPPLIMIT = c(5.0, 2.0, 5.0),
                       DATAMIN = c(0.10, 0.01, 0.15),
                       NDVALUE = c(0.05, 0.005, 0.075))
nd <- ndValues$NDVALUE
names(nd) <- ndValues$TOXIN
```

In all data, **Method = "ELISA"** and **Units = "ug/L"**.

After confirming the merge strategy that was used, I chose to use the **2016to2018ToxinData.csv** and ignore the other two. In terms of time spent, these mixed files and poorly documented data with changing variable names etc are more costly to prepare than the entire data analysis.

2.7.3 Standardize Data Structure

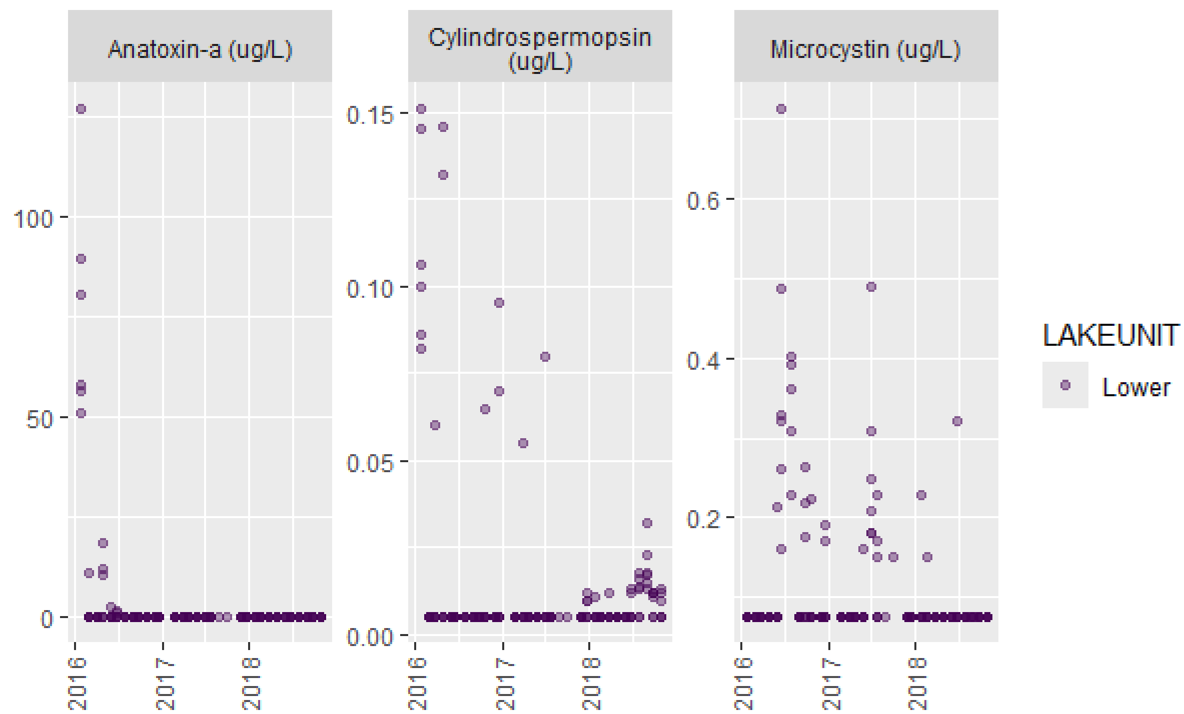
```
#prep <- receiveData(toxin1618, sourceCol = "raleigh_toxin", idCol = c("Parameter", "Site", "Date Collect
ed"), dropCol = c("Method", "Sample Type"))
```

```
tidyData <- toxin1618 %>%
  dplyr::select(-all_of(c("Method", "Sample Type"))) %>%
  # add new standard columns: SOURCE and SOURCEID
  dplyr::mutate(SOURCE = "raltoxin") %>%
  tidyr::unite("SOURCEID", all_of(c("Parameter", "Site", "Date Collected")), sep = '_', remove = FALSE) %
>%
  dplyr::mutate(SOURCEID = stringr::str_replace_all(SOURCEID, " ", ""))

# standardize column names
original <- names(tidyData)
standard <- stringr::str_replace_all(original, " ", "")
standard <- stringr::str_replace_all(standard, "[[:punct:]]", "")
standard <- toupper(standard)
names(tidyData) <- standard

# Create the LAKEUNIT column
# Make sure all site names in the lookup list source_setupDictionaries
# all(tidyData$SITE %in% names(lakeUnitList))
tidyData <- assignLAKEUNIT(df = tidyData, siteNameColumn = "SITE", lakeUnitList = lakeUnitList)

# Create the LOCATE column
# Make sure all site names in the lookup list source_setupDictionaries
# all(tidyData$SITE %in% names(locateList))
tidyData <- assignLOCATE(df = tidyData, siteNameColumn = "SITE", locateList = locateList)

# Finish standardizing
tidyData <- tidyData %>%
  dplyr::mutate(DATE = DATECOLLECTED,
                MONTH = lubridate::month(DATECOLLECTED, label = TRUE),
                YEAR = lubridate::year(DATECOLLECTED),
                SOURCETYPE = "Empirical",
                STATIONID = SITE, # bc no id provided
                STATION = SITE,
                DEPTHM = NA_real_, # TODO: were these grabs at standard depth?
                DEPTHTYPE = NA_character_, # TODO: can grab method be matched to a depth type?
                VARIABLE = PARAMETER,
                MEASUNIT = UNITS,
                VARTYPE = "Grab",
                VARLABEL = sprintf("%s (%s)", VARIABLE, MEASUNIT),
                # apply limit values
                VALUE = RESULT,
                VALUE = ifelse(RESULT == "ND" & VARIABLE == "Anatoxin-a", as.character(nd[["ANA"]]
), VALUE),
```

```
                    VALUE = ifelse(RESULT == "ND" & VARIABLE == "Microcystin", as.character(nd[["MIC"]
]), VALUE),
                    VALUE = ifelse(RESULT == "ND" & VARIABLE == "Cylindrospermopsin", as.character(nd
[["CYL"]]), VALUE),
                    VALUE = as.numeric(VALUE)) %>%
  dplyr::select(SOURCE,  SOURCEID,  SOURCETYPE, DATE,  STATIONID, STATION,  DEPTHM, DEPTHTY
PE, VARIABLE, VALUE, VARTYPE,  VARLABEL,  MEASUNIT,  YEAR,  MONTH, LAKEUNIT,  LOCATE)
```

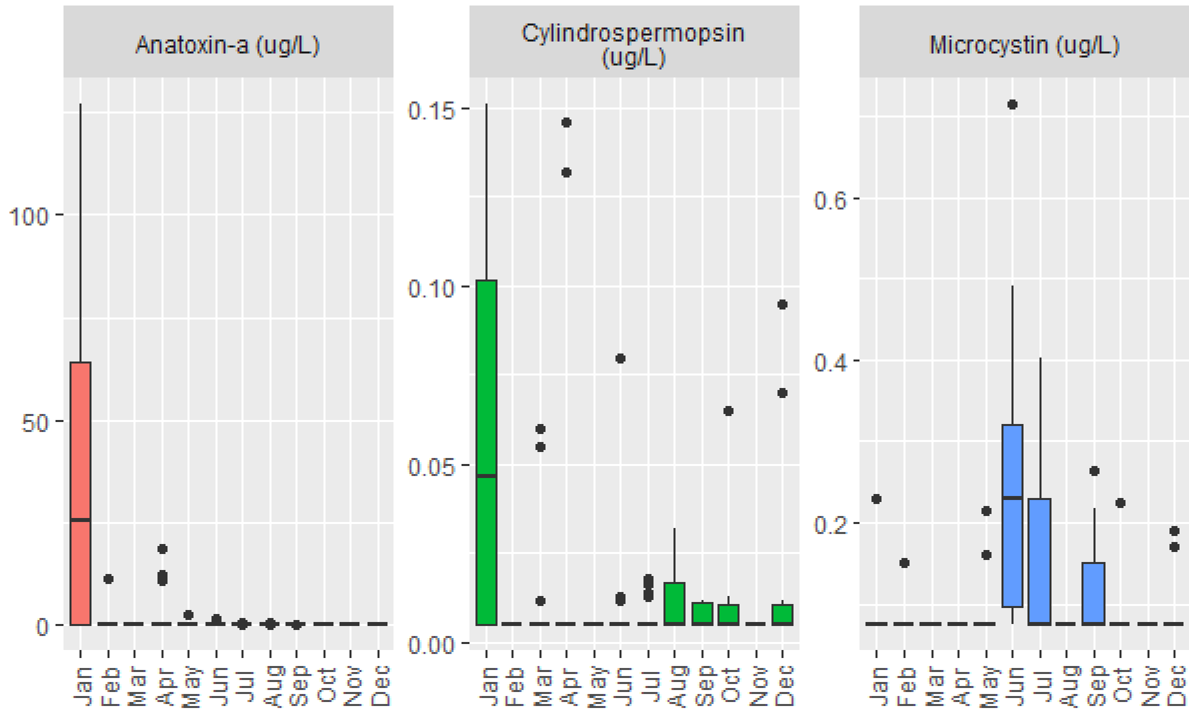
2.7.4 Quick Data Inspection

```
byDate <- ggplot() +
  geom_point(data = tidyData, aes(x = DATE, y = VALUE, color = LAKEUNIT, group = str_wrap(VARLABEL,
20)), alpha = 0.4) +
  labs(x = "", y = "") +
  facet_wrap(~str_wrap(VARLABEL, 20), scales = "free_y", ncol = 3) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byDate
```

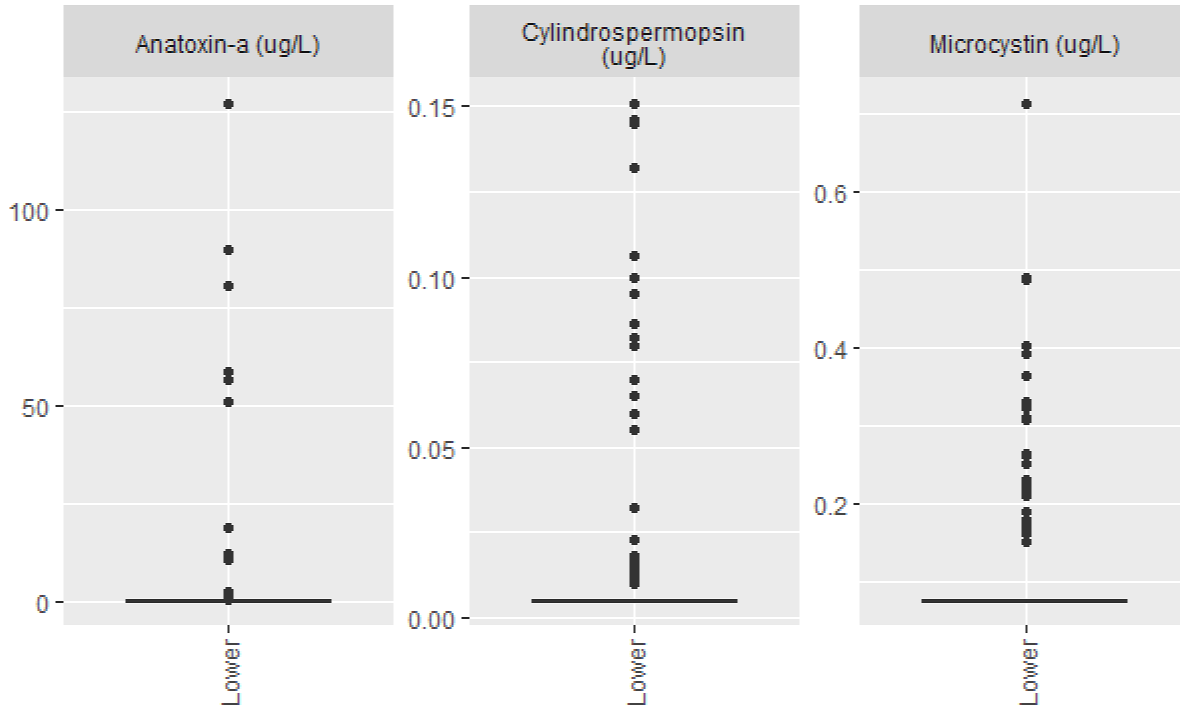



```
# ggsave(plot = byDate, filename = here::here("Data/Tidy/dataPrep/Figures", "raltoxin_byDate.png"), wi
dth = 6.5, height = 4)

byMonth<- ggplot() +
  geom_boxplot(data = tidyData, aes(x = MONTH, y = VALUE, fill = str_wrap(VARLABEL, 20)), show.lege
nd = F) +
  labs(x = "", y = "") +
  facet_wrap(~str_wrap(VARLABEL, 20), scales = "free_y", ncol = 3) +
```

```
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byMonth
```




```
# ggsave(plot = byMonth, filename = here::here("Data/Tidy/dataPrep/Figures", "raltoxin_byMonth.png")
, width = 6.5, height = 4)

byLakeunit<- ggplot() +
  geom_boxplot(data = tidyData, aes(x = LAKEUNIT, y = VALUE, fill = str_wrap(VARLABEL, 20)), show.leg
end = F) +
  labs(x = "", y = "") +
  facet_wrap(~str_wrap(VARLABEL, 20), scales = "free_y", ncol = 3) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byLakeunit
```




```
# ggsave(plot = byLakeunit, filename = here::here("Data/Tidy/dataPrep/Figures", "raltoxin_byLakeunit.png"), width = 6.5, height = 4)
```

2.7.5 Export Tidy Data

We export the full tidy data resource (**raltoxin_data.rds**) plus one file per variable (e.g. **raltoxin_ana.rds**).

```
# Save prepped data
# saveRDS(tidyData, here::here("Data/Tidy/dataPrep", "raltoxin_data.rds"))
# openxlsx::write.xlsx(tidyData, file = here::here("Data/Tidy/dataPrep/Excel", "raltoxin_data.xlsx"))
readr::write_csv(tidyData, here::here("Data/Tidy/AppendixC", "raltoxin_data.csv"))

# Anatoxin-a
anatot <- tidyData %>%
  dplyr::filter(VARIABLE == "Anatoxin-a")
#saveRDS(anatot, here::here("Data/Tidy/dataPrep", "raltoxin_anatot.rds"))
readr::write_csv(anatot, here::here("Data/Tidy/AppendixC", "raltoxin_anatot.csv"))

# Microcystin
mictot <- tidyData %>%
  dplyr::filter(VARIABLE == "Microcystin")
#saveRDS(mictot, here::here("Data/Tidy/dataPrep", "raltoxin_mictot.rds"))
readr::write_csv(mictot, here::here("Data/Tidy/AppendixC", "raltoxin_mictot.csv"))

# Cylindrospermopsin
cyltot <- tidyData %>%
```

```
  dplyr::filter(VARIABLE == "Cylindrospermopsin")
#saveRDS(cyltot, here::here("Data/Tidy/dataPrep", "raltoxin_cyltot.rds"))
readr::write_csv(cyltot, here::here("Data/Tidy/AppendixC", "raltoxin_cyltot.csv"))
```

Code created by KDV Decision Analysis LLC and last run 2024-08-29 with R version 4.4.1 (2024-06-14 ucrt)

2.8 Storet Data from NC DWR (storetDwr)

2.8.1 Raw Data

Our original analysis used the file *DWRLakeWaterQuality_1984_2019_FromSTORET_through2020.csv*. These data were replaced in early January 2023 by B&C (L. Strader) with the file DataforModelers_1984to2020_DWROnly.csv. They suspected that some data were accidentally being excluded from the original. The new data have fewer records, but also fewer stations. In the original file, the majority of the data were NOT from Falls Lake. After several back and forth to address different perceived qaqc issues or biases in the data related to how best to include the maximum number of photic samples without accidently including cdeeper samples - when many samples did not have any secchi depth information. In late January, we received the file DataforModelers_1984to2020_DWROnly_v2.csv. Notes about the preparation of these data and instructions to complete filtering here are included in the file DWRdata_PrepSummaryAndInstructions_LaurenStrader_20230124.pdf. In summary, preparation steps completed by BC (L. Strader):

- Grouped data by parameter, sampling location and date. Note for the historic data: there are multiple station names for the same location (e.g. J1250010 and J1250030 are the same location). So instead of grouping by actual station name, I grouped by lat/lon. I suspect the station names that end in "030" are only bottom water samples, but this isn't explicitly stated in the station metadata.
- For all non-profile data, I removed data associated with the deepest depth
- This left a handful of values that were still associated with "030" station names. I went ahead and manually removed these rows.
- Spot checked a few samples from the historic data as well as from 2019/2020 to make sure concentrations match with the raw data and that no surface water samples were mistakenly removed.

The expectation is that KDV will "filter to remove anything > 4.4 meters" depth.

2.8.2 Data Supplements

After review of initial data resources by TAW (Feb 2023) additional data were pulled from Storet. These had the same preparation steps. USGS and DWR are mixed in these data pulls, but only DWR are integrated here. We received updated DWR data for:

- Manganese (mg/L)
- Dissolved Oxygen (% saturation)

```
#NOTE: Every time we receive these data, the date format is different.  If pulling data from new source - c
heck very carefully that date import correctly!!!
#
```

```
raw <- readr::read_delim(here::here(rawFile),
                         col_types = "cccTcddcd", show_col_types = FALSE) %>%
  dplyr::select(-`...1`)

newMang <- readr::read_csv(here::here(rawMang), show_col_types = FALSE) %>% # parse issue is ok
  dplyr::mutate(m_date = lubridate::mdy_hm(m_date)) %>%
  dplyr::filter(mon_org == "NC-DENR")

newDO <- readr::read_csv(here::here("Data/Raw/Storet", "DWRUSGS_DOSaturation.csv"), show_col_ty
pes = FALSE) %>%
    dplyr::mutate(m_date = lubridate::mdy_hm(m_date)) %>%
  dplyr::filter(mon_org == "NC-DENR")

raw <- rbind(raw, newMang, newDO)

# table(raw$SampleType)
# table(raw$station_name)
# table(raw$mon_org)
# table(raw$parameter)

names(raw)

## [1] "station_name" "mon_org"      "m_date"       "SampleType"   "depth_m"
## [6] "secchi_m"     "parameter"    "value"

unique(raw$parameter)

##  [1] "Ammonia Nitrogen as N, mg/l"
##  [2] "CBOD5, mg/l"
##  [3] "Chlorophyll-a, ug/l"
##  [4] "Dissolved Organic Carbon, mg/l"
##  [5] "Dissolved Oxygen, mg/l"
##  [6] "Dissolved Phosphate, mg/l"
##  [7] "Fixed Suspended Solids, mg/l"
##  [8] "Nitrate-Nitrite as N, mg/l"
##  [9] "pH"
## [10] "Soluble Orthophosphate as P, mg/l"
## [11] "Soluble Phosphorus as P, mg/l"
## [12] "Specific Conductivity, uS/cm"
## [13] "Total Kjeldahl Nitrogen as N, mg/l"
## [14] "Total Organic Carbon, mg/l"
## [15] "Total Orthophosphate as P, mg/l"
## [16] "Total Phosphate as P, mg/l"
## [17] "Total Phosphorus as P, mg/l"
## [18] "Total Solids , mg/l"
## [19] "Total Suspended Solids, mg/l"
```

```
## [20] "Turbidity, FU"
## [21] "Turbidity, NTU"
## [22] "Volatile Suspended Solids, mg/l"
## [23] "Water Temperature, C"
## [24] "Total Organic Nitrogen - calculated, mg/l"
## [25] "Total N - calculated, mg/l"
## [26] "Total Manganese, ug/l"
## [27] "Dissolved Oxygen Saturation"
```

2.8.3 Exclude irrelevant and useless data

Remove all samples deeper than 4.4 m per BC instructions. This is to exclude samples deeper than the photic zone.

Also remove all data with NA in columns depth_m, value, m_date, or station_name. If we cannot locate the sample in space or time, we cannot use it.

Records removed based on each filter were:

- missing station id (0)
- missing date (178)
- missing value (0)
- missing depth (460)
- depth_m >= 4.4 (25660)

```
dwr <- raw %>%
  dplyr::filter(depth_m < 4.4) %>%
  dplyr::filter(!is.na(value), !is.na(station_name), !is.na(m_date), !is.na(depth_m)) %>%
  dplyr::rename(DEPTHM = "depth_m")
# from 103150 to 76852
```

This removes roughly 25% of the data.

2.8.4 Standardize DATE Information

We switch from Date-Time (PosixCt) to lubridate Date format. We then add columns for year and month.

```
dwr <- dwr %>%
   dplyr::rename(DATE = m_date) %>%
  dplyr::mutate(DATE = as.Date(DATE))

# Date format has changed a couple times, so this code might be needed if there are more changes
# DATE = lubridate::as_date(lubridate::mdy_hm(DATE)),

# Confirm all successfully parsed
assertthat::assert_that(sum(is.na(dwr$DATE)) < 1, msg = "Dates did not parse correctly. Check the code
- the date format may have changed again.")

## [1] TRUE
```

```
range(dwr$DATE)

## [1] "1984-01-09" "2020-12-09"

dwr <- dwr %>%
  dplyr::mutate(MONTH = lubridate::month(DATE, label = TRUE, abbr = TRUE),
         YEAR = lubridate::year(DATE))


group_by(dwr, YEAR) %>%
  summarize(N = n())

## # A tibble: 29 × 2
##     YEAR     N
##    <dbl> <int>
##  1  1984  3429
##  2  1985  3393
##  3  1986  3697
##  4  1987  2596
##  5  1988  1127
##  6  1989  1339
##  7  1990  1285
##  8  1991   560
##  9  1992   300
## 10  1993   313
## # ℹ 19 more rows
```

2.8.5 Manage SOURCE and STATION Information

The data include a data source column (mon_org) and we confirm it is just one source: NC-DENR. We name our SOURCE as “dwrStoret” to match our data records and naming conventions.

```
dwr <- dwr %>%
  dplyr::mutate(SOURCE = "storetDwr", # match file name
         SOURCEID = dplyr::row_number(),
         SOURCETYPE = "Empirical",
         STATION = station_name,
         STATIONID = station_name)


assertthat::assert_that(dplyr::n_distinct(dwr$SOURCEID) == nrow(dwr), msg = "The SOURCEID values ar
e not unique.")

## [1] TRUE

dwr <- dwr %>%
   dplyr::select(-station_name, -mon_org)
```

2.8.6 Standardize VARIABLE Information

```
sort(unique(dwr$parameter))
```

```
##  [1] "Ammonia Nitrogen as N, mg/l"
##  [2] "CBOD5, mg/l"
##  [3] "Chlorophyll-a, ug/l"
##  [4] "Dissolved Oxygen Saturation"
##  [5] "Dissolved Oxygen, mg/l"
##  [6] "Dissolved Phosphate, mg/l"
##  [7] "Fixed Suspended Solids, mg/l"
##  [8] "Nitrate-Nitrite as N, mg/l"
##  [9] "pH"
## [10] "Soluble Orthophosphate as P, mg/l"
## [11] "Soluble Phosphorus as P, mg/l"
## [12] "Specific Conductivity, uS/cm"
## [13] "Total Kjeldahl Nitrogen as N, mg/l"
## [14] "Total Manganese, ug/l"
## [15] "Total N - calculated, mg/l"
## [16] "Total Organic Carbon, mg/l"
## [17] "Total Organic Nitrogen - calculated, mg/l"
## [18] "Total Orthophosphate as P, mg/l"
## [19] "Total Phosphate as P, mg/l"
## [20] "Total Phosphorus as P, mg/l"
## [21] "Total Solids , mg/l"
## [22] "Total Suspended Solids, mg/l"
## [23] "Turbidity, FU"
## [24] "Turbidity, NTU"
## [25] "Volatile Suspended Solids, mg/l"
## [26] "Water Temperature, C"
```

Separated out the parameter name and measurement units, then recreated label. Also trimmed extra white spaces and checked for other typographic errors. Several variable names needed to be standardized:

- “Nitrate-Nitrite as N” to “Nitrate-Nitrite”
- “Total Kjeldahl Nitrogen as N” to “Kjeldahl Nitrogen”
- “Total Phosphorus as P” to “Total Phosphorus”
- “Total Organic Nitrogen - Calculated” to “Total Organic Nitrogen”
- “Total N - Calculated” to “Total Nitrogen”
- “Dissolved Oxygen Saturation” to “Dissolved Oxygen, %”

We also standardized some units:

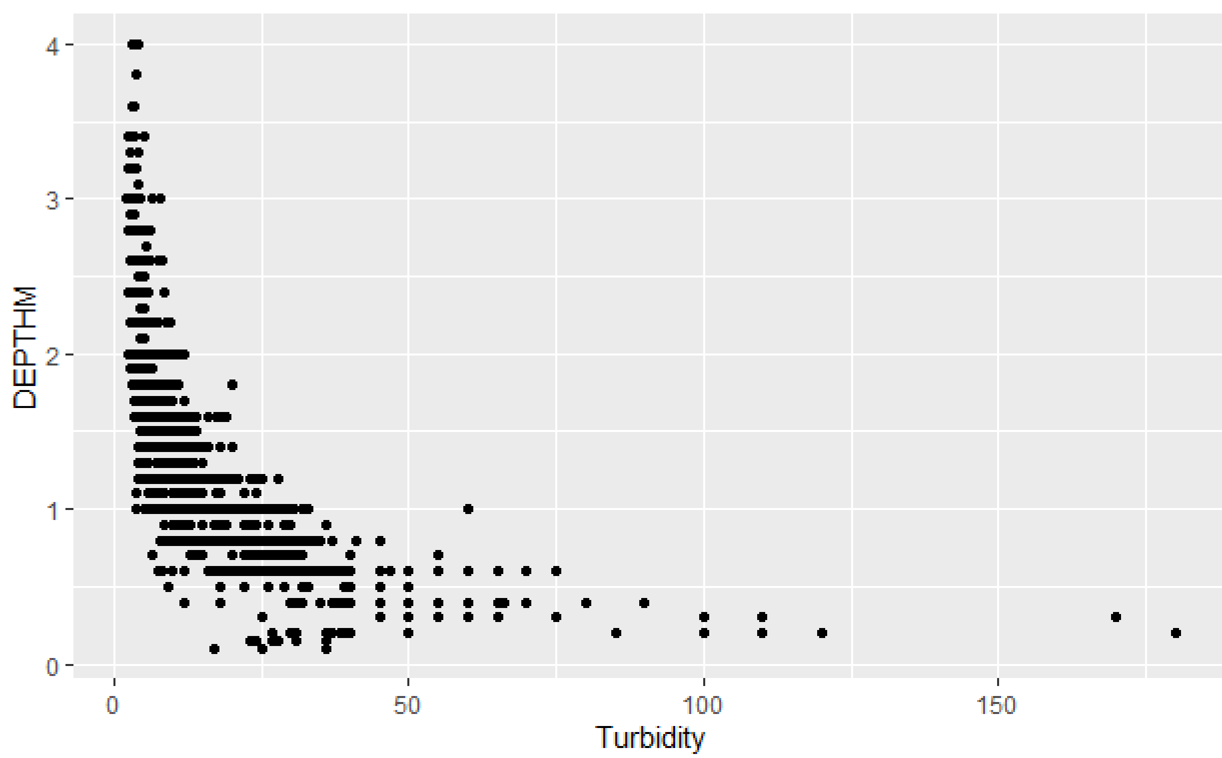
- “mg/l” to “mg/L”
- “ug/l” to “ug/L”
- “FU” to “FTU”

```
dwr <- dwr |>
  dplyr::mutate(parameter = gsub("Saturation", "Saturation, %", parameter),
         VARIABLE = stringr::str_trim(gsub(", .*$", "", parameter)),
                VARIABLE = gsub(" as N$", "", VARIABLE),
                VARIABLE = gsub(" as P$", "", VARIABLE),
                VARIABLE = gsub("Total Kjeldahl", "Kjeldahl", VARIABLE),
                VARIABLE = gsub("Total N - calculated", "Total Nitrogen", VARIABLE),
                VARIABLE = gsub("Total Organic Nitrogen - calculated",
                       "Total Organic Nitrogen", VARIABLE),
                MEASUNIT = gsub("^.*, ", "", parameter),
                MEASUNIT = gsub("g/l", "g/L", MEASUNIT),
                MEASUNIT = gsub("FU", "FTU", MEASUNIT),
                VARLABEL = sprintf("%s, %s", VARIABLE, MEASUNIT),
                VARTYPE = NA_character_,
                VALUE = value) |>
  dplyr::select(-parameter, -value)

group_by(dwr, VARIABLE) %>%
 summarize(N = n())

## # A tibble: 25 × 2
##    VARIABLE                    N
##    <chr>                   <int>
##  1 Ammonia Nitrogen         2706
##  2 CBOD5                     556
##  3 Chlorophyll-a            2416
##  4 Dissolved Oxygen        11723
##  5 Dissolved Oxygen Saturation  2734
##  6 Dissolved Phosphate         9
##  7 Fixed Suspended Solids    436
##  8 Kjeldahl Nitrogen        2655
##  9 Nitrate-Nitrite          2705
## 10 Soluble Orthophosphate    654
## # ℹ 15 more rows
```

2.8.7 Standardize DEPTH Information

```
# What are the photic zone depths for the samples we know are photic zone?
dplyr::group_by(dwr, MONTH) %>%
 dplyr::summarize(Mean = mean(DEPTHM, na.rm = T),
         SD = sd(DEPTHM, na.rm = T),
         Min = min(DEPTHM, na.rm = T),
         Max = max(DEPTHM, na.rm = T))

## # A tibble: 12 × 5
##    MONTH  Mean    SD   Min   Max
##    <ord> <dbl> <dbl> <dbl> <dbl>
```

```
## 1 Jan    1.67  1.14 0.02    4.3
## 2 Feb    1.60  1.15 0       4.3
## 3 Mar    1.63  1.16 0.1     4.38
## 4 Apr    1.72  1.20 0.01    4.3
## 5 May    1.77  1.17 0.1     4.3
## 6 Jun    1.75  1.18 0.101   4.13
## 7 Jul    1.76  1.19 0.047   4.3
## 8 Aug    1.74  1.21 0       4.3
## 9 Sep    1.65  1.18 0.1     4.34
## 10 Oct   1.65  1.15 0.1     4.3
## 11 Nov   1.65  1.13 0.0152  4.3
## 12 Dec   1.65  1.11 0       4.2

# Use turbidity as a gut check - Are samples shallower when turbidity is high?
ggplot(dplyr::filter(dwr, VARIABLE == "Turbidity", MEASUNIT == "NTU"), aes(x = VALUE, y = DEPTHM)) +
  geom_point() +
  labs(x = "Turbidity")
```




```
# Pivot, reduce to just secchi, and recombine with dwr data
# Some dates-sites do not have a secchi depth, so must filter out NA values
secchi <- dwr |>
  dplyr::select(-VARIABLE, -VALUE, -MEASUNIT, -VARLABEL, -SOURCEID) |>
  tidyr::pivot_longer(secchi_m, names_to = "VARIABLE", values_to = "VALUE") |>
  dplyr::mutate(MEASUNIT = "m",
                VARIABLE = "Secchi Depth",
```

```
                    VARLABEL = "Secchi Depth, m") |>
  dplyr::distinct() |>
 dplyr::filter(!is.na(VALUE)) |>
  dplyr::mutate(SOURCEID = paste(STATIONID, DATE, "secchi", sep = "_"))

dwr <- dwr |>
 dplyr::select(-secchi_m)

dwr <- rbind(dwr, secchi) |>
 dplyr::mutate(DEPTHTYPE = NA_character_) |>
  dplyr::select(SOURCE,   SOURCETYPE, SOURCEID,   DATE,   YEAR,   MONTH, STATIONID, STATION, DEPT
HM, DEPTHTYPE, VARIABLE, VALUE, VARTYPE, VARLABEL,   MEASUNIT)
```

2.8.8 Apply LAKEUNIT and LOCATE values

Multiple sites identified in these data are NOT from Falls Lake. These are identified in the lookup dictionary and labelled as “Other Lake”.

After confirming that all Falls Lake station ids are included within the lookup dictionary, we assigned the relevant LAKEUNIT and LOCATE codes.

```
# Confirmed stations in Falls Lake lists
assertthat::assert_that(all(unique(dwr$STATIONID) %in% names(lakeUnitList)), msg = "Some STATIONI
D are not found in the LAKEUNIT lookup dictionary. Update lookup dictionary as necessary.")

## [1] TRUE

assertthat::assert_that(all(unique(dwr$STATIONID) %in% names(locateList)), msg = "Some STATIONID a
re not found in the LOCATE lookup dictionary. Update lookup dictionary as necessary.")

## [1] TRUE

# Create LAKEUNIT column
dwr <- assignLAKEUNIT(df = dwr, siteNameColumn = "STATIONID", lakeUnitList = lakeUnitList)

assertthat::assert_that(sum(is.na(dwr$LAKEUNIT)) < 1, msg = "NA values are not allowed in LAKEUNIT a
ssignment.  Check the lookup tables")

## [1] TRUE

# Create the LOCATE column
dwr <- assignLOCATE(df = dwr,  siteNameColumn = "STATIONID", locateList = locateList)

assertthat::assert_that(sum(is.na(dwr$LOCATE)) < 1, msg = "NA values are not allowed in LOCATE assign
ment.  Check the lookup tables")

## [1] TRUE
```

2.8.9 Quick Data Inspection

```
# table(dwr$YEAR, dwr$MONTH)
# table(dwr$STATION, dwr$YEAR)
```

```
# table(dwr$LOCATE, dwr$LAKEUNIT)
# table(dwr$YEAR, dwr$LAKEUNIT)
# table(dwr$VARIABLE, dwr$YEAR)
```

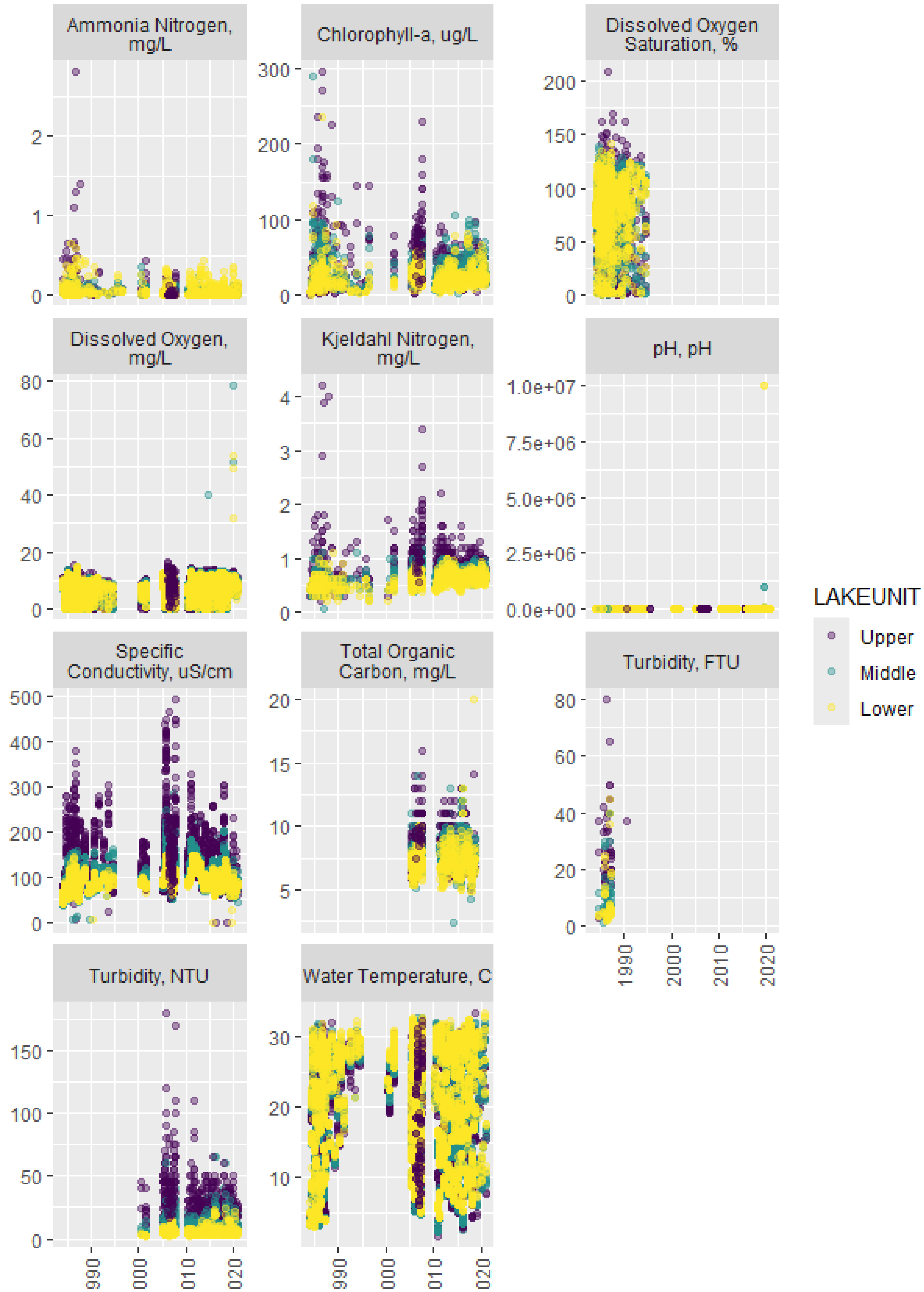
2.8.10 Drop Non-Falls Lake Samples

There are 1999 records in the dataset that are NOT from Falls Lakes. These are retained for potential use later, but they are excluded from the summary visualizations.

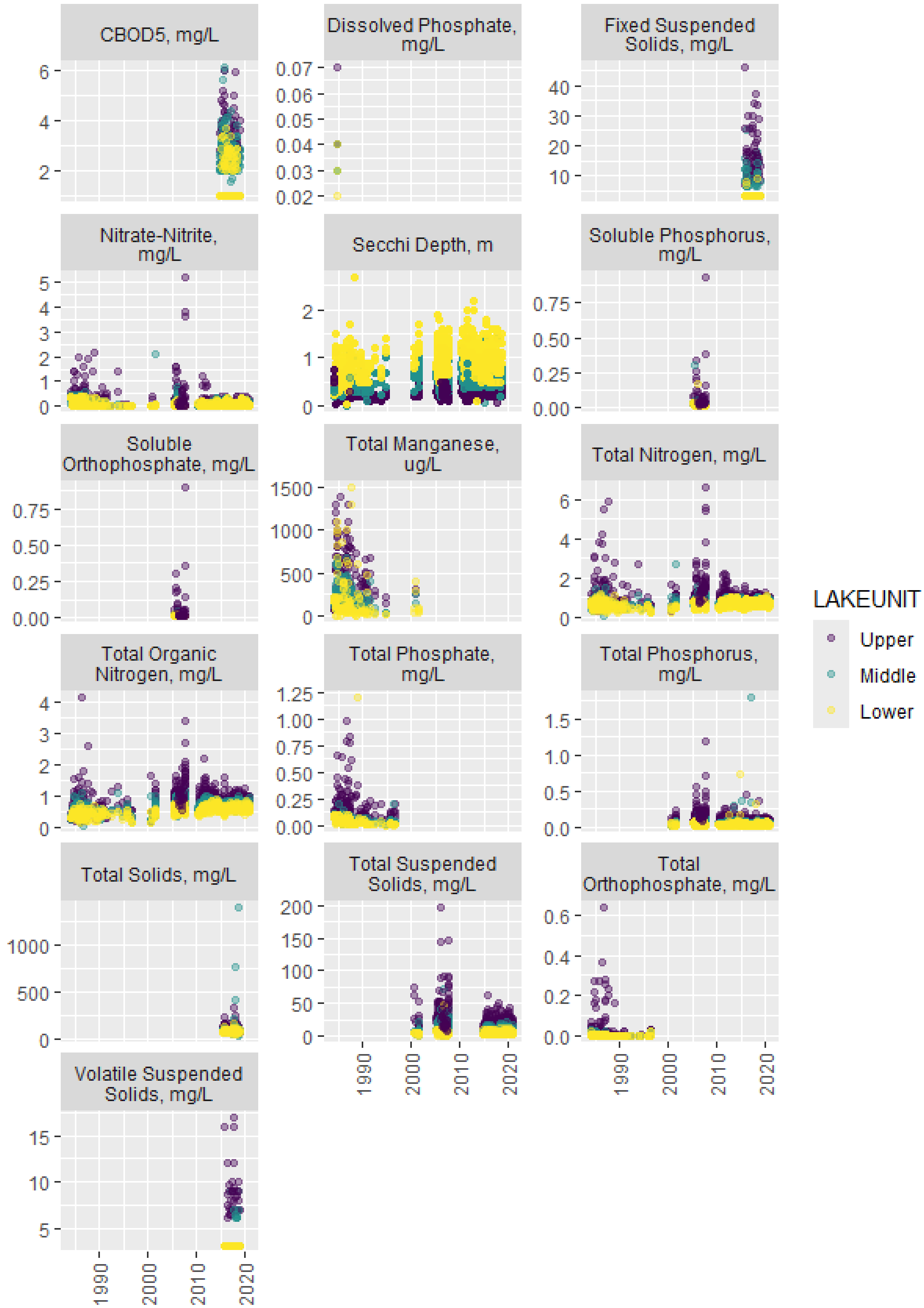
```
falls <- dwr %>%
  dplyr::filter(LAKEUNIT != "Other Lake")
```

2.8.11 Falls Lake Plots

```
favVariables <- c("Ammonia Nitrogen" , "Chlorophyll-a" , "Total Phosphorous", "Water Temperature" , "
Total Organic Carbon", "Dissolved Oxygen", "Dissolved Oxygen Saturation", "pH", "Nitrate/Nitrite", "Kjel
dahl Nitrogen", "Specific Conductivity", "Turbidity")

byDate_favs <- ggplot() +
  geom_point(data = dplyr::filter(falls, VARIABLE %in% favVariables), aes(x = DATE, y = VALUE, color = L
AKEUNIT, group = str_wrap(VARLABEL, 20)), alpha = 0.4, na.rm = T) +
  labs(x = "", y = "") +
  facet_wrap(~str_wrap(VARLABEL, 20), scales = "free_y", ncol = 3) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byDate_favs
```

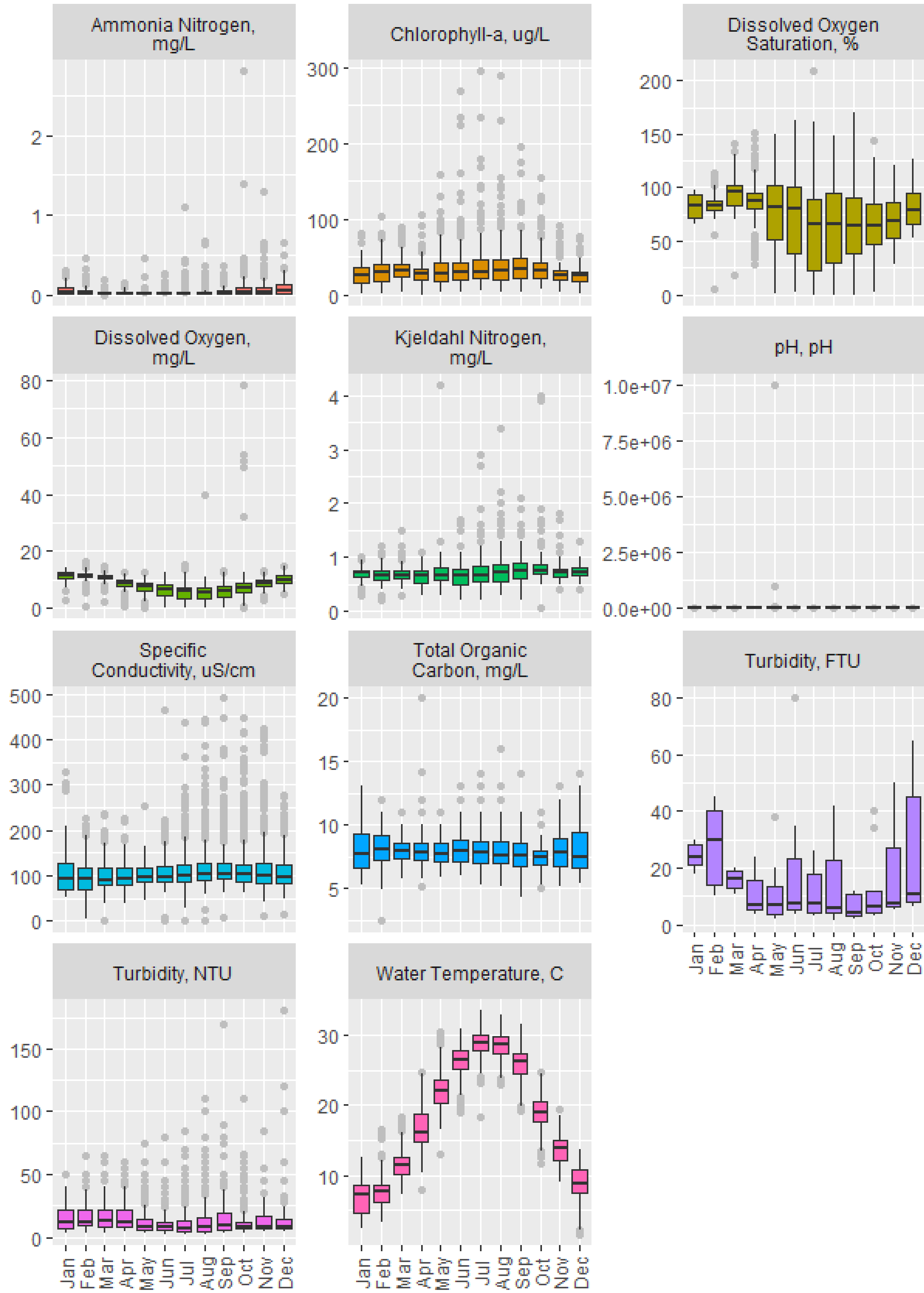

Ammonia Nitrogen, mg/L
Chlorophyll-a, ug/L
Dissolved Oxygen Saturation, %
Dissolved Oxygen, mg/L
Kjeldahl Nitrogen, mg/L
pH, pH
Specific Conductivity, uS/cm
Total Organic Carbon, mg/L
Turbidity, FTU
Turbidity, NTU
Water Temperature, C
LAKEUNIT
Upper
Middle
Lower
1990
2000
2010
2020

```
#ggsave(plot = byDate_favs, filename = here::here("Data/Tidy/dataPrep/Figures", "storetDwr_favsByDate.png"), width = 6.5, height = 8)

byDate_others <- ggplot() +
  geom_point(data = dplyr::filter(falls, !VARIABLE %in% favVariables), aes(x = DATE, y = VALUE, color = LAKEUNIT, group = str_wrap(VARLABEL, 20)), alpha = 0.4, na.rm = T) +
  labs(x = "", y = "") +
  facet_wrap(~str_wrap(VARLABEL, 20), scales = "free_y", ncol = 3) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byDate_others
```

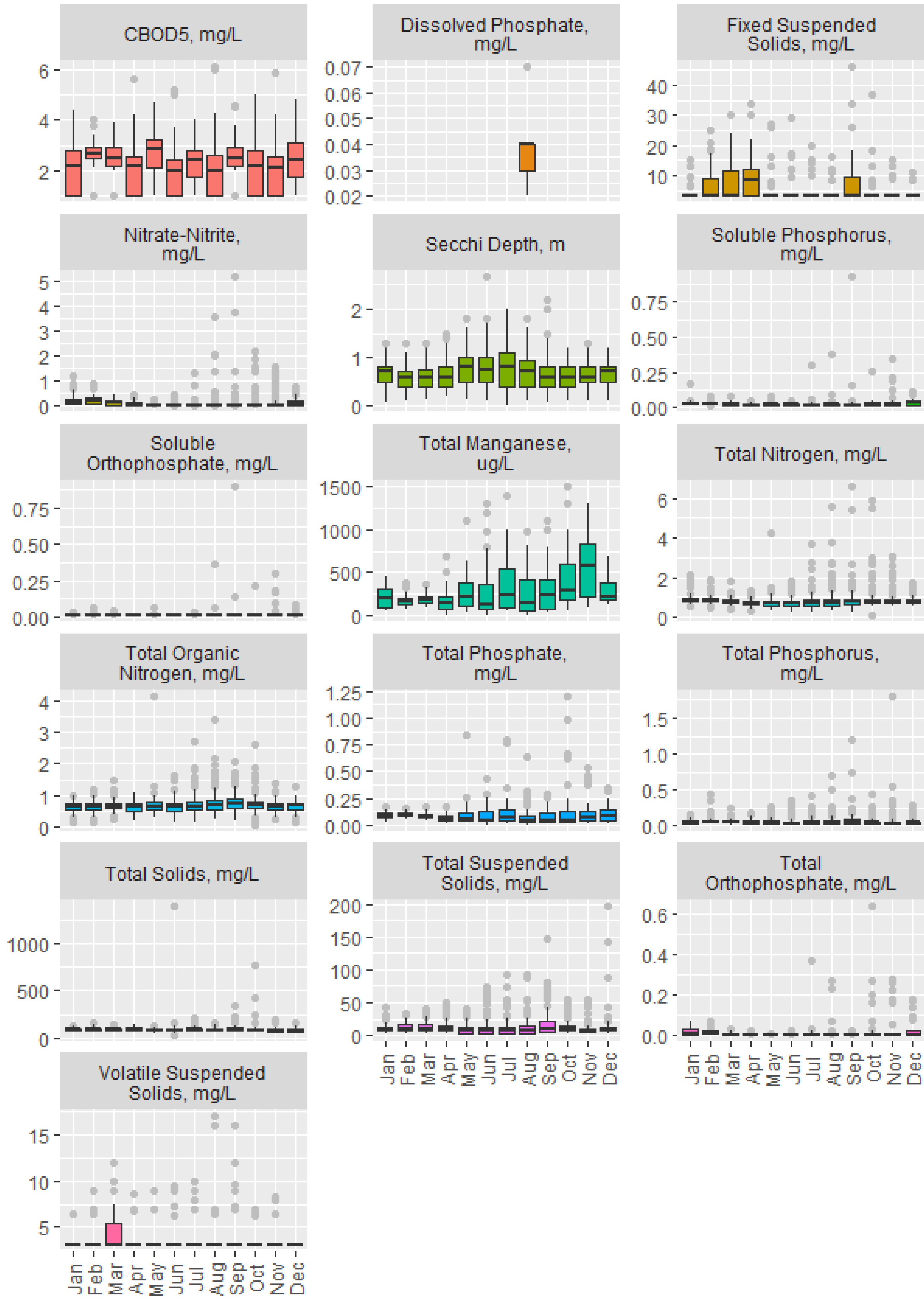


CBOD5, mg/L
Dissolved Phosphate, mg/L
Fixed Suspended Solids, mg/L
Nitrate-Nitrite, mg/L
Secchi Depth, m
Soluble Phosphorus, mg/L
Soluble Orthophosphate, mg/L
Total Manganese, ug/L
Total Nitrogen, mg/L
Total Organic Nitrogen, mg/L
Total Phosphate, mg/L
Total Phosphorus, mg/L
Total Solids, mg/L
Total Suspended Solids, mg/L
Total Orthophosphate, mg/L
Volatile Suspended Solids, mg/L
LAKEUNIT
Upper
Middle
Lower
1990
2000
2010
2020

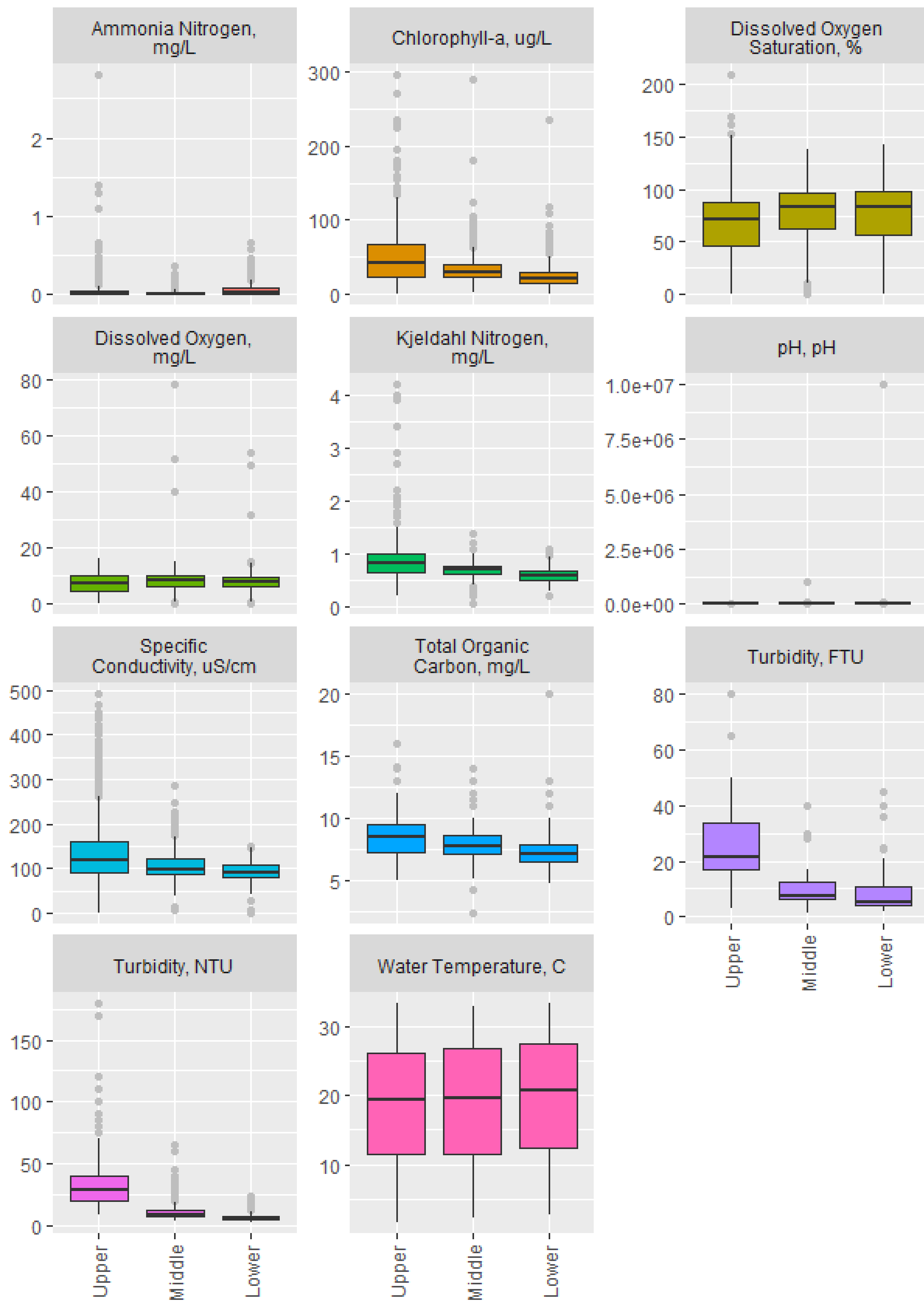
```
#ggsave(plot = byDate_others, filename = here::here("Data/Tidy/dataPrep/Figures", "storetDwr_othersB
yDate.png"), width = 6.5, height = 8)

byMonth_fav <- ggplot() +
  geom_boxplot(data = dplyr::filter(falls, VARIABLE %in% favVariables),
        aes(x = MONTH, y = VALUE, fill = str_wrap(VARLABEL, 20)), show.legend = F, na.rm = T, outlier.
color = "grey") +
  labs(x = "", y = "") +
  facet_wrap(~str_wrap(VARLABEL, 20), scales = "free_y", ncol = 3) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byMonth_fav
```


Ammonia Nitrogen, mg/L
Chlorophyll-a, ug/L
Dissolved Oxygen Saturation, %
Dissolved Oxygen, mg/L
Kjeldahl Nitrogen, mg/L
pH, pH
Specific Conductivity, uS/cm
Total Organic Carbon, mg/L
Turbidity, FTU
Turbidity, NTU
Water Temperature, C
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

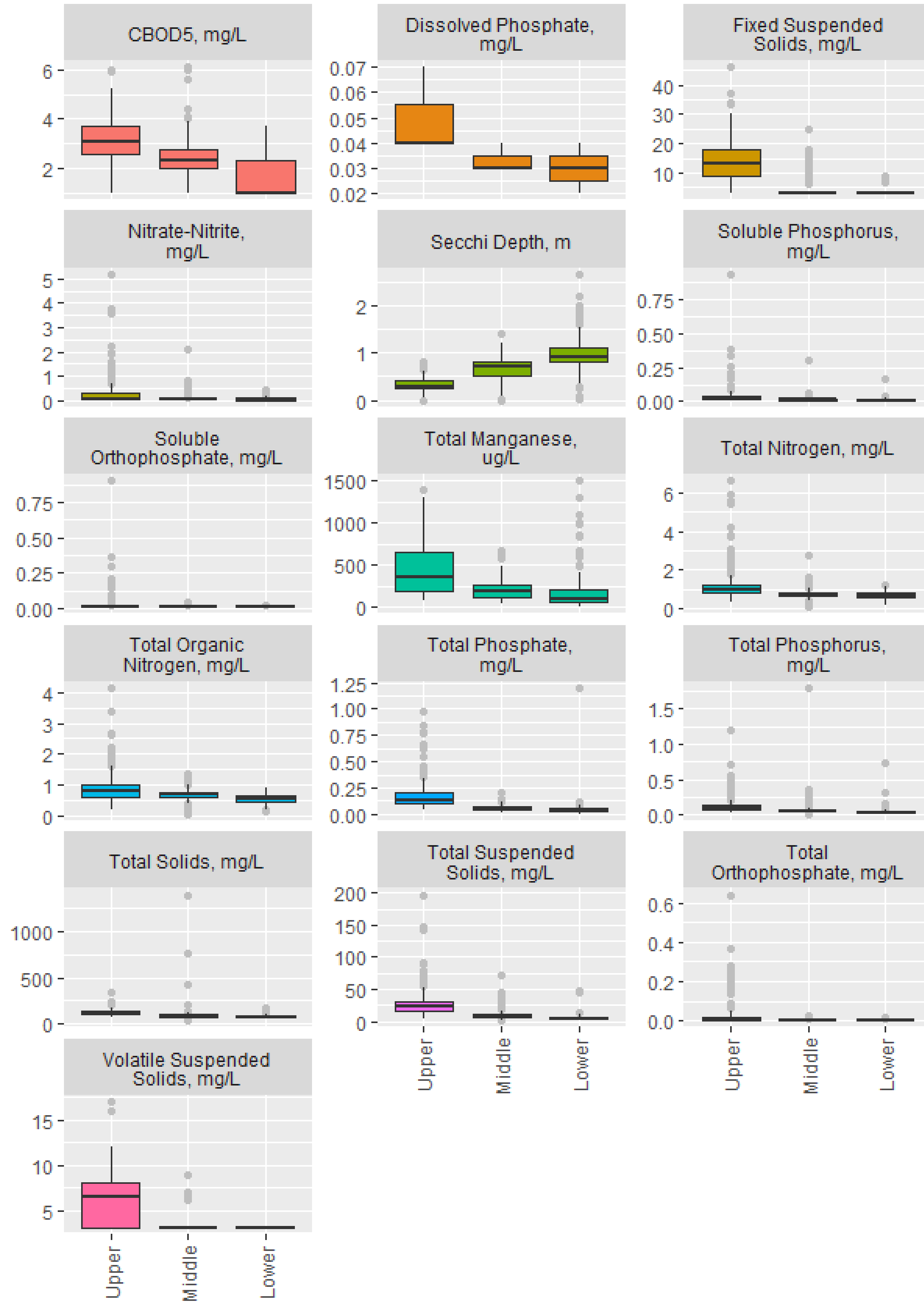
```
#ggsave(plot = byMonth_fav, filename = here::here("Data/Tidy/dataPrep/Figures", "storetDwr_FavsByM
onth.png"), width = 6.5, height = 8)

byMonth_other <- ggplot() +
  geom_boxplot(data = dplyr::filter(falls, !VARIABLE %in% favVariables), aes(x = MONTH, y = VALUE, fill
= str_wrap(VARLABEL, 20)), show.legend = F, na.rm = T, outlier.color = "grey") +
  labs(x = "", y = "") +
  facet_wrap(~str_wrap(VARLABEL, 20), scales = "free_y", ncol = 3) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byMonth_other
```


CBOD5, mg/L
Dissolved Phosphate, mg/L
Fixed Suspended Solids, mg/L
Nitrate-Nitrite, mg/L
Secchi Depth, m
Soluble Phosphorus, mg/L
Soluble Orthophosphate, mg/L
Total Manganese, ug/L
Total Nitrogen, mg/L
Total Organic Nitrogen, mg/L
Total Phosphate, mg/L
Total Phosphorus, mg/L
Total Solids, mg/L
Total Suspended Solids, mg/L
Total Orthophosphate, mg/L
Volatile Suspended Solids, mg/L
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

```
#ggsave(plot = byMonth_other, filename = here::here("Data/Tidy/dataPrep/Figures", "storetDwr_Others
ByMonth.png"), width = 6.5, height = 8)

byLakeunit_fav <- ggplot() +
  geom_boxplot(data = dplyr::filter(falls, VARIABLE %in% favVariables), aes(x = LAKEUNIT, y = VALUE, fil
l = str_wrap(VARLABEL, 20)), show.legend = F, na.rm = T, outlier.color = "grey") +
  labs(x = "", y = "") +
  facet_wrap(~str_wrap(VARLABEL, 20), scales = "free_y", ncol = 3) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byLakeunit_fav
```


Ammonia Nitrogen, mg/L
Chlorophyll-a, ug/L
Dissolved Oxygen Saturation, %
Dissolved Oxygen, mg/L
Kjeldahl Nitrogen, mg/L
pH, pH
Specific Conductivity, uS/cm
Total Organic Carbon, mg/L
Turbidity, FTU
Turbidity, NTU
Water Temperature, C
Upper
Middle
Lower

```
#ggsave(plot = byLakeunit_fav, filename = here::here("Data/Tidy/dataPrep/Figures", "storetDwr_favsBy
Lakeunit.png"), width = 6.5, height = 8)

byLakeunit_other <- ggplot() +
  geom_boxplot(data = dplyr::filter(falls, !VARIABLE %in% favVariables), aes(x = LAKEUNIT, y = VALUE, fi
ll = str_wrap(VARLABEL, 20)), show.legend = F, na.rm = T, outlier.color = "grey") +
  labs(x = "", y = "") +
  facet_wrap(~str_wrap(VARLABEL, 20), scales = "free_y", ncol = 3) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byLakeunit_other
```


CBOD5, mg/L
Dissolved Phosphate, mg/L
Fixed Suspended Solids, mg/L
Nitrate-Nitrite, mg/L
Secchi Depth, m
Soluble Phosphorus, mg/L
Soluble Orthophosphate, mg/L
Total Manganese, ug/L
Total Nitrogen, mg/L
Total Organic Nitrogen, mg/L
Total Phosphate, mg/L
Total Phosphorus, mg/L
Total Solids, mg/L
Total Suspended Solids, mg/L
Total Orthophosphate, mg/L
Volatile Suspended Solids, mg/L
Upper
Middle
Lower

```
#ggsave(plot = byLakeunit_other, filename = here::here("Data/Tidy/dataPrep/Figures", "storetDwr_othe
rsByLakeunit.png"), width = 6.5, height = 8)
```

2.8.12 Export Tidy Data

The full Falls Lake algae data are saved as **storetDwr_data.rds.** We retain the "Other Lake" data within the prepped data. It can be handled during the dataMerge steps, with the Falls Lake data going to the Falls Lake model and the Other lake data going into a separate location for comparisons.

```
remove(raw, secchi, falls)

# all sites all data
# saveRDS(dwr, here::here("Data/Tidy/dataPrep", "storetDwr_data.rds"))
# openxlsx::write.xlsx(dwr, file = here::here("Data/Tidy/dataPrep/Excel", "storetDwr_data.xlsx"),
#                    overwrite = TRUE)
readr::write_csv(dwr, here::here("Data/Tidy/AppendixC", "storetDwr_data.csv"))

# Individual variables

vars <- c("secchi" = "Secchi Depth",
            "cond" = "Specific Conductivity",
            "wtemp" = "Water Temperature",
            "do" = "Dissolved Oxygen",
            "dosat" = "Dissolved Oxygen Saturation",
            "mangtot" = "Total Manganese",
            "ph" = "pH",
            "ammonia" = "Ammonia Nitrogen",
            "chla" = "Chlorophyll-a",
            "nitnit" = "Nitrate-Nitrite",
            "nkjeld" = "Kjeldahl Nitrogen",
            "orthotot" = "Total Orthophosphate",
            "phosphatt" = "Total Phosphate",
            "turbid" = "Turbidity",
            "orthosol" = "Soluble Orthophosphate",
            "phosphatd" = "Dissolved Phosphate",
            "solublep" = "Soluble Phosphorus",
            "toc" = "Total Organic Carbon",
            "totalp" = "Total Phosphorus",
            "tss" = "Total Suspended Solids",
            "cbod" = "CBOD5",
            #"doc" = "Dissolved Organic Carbon",
            "tsolids" = "Total Solids",
            "fss" = "Fixed Suspended Solids",
            "vss" = "Volatile Suspended Solids",
            "ton" = "Total Organic Nitrogen",
            "totaln" = "Total Nitrogen")
```

```
assertthat::assert_that(all(dwr$VARIABLE %in% vars), msg = "The list of variables for the save loop is inc
omplete.")

## [1] TRUE

assertthat::assert_that(dplyr::n_distinct(dwr$VARIABLE) == length(vars), msg = "The set of variable nam
es does not match the set in the data.  Check the code.")

## [1] TRUE

# If not true, check and correct
# unique(falls$VARIABLE)[!unique(falls$VARIABLE) %in% vars] # find things to add to vars
# vars[!vars %in% unique(falls$VARIABLE)] # find things to remove from vars

for (i in seq(vars)) {
  print(names(vars[i]))
  sub <- dplyr::filter(dwr, VARIABLE == vars[[i]])
  readr::write_csv(sub, here::here(sprintf("Data/Tidy/AppendixC/storetDwr_%s.csv", names(vars[i]))))
}

## [1] "secchi"
## [1] "cond"
## [1] "wtemp"
## [1] "do"
## [1] "dosat"
## [1] "mangtot"
## [1] "ph"
## [1] "ammonia"
## [1] "chla"
## [1] "nitnit"
## [1] "nkjeld"
## [1] "orthotot"
## [1] "phosphatt"
## [1] "turbid"
## [1] "orthosol"
## [1] "phosphatd"
## [1] "solublep"
## [1] "toc"
## [1] "totalp"
## [1] "tss"
## [1] "cbod"
## [1] "tsolids"
## [1] "fss"
## [1] "vss"
## [1] "ton"
## [1] "totaln"
```

```
# for (i in seq(vars)) {
#   print(names(vars[i]))
#   sub <- dplyr::filter(dwr, VARIABLE == vars[[i]])
#   saveRDS(sub, here::here(sprintf("Data/Tidy/dataPrep/storetDwr_%s.rds", names(vars[i]))))
# }
```

Code created by KDV Decision Analysis LLC and last run 2024-08-29 with R version 4.4.1 (2024-06-14 ucrt).

2.9 Storet Data from USGS (storetUsgs)

2.9.1 Raw Data

```
raw <- readxl::read_excel(here::here(rawFile), guess_max = 10000, na = c("", "NA"))

limitNotes <- raw %>%
  dplyr::select(parameter, limit_type_high, limit_high) %>%
  dplyr::distinct()
openxlsx::write.xlsx(limitNotes, file = here::here(notesFile))
```

The file *USGSLakeWaterQuality_1989_2020_FromSTORET.xlsx* appears to contain lake water quality data from the EPA via STORET. There are many columns not relevant to our immediate analysis, so these are removed. - "mon_org" (all USGS) - "sample_type" (Sample-Routine, Quality Control Sample-Field Replicate, and Quality Control Sample-Blind) - "medium" (all Water)
- "ResultValueTypeName" (all Actual) - "comment"
- "qcode" (all NA) - "grouped_lake_stations" - "dam_distance_miles"
- "site_type" (all Lake)

Limit data are saved out to another table for reference as needed, with parameter, units, limit method, and limit: **usgs_limitNotes.xlsx**. After extracting these data, the limit information is removed from the main data table.

B&C prepared the data (see notes in storetDwr rmd) and the expectation is that KDV will "filter to remove anything > 4.4 meters" depth.

2.9.2 Data Supplements

After review of initial data resources by TAW (Feb 2023) additional data were pulled from Storet. These had the same preparation steps. USGS and DWR are mixed in these data pulls, but only DWR are integrated here. We removed all observations where depth_m was NA or > 4.4 m.

```
newMang <- readr::read_csv(here::here("Data/Raw/Storet", "DataforModelers_Manganese.csv"), show
_col_types = FALSE) %>% # parse issue is ok
  dplyr::select(station_name, mon_org, m_date, parameter, depth_m, value) %>%
  dplyr::filter(mon_org == "USGS") %>%
  dplyr::mutate(m_date = lubridate::mdy_hm(m_date))

# new DO % saturation were also received - but these were already included in the USGS collection, so th
e new DO file is not included here

# To merge in the data, the number of columns must match.
raw <- raw %>%
```

```
  dplyr::select(station_name, mon_org, m_date, parameter, depth_m, value)

raw <- rbind(raw, newMang)

names(raw)
```

```
## [1] "station_name" "mon_org"     "m_date"      "parameter"    "depth_m"
## [6] "value"
```

```
unique(raw$parameter)
```

```
##  [1] "Total Phosphorus as P, mg/l"       "Total Organic Nitrogen, mg/l"
##  [3] "Total Kjeldahl Nitrogen as N, mg/l" "Water Temperature, C"
##  [5] "pH"                                "Soluble Orthophosphate, mg/l"
##  [7] "Turbidity"                         "Total Nitrogen, mg/l"
##  [9] "Chlorophyll-a, ug/l"               "Total Organic Carbon, mg/l"
## [11] "Dissolved Oxygen, %"               "Secchi Depth, m"
## [13] "Dissolved Oxygen, mg/l"            "Specific Conductivity, uS/cm"
## [15] "Total Phosphorus, mg/l"            "Total Phosphate, mg/l"
## [17] "Dissolved Organic Nitrogen, mg/l"   "Soluble Phosphorus, mg/l"
## [19] "Dissolved Organic Carbon, mg/l"     "Nitrate-Nitrite as N, mg/l"
## [21] "Total Orthophosphate, mg/l"         "Recoverable Manganese, ug/l"
```

2.9.3 Exclude irrelevant and useless data

Remove all samples deeper than 4.4 m per BC instructions. This is to exclude samples deeper than the photic zone.

Also remove all data with NA in columns depth_m, value, m_date, or station_name. If we cannot locate the sample in space or time, we cannot use it.

Records removed based on each filter were:

- missing station id (0)
- missing date (0)
- missing value (2189)
- missing depth (1943)
- depth_m >= 4.4 (5530)

```
usgs <- raw %>%
 dplyr::filter(depth_m < 4.4) %>%
 dplyr::filter(!is.na(value), !is.na(station_name), !is.na(m_date), !is.na(depth_m))
# from 17489 to 8677
```

The raw data have 17489 records; the useable data have 8677 records.

```
dplyr::group_by(usgs, station_name) %>%
  dplyr::summarize(n = n())
```

```
## # A tibble: 11 × 2
##   station_name     n
##   <chr>        <int>
##  1 208480275     731
##  2 208524845    1490
##  3 2086490      1509
##  4 2086569       180
##  5 2086920      1118
##  6 208703650     954
##  7 208708905     618
##  8 208717595      19
##  9 208718195     640
## 10 2087588       508
## 11 2087701       910
```

```
dplyr::group_by(usgs, parameter) %>%
  dplyr::summarize(n = n())
```

```
## # A tibble: 18 × 2
##   parameter                             n
##   <chr>                             <int>
##  1 Chlorophyll-a, ug/l                440
##  2 Dissolved Organic Carbon, mg/l     109
##  3 Dissolved Organic Nitrogen, mg/l    70
##  4 Dissolved Oxygen, %                700
##  5 Dissolved Oxygen, mg/l             704
##  6 Recoverable Manganese, ug/l        690
##  7 Secchi Depth, m                    505
##  8 Soluble Orthophosphate, mg/l       338
##  9 Soluble Phosphorus, mg/l            29
## 10 Specific Conductivity, uS/cm       847
## 11 Total Kjeldahl Nitrogen as N, mg/l 703
## 12 Total Nitrogen, mg/l               296
## 13 Total Organic Carbon, mg/l         506
## 14 Total Organic Nitrogen, mg/l       420
## 15 Total Phosphorus as P, mg/l        656
## 16 Turbidity                          108
## 17 Water Temperature, C               716
## 18 pH                                 840
```

2.9.4 Assign SOURCE information

```
usgs <- usgs %>%
  dplyr::mutate(SOURCE = "storetUsgs",
         SOURCETYPE = "Empirical",
         SOURCEID = paste(station_name, gsub("-", "", depth_m), depth_m, parameter, row_number(),
sep = "_"))
```

```
assertthat::assert_that(dplyr::n_distinct(usgs$SOURCEID) == nrow(usgs), msg = "The SOURCEID values a
re not unique.")

## [1] TRUE
```

2.9.5 Standardize DATE Information

We switch from Date-Time (PosixCt) to lubridate Date format. We then add columns for year and month.

```
usgs <- usgs |>
  dplyr::rename(DATE = m_date) |>
 dplyr::mutate(DATE = lubridate::ymd(format(as_date(DATE), "%Y-%m-%d")),
                MONTH = lubridate::month(DATE, label = TRUE, abbr = TRUE),
         YEAR = lubridate::year(DATE))
```

2.9.6 Define VARIABLE characteristics

Separated out the parameter name and measurement units, then recreated label. Also trimmed extra white spaces and checked for other typographic errors. Several variable names needed to be standardized:

- “Ammonia Nitrogen as N” to “Ammonia Nitrogen”
- “Nitrate-Nitrite as N” to “Nitrate-Nitrite”
- “Total Kjeldahl Nitrogen as N” to “Kjeldahl Nitrogen”
- “Total Phosphorus as P” to “Total Phosphorus”
- “Dissolved Oxygen, %” to “Dissolved Oxygen Saturation, %”

We also standardized some units:

- “mg/l” to “mg/L”
- “ug/l” to “ug/L”
- “FU” to “FTU”

```
dplyr::group_by(usgs, parameter) %>%
  dplyr::summarize(n = n())

## # A tibble: 18 × 2
##   parameter                        n
##   <chr>                        <int>
##  1 Chlorophyll-a, ug/l           440
##  2 Dissolved Organic Carbon, mg/l   109
##  3 Dissolved Organic Nitrogen, mg/l    70
##  4 Dissolved Oxygen, %            700
##  5 Dissolved Oxygen, mg/l         704
##  6 Recoverable Manganese, ug/l     690
##  7 Secchi Depth, m                505
```

```
##  8 Soluble Orthophosphate, mg/l       338
##  9 Soluble Phosphorus, mg/l            29
## 10 Specific Conductivity, uS/cm       847
## 11 Total Kjeldahl Nitrogen as N, mg/l   703
## 12 Total Nitrogen, mg/l               296
## 13 Total Organic Carbon, mg/l         506
## 14 Total Organic Nitrogen, mg/l       420
## 15 Total Phosphorus as P, mg/l        656
## 16 Turbidity                          108
## 17 Water Temperature, C               716
## 18 pH                                 840
```

```
usgs <- usgs %>%
  dplyr::mutate(parameter = gsub("Oxygen, %", "Oxygen Saturation, %", parameter),
         VARIABLE = stringr::str_trim(gsub(", .*$", "", parameter)),
                VARIABLE = gsub(" as N$", "", VARIABLE),
                VARIABLE = gsub(" as P$", "", VARIABLE),
                VARIABLE = gsub("Total Kjeldahl", "Kjeldahl", VARIABLE),
                MEASUNIT = gsub("^.*, ", "", parameter),
                MEASUNIT = gsub("g/l", "g/L", MEASUNIT),
                MEASUNIT = gsub("FU", "FTU", MEASUNIT),
                VARLABEL = sprintf("%s, %s", VARIABLE, MEASUNIT),
                VARTYPE = NA_character_,
                VALUE = value) %>%
  dplyr::select(-parameter, -value)

dplyr::group_by(usgs, VARIABLE, MEASUNIT) %>%
  dplyr::summarize(n = n())
```

```
## # A tibble: 18 × 3
## # Groups:   VARIABLE [18]
##    VARIABLE                    MEASUNIT     n
##    <chr>                       <chr>    <int>
##  1 Chlorophyll-a               ug/L       440
##  2 Dissolved Organic Carbon    mg/L       109
##  3 Dissolved Organic Nitrogen  mg/L        70
##  4 Dissolved Oxygen            mg/L       704
##  5 Dissolved Oxygen Saturation %          700
##  6 Kjeldahl Nitrogen           mg/L       703
##  7 Recoverable Manganese       ug/L       690
##  8 Secchi Depth                m          505
##  9 Soluble Orthophosphate      mg/L       338
## 10 Soluble Phosphorus          mg/L        29
## 11 Specific Conductivity       uS/cm      847
## 12 Total Nitrogen              mg/L       296
```

```
## 13 Total Organic Carbon       mg/L       506
## 14 Total Organic Nitrogen     mg/L       420
## 15 Total Phosphorus           mg/L       656
## 16 Turbidity                  Turbidity  108
## 17 Water Temperature          C          716
## 18 pH                         pH         840
```

2.9.7 Define Station, and Depth columns

```
usgs <- usgs |>
  dplyr::mutate(STATION = station_name,
                STATIONID = station_name,
                DEPTHM = depth_m,
                DEPTHTYPE = NA_character_) %>%
  dplyr::select(-depth_m, -station_name)
```

2.9.8 Assign standard LAKEUNIT and LOCATE labels

```
dplyr::group_by(usgs, STATIONID) %>%
   dplyr::summarize(n = n())

## # A tibble: 11 × 2
##    STATIONID     n
##    <chr>     <int>
##  1 208480275   731
##  2 208524845  1490
##  3 2086490    1509
##  4 2086569     180
##  5 2086920    1118
##  6 208703650   954
##  7 208708905   618
##  8 208717595    19
##  9 208718195   640
## 10 2087588     508
## 11 2087701     910

# Create the LAKEUNIT column--------------------------------------------------
# Make sure all site names in the lookup list source_setupDictionaries
all(usgs$STATIONID %in% names(lakeUnitList))

## [1] TRUE

#after adding any names that were missing to the source_setup Dictionary
usgs <- assignLAKEUNIT(df = usgs, siteNameColumn = "STATIONID", lakeUnitList = lakeUnitList)

# Create the LOCATE column----------------------------------------------------
# Make sure all site names in the lookup list source_setupDictionaries
all(usgs$STATIONID %in% names(locateList))
```

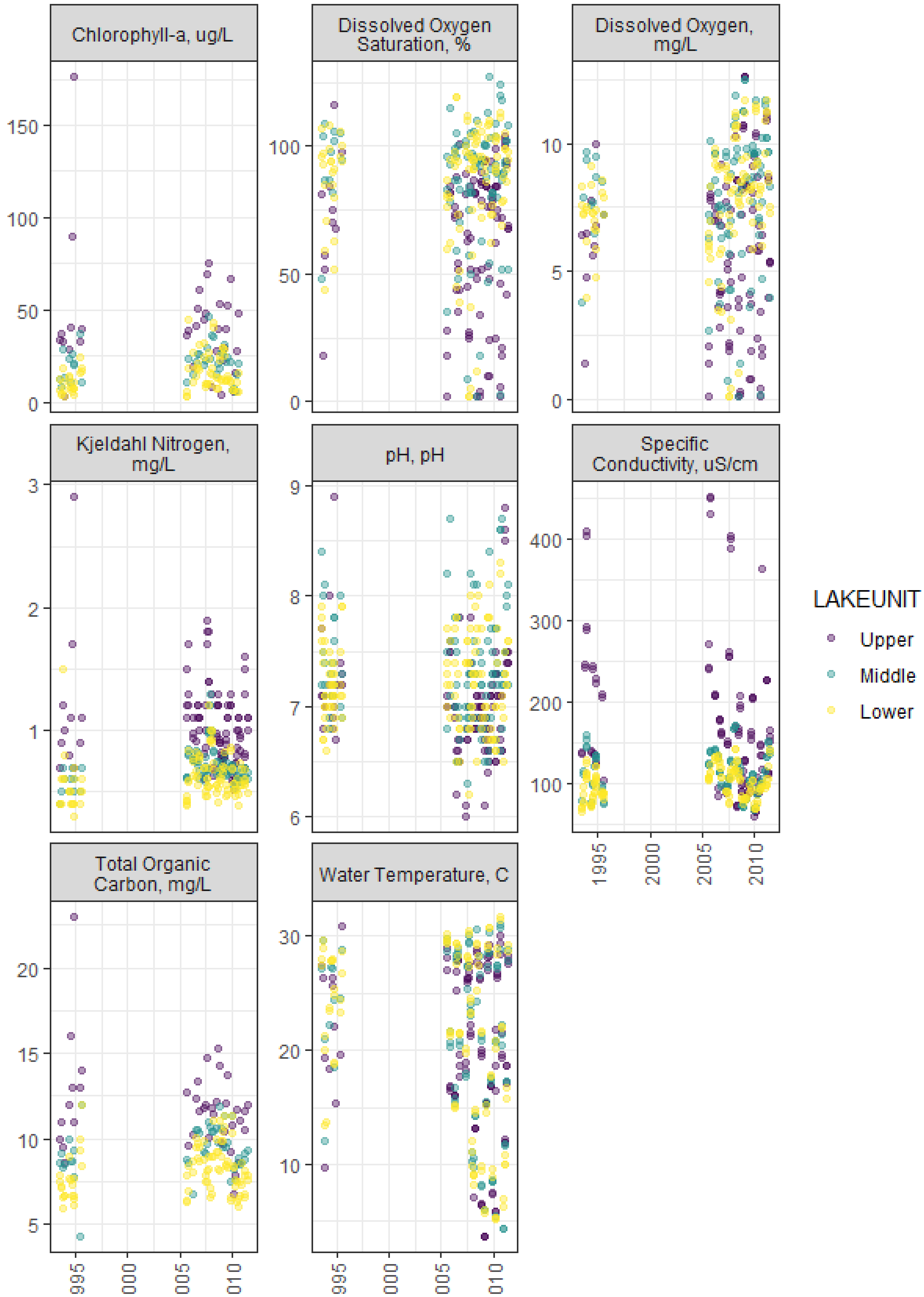
```
## [1] TRUE

usgs <- assignLOCATE(df = usgs,  siteNameColumn = "STATIONID", locateList = locateList)

dplyr::group_by(usgs, LAKEUNIT, STATIONID) %>%
  dplyr::summarize(n = n())

## # A tibble: 11 × 3
## # Groups:   LAKEUNIT [4]
##    LAKEUNIT   STATIONID     n
##    <ord>      <chr>     <int>
##  1 Upper      2086920    1118
##  2 Middle     208703650   954
##  3 Lower      208708905   618
##  4 Lower      208717595    19
##  5 Lower      208718195   640
##  6 Other Lake 208480275   731
##  7 Other Lake 208524845  1490
##  8 Other Lake 2086490    1509
##  9 Other Lake 2086569     180
## 10 Other Lake 2087588     508
## 11 Other Lake 2087701     910

# table(usgs$STATIONID, usgs$LAKEUNIT)
# table(usgs$STATIONID, is.na(usgs$LAKEUNIT))
```

2.9.9 Quick Data Inspection

Inspection of the Falls Lake data only. Data from other lakes are inspected at other stages in the project.

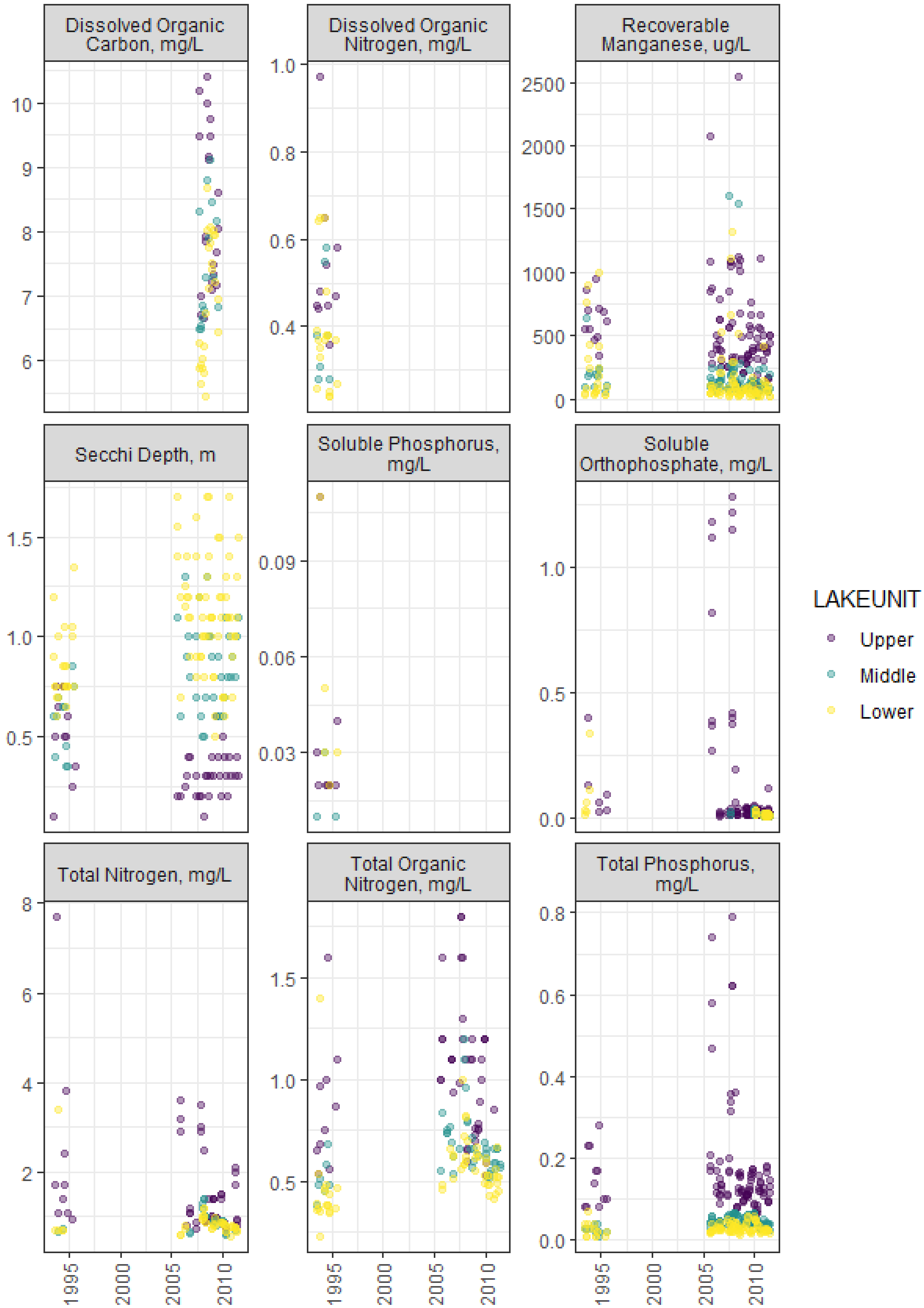
```
# Sites with NA for LAKEUNIT  are from other lakes
# Split these data out so they are not in visual data summaries
# Later recombine for export
other <- usgs %>% dplyr::filter(LAKEUNIT == "Other Lake")
usgs <- usgs %>% dplyr::filter(LAKEUNIT != "Other Lake")



favVariables <- c("Ammonia Nitrogen" , "Chlorophyll-a" , "Total Phosphorous", "Water Temperature" , "
Total Organic Carbon", "Dissolved Oxygen", "Dissolved Oxygen Saturation", "pH", "Nitrate/Nitrite", "Kjel
dahl Nitrogen", "Specific Conductivity", "Turbidity")

byDate_favs <- ggplot() +
  geom_point(data = dplyr::filter(usgs, VARIABLE %in% favVariables), aes(x = DATE, y = VALUE, color = L
AKEUNIT, group = str_wrap(VARLABEL, 20)), alpha = 0.4, na.rm = T) +
  labs(x = "", y = "") +
  facet_wrap(~str_wrap(VARLABEL, 20), scales = "free_y", ncol = 3) +
 theme_bw() +
```

```
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byDate_favs
```

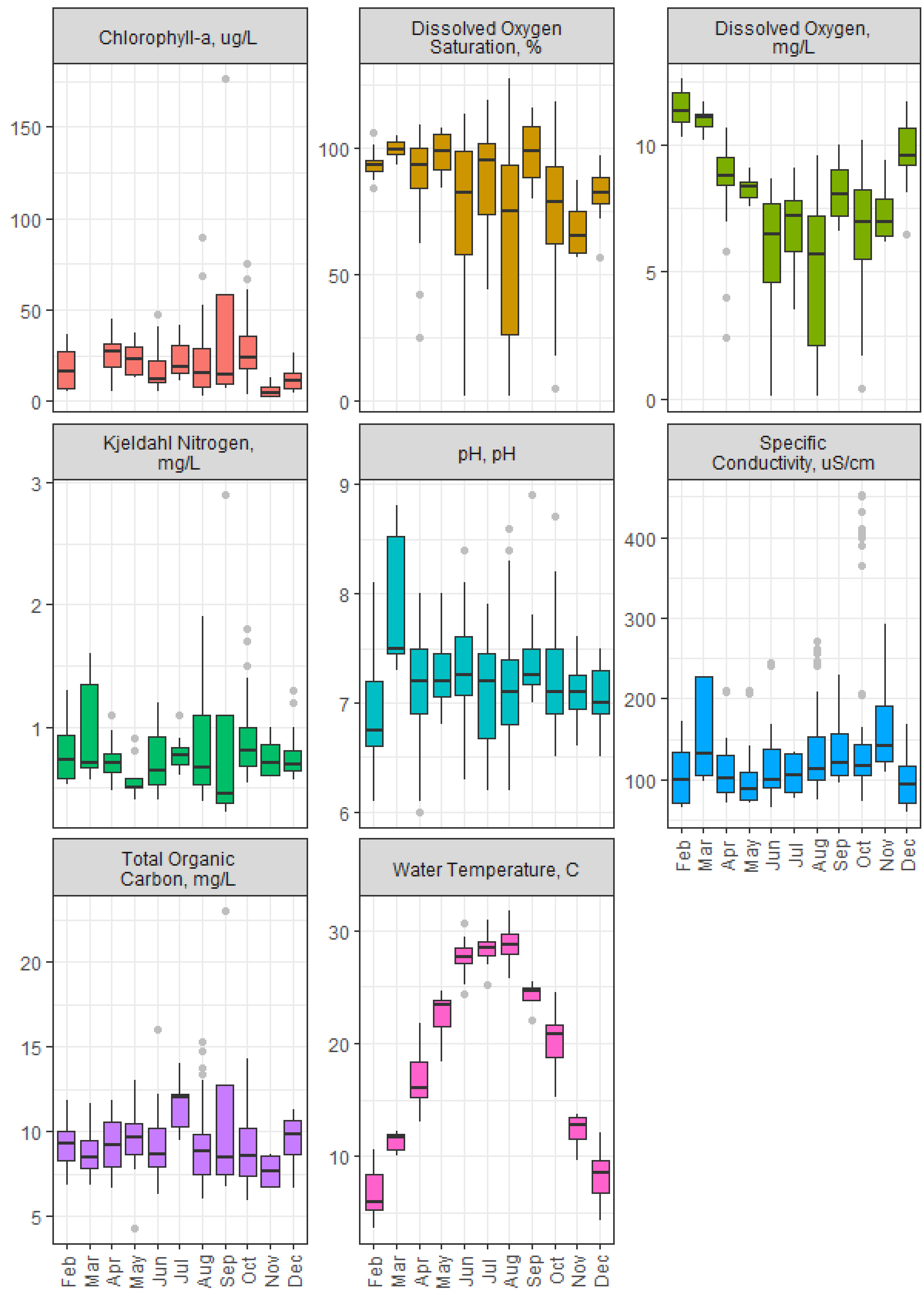


Chlorophyll-a, ug/L
Dissolved Oxygen Saturation, %
Dissolved Oxygen, mg/L
Kjeldahl Nitrogen, mg/L
pH, pH
Specific Conductivity, uS/cm
Total Organic Carbon, mg/L
Water Temperature, C
LAKEUNIT
Upper
Middle
Lower
1995
2000
2005
2010

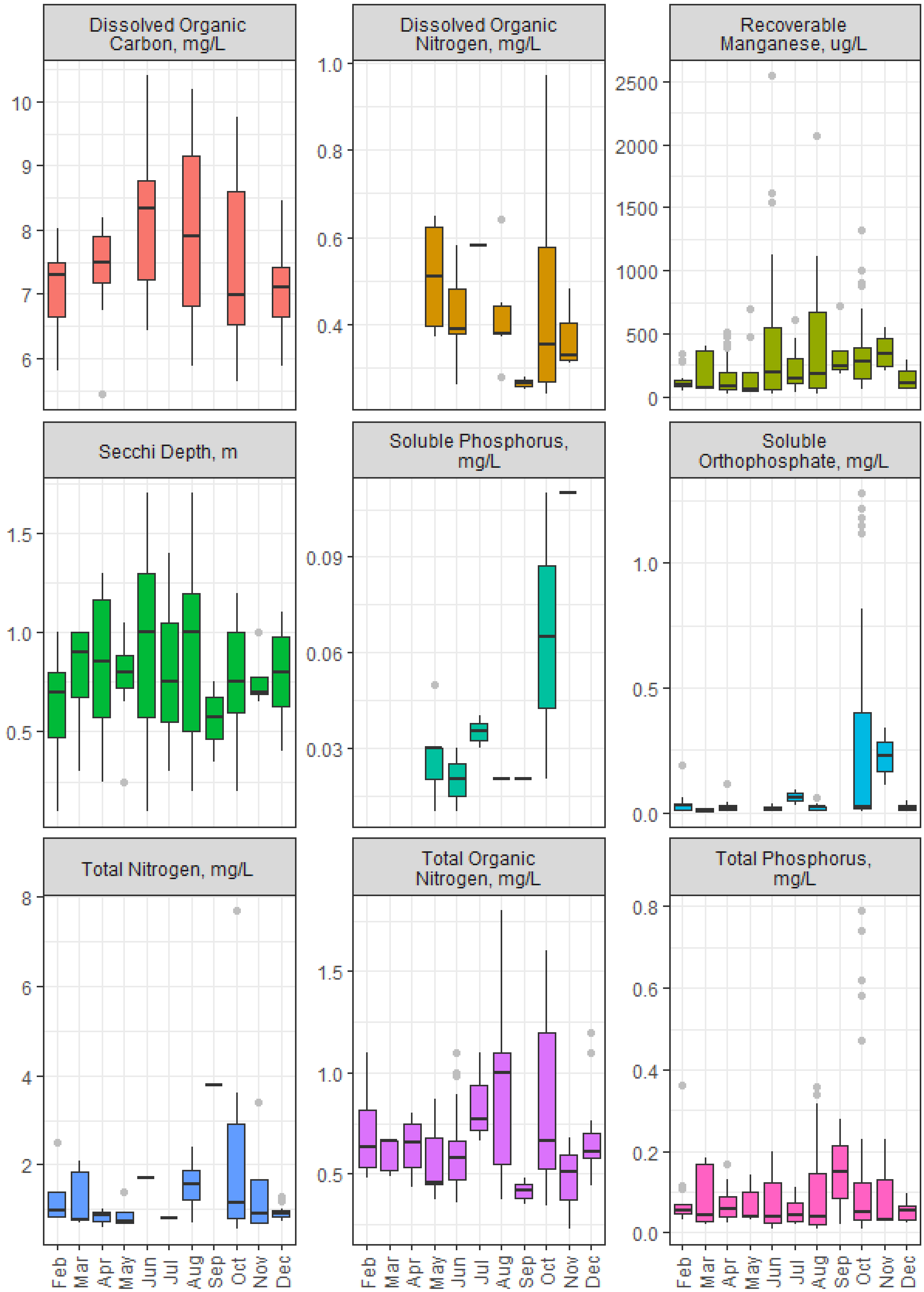
```
#ggsave(plot = byDate_favs, filename = here::here("Data/Tidy/dataPrep/Figures", "storetUsgs_favsByDa
te.png"), width = 6.5, height = 8)

byDate_others <- ggplot() +
  geom_point(data = dplyr::filter(usgs, !VARIABLE %in% favVariables),
        aes(x = DATE, y = VALUE, color = LAKEUNIT, group = str_wrap(VARLABEL, 20)), alpha = 0.4, na.r
m = T) +
  labs(x = "", y = "") +
  facet_wrap(~str_wrap(VARLABEL, 20), scales = "free_y", ncol = 3) +
  theme_bw() +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byDate_others
```


Dissolved Organic Carbon, mg/L
Dissolved Organic Nitrogen, mg/L
Recoverable Manganese, ug/L
Secchi Depth, m
Soluble Phosphorus, mg/L
Soluble Orthophosphate, mg/L
Total Nitrogen, mg/L
Total Organic Nitrogen, mg/L
Total Phosphorus, mg/L
LAKEUNIT
Upper
Middle
Lower
1995
2000
2005
2010

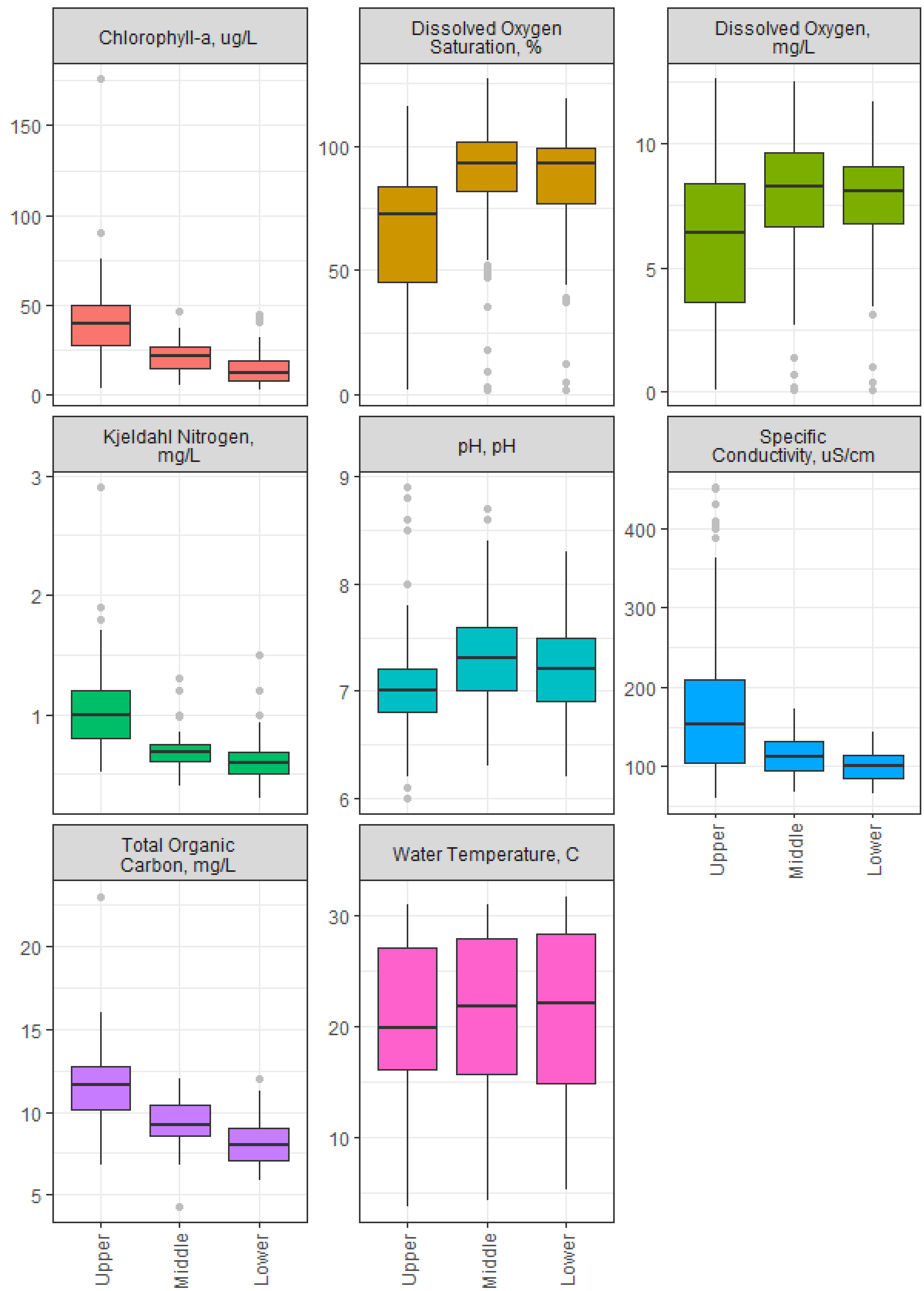
```
#ggsave(plot = byDate_others, filename = here::here("Data/Tidy/dataPrep/Figures", "storetUsgs_others
ByDate.png"), width = 6.5, height = 8)

byMonth_fav <- ggplot() +
  geom_boxplot(data = dplyr::filter(usgs, VARIABLE %in% favVariables), aes(x = MONTH, y = VALUE, fill
= str_wrap(VARLABEL, 20)), show.legend = F, na.rm = T, outlier.color = "grey") +
  labs(x = "", y = "") +
  facet_wrap(~str_wrap(VARLABEL, 20), scales = "free_y", ncol = 3) +
  theme_bw() +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byMonth_fav
```


Chlorophyll-a, ug/L
Dissolved Oxygen Saturation, %
Dissolved Oxygen, mg/L
Kjeldahl Nitrogen, mg/L
pH, pH
Specific Conductivity, uS/cm
Total Organic Carbon, mg/L
Water Temperature, C
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

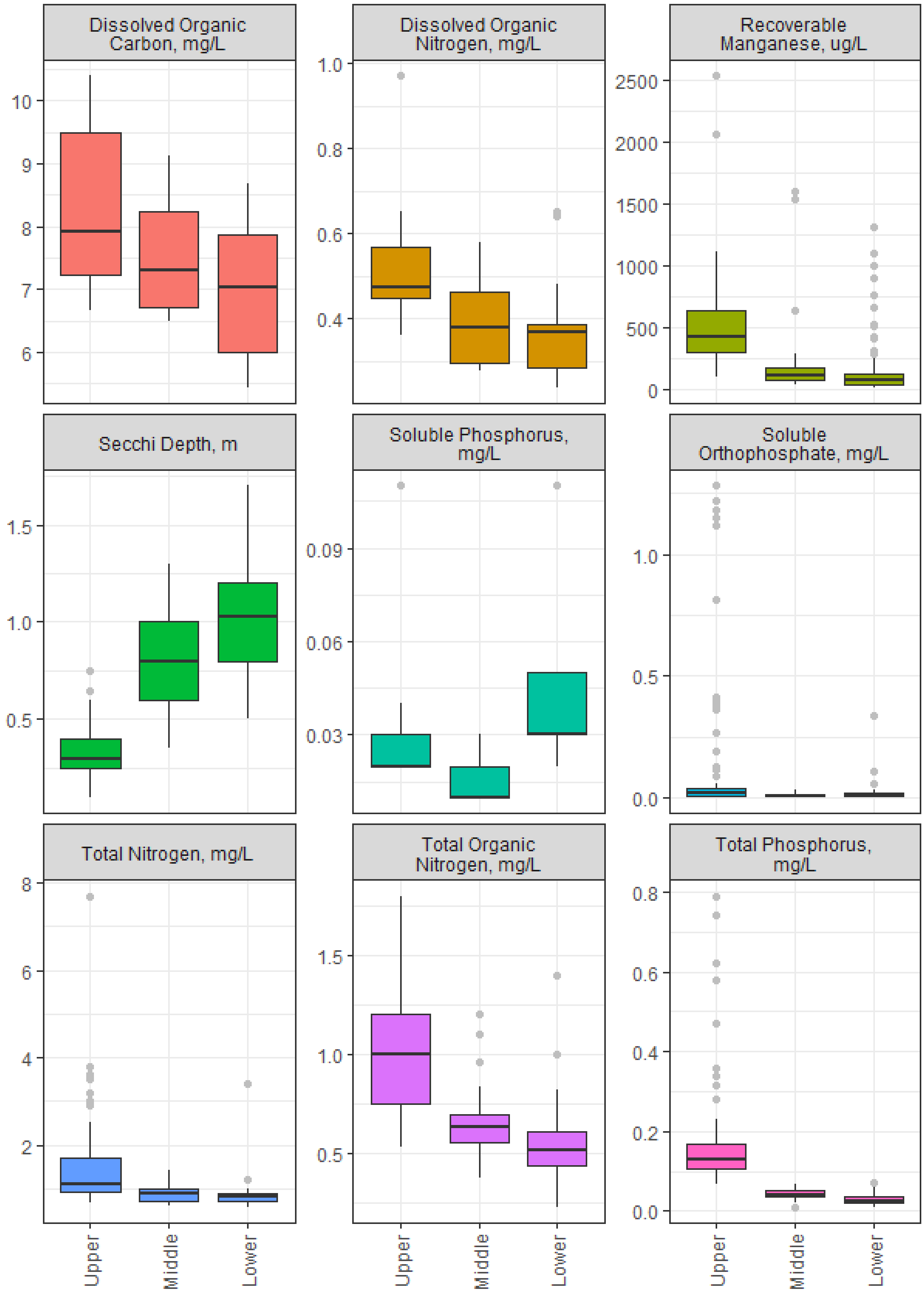
```
#ggsave(plot = byMonth_fav, filename = here::here("Data/Tidy/dataPrep/Figures", "storetUsgs_FavsBy
Month.png"), width = 6.5, height = 8)

byMonth_other <- ggplot() +
  geom_boxplot(data = dplyr::filter(usgs, !VARIABLE %in% favVariables), aes(x = MONTH, y = VALUE, fill
= str_wrap(VARLABEL, 20)), show.legend = F, na.rm = T, outlier.color = "grey") +
  labs(x = "", y = "") +
  facet_wrap(~str_wrap(VARLABEL, 20), scales = "free_y", ncol = 3) +
  theme_bw() +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byMonth_other
```


Dissolved Organic Carbon, mg/L
Dissolved Organic Nitrogen, mg/L
Recoverable Manganese, ug/L
Secchi Depth, m
Soluble Phosphorus, mg/L
Soluble Orthophosphate, mg/L
Total Nitrogen, mg/L
Total Organic Nitrogen, mg/L
Total Phosphorus, mg/L
Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

```
#ggsave(plot = byMonth_other, filename = here::here("Data/Tidy/dataPrep/Figures", "storetUsgs_Other
sByMonth.png"), width = 6.5, height = 8)

byLakeunit_fav <- ggplot() +
  geom_boxplot(data = dplyr::filter(usgs, VARIABLE %in% favVariables), aes(x = LAKEUNIT, y = VALUE, fi
ll = str_wrap(VARLABEL, 20)), show.legend = F, na.rm = T, outlier.color = "grey") +
  labs(x = "", y = "") +
  facet_wrap(~str_wrap(VARLABEL, 20), scales = "free_y", ncol = 3) +
  theme_bw() +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byLakeunit_fav
```


Chlorophyll-a, ug/L
Dissolved Oxygen Saturation, %
Dissolved Oxygen, mg/L
Kjeldahl Nitrogen, mg/L
pH, pH
Specific Conductivity, uS/cm
Total Organic Carbon, mg/L
Water Temperature, C
Upper
Middle
Lower

```
#ggsave(plot = byLakeunit_fav, filename = here::here("Data/Tidy/dataPrep/Figures", "storetUsgs_favsBy
Lakeunit.png"), width = 6.5, height = 8)

byLakeunit_other <- ggplot() +
  geom_boxplot(data = dplyr::filter(usgs, !VARIABLE %in% favVariables), aes(x = LAKEUNIT, y = VALUE, f
ill = str_wrap(VARLABEL, 20)), show.legend = F, na.rm = T, outlier.color = "grey") +
  labs(x = "", y = "") +
  facet_wrap(~str_wrap(VARLABEL, 20), scales = "free_y", ncol = 3) +
  theme_bw() +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byLakeunit_other
```


Dissolved Organic Carbon, mg/L
Dissolved Organic Nitrogen, mg/L
Recoverable Manganese, ug/L
Secchi Depth, m
Soluble Phosphorus, mg/L
Soluble Orthophosphate, mg/L
Total Nitrogen, mg/L
Total Organic Nitrogen, mg/L
Total Phosphorus, mg/L
Upper
Middle
Lower

```
#ggsave(plot = byLakeunit_other, filename = here::here("Data/Tidy/dataPrep/Figures", "storetUsgs_othe
rsByLakeunit.png"), width = 6.5, height = 8)
```

2.9.10 Export

The full algae data are saved as **storetUsgs_data.rds** (and a copy as excel). Then the individual files are saved as storetUsgs_**.rds, where the variable abbrieviation is used to reference each variable.

```
# Recombine other with the Falls Lake data
tidy <- rbind(usgs, other)


## Export Tidy Data
tidy <- tidy %>%
  dplyr::select(SOURCE, SOURCETYPE, SOURCEID, DATE, STATIONID, STATION, DEPTHM, DEPTHTYPE,
VARIABLE, VALUE, VARTYPE, VARLABEL, MEASUNIT, YEAR, MONTH, LAKEUNIT, LOCATE)

# saveRDS(tidy, here::here("Data/Tidy/dataPrep", "storetUsgs_data.rds"))
# openxlsx::write.xlsx(tidy, file = here::here("Data/Tidy/dataPrep/Excel", "storetUsgs_data.xlsx"), overwri
te = TRUE)
readr::write_csv(tidy, here::here("Data/Tidy/AppendixC", "storetUsgs_data.csv"))


# Individual variables

vars <- c("secchi" = "Secchi Depth",
          "cond" = "Specific Conductivity",
          "wtemp" = "Water Temperature",
          "do" = "Dissolved Oxygen",
          "dosat" = "Dissolved Oxygen Saturation",
          "mangrec" = "Recoverable Manganese",
          "ph" = "pH",
          "chla" = "Chlorophyll-a",
          #"nitnit" = "Nitrate-Nitrite",
          "nkjeld" = "Kjeldahl Nitrogen",
          #"orthotot" = "Total Orthophosphate",
          #"phosphatt" = "Total Phosphate",
          "turbid" = "Turbidity",
          "orthosol" = "Soluble Orthophosphate",
          "phosphats" = "Soluble Phosphorus",
          "toc" = "Total Organic Carbon",
          "totalp" = "Total Phosphorus",
          "doc" = "Dissolved Organic Carbon",
          "totaln" = "Total Nitrogen",
          "don" = "Dissolved Organic Nitrogen",
          "ton" = "Total Organic Nitrogen")
```

```
dplyr::n_distinct(tidy$VARIABLE) == length(vars)

## [1] TRUE

# If not true, check and correct
# unique(tidy$VARIABLE)[!unique(tidy$VARIABLE) %in% vars] # find things to add to vars
# vars[!vars %in% unique(tidy$VARIABLE)] # find things to remove from vars

# for (i in seq(vars)) {
#   print(names(vars[i]))
#   sub <- dplyr::filter(tidy, VARIABLE == vars[[i]])
#   saveRDS(sub, here::here(sprintf("Data/Tidy/dataPrep/storetUsgs_%s.rds", names(vars[i]))))
# }

for (i in seq(vars)) {
  print(names(vars[i]))
  sub <- dplyr::filter(tidy, VARIABLE == vars[[i]])
  readr::write_csv(sub, here::here(sprintf("Data/Tidy/AppendixC/storetUsgs_%s.csv", names(vars[i]))))
}

## [1] "secchi"
## [1] "cond"
## [1] "wtemp"
## [1] "do"
## [1] "dosat"
## [1] "mangrec"
## [1] "ph"
## [1] "chla"
## [1] "nkjeld"
## [1] "turbid"
## [1] "orthosol"
## [1] "phosphats"
## [1] "toc"
## [1] "totalp"
## [1] "doc"
## [1] "totaln"
## [1] "don"
## [1] "ton"
```

Code created by KDV Decision Analysis LLC and last run 2024-08-29 with R version 4.4.1 (2024-06-14 ucrt).

2.10 NCSU Toxin Data from Astrid Schnetzer Lab (emilyToxins)

2.10.1 Data Description

2.10.1.1 Toxins

Falls Lake toxin data collected 2019 - 2021 by Emily Pierce, graduate student of Dr. Astrid Schnietzer at NCSU in the file **FL Data_withChla.xlsx**. They provided data collected by three methods: Particulate, Filtering, and Accumulated Dissolved (SPATT). Sample treatments and detection limits were as follows:

Particulate method: 50 mLs of water was filtered & filters were extracted in 3 mLs of DI water. Detection limits (ug/L): - Cylindrospermopsin: 0.04 - Microcystin: 0.1 - Anatoxin-a: 0.1

Dissolved method: 1.5 mLs water collected post-filtering, no further treatment. Detection limits (ug/L): - Cylindrospermopsin: 0.0046 - Microcystin: 0.0115 - Anatoxin-a: 0.0115

Accumulated Dissolved method: SPATT devices containing 3g resin deployed for monthly period. SPATT resin extracted in 50 mLs of 50% MeOH. Extract diluted based on maximum MeOH content of specific toxin kit. Detection limits (mg toxin/g resin): - Cylindrospermopsin: 2.22 - Microcystin: 20.83 - Anatoxin-a: 41.67

```
# read in raw data
raw <- readxl::read_excel(here::here(rawFile),
                          sheet = "Data",
                          skip = 1,
                          na = c("NA", "", "na", "Deployed", "n/a"))

# raw data are wide format with dates as column names - these need to be coerced and rearranged
names(raw)[4:31] <- format(as.Date(as.numeric(names(raw)[4:31]), origin = "1899-12-30"), "%m/%d/%
Y")

tidy <- raw %>%
  tidyr::pivot_longer(cols = 4:31, names_to = "DATE", values_to = "VALUE") %>%
 dplyr::filter(!is.na(VALUE))
```

2.10.1.2 Chlorophyll-a

An updated version of the data received 2022-12-22 included the chlorophyll-a data collected with the toxin samples. The updated file is the one processed in this document.

2.10.2 Apply Standard Sample Information

We assigned the Toxin data (includes the chlorophyll-a also) to the VARIABLE column and replaced abbreviations with long variable names. We assigned Type data to VARTYPE. Measurement units were copied from the documentation (with correction of SPATT units per E. Pierce on 2022-12-14). DEPTHTYPE and DEPTHM were defined as “Grab” and “SPATT” with depths of 0.2 m and ___ respectively.

```
# Create the standard data structure
## chlorophyll data
chla <- tidy %>%
 dplyr::filter(Toxin == "CHL") %>%
  dplyr::rename(VARIABLE = Toxin) %>%
```

```
 dplyr::mutate(VALUE = as.numeric(VALUE),
         VARIABLE = "Chlorophyll-a",
                VARTYPE = NA_character_,
                MEASUNIT = "ug/L",
                VARLABEL = paste0(VARIABLE, ", ", MEASUNIT),
                DEPTHM = 0.2,
                DEPTHTYPE = "Grab") %>%
  dplyr::select(-Type)

#toxin data
tidy <- tidy %>%
 dplyr::filter(Toxin != "CHL") %>%
  dplyr::mutate(VARIABLE = Toxin,
                VARIABLE = if_else(VARIABLE == "MCY", "Microcystin", VARIABLE),
                VARIABLE = if_else(VARIABLE == "ANA", "Anatoxin-a", VARIABLE),
                VARIABLE = if_else(VARIABLE == "CYL", "Cylindrospermopsin", VARIABLE),
                VARIABLE = if_else(VARIABLE == "CHL", "Chlorophyll-a", VARIABLE),
                VARTYPE = Type,
                MEASUNIT = if_else(Type == "Accum_Dissolved", "mg/g of resin", "ug/L"),
                VARLABEL = paste0(VARIABLE, ", ", MEASUNIT),
                DEPTHM = if_else(Type == "Accum_Dissolved", NA_real_, 0.2),
                DEPTHTYPE = if_else(Type == "Accum_Dissolved", "SPATT", "Grab")) %>%
  dplyr::select(-Toxin, -Type)
```

2.10.3 Assign Value to “Below Detection”

These steps apply only to the toxins. Each BD measure was assigned a value of 50% of the detection limit for that toxin and method.

```
# Replace the Below Detection values with lookup values
bdValues <- list(
  Cyl = list(
    Part = 0.04/2,
    Diss = 0.0046/2,
    Accum = 2.22/2
  ),
  Mic = list(
    Part = 0.1/2,
    Diss = 0.0115/2,
    Accum = 20.83/2
  ),
  Ana = list(
    Part = 0.1/2,
    Diss = 0.0115/2,
    Accum = 41.67/2
  )
)
```

```
# Also create a lookup for applying thresholds to plots
partVals <- data.frame(
  VARIABLE = c("Cylindrospermopsin", "Microcystin", "Anatoxin-a"),
  CritVal = c(cylCrit, micCrit, anaCrit),
  BD = c(bdValues$Cyl$Part, bdValues$Mic$Part, bdValues$Ana$Part)
)

dissVals <- data.frame(
  VARIABLE = c("Cylindrospermopsin", "Microcystin", "Anatoxin-a"),
  CritVal = c(cylCrit, micCrit, anaCrit),
  BD = c(bdValues$Cyl$Diss, bdValues$Mic$Diss, bdValues$Ana$Diss)
)

accumVals <- data.frame(
  VARIABLE = c("Cylindrospermopsin", "Microcystin", "Anatoxin-a"),
  CritVal = c(cylCrit, micCrit, anaCrit),
  BD = c(bdValues$Cyl$Accum, bdValues$Mic$Accum, bdValues$Ana$Accum)
)

# we can't replace character values with numbers and if we coerce character
# values to numbers directly - then all "bd" will be converted to NA
# Therefore first change all "bd" to a "99999" placeholder (value higher than any measured value)
# Check max to ensure "99999" is good choice
# max( suppressWarnings(as.numeric(tidy$VALUE)), na.rm = TRUE)
tidy <- tidy %>%
  dplyr::mutate(VALUE = if_else(stringr::str_squish(stringr::str_to_lower(VALUE)) == "bd", "99999", VA
LUE)) %>%
  dplyr::mutate(VALUE = suppressWarnings(as.numeric(VALUE))) %>%
  dplyr::mutate(VALUE = if_else((VARTYPE == "Particulate" & VARIABLE == "Cylindrospermopsin" & VAL
UE == 99999), bdValues$Cyl$Part, VALUE),
                VALUE = if_else((VARTYPE == "Particulate" & VARIABLE == "Microcystin" & VALUE == 9
9999), bdValues$Mic$Part, VALUE),
                VALUE = if_else((VARTYPE == "Particulate" & VARIABLE == "Anatoxin-a" & VALUE == 9
9999), bdValues$Ana$Part, VALUE),
                VALUE = if_else((VARTYPE == "Dissolved" & VARIABLE == "Cylindrospermopsin" & VAL
UE == 99999), bdValues$Cyl$Diss, VALUE),
                VALUE = if_else((VARTYPE == "Dissolved" & VARIABLE == "Microcystin" & VALUE == 99
999), bdValues$Mic$Diss, VALUE),
                VALUE = if_else((VARTYPE == "Dissolved" & VARIABLE == "Anatoxin-a" & VALUE == 99
999), bdValues$Ana$Diss, VALUE),
                VALUE = if_else((VARTYPE == "Accum_Dissolved" & VARIABLE == "Cylindrospermopsin
" & VALUE == 99999), bdValues$Cyl$Accum, VALUE),
                VALUE = if_else((VARTYPE == "Accum_Dissolved" & VARIABLE == "Microcystin" & VAL
```

```
UE == 99999), bdValues$Mic$Accum, VALUE),
                VALUE = if_else((VARTYPE == "Accum_Dissolved" & VARIABLE == "Anatoxin-a" & VALU
E == 99999), bdValues$Ana$Accum, VALUE))

# Manually inspect
# View(tidy)
```

2.10.4 Calculate Total Toxins (Dissolved plus Particulate)

Other agencies report the total toxins per type (ug/L) as the sum of the dissolved and particulate portion. Emily's data provide both measures - but both were not always measured on the same day. Therefore the number of observations suitable to combine with other Falls Lake data is less than the total number of samples in her data.

```
# Retain spatt data
spatt <- dplyr::filter(tidy, VARTYPE == "Accum_Dissolved")

# Combine dissolved and particulate
tidy_wide <- dplyr::filter(tidy, VARTYPE != "Accum_Dissolved") %>%
  tidyr::pivot_wider(names_from = VARTYPE, values_from = VALUE) %>%
  dplyr::mutate(VALUE = Dissolved + Particulate,
                VARTYPE = "Total")

tidy <- tidy_wide %>%
  dplyr::select(-Dissolved, -Particulate) %>%
  rbind(spatt) %>%
  # bc many dates did not have a total value (if either diss or part is NA, answer is NA)
  dplyr::filter(!is.na(VALUE))

# Total sample events for Dissolved and/or Particulate
totSamples <- nrow(tidy_wide)


sampStatus <- tidy_wide %>%
  dplyr::mutate(Status = "No Data (SPATT Only)",
                Status = if_else(is.na(Dissolved) & !is.na(Particulate), "Particulate Only", Status),
                Status = if_else(!is.na(Dissolved) & is.na(Particulate), "Dissolved Only", Status),
                Status = if_else(!is.na(Dissolved) & !is.na(Particulate), "Calculated Total", Status)) %>%
  dplyr::select(DATE, Station, VARIABLE, Particulate, Dissolved, Total = VALUE, Status)

# Manually inspected the data against the raw spreadsheet to ensure correct
# View(test)

statusSumm <- dplyr::group_by(sampStatus, VARIABLE, Status) %>%
  dplyr::summarize(N = n(),
                   .groups = "drop") %>%
  dplyr::mutate(Status = factor(Status,
```

```
                                    levels = c("Calculated Total", "Dissolved Only",
                                               "Particulate Only", "No Data (SPATT Only)"), ordered = T)
)

# show results
dplyr::arrange(statusSumm, VARIABLE, Status)

## # A tibble: 9 × 3
##   VARIABLE          Status               N
##   <chr>             <ord>            <int>
## 1 Anatoxin-a        Calculated Total    74
## 2 Anatoxin-a        Dissolved Only       7
## 3 Anatoxin-a        Particulate Only    67
## 4 Cylindrospermopsin Calculated Total  101
## 5 Cylindrospermopsin Dissolved Only     18
## 6 Cylindrospermopsin Particulate Only   14
## 7 Microcystin       Calculated Total   290
## 8 Microcystin       Dissolved Only       2
## 9 Microcystin       Particulate Only     5
```

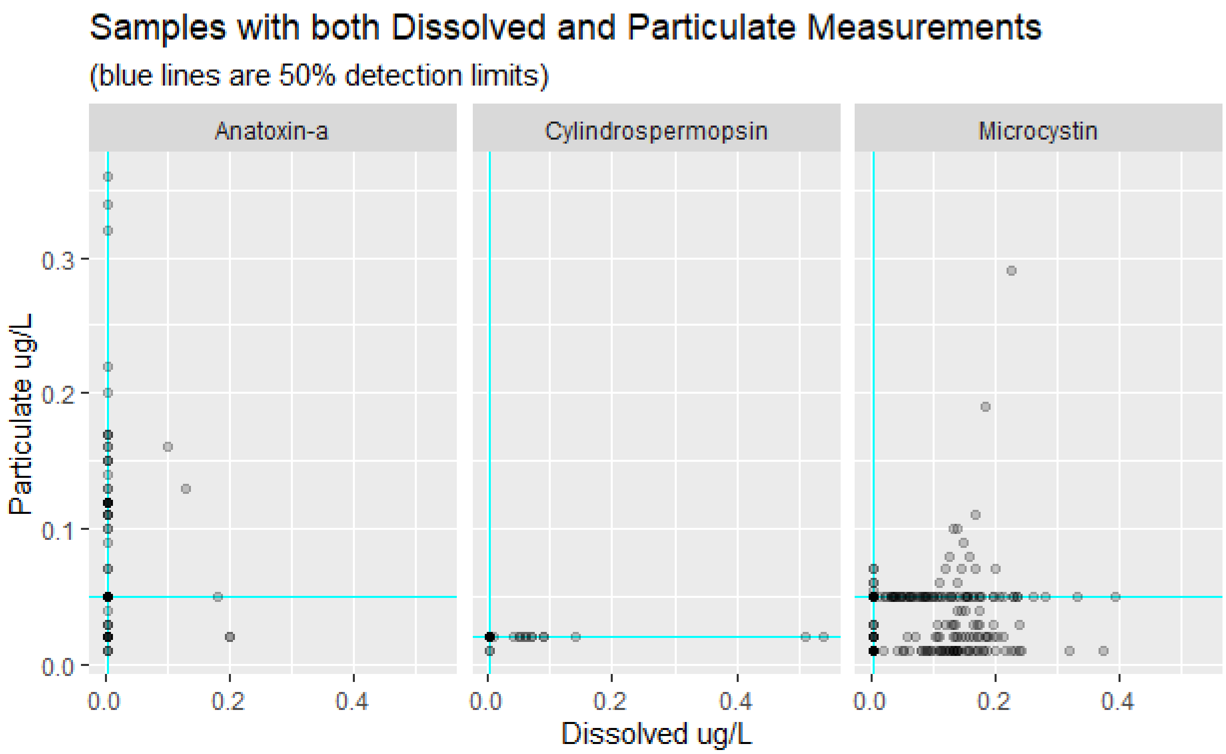
With 11, 28 sample dates, and 3 toxins, there are a total of 578 potential samples (from which particulate and dissolved could be calculated). However, Emily confirmed that their sampling criteria did NOT require them to always measure both components.

Of the 578 samples, only 465 report Total values.

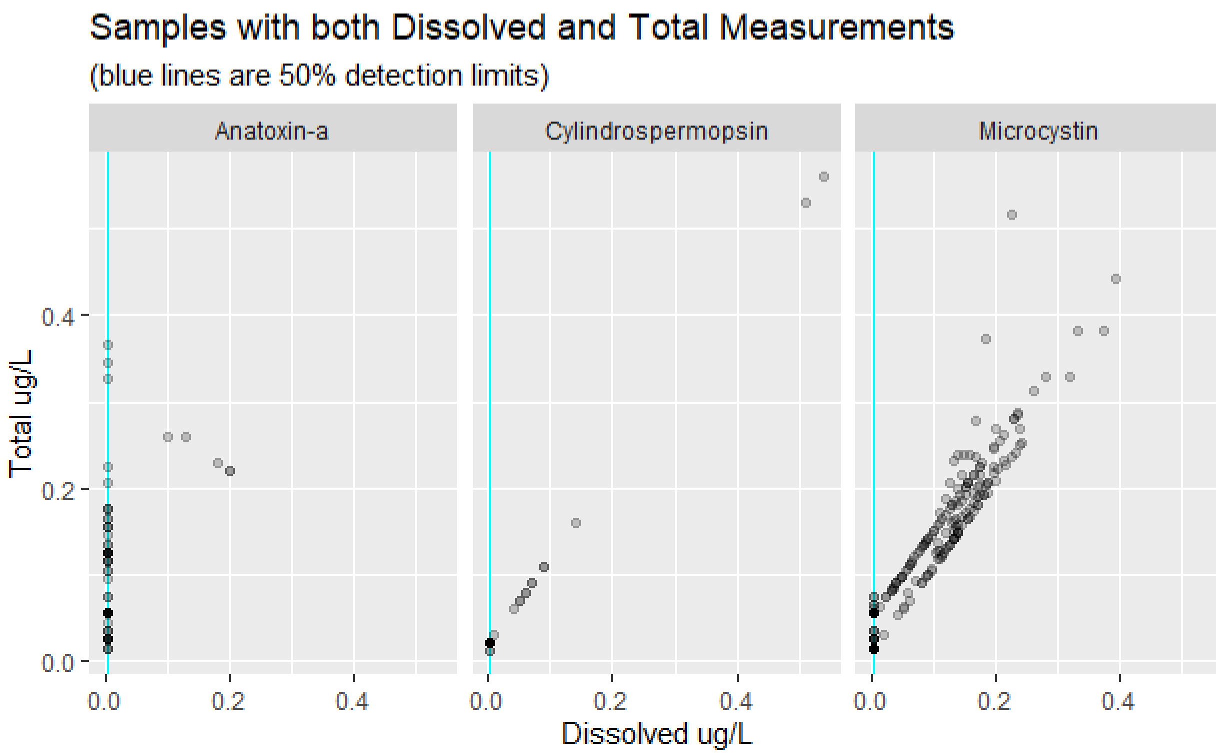
We did check if we could use a regression model to predict the total, but there are no relationships between the Particulate, Dissolved, or Total measures. We could perhaps use the Dissolved portion for Cylindrospermopsin and Microcystin and the Particulate portion for Anatoxin-a.

Regardless, we can safely state that the total for all dates with any measurement were well below all recommended thresholds.

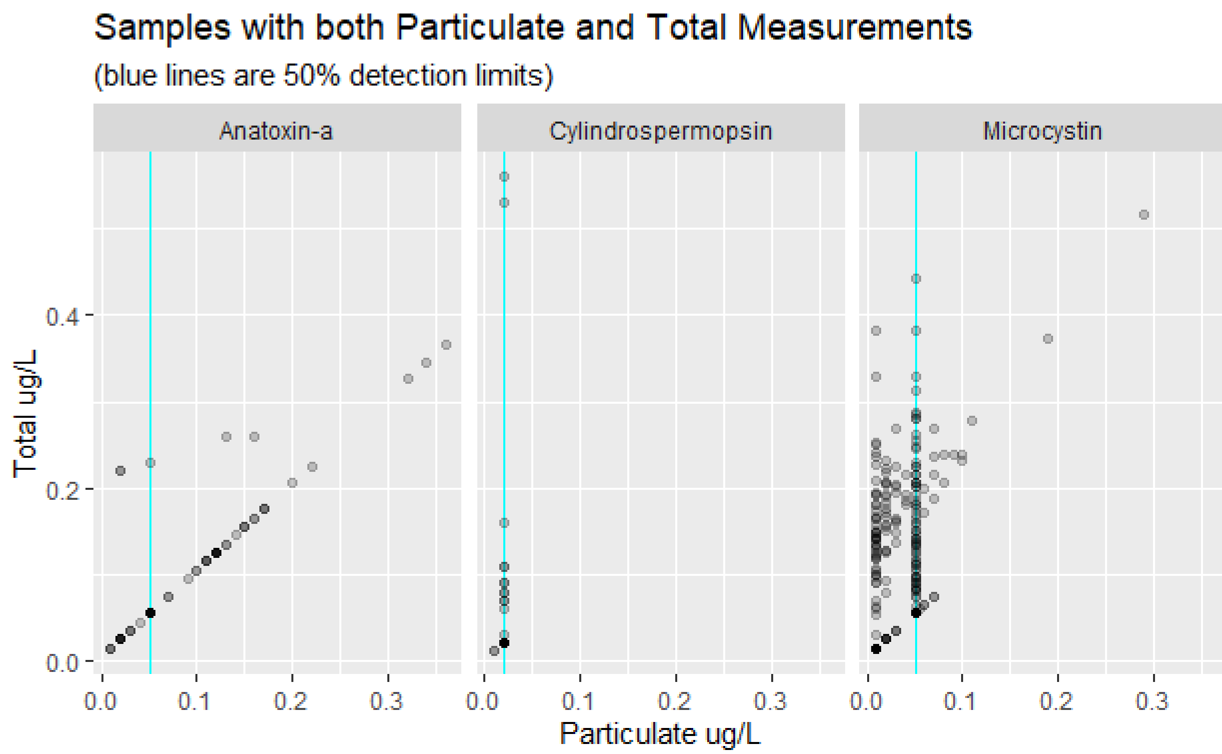
```
# Check if gaps could be filled by regression?
corrDissByPart <- ggplot() +
  geom_vline(data = dissVals, aes(xintercept = BD), color = "cyan") +
  geom_hline(data = partVals, aes(yintercept = BD), color = "cyan") +
  geom_point(data = sampStatus, aes(x = Dissolved, y = Particulate), alpha = .2, na.rm = T) +
  labs(title = "Samples with both Dissolved and Particulate Measurements",
       subtitle = "(blue lines are 50% detection limits)",
       x = "Dissolved ug/L", y = "Particulate ug/L") +
  facet_wrap(~VARIABLE)
corrDissByPart
```




```
# ggsave(plot = corrDissByPart, filename = here::here("Data/Tidy/dataPrep/Figures", "emilyToxins_corrDissByPart.png"), height = 8, width = 8)

corrDissByTot <- ggplot() +
  geom_vline(data = dissVals, aes(xintercept = BD), color = "cyan") +
  geom_point(data = sampStatus, aes(x = Dissolved, y = Total), alpha = .2, na.rm = T) +
  labs(title = "Samples with both Dissolved and Total Measurements",
       subtitle = "(blue lines are 50% detection limits)",
       x = "Dissolved ug/L", y = "Total ug/L") +
  facet_wrap(~VARIABLE)
corrDissByTot
```




```
# ggsave(plot = corrDissByTot, filename = here::here("Data/Tidy/dataPrep/Figures", "emilyToxins_corrDi
ssByTot.png"), height = 8, width = 8)

corrPartByTot <- ggplot() +
  geom_vline(data = partVals, aes(xintercept = BD), color = "cyan") +
  geom_point(data = sampStatus, aes(x = Particulate, y = Total), alpha = .2, na.rm = T) +
  labs(title = "Samples with both Particulate and Total Measurements",
       subtitle = "(blue lines are 50% detection limits)",
       x = "Particulate ug/L", y = "Total ug/L") +
  facet_wrap(~VARIABLE)
corrPartByTot
```




```
# ggsave(plot = corrPartByTot, filename = here::here("Data/Tidy/dataPrep/Figures", "emilyToxins_corrPartByTot.png"), height = 8, width = 8)
```

2.10.5Add date columns

```
tidy <- tidy %>%
  dplyr::mutate(DATE = lubridate::mdy(DATE),
                YEAR = lubridate::year(DATE),
                MONTH = lubridate::month(DATE, label = T, abbr = T))

chla <- chla %>%
  dplyr::mutate(DATE = lubridate::mdy(DATE),
                YEAR = lubridate::year(DATE),
                MONTH = lubridate::month(DATE, label = T, abbr = T))
```

2.10.6Add location columns

```
tidy <- tidy %>%
  dplyr::mutate(STATIONID = Station,
                STATION = Station) %>%
  dplyr::select(-Station)

chla <- chla %>%
  dplyr::mutate(STATIONID = Station,
                STATION = Station) %>%
  dplyr::select(-Station)
```

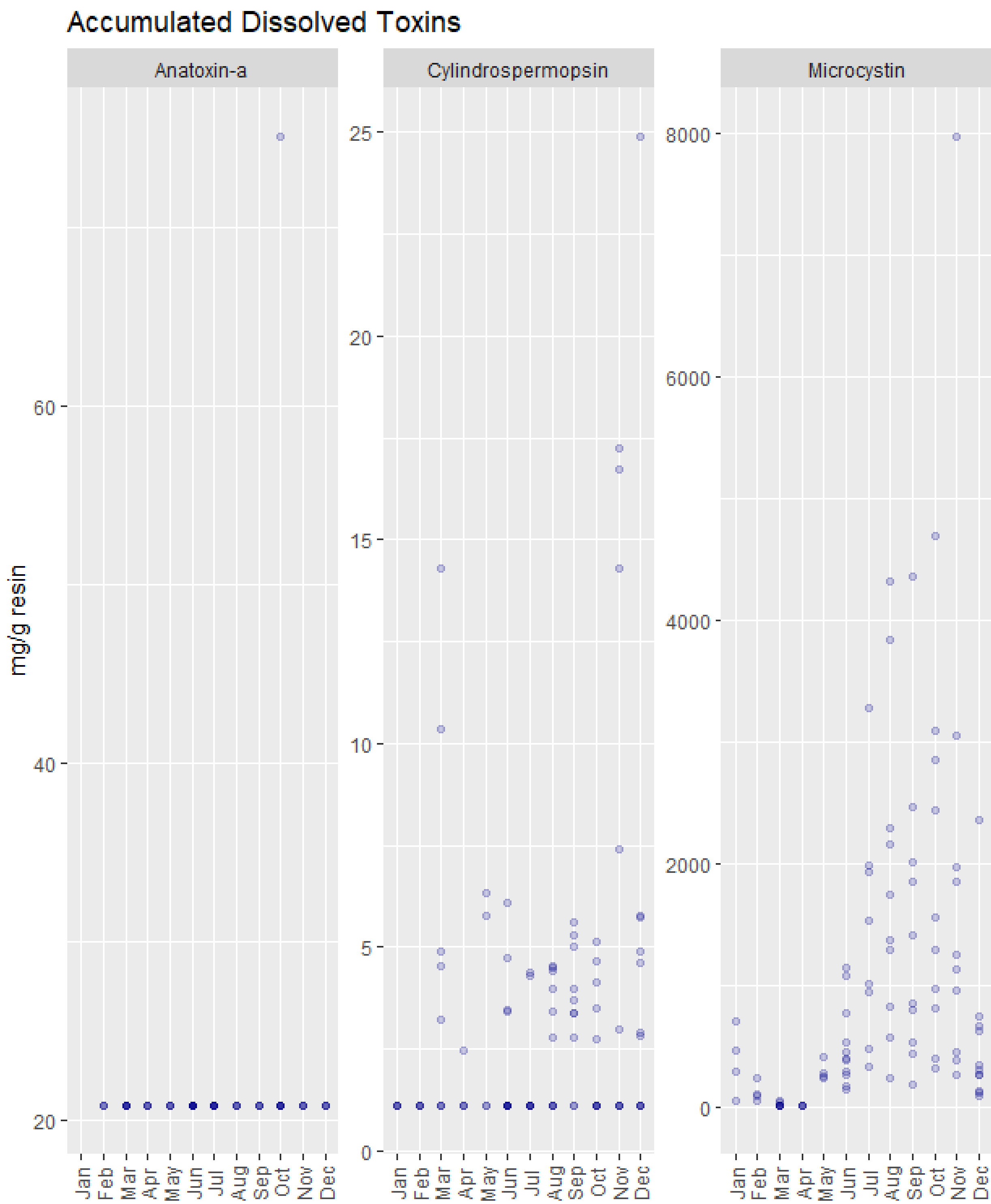
```
# Create the LAKEUNIT column
# Make sure all site names in the lookup list source_setupDictionaries
# all(tidy$STATIONID %in% names(lakeUnitList))
tidy <- assignLAKEUNIT(df = tidy, siteNameColumn = "STATIONID", lakeUnitList = lakeUnitList)
chla <- assignLAKEUNIT(df = chla, siteNameColumn = "STATIONID", lakeUnitList = lakeUnitList)

# Create the LOCATE column
# Make sure all site names in the lookup list source_setupDictionaries
# all(tidy$STATIONID %in% names(locateList))
tidy <- assignLOCATE(df = tidy, siteNameColumn = "STATIONID", locateList = locateList)
chla <- assignLOCATE(df = chla, siteNameColumn = "STATIONID", locateList = locateList)
```

2.10.7 Inspect the data

```
totalScatter <- ggplot(data = dplyr::filter(tidy, VARTYPE == "Total")) +
  geom_point(aes(x = MONTH, y = VALUE), alpha = 0.2, color = "darkblue", na.rm = T) +
            facet_wrap(~VARIABLE, scales = "free_y") +
  #geom_hline(data = partVals, aes(yintercept = CritVal), color = "red") +
  #geom_hline(data = partVals, aes(yintercept = BD), color = "cyan") +
  labs(title = "Sum of Dissolved and Particulate Measurements", y = "ug/L", x = "") +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
totalScatter
```

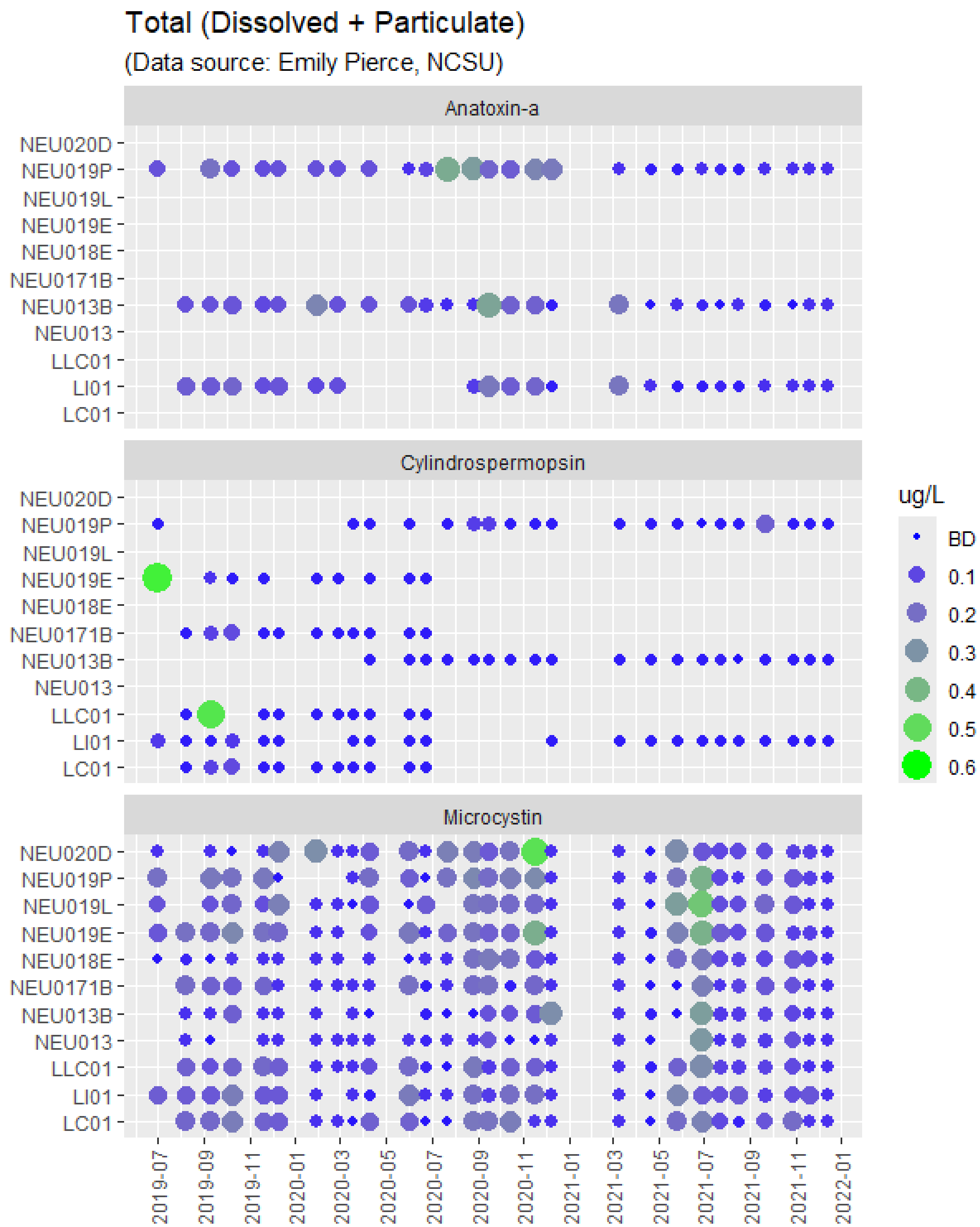

```
#ggsave(plot = totalScatter, filename = here::here("Data/Tidy/dataPrep/Figures", "emilyData_toxinTotal
s.png"), height = 8, width = 8)

spattScatter <- ggplot(data = dplyr::filter(tidy, VARTYPE == "Accum_Dissolved")) +
  geom_point(aes(x = MONTH, y = VALUE), alpha = 0.2, color = "darkblue", na.rm = T) +
```

```
                        facet_wrap(~VARIABLE, scales = "free_y") +
    #geom_hline(data = partVals, aes(yintercept = CritVal), color = "red") +
    #geom_hline(data = partVals, aes(yintercept = BD), color = "cyan") +
    labs(title = "Accumulated Dissolved Toxins", y = "mg/g resin", x = "") +
    theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
spattScatter
```



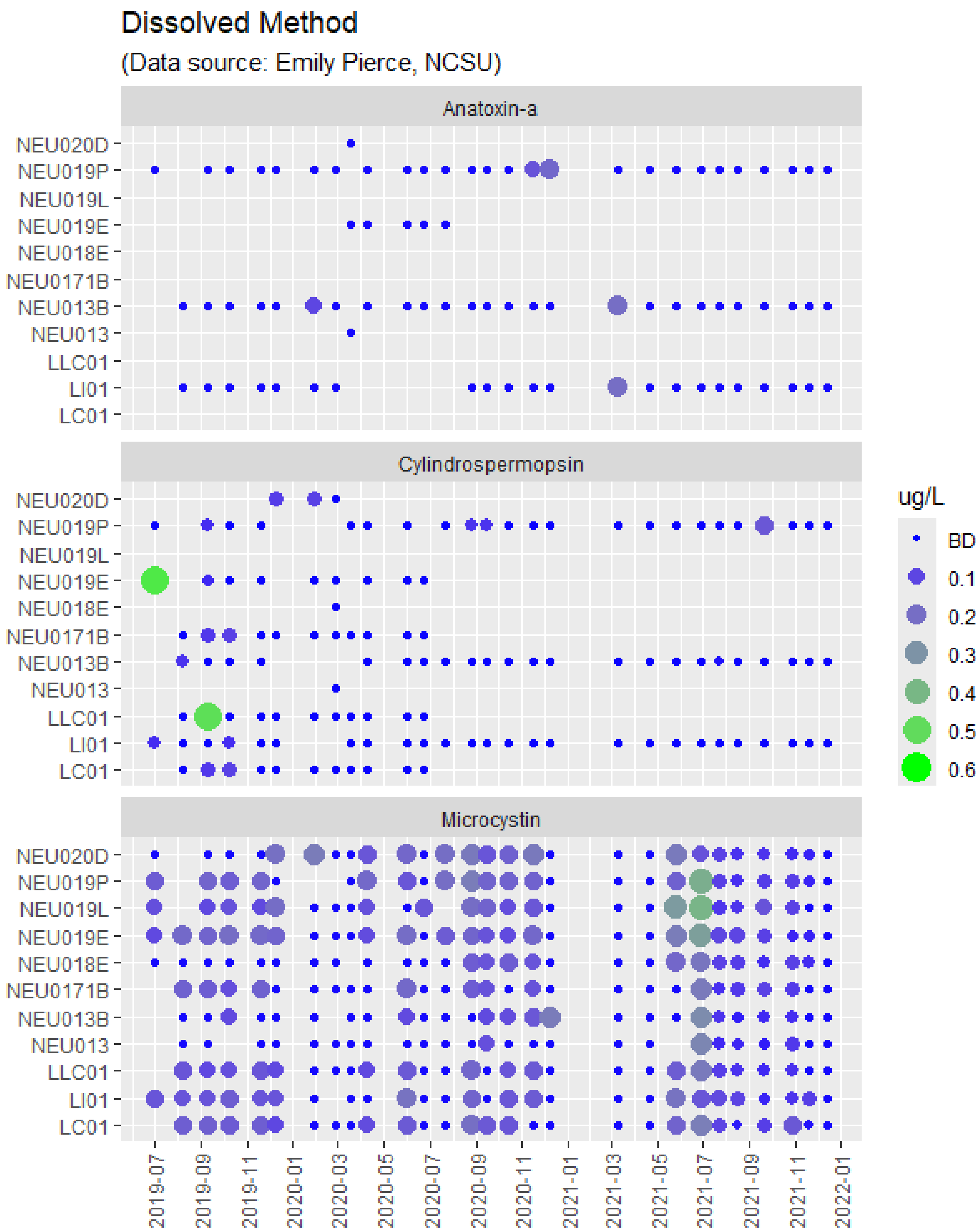

```
#ggsave(plot = spattScatter, filename = here::here("Data/Tidy/dataPrep/Figures", "emilyToxins_toxinSpa
tt.png"), height = 8, width = 8)

totSamps <- ggplot() +
  geom_point(dat = sampStatus, aes(x = lubridate::mdy(DATE), y = Station, color = Total, size = Total), n
```

```
a.rm = T) +
  labs(title = "Total (Dissolved + Particulate)", color = "ug/L", size = "ug/L", x = "", y = "",
       subtitle = "(Data source: Emily Pierce, NCSU)") +
  scale_x_date(date_breaks = "2 months", date_labels = "%Y-%m") +
  scale_color_gradient(low = "blue", high = "green", limits = c(0, 0.6), breaks = seq(0, 0.6, by=0.1), labels
= c("BD", "0.1", "0.2", "0.3", "0.4", "0.5", "0.6")) +
  scale_size_continuous(limits = c(0, 0.6), breaks = seq(0, 0.6, by=0.1), labels = c("BD", "0.1", "0.2", "0.3
", "0.4", "0.5", "0.6")) +
    guides(color= guide_legend(), size=guide_legend()) +
  facet_wrap(~VARIABLE, ncol = 1) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
totSamps
```



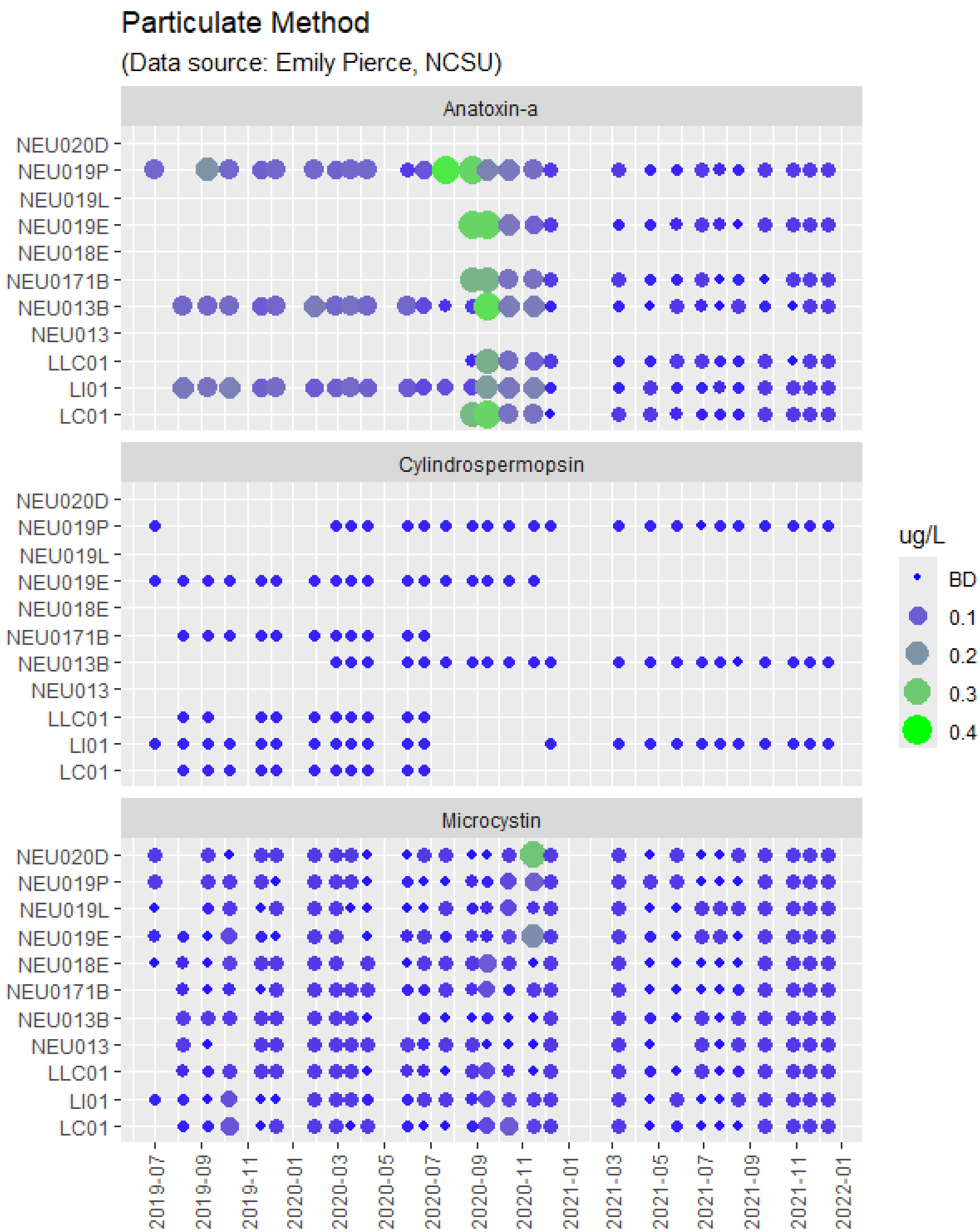

```
#ggsave(plot = totSamps, filename = here::here("Data/Tidy/dataPrep/Figures", "emilyToxins_totSamp.p
ng"), height = 8, width = 8)

dissSamps <- ggplot() +
  geom_point(dat = sampStatus, aes(x = lubridate::mdy(DATE), y = Station, color = Dissolved, size = Diss
```

```
olved), na.rm = T) +
  labs(title = "Dissolved Method", color = "ug/L", size = "ug/L", x = "", y = "",
       subtitle = "(Data source: Emily Pierce, NCSU)") +
  scale_x_date(date_breaks = "2 months", date_labels = "%Y-%m") +
  scale_color_gradient(low = "blue", high = "green", limits = c(0, 0.6), breaks = seq(0, 0.6, by=0.1), labels
= c("BD", "0.1", "0.2", "0.3", "0.4", "0.5", "0.6")) +
  scale_size_continuous(limits = c(0, 0.6), breaks = seq(0, 0.6, by=0.1), labels = c("BD", "0.1", "0.2", "0.3
", "0.4", "0.5", "0.6")) +
    guides(color= guide_legend(), size=guide_legend()) +
  facet_wrap(~VARIABLE, ncol = 1) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
dissSamps
```



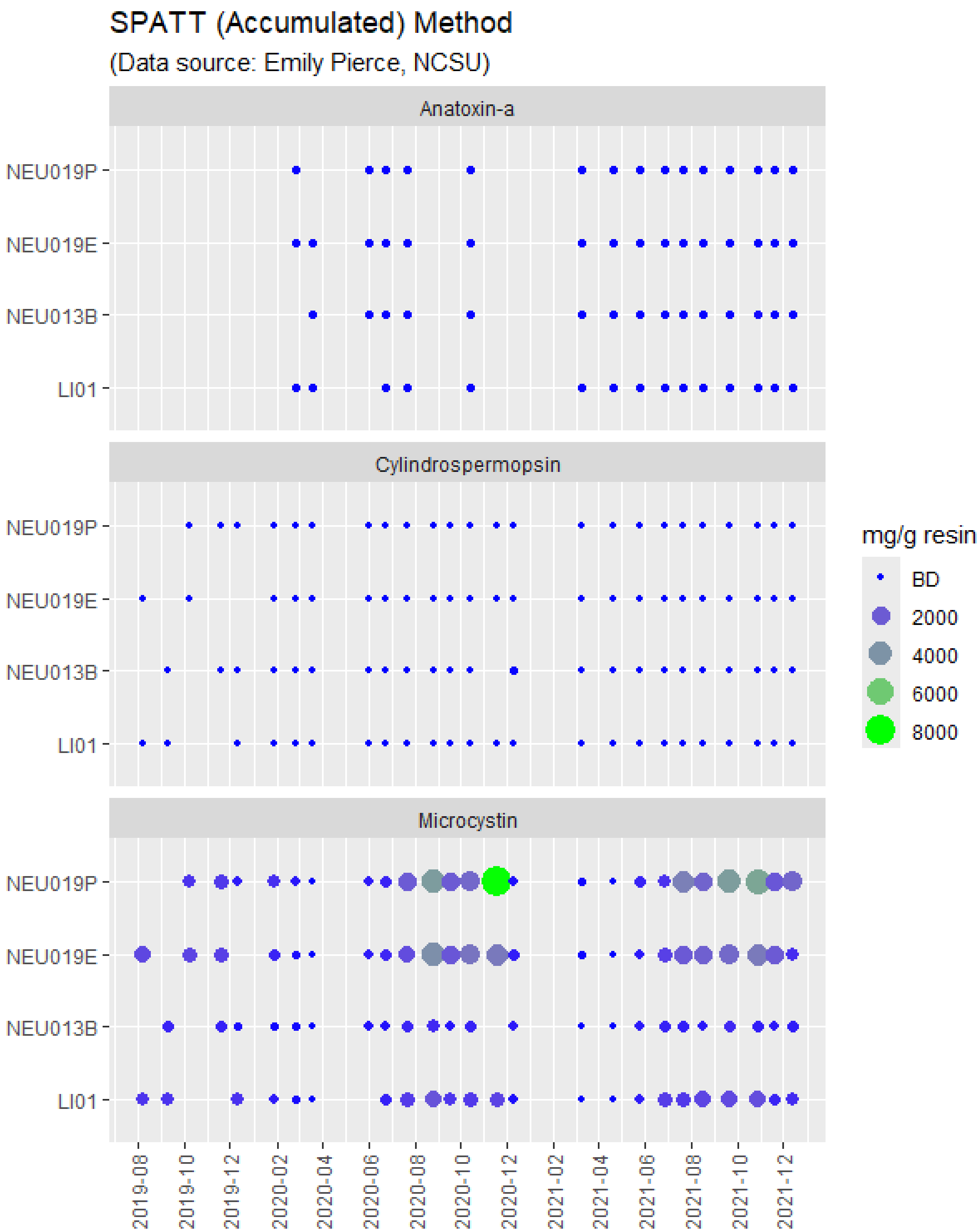

```
#ggsave(plot = dissSamps, filename = here::here("Data/Tidy/dataPrep/Figures", "emilyToxins_dissSamp.png"), height = 8, width = 8)

partSamps <- ggplot() +
  geom_point(dat = sampStatus, aes(x = lubridate::mdy(DATE), y = Station, color = Particulate, size = Pa
```

```
rticulate), na.rm = T) +
  labs(title = "Particulate Method", color = "ug/L", size = "ug/L", x = "", y = "",
       subtitle = "(Data source: Emily Pierce, NCSU)") +
  scale_x_date(date_breaks = "2 months", date_labels = "%Y-%m") +
  scale_color_gradient(low = "blue", high = "green", limits = c(0, 0.4), breaks = seq(0, 0.4, by=0.1), labels
= c("BD", "0.1", "0.2", "0.3", "0.4")) +
  scale_size_continuous(limits = c(0, 0.4), breaks = seq(0, 0.4, by=0.1), labels = c("BD", "0.1", "0.2", "0.3
", "0.4")) +
  guides(color= guide_legend(), size=guide_legend()) +
  facet_wrap(~VARIABLE, ncol = 1) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
partSamps
```




```
#ggsave(plot = partSamps, filename = here::here("Data/Tidy/dataPrep/Figures", "emilyToxins_partSamp
.png"), height = 8, width = 8)

accumSamps <- ggplot() +
  geom_point(dat = spatt, aes(x = lubridate::mdy(DATE), y = Station, color = VALUE, size = VALUE), na.r
```

```
m = T) +
   labs(title = "SPATT (Accumulated) Method", color = "mg/g resin", size = "mg/g resin", x = "", y = "",
          subtitle = "(Data source: Emily Pierce, NCSU)") +
   scale_x_date(date_breaks = "2 months", date_labels = "%Y-%m") +
   scale_color_gradient(low = "blue", high = "green", limits = c(0, 8000), breaks = seq(0, 8000, by=2000),
labels = c("BD", "2000", "4000", "6000", "8000")) +
   scale_size_continuous(limits = c(0, 8000), breaks = seq(0, 8000, by=2000), labels = c("BD", "2000", "40
00", "6000", "8000")) +
   guides(color= guide_legend(), size=guide_legend()) +
   facet_wrap(~VARIABLE, ncol = 1) +
   theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
accumSamps
```




```
#ggsave(plot = accumSamps, filename = here::here("Data/Tidy/dataPrep/Figures", "emilyToxins_accumSamp.png"), height = 5, width = 8)
```

SPATT samples are useful to note prevalence and/or events that might be missed through intermittent sampling. Critical thresholds do not apply to SPATT values due to differences in methods and measurements.

2.10.8 Source Reference

Assign SOURCE as "emilyToxins" and SOURCEID as a concatination of values STATIONID + DATE + VARIABLE + DEPTHTYPE.

```
tidy <- tidy %>%
  dplyr::mutate(SOURCE = "emilyToxins",
                SOURCEID = paste(STATIONID, DATE, VARIABLE, DEPTHTYPE, sep = "_"),
                SOURCETYPE = "Empirical")

assertthat::assert_that(dplyr::n_distinct(tidy$SOURCEID) == nrow(tidy), msg = "The SOURCEID values ar
e not unique.")

## [1] TRUE

chla <- chla %>%
  dplyr::mutate(SOURCE = "emilyToxins",
                SOURCEID = paste(STATIONID, DATE, VARIABLE, sep = "_"),
                SOURCETYPE = "Empirical")

assertthat::assert_that(dplyr::n_distinct(chla$SOURCEID) == nrow(chla), msg = "The SOURCEID values a
re not unique.")

## [1] TRUE
```

2.10.9 Final QAQC Checks

```
assertthat::assert_that(sum(is.na(tidy$VALUE)) < 1, msg = "There should be no NAs in the VALUE colum
n.")

## [1] TRUE

assertthat::assert_that(sum(is.na(chla$VALUE)) < 1, msg = "There should be no NAs in the VALUE colum
n.")

## [1] TRUE

assertthat::assert_that(sum(is.na(tidy$DATE)) < 1, msg = "There should be no NAs in the DATE column."
)

## [1] TRUE

assertthat::assert_that(sum(is.na(chla$DATE)) < 1, msg = "There should be no NAs in the DATE column."
)

## [1] TRUE

assertthat::assert_that(sum(is.na(tidy$STATIONID)) < 1, msg = "There should be no NAs in the STATIONI
D column.")
```

```
## [1] TRUE

assertthat::assert_that(sum(is.na(chla$STATIONID)) < 1, msg = "There should be no NAs in the STATIONI
D column.")

## [1] TRUE
```

2.10.10 Export tidy data

```
# Save prepped data

tidy <- rbind(tidy, chla)

# saveRDS(tidy, here::here("Data/Tidy/dataPrep", "emilyToxins_data.rds"))
# openxlsx::write.xlsx(tidy, file = here::here("Data/Tidy/dataPrep/Excel", "emilyToxin_data.xlsx"), overwri
te = TRUE)
readr::write_csv(tidy, here::here("Data/Tidy/AppendixC", "emilyToxins_data.csv"))

# Anatoxin-a
anatot <- tidy %>%
  dplyr::filter(VARIABLE == "Anatoxin-a", VARTYPE == "Total")
# saveRDS(anatot, here::here("Data/Tidy/dataPrep", "emilyToxins_anatot.rds"))
readr::write_csv(anatot, here::here("Data/Tidy/AppendixC", "emilyToxins_anatot.csv"))

anaspatt <- tidy %>%
  dplyr::filter(VARIABLE == "Anatoxin-a", VARTYPE == "Accum_Dissolved")
# saveRDS(anaspatt, here::here("Data/Tidy/dataPrep", "emilyToxins_anaspatt.rds"))
readr::write_csv(anaspatt, here::here("Data/Tidy/AppendixC", "emilyToxins_anaspatt.csv"))

# Microcystin
mictot <- tidy %>%
  dplyr::filter(VARIABLE == "Microcystin")
# saveRDS(mictot, here::here("Data/Tidy/dataPrep", "emilyToxins_mictot.rds"))
readr::write_csv(mictot, here::here("Data/Tidy/AppendixC", "emilyToxins_mictot.csv"))

micspatt <- tidy %>%
  dplyr::filter(VARIABLE == "Microcystin", VARTYPE == "Accum_Dissolved")
# saveRDS(micspatt, here::here("Data/Tidy/dataPrep", "emilyToxins_micspatt.rds"))
readr::write_csv(micspatt, here::here("Data/Tidy/AppendixC", "emilyToxins_micspatt.csv"))

# Cylindrospermopsin
cyltot <- tidy %>%
  dplyr::filter(VARIABLE == "Cylindrospermopsin")
# saveRDS(cyltot, here::here("Data/Tidy/dataPrep", "emilyToxins_cyltot.rds"))
readr::write_csv(cyltot, here::here("Data/Tidy/AppendixC", "emilyToxins_cyltot.csv"))

cylspatt <- tidy %>%
```

```
  dplyr::filter(VARIABLE == "Cylindrospermopsin", VARTYPE == "Accum_Dissolved")
# saveRDS(cylspatt, here::here("Data/Tidy/dataPrep", "emilyToxins_cylspatt.rds"))
readr::write_csv(cylspatt, here::here("Data/Tidy/AppendixC", "emilyToxins_cylspatt.csv"))

# Chlorophyll-a

# saveRDS(chla, here::here("Data/Tidy/dataPrep", "emilyToxins_chla.rds"))
readr::write_csv(chla, here::here("Data/Tidy/AppendixC", "emilyToxins_chla.csv"))
```

Code prepared by KDV Decision Analysis LLC. Code last run 2024-08-29 with R version 4.4.1 (2024-06-14 ucrt).

2.11 City of Raliegh Recent TOC Data

2.11.1 Data Description

This a supplement to the previously received Raleigh PUD (*ralpud*) data. It contains only the TOC data, for dates Jan 2018 through March 2022. It includes the median Raw measurement per day, as well as the median per day Settled, Finished, and Percent Removed.

```
raw <- readxl::read_excel(here::here(rawFile), skip = 2)
```

For our work, we only need the raw values. We extracted these data, plus the date information, and removed any records that were missing a value.

```
tidy <- raw %>%
  select(VALUE = `Median of Raw TOC`, starts_with("datestamp")) %>%
  na.omit()

head(tidy)

## # A tibble: 6 × 4
##   VALUE `datestamp - Year` `datestamp - Month` `datestamp - Day`
##   <dbl>              <dbl> <chr>                           <dbl>
## 1  6.23               2018 January                             2
## 2  6.26               2018 January                             3
## 3  6.3                2018 January                             4
## 4  6.52               2018 January                             5
## 5  6.26               2018 January                             6
## 6  6.21               2018 January                             7
```

2.11.2 Assign SOURCE Information

Source code is “raltoc”. We found no duplicated values.

```
tidy <- tidy %>%
  dplyr::mutate(SOURCE = "raltoc",
         SOURCEID = paste(`datestamp - Month`, `datestamp - Day`, `datestamp - Year`, VALUE),
         SOURCETYPE = "Empirical")

assertthat::assert_that(dplyr::n_distinct(tidy$SOURCEID) == nrow(tidy), msg = "SOURCEID values must be unique per observation.")
```

```
## [1] TRUE
```

2.11.3 Standardize DATE Information

Add the DATE, YEAR and MONTH columns. Confirm all data have an assigned date.

```
tidy <- tidy %>%
  dplyr::mutate(DATE = paste(`datestamp - Month`, `datestamp - Day`, ", ", `datestamp - Year`),
         DATE = lubridate::mdy(DATE),
         MONTH = lubridate::month(DATE, label = T, abbr = T),
         YEAR = lubridate::year(DATE)) %>%
  dplyr::select(-(starts_with("datestamp")))

assertthat::assert_that(sum(is.na(tidy$DATE)) < 1, msg = "NA values are not allowed in the DATE colum
n")

## [1] TRUE

table(tidy$YEAR)

## 
## 2018 2019 2020 2021 2022 
##  352  352  362  364   71

table(tidy$MONTH)

## 
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec 
## 151 134 132 116 120 120 123 122 120 123 118 122
```

2.11.4 Standardize DEPTH Information

Add DEPTHM and DEPTHTYPE columns.

These data did not provide depth, but they are assumed to come from surface water (DEPTHM assigned as 0.2 m), unless otherwise corrected by TAW or SME.

```
tidy <- tidy %>%
  dplyr::mutate(DEPTHM = 0.2,
         DEPTHTYPE = NA_character_)
```

2.11.5 Standardise STATION Information

Add STATION, STATIONID, LAKEUNIT, and LOCATE columns.

These data did not provide a station id, but the data are assumed to come from the Intake Surface, unless advised otherwise by TAW or SME.

```
tidy <- tidy %>%
  dplyr::mutate(STATIONID = "Intake Surface",
         STATION = STATIONID)

assertthat::assert_that(all(tidy$STATIONID %in% names(lakeUnitList)), msg = "Some station names in fil
e are not found in the LAKEUNIT assignment list.")
```

```
## [1] TRUE

tidy <- assignLAKEUNIT(df = tidy, siteNameColumn = "STATIONID", lakeUnitList = lakeUnitList)

assertthat::assert_that(all(tidy$STATIONID %in% names(locateList)), msg = "Some station names in file are not found in the LOCATE assignment list.")

## [1] TRUE

tidy <- assignLOCATE(df = tidy, siteNameColumn = "STATIONID", locateList = locateList)
```

2.11.6 Standardize VARIABLE Information

Add VARIABLE, VARTYPE, MEASUNIT and VARLABEL columns.

The variable is assigned as Total Organic Carbon and the units are assumed to be “mg/L” based on comparison of range to other data.

```
tidy <- tidy %>%
  dplyr::mutate(VARIABLE = "Total Organic Carbon",
         MEASUNIT = "mg/L",
         VARLABEL = paste(VARIABLE, ",", MEASUNIT),
                VARTYPE = NA_character_)
```

2.11.7 Export Tidy Data

These data are saved as both **raltoc_data.rds** (with copy saved also to Excel) and as **raltoc_toc.rds** (to conform to the standard convention of complete data set plus variable specific dataset, even though these data have only one variable).

```
# all sites all data
# saveRDS(tidy, here::here("Data/Tidy/dataPrep", "raltoc_data.rds"))
# openxlsx::write.xlsx(tidy, file = here::here("Data/Tidy/dataPrep/Excel", "raltoc_data.xlsx"), overwrite = TRUE)
readr::write_csv(tidy, here::here("Data/Tidy/AppendixC", "raltoc_toc.rds"))
```

Code authored by KDV Decision Analysis LLC and last run 2024-08-29 with R version 4.4.1 (2024-06-14 ucrt).

2.12 City of Raleigh Recent TOC Data (extraToc)

2.12.1 Data Description

This data was received on April 4, 2023 from L. Strader.

Attached is a spreadsheet with additional TOC data. It includes data from three sources. The first tab is what was sent to us directly from the City of Raleigh on 2/27/23. The second tab is what I pulled out of our old master WQ database. It only includes data collected by the City at the intake. The third tab is what I downloaded from the online WQ portal. Most of this should overlap with the portal data I already sent you. However, it may include additional data collected by DWR. I noticed that there is a discrepancy with how they report units for older TOC data so my lookup tables may have previously filtered it out. This issue has been fixed (and it looks like it only affected TOC data).

This data is supplement to Total Organic Carbon (TOC) data which we’d already received and processed (SOURCE = raltoc). We believe these new data contain a mix of observations which we already have and new data. Any duplicated observations will be dropped within the data merge step. The provided file **FallsLakeTOC.xlsx** contains three sheets:

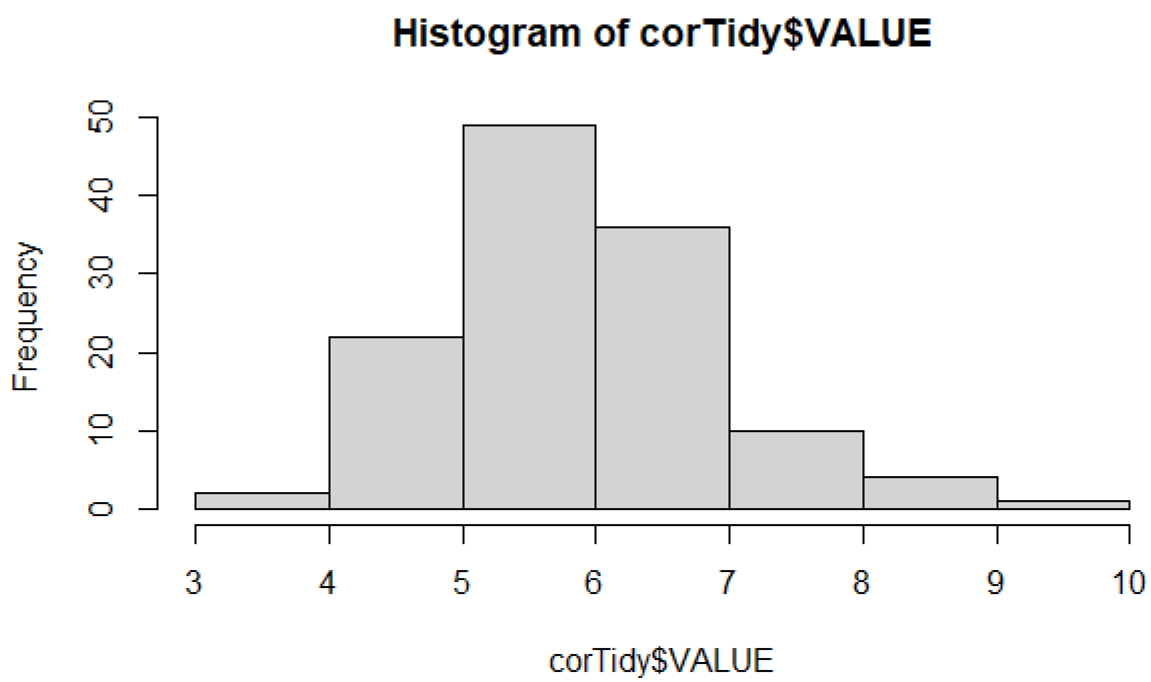
- dataReceivedFromCoR
  - Data received from City of Raleigh
- UNRBAWQDataBase
  - Data believed to be City of Raleigh data retrieved from the Brown and Caldwell (??) old master WQ Database
- WQPortal
  - Data pulled from the Water Quality Portal

2.12.2 Sheet 1: dataReceivedFromCoR

```
corRaw <- readxl::read_excel(here::here(rawFile), sheet = 1)

head(corRaw)

## # A tibble: 6 × 4
##   Site             `Date Collected`    Result             Units
##   <chr>            <chr>               <chr>              <chr>
## 1 EMJ Source Water 1/10/2013 10:00 AM 5.14               mg/L
## 2 EMJ Source Water 2/14/2013 9:44 AM  5.9930000000000003 mg/L
## 3 EMJ Source Water 3/14/2013 8:25 AM  6.5129999999999999 mg/L
## 4 EMJ Source Water 4/11/2013 8:25 AM  6.4240000000000004 mg/L
## 5 EMJ Source Water 5/9/2013 7:50 AM   6.3650000000000002 mg/L
## 6 EMJ Source Water 4/8/2021 8:28 AM   5.04               mg/L
```

Here we are renaming the column which contains the measured value of TOC to our standard column name 'VALUE' and dropping any observations in which this column is NA (N = rsum(is.na(as.numeric(corRaw$Result)))`.

```
corTidy <- corRaw %>%
  dplyr::rename(VALUE = Result) %>%
  dplyr::mutate(VALUE = as.numeric(VALUE)) %>%
  dplyr::filter(!is.na(VALUE))

hist(corTidy$VALUE)
```



2.12.2.1 Assign SOURCE Information

We assigned these data as SOURCE "extratoc_raltoc" and SOURCEID as concatenated values row number + Date Collected + Value

```
corTidy <- corTidy %>%
  dplyr::mutate(SOURCE = "extratoc_raltoc",
         SOURCEID = paste0(row_number(), "_", SOURCE, "_",
                  str_remove_all(`Date Collected`, " "),
                  round(VALUE, 1)),
         SOURCETYPE = "Empirical")

assertthat::assert_that(dplyr::n_distinct(corTidy$SOURCEID) == nrow(corTidy), msg = "SOURCEID values must be unique per observation.")

## [1] TRUE
```

2.12.2.2 Standardize DATE Information

```
corTidy$`Date Collected` <- sapply(corTidy$`Date Collected`,
                  function(x){
                   out <- str_split(x, " ") %>%
                    unlist(x)
                   return(out[1])
                  })
corTidy <- dplyr::mutate(corTidy,
             DATE = lubridate::mdy(`Date Collected`),
             MONTH = lubridate::month(DATE, label = T, abbr = T),
```

```
                  YEAR = lubridate::year(DATE)) %>%
  select(-c("Date Collected"))

table(corTidy$YEAR)

##
## 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022
##    7   12   13   13   12   12   13   11   15   16

table(corTidy$MONTH)

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##   9  10   9  11  11  10  10  11  12  10  11  10
```

2.12.2.3 Standardize DEPTH Information

Add DEPTHM and DEPTHTYPE columns.

These data did not provide depth, but they are assumed to come from surface water (DEPTHM assigned as 0.2 m), unless otherwise corrected by TAW or SME.

```
corTidy <- corTidy %>%
  dplyr::mutate(DEPTHM = 0.2,
                DEPTHTYPE = NA_character_)
```

2.12.2.4 Standardize STATION Information

Add STATION, STATIONID, LAKEUNIT, and LOCATE columns.

These data specified the site as 'EMJ Source Water' for all observations. We are making the assumption that this refers to the EM Johnson water treatment facility on Falls Lake thus we will specify the STATIONID and STATION as 'Intake Surface'.

```
corTidy <- corTidy %>%
  dplyr::mutate(STATIONID = "Intake Surface",
                STATION = "Intake Surface") %>%
  dplyr::select(-Site)

assertthat::assert_that(all(corTidy$STATIONID %in% names(lakeUnitList)), msg = "Some station names i
n file are not found in the LAKEUNIT assignment list.")

## [1] TRUE

corTidy <- assignLAKEUNIT(df = corTidy, siteNameColumn = "STATIONID", lakeUnitList = lakeUnitList)

assertthat::assert_that(all(corTidy$STATIONID %in% names(locateList)), msg = "Some station names in f
ile are not found in the LOCATE assignment list.")

## [1] TRUE

corTidy <- assignLOCATE(df = corTidy, siteNameColumn = "STATIONID", locateList = locateList)
```

2.12.2.5 Standardize VARIABLE Information

Add VARIABLE, VARTYPE, MEASUNIT and VARLABEL columns.

The variable is assigned as Total Organic Carbon. The units are provided in the original data as "mg/L".

```
corTidy <- corTidy %>%
  dplyr::rename(MEASUNIT = Units) %>%
  dplyr::mutate(VARIABLE = "Total Organic Carbon",
         VARLABEL = paste(VARIABLE, ",", MEASUNIT),
         VARTYPE = NA_character_) %>%
  # Order columns
  dplyr::select(SOURCE,
         SOURCEID,
         SOURCETYPE,
         DATE,
         STATIONID,
         STATION,
         DEPTHM,
         DEPTHTYPE,
         VARIABLE,
         VARTYPE,
         VARLABEL,
         VALUE,
         MEASUNIT,
         MONTH,
         YEAR,
         LAKEUNIT,
         LOCATE)
```

2.12.3 Sheet 2: UNRBAWQDataBase

We renamed the column of measured TOC values to our standard column name 'VALUE' and dropped any observations in which this column is NA.

```
unRaw <- readxl::read_excel(here::here(rawFile), sheet = 2)
head(unRaw)

## # A tibble: 6 × 5
##   Site                   `Date Collected`    Result Units SamplingDepth
##   <chr>                  <dttm>              <dbl> <chr> <chr>
## 1 CoR_Johnson_WP_Lab_Data 2000-02-07 00:00:00  7.5  mg/L  Surface
## 2 CoR_Johnson_WP_Lab_Data 2000-03-01 00:00:00  6.55 mg/L  Surface
## 3 CoR_Johnson_WP_Lab_Data 2000-03-29 00:00:00  5.76 mg/L  Surface
## 4 CoR_Johnson_WP_Lab_Data 2000-05-05 00:00:00  6.31 mg/L  Surface
## 5 CoR_Johnson_WP_Lab_Data 2000-06-01 00:00:00  6.43 mg/L  Surface
## 6 CoR_Johnson_WP_Lab_Data 2000-06-27 00:00:00  6.09 mg/L  Surface

unTidy <- unRaw %>%
  dplyr::rename(VALUE = Result) %>%
  dplyr::mutate(VALUE = as.numeric(VALUE)) %>%
  dplyr::filter(!is.na(VALUE))
```

2.12.3.1 Assign SOURCE Information

```
unTidy <- unTidy %>%
  dplyr::mutate(SOURCE = "extratoc_raltoc",
         SOURCEID = paste0(row_number(), "_", SOURCE, "_",
                  `Date Collected`,
                  round(VALUE, 1)),
         SOURCETYPE = "Empirical")

assertthat::assert_that(dplyr::n_distinct(unTidy$SOURCEID) == nrow(unTidy), msg = "SOURCEID values must be unique per observation.")

## [1] TRUE

assertthat::assert_that(all(!(unTidy$SOURCEID %in% corTidy$SOURCEID)), msg = "SOURCEID not unique when compared with COR SOURCEIDs.")

## [1] TRUE
```

2.12.3.2 Standardize DATE Information

```
unTidy <- dplyr::mutate(unTidy,
             DATE = lubridate::ymd(`Date Collected`),
             MONTH = lubridate::month(DATE, label = T, abbr = T),
             YEAR = lubridate::year(DATE)) %>%
  select(-c("Date Collected"))
```

2.12.3.3 Standardize DEPTH Information

Add DEPTHM and DEPTHTYPE columns.

Sampling depth for these data were specified as 'Surface'. Based on this, we assign the standard numeric approximation for surface samples (0.2m). The depth type was not specified, and will be left as NA within our tidy data.

```
unTidy <- unTidy %>%
  dplyr::mutate(DEPTHM = 0.2,
         DEPTHTYPE = NA_character_)
```

2.12.3.4 Standardize STATION Information

Add STATION, STATIONID, LAKEUNIT, and LOCATE columns.

These data specified the site as 'CoR_Johnson_WP_Lab_Data' for all observations. We are making the assumption that this refers to the EM Johnson water treatment facility on Falls Lake thus we will specify the STATIONID and STATION as 'Intake Surface'.

```
unTidy <- unTidy %>%
  dplyr::mutate(STATIONID = "Intake Surface",
         STATION = "Intake Surface") %>%
  dplyr::select(-Site)

assertthat::assert_that(all(unTidy$STATIONID %in% names(lakeUnitList)), msg = "Some station names in file are not found in the LAKEUNIT assignment list.")
```

```
## [1] TRUE

unTidy <- assignLAKEUNIT(df = unTidy, siteNameColumn = "STATIONID", lakeUnitList = lakeUnitList)


assertthat::assert_that(all(unTidy$STATIONID %in% names(locateList)), msg = "Some station names in fi
le are not found in the LOCATE assignment list.")

## [1] TRUE

unTidy <- assignLOCATE(df = unTidy, siteNameColumn = "STATIONID", locateList = locateList)
```

2.12.3.5 Standardize VARIABLE Information

Add VARIABLE, VARTYPE, MEASUNIT and VARLABEL columns.

The variable is assigned as Total Organic Carbon. The units are provided in the original data as "mg/L".

```
table(unTidy$Units)

##
## mg/L
##   91

unTidy <- unTidy %>%
  dplyr::rename(MEASUNIT = Units) %>%
  dplyr::mutate(VARIABLE = "Total Organic Carbon",
                VARLABEL = paste(VARIABLE, ",", MEASUNIT),
                VARTYPE = NA_character_) %>%
  # Order columns
  dplyr::select(SOURCE,
                SOURCEID,
                SOURCETYPE,
                DATE,
                STATIONID,
                STATION,
                DEPTHM,
                DEPTHTYPE,
                VARIABLE,
                VARTYPE,
                VARLABEL,
                VALUE,
                MEASUNIT,
                MONTH,
                YEAR,
                LAKEUNIT,
                LOCATE)
```

2.12.4 Sheet 3: WQPortal

```
wqRaw <- readxl::read_excel(here::here(rawFile), sheet = 3)
head(wqRaw)

## # A tibble: 6 × 7
##   Site    `Date Collected`    Result Units depth_m secchi_m SampleType
##   <chr>   <dttm>              <dbl> <lgl> <chr>   <chr>    <chr>
## 1 2086920 1991-07-10 14:20:00   16   NA    NA      NA       USGS, Sample-Routine
## 2 2086920 1991-11-05 15:00:00   12   NA    NA      NA       USGS, Sample-Routine
## 3 2086920 1992-05-19 15:00:00    7.4 NA    NA      NA       USGS, Sample-Routine
## 4 2086920 1992-06-30 13:00:00   12   NA    NA      NA       USGS, Sample-Routine
## 5 2086920 1992-10-29 10:45:00   14   NA    NA      NA       USGS, Sample-Routine
## 6 2086920 1993-05-07 11:00:00   17   NA    NA      NA       USGS, Sample-Routine

wqTidy <- wqRaw %>%
 dplyr::rename(VALUE = Result) %>%
 dplyr::filter(!is.na(VALUE))
```

2.12.4.1 Assign SOURCE Information

Based on the information within the data (SampleType column and the fact that it came from WQPortal), we have decided to classify this source as ‘storetUsgs’.

```
wqTidy <- wqTidy %>%
 dplyr::mutate(SOURCE = "extratoc_storetUsgs",
         SOURCEID = paste0(row_number(), "_", SOURCE, "_",
                   `Date Collected`,
                   round(VALUE, 1)),
         SOURCETYPE = "Empirical")

assertthat::assert_that(dplyr::n_distinct(wqTidy$SOURCEID) == nrow(wqTidy), msg = "SOURCEID values must be unique per observation.")

## [1] TRUE

assertthat::assert_that(all(!(wqTidy$SOURCEID %in% c(corTidy$SOURCEID, unTidy$SOURCEID))), msg = "SOURCEID not unique when compared with COR and UN SOURCEIDs.")

## [1] TRUE
```

2.12.4.2 Standardize DATE Information

```
wqTidy <- dplyr::mutate(wqTidy,
            DATE = lubridate::as_date(`Date Collected`),
            MONTH = lubridate::month(DATE, label = T, abbr = T),
            YEAR = lubridate::year(DATE)) %>%
 select(-c("Date Collected"))
```

2.12.4.3 Standardize DEPTH Information

Add DEPTHM and DEPTHTYPE columns. First coerce depth values to numeric data (drops all non-numeric entries, N = 39).

```
wqTidy <- wqTidy %>%
  dplyr::rename(DEPTHM = depth_m) %>%
  dplyr::mutate(DEPTHM = as.numeric(DEPTHM)) %>%
  dplyr::mutate(DEPTHTYPE = NA_character_) %>%
  dplyr::mutate(secchi_m = as.numeric(secchi_m))

tooDeep <- sum(wqTidy$DEPTHM >= 4.4, na.rm = T)

wqTidy <- wqTidy %>% dplyr::filter(DEPTHM < 4.4)

shallowSecchi <- sum(wqTidy$DEPTHM > (2* wqTidy$secchi_m), na.rm = T)

wqTidy <- wqTidy %>% dplyr::filter(DEPTHM < 2 * secchi_m)
```

We also remove all records greater than 4.4 m depth (N = 154) and then and greater than 2x sechhi depth (N = 452) per Bray Curtis instructions to match other data prep .

2.12.4.4 Standardize STATION Information

Add STATION, STATIONID, LAKEUNIT, and LOCATE columns.

```
wqTidy <- wqTidy %>%
  dplyr::mutate(STATIONID = Site,
         STATION = Site)

assertthat::assert_that(all(wqTidy$STATIONID %in% names(lakeUnitList)), msg = "Some station names i
n file are not found in the LAKEUNIT assignment list.")

## [1] TRUE

wqTidy <- assignLAKEUNIT(df = wqTidy, siteNameColumn = "STATIONID", lakeUnitList = lakeUnitList)

assertthat::assert_that(all(wqTidy$STATIONID %in% names(locateList)), msg = "Some station names in f
ile are not found in the LOCATE assignment list.")

## [1] TRUE

wqTidy <- assignLOCATE(df = wqTidy, siteNameColumn = "STATIONID", locateList = locateList)
```

2.12.4.5 Standardize VARIABLE Information

Add VARIABLE, VARTYPE, MEASUNIT and VARLABEL columns.

The variable is assigned as Total Organic Carbon and the units are assumed to be “mg/L” based on comparison of range to other data. PENDING REVIEW.

```
table(wqTidy$Units)

## < table of extent 0 >

wqTidy <- wqTidy %>%
  dplyr::mutate(MEASUNIT = "mg/L",
         VARIABLE = "Total Organic Carbon",
```

```
           VARLABEL = paste(VARIABLE, ",", MEASUNIT),
           VARTYPE = SampleType) %>%
  # Order columns
  dplyr::select(SOURCE,
           SOURCEID,
           SOURCETYPE,
           DATE,
           STATIONID,
           STATION,
           DEPTHM,
           DEPTHTYPE,
           VARIABLE,
           VARTYPE,
           VARLABEL,
           VALUE,
           MEASUNIT,
           MONTH,
           YEAR,
           LAKEUNIT,
           LOCATE)
```

2.12.5 Combine and Export Tidy Data

These data are saved as both **extraToc_data.rds** (with copy saved also to Excel) and as **extraToc_toc.rds** (to conform to the standard convention of complete data set plus variable specific dataset, even though these data have only one variable).

```
tidy <- rbind(corTidy, unTidy, wqTidy)

# all sites all data
# saveRDS(tidy, here::here("Data/Tidy/dataPrep", "extraToc_data.rds"))
# openxlsx::write.xlsx(tidy, file = here::here("Data/Tidy/dataPrep/Excel", "extraToc_data.xlsx"), overwrite
= TRUE)
readr::write_csv(tidy, here::here("Data/Tidy/AppendixC", "extraToc_data.csv"))

# saveRDS(tidy, here::here("Data/Tidy/dataPrep", "extraToc_toc.rds"))
readr::write_csv(tidy, here::here("Data/Tidy/AppendixC", "extraToc_toc.csv"))
```

Code created by KDV Decision Analysis LLC and last run 2024-08-29 with R version 4.4.1 (2024-06-14 ucrt).

2.13 Falls Lake Raleigh PUD 2013 to 2018 (ralpud)

2.13.1 Important Notice

These Raleigh PUD data were provided by E. Buchan from City of Raleigh. After tidying and summarizing them, we realized they partially overlap with the older “Raleigh toxin” data set we received from UNRBA (source = **raltoxin**). The Raleigh Toxin data contain monthly Anatoxin-a, Cylindrospermopsin, and Microcystin data for the years 2016, 2017, and 2018. These PUD data contain samples from the same stations for 2017 and 2016, but the 2016 anatoxin-a data are missing.

2.13.2 Read in Raw Data

Read in data, skip big photo row. Read in each data set, both sheets from 'Falls Lake 01-2018–10-2018' and 'Falls Lake 2013-17'. Note that dates on file name and tabs do not always match file contents.

```
path18 <- here::here(rawFile18)
path13 <- here::here(rawFile13)

# 2018 data on first sheet
raw_2018 <- openxlsx::read.xlsx(path18, startRow = 4, sheet = 1)
# 2013-2017 data on second sheet
raw_Pre2018 <- openxlsx::read.xlsx(path18, startRow = 4, sheet = 2)
# 2013-2017 data in separate file
raw_Sep <- openxlsx::read.xlsx(path13, startRow = 4)
```

Checking for overlap between each file. With the code below I confirm that the file titled 'Falls Lake 2013-17' is identical to the second sheet within the file titled 'Falls Lake 01-2018–10-2018'. I also confirm that there is no overlap of dates between the 2013-2017 and 2018 data sets.

```
# Check to make sure entire DFs overlap for both sets of 2013-2017 data
NROW(inner_join(raw_Pre2018, raw_Sep)) == NROW(raw_Pre2018)

## [1] TRUE

NROW(inner_join(raw_Pre2018, raw_Sep)) == NROW(raw_Sep)

## [1] TRUE

# No identical rows within the 2018 data and 2013-17 data.
NROW(inner_join(raw_2018, raw_Sep))

## [1] 0

# Confirm that there are no shared dates AND all dates within the 2013-2017 set
# occur before the first date within the 2018 set
raw_Pre2018 <- dplyr::mutate(raw_Pre2018, Date.Collected = as_date(Date.Collected,
                                           origin = "1899-12-30")) %>%
  arrange(Date.Collected)

raw_2018 <- dplyr::mutate(raw_2018, Date.Collected = as_date(Date.Collected,
                                           origin = "1899-12-30")) %>%
  arrange(Date.Collected)

any(raw_Pre2018$Date.Collected %in% raw_2018$Date.Collected)

## [1] FALSE

raw_Pre2018[NROW(raw_Pre2018),]$Date.Collected < raw_2018[1,]$Date.Collected
```

```
## [1] TRUE
```

Combine the 2013-2017 and 2018 data sets.

```
rawData <- rbind(raw_Pre2018, raw_2018)

rm(raw_Pre2018, raw_2018, raw_Sep, path18, path13)

head(rawData)

##         Parameter            Site Date.Collected Result      Units Sample.Type
## 1      Alkalinity Honeycutt Creek     2013-01-29   33.8       mg/L        Grab
## 2        Chloride Honeycutt Creek     2013-01-29   9.05       mg/L        Grab
## 3         E. coli Honeycutt Creek     2013-01-29     11 MPN/100mL        Grab
## 4 Total coliform Honeycutt Creek      2013-01-29    225 MPN/100mL        Grab
## 5    Conductivity Honeycutt Creek     2013-01-29  119.2   umhos/cm        Grab
## 6              DO Honeycutt Creek     2013-01-29  12.14       mg/L        Grab
##          Method
## 1      SM 2320B
## 2     EPA 300.0
## 3 SM 19th 9223B
## 4 SM 19th 9223B
## 5      SM 2510B
## 6    SM 4500 O G
```

2.13.3 Reduce Parameter Set

These data contain many more variables than we use for our project.

```
table(rawData$Parameter)

## 
##          Alkalinity            Aluminum             Ammonia 
##                 579                 148                 296 
##          Anatoxin-a            Antimony             Arsenic 
##                 109                 380                 380 
##              Barium             Benzene           Beryllium 
##                 144                 109                 380 
##             Cadmium            Chloride       Chlorophyll a 
##                 380                 359                 126 
##            Chromium              Cobalt        Conductivity 
##                 380                 380                 401 
##              Copper  Cylindrospermopsin                  DO 
##                 380                 109                 594 
##                 DOC             E. coli        Enterococcus 
##                 414                 414                 414 
##        Ethylbenzene            Fluoride             Geosmin 
##                 108                 366                  11 
##                Iron                Lead           Manganese 
```

```
##              614              380              599
##          Mercury methyl tert butyl ether                MIB
##              186               97               11
##          Microcystin          Molybdenum           Nickel
##              109              380              380
##            Nitrate            Nitrite              ORP
##              341              351              451
##               pH            Selenium           Silica
##              595              380              371
##           Sliver            Sulfate        Temperature
##              380              354              597
##          Thallium              TKN              TOC
##              380              366              595
##           Toluene       Total coliform    Total Phosphorus
##              108              414              367
##         Turbidity            UV254          Vanadium
##              590              414              378
##      Xylenes (Total)             Zinc
##              108              379
```

```
chooseVar <- c("Ammonia", "Anatoxin-a", "Chlorophyll a", "Conductivity", "Cylindrospermopsin", "DO",
"DOC", "Geosmin", "Manganese", "Microcystin", "Nitrate", "Nitrite", "pH", "Temperature", "TKN", "TOC"
, "Total Phosphorus", "Turbidity")

rawData <- rawData %>%
  dplyr::filter(Parameter %in% chooseVar)
```

We remove the parameters we will not use, keeping only: Ammonia, Anatoxin-a, Chlorophyll a, Conductivity, Cylindrospermopsin, DO, DOC, Geosmin, Manganese, Microcystin, Nitrate, Nitrite, pH, Temperature, TKN, TOC, Total Phosphorus, and Turbidity

2.13.4 Standardize the Data Structure

Beginning exploration of Site locations.

We determined upper/middle/lower (relating to Highways 98 and 50) for these by searching for the location on Google maps.

- Middle: US Hwy 98
- Lower: Intake (Surface, 223, 233, and 243), Honeycutt Creek, Upper Barton Creek, Lower Barton Creek, New Light Creek

Details of these intake locations are considered sensitive and are in the **FallsLakeIntake.pdf** received from Alix via email 2022-05-09 and placed in the toxin data folder.

2.13.4.1 Add LAKEUNIT

```
# Make sure all names in the lookup list source_setupDictionaries
all(rawData$Site %in% names(lakeUnitList))

## [1] TRUE
```

```
lakeDf <- assignLAKEUNIT(df = rawData, siteNameColumn = "Site", lakeUnitList = lakeUnitList)
```

2.13.4.2 Add SOURCE, MONTH, YEAR

Rename a few columns and establish the *MONTH*, *YEAR*, and *SOURCEID* columns.

```
lakeDf <- rename(lakeDf, DATE = Date.Collected, MEASUNIT = Units) %>%
  dplyr::mutate(MONTH = month(DATE, label = TRUE, abbr = TRUE),
                YEAR = year(DATE),
                SOURCE = "ralpud",
                SOURCEID = paste0(Parameter, "_", MEASUNIT, "_", str_remove_all(Site, " "), "_", DAT
E),
                SOURCETYPE = "Empirical")
```

2.13.4.3 Methods and Units

Thes data provide detailed methods notes. We checked if individual parameters had multiple measurements methods. Only manganese had more than one method: EPA 200.8 (mg/L) and SM 3111B (ppm). All other variables had one method and one measurement unit. All samples were surface grab samples.

```
table(lakeDf$Method, lakeDf$Parameter)

## 
##              Ammonia Anatoxin-a Chlorophyll a Conductivity Cylindrospermopsin
##   ELISA            0        109             0            0                109
##   EPA 200.8        0          0             0            0                  0
##   EPA 300.0        0          0             0            0                  0
##   EPA 350.1      296          0             0            0                  0
##   EPA 351.2        0          0             0            0                  0
##   EPA 365.3        0          0             0            0                  0
##   EPA 446.0        0          0           126            0                  0
##   SM 2130 B        0          0             0            0                  0
##   SM 2510B         0          0             0          401                  0
##   SM 2550          0          0             0            0                  0
##   SM 3111B         0          0             0            0                  0
##   SM 4500 HB       0          0             0            0                  0
##   SM 4500 O G      0          0             0            0                  0
##   SM 5310C         0          0             0            0                  0
##   SM 6040 D        0          0             0            0                  0
## 
##               DO DOC Geosmin Manganese Microcystin Nitrate Nitrite  pH
##   ELISA        0   0       0         0         109       0       0   0
##   EPA 200.8    0   0       0       362           0       0       0   0
##   EPA 300.0    0   0       0         0           0     341     351   0
##   EPA 350.1    0   0       0         0           0       0       0   0
##   EPA 351.2    0   0       0         0           0       0       0   0
##   EPA 365.3    0   0       0         0           0       0       0   0
##   EPA 446.0    0   0       0         0           0       0       0   0
##   SM 2130 B    0   0       0         0           0       0       0   0
```

```
## SM 2510B     0   0     0       0         0      0      0   0
## SM 2550      0   0     0       0         0      0      0   0
## SM 3111B     0   0     0     237         0      0      0   0
## SM 4500 HB   0   0     0       0         0      0      0 595
## SM 4500 O G 594  0     0       0         0      0      0   0
## SM 5310C     0 414     0       0         0      0      0   0
## SM 6040 D    0   0    11       0         0      0      0   0
##
##           Temperature TKN TOC Total Phosphorus Turbidity
## ELISA               0   0   0                0         0
## EPA 200.8           0   0   0                0         0
## EPA 300.0           0   0   0                0         0
## EPA 350.1           0   0   0                0         0
## EPA 351.2           0 366   0                0         0
## EPA 365.3           0   0   0              367         0
## EPA 446.0           0   0   0                0         0
## SM 2130 B           0   0   0                0       590
## SM 2510B            0   0   0                0         0
## SM 2550           597   0   0                0         0
## SM 3111B            0   0   0                0         0
## SM 4500 HB          0   0   0                0         0
## SM 4500 O G         0   0   0                0         0
## SM 5310C            0   0 595                0         0
## SM 6040 D           0   0   0                0         0
```

```
table(lakeDf$MEASUNIT, lakeDf$Parameter)
```

```
##
##           Ammonia Anatoxin-a Chlorophyll a Conductivity Cylindrospermopsin  DO
## °C              0          0             0            0                  0   0
## C               0          0             0            0                  0   0
## mg/L          296          0             0            0                  0 594
## ng/L            0          0             0            0                  0   0
## NTU             0          0             0            0                  0   0
## pH              0          0             0            0                  0   0
## ph Units        0          0             0            0                  0   0
## ppm             0          0             0            0                  0   0
## ug/L            0        109           126            0                109   0
## umhos/cm        0          0             0          401                  0   0
##
##           DOC Geosmin Manganese Microcystin Nitrate Nitrite  pH Temperature
## °C          0       0         0           0       0       0   0         591
## C           0       0         0           0       0       0   0           6
## mg/L      414       0       363           0     341     351   0           0
## ng/L        0      11         0           0       0       0   0           0
```

```
##   NTU        0     0      0        0     0     0  0        0
##   pH         0     0      0        0     0     0  6        0
##   ph Units   0     0      0        0     0     0 589       0
##   ppm        0     0    236        0     0     0  0        0
##   ug/L       0     0      0      109     0     0  0        0
##   umhos/cm   0     0      0        0     0     0  0        0
##
##            TKN TOC Total Phosphorus Turbidity
##   °C         0   0                0         0
##   C          0   0                0         0
##   mg/L     366 595              367         0
##   ng/L       0   0                0         0
##   NTU        0   0                0       590
##   pH         0   0                0         0
##   ph Units   0   0                0         0
##   ppm        0   0                0         0
##   ug/L       0   0                0         0
##   umhos/cm   0   0                0         0
```

```
table(lakeDf$Sample.Type)
```

```
##
## Grab
## 6558
```

2.13.5 Define and Apply Detection limits

However, sometimes the data had measured values lower than these detection limits, so I assume a different lab or method may have been used to prepare these data. For the purposes of this data analysis, I used the lower of two values to replace “non detect values”.

- half of the lower limit referenced in City of Raleigh table
- half of the minimum value reported in the measured data

2.13.5.1 Limit Lookup Table

Rows with character values in the Result column indicating no data or invalid data were deleted. These included: * ‘x’- unknown, treated as no sample * ‘out of hold’ - interpreted as data collected, but past valid date for analysis, therefore invalid data * ‘no data’ - interpreted as no data collected * ‘NO SAMPLE’ - interpreted as no data collected * ‘na’- interpreted as no data collected

```
lakeDf <- dplyr::filter(lakeDf, !Result %in% c("x", "out of hold", "no data", "NO SAMPLE", "na")) # remove
s ~200 rows
```

Several toxin data were recorded as ND, indicating measures below detection. We have detection limit data for these toxins at this lab, but some of the empirical data have lower limits. We replaced “ND” entries with half of the detection limits. We also saved a summary of the observed mniimum and maximum values in these data as **ralpud_detectionlimits.xlsx**

```
anaRange <- range(as.numeric(lakeDf$Result[lakeDf$Parameter == "Anatoxin-a" & lakeDf$Result != "ND
"]))
micRange <- range(as.numeric(lakeDf$Result[lakeDf$Parameter == "Microcystin" & lakeDf$Result != "N
```

```
D"]))
cylRange <- range(as.numeric(lakeDf$Result[lakeDf$Parameter == "Cylindrospermopsin" & lakeDf$Resul
t != "ND"]))


ndValues <- data.frame(Toxin = c("Anatoxin-a", "Cylindrospermopsin", "Microcystin"),
                       LowLimit = c(0.15, 0.01, 0.3),
                       UppLimit = c(5.0, 2.0, 5.0),
                       DataMin = c(anaRange[1], cylRange[1], micRange[1]))

ndValues <- dplyr::mutate(ndValues, ND = pmin(LowLimit/2, DataMin/2))
#openxlsx::write.xlsx(ndValues, here::here("Data/Tidy/dataPrep/Excel", "ralpud_detectionlimits.xlsx"), o
verwrite = TRUE)
```

Rows with values indicated measurements below detection (with < symbol) were converted to half their value. Values entered as “ND”, assumed to mean non-detect, were converted to whichever was lower: half the minimum observed value or

```
replaceNDs <- function(x){
 out <- x
 # Lower detection limit
 if(grepl("<", x)){
  out <- str_remove(x, "<") %>%
   as.numeric()*0.5
  # Upper detection limit
 } else if(grepl(">", x)){
  out <- str_remove(x, ">") %>%
   as.numeric()*1.5
  # This will likely need to change - yes - because can't apply a blanket limit, each param is different
  # Use 0 for now bc we know that is not a valid measurement
 }else if(x == "ND"){
 out <- 0
  # Deal with NAs
 } else {
  # Attempt to convert to numeric, if it throws a warning print what it's trying to
  # convert
  tryCatch(
   {
    out <- as.numeric(x)
   },
   warning = function(w){
    print(x)
   }
  )

  out <- as.numeric(x)
```

```
  }
  return(out)
}

lakeDf <- dplyr::mutate(lakeDf, Result = vapply(Result, replaceNDs, numeric(1), USE.NAMES = FALSE))

# Apply any defined detection limits where 0 was used as a placeholder

for (i in seq(ndValues$Toxin)){
  lakeDf <- lakeDf %>%
    dplyr::mutate(Result = if_else(Parameter == ndValues$Toxin[i] & near(Result, 0), ndValues$ND[i], R
esult ))
}
```

2.13.6 Standarize names for parameters and units

Parameter changes:

- “Ammonia” becoems “Ammonia Nitrogen”
- “DO” becomes “Dissolved Oxygen”
- “DOC” becomes “Dissolved Organic Carbon”
- “TKN” becomes “Kjeldahl Nitrogen”
- “TOC” becomes “Total Organic Carbon”
- “Chlorophyll a” becomes “Chlorophyll-a”
- “Temperature” becomes “Water Temperature”

Measurement unit changes:

- “ph Units” becomes “pH”
- “°C” becomes “C”
- converting ppm to mg/L

```
lakeDf <- lakeDf %>%
  dplyr::mutate(Parameter = if_else(Parameter == "DO", "Dissolved Oxygen", Parameter),
                Parameter = if_else(Parameter == "DOC", "Dissolved Organic Carbon", Parameter),
                Parameter = if_else(Parameter == "TOC", "Total Organic Carbon", Parameter),
                Parameter = if_else(Parameter == "TKN", "Kjeldahl Nitrogen", Parameter),
                Parameter = if_else(Parameter == "Chlorophyll a", "Chlorophyll-a", Parameter),
                Parameter = if_else(Parameter == "Temperature", "Water Temperature", Parameter),
                Parameter = if_else(Parameter == "Ammonia", "Ammonia Nitrogen", Parameter),
                MEASUNIT = if_else(MEASUNIT == "°C", "C", MEASUNIT),
                MEASUNIT = if_else(MEASUNIT == "ph Units", "pH", MEASUNIT),
                MEASUNIT = if_else(MEASUNIT == "ppm", "mg/L", MEASUNIT),
                VARLABEL = paste0(Parameter, ", ", MEASUNIT),
```

```
                    VARTYPE = Method,
                    VALUE = Result) %>%
  dplyr::rename(VARIABLE = Parameter)
```

2.13.7 Add LOCATE

Below we create the LOCATE column (based on work in the **dataPrep_raltoxin.Rmd**) to specify whether the site is on an arm or the main body of the lake. After that we add the following variables:

- STATION
- STATIONID
- DEPTHM
- DEPTHTYPE

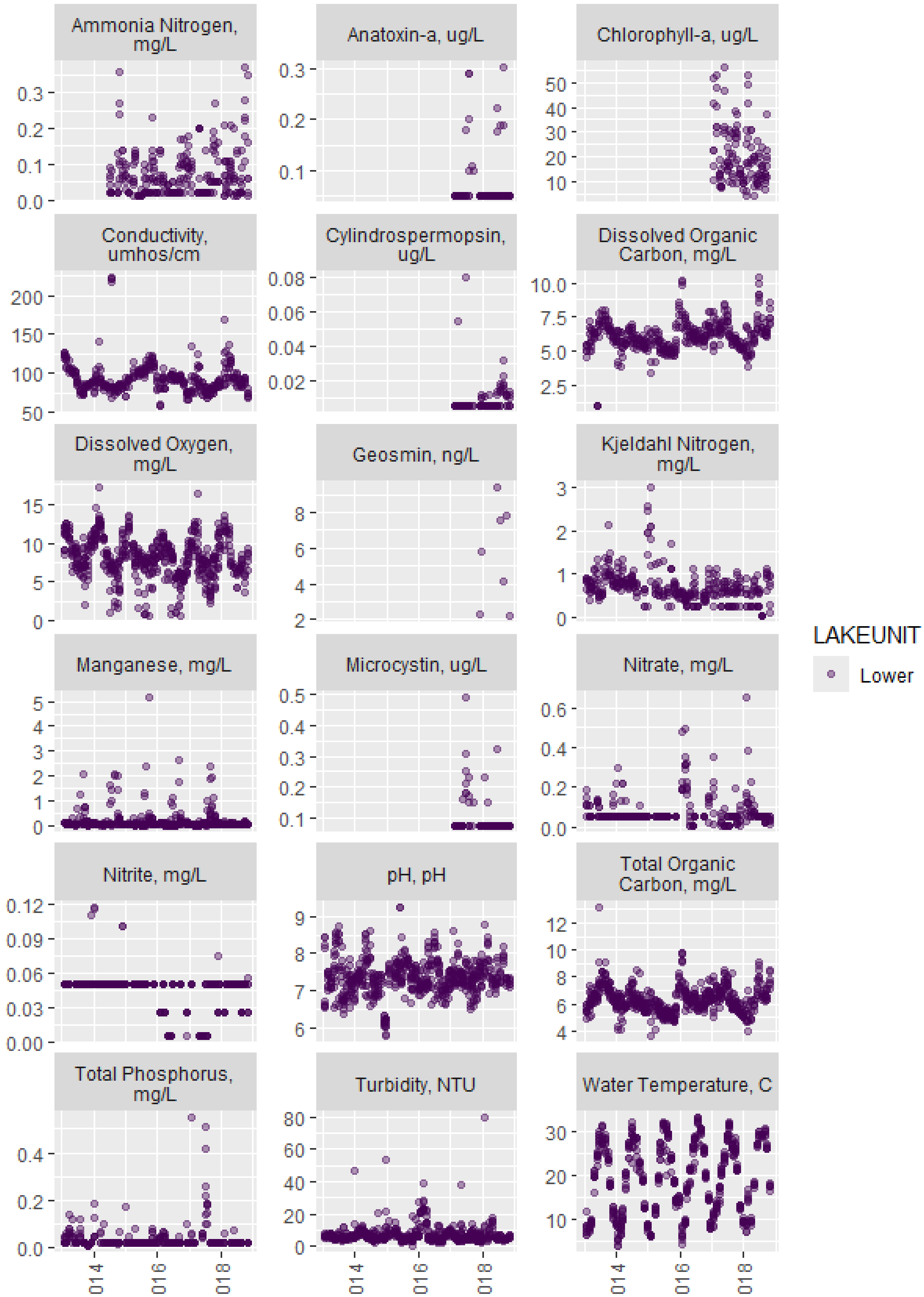
We also rename other variables here to maintain the established data structure.

One date at Site = Intake has no Sample.Type, but all others "Grab", so enter "Grab". This becomes the DEPTHTYPE.

```
# Create the LOCATE column
lakeDf <- assignLOCATE(df = lakeDf, siteNameColumn = "Site", locateList = locateList)

# unique(lakeDf$Site) # check if these are the desired station names

# Create STATION, rename existing variables and add new variables to conformt to
# existing data structure
lakeDf <- lakeDf %>%
  dplyr::rename(STATION = Site,
                    DEPTHTYPE = Sample.Type) %>%
  dplyr::mutate(STATIONID = STATION,
                    DEPTHM = NA_real_,
                    DEPTHTYPE = "Grab")

# Reorder data.frame
lakeDf <- dplyr::select(lakeDf, SOURCE, SOURCEID, SOURCETYPE, DATE, STATIONID, STATION, DEPTHM,
DEPTHTYPE, VARIABLE, VALUE, VARTYPE, VARLABEL, MEASUNIT, YEAR, MONTH, LAKEUNIT, LOCATE)
```

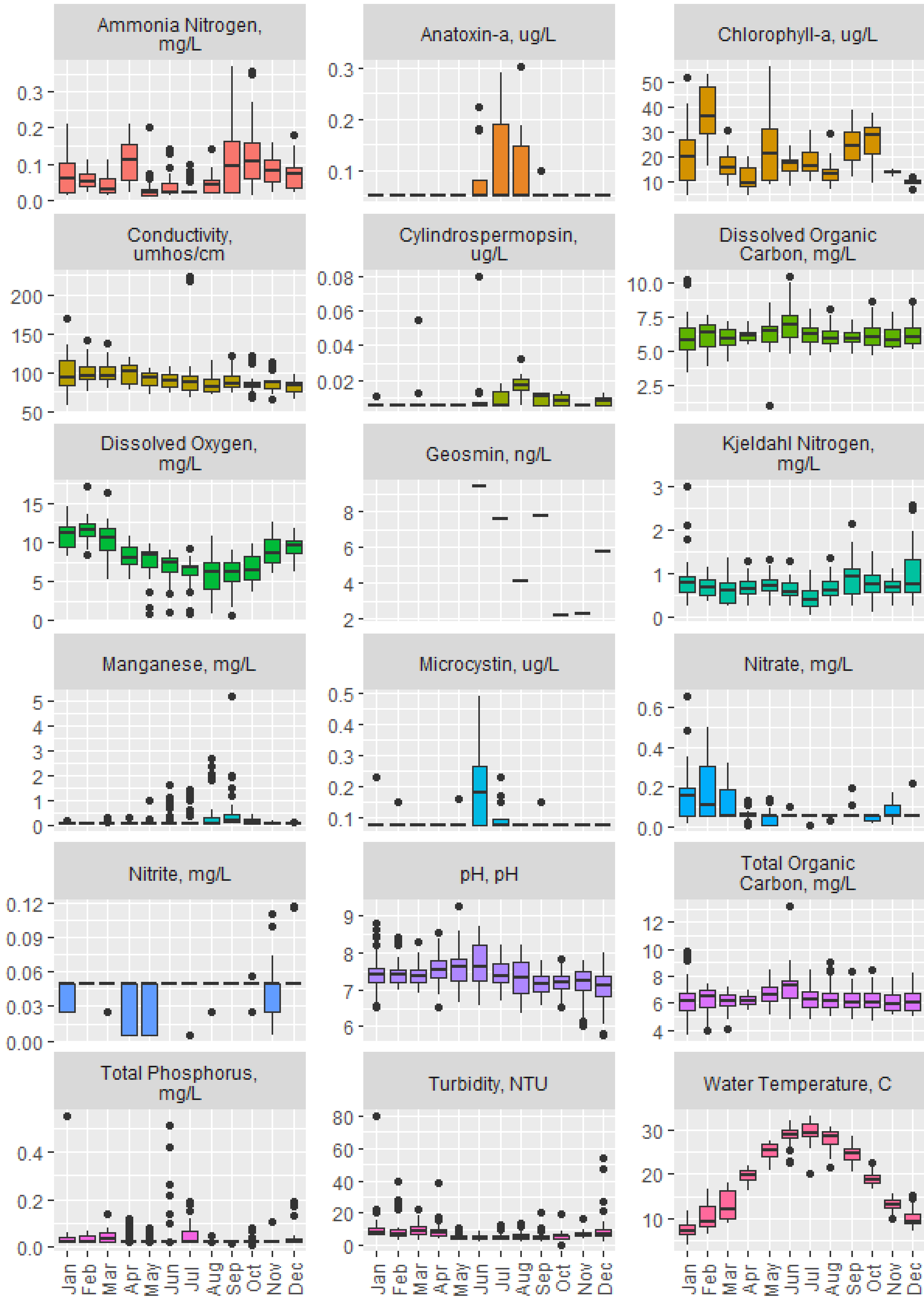
2.13.8 Quick Data Inspection

```
byDate <- ggplot() +
  geom_point(data = lakeDf, aes(x = DATE, y = VALUE, color = LAKEUNIT, group = str_wrap(VARLABEL, 2
0)), alpha = 0.4) +
  labs(x = "", y = "") +
  facet_wrap(~str_wrap(VARLABEL, 20), scales = "free_y", ncol = 3) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byDate
```

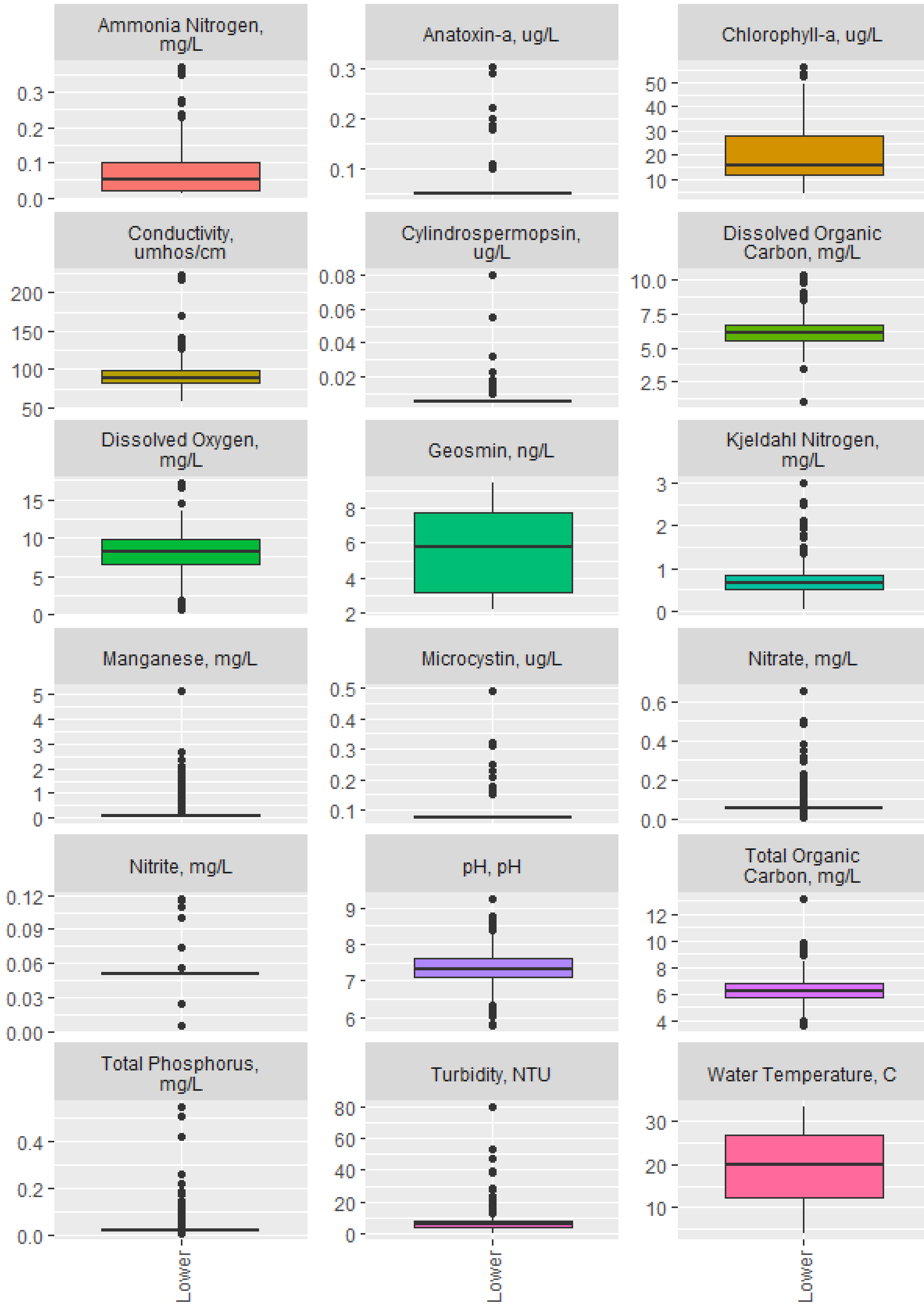


Ammonia Nitrogen, mg/L
Anatoxin-a, ug/L
Chlorophyll-a, ug/L
Conductivity, umhos/cm
Cylindrospermopsin, ug/L
Dissolved Organic Carbon, mg/L
Dissolved Oxygen, mg/L
Geosmin, ng/L
Kjeldahl Nitrogen, mg/L
Manganese, mg/L
Microcystin, ug/L
Nitrate, mg/L
Nitrite, mg/L
pH, pH
Total Organic Carbon, mg/L
Total Phosphorus, mg/L
Turbidity, NTU
Water Temperature, C
2014
2016
2018
LAKEUNIT
Lower

```
#ggsave(plot = byDate, filename = here::here("Data/Tidy/dataPrep/Figures", "ralpud_byDate.png"), widt
h = 6.5, height = 8)

byMonth<- ggplot() +
  geom_boxplot(data = lakeDf, aes(x = MONTH, y = VALUE, fill = str_wrap(VARLABEL, 20)), show.legend
= F) +
  labs(x = "", y = "") +
  facet_wrap(~str_wrap(VARLABEL, 20), scales = "free_y", ncol = 3) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byMonth
```


Ammonia Nitrogen, mg/L
Anatoxin-a, ug/L
Chlorophyll-a, ug/L
Conductivity, umhos/cm
Cylindrospermopsin, ug/L
Dissolved Organic Carbon, mg/L
Dissolved Oxygen, mg/L
Geosmin, ng/L
Kjeldahl Nitrogen, mg/L
Manganese, mg/L
Microcystin, ug/L
Nitrate, mg/L
Nitrite, mg/L
pH, pH
Total Organic Carbon, mg/L
Total Phosphorus, mg/L
Turbidity, NTU
Water Temperature, C
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

```
#ggsave(plot = byMonth, filename = here::here("Data/Tidy/dataPrep/Figures", "ralpud_byMonth.png"), width = 6.5, height = 8)

byLakeunit<- ggplot() +
  geom_boxplot(data = lakeDf, aes(x = LAKEUNIT, y = VALUE, fill = str_wrap(VARLABEL, 20)), show.legend = F) +
  labs(x = "", y = "") +
  facet_wrap(~str_wrap(VARLABEL, 20), scales = "free_y", ncol = 3) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5))
byLakeunit
```



Ammonia Nitrogen, mg/L
Anatoxin-a, ug/L
Chlorophyll-a, ug/L
Conductivity, umhos/cm
Cylindrospermopsin, ug/L
Dissolved Organic Carbon, mg/L
Dissolved Oxygen, mg/L
Geosmin, ng/L
Kjeldahl Nitrogen, mg/L
Manganese, mg/L
Microcystin, ug/L
Nitrate, mg/L
Nitrite, mg/L
pH, pH
Total Organic Carbon, mg/L
Total Phosphorus, mg/L
Turbidity, NTU
Water Temperature, C
Lower
Lower
Lower

```
#ggsave(plot = byLakeunit, filename = here::here("Data/Tidy/dataPrep/Figures", "ralpud_byLakeunit.png
"), width = 6.5, height = 8)
```

2.13.9 Export Tidy Data

We export the full tidy data resource (**ralpud_data.rds**) plus one file per variable (e.g. **ralpud_ana.rds**). Variables currently exported:

- Anatoxin-a
- Cylindrospermopsin
- Microcystin
- Water Temperature
- Manganese
- Chlorophyll-a
- Dissolved Oxygen
- Dissolved Organic Carbon
- Total Organic Carbon
- pH
- Conductivity
- Nitrite
- Nitrate
- Kjeldahl Nitrogen
- Turbidity
- Total Phosphorus
- Geosmin

Exported variable data are next handled by the **dataMerge** series of Markdown files where information from multiple sources are assembled into one file per variable.

```
# All data from this resource:
# saveRDS(lakeDf, here::here("Data/Tidy/dataPrep", "ralpud_data.rds"))
# openxlsx::write.xlsx(lakeDf, file = here::here("Data/Tidy/dataPrep/Excel", "ralpud_data.xlsx"))
readr::write_csv(lakeDf, here::here("Data/Tidy/AppendixC", "ralpud_data.csv"))

# Toxins only measures 2017 & 2018; not measures at
# numbered depth intakes (only at surface intake)

# Anatoxin-a data
anatot <- lakeDf %>%
  dplyr::filter(VARIABLE == "Anatoxin-a")
# saveRDS(anatot, here::here("Data/Tidy/dataPrep", "ralpud_anatot.rds"))
```

```
readr::write_csv(anatot, here::here("Data/Tidy/AppendixC", "ralpud_anatot.csv"))
rm(anatot)

# Cylindrospermopsin Data
cyltot <- lakeDf %>%
  dplyr::filter(VARIABLE == "Cylindrospermopsin")
# saveRDS(cyltot, here::here("Data/Tidy/dataPrep", "ralpud_cyltot.rds"))
readr::write_csv(cyltot, here::here("Data/Tidy/AppendixC", "ralpud_cyltot.csv"))
rm(cyltot)

# Microcystin Data
mictot <- lakeDf %>%
  dplyr::filter(VARIABLE == "Microcystin")
# saveRDS(mictot, here::here("Data/Tidy/dataPrep", "ralpud_mictot.rds"))
readr::write_csv(mictot, here::here("Data/Tidy/AppendixC", "ralpud_mictot.csv"))
rm(mictot)

# Chlorophyll-a Data
chla <- lakeDf %>%
  dplyr::filter(VARIABLE == "Chlorophyll-a")
# saveRDS(chla, here::here("Data/Tidy/dataPrep", "ralpud_chla.rds"))
readr::write_csv(chla, here::here("Data/Tidy/AppendixC", "ralpud_chla.csv"))
rm(chla)

# Water Temperature Data
wtemp <- lakeDf %>%
  dplyr::filter(VARIABLE == "Water Temperature")
# saveRDS(wtemp, here::here("Data/Tidy/dataPrep", "ralpud_wtemp.rds"))
readr::write_csv(wtemp, here::here("Data/Tidy/AppendixC", "ralpud_wtemp.csv"))
rm(wtemp)

# Manganese
mang <- lakeDf %>%
  dplyr::filter(VARIABLE == "Manganese")
# saveRDS(mang, here::here("Data/Tidy/dataPrep", "ralpud_mang.rds"))
readr::write_csv(mang, here::here("Data/Tidy/AppendixC", "ralpud_mang.csv"))
rm(mang)

# Dissolved Oxygen
do <- lakeDf %>%
  dplyr::filter(VARIABLE == "Dissolved Oxygen")
# saveRDS(do, here::here("Data/Tidy/dataPrep", "ralpud_do.rds"))
readr::write_csv(do, here::here("Data/Tidy/AppendixC", "ralpud_do.csv"))
rm(do)
```

```
# Geosmin
geosmin <- lakeDf %>%
  dplyr::filter(VARIABLE == "Geosmin")
# saveRDS(geosmin, here::here("Data/Tidy/dataPrep", "ralpud_geosmin.rds"))
readr::write_csv(geosmin, here::here("Data/Tidy/AppendixC", "ralpud_geosmin.csv"))
rm(geosmin)

# pH
ph <- lakeDf %>%
  dplyr::filter(VARIABLE == "pH")
# saveRDS(ph, here::here("Data/Tidy/dataPrep", "ralpud_ph.rds"))
readr::write_csv(ph, here::here("Data/Tidy/AppendixC", "ralpud_ph.csv"))
rm(ph)

# Turbidity
turbid <- lakeDf %>%
  dplyr::filter(VARIABLE == "Turbidity")
# saveRDS(turbid, here::here("Data/Tidy/dataPrep", "ralpud_turbid.rds"))
readr::write_csv(turbid, here::here("Data/Tidy/AppendixC", "ralpud_turbid.csv"))
rm(turbid)

# Total Organic Carbon
toc <- lakeDf %>%
  dplyr::filter(VARIABLE == "Total Organic Carbon")
# saveRDS(toc, here::here("Data/Tidy/dataPrep", "ralpud_toc.rds"))
readr::write_csv(toc, here::here("Data/Tidy/AppendixC", "ralpud_toc.csv"))
rm(toc)

# Dissolved Organic Carbon
doc <- lakeDf %>%
  dplyr::filter(VARIABLE == "Dissolved Organic Carbon")
# saveRDS(doc, here::here("Data/Tidy/dataPrep", "ralpud_doc.rds"))
readr::write_csv(doc, here::here("Data/Tidy/AppendixC", "ralpud_doc.csv"))
rm(doc)

# Nitrate
nitrate <- lakeDf %>%
  dplyr::filter(VARIABLE == "Nitrate")
# saveRDS(nitrate, here::here("Data/Tidy/dataPrep", "ralpud_nitrate.rds"))
readr::write_csv(nitrate, here::here("Data/Tidy/AppendixC", "ralpud_nitrate.csv"))
rm(mitrate)

# Nitrite
```

```
nitrite <- lakeDf %>%
  dplyr::filter(VARIABLE == "Nitrite")
# saveRDS(nitrite, here::here("Data/Tidy/dataPrep", "ralpud_nitrite.rds"))
readr::write_csv(nitrite, here::here("Data/Tidy/AppendixC", "ralpud_nitrite.csv"))
rm(nitrite)

# Total Kjeldahl Nitrogen
nkeld <- lakeDf %>%
  dplyr::filter(VARIABLE == "Kjeldahl Nitrogen")
# saveRDS(nkeld, here::here("Data/Tidy/dataPrep", "ralpud_nkeld.rds"))
readr::write_csv(nkeld, here::here("Data/Tidy/AppendixC", "ralpud_nkeld.csv"))
rm(nkeld)

# Total Phosphorus
totalp <- lakeDf %>%
  dplyr::filter(VARIABLE == "Total Phosphorus")
# saveRDS(totalp, here::here("Data/Tidy/dataPrep", "ralpud_totalp.rds"))
readr::write_csv(totalp, here::here("Data/Tidy/AppendixC", "ralpud_totalp.csv"))
rm(phost)

# Ammonia
ammonia <- lakeDf %>%
  dplyr::filter(VARIABLE == "Ammonia Nitrogen")
# saveRDS(ammonia, here::here("Data/Tidy/dataPrep", "ralpud_ammonia.rds"))
readr::write_csv(ammonia, here::here("Data/Tidy/AppendixC", "ralpud_ammonia.csv"))
rm(ammonia)

# Conductivity
cond <- lakeDf %>%
  dplyr::filter(VARIABLE == "Conductivity")
# saveRDS(cond, here::here("Data/Tidy/dataPrep", "ralpud_cond.rds"))
readr::write_csv(cond, here::here("Data/Tidy/AppendixC", "ralpud_cond.csv"))
rm(cond)
```

Code authored by KDV Decision Analysis LLC and last run 2024-08-29 with R version 4.4.1 (2024-06-14 ucrt).

2.14 Prep of Precipitation Data (precip)

2.14.1Data Source

An annual analysis of precipitation in the Upper Neuse watershed was previously completed in R by Brown and Caldwell (Matt; 10/31/2021). That project summarized annual precipitation from 1990 through 2020. Data were pulled from NOAA's Global Historical Climatology Network for stations within the Upper Neuse River Basin. Also download the data from RDU. That project code and data were available as an R project with Markdown documentation (**Data/Raw/Precip/Original_PrecipPrep_RProj/NLDAS_mainScript.html**).

The precipitation data are in tenths of mm (https://www.ncei.noaa.gov/pub/data/ghcn/daily/readme.txt) and have been throroughly QAQCd by the data managers (https://www.ncei.noaa.gov/products/land-based-station/global-historical-climatology-network-daily).

I used the prepared data (daily precip) prepared prior to the summary to annual values as the starting point for our Bayesian analysis. These were available as R *.rds binary data files.

```
basinPrcp <- readRDS(here::here(rawBasin))
rduPrcp <- readRDS(here::here(rawRdu))

# combine the data
precip <- rbind(basinPrcp, rduPrcp)
```

2.14.2 Convert to Inches

To convert 10th mm values to inches, we divided by 10 and then by 25.4.

```
precip <- precip %>%
  dplyr::mutate(prcp = (prcp/10)/25.4)
```

2.14.3 Assign Source, Date, Julian Date, Month, Year

The source for these data is labelled: **precip.**

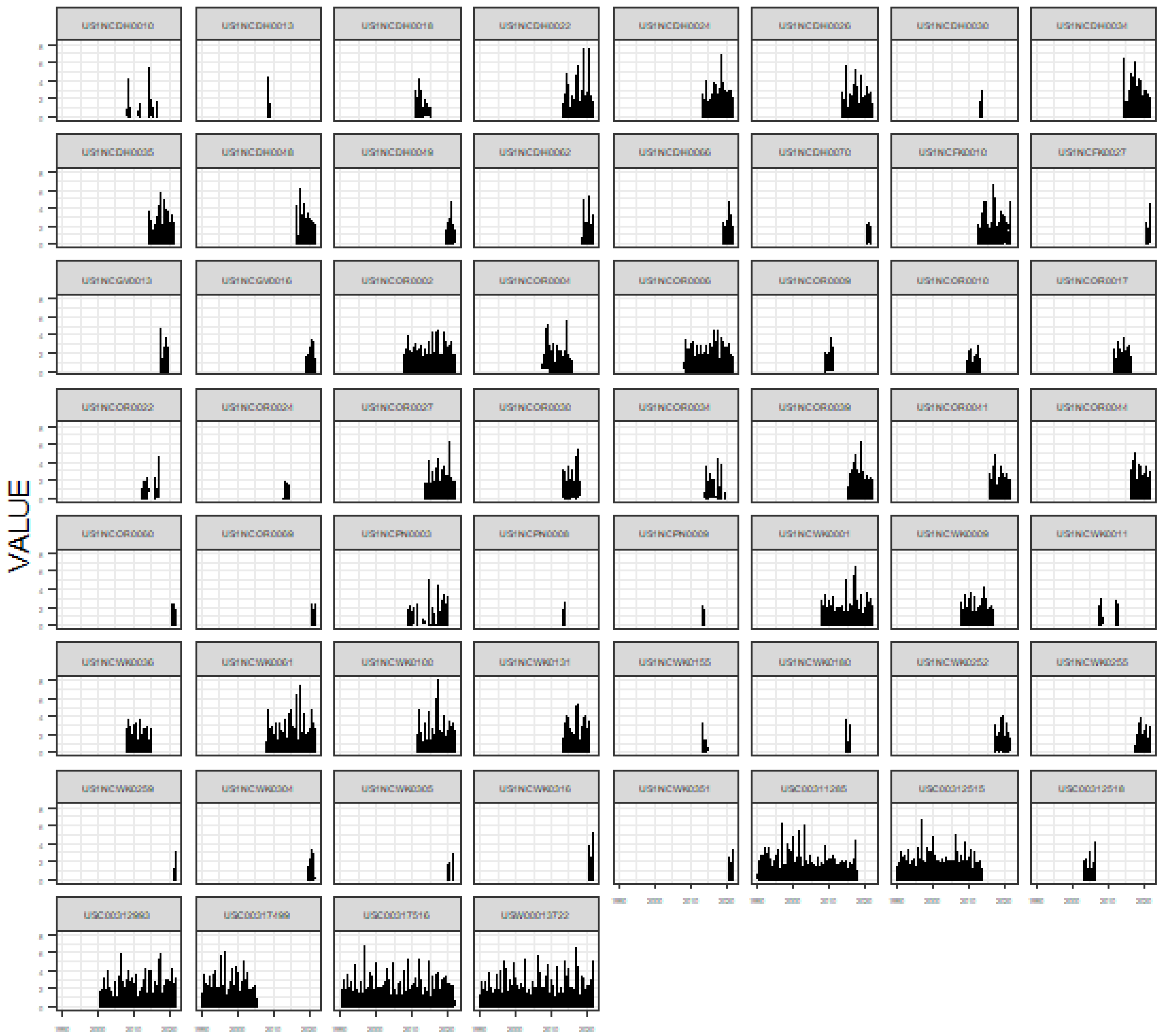
```
precip <- precip %>%
  dplyr::rename("DATE" = date,
                "VALUE" = prcp,
                "STATIONID" = id) %>%
  dplyr::mutate(SOURCE = "precip",
                JDATE = lubridate::yday(DATE),
                MONTH = lubridate::month(DATE, label = TRUE, abbr = TRUE),
                YEAR = lubridate::year(DATE))

# Check for missing values.
missing <- sum(is.na(precip$VALUE))
```

2.14.4 Check for Missing Data

Not all stations (60) have complete data; there are 22172 NA records.

Check for missingness via time series panel

```
byStation <- ggplot() +
   geom_line(data = precip, aes(x = DATE, y = VALUE)) +
   labs(x = "") +
   facet_wrap(~STATIONID) +
   theme_bw() +
   theme(strip.text = element_text(size = 4),
         axis.text = element_text(size = 3))
byStation
```



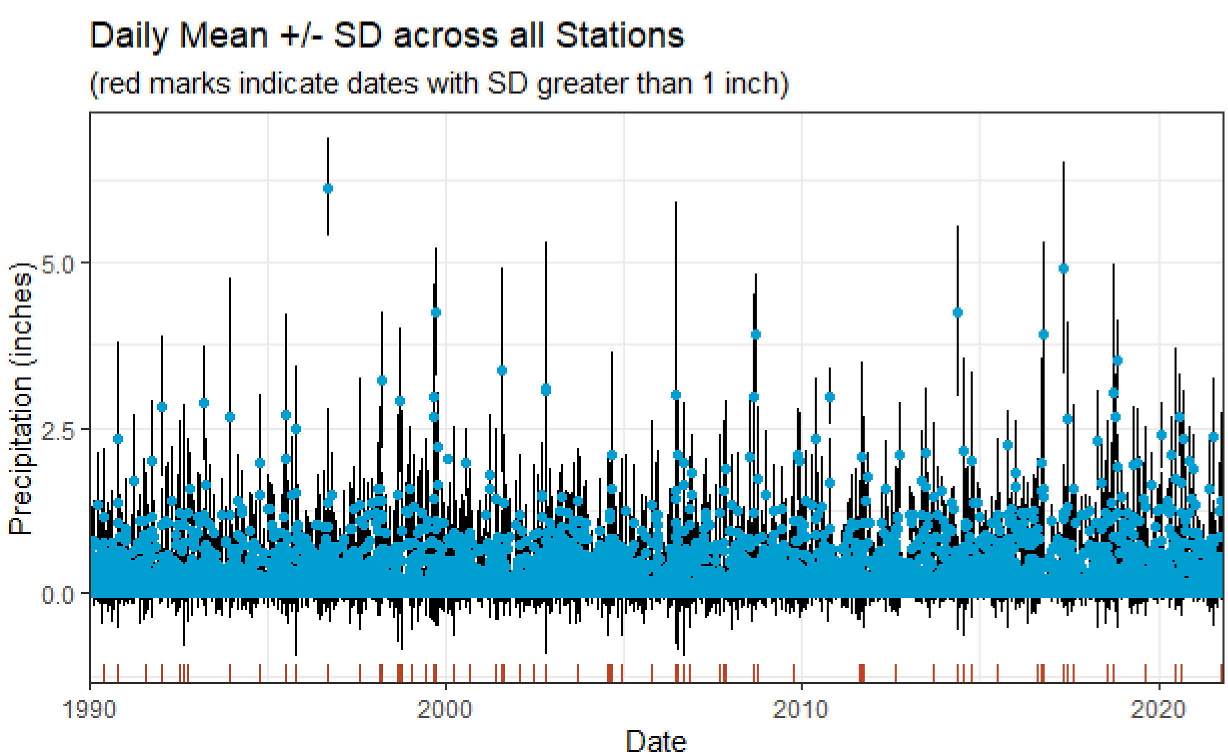

```
#ggsave(plot = byStation, filename = here::here("Data/Tidy/dataPrep/Figures", "precip_byStationTS.png
"), width = 6.5, height = 8)
```

There are 22172 missing data records, roughly 14.55% of the data. We will need to be careful not to apply sums or averages to incomplete months and years. A few missing records is potentially ok, but too many will bias the estimates. One option may be to interpolate across stations, if only one or two stations are missing data on any given day. However, there can be quite high variance among stations.

2.14.5Check Variance

```
# Check tally of measurements per  calendar day
precipTally <- precip %>%
 # dplyr::filter(VALUE > 0) %>%
  group_by(DATE) %>%
  dplyr::summarize(N = n(), # number of stations
              NMissing = sum(is.na(VALUE)),
```

```
            NZeros = sum(near(VALUE, 0)),
                     Mean = mean(VALUE, na.rm = TRUE),
                     SD = sd(VALUE, na.rm = TRUE),
                     .groups = "drop")

oneinchSD <- dplyr::filter(precipTally, SD > 1)
twoinchSD <- dplyr::filter(precipTally, SD > 2)
threeinchSD <- dplyr::filter(precipTally, SD > 3) # none

variance <- ggplot() +
 geom_segment(data = precipTally, aes(x = DATE, xend = DATE, y = Mean - SD, yend = Mean + SD), na.r
m = T) +
 geom_point(data = precipTally, aes(x = DATE, y = Mean), color = bc_colors[["BCBlue"]]) +
 geom_rug(data = oneinchSD, aes(x = DATE), color = bc_colors[["BCRed"]]) +
 scale_x_date(expand = c(0,0)) +
  labs(x = "Date", y = "Precipitation (inches)", title = "Daily Mean +/- SD across all Stations",
      subtitle = "(red marks indicate dates with SD greater than 1 inch)") +
  theme_bw()

variance
```




```
#ggsave(plot = variance, filename = here::here("Data/Tidy/dataPrep/Figures", "precip_variance.png"), w
idth = 6.5, height = 5)
```

The red rug plot indicates dates with variance greater than 1-inch rainfall (N = 82 dates). This is very high variance across the stations - but it is equally dispersed across all years, so not likely due to data entry errors.

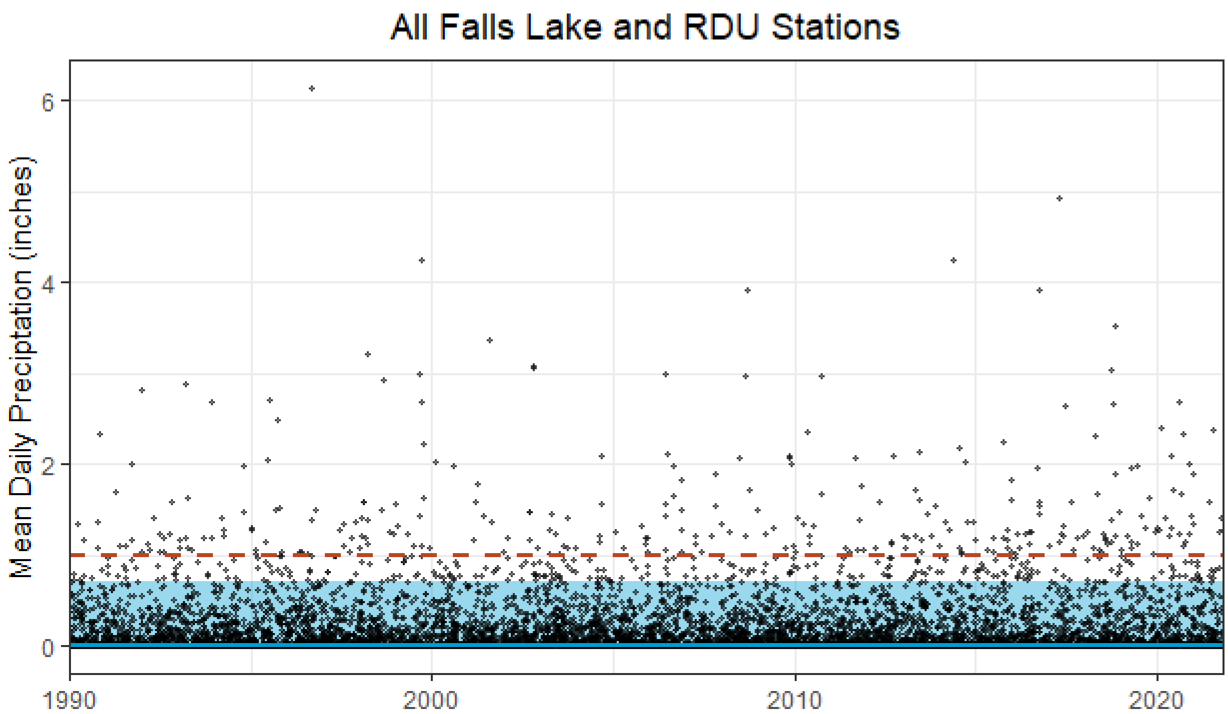
We chose to retain the daily average value (across all stations) for the precipitation analysis. This is the average rainfall to fall at any one station, not the sum of all stations.

```
precip <- precipTally %>%
  dplyr::select(DATE, VALUE = Mean) %>%
  dplyr::mutate(SOURCE = "precip",
                JDATE = lubridate::yday(DATE),
                MONTH = lubridate::month(DATE, label = TRUE, abbr = TRUE),
                YEAR = lubridate::year(DATE))
```

2.14.6 Explore Daily Mean Values

2.14.6.1 Time Series with Median, 5th and 95th percentiles

```
dailyTs <- ggplot() +
  annotate(geom = "rect", xmin = min(precip$DATE), xmax = max(precip$DATE),
           ymin = quantile(precip$VALUE, 0.05, na.rm = T),
           ymax = quantile(precip$VALUE, 0.95, na.rm = T),
           fill = bc_colors[["BCBlue"]], alpha = 0.4) +
  geom_point(data = precip, aes(x = DATE, y = VALUE), color = "black", alpha = 0.5, size = 0.8) +
  geom_hline(yintercept = median(precip$VALUE, na.rm = T), color = bc_colors[["BCBlue"]], linewidth =
1) +
  geom_hline(yintercept = 1, color = bc_colors[["BCRed"]], linewidth = 1, linetype = "dashed") +
  scale_x_date(expand = c(0,0)) +
  scale_color_bc(bc_palettes, sub_pal = "cool", reverse = T) +
  labs(x = "", y = "Mean Daily Preciptation (inches)", title = "All Falls Lake and RDU Stations") +
  theme_bw() +
  theme(plot.title = element_text(hjust = 0.5), plot.subtitle = element_text(hjust = 0.5))

dailyTs
```




```
#ggsave(plot = dailyTs, filename = here::here("Data/Tidy/dataPrep/Figures", "precip_dailyTs.png"), width = 6.5, height = 3)
```

The blue line represents the median precipitation (0.0055118 inch) and the blue box covers range from the 5th to 95th percentile. Values above the blue box represent unusually high lake levels during this reporting period (5% of measures were above the blue box). Values below the blue box represent unusually low lake levels during this reporting period (5% of measures were below the blue box).

The red dashed line shows 1 inch mean daily rainfal. From the SME review appendix and regulatory definitions used to manage stormwater: retention ponds must handle 1 inch of rain (based on rolling 24 hour window).

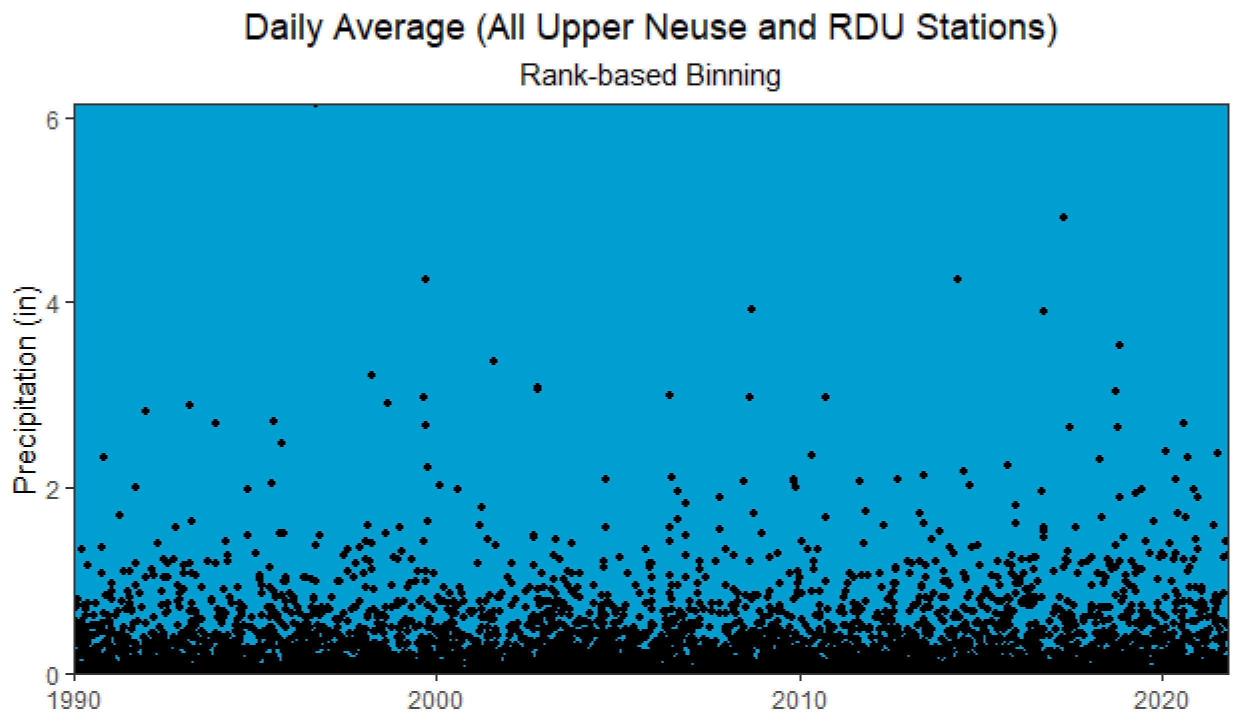
2.14.6.2 Alternative Bin Methods

We calculated the daily average lake level (based on calendar date). We then visualized different strategies to bin the data (rank-, range-, and percentile-based bins). If UNRBA would like to use a specific value for a reference point, we will need to define manual bins.

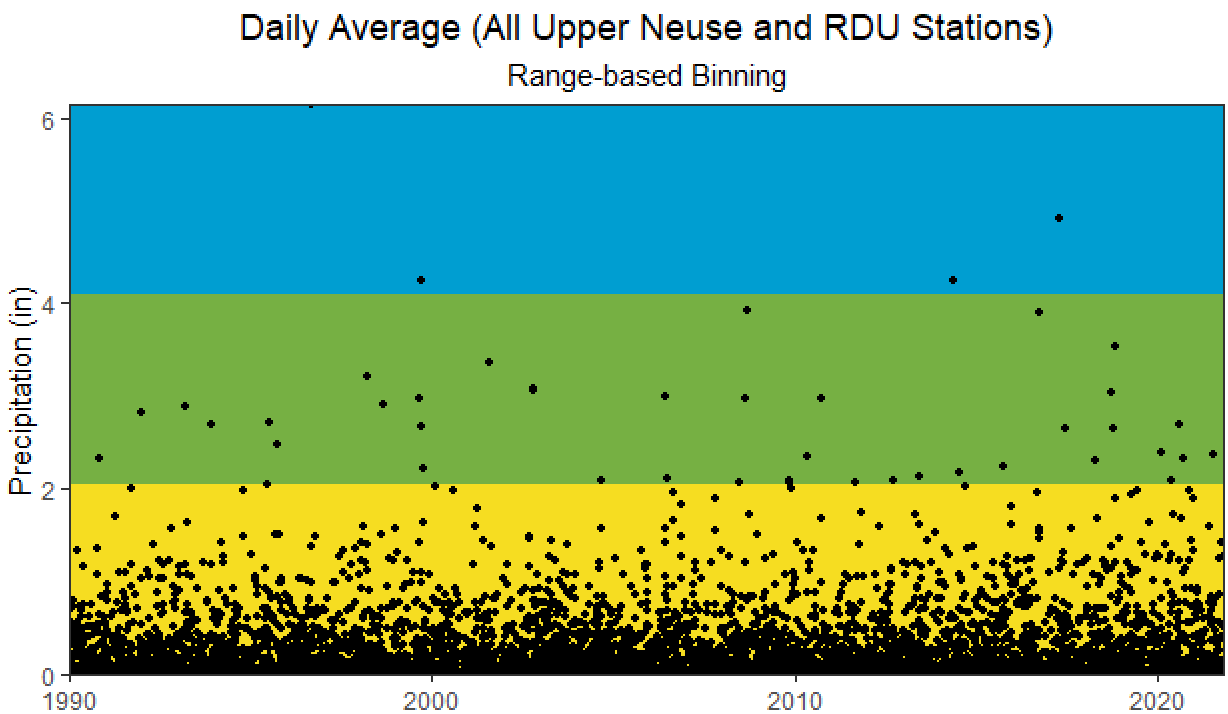
- Rank-based bins sort the values then put the lowest 1/3 into Low, the middle 1/3 into Moderate, and the highest 1/3 into High. This method includes special rules for handling over-represented values and breaking ties. If UNRBA wishes to use rank-based bins, we should discuss these rules in detail.
- Range-based bins divide the numeric range (min to max values) into three equal parts: Low, Moderate, and High.
- Percentile-based bins place data below the 25th percentile value into the Low bin, and data above the 75th percentile into the High bin, and all other data into the Moderate bin. These

percentile cut values can be adjusted to modify the rarity of observations labelled Low and High.

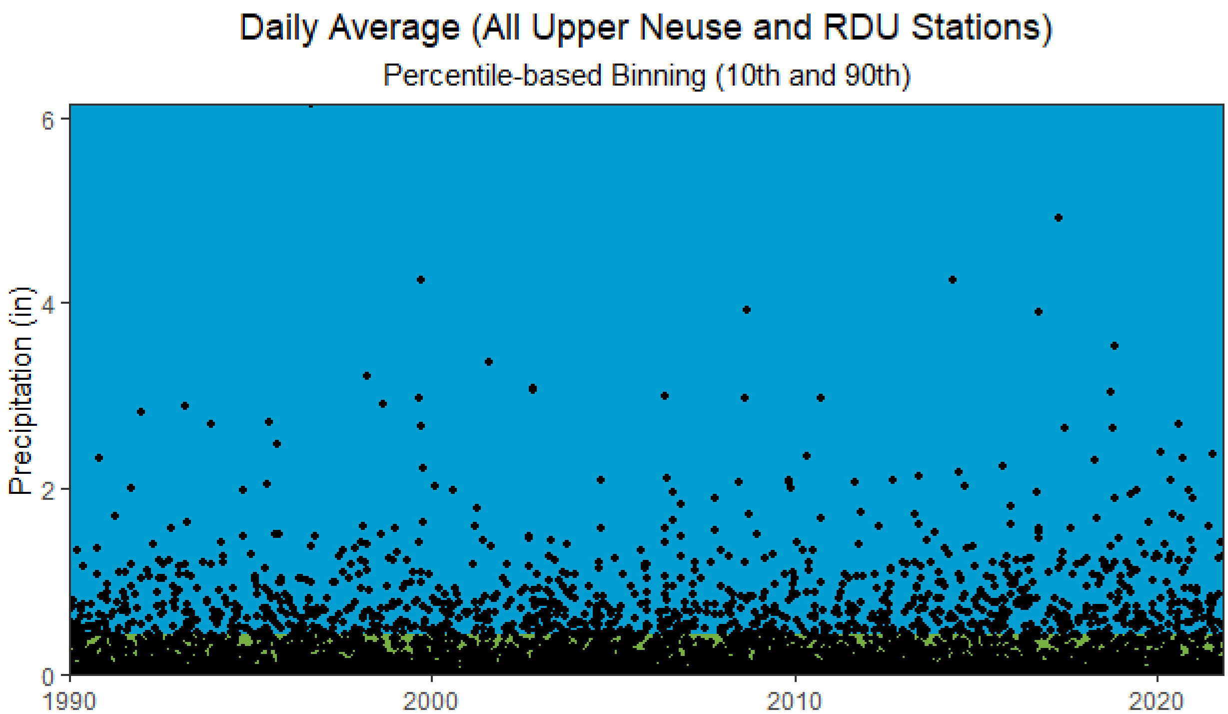
```
# Low, Moderate, High bins
precipRank <- binByRank(tidyDf = precip, valCol = "VALUE")
precipRange <- binByRange(tidyDf = precip, valCol = "VALUE")
precipPercent <- binByPercentile(tidyDf = precip, valCol = "VALUE")
precipManual <- binByManual(tidyDf = precip, valCol = "VALUE", binCutVals = c(-Inf, 1, 3, Inf), binLabels
= c("Normal", "High", "Very High"))

precipCutRank <- precipRank$cutPoints
precipCutRange <- precipRange$cutPoints
precipCutPerc <- precipPercent$cutPoints
precipCutMan <- precipManual$cutPoints

# Rank based bins (1/3 of data observations in each bin)
rankPlot <- ggplot() +
  annotate(geom = "rect", xmin = min(precip$DATE), xmax = max(precip$DATE),
        ymin = -Inf, ymax = precipCutRank[2], fill = bc_colors[["BCYellow"]]) +
  annotate(geom = "rect", xmin = min(precip$DATE), xmax = max(precip$DATE),
        ymin = precipCutRank[2], ymax = precipCutRank[3], fill = bc_colors[["BCGreen"]]) +
  annotate(geom = "rect", xmin = min(precip$DATE), xmax = max(precip$DATE),
        ymin = precipCutRank[3], ymax = Inf, fill = bc_colors[["BCBlue"]]) +
  geom_point(data = precip, aes(x = DATE, y = VALUE), color = "black", size = 1) +
  labs(x = "", y = "Precipitation (in)", title = "Daily Average (All Upper Neuse and RDU Stations)", subtitle =
"Rank-based Binning") +
   scale_y_continuous(expand = c(0,0)) +
  scale_x_date(expand = c(0,0)) +
  theme_bw() +
  theme(plot.title = element_text(hjust = 0.5), plot.subtitle = element_text(hjust = 0.5))

rankPlot
```



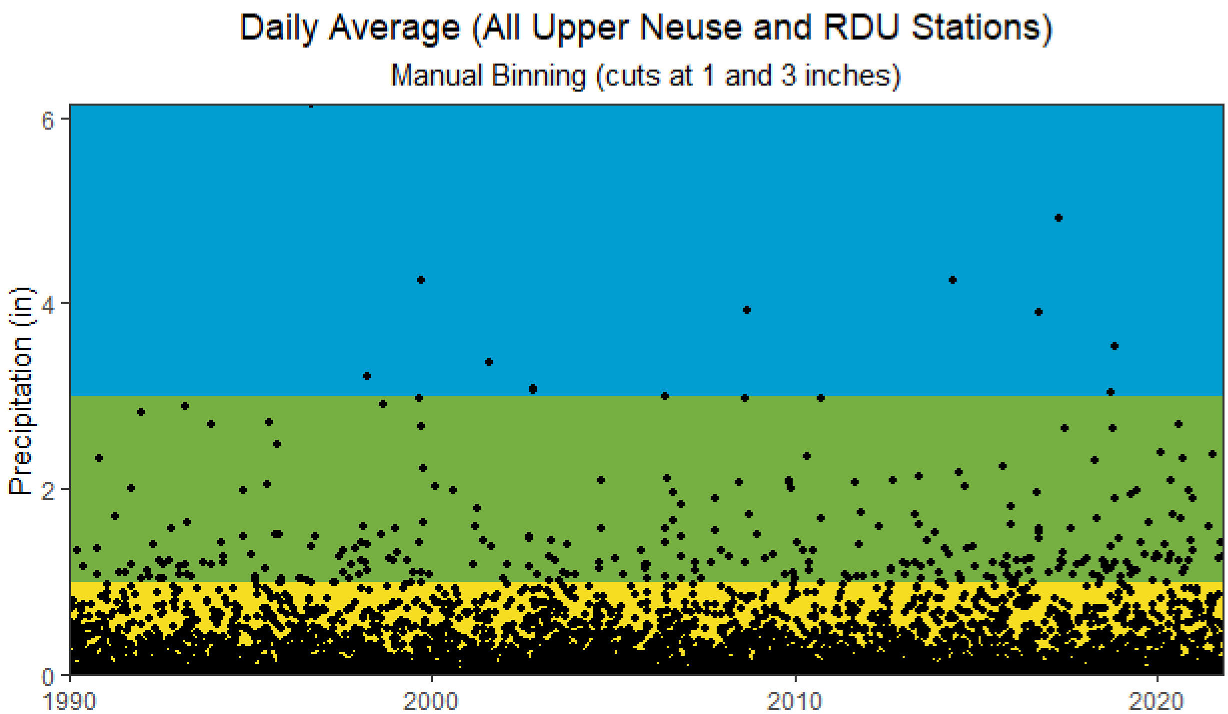

```
#ggsave(plot = rankPlot, filename = here::here("Data/Tidy/dataPrep/Figures", "precip_precipRank.png"),
width = 6.5, height = 3)

# Range based bins(min to max range divided into three equal segments)
rangePlot <- ggplot() +
  annotate(geom = "rect", xmin = min(precip$DATE), xmax = max(precip$DATE),
        ymin = -Inf, ymax = precipCutRange[2], fill = bc_colors[["BCYellow"]]) +
  annotate(geom = "rect", xmin = min(precip$DATE), xmax = max(precip$DATE),
        ymin = precipCutRange[2], ymax = precipCutRange[3], fill = bc_colors[["BCGreen"]]) +
  annotate(geom = "rect", xmin = min(precip$DATE), xmax = max(precip$DATE),
        ymin = precipCutRange[3], ymax = Inf, fill = bc_colors[["BCBlue"]]) +
  geom_point(data = precip, aes(x = DATE, y = VALUE), color = "black", size = 1) +
  labs(x = "", y = "Precipitation (in)", title = "Daily Average (All Upper Neuse and RDU Stations)", subtitle =
"Range-based Binning") +
   scale_y_continuous(expand = c(0,0)) +
  scale_x_date(expand = c(0,0)) +
  theme_bw() +
  theme(plot.title = element_text(hjust = 0.5), plot.subtitle = element_text(hjust = 0.5))

rangePlot
```




```
#ggsave(plot = rangePlot , filename = here::here("Data/Tidy/dataPrep/Figures", "precip_precipRange.pn
g"), width = 6.5, height = 3)

# Percentile based bins (lowest 10%, middle, highest 10%)
percentilePlot <- ggplot() +
  annotate(geom = "rect", xmin = min(precip$DATE), xmax = max(precip$DATE),
           ymin = -Inf, ymax = precipCutPerc[2], fill = bc_colors[["BCYellow"]]) +
  annotate(geom = "rect", xmin = min(precip$DATE), xmax = max(precip$DATE),
           ymin = precipCutPerc[2], ymax = precipCutPerc[3], fill = bc_colors[["BCGreen"]]) +
  annotate(geom = "rect", xmin = min(precip$DATE), xmax = max(precip$DATE),
           ymin = precipCutPerc[3], ymax = Inf, fill = bc_colors[["BCBlue"]]) +
  geom_point(data = precip, aes(x = DATE, y = VALUE), size = 1) +
  labs(x = "", y = "Precipitation (in)", title = "Daily Average (All Upper Neuse and RDU Stations)", subtitle =
"Percentile-based Binning (10th and 90th)") +
   scale_y_continuous(expand = c(0,0)) +
  scale_x_date(expand = c(0,0)) +
  theme_bw() +
  theme(plot.title = element_text(hjust = 0.5), plot.subtitle = element_text(hjust = 0.5))

percentilePlot
```




```r
#ggsave(plot = percentilePlot , filename = here::here("Data/Tidy/dataPrep/Figures", "precip_precipPerce
ntile.png"), width = 6.5, height = 3)

# Percentile based bins (lowest 10%, middle, highest 10%)
manualPlot <- ggplot() +
  annotate(geom = "rect", xmin = min(precip$DATE), xmax = max(precip$DATE),
           ymin = -Inf, ymax = precipCutMan[2], fill = bc_colors[["BCYellow"]]) +
  annotate(geom = "rect", xmin = min(precip$DATE), xmax = max(precip$DATE),
           ymin = precipCutMan[2], ymax = precipCutMan[3], fill = bc_colors[["BCGreen"]]) +
  annotate(geom = "rect", xmin = min(precip$DATE), xmax = max(precip$DATE),
           ymin = precipCutMan[3], ymax = Inf, fill = bc_colors[["BCBlue"]]) +
  geom_point(data = precip, aes(x = DATE, y = VALUE), size = 1) +
  scale_y_continuous(expand = c(0,0)) +
  labs(x = "", y = "Precipitation (in)", title = "Daily Average (All Upper Neuse and RDU Stations)", subtitle =
"Manual Binning (cuts at 1 and 3 inches)") +
  scale_x_date(expand = c(0,0)) +
  theme_bw() +
  theme(plot.title = element_text(hjust = 0.5), plot.subtitle = element_text(hjust = 0.5))

manualPlot
```



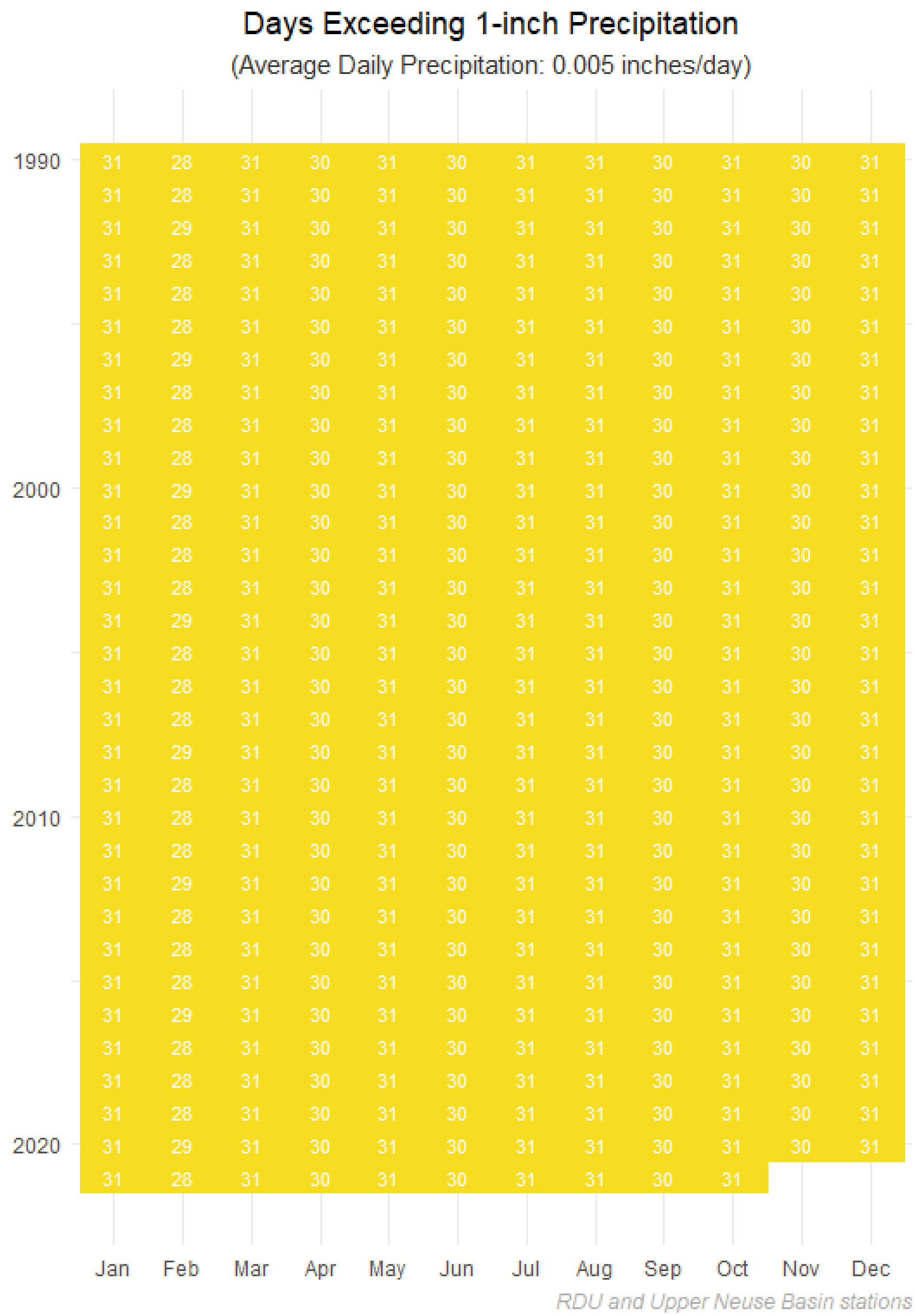

```
# ggsave(plot = manualPlot , filename = here::here("Data/Tidy/dataPrep/Figures", "precip_precipManual
.png"), width = 6.5, height = 3)
```

2.14.6.3 Monthly Exceedance Days

From the SME review appendix and regulatory definitions used to manage stormwater: retention ponds must handle 1 inch of rain (based on rolling 24 hour window). We do not have data to calculate the rolling average, but we can examine how often per month rainfall exceeds the 1-inch value,

```
exceed <- precipManual$binnedData %>%
 dplyr::group_by(YEAR, MONTH) %>%
 dplyr::summarize(N = n(),
            NExceed1 = sum(BINMAN != "Normal"),
            NExceed3 = sum(BINMAN == "Very High"),
            .groups = "drop")

yearMonthExceed <- ggplot(data = exceed) +
  geom_raster(aes(x = MONTH, y = YEAR, fill = (NExceed1 > 0))) +
 geom_point(data = dplyr::filter(exceed, NExceed3 > 0), aes(x = MONTH, y = YEAR, color = "red"), size =
6) +
 geom_text(data = dplyr::filter(exceed, NExceed1 > 0), aes(x = MONTH, y = YEAR, label = NExceed1), siz
e = 3, color = "white") +
 scale_y_reverse() +
 scale_fill_manual(values = c(bc_colors[["BCYellow"]], bc_colors[["BCGreen"]]), labels = c("None", "One
or More")) +
 scale_color_manual(values = c(bc_colors[["BCBlue"]]), labels = c("One or More Days\nExceed 3 inches"
```

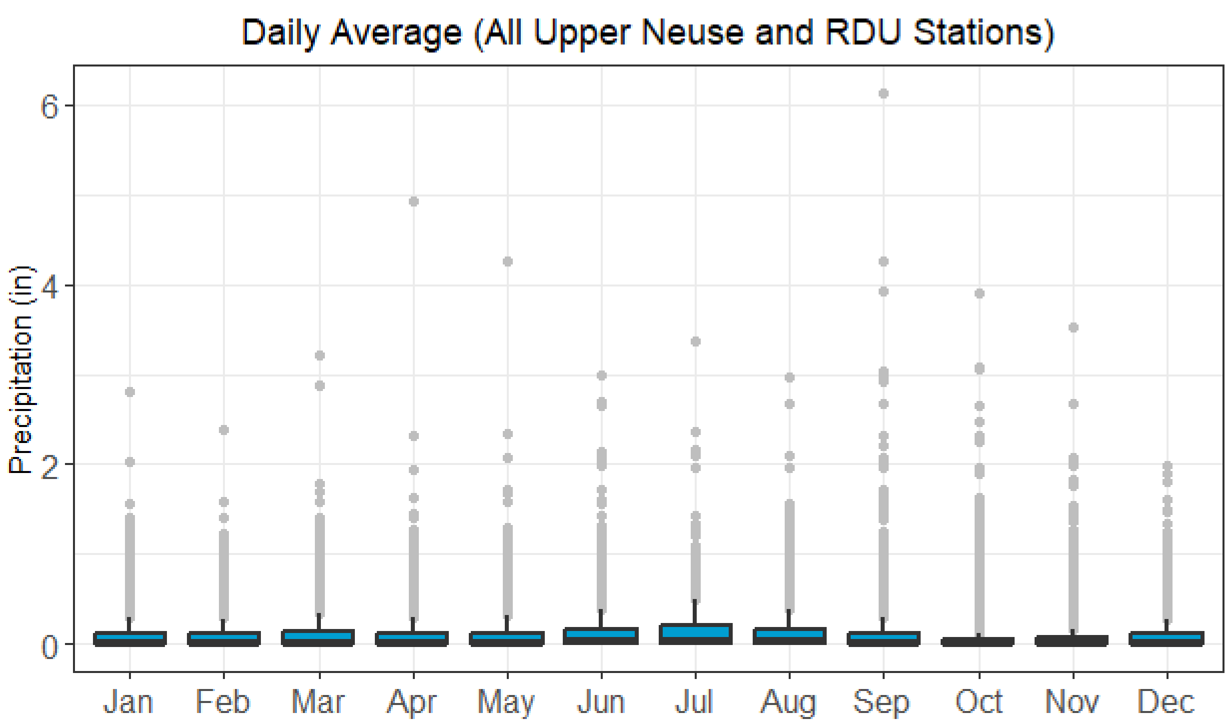
```
)) +
  labs(title = "Days Exceeding 1-inch Precipitation",
      subtitle = paste("(Average Daily Precipitation:", 0.005 , "inches/day)"),
         x = NULL, y = NULL, fill = "Number\nof Days", color = "",
                  caption = "RDU and Upper Neuse Basin stations") +
  theme_minimal() +
     theme(plot.title = element_text(hjust = 0.5),
              plot.subtitle = element_text(hjust = 0.5, color = "grey20"),
              plot.caption = element_text(hjust = 1, color = "darkgrey", face = "italic"),
              axis.title.y.right = element_text(margin = margin(t = 0, r = 0, b = 0, l = 20)))
yearMonthExceed
```




```
#ggsave(plot = yearMonthExceed, filename = here::here("Data/Tidy/dataPrep/Figures", "precip_yearMonthExceed.png"), width = 6.5, height = 8)
```

2.14.6.4 Month and Year Boxplots

```
precipByMonth <- ggplot() +
 # geom_jitter(data = level, aes(x = MONTH, y = VALUE, color = YEAR), width = 0.1) +
  geom_boxplot(data = precip, aes(x = MONTH, y = VALUE), fill = bc_colors[["BCBlue"]], outlier.color = "
grey", linewidth = 0.8) +
 labs(x = "", y = "Precipitation (in)", title = "Daily Average (All Upper Neuse and RDU Stations)") +
 theme_bw() +
 theme(axis.text.y = element_text(size = 12), axis.text.x = element_text(size = 12)) +
 theme(plot.title = element_text(hjust = 0.5), plot.subtitle = element_text(hjust = 0.5))

precipByMonth
```




```
# ggsave(plot = precipByMonth, filename = here::here("Data/Tidy/dataPrep/Figures", "precip_precipBy
Month.png"), width = 6.5, height = 3)

precipByYear <- ggplot() +
 #geom_jitter(data = level, aes(x = YEAR, y = VALUE, color = MONTH), width = 0.1) +
  geom_boxplot(data = precip, aes(x = as.factor(YEAR), y = VALUE), fill = bc_colors[["BCBlue"]], outlier.c
olor = "grey", linewidth = 0.8) +
 labs(x = "", y = "Precipitation (in)", title = "Daily Average (All Upper Neuse and RDU Stations)") +
 theme_bw() +
 theme(axis.text.y = element_text(size = 12), axis.text.x = element_text(angle = 90, size = 12, vjust = 0.4
)) +
 theme(plot.title = element_text(hjust = 0.5), plot.subtitle = element_text(hjust = 0.5))
```

```
# precipByYear
ggsave(plot = precipByYear, filename = here::here("Data/Tidy/dataPrep/Figures", "precip_precipByYear.
png"), width = 6.5, height = 3)
```

2.14.7 Identify Dry and Wet Periods

We chose "12+ consecutive days" with (or without) precipitation to define a wet (or dry) event.

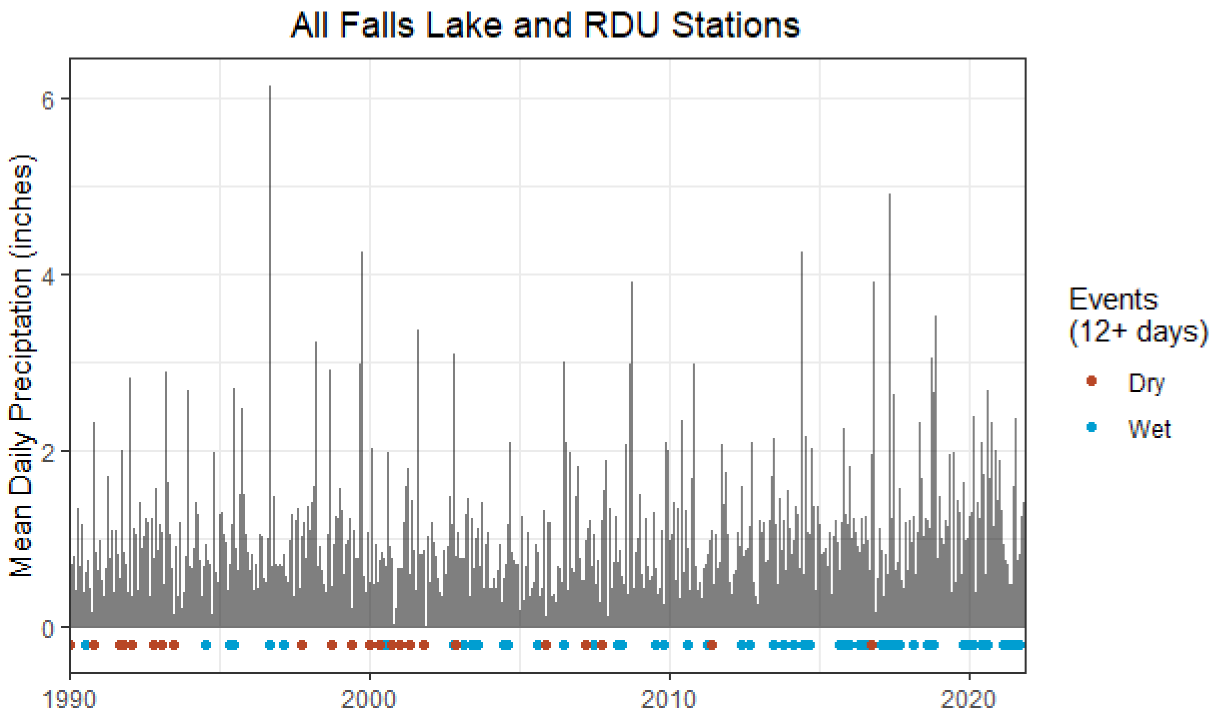
```
# How many dry days before labelled a dry event?
dryDays <- 12
wetDays <- 12

#Solution modified from loreabad6
#https://stackoverflow.com/questions/51371155/r-select-rainfall-events-and-calculate-rainfall-event-tot
al-from-time-series-da
dryEvents <- precip %>%
  # Set a rain flag if there is rain registered on the gauge
  dplyr::mutate(RainFlag = ifelse(VALUE > 0, 1, 0),
                # Create a column that contains the number of consecutive times there was rain or not.
  # Use `rle`` which indicates how many times consecutive values happen, and `rep`` to repeat it for each r
ow.
              RainLength = rep(rle(RainFlag)$lengths, rle(RainFlag)$lengths)) %>%
    # Set a flag for an event happening, when there is rain there is a rain event,
  # when it is 0 but not for six consecutive times, it is still a rain event
  mutate(EventFlag = ifelse(RainFlag == 1, 1, ifelse(RainFlag == 0 & RainLength < dryDays, 1, 0))) %>%
  # Correct for the case when the dataset starts with no rain for less than six consecutive times
  # If within the first six rows there is no rain registered, then the event flag should change to 1 (assume n
ormal rain)
  mutate(EventFlag = ifelse(row_number() < dryDays & RainFlag == 0, 1, EventFlag)) %>%
  # Add an id to each event (rain or not), to group by on the pivot table
  mutate(EventId = rep(seq(1,length(rle(EventFlag)$lengths)), rle(EventFlag)$lengths))

dryPivot <- dryEvents %>%
  # Select only the dry events
  filter(EventFlag == 0) %>%
  # Group by id
  group_by(EventId) %>%
  summarize(
    eventStart = first(DATE),
    eventEnd = last(DATE),
    eventType = "Dry"
  )

#dryPivot

wetEvents <- precip %>%
```

```
  dplyr::mutate(RainFlag = ifelse(VALUE > 0, 1, 0),
         RainLength = rep(rle(RainFlag)$lengths, rle(RainFlag)$lengths)) %>%
  mutate(EventFlag = ifelse(RainFlag == 0, 0, ifelse(RainFlag == 1 & RainLength < wetDays, 0, 1))) %>%
  mutate(EventFlag = ifelse(row_number() < wetDays & RainFlag == 1, 0, EventFlag)) %>%
  mutate(EventId = rep(seq(1,length(rle(EventFlag)$lengths)), rle(EventFlag)$lengths))

wetPivot <- wetEvents %>%
  # Select only the wet events
  filter(EventFlag == 1) %>%
  # Group by id
  group_by(EventId) %>%
  summarize(
    eventStart = first(DATE),
    eventEnd = last(DATE),
    eventType = "Wet"
  )
#
wetPivot
```

```
## # A tibble: 65 × 4
##    EventId eventStart eventEnd   eventType
##      <int> <date>     <date>     <chr>
##  1       2 1990-07-10 1990-07-22 Wet
##  2       4 1994-07-20 1994-08-06 Wet
##  3       6 1995-05-09 1995-05-20 Wet
##  4       8 1995-06-02 1995-06-13 Wet
##  5      10 1995-06-18 1995-07-02 Wet
##  6      12 1996-09-02 1996-09-13 Wet
##  7      14 1997-02-04 1997-02-16 Wet
##  8      16 2000-07-20 2000-08-05 Wet
##  9      18 2000-08-24 2000-09-06 Wet
## 10      20 2002-10-20 2002-11-01 Wet
## # ℹ 55 more rows
```

```
events <- rbind(wetPivot, dryPivot)

eventTs <- ggplot() +
  geom_point(data = events, aes(x = eventStart, y = -0.2, color = eventType)) +
  geom_line(data = precip, aes(x = DATE, y = VALUE), color = "black", alpha = 0.5, linewidth = 0.5) +
  scale_x_date(expand = c(0,0)) +
  scale_color_manual(values = c(bc_colors[["BCRed"]], bc_colors[["BCBlue"]])) +
  labs(x = "", y = "Mean Daily Preciptation (inches)", title = "All Falls Lake and RDU Stations",
     color = "Events\n(12+ days)") +
  theme_bw() +
  theme(plot.title = element_text(hjust = 0.5), plot.subtitle = element_text(hjust = 0.5))
```

```
eventTs
```




```
# ggsave(plot = eventTs, filename = here::here("Data/Tidy/dataPrep/Figures", "precip_eventTs.png"), wi
dth = 6.5, height = 3)
```

2.14.8 Annual Rainfall Patterns

The annual rainfall patterns are calculated after averaging the rainfall measured across all available stations for a given date. All dates have at least one reporting station, most have many. Variability among stations can be high (eg scattered storms), but annual totals should be less sensitivity to this variability. An exception would be if periods with few stations collected from stations with localized effects, such as heat island effects.

```
# Calculate median and mean by year
yrStats <- precip %>%
  dplyr::group_by(YEAR) %>%
  dplyr::summarize(sum = round(sum(VALUE),3),
            nrainy = round(sum(VALUE > 0),3),
            median = round(median(VALUE),3),
            mean = round(mean(VALUE),3),
            sd = round(sd(VALUE),3),
            .groups = "drop") %>%
  dplyr::mutate(sum_rv = scale(sum, scale = F),
          nrainy_rv = scale(nrainy, scale = F))
yrStats
```

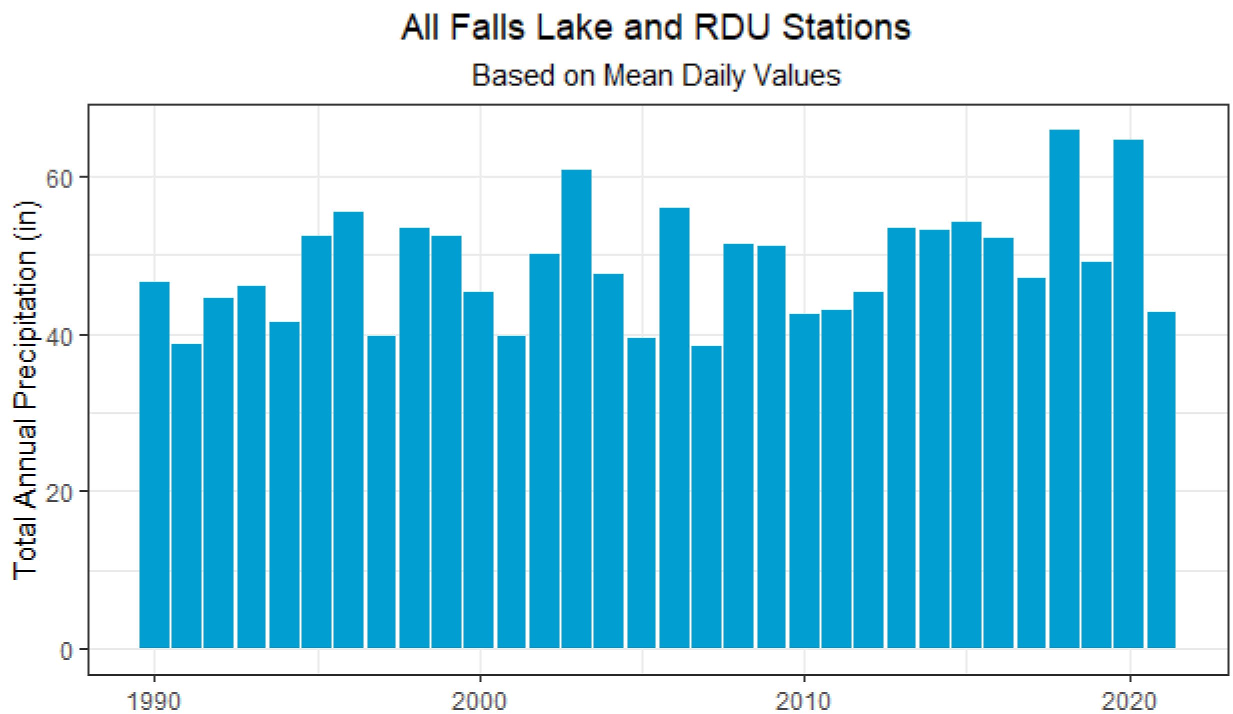
```
## # A tibble: 32 × 8
##     YEAR   sum nrainy median  mean    sd sum_rv[,1] nrainy_rv[,1]
##    <dbl> <dbl>  <dbl>  <dbl> <dbl> <dbl>      <dbl>         <dbl>
##  1  1990  46.4    187  0.004 0.127 0.248      -2.41        -22.6
##  2  1991  38.6    173  0     0.106 0.247     -10.2         -36.6
##  3  1992  44.6    198  0.004 0.122 0.279      -4.22        -11.6
##  4  1993  45.9    189  0.002 0.126 0.306      -2.88        -20.6
##  5  1994  41.5    200  0.006 0.114 0.238      -7.31         -9.56
##  6  1995  52.3    181  0     0.143 0.333       3.53        -28.6
##  7  1996  55.3    215  0.017 0.151 0.389       6.54          5.44
##  8  1997  39.6    174  0     0.109 0.228      -9.16        -35.6
##  9  1998  53.4    188  0.002 0.146 0.35        4.65        -21.6
## 10  1999  52.3    171  0     0.143 0.407       3.50        -38.6
## # ℹ 22 more rows
```

```
meanSumAllYears <- mean(yrStats$sum)
sdSumAllYears <- sd(yrStats$sum)

meanNRainyAllYears <- mean(yrStats$nrainy)
sdNRainyAllYears <- sd(yrStats$nrainy)
```

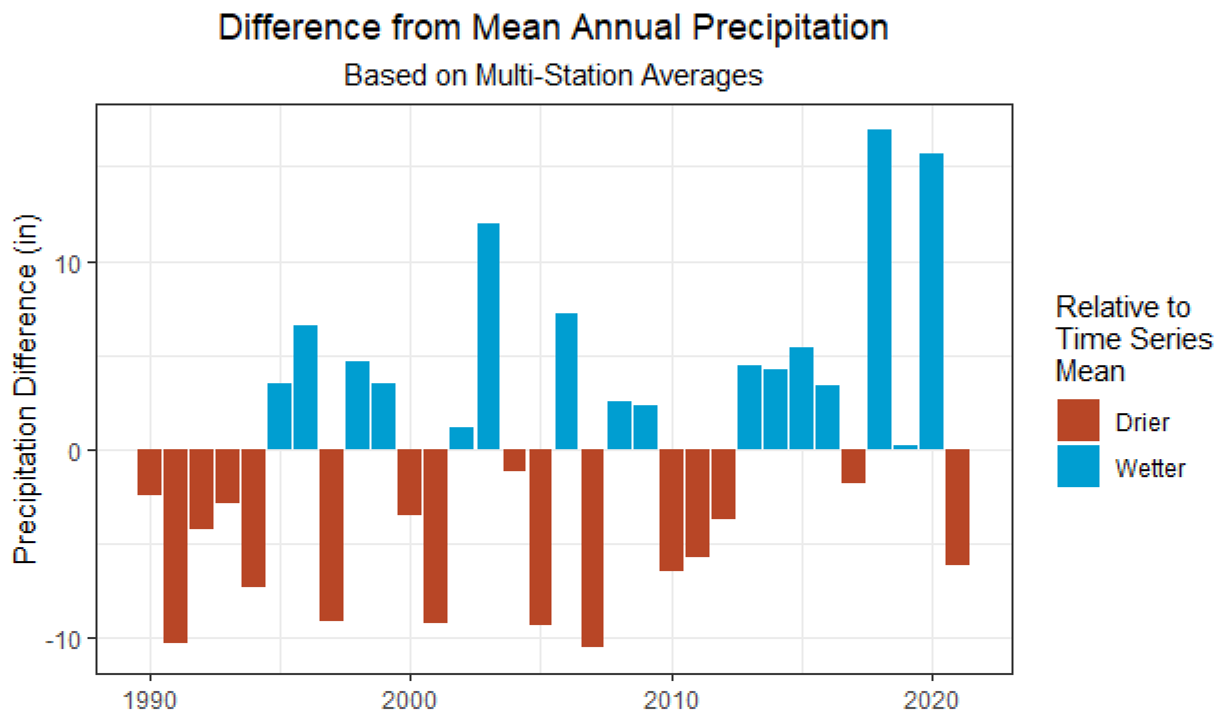
For better perspective on wet versus dry periods, we reentered the data relative to the overall mean across all years. The overall average of total annual precipitation (at a given gauge) is 48.7921562 inches and standard deviation is 7.1918677. The overall average of total annual number of days with measureable precipitation (at a given gauge) is 209.5625 inches and standard deviation is 28.121783.

2.14.8.1 Total Annual Rainfall

```
# Total Annual Precip
yrInches <- ggplot() +
  geom_col(data = yrStats, aes(x = YEAR, y = sum), fill = bc_colors[["BCBlue"]]) +
  labs(x = "", y = "Total Annual Precipitation (in)", title = "All Falls Lake and RDU Stations",
     subtitle = "Based on Mean Daily Values") +
  theme_bw() +
  theme(plot.title = element_text(hjust = 0.5), plot.subtitle = element_text(hjust = 0.5))

yrInches
```




```
ggsave(plot = yrInches, filename = here::here("Data/Tidy/dataPrep/Figures", "precip_yrInches.png"), wi
dth = 6.5, height = 5)

# Centered and Rescaled Annual Rainfall
yrInchesCentered <- ggplot() +
  geom_col(data = yrStats, aes(x = YEAR, y = sum_rv, fill = sum_rv > 0)) +
  scale_fill_manual(values = c(bc_colors[["BCRed"]], bc_colors[["BCBlue"]]), labels = c("Drier", "Wetter"))
+
  labs(x = "", y = "Precipitation Difference (in)", title = "Difference from Mean Annual Precipitation",
     subtitle = "Based on Multi-Station Averages", fill = "Relative to\nTime Series\nMean") +
  theme_bw() +
  theme(plot.title = element_text(hjust = 0.5), plot.subtitle = element_text(hjust = 0.5))

yrInchesCentered
```

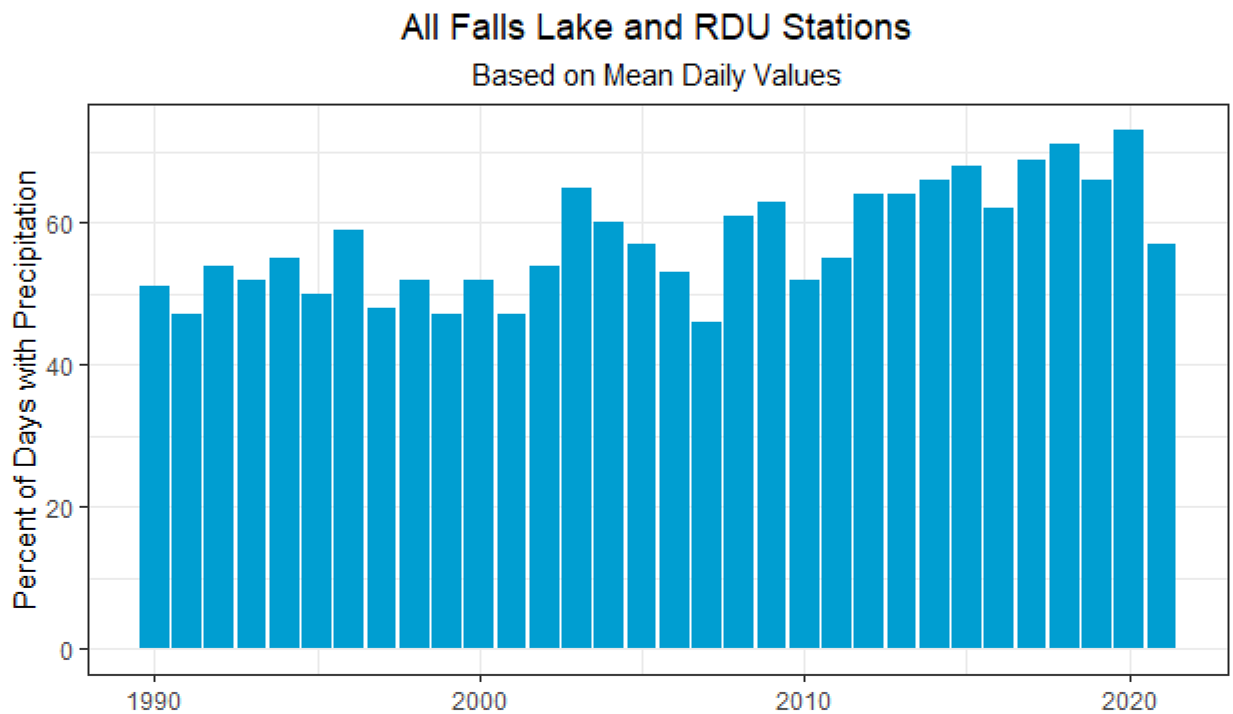



```
# ggsave(plot = yrInchesCentered, filename = here::here("Data/Tidy/dataPrep/Figures", "precip_yrInches
Centered.png"), width = 6.5, height = 5)
```

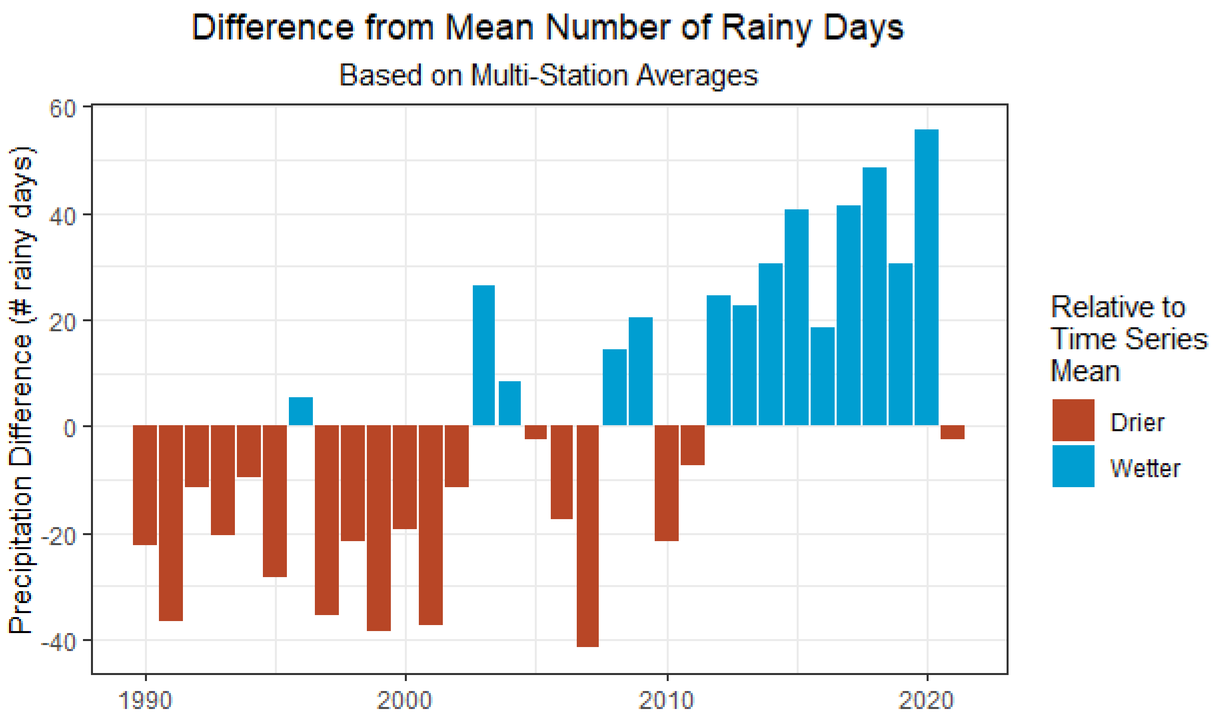
2.14.8.2 Annual Number of Days with Rain

The percent of days with precipitation gives a different perspective on whether a year is wet versus dry. Infrequent heavy rainfall can deliver similar quatities as frequent smaller rainfall events - but may not influence Falls lake the same.

```
# Percent Rainy Days
yrDays <- ggplot() +
 geom_col(data = yrStats, aes(x = YEAR, y = round((nrainy*100)/365, 0)), fill = bc_colors[["BCBlue"]]) +
 #scale_y_continuous(limits = c(0, 100), breaks = seq(0, 100, by = 20), expand = c(0,0)) +
 labs(x = "", y = "Percent of Days with Precipitation", title = "All Falls Lake and RDU Stations",
    subtitle = "Based on Mean Daily Values") +
 theme_bw() +
 theme(plot.title = element_text(hjust = 0.5), plot.subtitle = element_text(hjust = 0.5))

yrDays
```



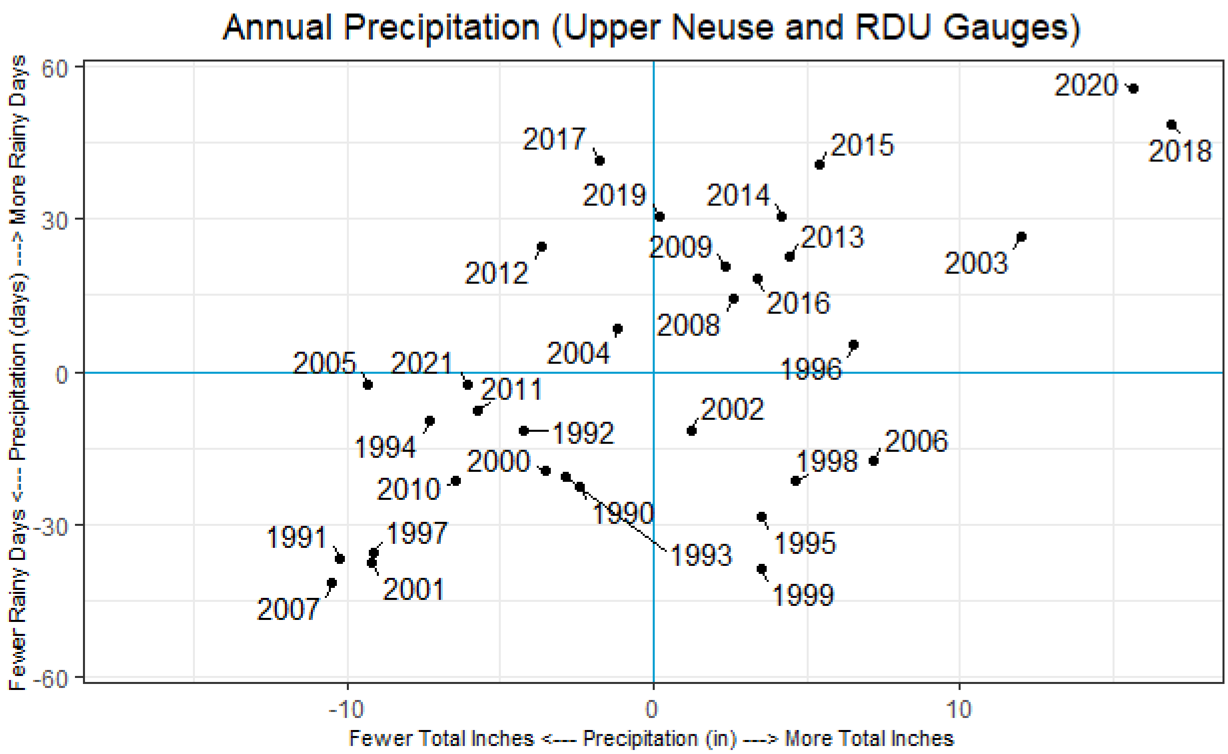

```
# ggsave(plot = yrDays , filename = here::here("Data/Tidy/dataPrep/Figures", "precip_yrDays.png"), widt
h = 6.5, height = 5)

# Centered and Rescaled Perc Rainy Days
yrDaysCentered <- ggplot() +
  geom_col(data = yrStats, aes(x = YEAR, y = nrainy_rv, fill = nrainy_rv > 0)) +
  scale_fill_manual(values = c(bc_colors[["BCRed"]], bc_colors[["BCBlue"]]), labels = c("Drier", "Wetter"))
+
  labs(x = "", y = "Precipitation Difference (# rainy days)", title = "Difference from Mean Number of Rainy
Days",
     subtitle = "Based on Multi-Station Averages", fill = "Relative to\nTime Series\nMean") +
  theme_bw() +
  theme(plot.title = element_text(hjust = 0.5), plot.subtitle = element_text(hjust = 0.5))

yrDaysCentered
```




```
# ggsave(plot = yrDaysCentered , filename = here::here("Data/Tidy/dataPrep/Figures", "precip_yrDaysCentered.png"), width = 6.5, height = 5)
```

2.14.8.3 Preciptation magic quadrat

```
quadrat <- ggplot() +
 geom_hline(yintercept = 0, color = bc_colors[["BCBlue"]]) +
 geom_vline(xintercept = 0, color = bc_colors[["BCBlue"]]) +
 # geom_hline(yintercept = meanNRainyAllYears, color = bc_colors[["BCBlue"]]) +
 # geom_vline(xintercept = meanSumAllYears, color = bc_colors[["BCBlue"]]) +
 geom_text_repel(data = yrStats, aes(x = sum_rv, y = nrainy_rv, label = YEAR), min.segment.length = 0)
+
 geom_point(data = yrStats, aes(x = sum_rv, y = nrainy_rv)) +
 scale_x_continuous(limits = c(-max(abs(yrStats$sum_rv)), max(abs(yrStats$sum_rv)))) +
  scale_y_continuous(limits = c(-max(abs(yrStats$nrainy_rv)), max(abs(yrStats$nrainy_rv)))) +
 labs(x = "Fewer Total Inches <--- Precipitation (in) ---> More Total Inches",
     y = "Fewer Rainy Days <--- Precipitation (days) ---> More Rainy Days",
     title = "Annual Precipitation (Upper Neuse and RDU Gauges)") +
 theme_bw() +
 theme(plot.title = element_text(hjust = 0.5), plot.subtitle = element_text(hjust = 0.5),
      axis.title = element_text(size = 8))

quadrat
```



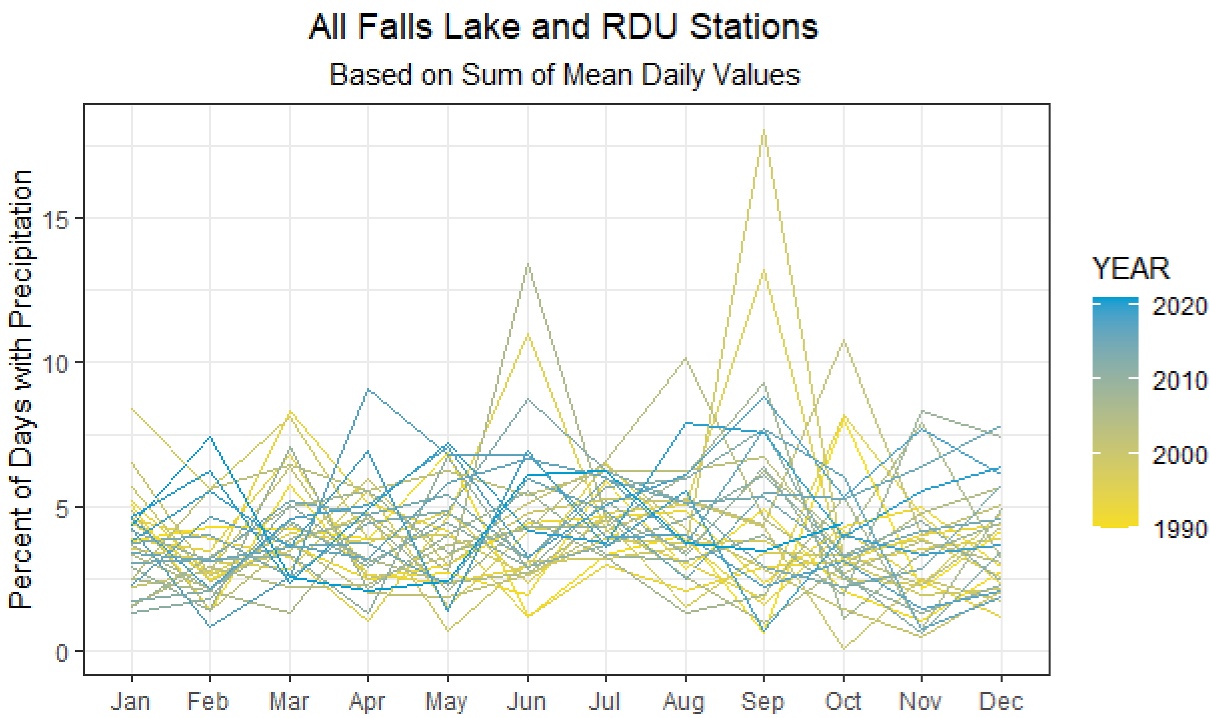

```
#ggsave(plot = quadrat, filename = here::here("Data/Tidy/dataPrep/Figures", "precip_quadrat.png"), wi
dth = 6.5, height = 5)
```

2.14.9 Monthly Rainfall Patterns

In addition to knowing if a given year is wet or dry (relative to all years on record), it may be useful to know if a given month is wet or dry (relative to all months on record). Annual scales are relative to the overall average (across all years total annual precipitation), but monthly scales are relative to overall median (across all months from all years, N ~ 12 months by 32 years).

```
# Calculate median and mean by month
monStats <- precip %>%
  dplyr::group_by(MONTH, YEAR) %>%
  dplyr::summarize(sum = round(sum(VALUE),3),
            nrainy = round(sum(VALUE > 0),3),
            median = round(median(VALUE),3),
            mean = round(mean(VALUE),3),
            sd = round(sd(VALUE),3),
            .groups = "drop")
  #dplyr::group_by(MONTH) %>%
monStats <- monStats %>%
  dplyr::mutate(sum_rv = sum - median(monStats$sum),
          nrainy_rv = nrainy - median(monStats$nrainy))
  #dplyr::ungroup()

# Simple time series lines (hard to read)
simpleTs <- ggplot() +
```

```
geom_line(data = monStats, aes(x = MONTH, y = sum, group = YEAR, color = YEAR)) +
scale_color_gradient(low = bc_colors[["BCYellow"]], high = bc_colors[["BCBlue"]]) +
labs(x = "", y = "Percent of Days with Precipitation", title = "All Falls Lake and RDU Stations",
    subtitle = "Based on Sum of Mean Daily Values") +
theme_bw() +
theme(plot.title = element_text(hjust = 0.5), plot.subtitle = element_text(hjust = 0.5))

simpleTs
```

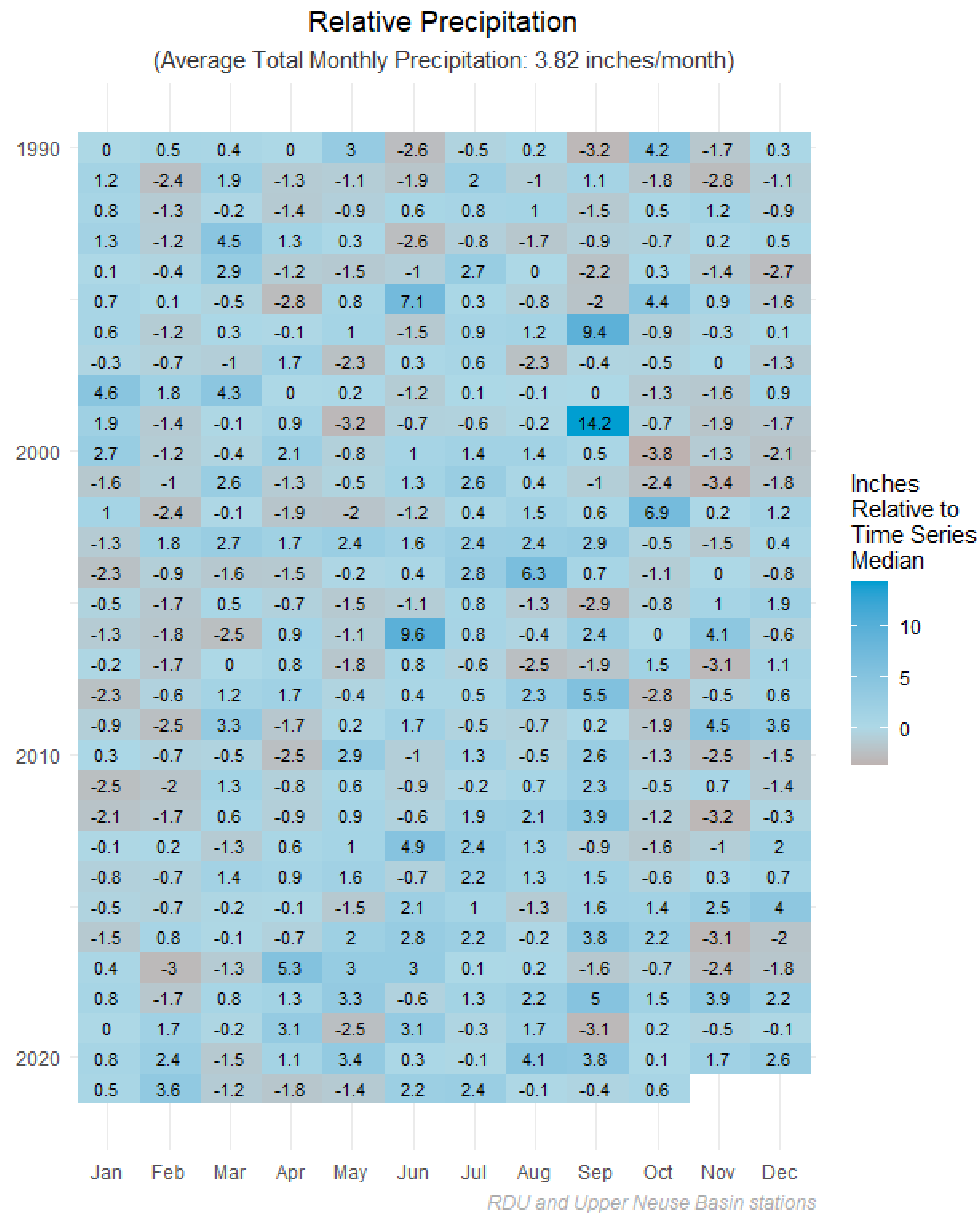



```
#ggsave(plot = simpleTs, filename = here::here("Data/Tidy/dataPrep/Figures", "precip_simpleTs.png"), w
idth = 6.5, height = 5)
```

Heat maps to visualize variability across years (within months) and across months (within years).

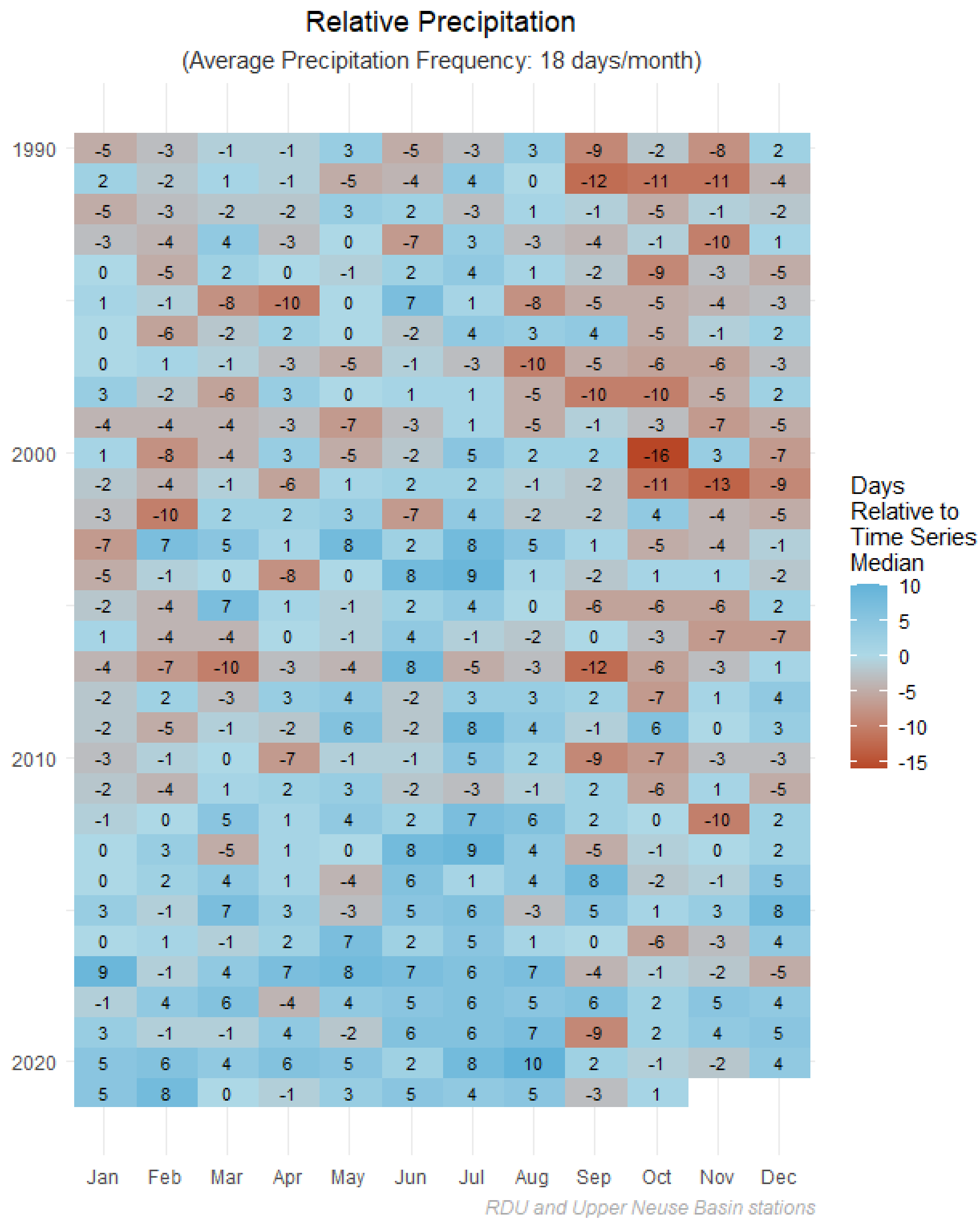
```
yearMonthSum <- ggplot(data = monStats) +
  geom_raster(aes(x = MONTH, y = YEAR, fill = sum_rv)) +
 geom_text(aes(x = MONTH, y = YEAR, label = round(sum_rv, 1)), size = 3) +
 scale_y_reverse() +
 scale_fill_gradient2(low = bc_colors[["BCRed"]], mid = "lightblue", high = bc_colors[["BCBlue"]]) +
  labs(title = "Relative Precipitation",
      subtitle = paste("(Average Total Monthly Precipitation:", round(median(monStats$sum),2), "inches
/month)"),
          x = NULL, y = NULL, fill = "Inches\nRelative to\nTime Series\nMedian",
                caption = "RDU and Upper Neuse Basin stations") +
  theme_minimal() +
    theme(plot.title = element_text(hjust = 0.5),
```

```
        plot.subtitle = element_text(hjust = 0.5, color = "grey20"),
        plot.caption = element_text(hjust = 1, color = "darkgrey", face = "italic"),
        axis.title.y.right = element_text(margin = margin(t = 0, r = 0, b = 0, l = 20)))

yearMonthSum
```




```
# ggsave(plot = yearMonthSum, filename = here::here("Data/Tidy/dataPrep/Figures", "precip_yearMonthSum.png"), width = 6.5, height = 8)

yearMonthNRainy <- ggplot(data = monStats) +
  geom_raster(aes(x = MONTH, y = YEAR, fill = nrainy_rv)) +
```

```
  geom_text(aes(x = MONTH, y = YEAR, label = round(nrainy_rv, 1)), size = 3) +
  scale_fill_gradient2(low = bc_colors[["BCRed"]], mid = "lightblue", high = bc_colors[["BCBlue"]]) +
  scale_y_reverse() +
  labs(title = "Relative Precipitation",
          subtitle = paste("(Average Precipitation Frequency:", round(median(monStats$nrainy),2), "day
s/month)"),
        x = NULL, y = NULL, fill = "Days\nRelative to\nTime Series\nMedian",
              caption = "RDU and Upper Neuse Basin stations") +
  theme_minimal() +
    theme(plot.title = element_text(hjust = 0.5),
            plot.subtitle = element_text(hjust = 0.5, color = "grey20"),
            plot.caption = element_text(hjust = 1, color = "darkgrey", face = "italic"),
            axis.title.y.right = element_text(margin = margin(t = 0, r = 0, b = 0, l = 20)))

yearMonthNRainy
```




```
#ggsave(plot = yearMonthNRainy, filename = here::here("Data/Tidy/dataPrep/Figures", "precip_yearMonthNRainy.png"), width = 6.5, height = 8)
```

2.14.10 Calculate Rolling Averages

This is the 30-day rolling average of the daily average precipitation.

```
# Ensure there are no gaps within dates
all(precip$DATE %in% seq(min(precip$DATE), max(precip$DATE), by = "+1 day"))

## [1] TRUE

# Confirm one observation per day
length(unique(precip$DATE)) == nrow(precip)

## [1] TRUE

precip15avg <- precip %>%
  dplyr::mutate(VALUE = zoo::rollmean(VALUE, k = 15, fill = NA, align = "right")) %>%
  tidyr::drop_na(VALUE)

precip30avg <- precip %>%
  dplyr::mutate(VALUE = zoo::rollmean(VALUE, k = 30, fill = NA, align = "right")) %>%
  tidyr::drop_na(VALUE)
```

2.14.11 Calculate Rolling Total

This is the 30-day rolling sum of the daily average precipitation.

```
precip30sum <- precip %>%
  dplyr::mutate(VALUE = zoo::rollsum(VALUE, k = 30, fill = NA, align = "right")) %>%
  tidyr::drop_na(VALUE)
```

2.14.12 Export Tidy Data

The daily precip values are exported as **dataPrep/precip_lakewide_[precipdaily].rds**, with precipdaily, precip15avg, precip30avg, precip30sum.

The dry and wet event data, defined as sequences of 12 dry days and 12 wet days, respectively, are saved as **dataPrep/precip_events.rds**.

All exported data are also saved as xlsx files in matching Excel folder.

```
precip <- precip %>%
  dplyr::mutate(
    MEASUNIT = "inches/day",
    VARIABLE = "Precipitation, Daily",
    STATIONID = "Falls Lake",
    DEPTHM = NA_real_,
    LAKEUNIT = "Lakewide",
    LOCATE = "Lakewide")

precip15avg <- precip15avg %>%
  dplyr::mutate(
    MEASUNIT = "inches/day",
    VARIABLE = "Precipitation, 15-day Rolling Average",
    STATIONID = "Falls Lake",
    DEPTHM = NA_real_,
    LAKEUNIT = "Lakewide",
```

```
    LOCATE = "Lakewide")

precip30avg <- precip30avg %>%
  dplyr::mutate(
    MEASUNIT = "inches/day",
    VARIABLE = "Precipitation, 30-day Rolling Average",
    STATIONID = "Falls Lake",
    DEPTHM = NA_real_,
    LAKEUNIT = "Lakewide",
    LOCATE = "Lakewide")

precip30sum <- precip30sum %>%
  dplyr::mutate(
    MEASUNIT = "inches/mo",
    VARIABLE = "Precipitation, 30-day Rolling Sum",
    STATIONID = "Falls Lake",
    DEPTHM = NA_real_,
    LAKEUNIT = "Lakewide",
    LOCATE = "Lakewide")

# Export the continuous precipitation time series data
precip <- dplyr::select(precip, SOURCE, DATE, MONTH, YEAR, STATIONID, DEPTHM, LAKEUNIT, LOCATE,
VARIABLE, VALUE, MEASUNIT)
# saveRDS(precip, here::here("Data/Tidy/dataPrep", "precip_precipdaily.rds"))
# openxlsx::write.xlsx(precip, here::here("Data/Tidy/dataPrep/Excel", "precip_precipdaily.xlsx"))
readr::write_csv(precip, here::here("Data/Tidy/AppendixC", "precip_precipdaily.csv"))


# Export rolling data
precip15avg <- dplyr::select(precip15avg, SOURCE, DATE, MONTH, YEAR, STATIONID, DEPTHM, LAKEUNI
T, LOCATE, VARIABLE, VALUE, MEASUNIT)
# saveRDS(precip15avg, here::here("Data/Tidy/dataPrep", "precip_precip15avg.rds"))
# openxlsx::write.xlsx(precip15avg, here::here("Data/Tidy/dataPrep/Excel", "precip_precip15avg.xlsx"))
readr::write_csv(precip15avg, here::here("Data/Tidy/AppendixC", "precip_precip15avg.csv"))

precip30avg <- dplyr::select(precip30avg, SOURCE, DATE, MONTH, YEAR, STATIONID, DEPTHM, LAKEUNI
T, LOCATE, VARIABLE, VALUE, MEASUNIT)
# saveRDS(precip30avg, here::here("Data/Tidy/dataPrep", "precip_precip30avg.rds"))
# openxlsx::write.xlsx(precip30avg, here::here("Data/Tidy/dataPrep/Excel", "precip_precip30avg.xlsx"))
readr::write_csv(precip30avg, here::here("Data/Tidy/AppendixC", "precip_precip30avg.csv"))

precip30sum <- dplyr::select(precip30sum, SOURCE, DATE, MONTH, YEAR, STATIONID, DEPTHM, LAKEU
NIT, LOCATE, VARIABLE, VALUE, MEASUNIT)
# saveRDS(precip30sum, here::here("Data/Tidy/dataPrep", "precip_precip30sum.rds"))
```

```
# openxlsx::write.xlsx(precip30avg, here::here("Data/Tidy/dataPrep/Excel", "precip_precip30sum.xlsx"))
readr::write_csv(precip30sum, here::here("Data/Tidy/AppendixC", "precip_precip30sum.csv"))

# Export the event data
events <- events %>%
  dplyr::rename(EVENTTYPE = eventType,
                DATESTART = eventStart,
                DATEEND = eventEnd) %>%
  dplyr::mutate(EVENTNAME = NA_character_,
                SOURCE = "precip") %>%
  dplyr::select(EVENTTYPE, EVENTNAME, DATESTART, DATEEND, SOURCE)

# saveRDS(events, here::here("Data/Tidy/dataMerge", "tidy_events_precip.rds"))
# openxlsx::write.xlsx(events, here::here("Data/Tidy/dataMerge/Excel", "tidy_events_precip.xlsx"))
readr::write_csv(events, here::here("Data/Tidy/AppendixC", "tidy_events_precip.csv"))
```

Code created by KDV Decision Analysis LLC and last run 2024-08-29 with R version 4.4.1 (2024-06-14 ucrt).

2.14.13 Falls Lake Residence Times 1987-2022 (resid)

2.14.14 Data Import and Tidy

Raw data are found in **UNRBA/ResidenceTime/FallsLakeResidenceTimes_1987to2022.xlsx.**

```
raw <- readxl::read_excel(here::here("Data/Raw/UNRBA/ResidenceTime", "FallsLakeResidenceTimes_1
987to2022.xlsx"), na = c("", "NA"))

names(raw)

##  [1] "Date"
##  [2] "WaterElevation_ft"
##  [3] "Flow_cfs"
##  [4] "Flow_15DayRollingAverage"
##  [5] "WaterElevation_15DayRollingAverage"
##  [6] "Flow_30DayRollingAverage"
##  [7] "WaterElevation_30DayRollingAverage"
##  [8] "vol_ft3"
##  [9] "vol_ft3_15DayRollingAverage"
## [10] "vol_ft3_30DayRollingAverage"
## [11] "residence_time_days_15DayRollingAverage"
## [12] "residence_time_days_30DayRollingAverage"
```

2.14.15 Add Source, Date, Month, and Year

The source for these data is labelled: **residence.**

```
raw <- raw %>%
  dplyr::mutate(SOURCE = "residence",
                DATE = format(as_date(Date), "%Y-%m-%d"),
```

```
          JDATE = lubridate::yday(DATE),
          MONTH = lubridate::month(Date, label = TRUE, abbr = TRUE),
          YEAR = lubridate::year(Date)) %>%
 dplyr::filter(YEAR >= 1991)
```

2.14.16 Organize Variable Columns

The data contain multiple variables related to the calculation of residence times: Date, WaterElevation_ft, Flow_cfs, Flow_15DayRollingAverage, WaterElevation_15DayRollingAverage, Flow_30DayRollingAverage, WaterElevation_30DayRollingAverage, vol_ft3, vol_ft3_15DayRollingAverage, vol_ft3_30DayRollingAverage, residence_time_days_15DayRollingAverage, residence_time_days_30DayRollingAverage, SOURCE, DATE, JDATE, MONTH, YEAR. We only need to keep the two residence time variables and then pivot the data and add the following other columns:

- MEASUNIT
  - Specifies unit of measurement for VARIABLE

```
tidy <- raw %>%
 dplyr::select(SOURCE:YEAR, starts_with("residence")) %>%
 dplyr::mutate(DATE = lubridate::ymd(DATE)) %>% # because coerced to string?
 tidyr::pivot_longer(cols = c("residence_time_days_15DayRollingAverage", "residence_time_days_30DayRollingAverage"), names_to = "VARIABLE", values_to = "VALUE") %>%
 dplyr::mutate(MEASUNIT = if_else(stringr::str_detect(VARIABLE, "15"), "15-day rolling average", "30-day rolling average"),
          VARIABLE = "Residence Time")
```

2.14.17 Remove NA VALUES

There are NA values for the first entries where rolling values could not be calculated. These NA values were removed.

```
tidy <- tidy %>%
  drop_na(c("VALUE"))
```

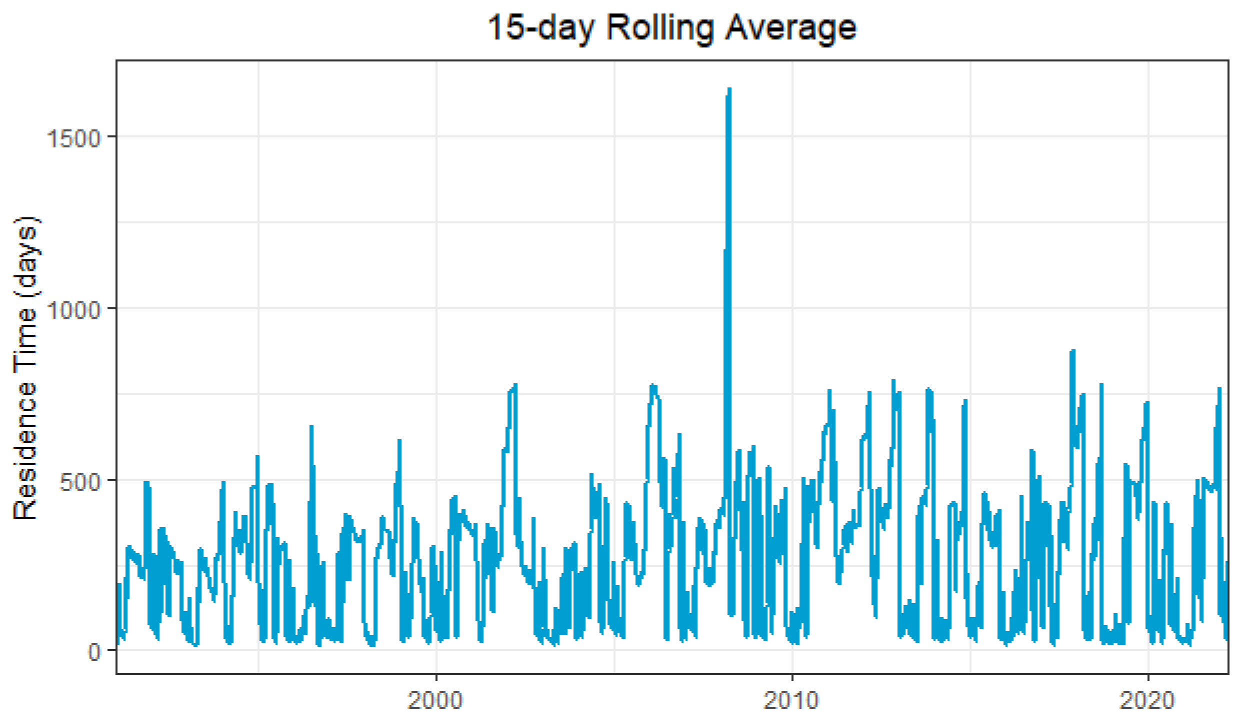
2.14.18 Explore Data

2.14.18.1 15-day Rolling Average

```
short <- dplyr::filter(tidy, MEASUNIT == "15-day rolling average")
```

2.14.18.1.1 Simple Time Series

```
shortTs <- ggplot() +
 geom_line(data = short, aes(x = DATE, y = VALUE), color = bc_colors[["BCBlue"]], linewidth = 1, na.rm = T) +
 labs(x = "", y = "Residence Time (days)", title = "15-day Rolling Average") +
 scale_x_date(expand = c(0,0)) +
 theme_bw() +
 theme(plot.title = element_text(hjust = 0.5), plot.subtitle = element_text(hjust = 0.5))

shortTs
```

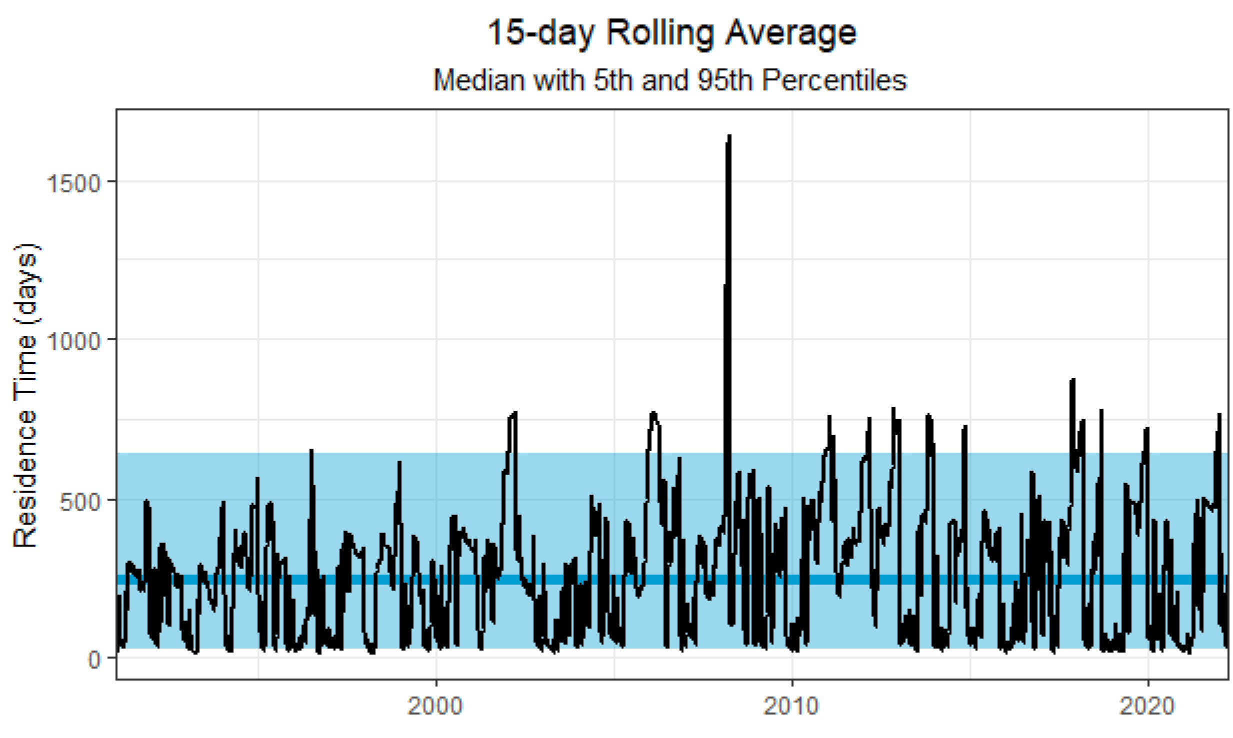



```
ggsave(plot = shortTs, filename = here::here("Data/Tidy/dataPrep/Figures", "residence_15DayTs.png"),
width = 5, height = 3)
```

2.14.18.1.2 Median with 5th and 95th Percentile

```
short <- dplyr::filter(tidy, MEASUNIT == "15-day rolling average")

shortSumm <- data.frame(
  VAR = c("q05", "q50", "q95"),
  VAL = c(quantile(short$VALUE, 0.05, na.rm = T),
        median(short$VALUE, na.rm = T),
        quantile(short$VALUE, 0.95, na.rm = T))
  )
shortSumm

##     VAR       VAL
## 5%  q05  27.62097
##     q50 247.18592
## 95% q95 644.59643

# Continuous time series of elevation
shortDist <- ggplot() +
  annotate(geom = "rect", xmin = min(short$DATE), xmax = max(short$DATE),
         ymin = quantile(short$VALUE, 0.05, na.rm = T),
         ymax = quantile(short$VALUE, 0.95, na.rm = T),
         fill = bc_colors[["BCBlue"]], alpha = 0.4) +
  geom_hline(yintercept = median(short$VALUE, na.rm = T), color = bc_colors[["BCBlue"]], linewidth = 2)
```

```
+
  geom_line(data = short, aes(x = DATE, y = VALUE), color = "black", linewidth = 1) +
  scale_x_date(expand = c(0,0)) +
  scale_color_bc(bc_palettes, sub_pal = "cool", reverse = T) +
  labs(x = "", y = "Residence Time (days)", title = "15-day Rolling Average", subtitle = "Median with 5th an
d 95th Percentiles") +
  theme_bw() +
  theme(plot.title = element_text(hjust = 0.5), plot.subtitle = element_text(hjust = 0.5))

shortDist
```



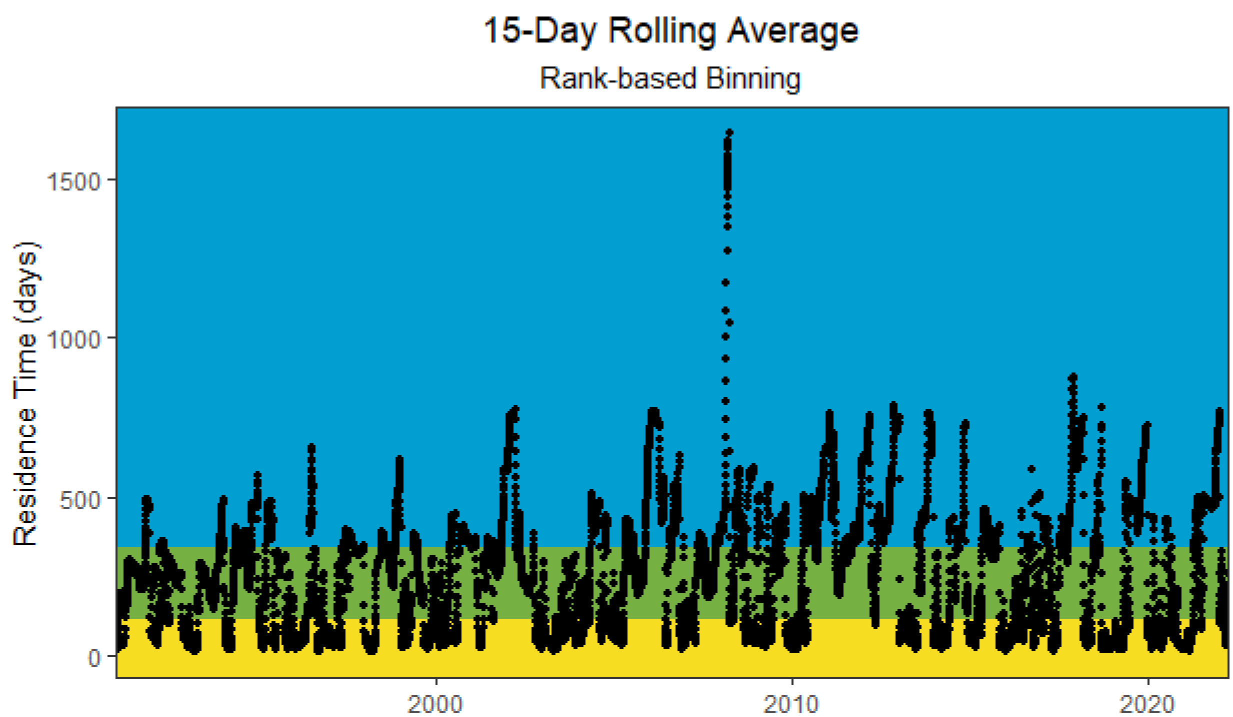

```
#ggsave(plot = shortDist, filename = here::here("Data/Tidy/dataPrep/Figures", "residence_15dayMedian
.png"), width = 5, height = 3)
```

The blue line represents the median residence time (247.1859157 days) and the blue box covers range from the 5th to 95th percentiles (27.6209748 days and 644.5964253 days, respectively). Values above the blue box represent unusually long residence times during this reporting period (5% of measures were above the blue box). Values below the blue box represent unusually long residence times during this reporting period (5% of measures were below the blue box).

2.14.18.1.3 Alternative Binning Strategies

```
shortRank <- binByRank(tidyDf = short, valCol = "VALUE")
shortRange <- binByRange(tidyDf = short, valCol = "VALUE")
shortPercent <- binByPercentile(tidyDf = short, valCol = "VALUE")

sCutRank <- shortRank$cutPoints
```

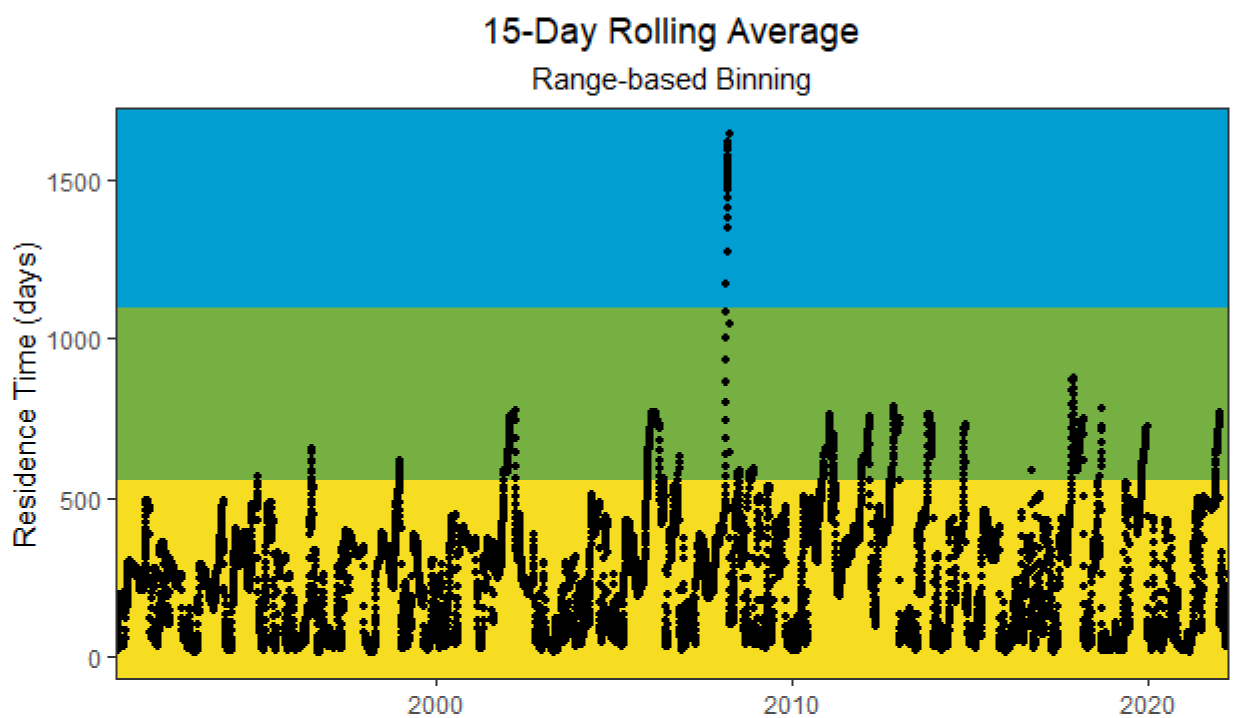
```
sCutRange <- shortRange$cutPoints
sCutPerc <- shortPercent$cutPoints

# Rank based bins (1/3 of data observations in each bin)
shortRank <- ggplot() +
 annotate(geom = "rect", xmin = min(short$DATE), xmax = max(short$DATE),
        ymin = -Inf, ymax = sCutRank[2], fill = bc_colors[["BCYellow"]]) +
 annotate(geom = "rect", xmin = min(short$DATE), xmax = max(short$DATE),
        ymin = sCutRank[2], ymax = sCutRank[3], fill = bc_colors[["BCGreen"]]) +
 annotate(geom = "rect", xmin = min(short$DATE), xmax = max(short$DATE),
        ymin = sCutRank[3], ymax = Inf, fill = bc_colors[["BCBlue"]]) +
 geom_point(data = short, aes(x = DATE, y = VALUE), color = "black", size = 1) +
 labs(x = "", y = "Residence Time (days)", title = "15-Day Rolling Average", subtitle = "Rank-based Binning
") +
 scale_x_date(expand = c(0,0)) +
 theme_bw() +
 theme(plot.title = element_text(hjust = 0.5), plot.subtitle = element_text(hjust = 0.5))

shortRank
```




```
#ggsave(plot = shortRank, filename = here::here("Data/Tidy/dataPrep/Figures", "residence_15dayRank.p
ng"), width = 5, height = 3)
```

The rank-based cut points were: 112.1919016 and 342.6820342. Each bin contains an equal number of observations.

```
# Range based bins(min to max range divided into three equal segments)
shortRange <- ggplot() +
  annotate(geom = "rect", xmin = min(short$DATE), xmax = max(short$DATE),
        ymin = -Inf, ymax = sCutRange[2], fill = bc_colors[["BCYellow"]]) +
  annotate(geom = "rect", xmin = min(short$DATE), xmax = max(short$DATE),
        ymin = sCutRange[2], ymax = sCutRange[3], fill = bc_colors[["BCGreen"]]) +
  annotate(geom = "rect", xmin = min(short$DATE), xmax = max(short$DATE),
        ymin = sCutRange[3], ymax = Inf, fill = bc_colors[["BCBlue"]]) +
  geom_point(data = short, aes(x = DATE, y = VALUE), color = "black", size = 1) +
  labs(x = "", y = "Residence Time (days)", title = "15-Day Rolling Average", subtitle = "Range-based Binnin
g") +
  scale_x_date(expand = c(0,0)) +
  theme_bw() +
  theme(plot.title = element_text(hjust = 0.5), plot.subtitle = element_text(hjust = 0.5))

shortRange
```

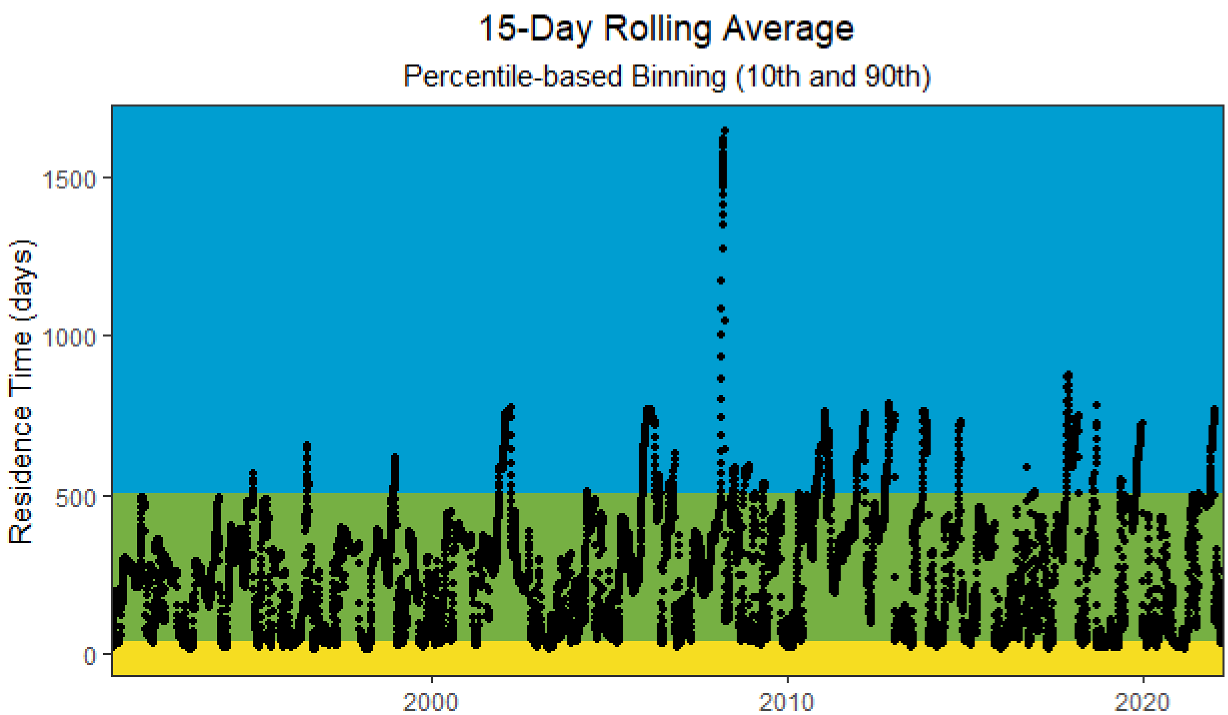



```
#ggsave(plot = shortRange , filename = here::here("Data/Tidy/dataPrep/Figures", "residence_15dayRan
ge.png"), width = 5, height = 3)
```

The range-based cut points were: 555.9609697 and 1097.5519311. Each bin covers an equal distance on the observed scale of measures.

```
# Percentile based bins (lowest 10%, middle, highest 10%)
shortPercentile <- ggplot() +
  annotate(geom = "rect", xmin = min(short$DATE), xmax = max(short$DATE),
        ymin = -Inf, ymax = sCutPerc[2], fill = bc_colors[["BCYellow"]]) +
```

```
annotate(geom = "rect", xmin = min(short$DATE), xmax = max(short$DATE),
        ymin = sCutPerc[2], ymax = sCutPerc[3], fill = bc_colors[["BCGreen"]]) +
 annotate(geom = "rect", xmin = min(short$DATE), xmax = max(short$DATE),
        ymin = sCutPerc[3], ymax = Inf, fill = bc_colors[["BCBlue"]]) +
 geom_point(data = short, aes(x = DATE, y = VALUE), size = 1) +
 labs(x = "", y = "Residence Time (days)", title = "15-Day Rolling Average", subtitle = "Percentile-based Bi
nning (10th and 90th)") +
 scale_x_date(expand = c(0,0)) +
 theme_bw() +
 theme(plot.title = element_text(hjust = 0.5), plot.subtitle = element_text(hjust = 0.5))

shortPercentile
```



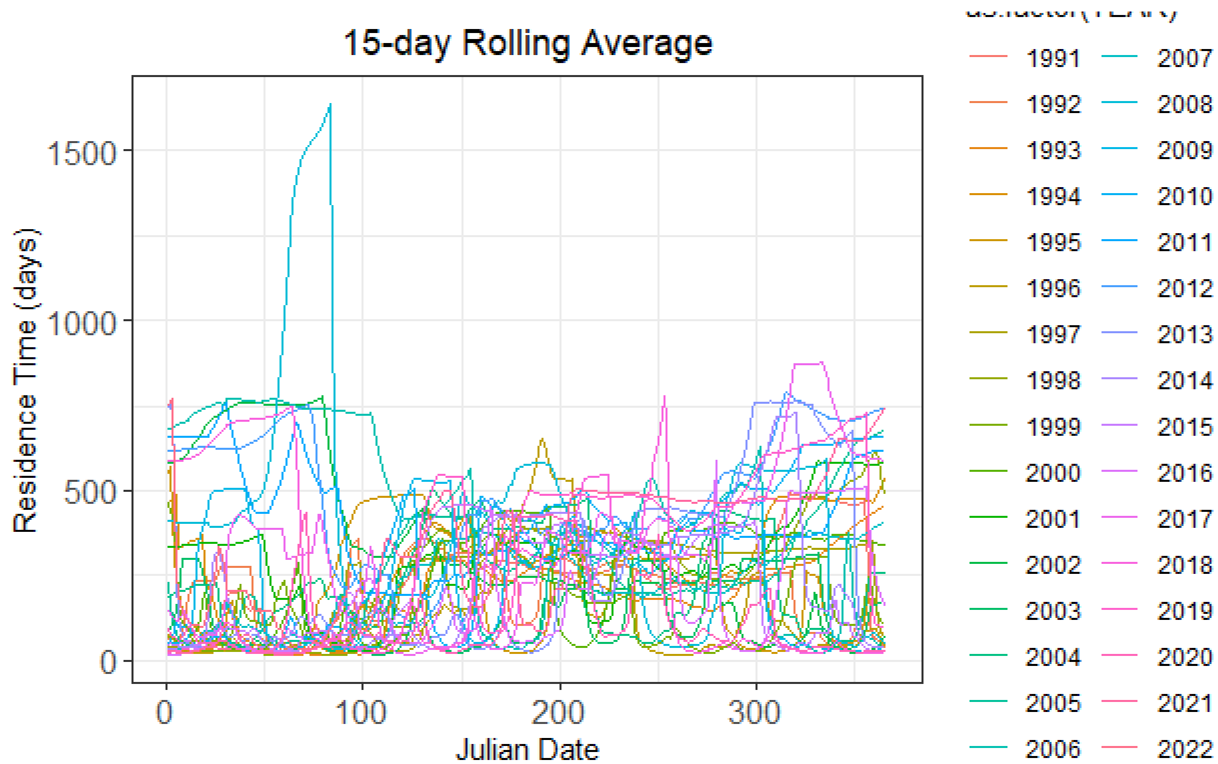

```
#ggsave(plot = shortPercentile , filename = here::here("Data/Tidy/dataPrep/Figures", "residence_15dayP
ercentile.png"), width = 5, height = 3)
```

The percentile-based cut points were: 36.7208589 and 507.1445256. The central bin contains 80% of observations and the Low and High bin each contain 10% of the observations.

2.14.18.1.4 Julian Day Time Series

```
annualShortTs <- ggplot() +
 geom_line(data = short, aes(x = JDATE, y = VALUE, color = as.factor(YEAR))) +
 labs(x = "Julian Date", y = "Residence Time (days)", title = "15-day Rolling Average") +
 #scale_x_continuous(expand = c(0,0)) +
 #scale_color_bc(bc_palettes, sub_pal = "mixed") +
 theme_bw() +
```

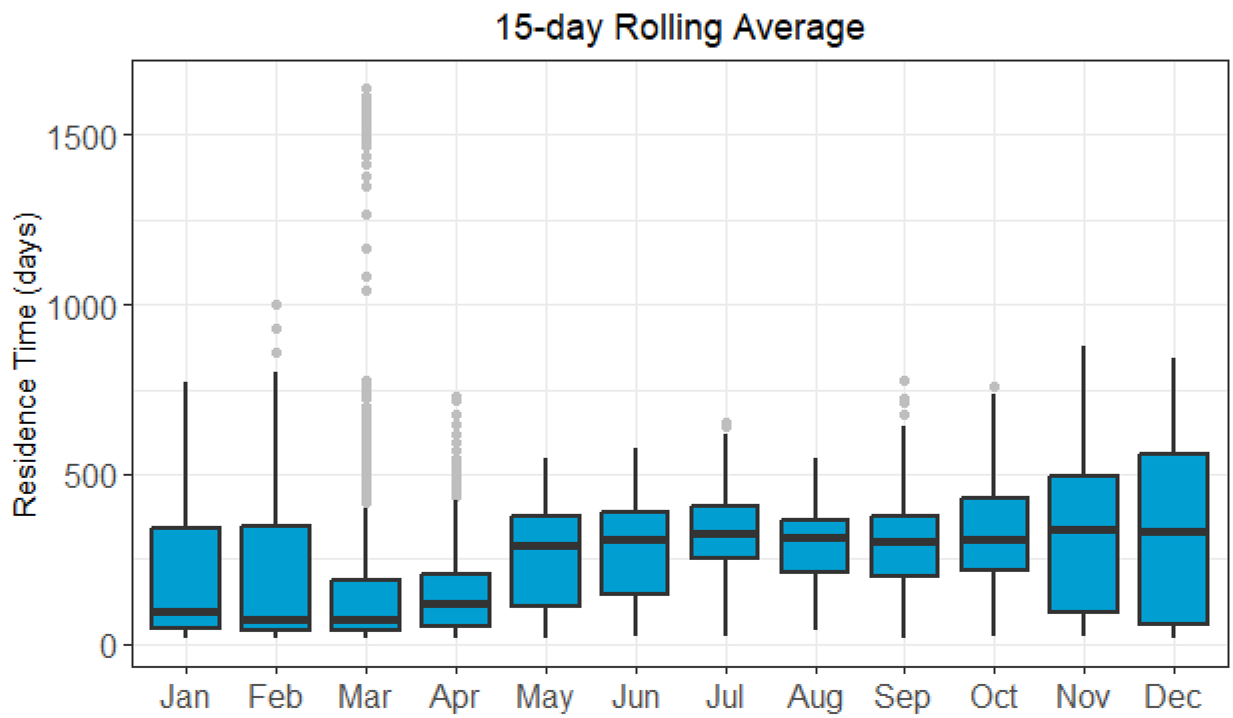
```
  theme(axis.text.y = element_text(size = 12), axis.text.x = element_text(size = 12)) +
  theme(plot.title = element_text(hjust = 0.5), plot.subtitle = element_text(hjust = 0.5))

annualShortTs
```



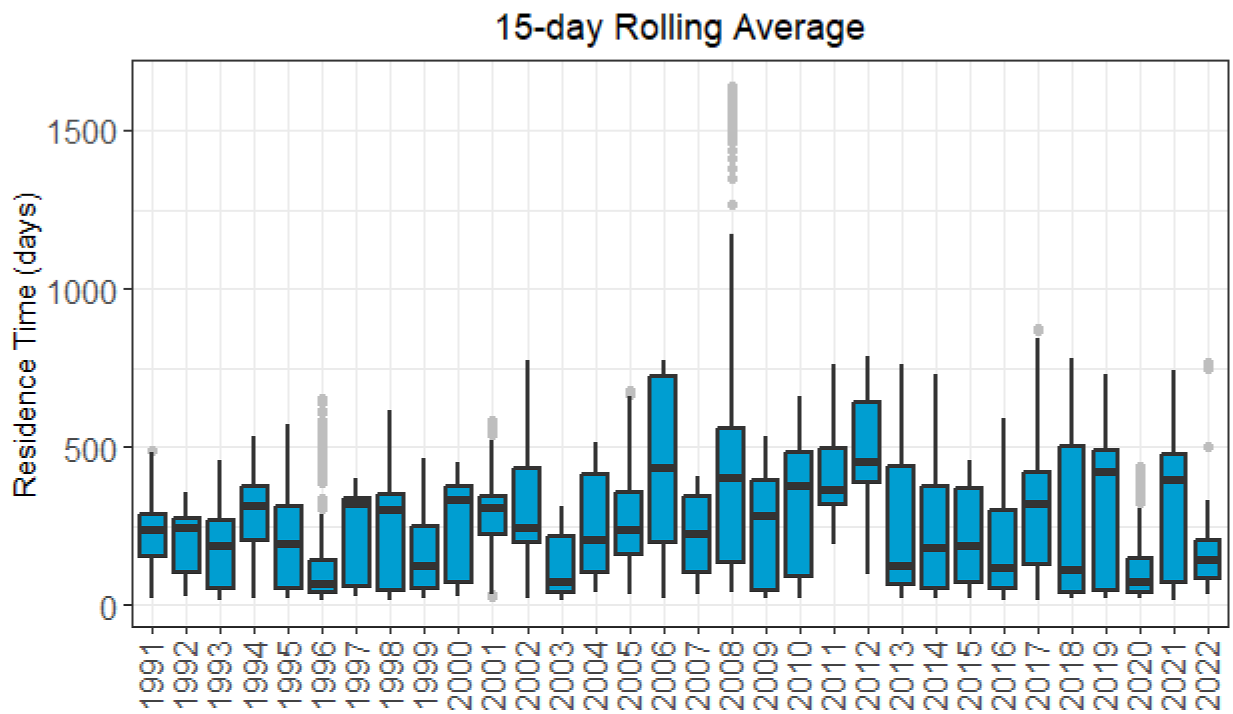

```
#ggsave(plot = annualShortTs , filename = here::here("Data/Tidy/dataPrep/Figures", "residence_15dayAnnualTs.png"), width = 5, height = 3)
```

2.14.18.1.5 Month and Year Boxplots

```
shortByMonth <- ggplot() +
  # geom_jitter(data = level, aes(x = MONTH, y = VALUE, color = YEAR), width = 0.1) +
   geom_boxplot(data = short, aes(x = MONTH, y = VALUE), fill = bc_colors[["BCBlue"]], outlier.color = "grey", linewidth = 0.8) +
  labs(x = "", y = "Residence Time (days)", title = "15-day Rolling Average") +
  theme_bw() +
  theme(axis.text.y = element_text(size = 12), axis.text.x = element_text(size = 12)) +
  theme(plot.title = element_text(hjust = 0.5), plot.subtitle = element_text(hjust = 0.5))

shortByMonth
```




```
ggsave(plot = shortByMonth, filename = here::here("Data/Tidy/dataPrep/Figures", "residence_15dayBy
Month.png"), width = 6.5, height = 3)

shortByYear <- ggplot() +
  #geom_jitter(data = level, aes(x = YEAR, y = VALUE, color = MONTH), width = 0.1) +
   geom_boxplot(data = short, aes(x = as.factor(YEAR), y = VALUE), fill = bc_colors[["BCBlue"]], outlier.co
lor = "grey", linewidth = 0.8) +
  labs(x = "", y = "Residence Time (days)", title = "15-day Rolling Average") +
  theme_bw() +
  theme(axis.text.y = element_text(size = 12), axis.text.x = element_text(angle = 90, size = 12, vjust = 0.4
)) +
  theme(plot.title = element_text(hjust = 0.5), plot.subtitle = element_text(hjust = 0.5))

shortByYear
```

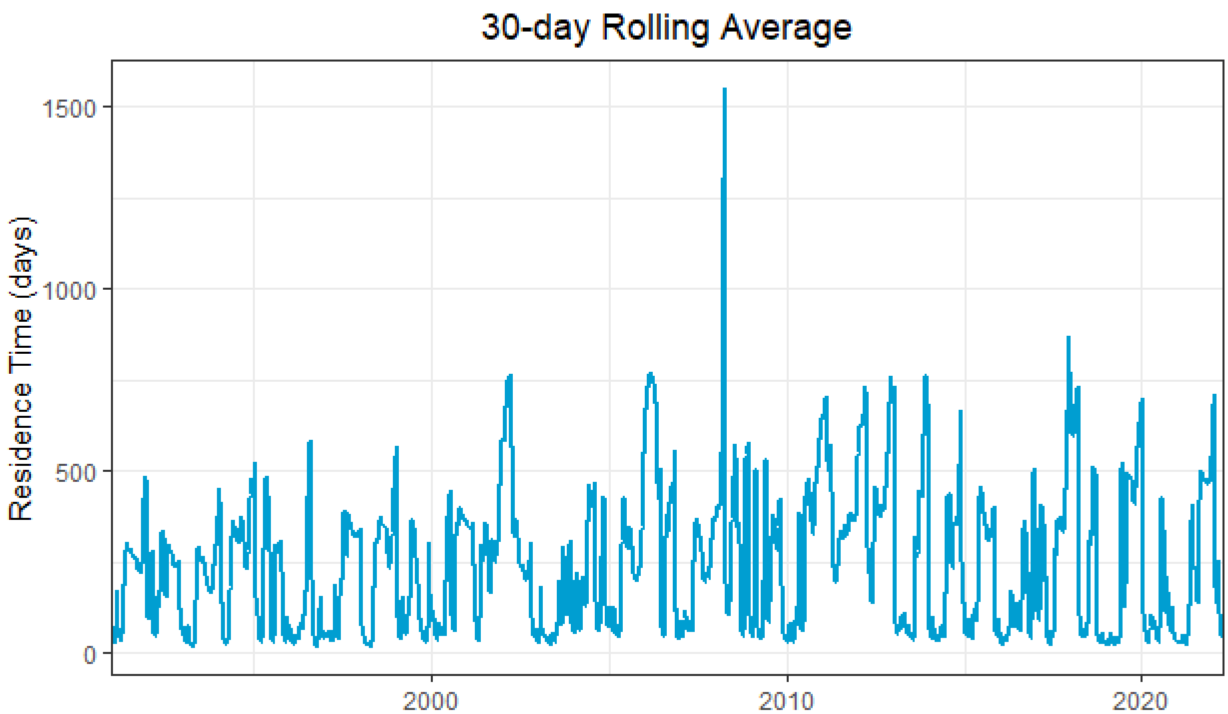



```
#ggsave(plot = shortByYear, filename = here::here("Data/Tidy/dataPrep/Figures", "residence_15dayByYear.png"), width = 6.5, height = 3)
```

2.14.19 30-day Rolling Average

2.14.19.1 Simple Time Series

```
long <- dplyr::filter(tidy, MEASUNIT == "30-day rolling average")

longTs <- ggplot() +
  geom_line(data = long, aes(x = DATE, y = VALUE), color = bc_colors[["BCBlue"]], linewidth = 1, na.rm = T) +
  labs(x = "", y = "Residence Time (days)", title = "30-day Rolling Average") +
  scale_x_date(expand = c(0,0)) +
  theme_bw() +
  theme(plot.title = element_text(hjust = 0.5), plot.subtitle = element_text(hjust = 0.5))

longTs
```

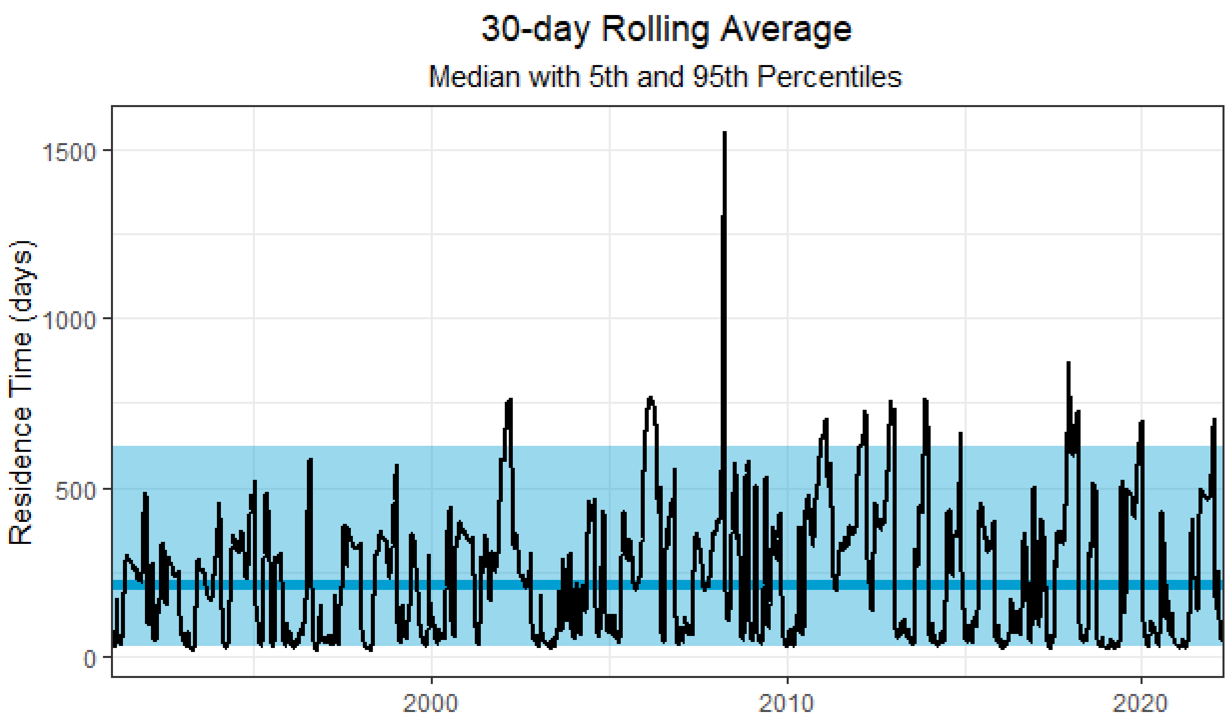



```
#ggsave(plot = longTs, filename = here::here("Data/Tidy/dataPrep/Figures", "residence_30dayTs.png"),
width = 5, height = 3)
```

2.14.19.2 Median with 5th and 95th Percentiles

```
longSumm <- data.frame(
  VAR = c("q05", "q50", "q95"),
  VAL = c(quantile(long$VALUE, 0.05, na.rm = T),
       median(long$VALUE, na.rm = T),
       quantile(long$VALUE, 0.95, na.rm = T))
  )
longSumm

##     VAR       VAL
## 5%  q05  30.15397
##     q50 214.52709
## 95% q95 623.39258

# Continuous time series of elevation
longDist <- ggplot() +
  annotate(geom = "rect", xmin = min(long$DATE), xmax = max(long$DATE),
        ymin = quantile(long$VALUE, 0.05, na.rm = T),
        ymax = quantile(long$VALUE, 0.95, na.rm = T),
        fill = bc_colors[["BCBlue"]], alpha = 0.4) +
  geom_hline(yintercept = median(long$VALUE, na.rm = T), color = bc_colors[["BCBlue"]], linewidth = 2)
+
  geom_line(data = long, aes(x = DATE, y = VALUE), color = "black", linewidth = 1) +
```

```
  scale_x_date(expand = c(0,0)) +
  scale_color_bc(bc_palettes, sub_pal = "cool", reverse = T) +
  labs(x = "", y = "Residence Time (days)", title = "30-day Rolling Average", subtitle = "Median with 5th an
d 95th Percentiles") +
  theme_bw() +
  theme(plot.title = element_text(hjust = 0.5), plot.subtitle = element_text(hjust = 0.5))

longDist
```



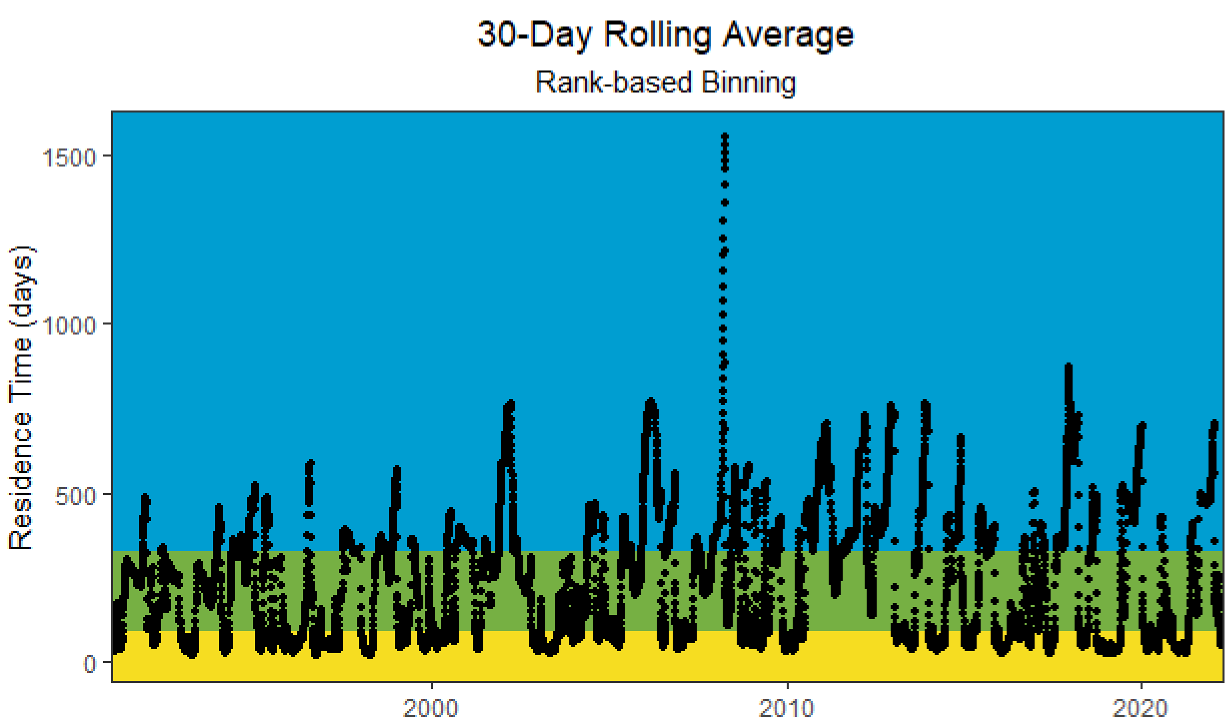

```
#ggsave(plot = longDist, filename = here::here("Data/Tidy/dataPrep/Figures", "residence_30dayMedian.
png"), width = 6.5, height = 3)
```

The blue line represents the median residence time (214.5270856 days) and the blue box covers range from the 5th to 95th percentile. Values above the blue box represent unusually long residence times during this reporting period (5% of measures were above the blue box). Values below the blue box represent unusually long residence times during this reporting period (5% of measures were below the blue box).

2.14.19.3 Alternative Binning Strategies

```
longRank <- binByRank(tidyDf = long, valCol = "VALUE")
longRange <- binByRange(tidyDf = long, valCol = "VALUE")
longPercent <- binByPercentile(tidyDf = long, valCol = "VALUE")

lCutRank <- longRank$cutPoints
lCutRange <- longRange$cutPoints
lCutPerc <- longPercent$cutPoints
```

```
# Rank based bins (1/3 of data observations in each bin)
longRank <- ggplot() +
 annotate(geom = "rect", xmin = min(long$DATE), xmax = max(long$DATE),
        ymin = -Inf, ymax = lCutRank[2], fill = bc_colors[["BCYellow"]]) +
 annotate(geom = "rect", xmin = min(long$DATE), xmax = max(long$DATE),
        ymin = lCutRank[2], ymax = lCutRank[3], fill = bc_colors[["BCGreen"]]) +
 annotate(geom = "rect", xmin = min(long$DATE), xmax = max(long$DATE),
        ymin = lCutRank[3], ymax = Inf, fill = bc_colors[["BCBlue"]]) +
 geom_point(data = long, aes(x = DATE, y = VALUE), color = "black", size = 1) +
 labs(x = "", y = "Residence Time (days)", title = "30-Day Rolling Average", subtitle = "Rank-based Binning
") +
 scale_x_date(expand = c(0,0)) +
 theme_bw() +
 theme(plot.title = element_text(hjust = 0.5), plot.subtitle = element_text(hjust = 0.5))

longRank
```

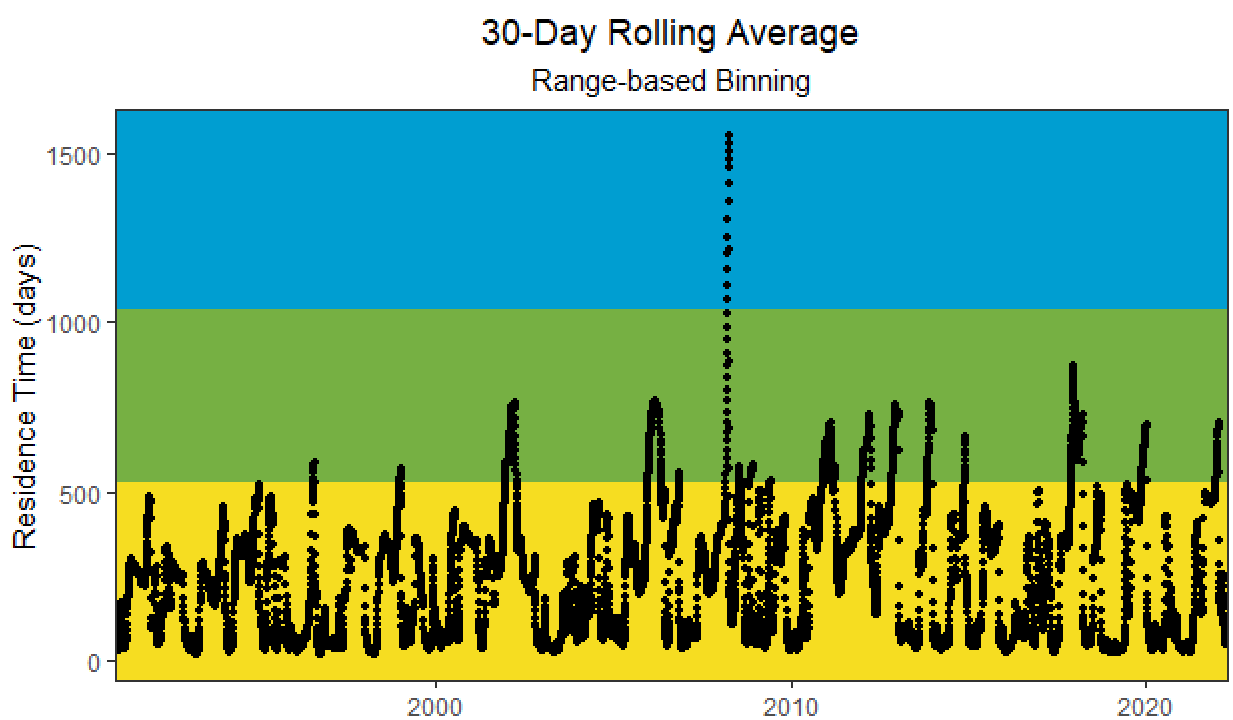



```
#ggsave(plot = longRank, filename = here::here("Data/Tidy/dataPrep/Figures", "residence_30dayRank.p
ng"), width = 6.5, height = 3)
```

The rank-based cut points were: 90.0426286 and 323.434135. Each bin contains an equal number of observations.

```
# Range based bins(min to max range divided into three equal segments)
longRange <- ggplot() +
 annotate(geom = "rect", xmin = min(long$DATE), xmax = max(long$DATE),
```

```
        ymin = -Inf, ymax = lCutRange[2], fill = bc_colors[["BCYellow"]]) +
  annotate(geom = "rect", xmin = min(long$DATE), xmax = max(long$DATE),
        ymin = lCutRange[2], ymax = lCutRange[3], fill = bc_colors[["BCGreen"]]) +
  annotate(geom = "rect", xmin = min(long$DATE), xmax = max(long$DATE),
        ymin = lCutRange[3], ymax = Inf, fill = bc_colors[["BCBlue"]]) +
  geom_point(data = long, aes(x = DATE, y = VALUE), color = "black", size = 1) +
  labs(x = "", y = "Residence Time (days)", title = "30-Day Rolling Average", subtitle = "Range-based Binnin
g") +
  scale_x_date(expand = c(0,0)) +
  theme_bw() +
  theme(plot.title = element_text(hjust = 0.5), plot.subtitle = element_text(hjust = 0.5))

longRange
```

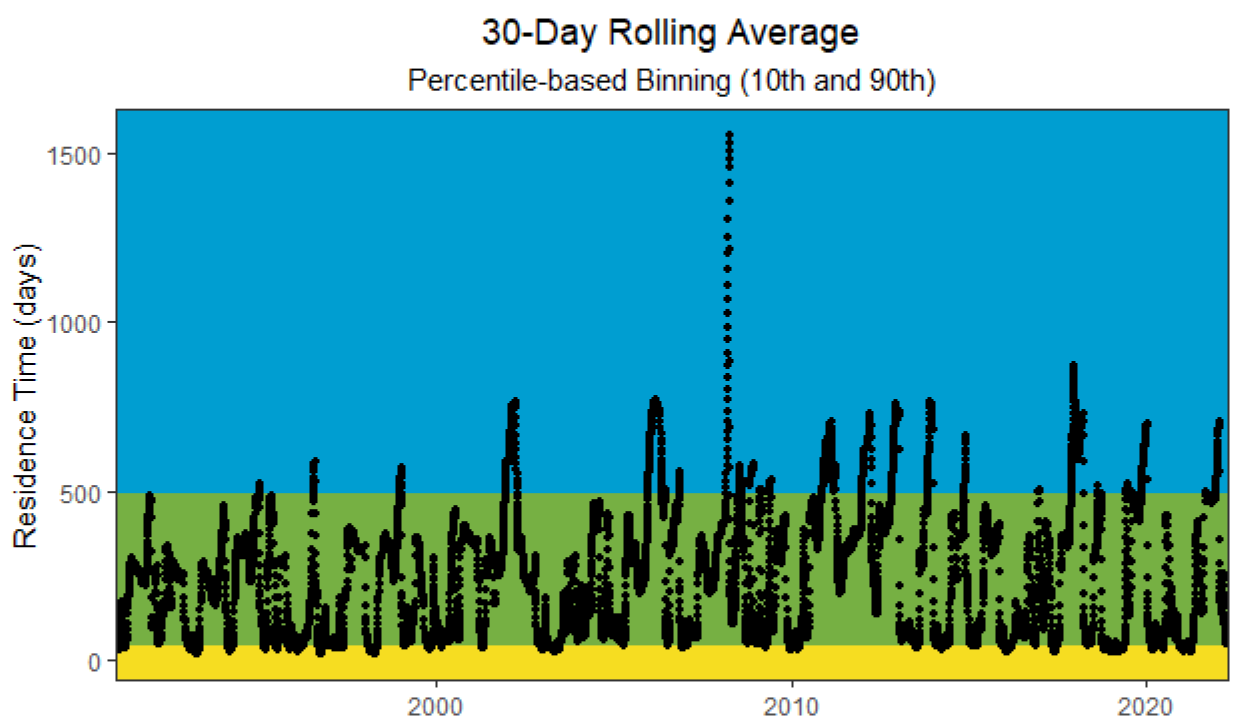



```
#ggsave(plot = longRange , filename = here::here("Data/Tidy/dataPrep/Figures", "residence_30dayRang
e.png"), width = 6.5, height = 3)
```

The range-based cut points were: 528.1524912 and 1039.6696083. Each bin covers an equal distance on the observed scale of measures.

```
# Percentile based bins (lowest 10%, middle, highest 10%)
longPercentile <- ggplot() +
  annotate(geom = "rect", xmin = min(long$DATE), xmax = max(long$DATE),
        ymin = -Inf, ymax = lCutPerc[2], fill = bc_colors[["BCYellow"]]) +
  annotate(geom = "rect", xmin = min(long$DATE), xmax = max(long$DATE),
        ymin = lCutPerc[2], ymax = lCutPerc[3], fill = bc_colors[["BCGreen"]]) +
  annotate(geom = "rect", xmin = min(long$DATE), xmax = max(long$DATE),
```

```
      ymin = lCutPerc[3], ymax = Inf, fill = bc_colors[["BCBlue"]]) +
 geom_point(data = long, aes(x = DATE, y = VALUE), size = 1) +
 labs(x = "", y = "Residence Time (days)", title = "30-Day Rolling Average", subtitle = "Percentile-based Bi
nning (10th and 90th)") +
 scale_x_date(expand = c(0,0)) +
 theme_bw() +
 theme(plot.title = element_text(hjust = 0.5), plot.subtitle = element_text(hjust = 0.5))

longPercentile
```



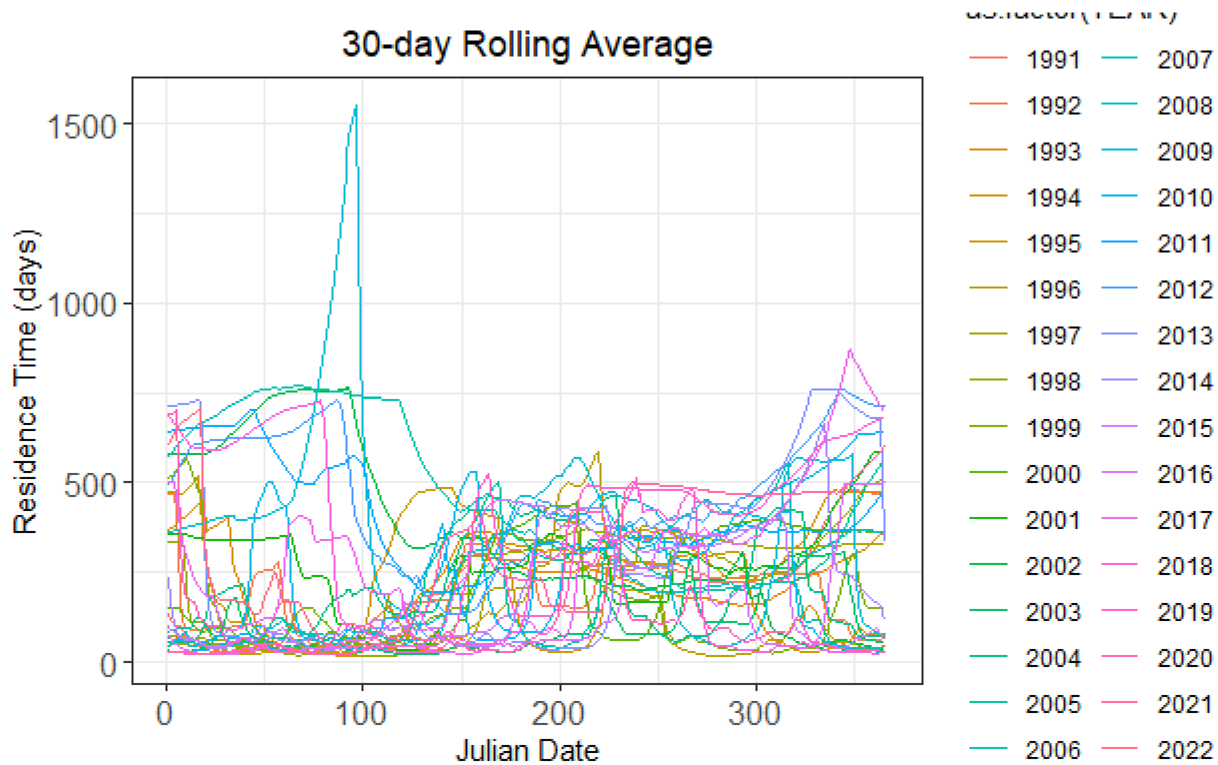

```
#ggsave(plot = longPercentile , filename = here::here("Data/Tidy/dataPrep/Figures", "residence_30dayP
ercentile.png"), width = 6.5, height = 3)
```

The percentile-based cut points were: 38.7650576 and 489.6550949. The central bin contains 80% of observations and the Low and High bin each contain 10% of the observations.

2.14.19.4 Julian Time Series

```
longAnnualTs <- ggplot() +
 geom_line(data = long, aes(x = JDATE, y = VALUE, color = as.factor(YEAR))) +
 labs(x = "Julian Date", y = "Residence Time (days)", title = "30-day Rolling Average") +
 #scale_x_continuous(expand = c(0,0)) +
 #scale_color_bc(bc_palettes, sub_pal = "mixed") +
 theme_bw() +
 theme(axis.text.y = element_text(size = 12), axis.text.x = element_text(size = 12)) +
 theme(plot.title = element_text(hjust = 0.5), plot.subtitle = element_text(hjust = 0.5))
```

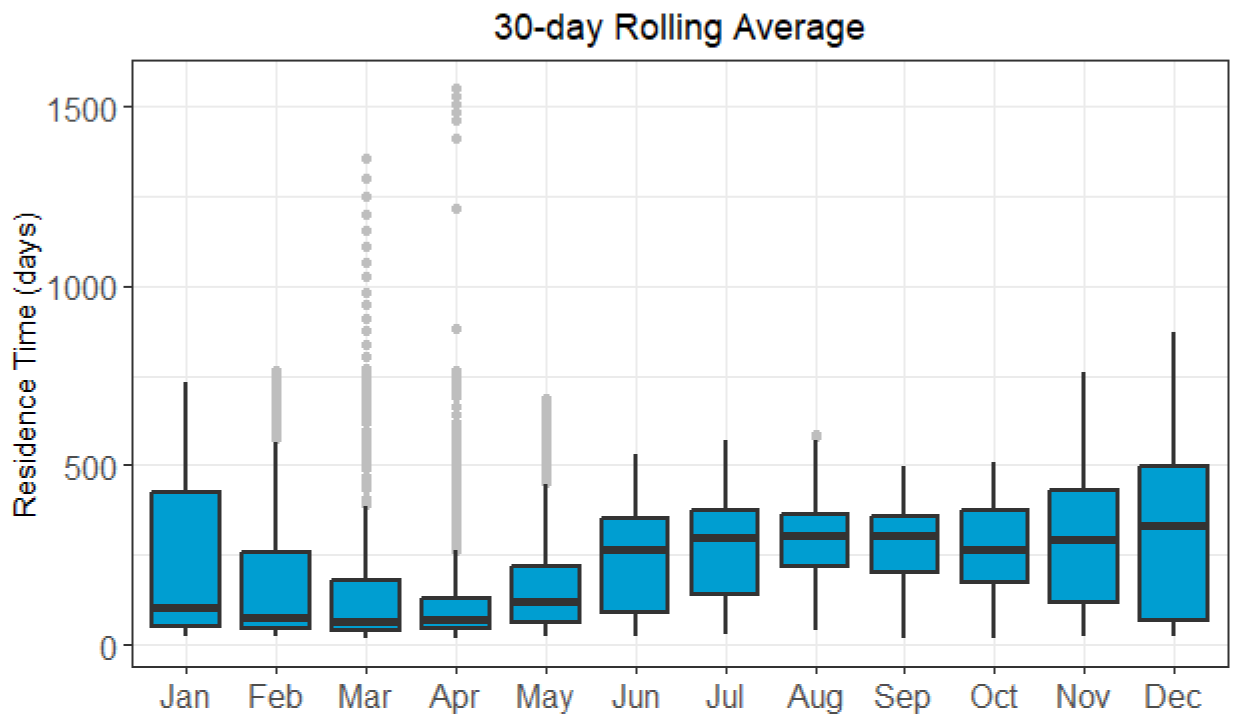
```
longAnnualTs
```



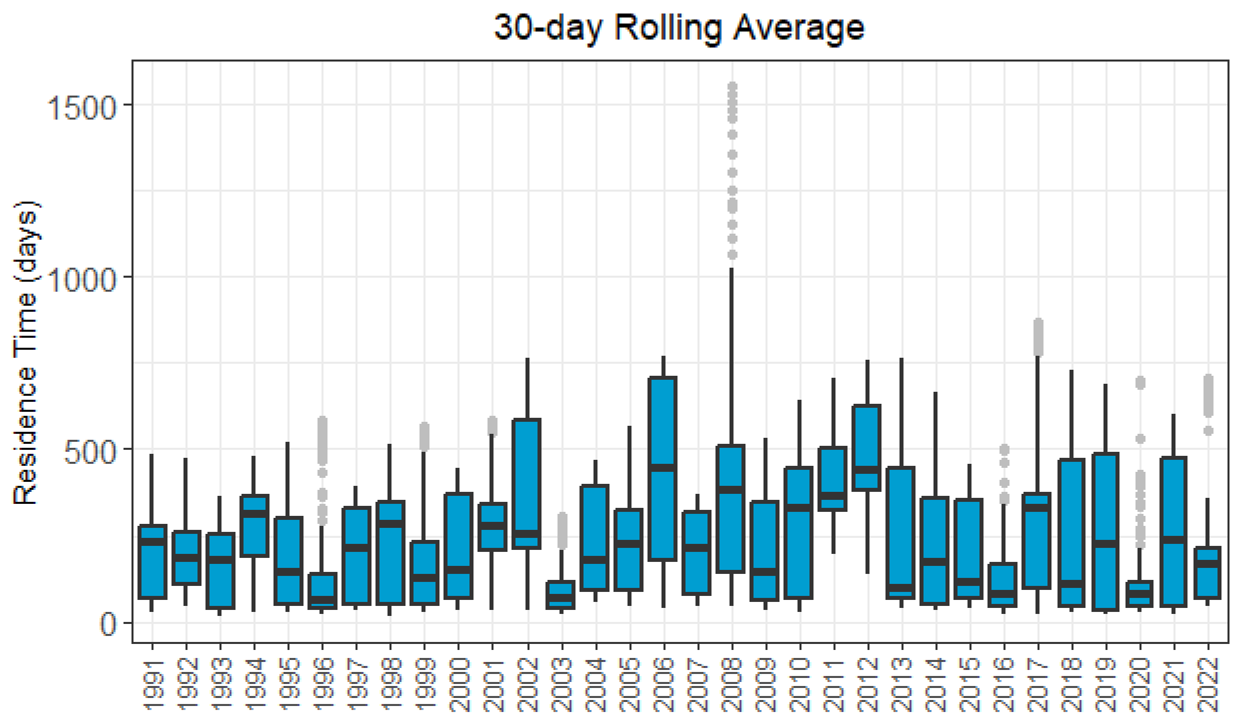

```
#ggsave(plot = longAnnualTs , filename = here::here("Data/Tidy/dataPrep/Figures", "residence_30dayAn
nualTs.png"), width = 5, height = 3)
```

2.14.19.5 Month and Year Boxplots

```
longByMonth <- ggplot() +
 # geom_jitter(data = level, aes(x = MONTH, y = VALUE, color = YEAR), width = 0.1) +
  geom_boxplot(data = long, aes(x = MONTH, y = VALUE), fill = bc_colors[["BCBlue"]], outlier.color = "gr
ey", linewidth = 0.8) +
 labs(x = "", y = "Residence Time (days)", title = "30-day Rolling Average") +
 theme_bw() +
 theme(axis.text.y = element_text(size = 12), axis.text.x = element_text(size = 12)) +
 theme(plot.title = element_text(hjust = 0.5), plot.subtitle = element_text(hjust = 0.5))

longByMonth
```




```
#ggsave(plot = longByMonth, filename = here::here("Data/Tidy/dataPrep/Figures", "residence_30dayBy
Month.png"), width = 5, height = 3)

longByYear <- ggplot() +
  #geom_jitter(data = level, aes(x = YEAR, y = VALUE, color = MONTH), width = 0.1) +
    geom_boxplot(data = long, aes(x = as.factor(YEAR), y = VALUE), fill = bc_colors[["BCBlue"]], outlier.col
or = "grey", linewidth = 0.8) +
  labs(x = "", y = "Residence Time (days)", title = "30-day Rolling Average") +
  theme_bw() +
  theme(axis.text.y = element_text(size = 12), axis.text.x = element_text(angle = 90, size = 10, vjust = 0.4
)) +
  theme(plot.title = element_text(hjust = 0.5), plot.subtitle = element_text(hjust = 0.5))

longByYear
```




```
#ggsave(plot = longByYear, filename = here::here("Data/Tidy/dataPrep/Figures", "residence_30dayByYe
ar.png"), width = 6.5, height = 3)
```

2.14.20 Export Tidy Data

We export two files *residence_15day.rds **and** residence_30day.rds**, as rds format into the dataPrep folder. Then we export the merged set of residence time variables as** tidy_lakewide_residence** as both rds and xlsx into the dataMerge folder.

```
short <- short %>%
  dplyr::mutate(VARIABLE = sprintf("%s (%s)", VARIABLE, str_to_lower(MEASUNIT)),
         MEASUNIT = "days",
         # Add standard columns that don't apply to lakewide measures, but required for integration wit
h other data
         LAKEUNIT = "Lakewide",
         LOCATE = "Lakewide",
         STATIONID = "Falls Lake",
         DEPTHM = NA_real_) %>%
 dplyr::select(-JDATE)
#saveRDS(short, here::here("Data/Tidy/dataPrep", "residence_resid15day.rds"))
readr::write_csv(short, here::here("Data/Tidy/AppendixC", "residence_resid15day.csv"))

long <- long %>%
  dplyr::mutate(VARIABLE = sprintf("%s (%s)", VARIABLE, str_to_lower(MEASUNIT)),
         MEASUNIT = "days",
         LAKEUNIT = "Lakewide",
         LOCATE = "Lakewide",
```

```
             STATIONID = "Falls Lake",
             DEPTHM = NA_real_) %>%
  dplyr::select(-JDATE)
#saveRDS(long, here::here("Data/Tidy/dataPrep", "residence_resid30day.rds"))
readr::write_csv(long, here::here("Data/Tidy/AppendixC", "residence_resid30day.csv"))

residence <- rbind(short, long)

# All residence time data
# saveRDS(long, here::here("Data/Tidy/dataPrep", "residence_lakewide_resid.rds"))
# openxlsx::write.xlsx(long, file = here::here("Data/Tidy/dataPrep/Excel", "residence_lakewide_resid.xlsx
"), overwrite = TRUE)
readr::write_csv(long, here::here("Data/Tidy/AppendixC", "residence_lakewide_resid.csv"))
```

Code prepared by KDV Decision Analysis LLC. Code last run 2024-08-29 with R version 4.4.1 (2024-06-14 ucrt).

2.15 Nutrient Loads to Lake Units (segloads)

The original load data for all three sources (sediments, atmosphere, and tributaries) were determined to have errors. A. Matos reworked all data, correcting calculation errors and extending the time series, and delivered improved data at end Oct 2023. These new data matched our tidy format and were already allocated to the new lake unit divisions. Thus our original data prep files (dataPrep_gam, dataPrep_bcAtmos, and dataPrep_sed) and data merge files (dataMerge_tnload and dataMerge_tpload) were all moved to the archive. This is

2.15.1 Nitrogen Loading

2.15.1.1 Sediment

The sediment load data were received as lbs/mo attributed at the level of month. We expanded the time series to daily values for the full extent of the data (Jan 1984 to Dec 2023). Each date was given the associated lbs/mo value.

```
# Sediment loads import as lbs/mo and require date expansion
tnsed <- readxl::read_xlsx(here::here(rawFile), sheet = "Sed_monthly_TN") %>%
  dplyr::select(-`Mo-Yr`, -DATE) %>%
  # Replace 4 letter abbr of September with 3 letter so following left join functions
  dplyr::mutate(MONTH = ifelse(MONTH == "Sept", "Sep", MONTH))



sedDates <- data.frame(DATE = seq(as.Date("1984-01-01"), as.Date("2023-12-31"), "+1 day")) %>%
  dplyr::mutate(MONTH = lubridate::month(DATE, abbr = T, label = T),
             YEAR = lubridate::year(DATE))
tnsed <- sedDates %>%
  dplyr::left_join(tnsed, by = c("YEAR", "MONTH")) %>%
  dplyr::mutate(VARIABLE = "Total Nitrogen Load",
```

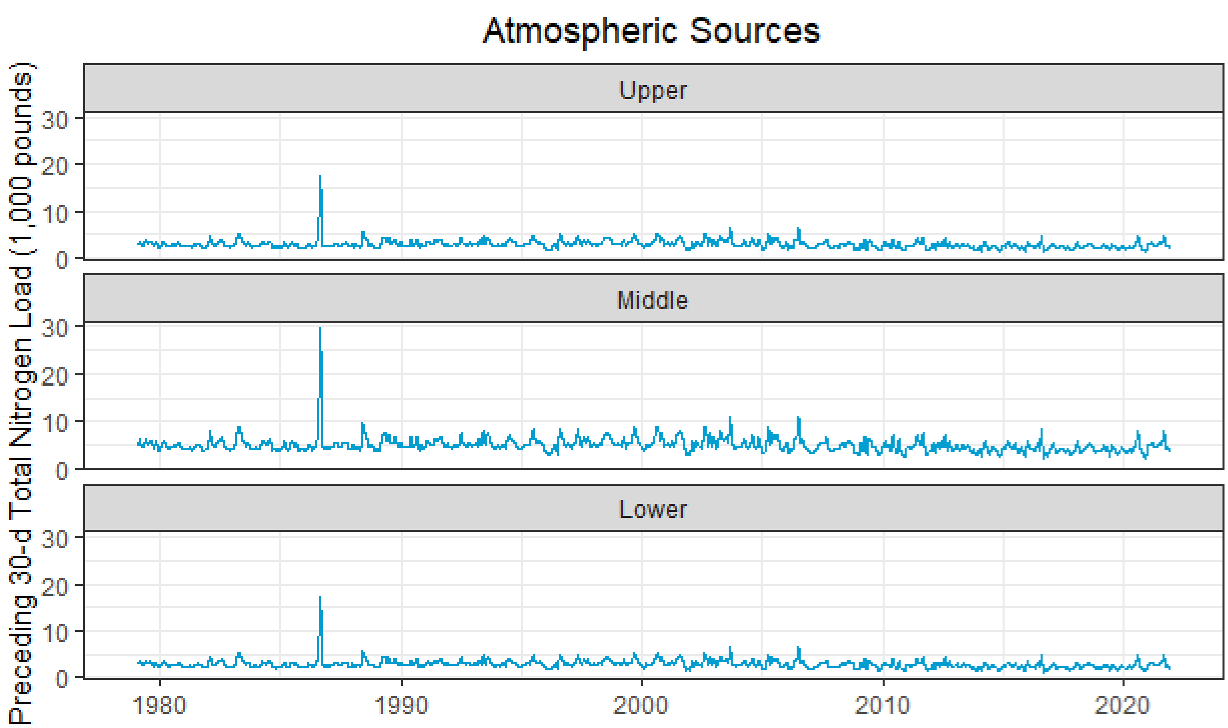
```
            LAKEUNIT = factor(LAKEUNIT, levels = c("Upper", "Middle", "Lower"), ordered = T))
rm(sedDates)


# Convert from lbs/mo to lbs per 30 day rolling sum
tnsed <- tnsed %>%
  dplyr::mutate(VALUE = zoo::rollsum(VALUE/30, 30, fill = NA, align = "right"), .by = "LAKEUNIT")


tsPlotData <- tnsed %>%
  dplyr::mutate(VALUE = VALUE/1000)

fig <- ggplot() +
  geom_line(data = tidyr::drop_na(tsPlotData, LAKEUNIT), aes(x = DATE, y = VALUE), color = bc_colors[["
BCBlue"]]) +
  scale_y_continuous(label = scales::label_comma()) +
  labs(title = "Sediment Sources", x = "", y = "Preceding 30-d Total Nitrogen Load (1,000 pounds)") +
  facet_wrap(~LAKEUNIT, nrow = 3) +
    theme_bw() +
  theme(plot.title = element_text(hjust = 0.5))
#ggsave(fig, filename = here::here("Data/Tidy/dataPrep/Figures", "tnload_sed_ts.png"), width = 6.5, hei
ght = 4.5)
rm(fig, tsPlotData)
```

2.15.1.2 Atmospheric

The atmospheric load data were received as lbs/mo attributed at the level of month. We expanded the time series to daily values for the full extent of the data (Jan 1979 to Dec 2021). Each date was given the associated lbs/mo value.

```
# Atmospheric loads import as lbs/mo and require date expansion
tnatmos <- readxl::read_xlsx(here::here("Data/Raw/UNRBA/SegmentLoads/tidy_tnatmos.xlsx"), sheet =
"Month") %>%
  dplyr::select(-`Mon-Yr`, -DATE)
atmosDates <- data.frame(DATE = seq(as.Date("1979-01-01"), as.Date("2021-12-31"), "+1 day")) %>%
  dplyr::mutate(MONTH = lubridate::month(DATE, abbr = T, label = T),
            YEAR = lubridate::year(DATE))
tnatmos <- atmosDates %>%
  dplyr::left_join(tnatmos, by = c("YEAR", "MONTH")) %>%
  dplyr::mutate(VARIABLE = "Total Nitrogen Load",
            LAKEUNIT = factor(LAKEUNIT, levels = c("Upper", "Middle", "Lower"), ordered = T))
rm(atmosDates)

# Convert from lbs/mo to lbs per 30 day rolling sum
tnatmos <- tnatmos %>%
  dplyr::mutate(VALUE = zoo::rollsum(VALUE/30, 30, fill = NA, align = "right"), .by = "LAKEUNIT")
```

```
tsPlotData <- tnatmos %>%
  dplyr::mutate(VALUE = VALUE/1000)


fig <- ggplot() +
  geom_line(data = tidyr::drop_na(tsPlotData, LAKEUNIT), aes(x = DATE, y = VALUE), color = bc_colors[["
BCBlue"]]) +
  scale_y_continuous(label = scales::label_comma()) +
  labs(title = "Atmospheric Sources", x = "", y = "Preceding 30-d Total Nitrogen Load (1,000 pounds)") +
  facet_wrap(~LAKEUNIT, nrow = 3) +
    theme_bw() +
  theme(plot.title = element_text(hjust = 0.5))
#ggsave(fig, filename = here::here("Data/Tidy/dataPrep/Figures", "tnload_atmos_ts.png"), width = 6.5,
height = 4.5)
fig
```




```
rm(fig, tsPlotData)
```

Per the one large spike in atmospheric load time series (see email correspondance with A. Matos, 2023-11-07 and 08)

This spike occurs in August 1986. The weeks in this month had very high rainfall amounts, and we do not have precipitation concentration data. For these weeks in August, we used the last week in July that did have nutrient concentration data. For both ammonia and nitrate, the July 1986 concentrations were very high. There is also no concentration data in September. We do have measurements in October that are lower. If we want to use those we would go from a monthly rate of so we used the most recent

Rates I gave you in pounds per month for the “new” segments for August and September 1986 (I had used the same assumption for Sept so may as well change that one too but it rained less so not as pronounced:

August: - New Lower : 17366.69 - New Middle: 29804.22 - New Upper: 17338.03

September: - New Lower : 2688.206 - New Middle: 4613.422 - New Upper: 2683.77

Rates that would result if we select Oct concentrations rather than July

August: - NewLower: 7437.197 - NewMiddle: 12763.51 - NewUpper: 7424.924

September: - NewLower: 2244.343 - NewMiddle: 3851.677 - NewUpper: 2240.639

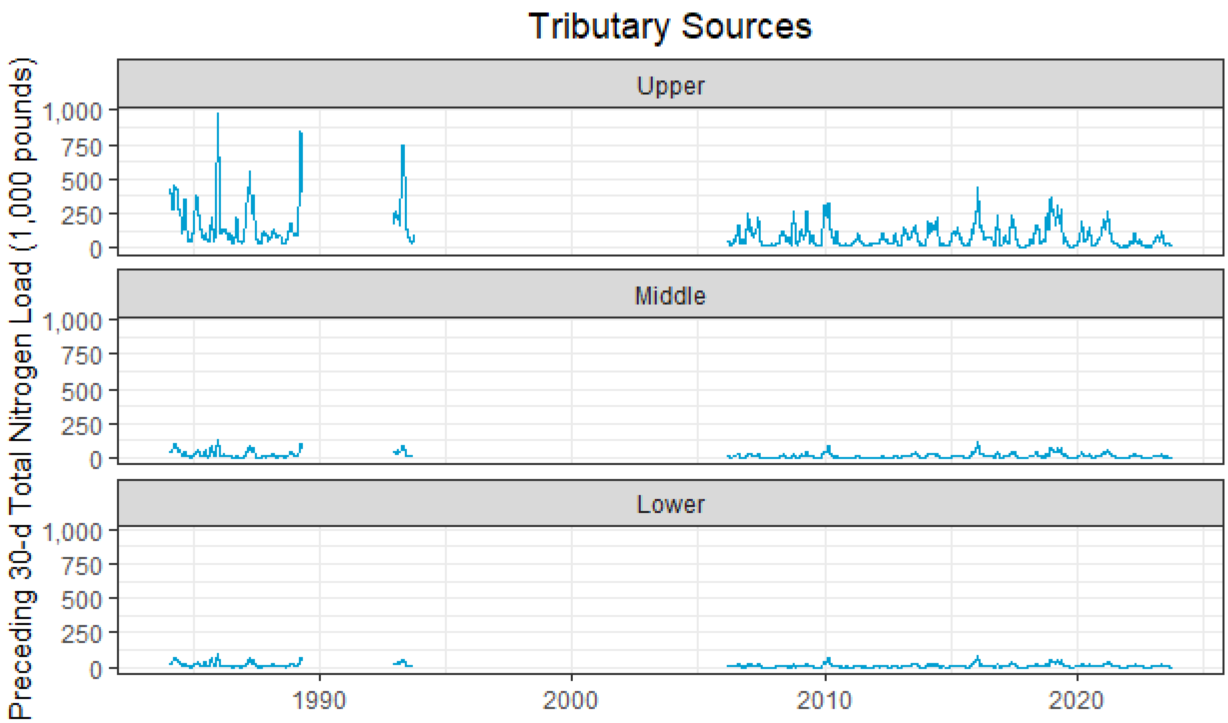
[This choice] also affects TP and TOC deposition, and loads between segments.

2.15.1.3 Tributary

The tributary load data were received as lbs/day attributed at the level of date. We calculated the rolling 30-day sum to serve as a lbs/mo estimate. Each date was given it’s own lbs/mo value. The rolling sum results in NA for the first 29 values. We replaced these NA values with the sum of all January 1984 dates.

```
# Tributary loads as lbs/day - so calculate the 30-day rolling sum
tntrib <- readxl::read_xlsx(here::here("Data/Raw/UNRBA/SegmentLoads/tidy_tntrib.xlsx"), sheet = "Day
", col_types = c("text", "date", "numeric", "text", "text", "text", "text", "numeric", "text", "numeric", "tex
t", "text"))
jan84 <- sum(dplyr::filter(tntrib, YEAR == 1984, MONTH == "Jan")[["VALUE"]])
tntrib <- tntrib %>%
  dplyr::mutate(DATE = as.Date(DATE)) %>%
  dplyr::mutate(VALUE = zoo::rollsum(VALUE, k = 30, fill = NA, align = "right")) %>%
  dplyr::mutate(VALUE = if_else(is.na(VALUE) & YEAR == 1984 & MONTH == "Jan", jan84, VALUE)) %>%
  dplyr::mutate(MEASUNIT = "lbs/month") %>%
  dplyr::select(-`Mo-Yr`) %>%
  dplyr::mutate(VARIABLE = "Total Nitrogen Load",
          LAKEUNIT = factor(LAKEUNIT, levels = c("Upper", "Middle", "Lower"), ordered = T),
          MONTH = lubridate::month(DATE, label = TRUE, abbr = TRUE))
rm(jan84)

# Convert from lbs/mo to lbs per 30 day rolling sum
tntrib <- tntrib %>%
  dplyr::mutate(VALUE = zoo::rollsum(VALUE/30, 30, fill = NA, align = "right"), .by = "LAKEUNIT")

tsPlotData <- tntrib %>%
  dplyr::mutate(VALUE = VALUE/1000)


fig <- ggplot() +
  geom_line(data = drop_na(tsPlotData, LAKEUNIT), aes(x = DATE, y = VALUE), color = bc_colors[["BCBlu
e"]], size = 0.5) +
  scale_y_continuous(label = scales::label_comma()) +
  labs(title = "Tributary Sources", x = "", y = "Preceding 30-d Total Nitrogen Load (1,000 pounds)") +
```

```
  facet_wrap(~LAKEUNIT, nrow = 3) +
  theme_bw() +
  theme(plot.title = element_text(hjust = 0.5))
#ggsave(fig, filename = here::here("Data/Tidy/dataPrep/Figures", "tnload_trib_ts.png"), width = 6.5, hei
ght = 4.5)
fig
```



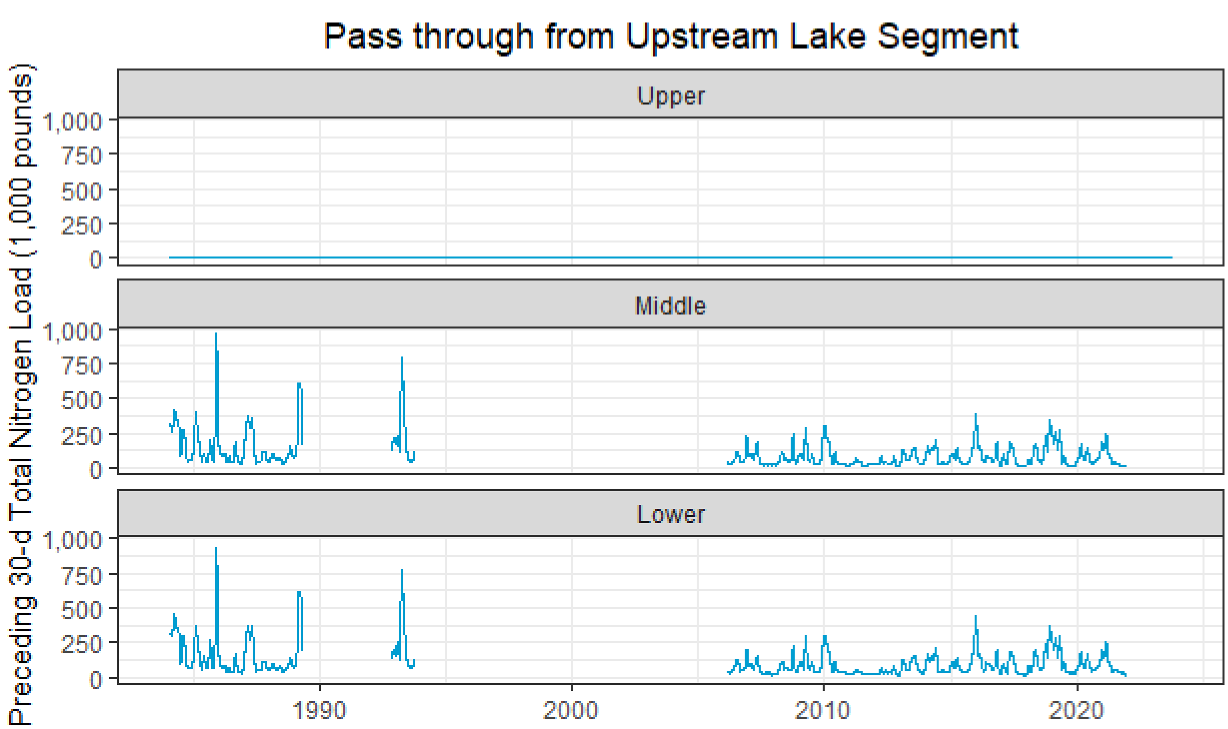

```
rm(fig, tsPlotData)
```

2.15.1.4 Pass Through

The pass through load data were received as lbs/mo attributed at the level of month. We expanded the time series to daily values for the full extent of the data (Jan 1979 to Dec 2021). Each date was given the associated lbs/mo value.

```
tnpass <- readxl::read_xlsx(here::here("Data/Raw/UNRBA/SegmentLoads/tidy_tnsegment.xlsx"),
                    sheet = "Segment_monthly_TN") %>%
  dplyr::select(-`Mo-Yr`, -DATE)  %>%
  # Replace 4 letter abbr of September with 3 letter so following left join functions
  dplyr::mutate(MONTH = ifelse(MONTH == "Sept", "Sep", MONTH))

tnpassDates <- data.frame(DATE = seq(as.Date("1984-01-01"), as.Date("2023-12-31"),
                          by = "+1 day")) %>%
  dplyr::mutate(MONTH = lubridate::month(DATE, abbr = T, label = T),
         YEAR = lubridate::year(DATE))

tnpass <- left_join(tnpassDates, tnpass, by = c("YEAR", "MONTH")) %>%
```

```
  dplyr::mutate(VARIABLE = "Total Nitrogen Load",
           LAKEUNIT = factor(LAKEUNIT, levels = c("Upper", "Middle", "Lower"), ordered = T),
           SOURCE = "PASS")

rm(tnpassDates)


# Convert from lbs/mo to lbs per 30 day rolling sum
tnpass <- tnpass %>%
  dplyr::mutate(VALUE = zoo::rollsum(VALUE/30, 30, fill = NA, align = "right"), .by = "LAKEUNIT")

tsPlotData <- tnpass %>%
  dplyr::mutate(VALUE = VALUE/1000)

fig <- ggplot() +
  geom_line(data = tidyr::drop_na(tsPlotData, LAKEUNIT), aes(x = DATE, y = VALUE), color = bc_colors[["
BCBlue"]]) +
  scale_y_continuous(label = scales::label_comma()) +
  labs(title = "Pass through from Upstream Lake Segment", x = "", y = " Preceding 30-d Total Nitrogen Loa
d (1,000 pounds)") +
  facet_wrap(~LAKEUNIT, nrow = 3) +
  theme_bw() +
  theme(plot.title = element_text(hjust = 0.5))
fig
```

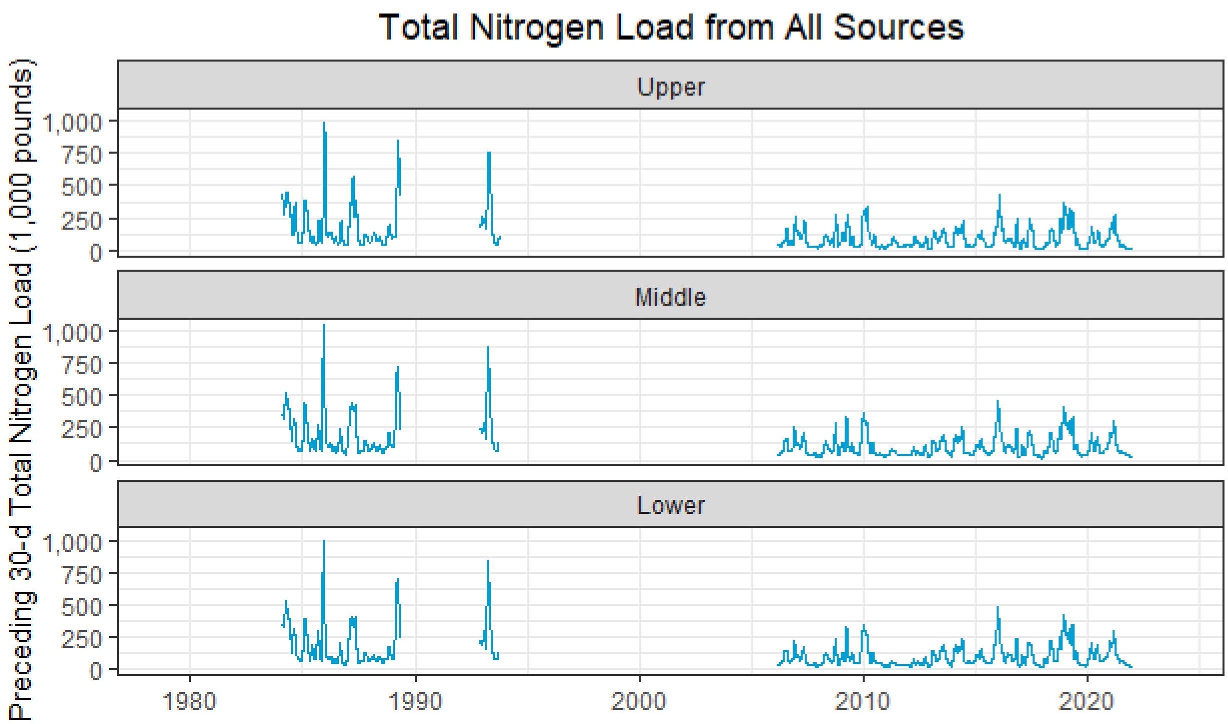


```
#ggsave(fig, filename = here::here("Data/Tidy/dataPrep/Figures", "tnload_tnpass_ts.png"), width = 6.5, height = 4.5)
rm(fig)
```

2.15.1.5 All Sources Combined

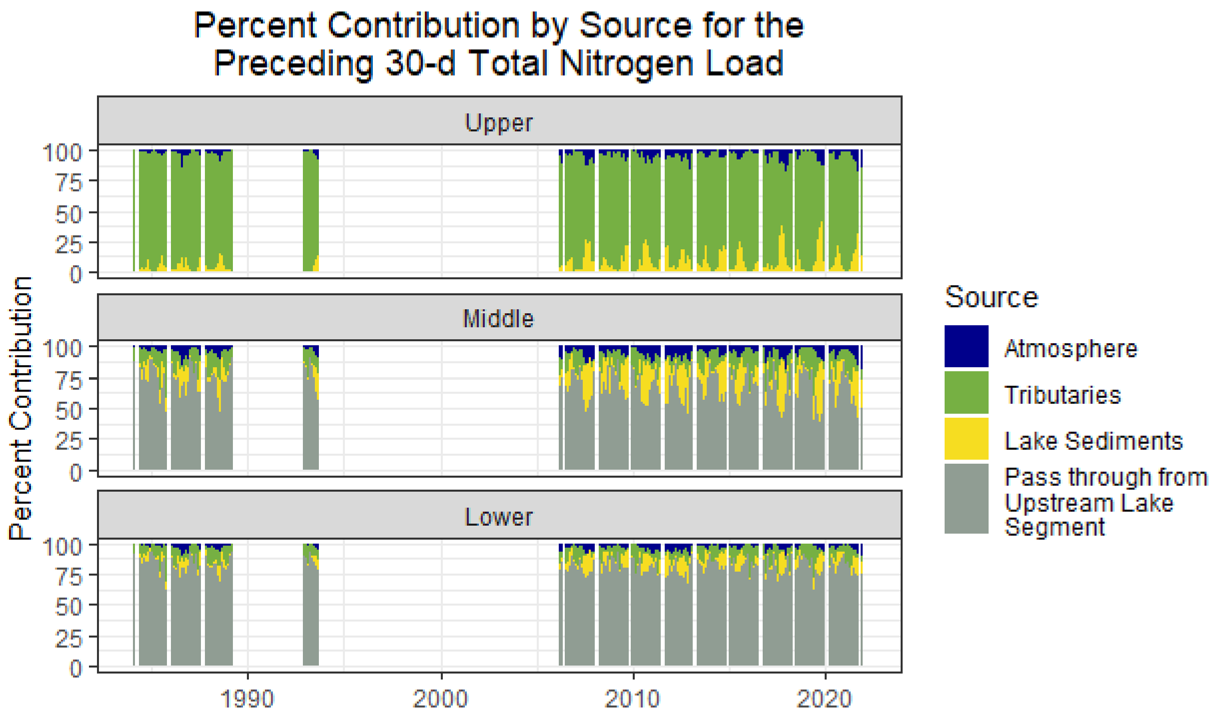
After combining all sources, measurements are converted from lbs/mo to lbs per 30-day rolling sum by dividing each measurement by 30, then performing a 30 day rolling sum on the result.

```
tnAll <- rbind(tnsed, tnatmos, tntrib, tnpass) %>%
  tidyr::pivot_wider(names_from = SOURCE, values_from = VALUE) %>%
  dplyr::select(-`NA`) %>%
  dplyr::mutate(TOTAL = SED + ATMOS + TRIB + PASS,
                PSED = round((SED/TOTAL)*100, 1),
                PATMOS = round((ATMOS/TOTAL)*100, 1),
                PTRIB = round((TRIB/TOTAL)*100, 1),
                PPASS = round((PASS/TOTAL)*100, 1),
                MEASUNIT = "(lbs), per 30-day rolling sum")

# Store temporary plot data with TOTAL/1000 to ease readability of figure
tsPlotData <- tnAll %>%
  dplyr::mutate(TOTAL = TOTAL/1000)


fig <- ggplot() +
  geom_line(data = tidyr::drop_na(tsPlotData, LAKEUNIT), aes(x = DATE, y = TOTAL), color = bc_colors[["BCBlue"]]) +
  scale_y_continuous(label = scales::label_comma()) +
  labs(title = "Total Nitrogen Load from All Sources", x = "", y = "Preceding 30-d Total Nitrogen Load (1,000 pounds)") +
  facet_wrap(~LAKEUNIT, nrow = 3) +
  theme_bw() +
  theme(plot.title = element_text(hjust = 0.5))
fig
```




```
#ggsave(fig, filename = here::here("Data/Tidy/dataPrep/Figures", "tnload_all_ts.png"), width = 6.5, heig
ht = 4.5)
rm(fig, tsPlotData)


percPlotData <- tnAll %>%
  tidyr::pivot_longer(cols = PSED:PPASS, names_to = "LOADSRC", values_to = "VALUE") %>%
  dplyr::mutate(LOADSRC = factor(LOADSRC, levels = c("PATMOS", "PTRIB", "PSED", "PPASS"), ordered =
T)) #%>%

fig <- ggplot() +
  geom_col(data = tidyr::drop_na(percPlotData, LAKEUNIT), aes(x = DATE, y = VALUE, fill = LOADSRC)) +
  labs(title = "Percent Contribution by Source for the\nPreceding 30-d Total Nitrogen Load", x = "",
     y = "Percent Contribution", fill = "Source") +
  scale_fill_manual(values = c("PATMOS" = "darkblue", "PTRIB" = bc_colors[["BCGreen"]],
                        "PSED" = bc_colors[["BCYellow"]], "PPASS" = bc_colors[["BCWarmGrey"]]),
                 labels = c("PATMOS" = "Atmosphere", "PTRIB" = "Tributaries",
                        "PSED" = "Lake Sediments", "PPASS" = "Pass through from\nUpstream Lake\nSegment
")) +
  facet_wrap(~LAKEUNIT, nrow = 3) +
   theme_bw() +
  theme(plot.title = element_text(hjust = 0.5),
      plot.subtitle = element_text(hjust = 0.5))
#ggsave(fig, filename = here::here("Data/Tidy/dataPrep/Figures", "tnload_allPercentsBySource_ts.png"),
```

```
width = 6.5, height = 4.5)
fig
```




```
rm(fig)
```

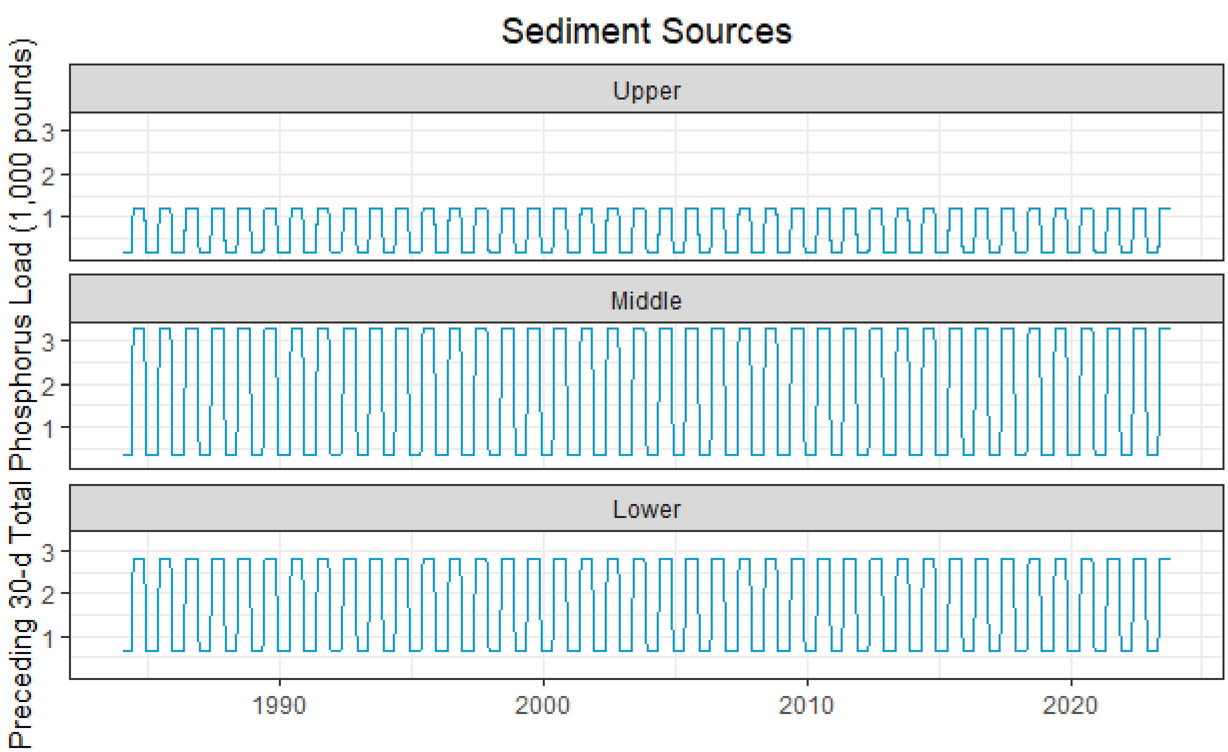
2.15.2 Phosphorus Loading

2.15.2.1 Sediment

The sediment load data were received as lbs/mo attributed at the level of month. We expanded the time series to daily values for the full extent of the data (Jan 1984 to Oct 2023). Each date was given the associated lbs/mo value.

```
# Sediment loads import as lbs/mo and require date expansion
tpsed <- readxl::read_xlsx(here::here("Data/Raw/UNRBA/SegmentLoads/tidy_tpsed.xlsx"), sheet = "Sed
_monthly_TP") %>%
  dplyr::select(-`Mo-Yr`, -DATE) %>%
  # Replace 4 letter abbr of September with 3 letter so following left join functions
  dplyr::mutate(MONTH = ifelse(MONTH == "Sept", "Sep", MONTH))

sedDates <- data.frame(DATE = seq(as.Date("1984-01-01"), as.Date("2023-10-31"), "+1 day")) %>%
  dplyr::mutate(MONTH = lubridate::month(DATE, abbr = T, label = T),
         YEAR = lubridate::year(DATE))
tpsed <- sedDates %>%
  dplyr::left_join(tpsed, by = c("YEAR", "MONTH")) %>%
  dplyr::mutate(VARIABLE = "Total Phosphorus Load",
         LAKEUNIT = factor(LAKEUNIT, levels = c("Upper", "Middle", "Lower"), ordered = T))
rm(sedDates)
```

```
tpsed <- tpsed  %>%
  dplyr::mutate(VALUE = zoo::rollsum(VALUE/30, 30, fill = NA, align = "right"), .by = "LAKEUNIT")

tsPlotData <- tpsed %>%
  dplyr::mutate(VALUE = VALUE/1000)

fig <- ggplot() +
  geom_line(data = tidyr::drop_na(tsPlotData, LAKEUNIT), aes(x = DATE, y = VALUE), color = bc_colors[["
BCBlue"]]) +
  scale_y_continuous(label = scales::label_comma()) +
  labs(title = "Sediment Sources", x = "", y = "Preceding 30-d Total Phosphorus Load (1,000 pounds)") +
  facet_wrap(~LAKEUNIT, nrow = 3) +
   theme_bw() +
  theme(plot.title = element_text(hjust = 0.5))
fig
```

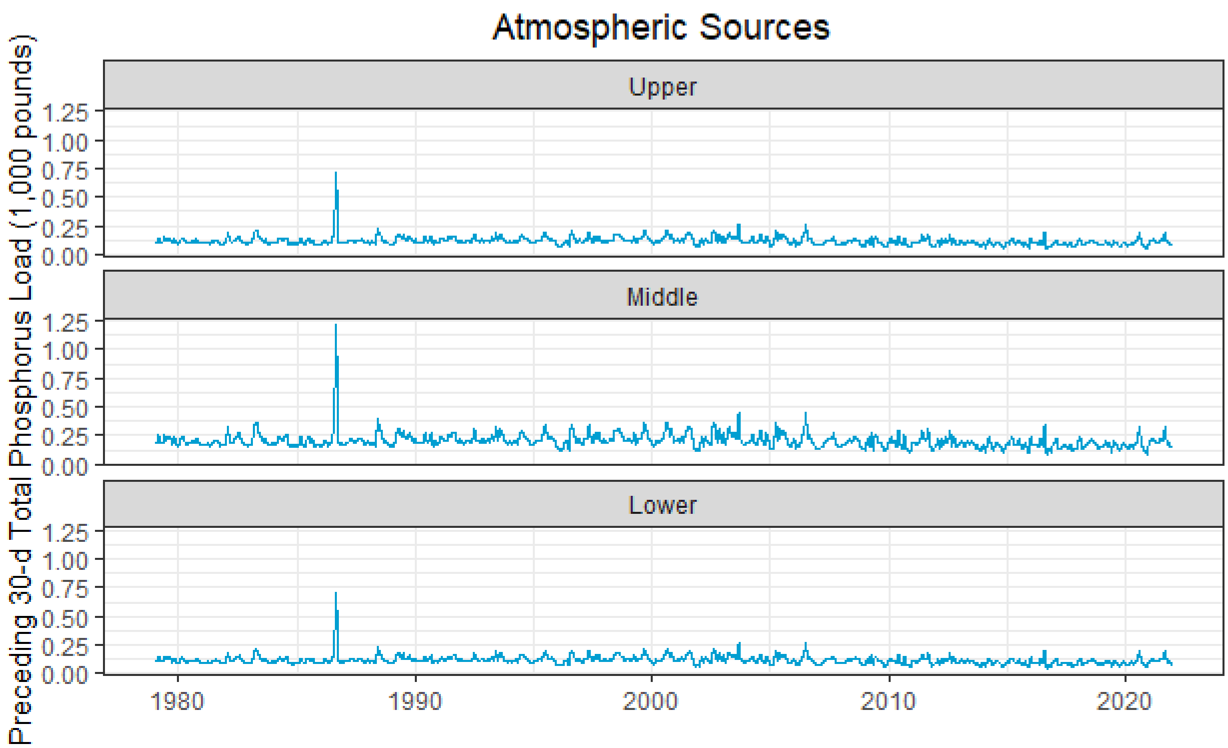



```
#ggsave(fig, filename = here::here("Data/Tidy/dataPrep/Figures", "tpload_sed_ts.png"), width = 6.5, hei
ght = 4.5)
rm(fig, tsPlotData)
```

2.15.2.2 Atmospheric

The sediment load data were received as lbs/mo attributed at the level of month. We expanded the time series to daily values for the full extent of the data (Jan 1979 to Dec 2021). Each date was given the associated lbs/mo value.

```
# Atmospheric loads import as lbs/mo and require date expansion
tpatmos <- readxl::read_xlsx(here::here("Data/Raw/UNRBA/SegmentLoads/tidy_tpatmos.xlsx"), sheet =
"Month") %>%
  dplyr::select(-`Mon-Yr`, -DATE)
atmosDates <- data.frame(DATE = seq(as.Date("1979-01-01"), as.Date("2021-12-31"), "+1 day")) %>%
  dplyr::mutate(MONTH = lubridate::month(DATE, abbr = T, label = T),
         YEAR = lubridate::year(DATE))
tpatmos <- atmosDates %>%
  dplyr::left_join(tpatmos, by = c("YEAR", "MONTH")) %>%
  dplyr::mutate(VARIABLE = "Total Phosphorus Load",
         LAKEUNIT = factor(LAKEUNIT, levels = c("Upper", "Middle", "Lower"), ordered = T))
rm(atmosDates)

tpatmos <- tpatmos %>%
  dplyr::mutate(VALUE = zoo::rollsum(VALUE/30, 30, fill = NA, align = "right"), .by = "LAKEUNIT")

tsPlotData <- tpatmos %>%
  dplyr::mutate(VALUE = VALUE/1000)


fig <- ggplot() +
  geom_line(data = tidyr::drop_na(tsPlotData, LAKEUNIT), aes(x = DATE, y = VALUE), color = bc_colors[["
BCBlue"]]) +
  scale_y_continuous(label = scales::label_comma()) +
  labs(title = "Atmospheric Sources", x = "", y = "Preceding 30-d Total Phosphorus Load (1,000 pounds)")
+
  facet_wrap(~LAKEUNIT, nrow = 3) +
   theme_bw() +
  theme(plot.title = element_text(hjust = 0.5))
fig
```



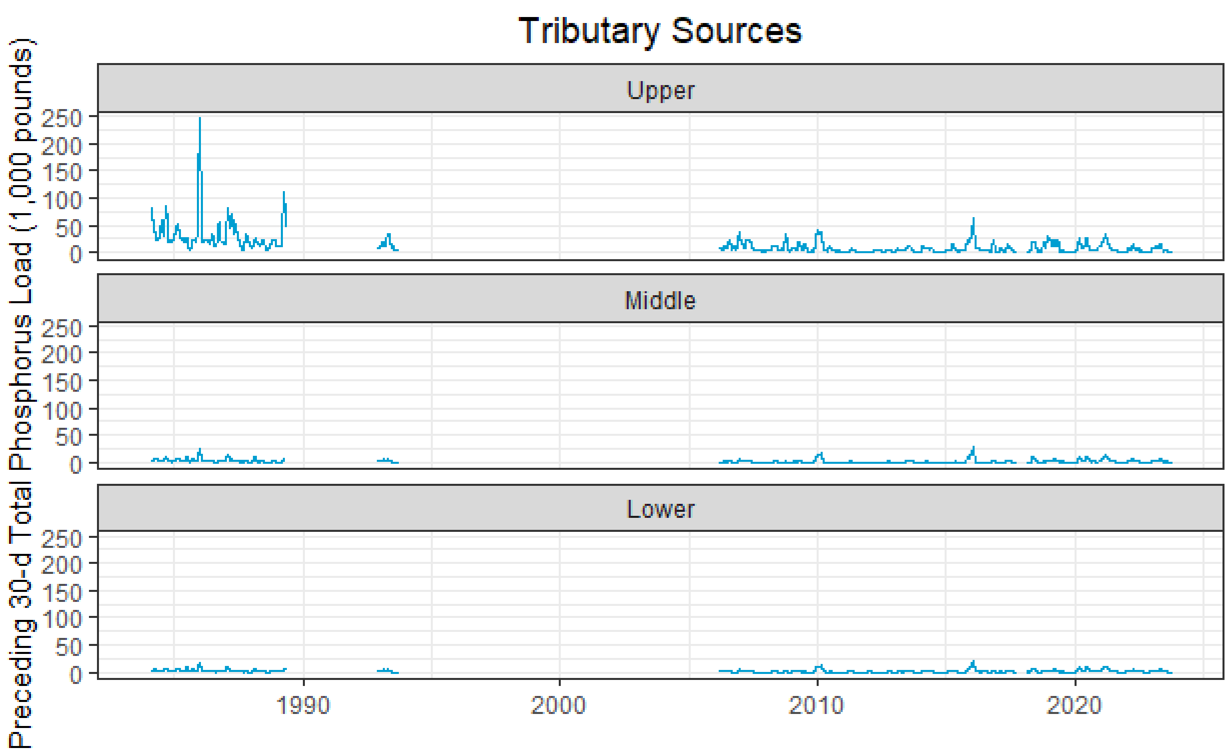

```
#ggsave(fig, filename = here::here("Data/Tidy/dataPrep/Figures", "tpload_atmos_ts.png"), width = 6.5,
height = 4.5)
rm(fig, tsPlotData)
```

2.15.2.3 Tributary

The tributary load data were received as lbs/day attributed at the level of date. We calculated the rolling 30-day sum to serve as a lbs/mo estimate. Each date was given it's own lbs/mo value. The rolling sum results in NA for the first 29 values. We replaced these NA values with the sum of all January 1984 dates.

```
# Tributary loads as lbs/day - so calculate the 30-day rolling sum
tptrib <- readxl::read_xlsx(here::here("Data/Raw/UNRBA/SegmentLoads/tidy_tptrib.xlsx"), sheet = "Day
", col_types = c("text", "date", "numeric", "text", "text", "text", "text", "numeric", "text", "numeric", "tex
t", "text"))
jan84 <- sum(dplyr::filter(tptrib, YEAR == 1984, MONTH == "Jan")[["VALUE"]])
tptrib <- tptrib %>%
  dplyr::mutate(DATE = as.Date(DATE)) %>%
  dplyr::mutate(VALUE = zoo::rollsum(VALUE, k = 30, fill = NA, align = "right")) %>%
  dplyr::mutate(VALUE = if_else(is.na(VALUE) & YEAR == 1984 & MONTH == "Jan", jan84, VALUE)) %>%
  dplyr::mutate(MEASUNIT = "lbs/month") %>%
  dplyr::select(-`Mo-Yr`) %>%
  dplyr::mutate(VARIABLE = "Total Phosphorus Load",
           LAKEUNIT = factor(LAKEUNIT, levels = c("Upper", "Middle", "Lower"), ordered = T),
           MONTH = lubridate::month(DATE, label = TRUE, abbr = TRUE))
rm(jan84)
```

```
tptrib <- tptrib  %>%
  dplyr::mutate(VALUE = zoo::rollsum(VALUE/30, 30, fill = NA, align = "right"), .by = "LAKEUNIT")
#"Preceding 30-d Total Phosphorus Load (1,000 pounds)"

tsPlotData <- tptrib %>%
  dplyr::mutate(VALUE = VALUE/1000)

fig <- ggplot() +
  geom_line(data = tsPlotData, aes(x = DATE, y = VALUE), color = bc_colors[["BCBlue"]], size = 0.5) +
  scale_y_continuous(label = scales::label_comma()) +
  labs(title = "Tributary Sources", x = "", y = "Preceding 30-d Total Phosphorus Load (1,000 pounds)") +
  facet_wrap(~LAKEUNIT, nrow = 3) +
  theme_bw() +
  theme(plot.title = element_text(hjust = 0.5))
fig
```

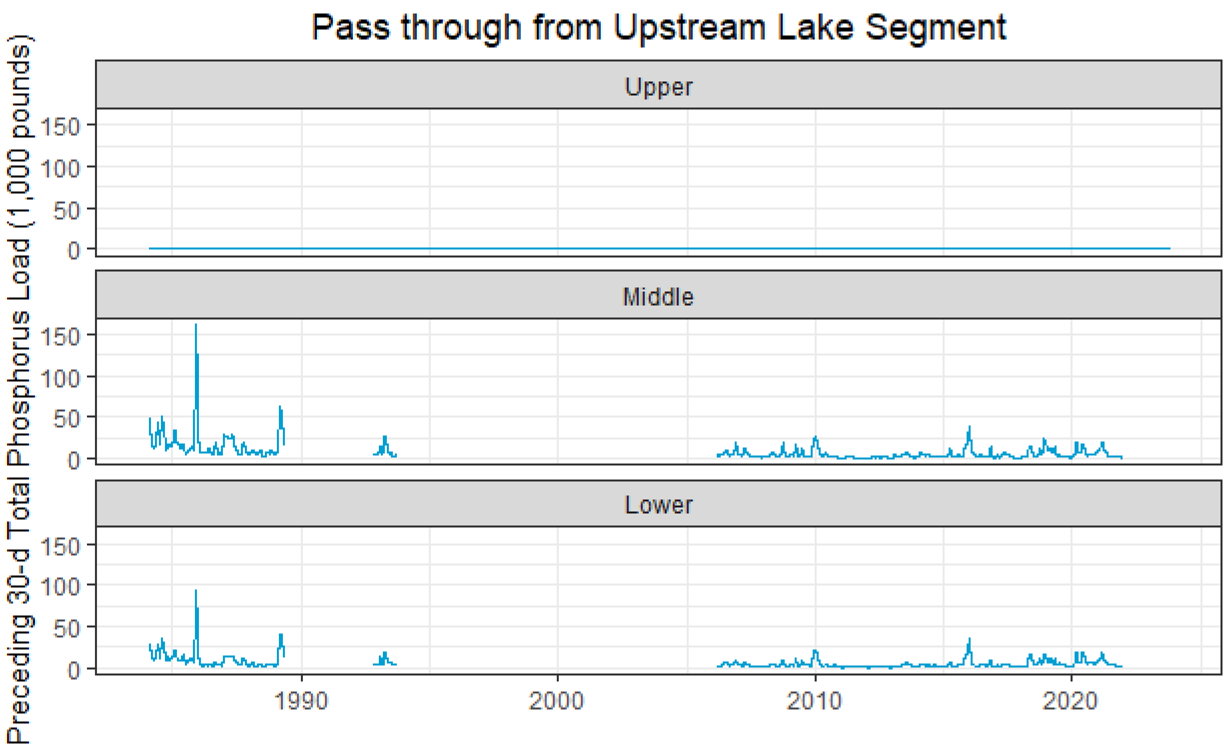



```
#ggsave(fig, filename = here::here("Data/Tidy/dataPrep/Figures", "tpload_trib_ts.png"), width = 6.5, hei
ght = 4.5)
rm(fig)
```

2.15.2.4 Pass Through

```
tppass <- readxl::read_xlsx(here::here("Data/Raw/UNRBA/SegmentLoads/tidy_tpsegment.xlsx"),
                            sheet = "Segment_monthly_TP") %>%
  dplyr::select(-`Mo-Yr`, -DATE) %>%
  # Replace 4 letter abbr of September with 3 letter so following left join functions
```

```
  dplyr::mutate(MONTH = ifelse(MONTH == "Sept", "Sep", MONTH))

tppassDates <- data.frame(DATE = seq(as.Date("1984-01-01"), as.Date("2023-12-31"),
                                     by = "+1 day")) %>%
  dplyr::mutate(MONTH = lubridate::month(DATE, abbr = T, label = T),
                YEAR = lubridate::year(DATE))

tppass <- left_join(tppassDates, tppass, by = c("YEAR", "MONTH")) %>%
  dplyr::mutate(VARIABLE = "Total Phosphorus Load",
                LAKEUNIT = factor(LAKEUNIT, levels = c("Upper", "Middle", "Lower"), ordered = T),
                SOURCE = "PASS")

rm(tppassDates)

tppass <- tppass  %>%
  dplyr::mutate(VALUE = zoo::rollsum(VALUE/30, 30, fill = NA, align = "right"), .by = "LAKEUNIT")
#"Preceding 30-d Total Phosphorus Load (1,000 pounds)"

tsPlotData <- tppass %>%
  dplyr::mutate(VALUE = VALUE/1000)

fig <- ggplot() +
  geom_line(data = tidyr::drop_na(tsPlotData, LAKEUNIT), aes(x = DATE, y = VALUE), color = bc_colors[["
BCBlue"]]) +
  scale_y_continuous(label = scales::label_comma()) +
  labs(title = "Pass through from Upstream Lake Segment", x = "", y = "Preceding 30-d Total Phosphorus L
oad (1,000 pounds)") +
  facet_wrap(~LAKEUNIT, nrow = 3) +
  theme_bw() +
  theme(plot.title = element_text(hjust = 0.5))
fig
```



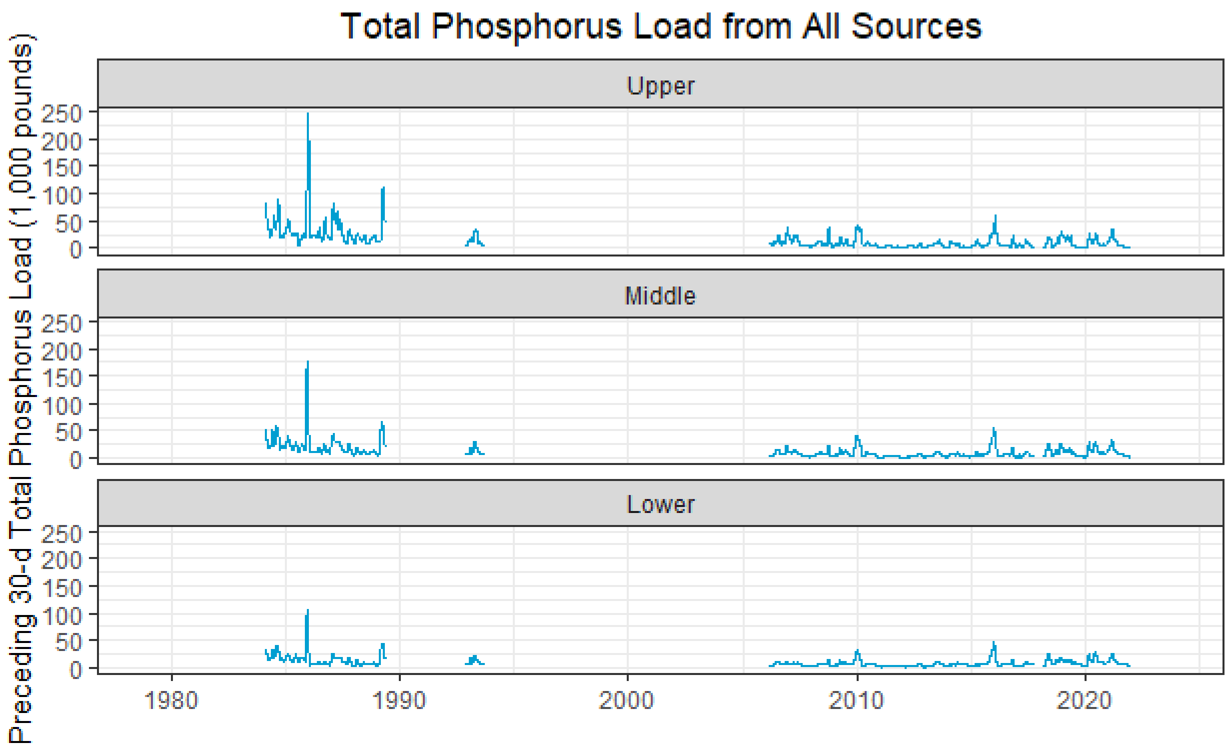

```
#ggsave(fig, filename = here::here("Data/Tidy/dataPrep/Figures", "tpload_tppass_ts.png"), width = 6.5, height = 4.5)
rm(fig)
```

2.15.2.5 All Sources Combined

After combining all sources, measurements are converted from lbs/mo to lbs per 30-day rolling sum by dividing each measurement by 30, then performing a 30 day rolling sum on the result.

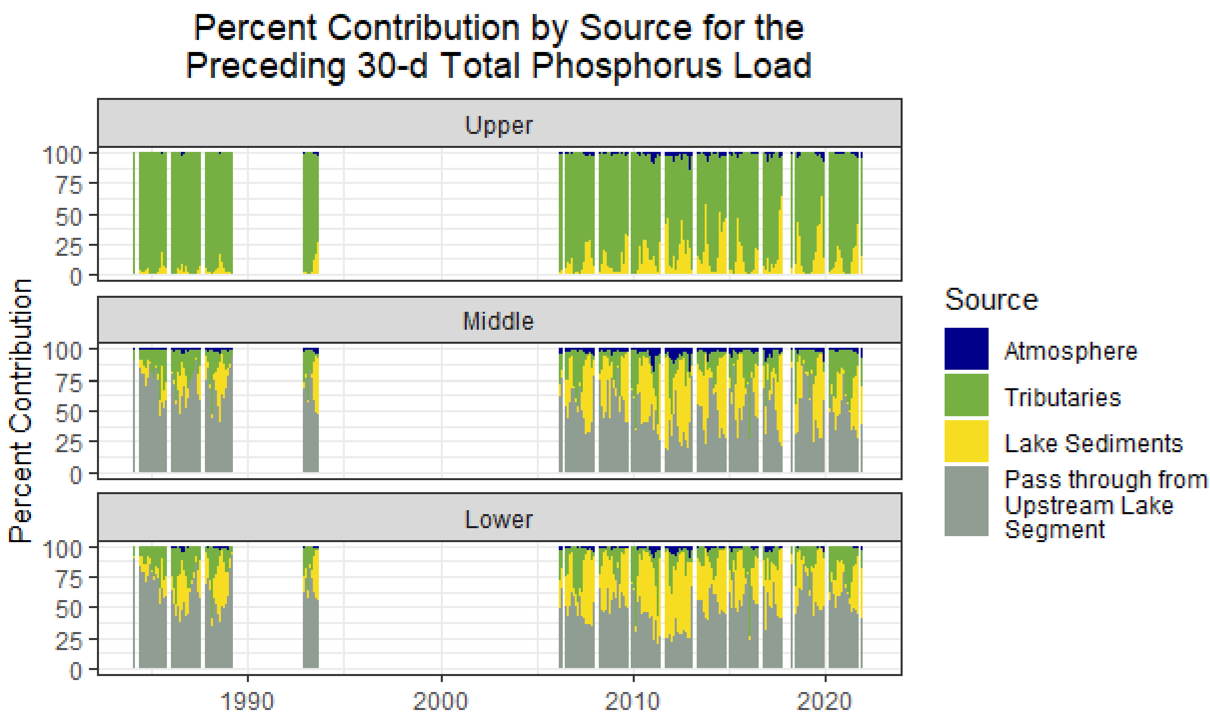
```
tpAll <- rbind(tpsed, tpatmos, tptrib, tppass) %>%
  tidyr::pivot_wider(names_from = SOURCE, values_from = VALUE) %>%
  dplyr::mutate(TOTAL = SED + ATMOS + TRIB + PASS,
                PSED = round((SED/TOTAL)*100, 1),
                PATMOS = round((ATMOS/TOTAL)*100, 1),
                PTRIB = round((TRIB/TOTAL)*100, 1),
                PPASS = round((PASS/TOTAL) * 100, 1),
                MEASUNIT = "(lbs), per 30-day rolling sum")

# Store temporary plot data with TOTAL/1000 to ease readability of figure
tsPlotData <- tpAll %>%
  dplyr::mutate(TOTAL = TOTAL/1000)


fig <- ggplot() +
  geom_line(data = tidyr::drop_na(tsPlotData, LAKEUNIT), aes(x = DATE, y = TOTAL), color = bc_colors[["
BCBlue"]]) +
  scale_y_continuous(label = scales::label_comma()) +
```

```
  labs(title = "Total Phosphorus Load from All Sources", x = "", y = "Preceding 30-d Total Phosphorus Load
(1,000 pounds)") +
  facet_wrap(~LAKEUNIT, nrow = 3) +
  theme_bw() +
  theme(plot.title = element_text(hjust = 0.5))
fig
```




```
#ggsave(fig, filename = here::here("Data/Tidy/dataPrep/Figures", "tpload_all_ts.png"), width = 6.5, heig
ht = 4.5)
rm(fig, tsPlotData)

percPlotData <- tpAll %>%
  tidyr::pivot_longer(cols = PSED:PPASS, names_to = "LOADSRC", values_to = "VALUE") %>%
  dplyr::mutate(LOADSRC = factor(LOADSRC, levels = c("PATMOS", "PTRIB", "PSED", "PPASS"), ordered =
T))

percPlotData <- percPlotData %>%
  dplyr::mutate(isSep = MONTH == "Sep")


fig <- ggplot() +
  geom_col(data = tidyr::drop_na(percPlotData, LAKEUNIT), aes(x = DATE, y = VALUE, fill = LOADSRC)) +
  #geom_rug(data = tidyr::drop_na(percPlotData, LAKEUNIT), aes(xisSep)) #+
  labs(title = "Percent Contribution by Source for the\nPreceding 30-d Total Phosphorus Load", x = "",
     y = "Percent Contribution", fill = "Source") +
```

```
scale_fill_manual(values = c("PATMOS" = "darkblue", "PTRIB" = bc_colors[["BCGreen"]],
                             "PSED" = bc_colors[["BCYellow"]], "PPASS" = bc_colors[["BCWarmGrey"]]),
                  labels = c("PATMOS" = "Atmosphere", "PTRIB" = "Tributaries",
                             "PSED" = "Lake Sediments",
                             "PPASS" = "Pass through from\nUpstream Lake\nSegment")) +
facet_wrap(~LAKEUNIT, nrow = 3) +
  theme_bw() +
theme(plot.title = element_text(hjust = 0.5),
      plot.subtitle = element_text(hjust = 0.5))
fig
```




```
#ggsave(fig, filename = here::here("Data/Tidy/dataPrep/Figures", "tpload_allPercentsBySource_ts.png"),
width = 6.5, height = 4.5)
rm(fig)
```

2.15.3A note on NAs

To better represent these data as time series' within each figure, we have joined each data set with a data.frame of NAs for each date from the first to last observation. This results in a combined data set in which all dates between the start and end date of the data have an observation. If there were no data provided for that date, then all fields for that date will be NA. This has allowed us to use line graphs to represent the time series while maintaining blank space for any date for which there were no data provided. Before writing the data out, we drop all observations for which the VALUE column is NA, thus removing all generated and provided NA observations.

2.15.4 Export data

We export the full tidy data resource (**segnloads_data.rds** and **segploads_data.rds**) plus one file per variable (e.g. **segloads_tnload.rds**).

```
tnLong <- tnAll %>%
  dplyr::select(DATE:MEASUNIT, Sediment = SED, Atmosphere = ATMOS, Tributary = TRIB,
         `Pass Through` = PASS, `All Sources` = TOTAL) %>%
  tidyr::pivot_longer(cols = Sediment:`All Sources`, names_to = "SOURCE", values_to = "VALUE") %>%
  tidyr::drop_na(VALUE) %>%
  dplyr::mutate(VARIABLE = paste(SOURCE, VARIABLE),
         SOURCE = "segloads")
# saveRDS(tnLong, here::here("Data/Tidy/dataPrep", "segnloads_data.rds"))
readr::write_csv(tnLong, here::here("Data/Tidy/AppendixC", "segnloads_data.csv"))

tpLong <- tpAll %>%
  dplyr::select(DATE:MEASUNIT, Sediment = SED, Atmosphere = ATMOS, Tributary = TRIB,
         `Pass Through` = PASS, `All Sources` = TOTAL) %>%
  tidyr::pivot_longer(cols = Sediment:`All Sources`, names_to = "SOURCE", values_to = "VALUE") %>%
  tidyr::drop_na(VALUE) %>%
  dplyr::mutate(VARIABLE = paste(SOURCE, VARIABLE),
         SOURCE = "segloads")
#saveRDS(tpLong, here::here("Data/Tidy/dataPrep", "segploads_data.rds"))
readr::write_csv(tpLong, here::here("Data/Tidy/AppendixC", "segploads_data.csv"))

# Total Load only

segloads_tnload <- tnAll %>% dplyr::select(DATE:MEASUNIT, VALUE = TOTAL) %>%
  tidyr::drop_na(VALUE) %>%
  dplyr::mutate(SOURCE = "segloads")
#saveRDS(segloads_tnload, here::here("Data/Tidy/dataPrep", "segloads_tnload.rds"))
readr::write_csv(segloads_tnload, here::here("Data/Tidy/AppendixC", "segloads_tnload.csv"))

segloads_tpload <- tpAll %>% dplyr::select(DATE:MEASUNIT, VALUE = TOTAL) %>%
  tidyr::drop_na(VALUE) %>%
  dplyr::mutate(SOURCE = "segloads")
#saveRDS(segloads_tpload, here::here("Data/Tidy/dataPrep", "segloads_tpload.rds"))
readr::write_csv(segloads_tpload, here::here("Data/Tidy/AppendixC", "segloads_tpload.csv"))

# Atpsphere only
tnatmos <- tnAll %>% dplyr::select(DATE:MEASUNIT, VALUE = ATMOS) %>%
  tidyr::drop_na(VALUE) %>%
  dplyr::mutate(VARIABLE = "Atmospheric Total Nitrogen Load",
         SOURCE = "segloads")
#saveRDS(tnatmos, here::here("Data/Tidy/dataPrep", "segloads_tnatmos.rds"))
readr::write_csv(tnatmos, here::here("Data/Tidy/AppendixC", "segloads_tnatmos.csv"))
```

```
tpatmos <- tpAll %>% dplyr::select(DATE:MEASUNIT, VALUE = ATMOS) %>%
  tidyr::drop_na(VALUE) %>%
  dplyr::mutate(VARIABLE = "Atmospheric Total Phosphrus Load",
         SOURCE = "segloads")
#saveRDS(tpatmos, here::here("Data/Tidy/dataPrep", "segloads_tpatmos.rds"))
readr::write_csv(tpatmos, here::here("Data/Tidy/AppendixC", "segloads_tpatmos.csv"))

# Tributary only
tntrib <- tnAll %>% dplyr::select(DATE:MEASUNIT, VALUE = TRIB) %>%
  tidyr::drop_na(VALUE) %>%
  dplyr::mutate(VARIABLE = "Tributary Total Nitrogen Load",
         SOURCE = "segloads")
#saveRDS(tntrib, here::here("Data/Tidy/dataPrep", "segloads_tntrib.rds"))
readr::write_csv(tntrib, here::here("Data/Tidy/AppendixC", "segloads_tntrib.csv"))

tptrib <- tpAll %>% dplyr::select(DATE:MEASUNIT, VALUE = TRIB) %>%
  tidyr::drop_na(VALUE) %>%
  dplyr::mutate(VARIABLE = "Tributary Total Phosphorus Load",
         SOURCE = "segloads")
#saveRDS(tptrib, here::here("Data/Tidy/dataPrep", "segloads_tptrib.rds"))
readr::write_csv(tptrib, here::here("Data/Tidy/AppendixC", "segloads_tptrib.csv"))

# Sediment Only
tnsed <- tnAll %>% dplyr::select(DATE:MEASUNIT, VALUE = SED) %>%
  tidyr::drop_na(VALUE) %>%
  dplyr::mutate(VARIABLE = "Sediment Total Nitrogen Load",
         SOURCE = "segloads")
#saveRDS(tnsed, here::here("Data/Tidy/dataPrep", "segloads_tnsed.rds"))
readr::write_csv(tnsed, here::here("Data/Tidy/AppendixC", "segloads_tnsed.csv"))

tpsed <- tpAll %>% dplyr::select(DATE:MEASUNIT, VALUE = SED) %>%
  tidyr::drop_na(VALUE) %>%
  dplyr::mutate(VARIABLE = "Sediment Total Phosphorus Load",
         SOURCE = "segloads")
#saveRDS(tpsed, here::here("Data/Tidy/dataPrep", "segloads_tpsed.rds"))
readr::write_csv(tpsed, here::here("Data/Tidy/AppendixC", "segloads_tpsed.csv"))


# Pass Through Only
tnpass <- tnAll %>% dplyr::select(DATE:MEASUNIT, VALUE = PASS) %>%
  tidyr::drop_na(VALUE) %>%
  dplyr::mutate(VARIABLE = "Pass Through Total Nitrogen Load",
         SOURCE = "segloads")
```

```
#saveRDS(tnpass, here::here("Data/Tidy/dataPrep", "segloads_tnpass.rds"))
readr::write_csv(tnpass, here::here("Data/Tidy/AppendixC", "segloads_tnpass.csv"))

tppass <- tpAll %>% dplyr::select(DATE:MEASUNIT, VALUE = PASS) %>%
  tidyr::drop_na(VALUE) %>%
  dplyr::mutate(VARIABLE = "Pass Through Total Phosphorus Load",
             SOURCE = "segloads")
#saveRDS(tppass, here::here("Data/Tidy/dataPrep", "segloads_tppass.rds"))
readr::write_csv(tppass, here::here("Data/Tidy/AppendixC", "segloads_tppass.csv"))
```

Code prepared by KDV Decision Analysis LLC. Code last run 2024-08-29 with R version 4.4.1 (2024-06-14 ucrt).

Section 3: Data Merge

3.1 General Outline of Steps to merge data (by variable) from multiple sources

3.1.1 Assemble Data

Most data, excluding lakewide variables, were sourced from multiple agencies and partners. After each data source had been prepped to a standardized format, the data were merged and restructured such that each variable existed within its own file (e.g., the individual source files caae_wtemp.rds, durmCity_wtemp.rds, ralpud_wtemp.rds, storetDwr_wtemp.rds, storetUsgs_wtemp.rds were merged into a single tidy_wtemp.rds for all water temperature data).

First all individual sources were identified and reviewed to ensure they matched the standards (no missing values, no data from other lakes, only one unit of measurement, only surface water samples, etc.). Prior to merging, each source was summarized with count of records, number of stations, range of values, and date range so that the prepared data could be easily reviewed for accuracy. Once merged, the same basic statistics were again reviewed, then additional steps were taken to ensure data quality.

- Confirm only one variable is present
- Confirm no NA values are present in the core analysis columns
- Confirm only one measurement unit is present
- Identify and remove duplicated records (some agencies share data and so data could be duplicated across sources)
- Check for and remove any obvious data errors (e.g., impossible values that clearly were typographic errors)

3.1.2 Explore Data

The assembled data were presented, variable by variable, to the UNRBA team for review through a series of summary tables and figures. These included presentation of:

- **To examine data range**: the overall histogram and summary statistics of the merged data values

- **To examine sample balance, variability, and representativeness:** summaries of data count, number of years, mean, standard deviation for each lake unit by month combination
- **To explore general spatial and temporal trends and discuss the validity of outliers**: density plots with rug notation for the overall data and box plots of distributions by year (long term trends) and month (seasonal trends) by lake unit
- **To address questions regarding the inclusion of arm data along with the lake (thalweg) data**: box plots of distributions by year (long term trends) and month (seasonal trends) by lake unit.
- **To begin discussions of binning the data for the Bayesian models**: the default 3-category rank based bin plot with data overlay.

3.1.3 Exceptions to General Steps

The data merge step for the total nitrogen and total phosphorus concentrations provided all the information listed above, but each data source reported the nutrient values differently (i.e., as different components). Therefore, for each nutrient, multiple files from an individual source were sometimes imported and combined via equations provided by UNRBA (as documented in the code) to calculate the total concentrations.

3.2 Merge of Algae Biovolume Data

3.2.1 Gather Data Resources

3.2.2 List Associated Files

Algae Biovolume data are identified by the ***Algae_biovolume** suffix.

```
## [1] "deqAlgae_biovolume.rds"  "durmAlgae_biovolume.rds"
```

We do not include the Jordan Lake data in our analyses, so we have biovolume data from two sources. As we read in each source, we immediately remove any records for “Other Lake” or with a VALUE of NA. These should have been removed in the dataPrep satge, so this filtering code is just an extra precaution.

3.2.3 City of Durham (durm)

Some quick tabular summaries of the Durham data:

```
##   FL-DS4 FL-SR1801     D3-1    FL-ATS
##  "Upper"   "Upper"   "Upper"   "Upper"

##
## 2017 2018 2021
##    4    4    4

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##   0   0   0   1   3   1   1   4   2   0   0   0

##
##           2017 2018 2021
##   Upper      4    4    4
##   Middle     0    0    0
```

```
##   Lower        0    0    0
##   Other Lake   0    0    0
```

This source provides 92 Algae Biovolume records for 4 station ids and 3 years spanning 2017 to 2021. The number of unique sample events (date-station) in Durham data is: 12.

3.2.4 Department of Environmental Quality (deq)

Some quick tabular summaries of the DEQ data:

```
##          LC01          LI01        NEU013       NEU013B       NEU018E
##      "Middle"      "Middle"       "Upper"       "Upper"      "Middle"
##       NEU019L       NEU019P       NEU020D Sandling Beach         ELL10
##       "Lower"       "Lower"       "Lower"      "Middle"       "Upper"

##
## 2001 2005 2006 2007 2008 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
##    1   12   30   20    1    3   35   35   36   37   36   35   36   35   35   37
## 2021 2022
##   31    9

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##  40  37  49  29  42  39  47  36  37  36  36  36

##
##             2001 2005 2006 2007 2008 2010 2011 2012 2013 2014 2015 2016 2017
##   Upper        0    4   15   10    0    1   12   11   12   13   11   12   12
##   Middle       0    4    7    5    1    1   11   12   12   12   12   12   12
##   Lower        1    4    8    5    0    1   12   12   12   12   13   11   12
##   Other Lake   0    0    0    0    0    0    0    0    0    0    0    0    0
##
##             2018 2019 2020 2021 2022
##   Upper       10   12   11   10    3
##   Middle      12   12   12   11    3
##   Lower       13   11   14   10    3
##   Other Lake   0    0    0    0    0
```

This source provides 11597 Algae Biovolume records for 10 station ids and 18 years spanning 2001 to 2022. The number of unique sample events (date-station) in DEQ data is: 588.

3.2.5 Merge Data Sources

We merge and summarize the data, then check for data errors, duplicated entries (within or across data sources)

In total, we assembled 476 Algae Biovolume sample events into two tidy dataframes: one with all records (multiple algae types observed per date-station sample event; N = 11689) and one with a total biovolume per sample event (removing group level details).

Data were qaqc'd to confirm:

- only one variable is present

- no NA values are present
- only one measurement unit is present (OR if more than one is present, additional processing is required)

3.2.6 Summary

The table below summarizes the number of sample events from each source.

```
## # A tibble: 2 × 7
##   SOURCE        N NStations NDates NYears MinYear MaxYear
##   <chr>     <int>     <int>  <int>  <int>   <dbl>   <dbl>
## 1 deqAlgae    464        10    177     18    2001    2022
## 2 durmAlgae    12         4      9      3    2017    2021
```

There are very few samples from the Upper lake unit:

```
##
##        Upper Middle Lower Other Lake
##   2001     0      0     1          0
##   2005     4      4     4          0
##   2006    15      7     8          0
##   2007    10      5     5          0
##   2008     0      1     0          0
##   2010     1      1     1          0
##   2011    12     11    12          0
##   2012    11     12    12          0
##   2013    12     12    12          0
##   2014    13     12    12          0
##   2015    11     12    13          0
##   2016    12     12    11          0
##   2017    16     12    12          0
##   2018    14     12    13          0
##   2019    12     12    11          0
##   2020    11     12    14          0
##   2021    14     11    10          0
##   2022     3      3     3          0
```

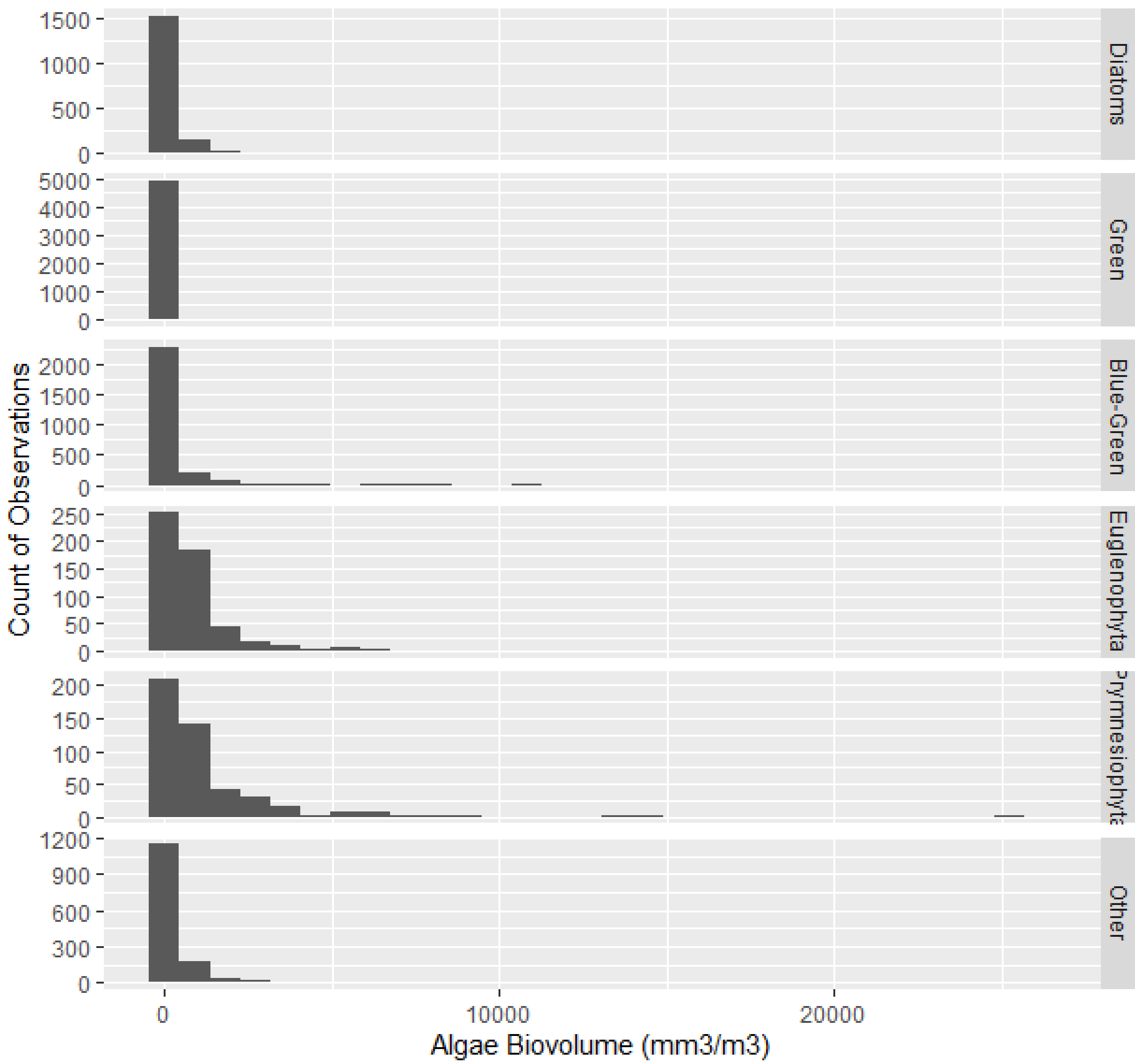
The table below has one row for each sample date and lists the max biovolume measured in the lake (across all samples from all stations in all lakeunits) *for each algal type*. There may be multiple sites per lakeunit, but the total number of samples among lake units and across dates varies - so we cannot compare total values.

3.2.7 Check for and Remove Error Entries

All biovolume entires are plausible values, so we did not identify and remove any records as errors.

Quantiles	Value
0%	0.0000
10%	2.0000
20%	5.0000

Quantiles	Value
30%	9.0000
40%	16.0000
50%	29.0000
60%	50.0000
70%	89.0000
80%	189.0000
90%	529.0455
100%	26136.0000



3.2.8 Check for and Remove Duplicates

All records with equal DATE, STATIONID, DEPTHM, GENUS, SPECIES, and VALUE are treated as duplicated values and dropped. Genus and species are both recorded because often observations are only ID'd to GENUS and species is left as 'spp.'.

There are 50 duplicated records. Duplicated rows were removed from the data, keeping only one record per duplicate set.

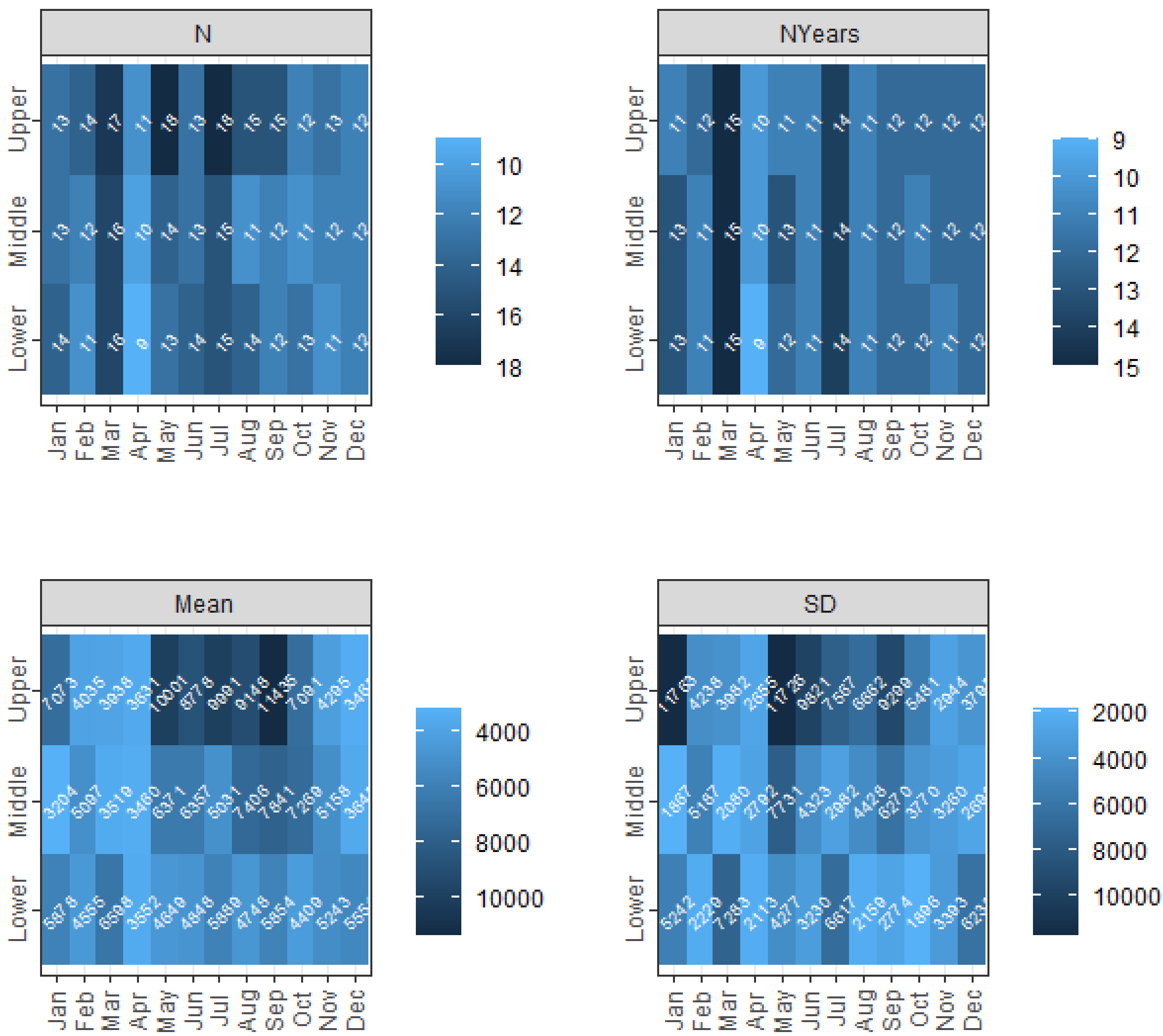
3.2.9 Data Summaries

After removing errors and duplicates, there are 11664 records remaining for 476 sample events (date-station).

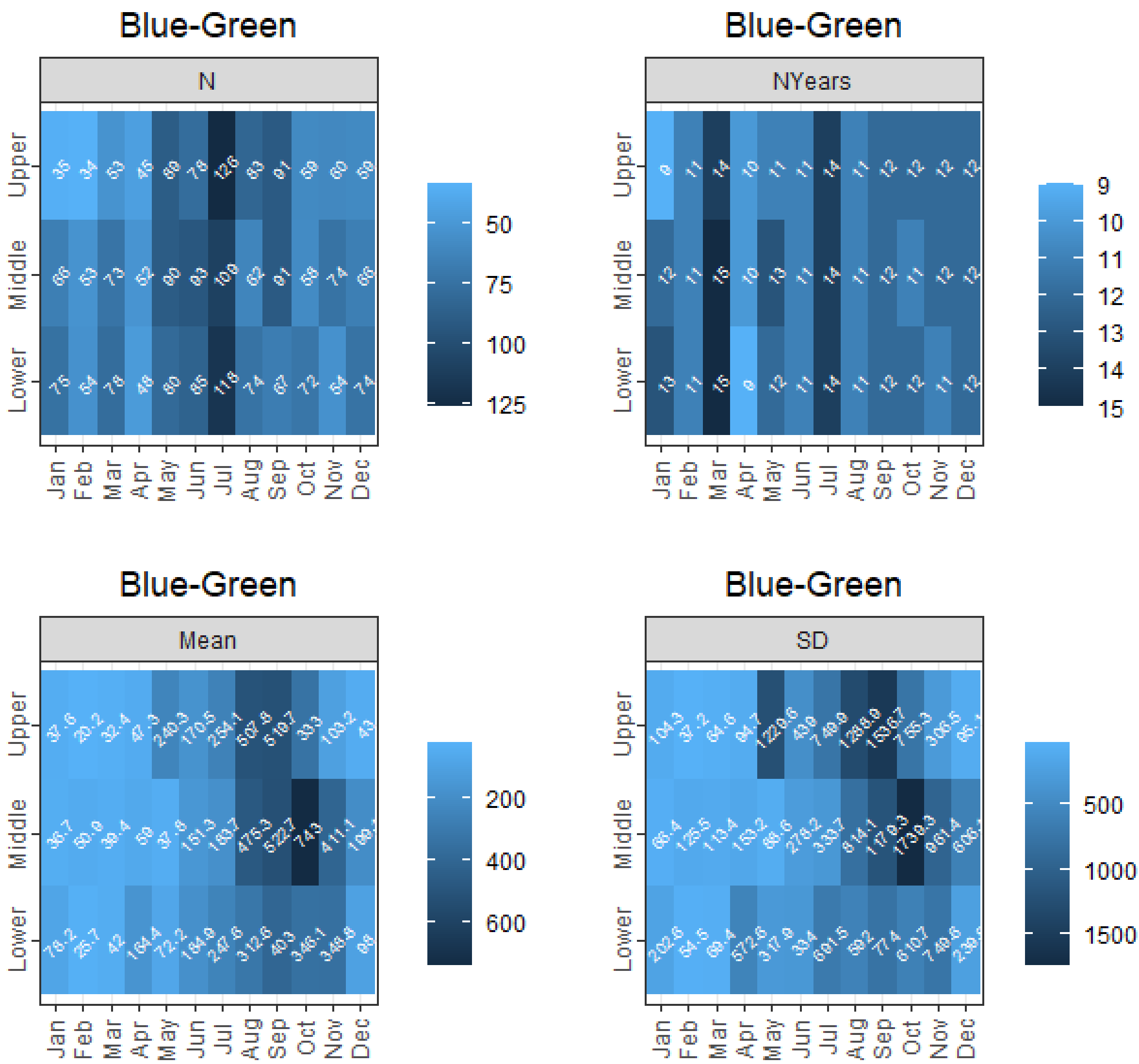
These 476 Algae Biovolume sample events cover 14 station ids and 18 years spanning 2001 to 2022.

3.2.10 Sample Effort and Values

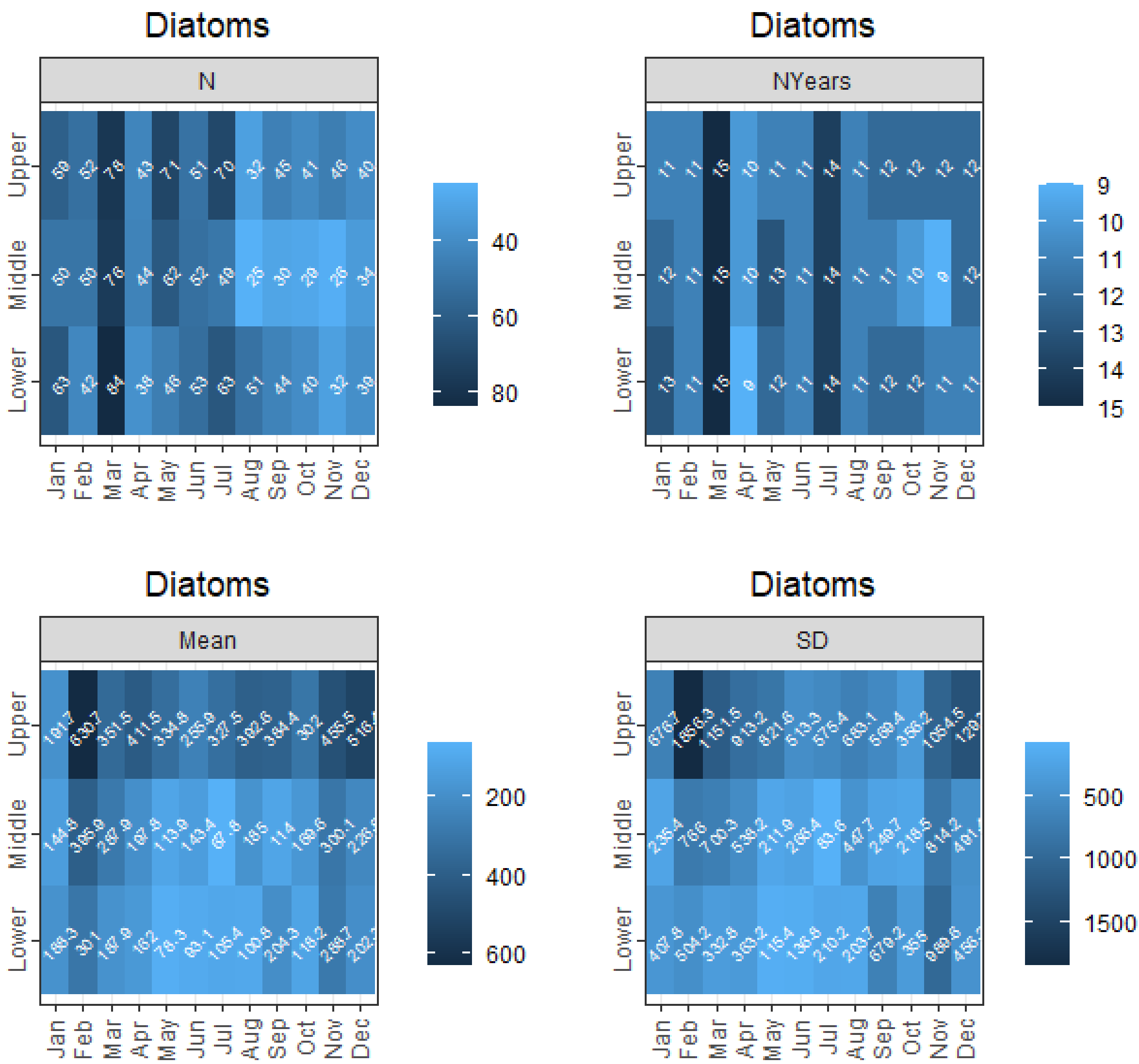
3.2.10.1 All Types



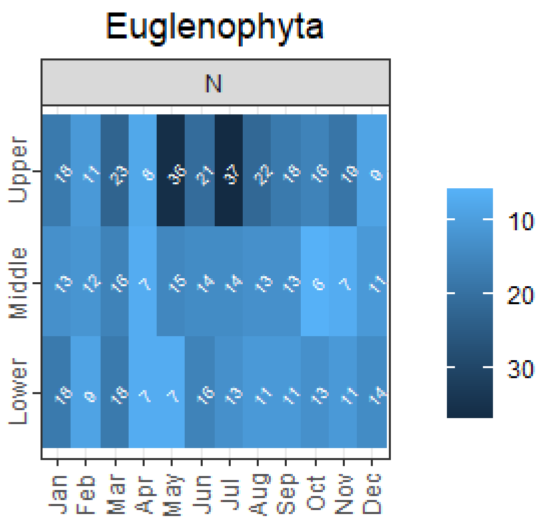
3.2.10.2 Blue-Green

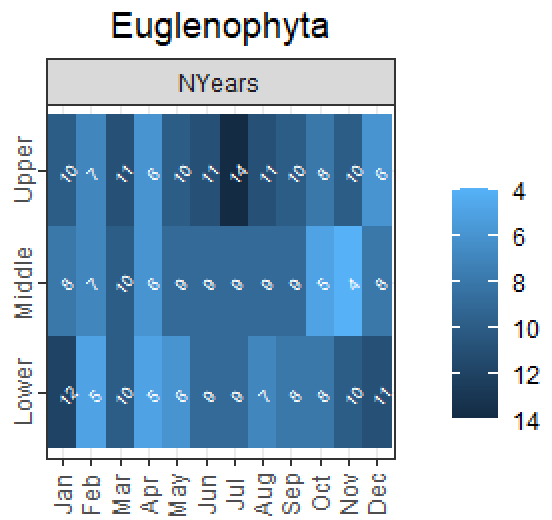


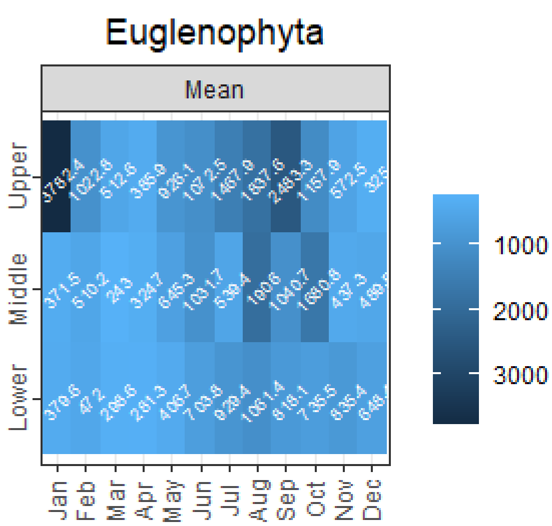
3.2.10.3 Diatoms

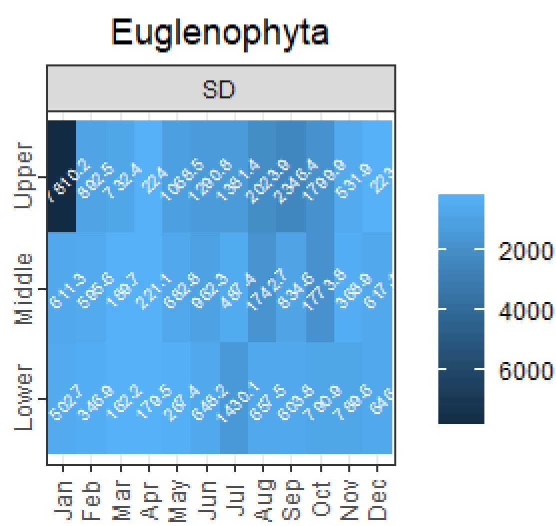


3.2.10.4 Euglenophyta

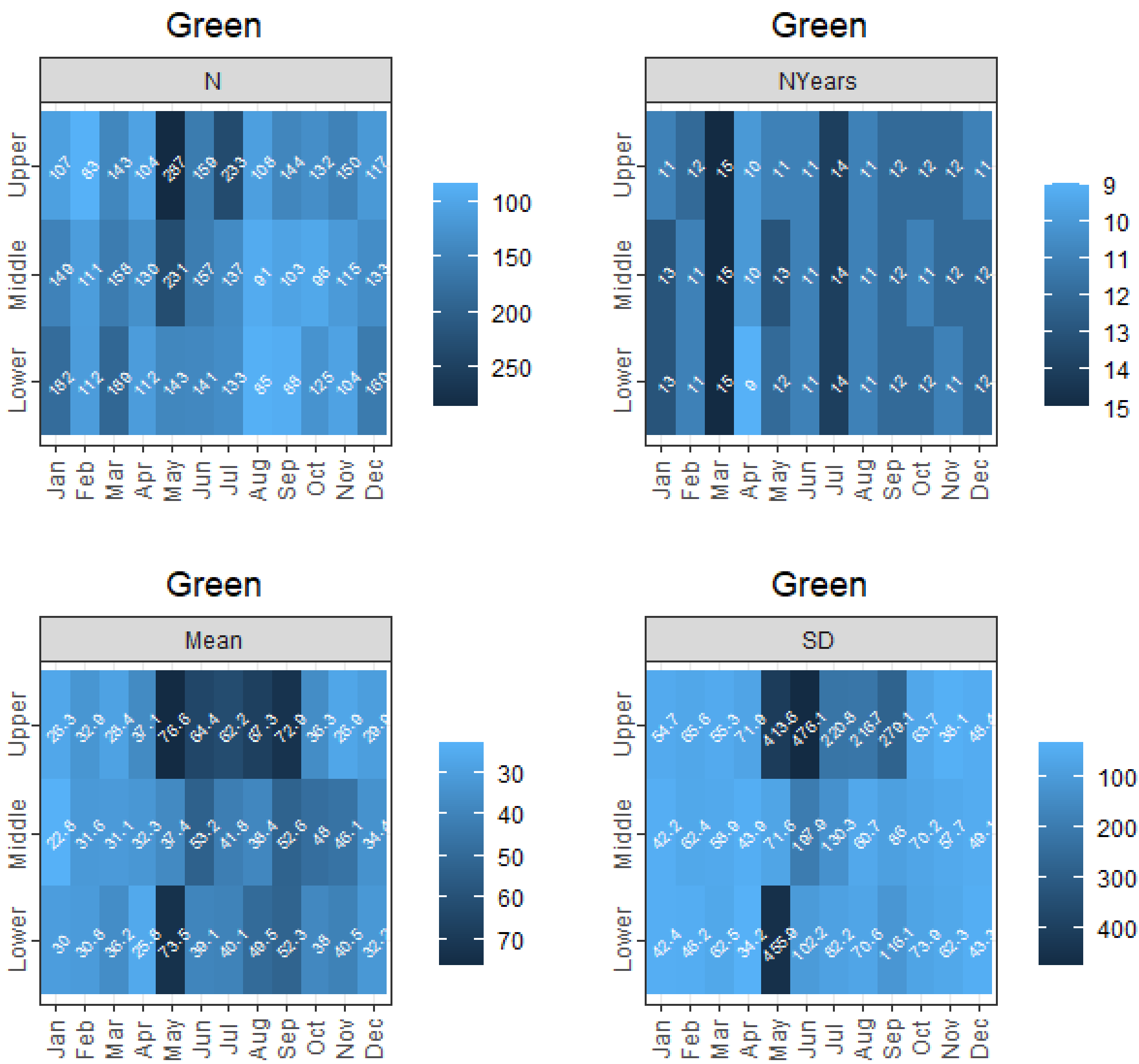




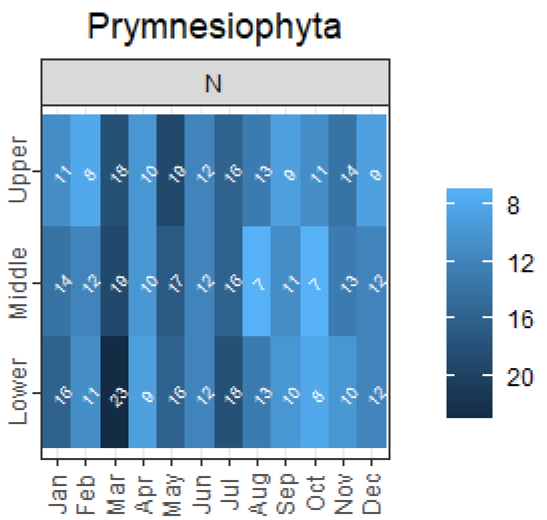


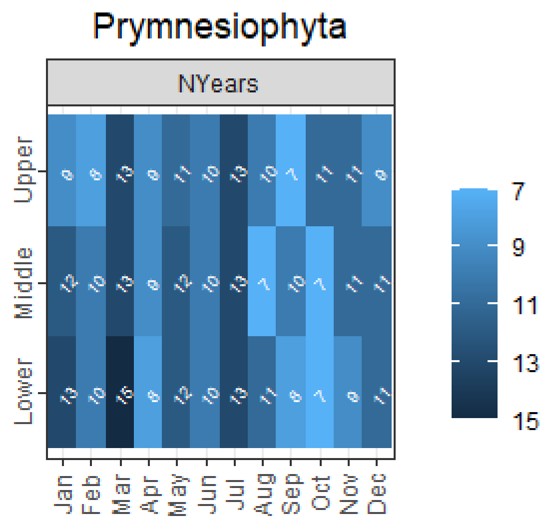


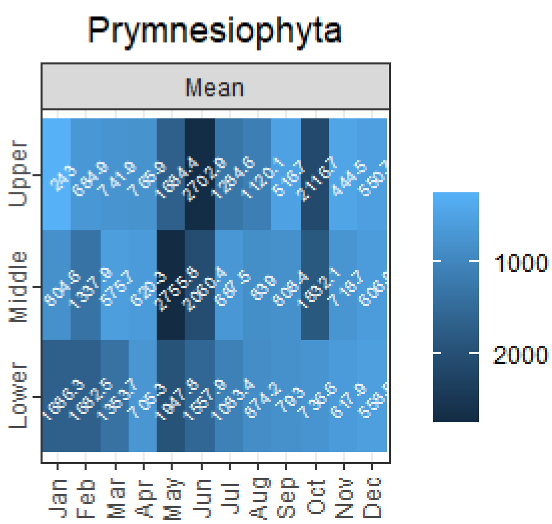
3.2.10.5 Green

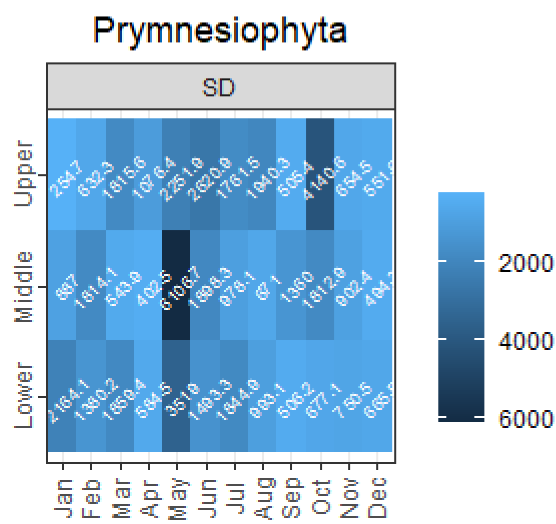

Green
N
Upper
Middle
Lower
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
100
150
200
250
Green
NYears
9
10
11
12
13
14
15
Green
Mean
30
40
50
60
70
Green
SD
100
200
300
400

3.2.10.6 Prymnesiophyta

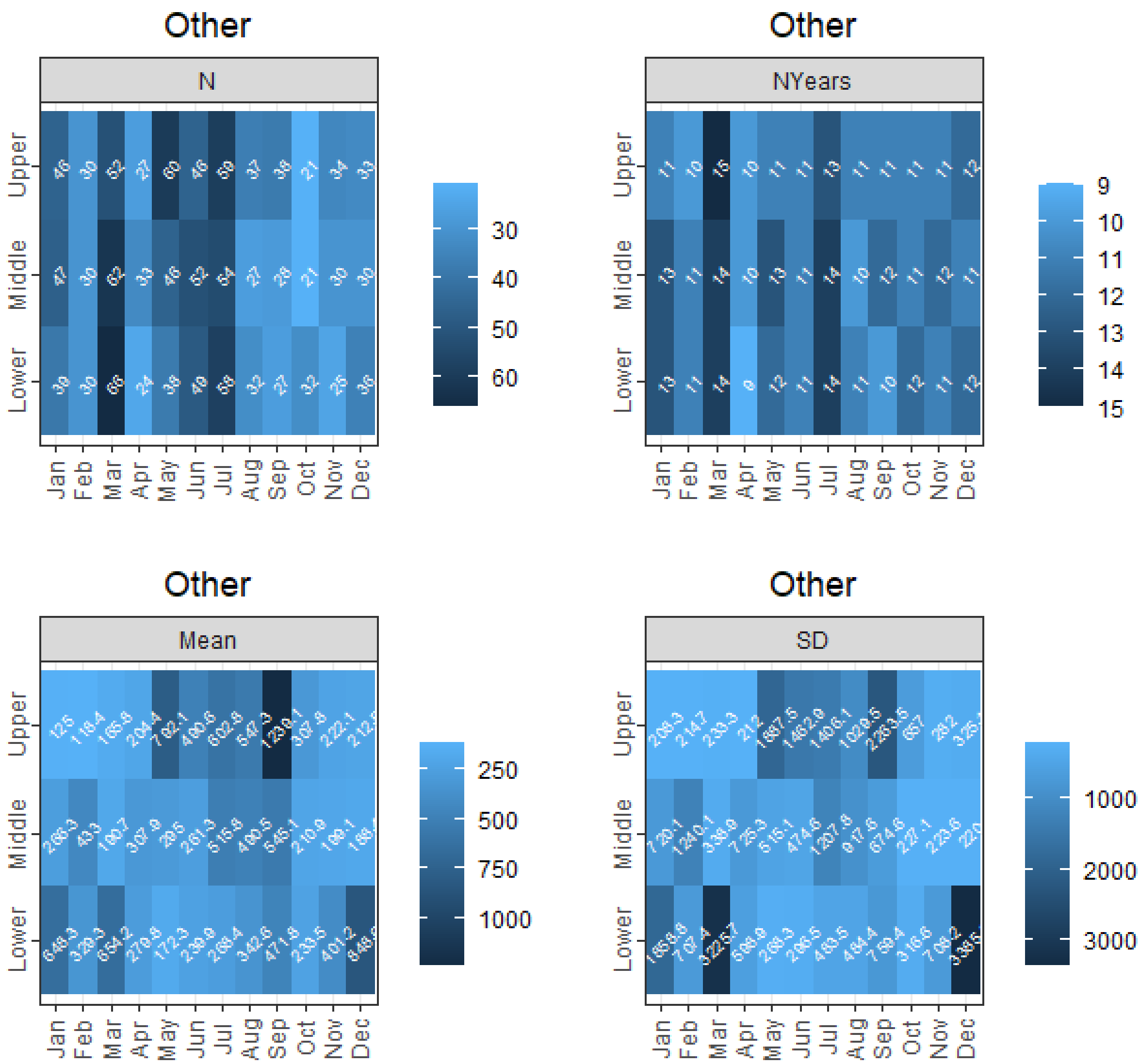








3.2.10.7 Other



3.2.11 Density Plot and Outliers

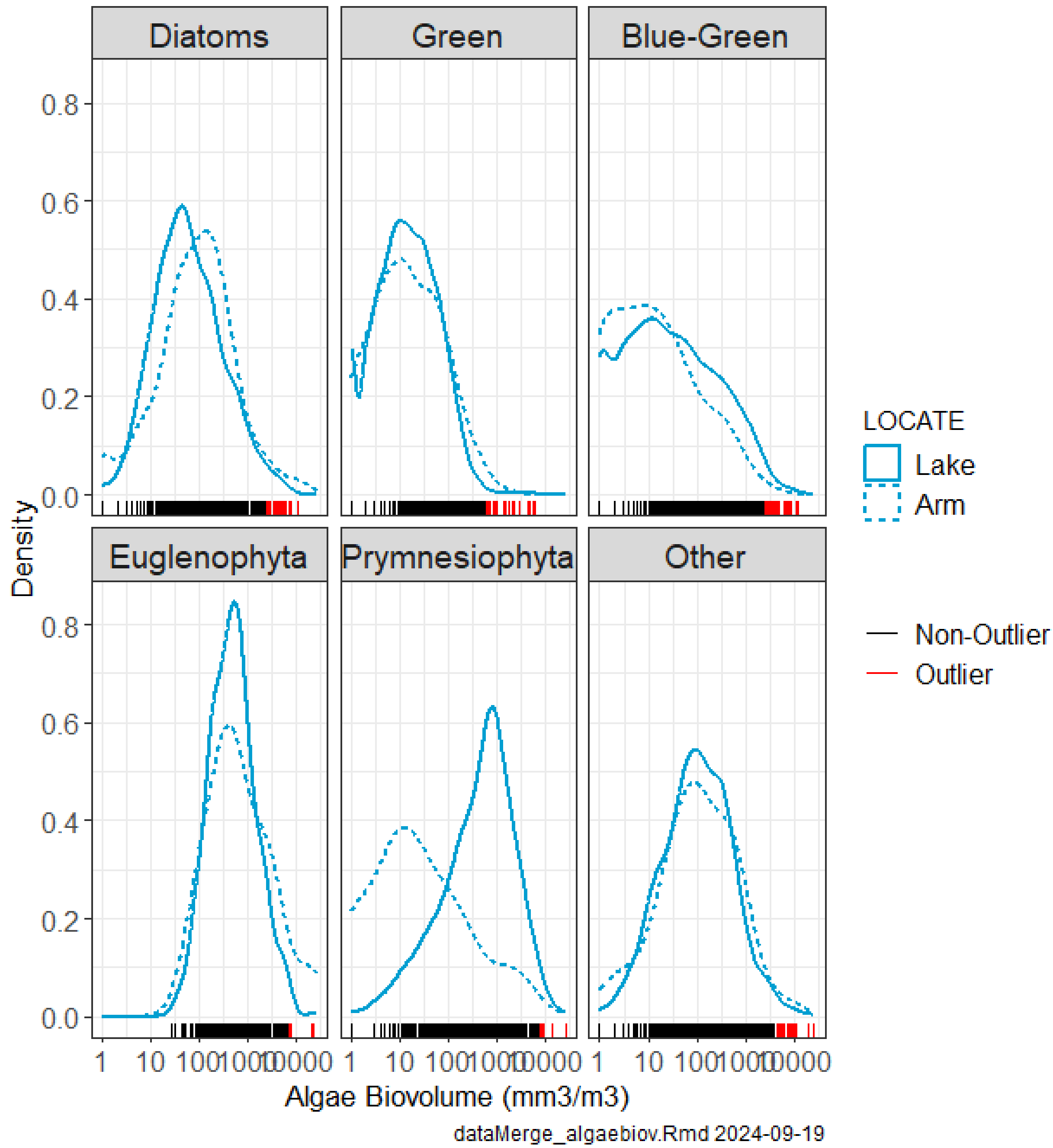
The mean and standard deviation for each algal type, across all sample events (date-station) and including values from bot the lake arms and thalweg.

ALGALTYPE	mean	sd
Diatoms	248.21076	687.1897
Green	43.48124	182.9381
Blue-Green	222.21160	725.9609
Euglenophyta	987.82273	1893.2006
Prymnesiophyta	1156.07245	2048.4564
Other	396.86001	1275.0566

In the figure below, the distribution of all lake (thalweg) values is shown as the blue solid line and the lake arm values are shown as the blue dashed line. Below the density plot are rug marks for each observed value. The orange rug marks are values greater than three standard deviations from the overall mean of that algal type. Note that the x-axis is shown on a log10 scale.

In general, lake and thalweg have similar values within these data, with the exception of the Prymnesiophyta. *HOWEVER*, there are almost no arm samples - so any inference of difference cannot be tested with these data.

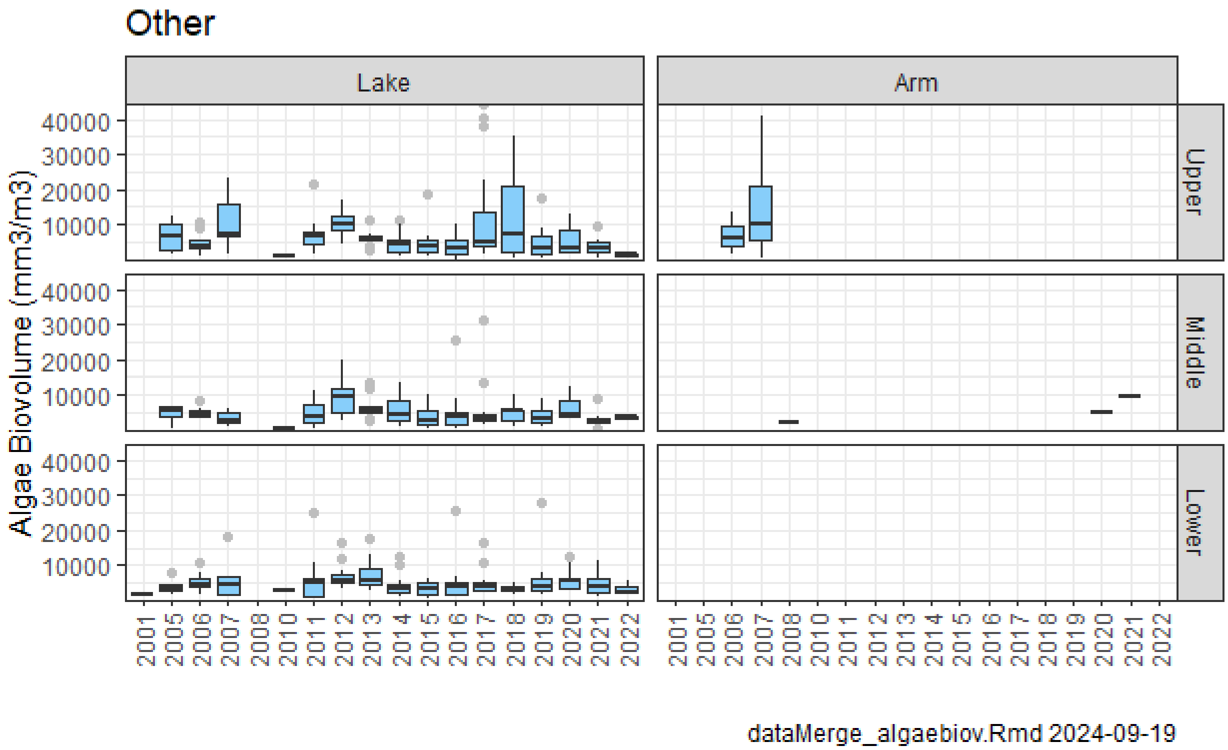
The extreme values (+/- 3SD) are retained for our model project as true, but unusual, values - unless our TAW or SME teams indicate these are data errors.



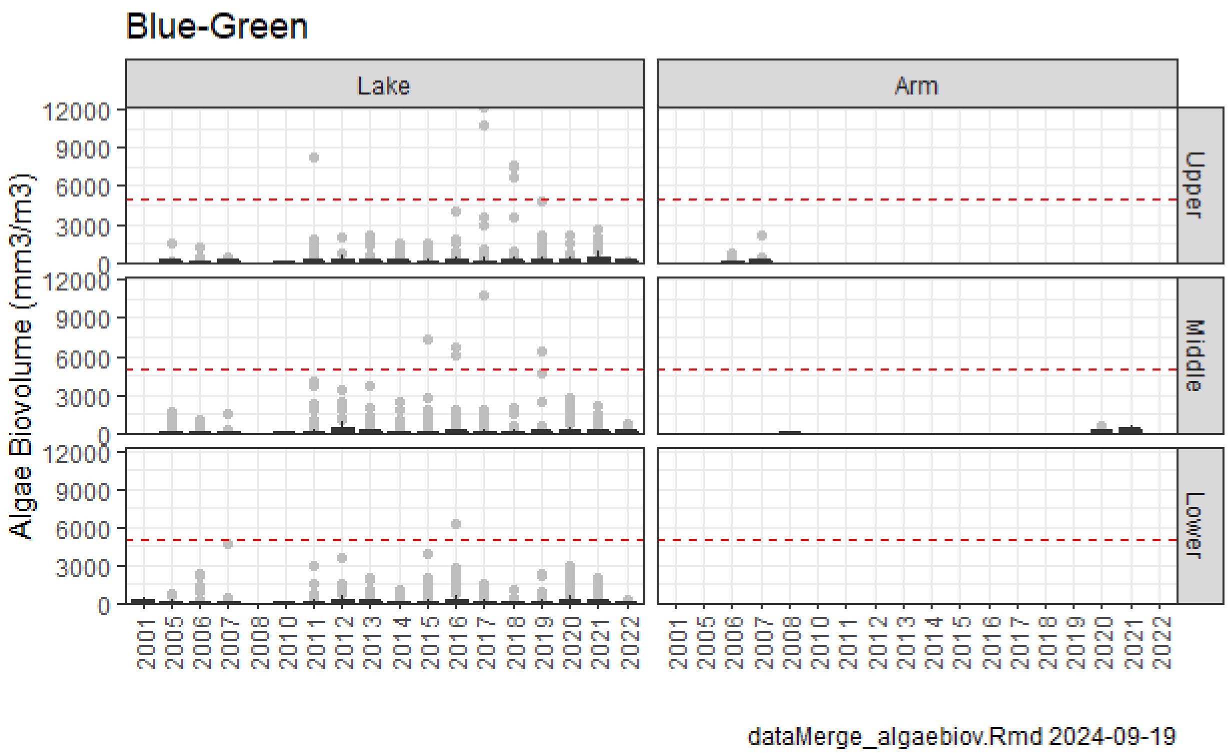
The 3 SD outlier values identified in this plot are:

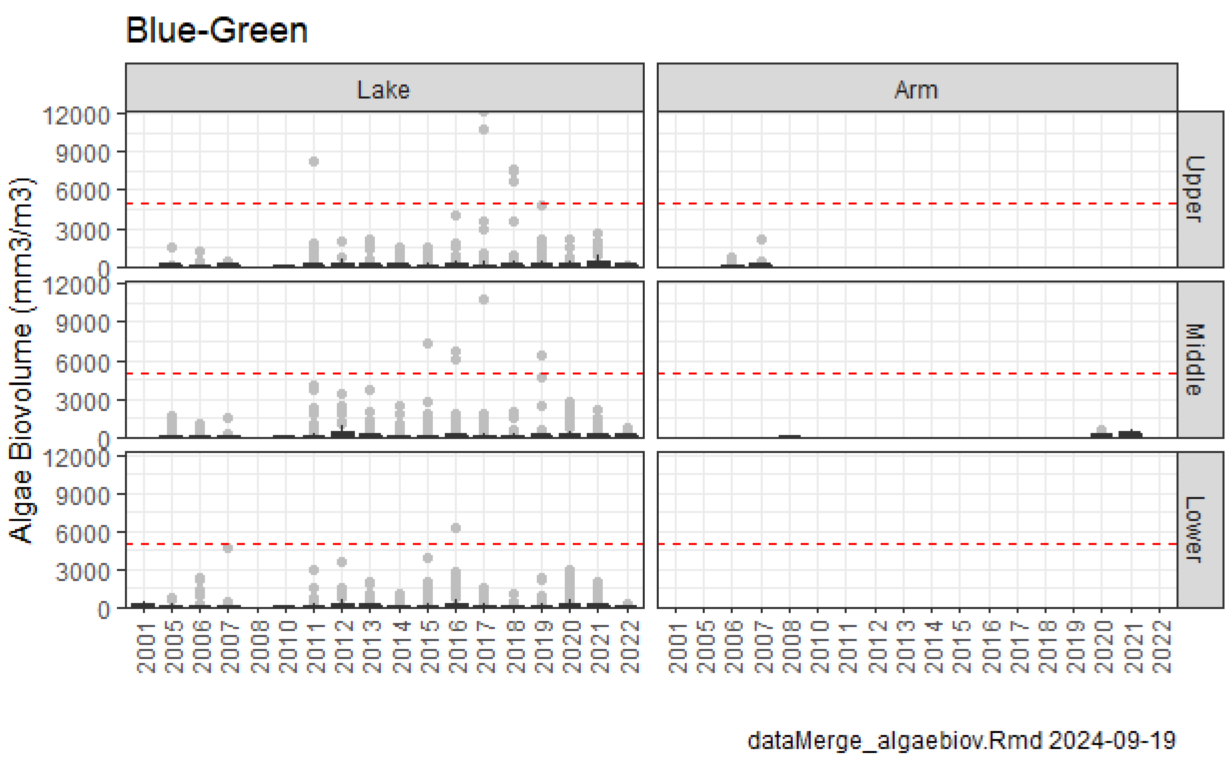
3.2.12 Annual Variance

3.2.12.1 All Types

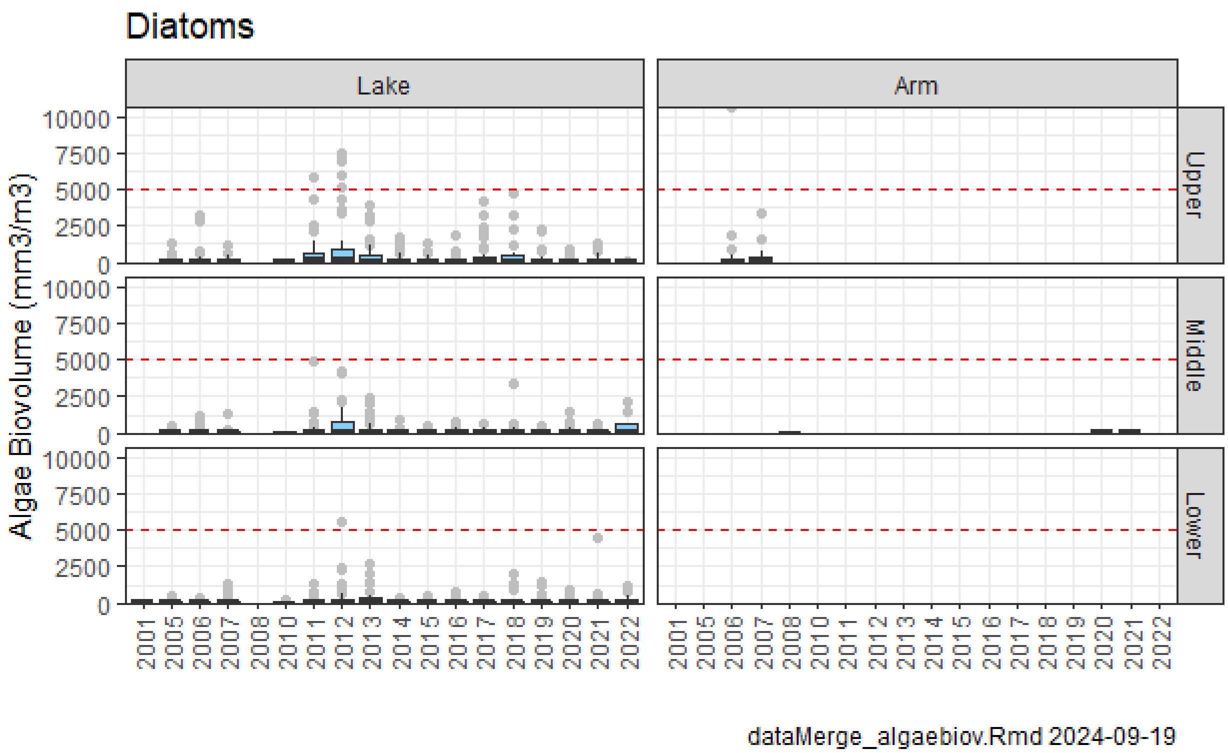


3.2.12.2 Blue-Green

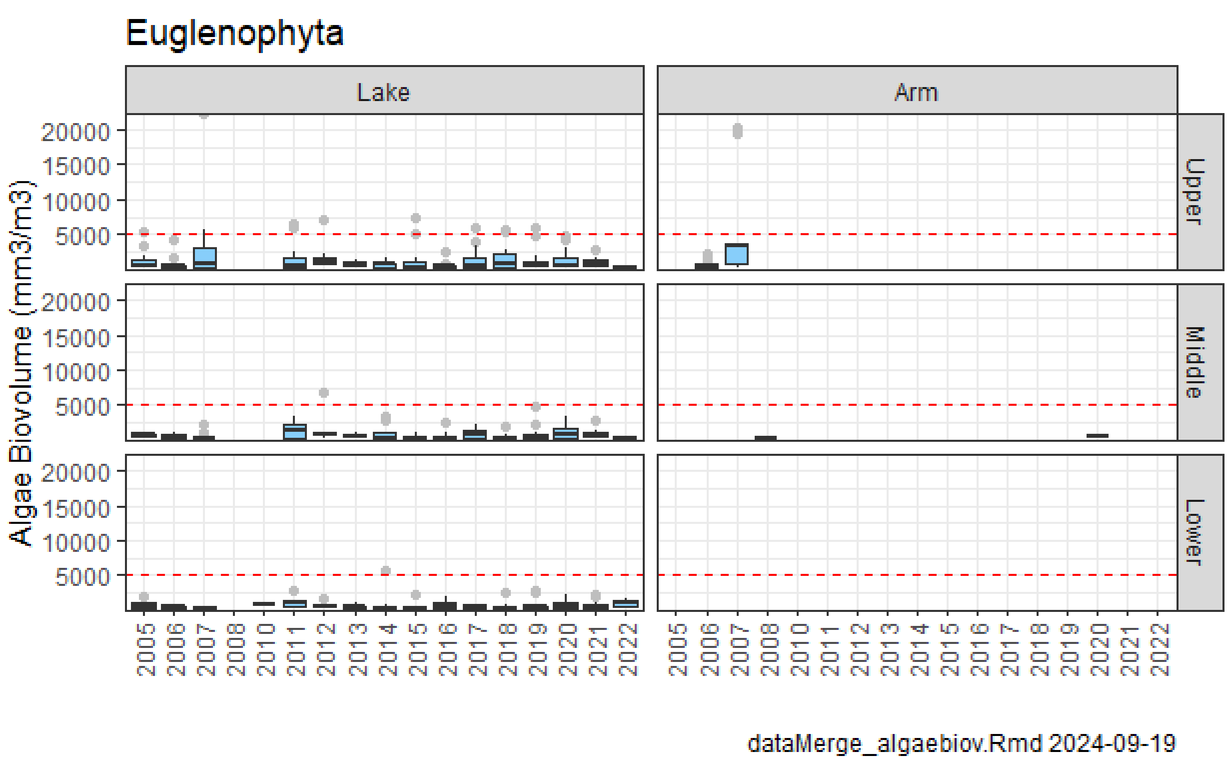




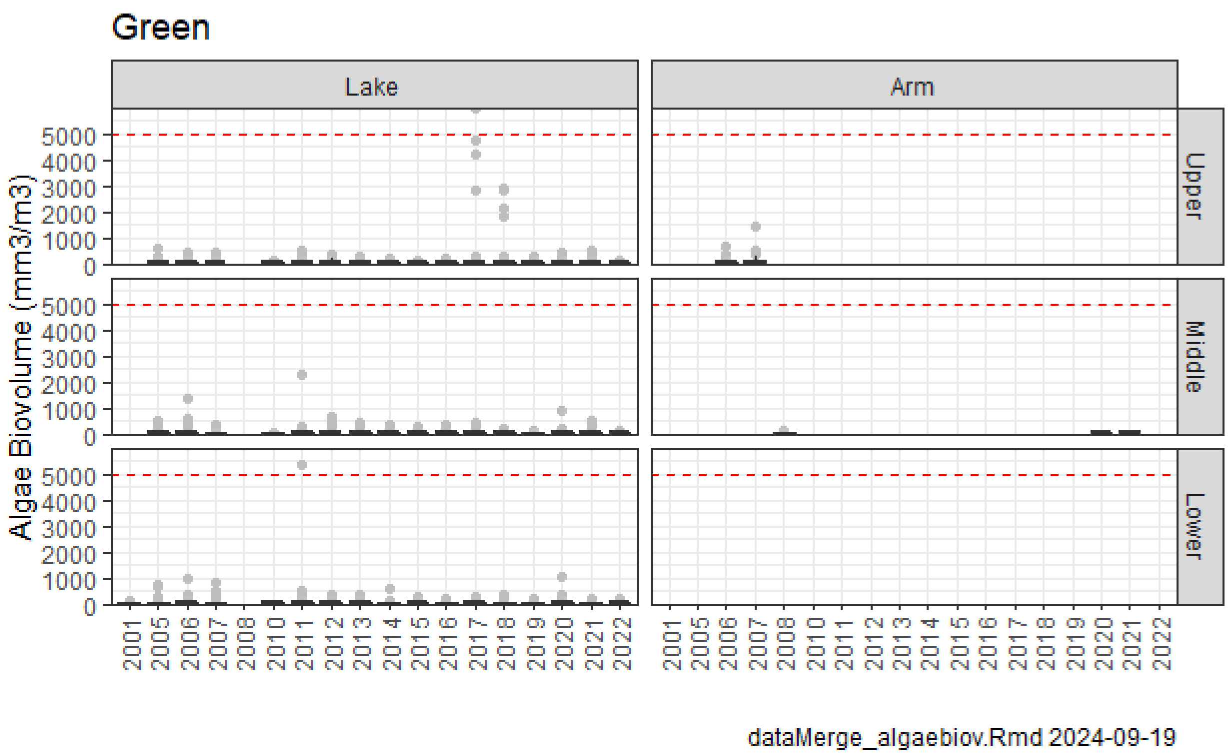
3.2.12.3 Diatoms



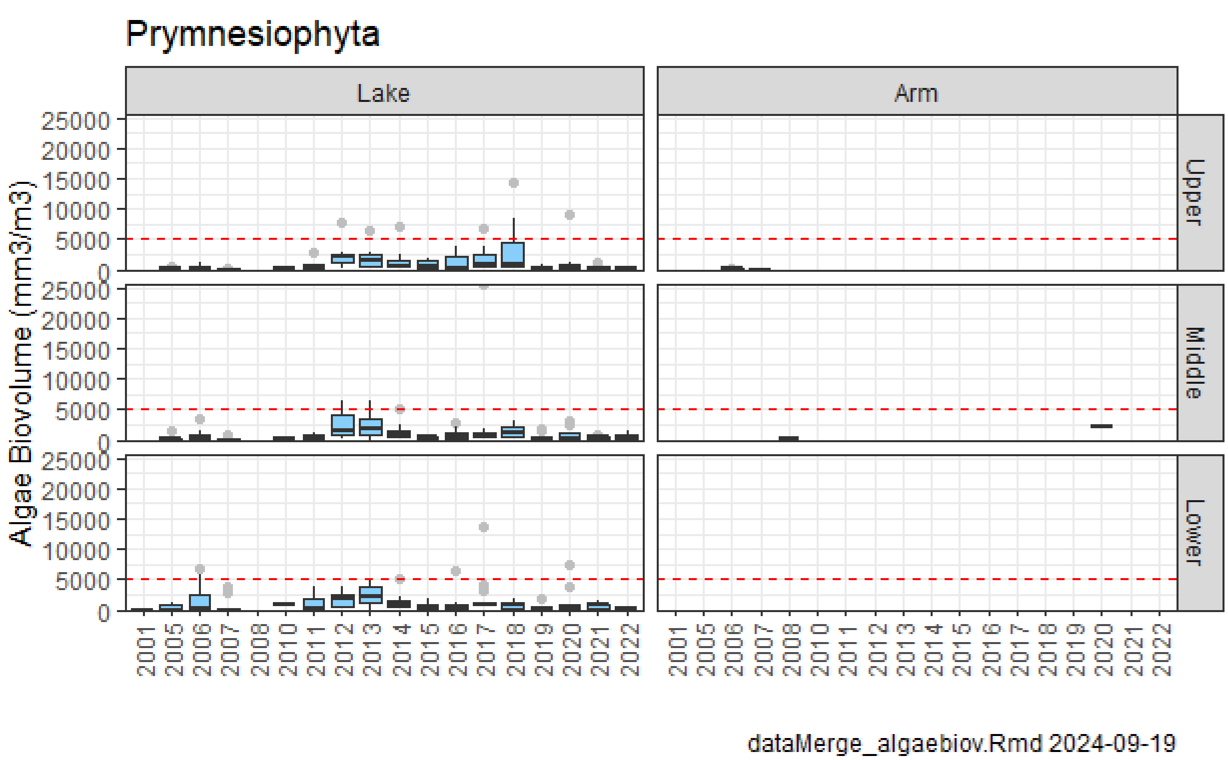
3.2.12.4 Euglenophyta



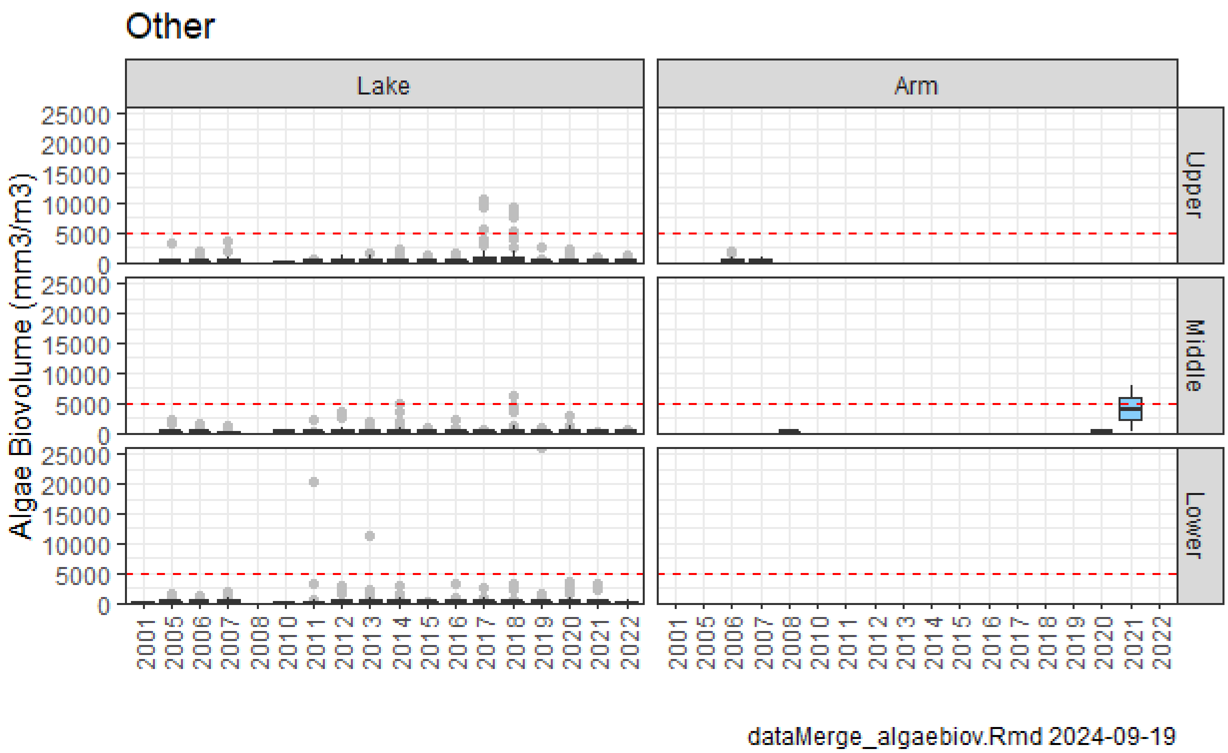
Green



3.2.12.5 Prymnesiophyta



3.2.12.6 Other



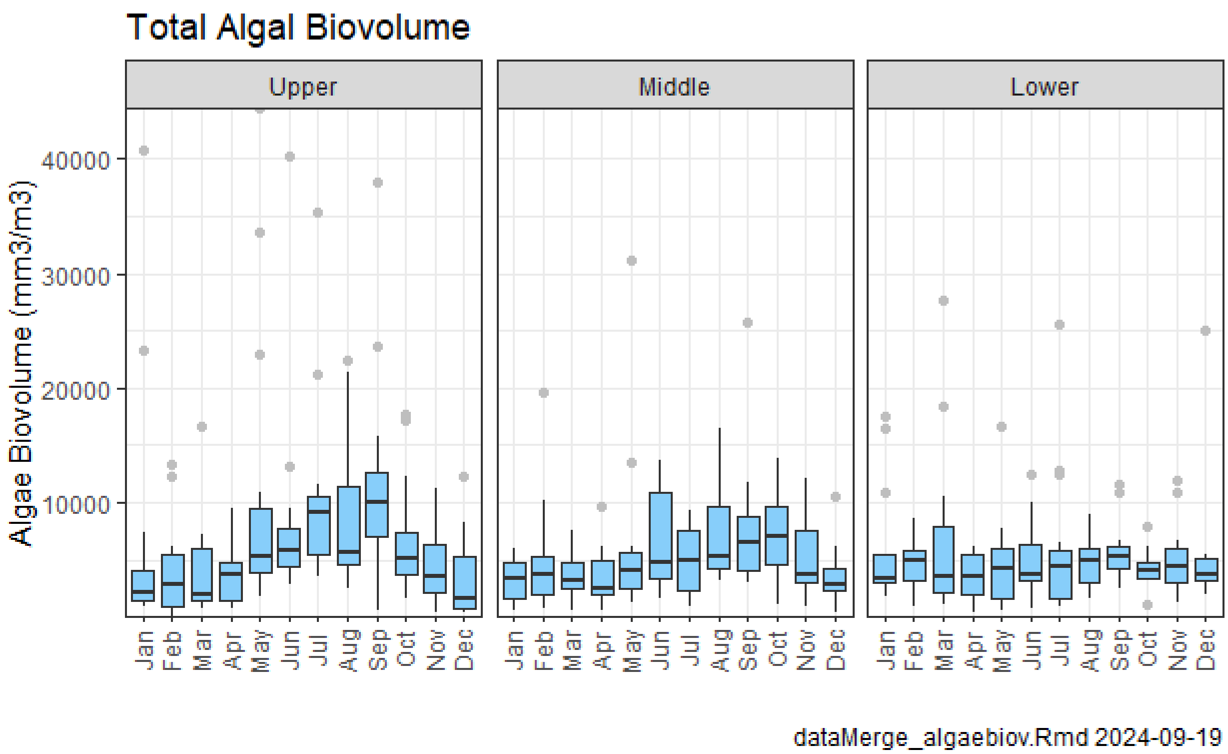
3.2.13 Historic versus Recent Comparison

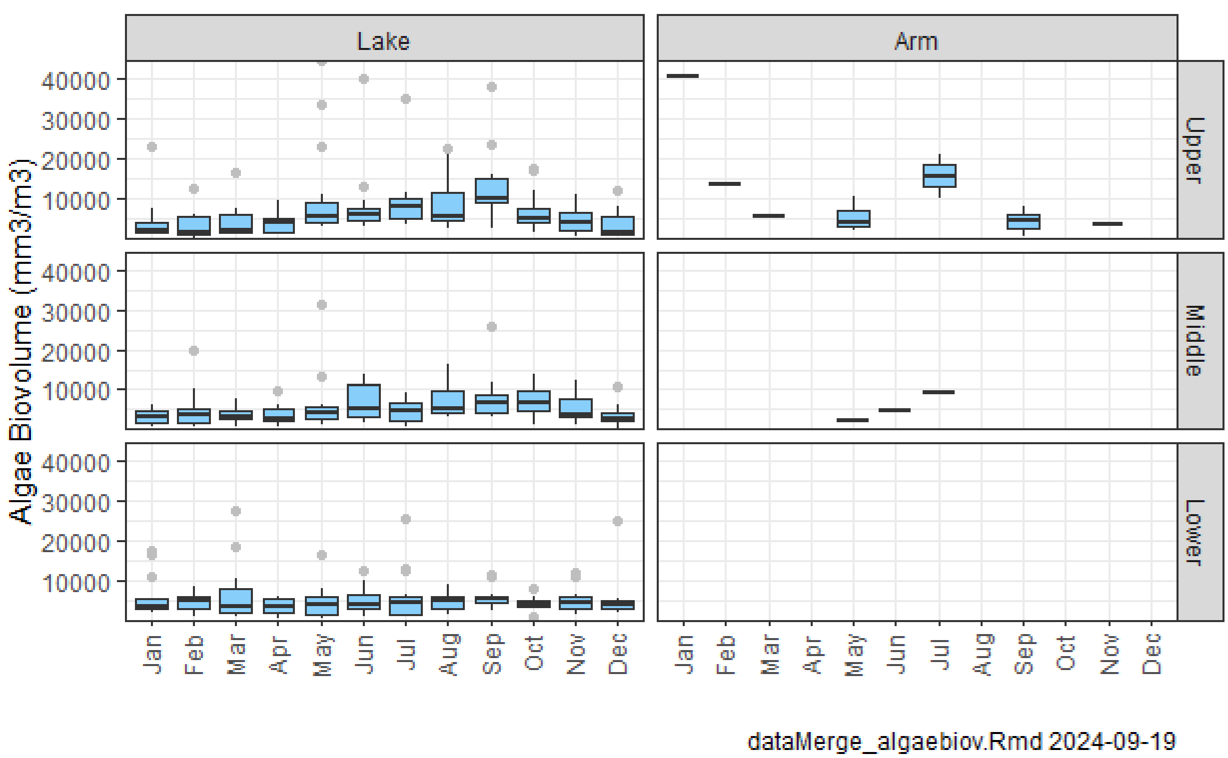
Normally we compare the data from early years (1993 to 2009) to recent years (2011 to 2020). *However*, these comparisons are suspect because sample regimes differ across time - sometimes monthly monitoring other times only if triggered by events indicating potential bloom events

3.2.14 Seasonal Trends

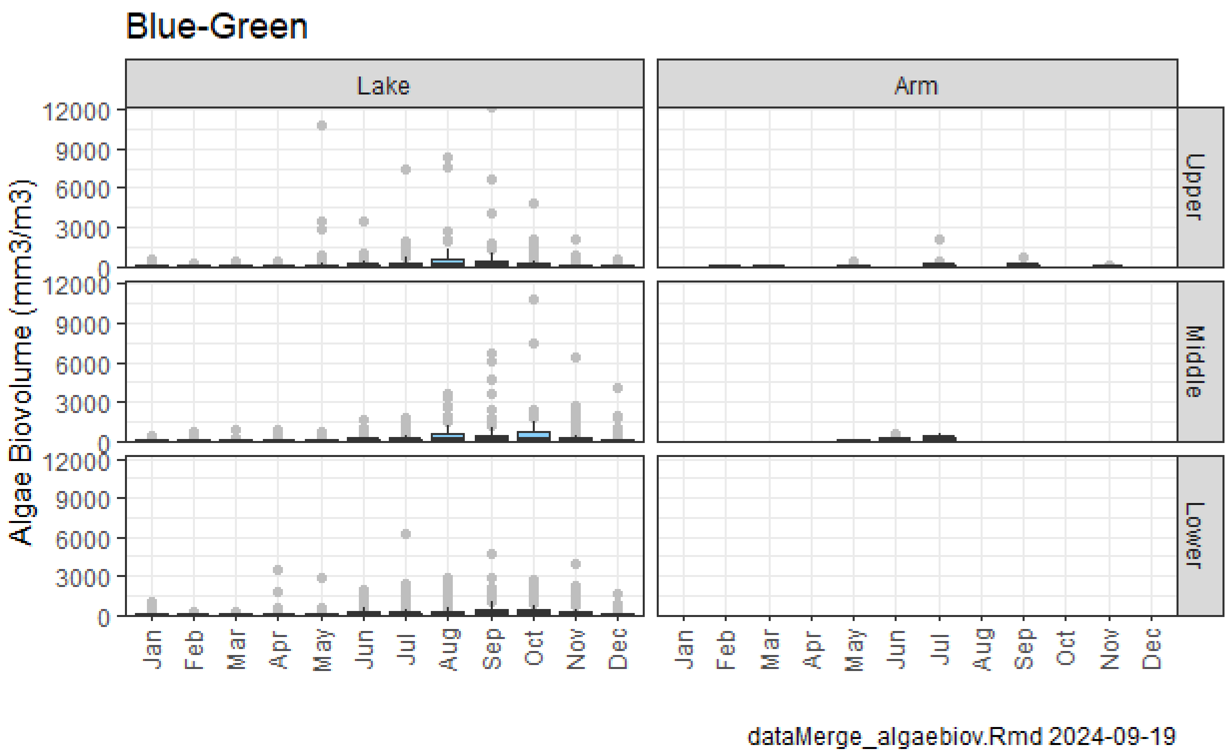
3.2.14.1 Total Biovolume

The sum of all algal types for a given date-station sample event.

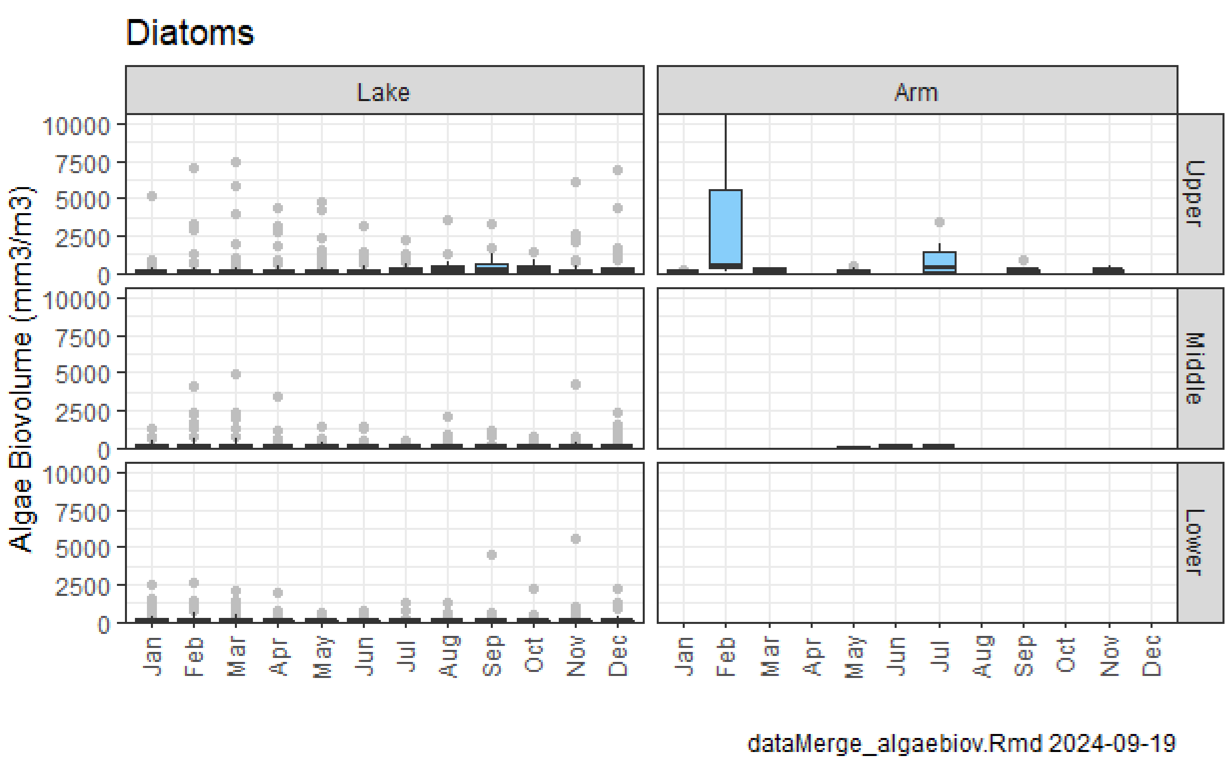

Total Algal Biovolume
Upper
Middle
Lower
Algae Biovolume (mm3/m3)
40000
30000
20000
10000
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
dataMerge_algaebiov.Rmd 2024-09-19


Lake
Arm
Upper
Middle
Lower
Algae Biovolume (mm3/m3)
40000
30000
20000
10000
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
dataMerge_algaebiov.Rmd 2024-09-19

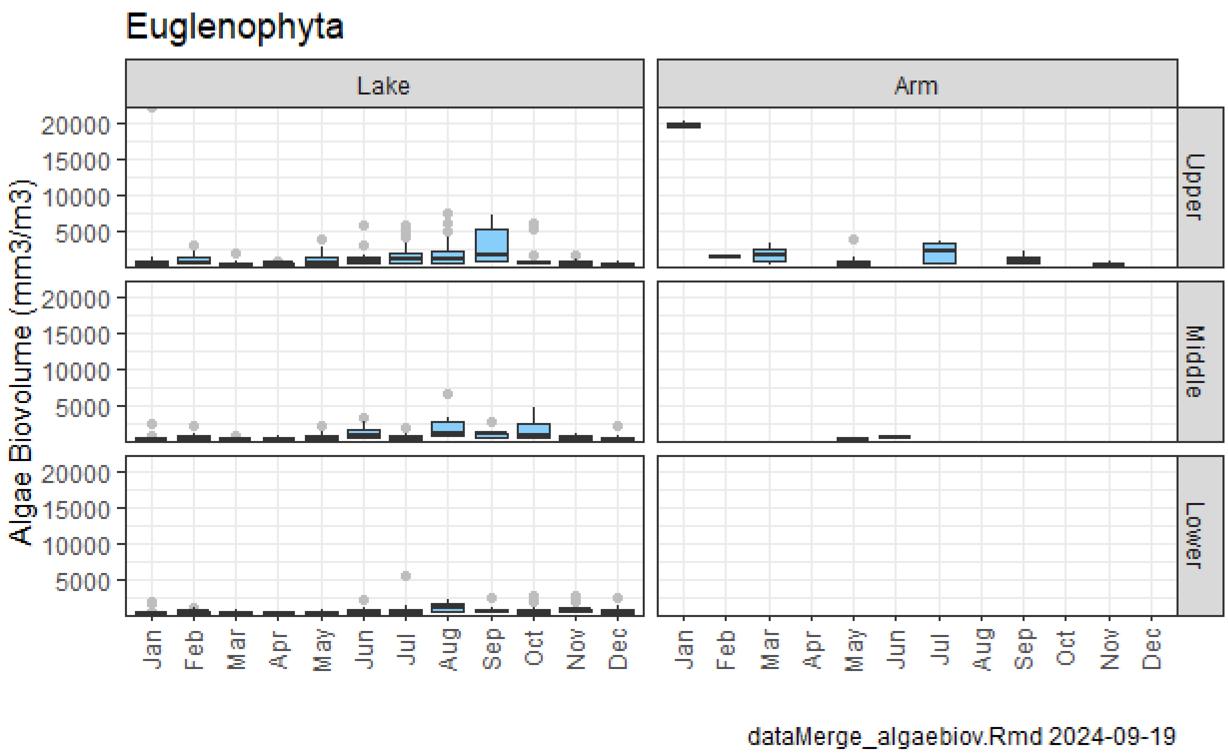
3.2.14.2 Blue-Green



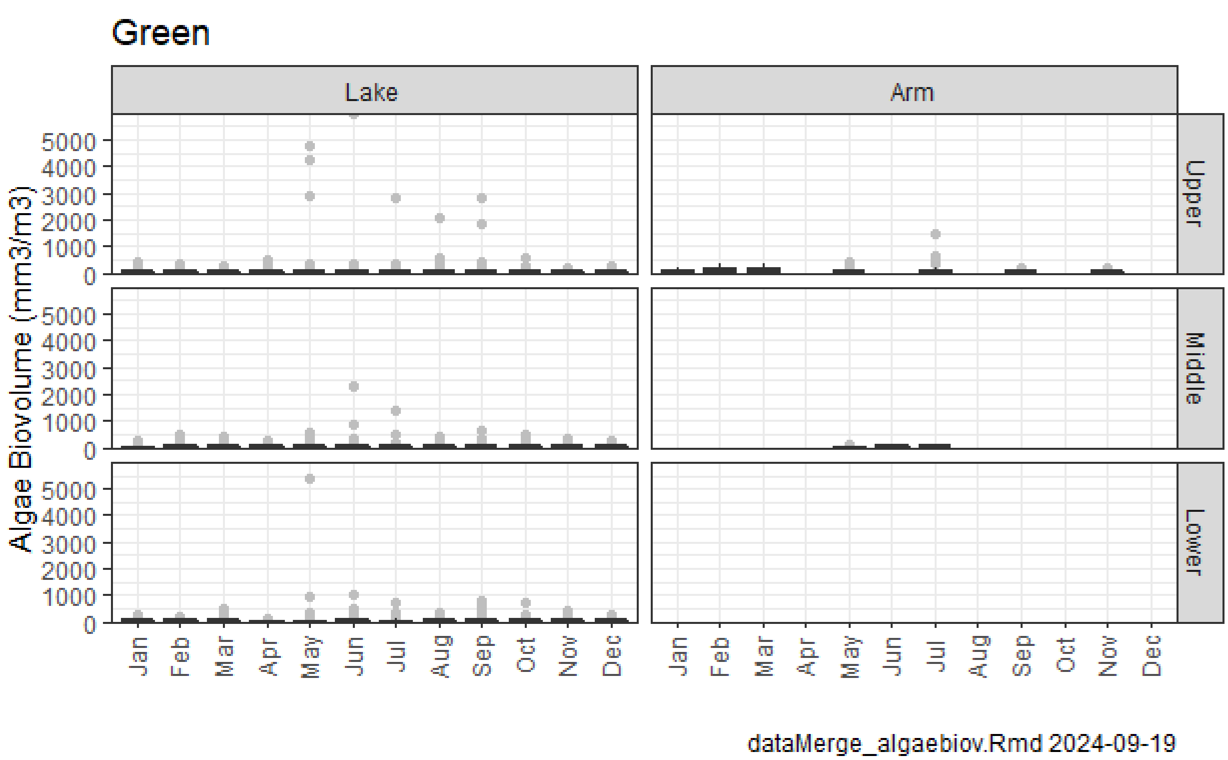
3.2.14.3 Diatoms



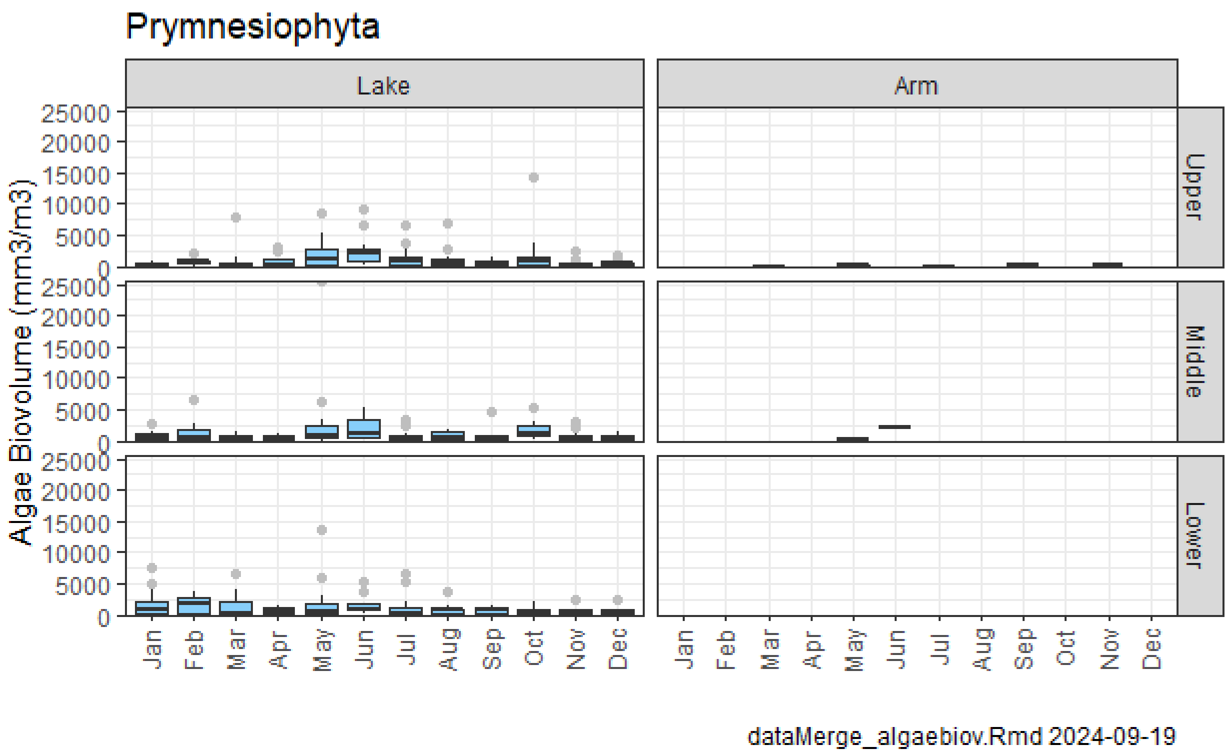
3.2.14.4 Euglenophyta



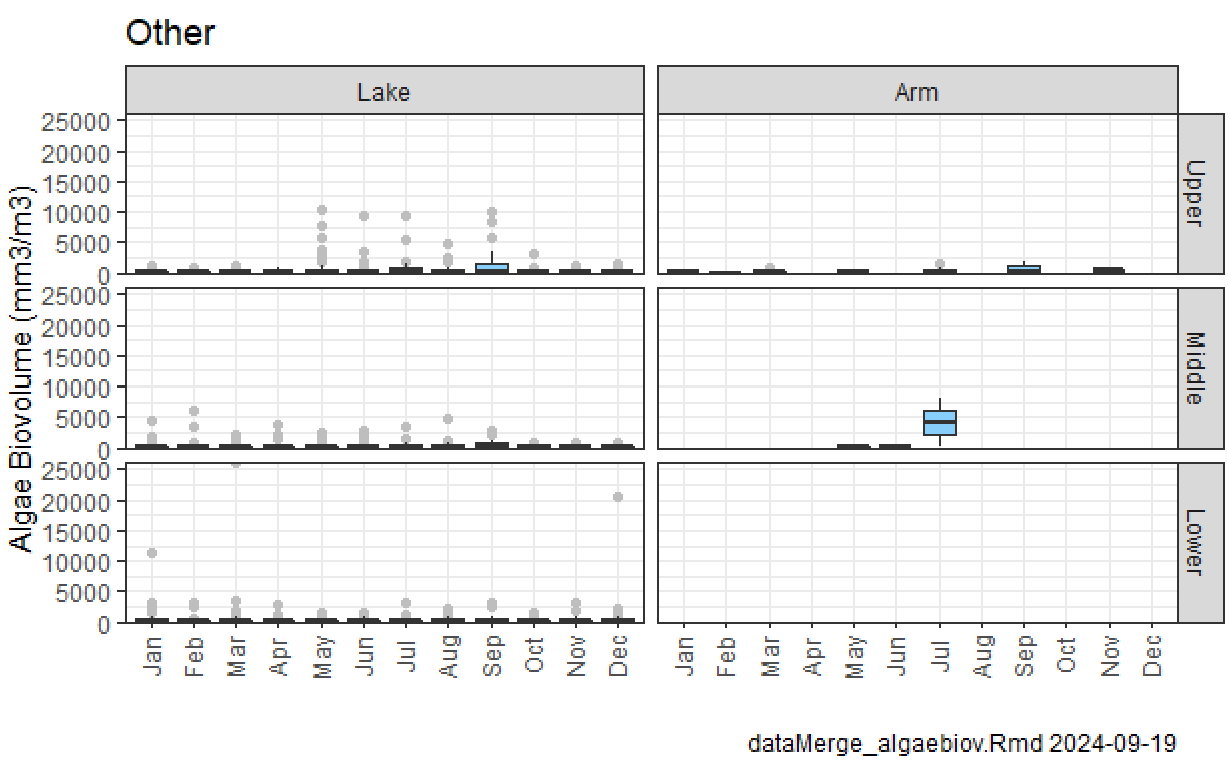
3.2.14.5 Green



3.2.14.6 Prymnesiophyta

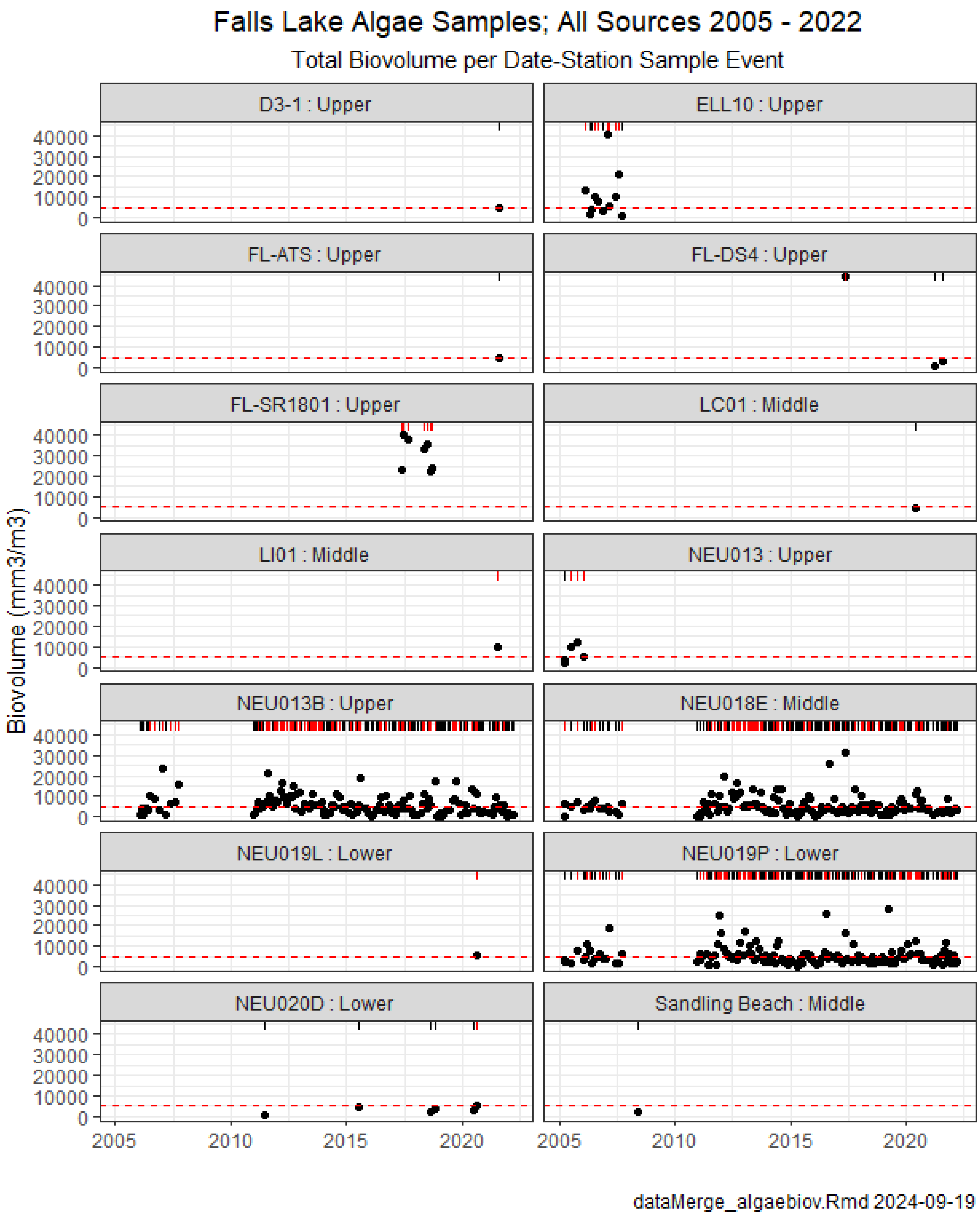


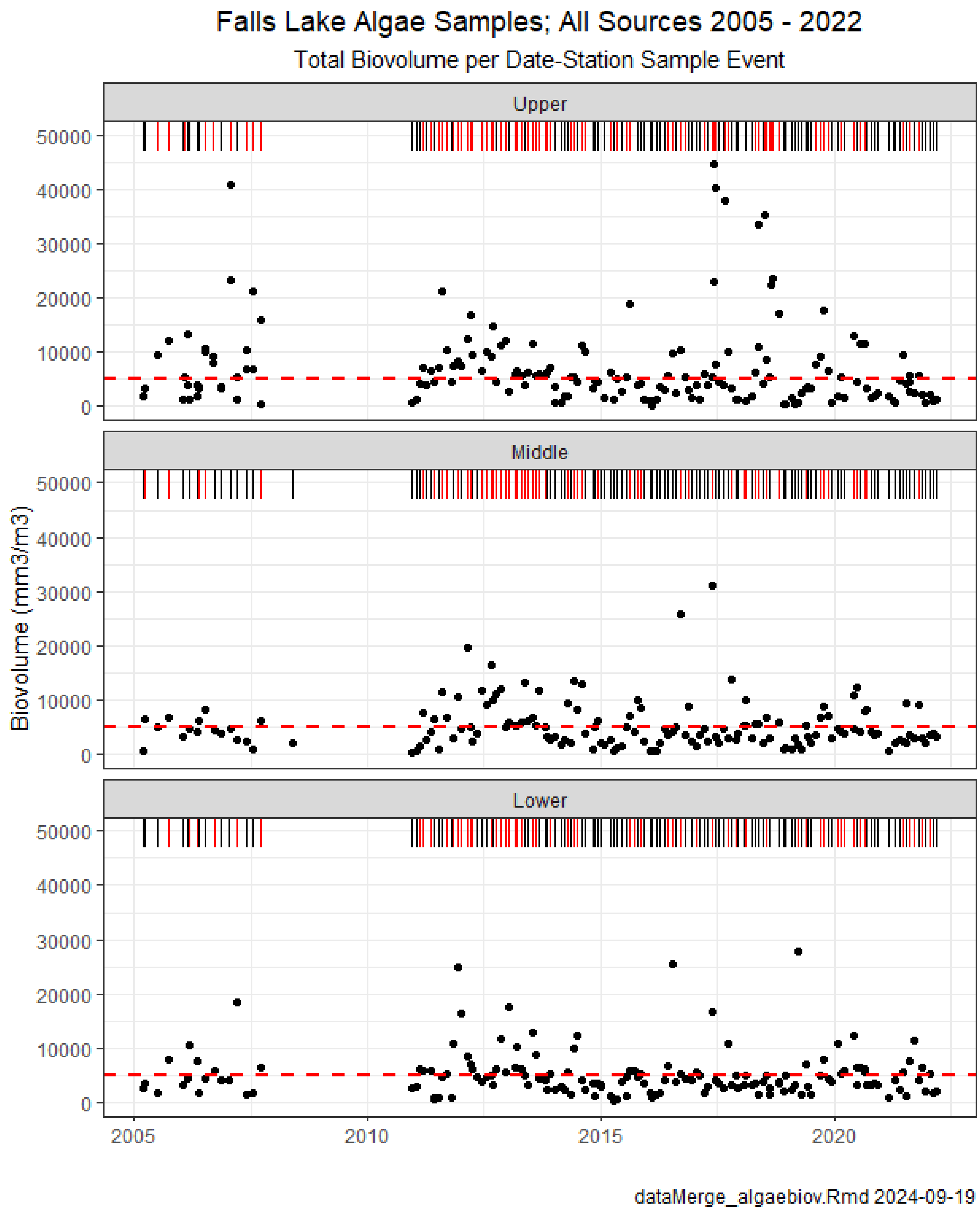
3.2.14.7 Other

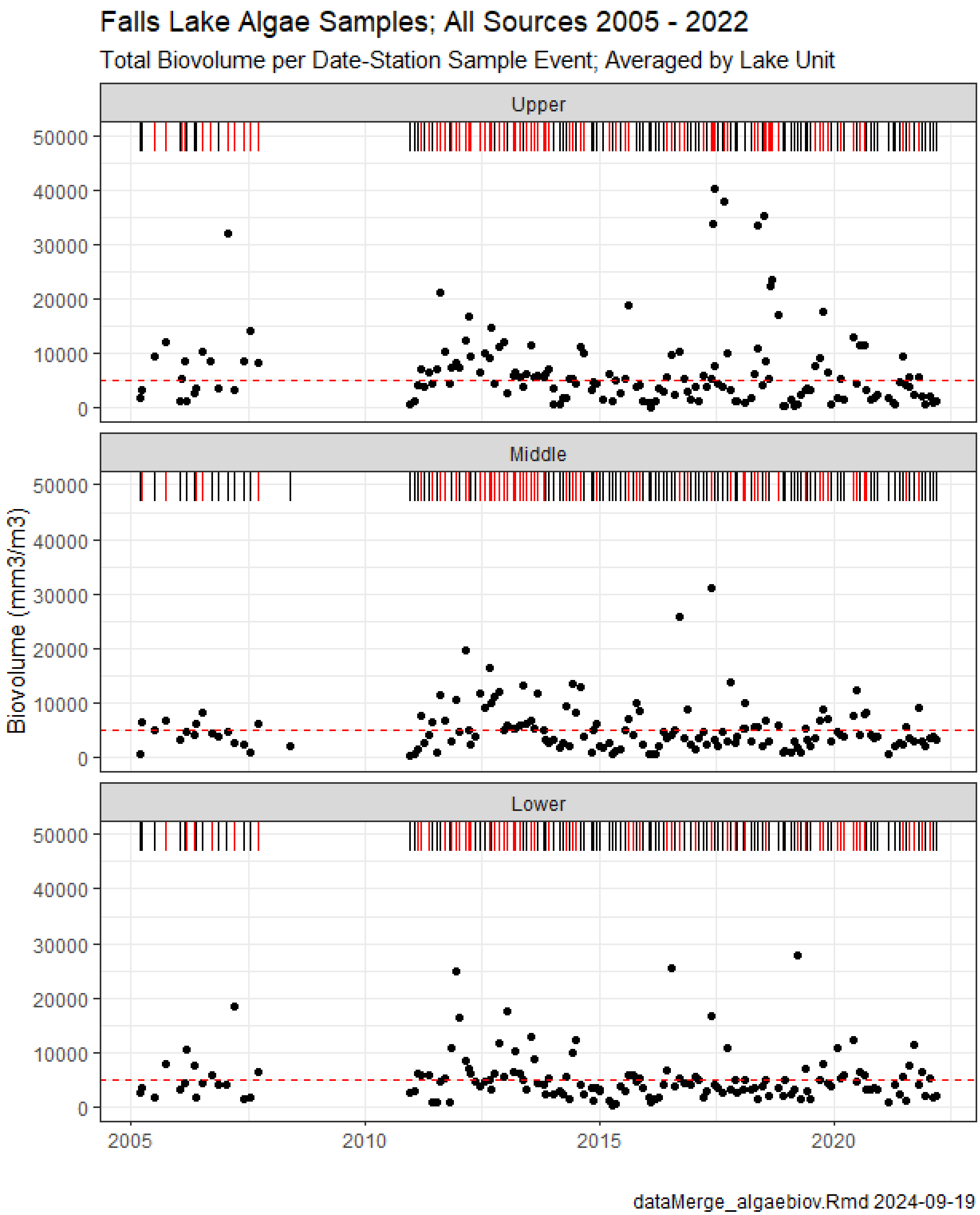


3.2.15 Time Series Plot

For the time series plots, the algae observations are summed by type within date-station samples.


Falls Lake Algae Samples; All Sources 2005 - 2022
Total Biovolume per Date-Station Sample Event
D3-1 : Upper
ELL10 : Upper
FL-ATS : Upper
FL-DS4 : Upper
FL-SR1801 : Upper
LC01 : Middle
LI01 : Middle
NEU013 : Upper
NEU013B : Upper
NEU018E : Middle
NEU019L : Lower
NEU019P : Lower
NEU020D : Lower
Sandling Beach : Middle
Biovolume (mm3/m3)
40000
30000
20000
10000
0
2005
2010
2015
2020
dataMerge_algaebiov.Rmd 2024-09-19


Falls Lake Algae Samples; All Sources 2005 - 2022
Total Biovolume per Date-Station Sample Event
Upper
Middle
Lower
Biovolume (mm3/m3)
0
10000
20000
30000
40000
50000
2005
2010
2015
2020
dataMerge_algaebiov.Rmd 2024-09-19



Bloom Events

Bloom event are sample events where the total biovolume exceeds 5000 mm3/m3. We calculate total biovolume by date-station and then filter out all rows where this total is less than 5000 mm3/m3.

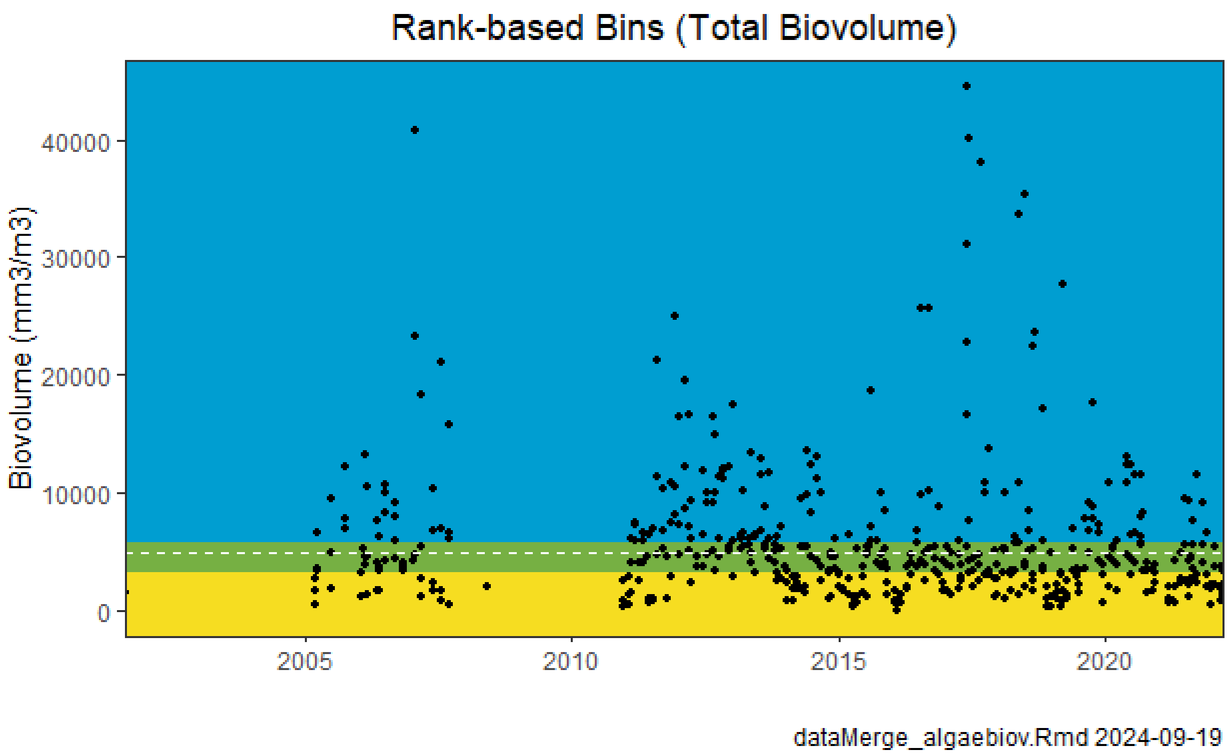
We then summarise the data to only include a single observation per bloom event. The EVENTNAME column is assigned to the ALGALTYPE with the highest biovolume for that bloom.

The are 116 dates (of 186 total dates. In some time periods and locations, samples are not taken regularly but only when a bloom is suspected, so the percent of dates with bloom may be inflated.

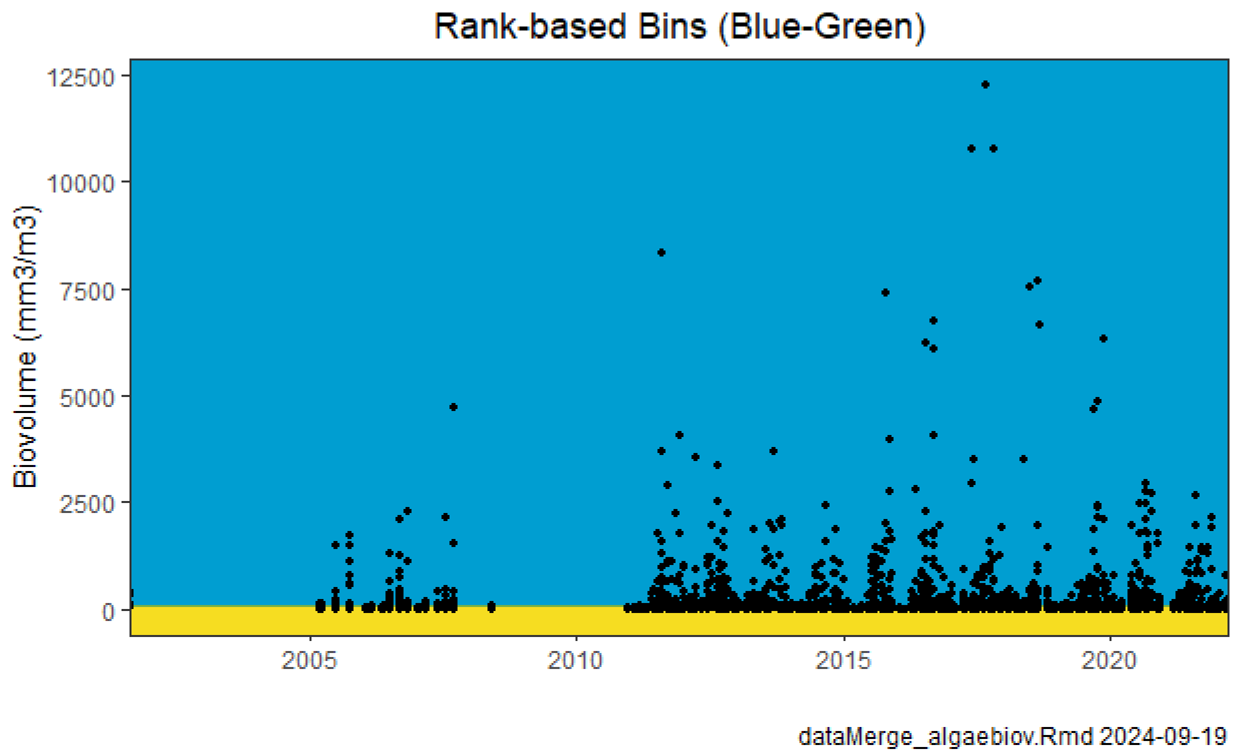
We saved the bloom data as **dataMerge/tidy_events_bloom.rds**.

3.2.16 Proposed Bins

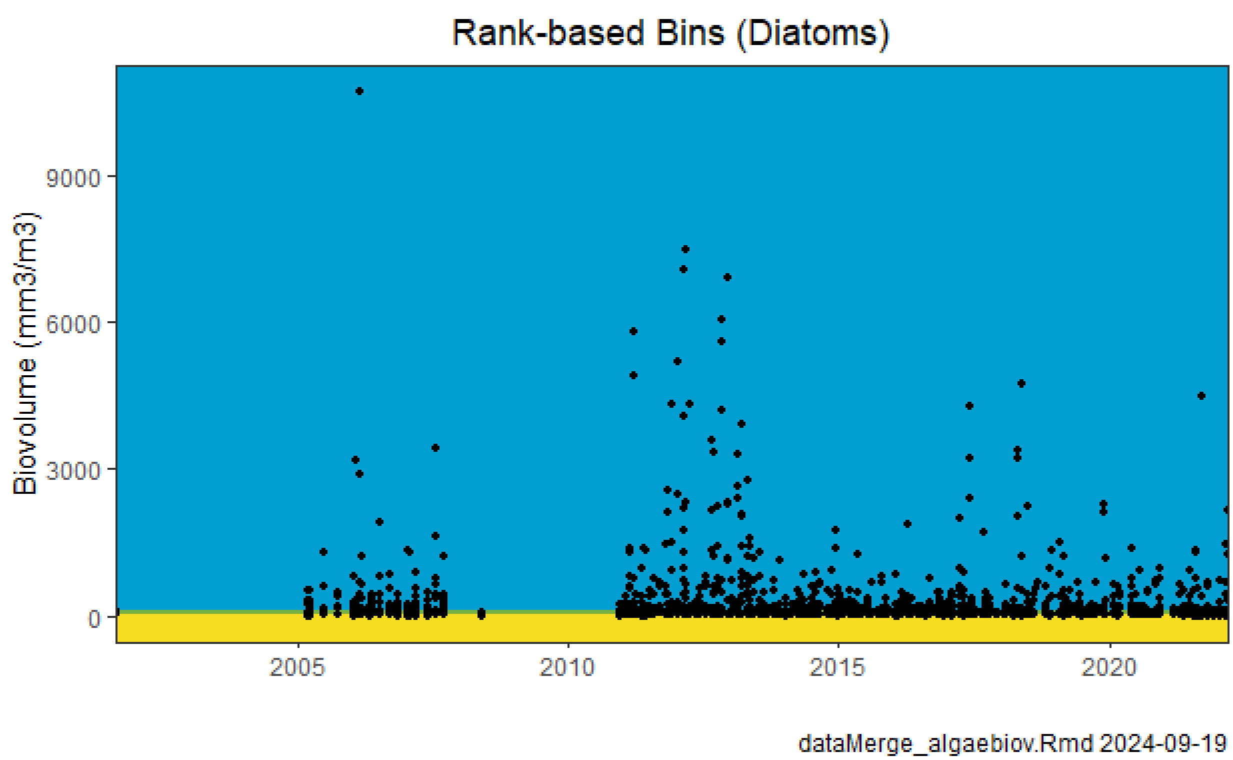
3.2.16.1 Total Biovolume



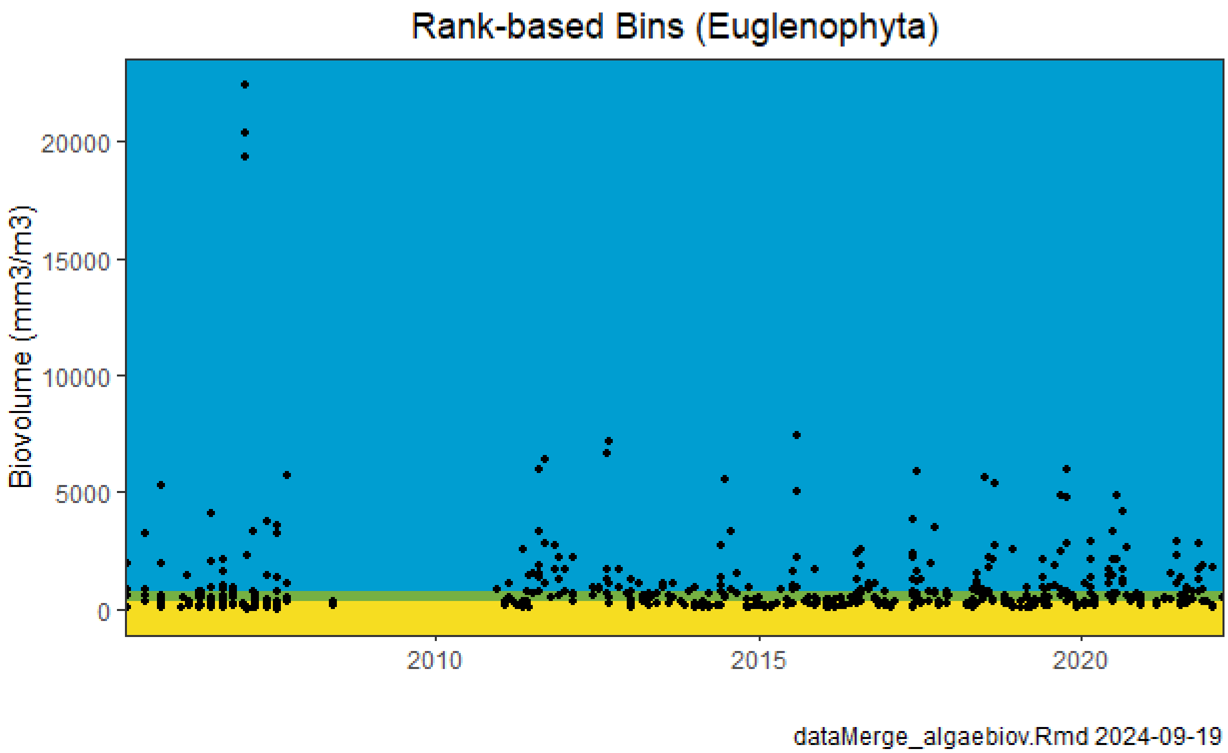
3.2.16.2 Blue-Green



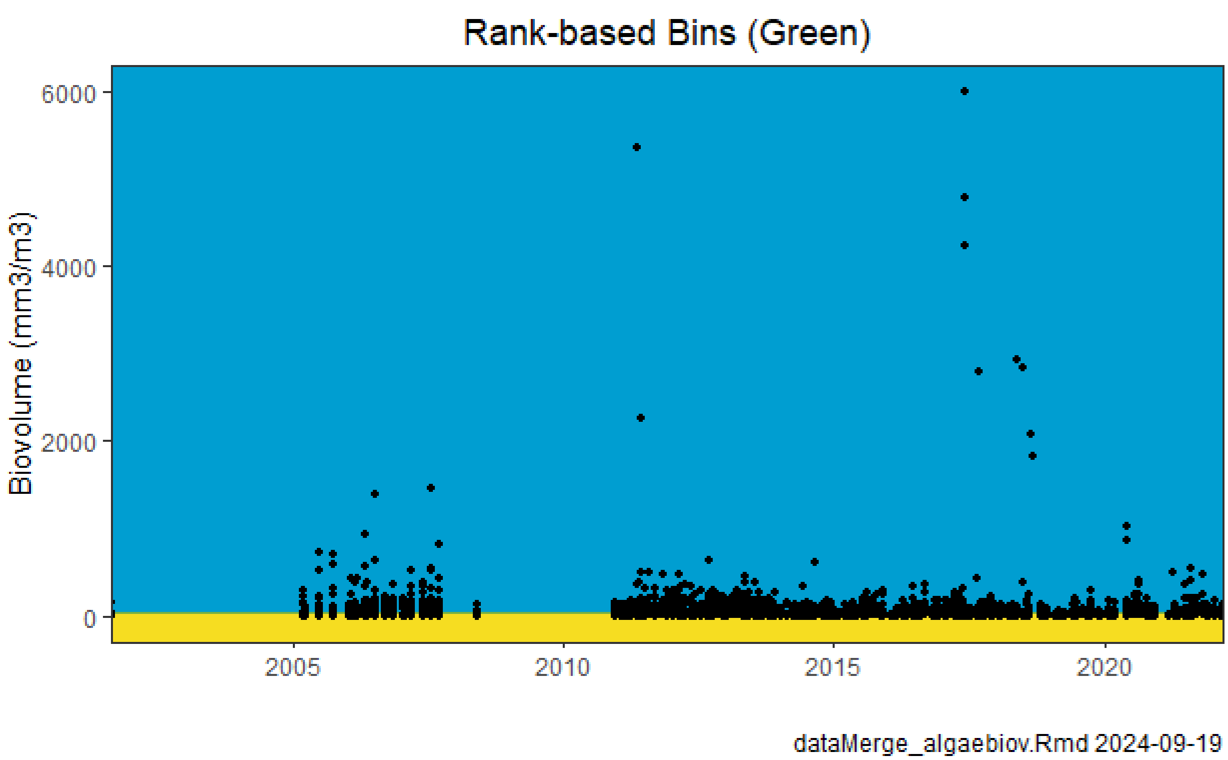
3.2.16.3 Diatoms



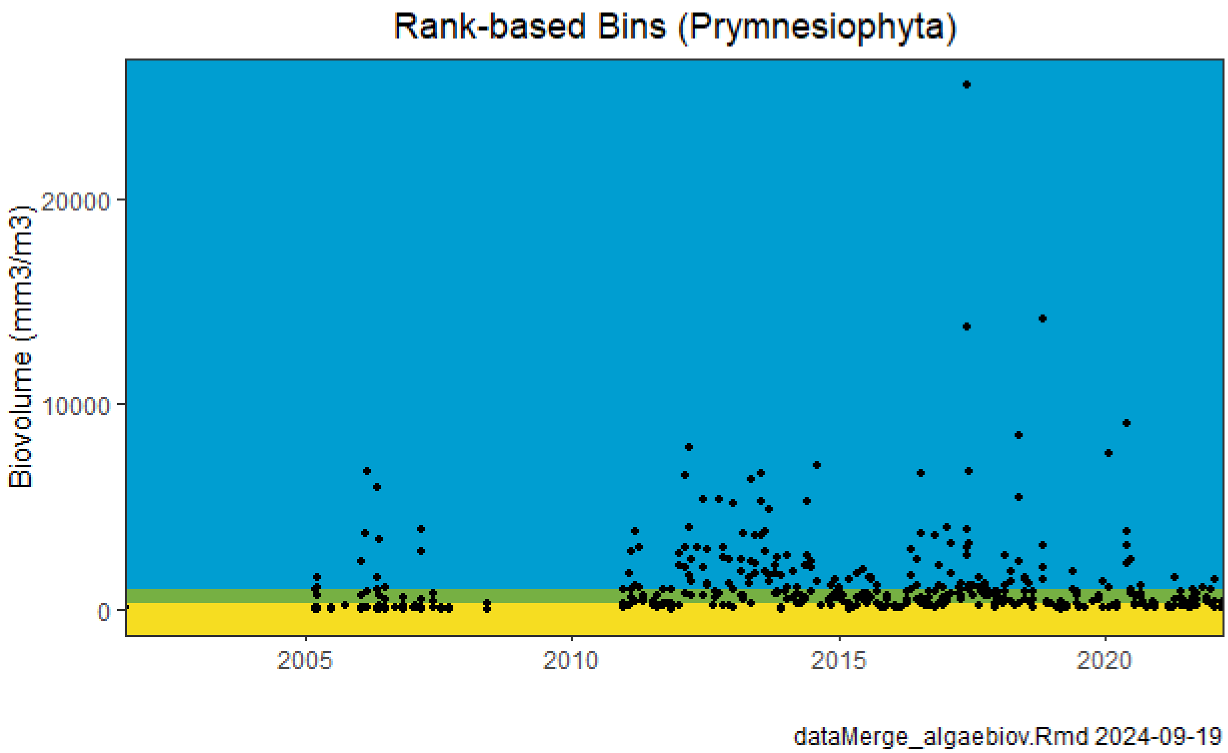
3.2.16.4 Euglenophyta



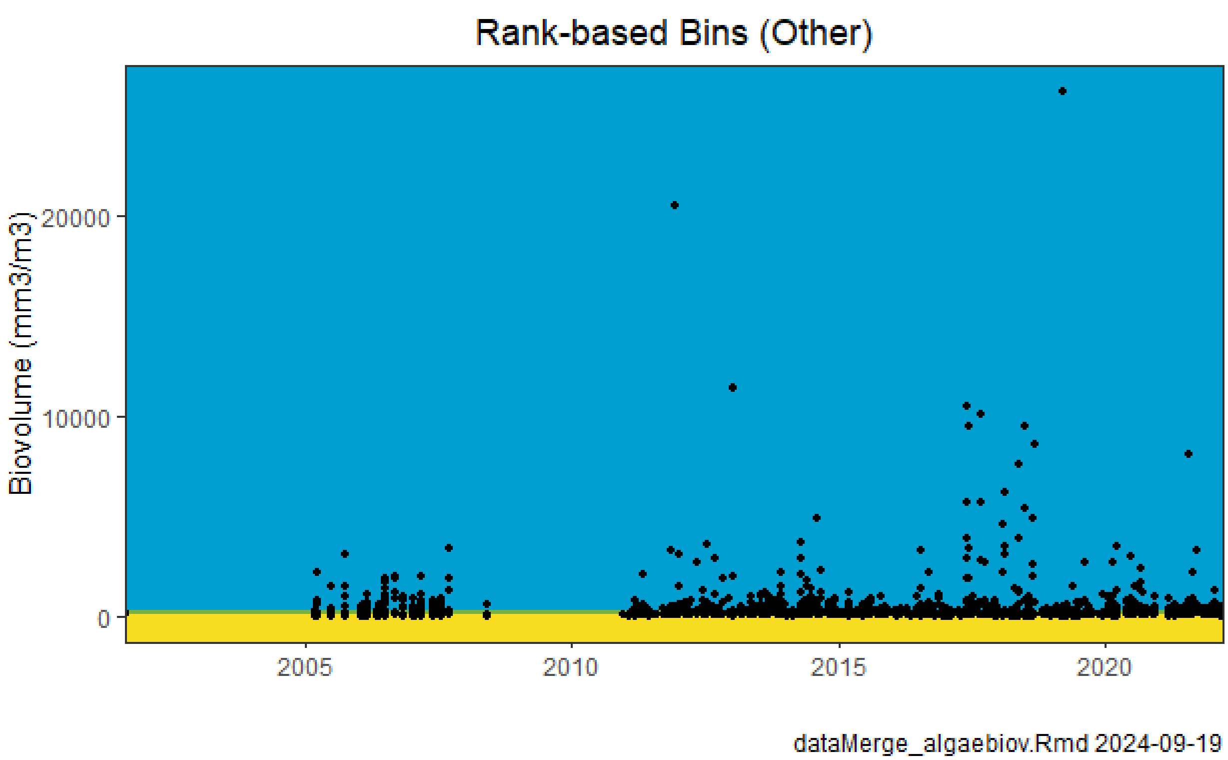
3.2.16.5 Green



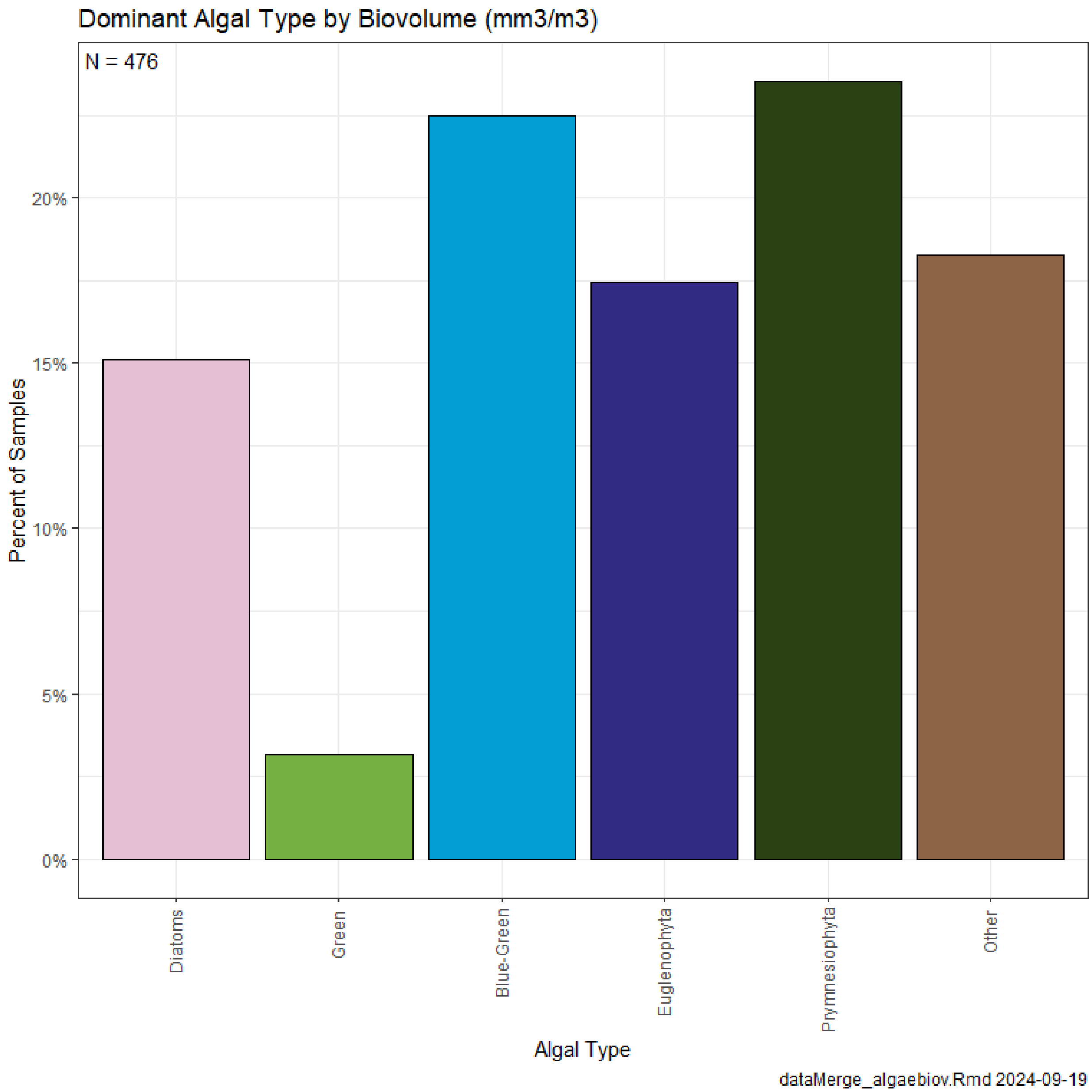
3.2.16.6 Prymnesiophyta

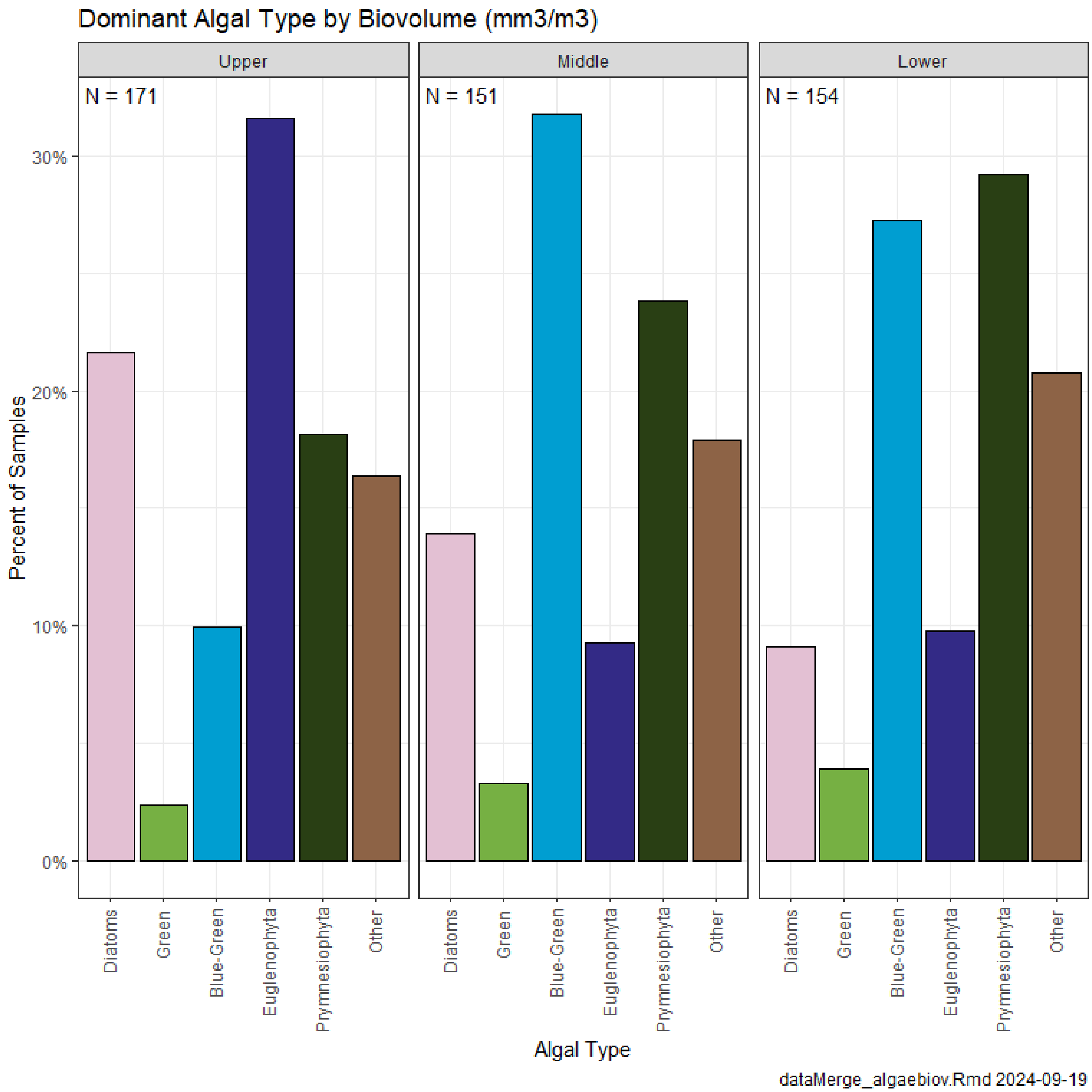


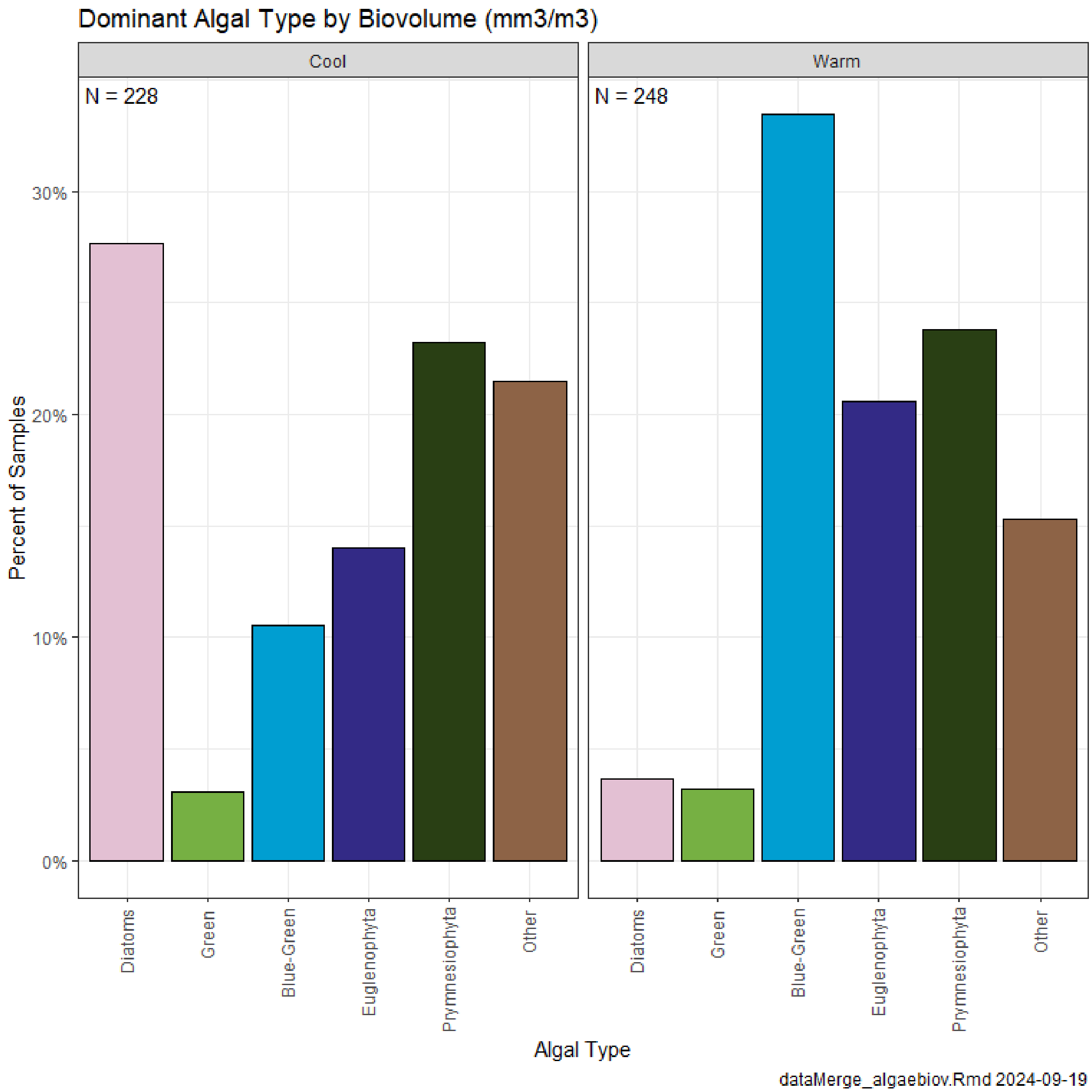
3.2.16.7 Other



3.2.17 Dominant Algal Type


Dominant Algal Type by Biovolume (mm3/m3)
N = 476
Percent of Samples
0%
5%
10%
15%
20%
Diatoms
Green
Blue-Green
Euglenophyta
Prymnesiophyta
Other
Algal Type
dataMerge_algaebiov.Rmd 2024-09-19


Dominant Algal Type by Biovolume (mm3/m3)
Upper
Middle
Lower
N = 171
N = 151
N = 154
30%
20%
10%
0%
Percent of Samples
Diatoms
Green
Blue-Green
Euglenophyta
Prymnesiophyta
Other
Algal Type
dataMerge_algaebiov.Rmd 2024-09-19



3.2.18 Export Merged Data

The merged data files represent all data gathered to date for this variable. We drop some of the information that was used as qaqc during prep and merging steps: SOURCETYPE, DEPTHTYPE, VARTYPE, VARLABEL. The final merged data are saved as:

- **tidy_algaebiov** (rds and xlsx): include all the data with taxonomic and group information
- **tidy_totbiov** (rds and xlsx): data summed for total biovolume for each date-station sample event
- **tidy_dombiov** (rds and xlsx): data describing the algalgroup with the greatest biovolume for each station ID and date

Code authored by KDV Decision Analysis LLC and last run 2024-09-19 with R version 4.4.1 (2024-06-14 ucrt).

3.3 Merge All Chlorophyll-a Data

3.3.1 Gather Data Resources

3.3.1.1 List associated files

Chlorophyll-a data are identified by the **_Chlorophyll-a** suffix chla data are identified by the **_chla** suffix

The available Chlorophyll-a sources are: caae_chla.rds, deqAlgae_chla.rds, durmCity_chla.rds, emilyToxins_chla.rds, ralpud_chla.rds, storetDwr_chla.rds, storetUsgs_chla.rds.

Sources

To facilitate removal of duplicates, each data source was assigned a priority. When duplicate observations are filtered out, the record from the lower priority data is the record removed.

3.3.1.2 Emily Toxins (emilyToxins)

Data acquired from Emily Pierce at NCSU, student of Astrid Schneitzer.

This source provides 297 Chlorophyll-a records for 11 station ids and 3 years spanning 2019 to 2021.

```
##
##          2019 2020 2021
##   LC01       5   12   10
##   LI01       6   12   10
##   LLC01      5   12   10
##   NEU013     4   12    9
##   NEU013B    5   12   10
##   NEU0171B   5   12   10
##   NEU018E    6   11   10
##   NEU019E    6   12   10
##   NEU019L    5   12   10
##   NEU019P    5   12   10
##   NEU020D    5   12   10

##
##       2019 2020 2021
##   Jan    0   11    0
##   Feb    0   11    0
##   Mar    0   10   11
##   Apr    0   11   11
##   May    0    0   10
##   Jun    0   22   11
##   Jul    6   11   11
##   Aug    8   11   11
##   Sep   11   11   11
##   Oct   10   11   11
```

```
##   Nov   11   11   11
##   Dec   11   11   11

##
##            Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##   Upper       2   2   4   4   1   6   4   6   6   5   6   6
##   Middle      6   6  11  12   6  18  15  18  18  18  18  18
##   Lower       3   3   6   6   3   9   9   6   9   9   9   9
##   Other Lake  0   0   0   0   0   0   0   0   0   0   0   0
```

3.3.1.3 City of Raleigh (ralpud)

There are four file sets from the City of Raleigh Public Works: **raltoxin**, **ralpud**, **ecAlgae**, and **ecToxins.** Chlorophyll-a data are found only in **ralpud.**

This source provides 126 Chlorophyll-a records for 6 station ids and 2 years spanning 2017 to 2018.

```
##
##    Honeycutt Creek     Intake Surface Lower Barton Creek    New Light Creek
##                 21                 21                 21                 21
## Upper Barton Creek          US Hwy 98
##                 21                 21

##
##      Upper      Middle      Lower Other Lake
##          0          0        126          0

##
## 2017 2018
##   72   54

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##  12  12  12  12  12  12  12  12  12   6   6   6
```

3.3.1.4 DEQ Algae (deqAlgae)

NC DEQ (D. Wiltsie) provided chlorophyll-a data in the resource referenced as source: **deqAlgae.** This source provides 428 Chlorophyll-a records for 8 station ids and 15 years spanning 2006 to 2022.

```
##
##       ELLERBE CREEK (FALLS LAKE) NEAR MOUTH
##                                          10
##      FALLS LAKE @ MARKER #1 NEAR BAYLEAF NC
##                                           2
## FALLS LAKE @ MOUTH LEDGE CK NR CREEDMOOR NC
##                                         137
##             FALLS LAKE @ MOUTH OF BEAVERDAM
##                                           1
##         FALLS LAKE AT I-85 NEAR NORTHSIDE NC
##                                           1
##     FALLS LAKE AT NC HWY 98 NEAR BAYLEAF NC
```

```
##                                  137
##            FALLS LAKE BAYLEAF CHURCH ROAD
##                                    1
##              FALLS LAKE IN LICK CREEK ARM
##                                    1
##                FALLS LAKE NEAR REDWOOD NC
##                                  136
##                       FALLS OF THE NEUSE
##                                    1
##              FALLS OF THE NEUSE RESERVOIR
##                                    1

##
##     Upper     Middle      Lower Other Lake
##       147       140       141          0

##
## 2006 2007 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022
##   29   16    2   35   33   33   34   27   38   38   34   36   33   33    7

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##  39  37  38  25  40  37  39  32  35  31  39  36
```

3.3.1.5 City of Durham (durmCity)

This source provides 244 Chlorophyll-a records for 2 station ids and 4 years spanning 2015 to 2018.

```
##
##    FL-DS4 FL-SR1801
##       122       122

##
##     Upper     Middle      Lower Other Lake
##       244          0          0          0

##
## 2015 2016 2017 2018
##   61   69   52   62

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##   0   0   0  29  38  36  40  31  28  42   0   0
```

3.3.1.6 Center for Applied Aquatic Ecology NCSU (caae)

CAAE provided chlorophyll-a data in the resource referenced as source: caae.

This source provides 848 Chlorophyll-a records for 15 station ids and 5 years spanning 2014 to 2018.

```
##
##            Falls Lake 1      Falls Lake 1 Channel     Falls Lake 10 Channel
```

```
##                    24                    50                    49
##    Falls Lake 11 Channel            Falls Lake 2            Falls Lake 4
##                    50                    24                    24
##            Falls Lake 5            Falls Lake 6      Falls Lake 6 Channel
##                    22                    28                    48
##     Falls Lake 7 Channel      Falls Lake 8 Channel      Falls Lake 9 Channel
##                    49                    49                    50
## Falls Lake Hwy 50 Channel    Falls Lake I85 Channel Falls Lake Intake Channel
##                   132                   123                   126

##
##     Upper     Middle      Lower Other Lake
##       245       255       348         0

##
## 2014 2015 2016 2017 2018
##   79  189  214  200  166

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##  57  60  66  70  75  76  75  90  81  76  67  55
```

3.3.1.7 Storet DWR Data

This source provides 2359 Chlorophyll-a records for 25 station ids and 28 years spanning 1984 to 2020.

```
##
## J1250000 J1370000 J1430000 J1590000 J1670000 J1675000 J1690000 J1715000
##       61       70       45       45        2       66        3       69
## J1725000 J1727000 J1740000     LC01     LI01    LLC01   NEU010   NEU013
##       46       73       70      161      111      160       53       18
##  NEU013B NEU0171B  NEU018C  NEU018E  NEU019E  NEU019L  NEU019P  NEU020D
##      173      171       47      173      176      175      176      177
## NEUELL10
##       38

##
##     Upper     Middle      Lower Other Lake
##       458      1184       717         0

##
## 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 2001 2005 2006
##  109  102  109   67   25   29   30   12   10   15    6   18   18   23   90  247
## 2007 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
##  197   74  111  118  114  118  129  130  132   99  117  110
```

```
##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
## 162 183 196 206 184 233 206 257 204 200 169 159
```

##Storet USGS Data

This source provides 146 Chlorophyll-a records for 5 station ids and 9 years spanning 1993 to 2010.

```
##
##   2086920 208703650 208708905 208717595 208718195
##        34        38        36         1        37

##
##      Upper     Middle      Lower Other Lake
##         34         38         74          0

##
## 1993 1994 1995 2005 2006 2007 2008 2009 2010
##   16   19    8    9   16   19   23   22   14

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##   0  12   0  17   8  25   7  33   4  27   4   9
```

3.3.2 Merge Data Resources

```
##
##        caae    deqAlgae    durmCity emilyToxins      ralpud   storetDwr
##         848         428         244         297         126        2359
##  storetUsgs
##         146

##
##      Upper     Middle      Lower Other Lake
##       1180       1781       1487          0

##
## 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 2001 2005 2006
##  109  102  109   67   25   29   30   12   10   31   25   26   18   23   99  292
## 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022
##  232   23   22   90  146  151  147  231  406  451  494  415  210  274  142    7

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
## 281 315 333 381 367 452 407 485 397 414 318 298
```

In total, we assembled 4448 Chlorophyll-a records. into a single tidy dataframe. This included data from Raleigh PUD (126 records), EmilyToxins (297 records), CAAE (848 records), City of Durham (244 records), DEQ (428 records), Storet DWR (2359 records), and Storet USGS (146 records).`

Merge data were qaqc'ed to confirm:

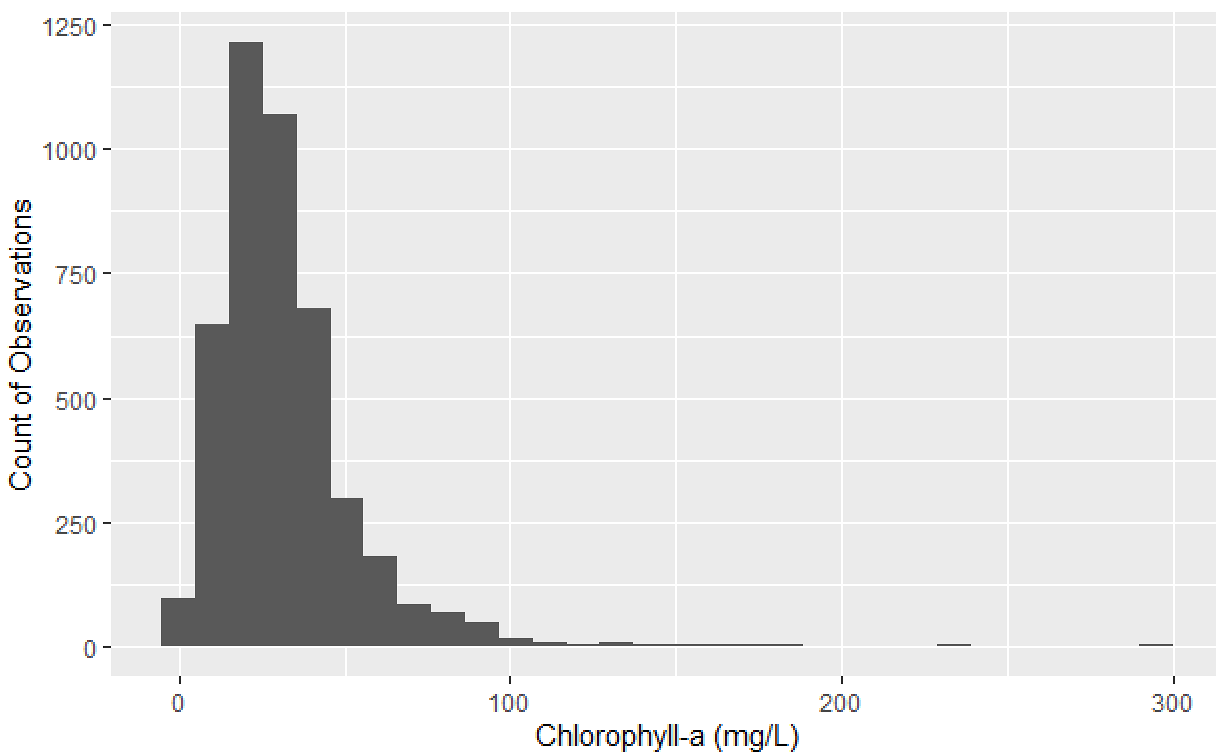
- only one variable is present

- no NA values are present
- only one measurement unit is present (OR if more that one is present, additional processing is required)

3.3.2.1 Check for and Remove Errors

These data had no values that could be flagged as obvious data errors. There are some extreme values, but we retain these pending review by the SME and TAW teams.

Quantiles	ChlA.value
0%	0.00
10%	12.00
20%	17.00
30%	20.71
40%	24.00
50%	28.00
60%	31.52
70%	36.30
80%	42.56
90%	55.60
100%	295.00



Check and Remove Duplicates

Due to the shared structure, all chlorophyll data can be merged into a single dataframe. We have to check for duplicates because some data resources overlap.

```
##
##      caae    deqAlgae    durmCity emilyToxins     ralpud   storetDwr
##       848        428        244        297        126       2357
##  storetUsgs
##       146
```

Of all data received (4448 records), at least 2 are clear duplicates (shared DATE, STATIONID, DEPTHM, and measured VALUE) and are easily dropped.

3.3.2.2 Check Units and Methods

```
##
##      caae deqAlgae durmCity emilyToxins ralpud storetDwr storetUsgs
##   ug/L  848     428     244        297    126     2357       146

##
##                   caae deqAlgae durmCity emilyToxins ralpud storetDwr
##   Empirical         848       0       0          0     0        0
##   EPA 446.0           0       0       0          0   126        0
##   Fluoromter, SM 445    0     428       0          0     0        0
##
##                   storetUsgs
##   Empirical                0
##   EPA 446.0                0
##   Fluoromter, SM 445        0
```

Method 446 is in vitro measurement with visible spectrophotometry Method 445 is in vitro measurement with fluorescence

From a comparative study of Chlorophyll-a measurements in estuarine sediments (Pinckney & Zingmark 1994, https://www.sciencedirect.com/science/article/abs/pii/0167701294900264?via%3Dihub):

- “The SPEC method overestimated the chla concentration by 16% but the relationship between SPEC and HPLC values was constant.”
- “The FLUO method underestimated chla concentrations by 3% and the relationship to HPLC determined values was also constant.”
- “A paired-comparison of SPEC and FLUO methods showed that although the values were linearly correlated, the FLUO method produced lower chla values than the SPEC method. Although SPEC and FLUO methods overestimate and underestimate (respectively) sediment chla concentrations, the relationship was linear across a wide range of naturally occurring concentrations. Both SPEC and FLUO methods are suitable for showing relative differences in chla concentrations, but should be corrected when absolute concentrations are important.”

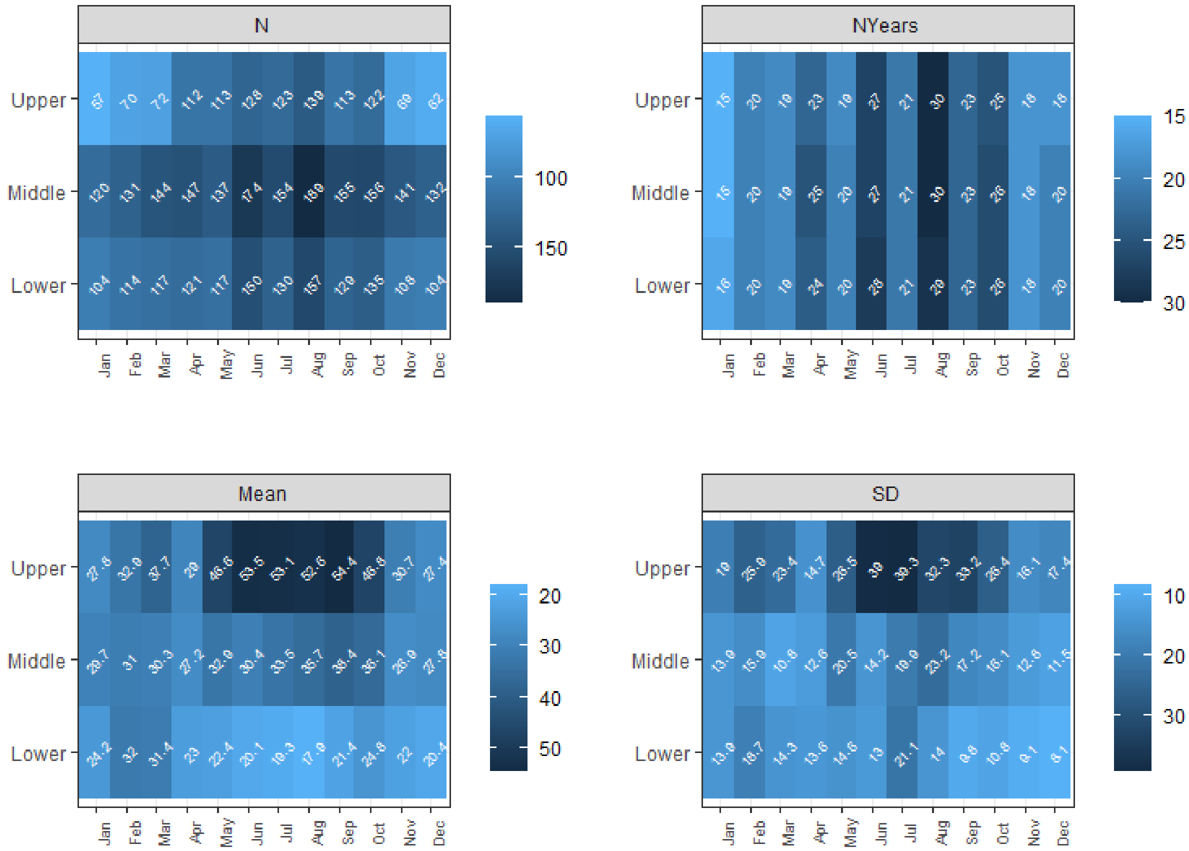
```
##
##      Empirical EPA 446.0 Fluoromter, SM 445
##   1984        0         0                  0
##   1985        0         0                  0
```

```
##   1986      0     0          0
##   1987      0     0          0
##   1988      0     0          0
##   1989      0     0          0
##   1990      0     0          0
##   1991      0     0          0
##   1992      0     0          0
##   1993      0     0          0
##   1994      0     0          0
##   1995      0     0          0
##   1996      0     0          0
##   2001      0     0          0
##   2005      0     0          0
##   2006      0     0         29
##   2007      0     0         16
##   2008      0     0          0
##   2009      0     0          0
##   2010      0     0          2
##   2011      0     0         35
##   2012      0     0         33
##   2013      0     0         33
##   2014     79     0         34
##   2015    189     0         27
##   2016    214     0         38
##   2017    200    72         38
##   2018    166    54         34
##   2019      0     0         36
##   2020      0     0         33
##   2021      0     0         33
##   2022      0     0          7
##
##             Empirical EPA 446.0 Fluoromter, SM 445
##   Upper           245     0         147
##   Middle          255     0         140
##   Lower           348   126         141
##   Other Lake        0     0           0
```

3.3.3 Data Summaries

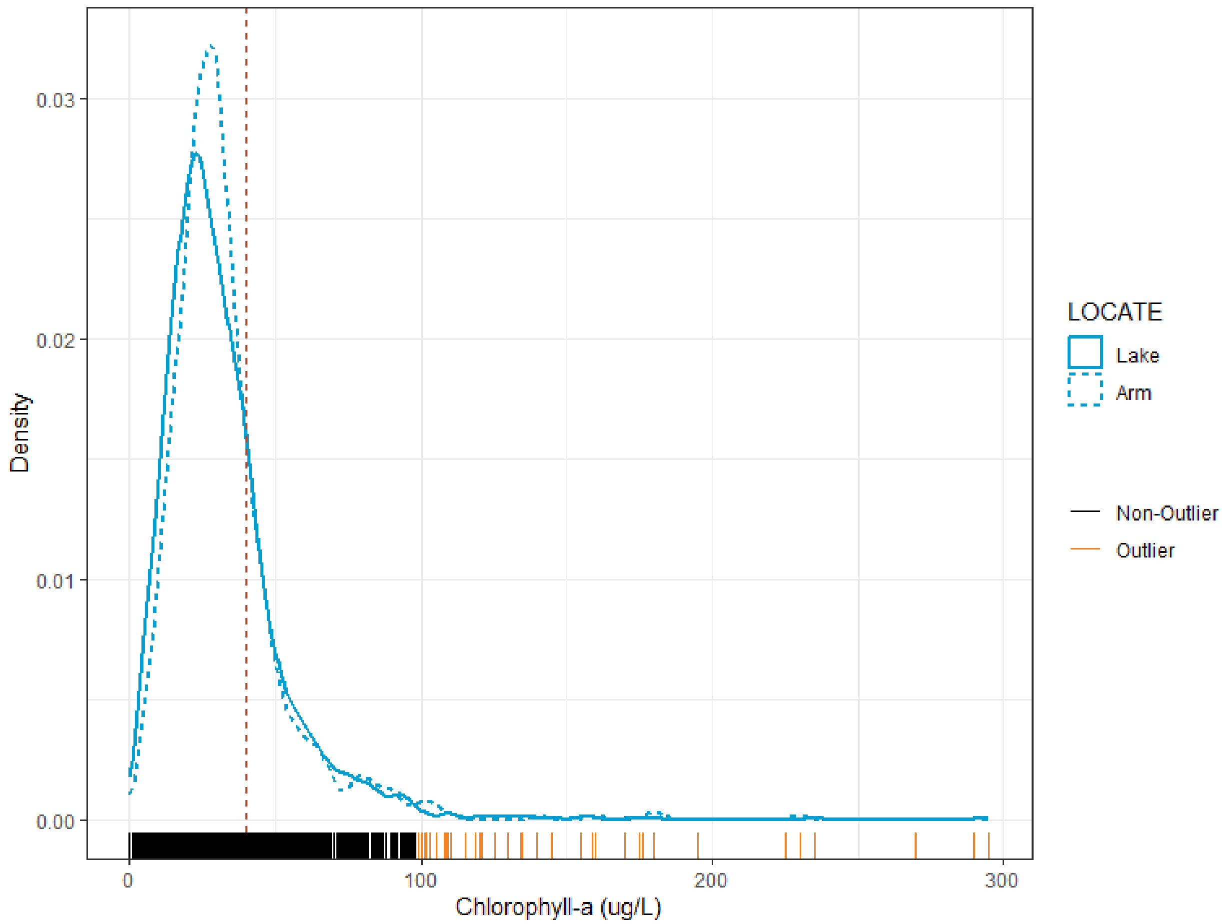
The adjusted data provide 4446 Chlorophyll-a records for 55 station ids and 32 years spanning 1984 to 2022.

3.3.3.1 Sample Effort and Values



3.3.3.2 Density Plot and Outliers

The distribution of all lake (thalweg) values is shown as the blue solid line and the lake arm values are shown as the blue dashed line. Below the density plot are rug marks for each observed value. The orange rug marks are values greater than three standard deviations from the overall mean (32.0292848). The SD of all data, thalweg and arms, is 22.2313483. The extreme values (+/- 3SD) are retained for our model project as true, but unusual, values - unless our TAW or SME teams indicate these are data errors.



The 3 SD outlier values identified in this plot are:

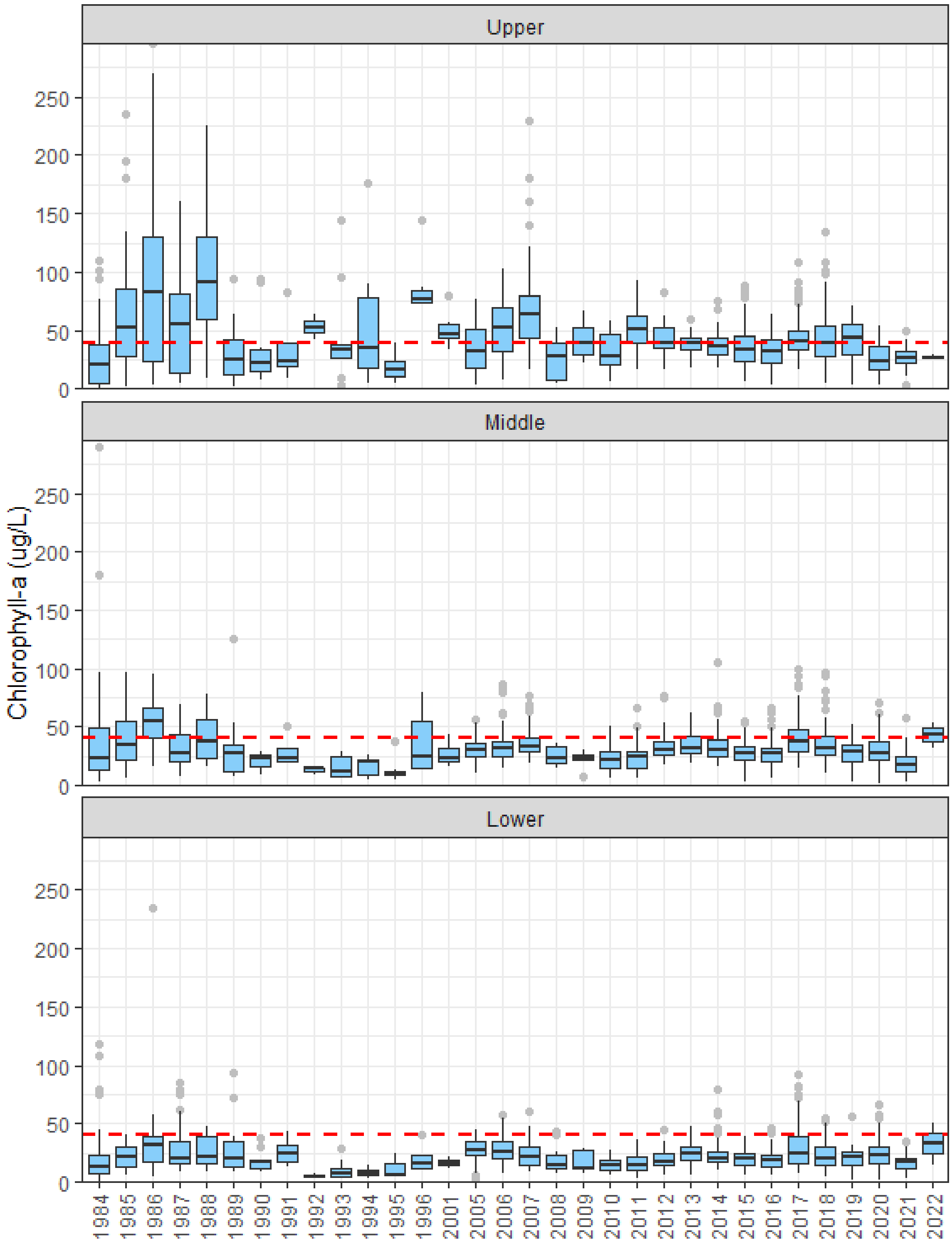
DATE	YEAR	MONTH	SOURCE	VALUE
2017-05-24	2017	May	storetDwr	99.0
1986-10-28	1986	Oct	storetDwr	99.0
2007-08-09	2007	Aug	storetDwr	100.0
2006-10-24	2006	Oct	storetDwr	100.0
2007-06-21	2007	Jun	storetDwr	100.0
1984-10-24	1984	Oct	storetDwr	101.5
2018-05-31	2018	May	caae	102.0
2006-02-23	2006	Feb	deqAlgae	103.0
2006-02-23	2006	Feb	storetDwr	103.0
1985-07-10	1985	Jul	storetDwr	103.0
2014-04-22	2014	Apr	storetDwr	105.0
2018-06-27	2018	Jun	caae	108.0
1984-08-15	1984	Aug	storetDwr	108.5
2017-06-19	2017	Jun	durmCity	109.0

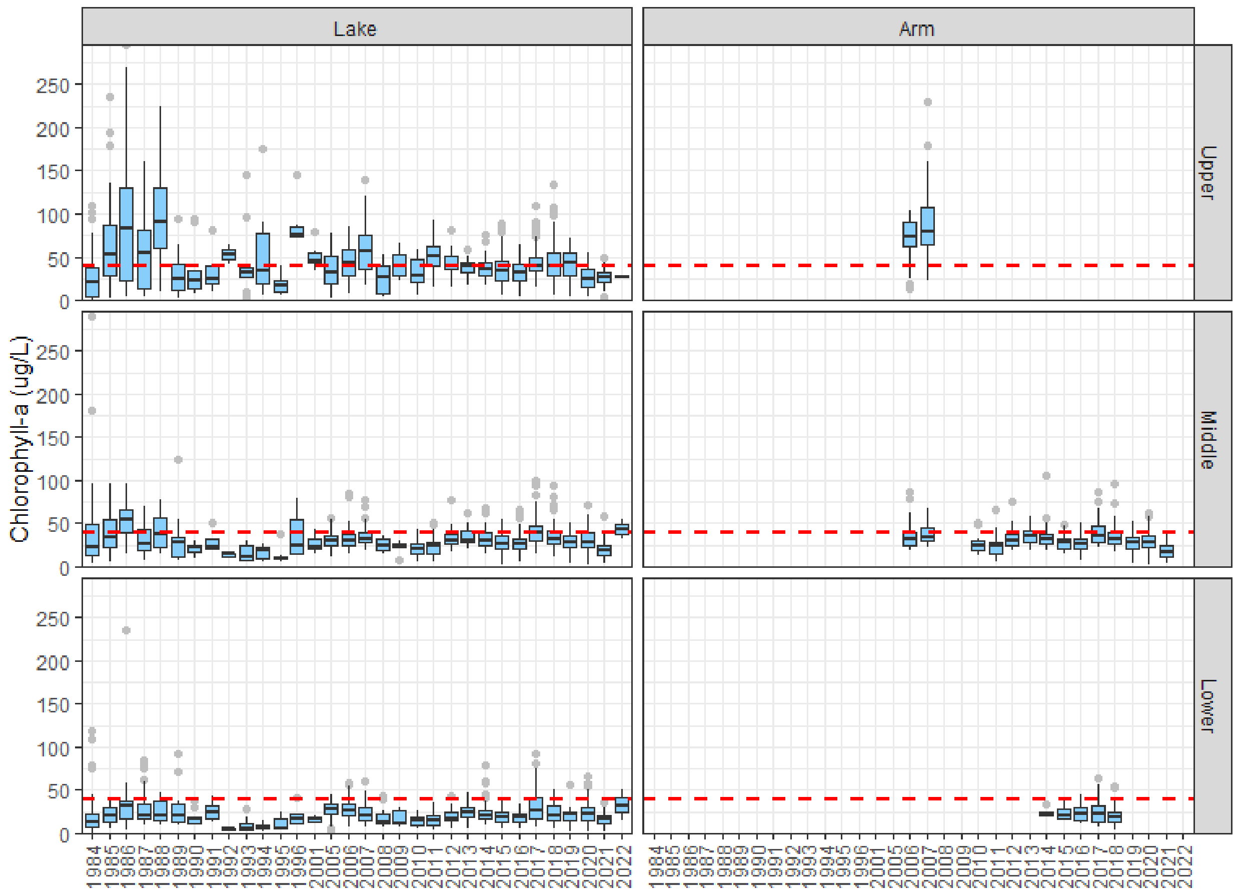
DATE	YEAR	MONTH	SOURCE	VALUE
2007-09-20	2007	Sep	storetDwr	110.0
2007-05-09	2007	May	storetDwr	110.0
1986-07-16	1986	Jul	storetDwr	110.0
1985-08-13	1985	Aug	storetDwr	110.0
1984-09-17	1984	Sep	storetDwr	110.0
1985-09-24	1985	Sep	storetDwr	115.0
1984-08-16	1984	Aug	storetDwr	118.5
1987-07-01	1987	Jul	storetDwr	120.0
2007-09-06	2007	Sep	storetDwr	121.0
1986-06-24	1986	Jun	storetDwr	125.0
1989-10-16	1989	Oct	storetDwr	125.0
1986-05-27	1986	May	storetDwr	130.0
1988-08-08	1988	Aug	storetDwr	130.0
1986-10-28	1986	Oct	storetDwr	130.0
2018-05-29	2018	May	durmCity	134.0
1985-06-12	1985	Jun	storetDwr	135.0
1986-06-24	1986	Jun	storetDwr	135.0
2007-08-22	2007	Aug	storetDwr	140.0
2007-07-12	2007	Jul	storetDwr	140.0
1993-08-30	1993	Aug	storetDwr	145.0
1996-07-10	1996	Jul	storetDwr	145.0
1986-10-28	1986	Oct	storetDwr	155.0
1987-08-12	1987	Aug	storetDwr	155.0
1986-08-06	1986	Aug	storetDwr	155.0
1986-05-27	1986	May	storetDwr	159.0
2007-06-07	2007	Jun	storetDwr	160.0
1987-09-15	1987	Sep	storetDwr	160.0
1986-07-16	1986	Jul	storetDwr	170.0
1986-09-30	1986	Sep	storetDwr	175.0
1994-09-29	1994	Sep	storetUsgs	176.0
2007-07-26	2007	Jul	deqAlgae	180.0
2007-07-26	2007	Jul	storetDwr	180.0
1985-07-10	1985	Jul	storetDwr	180.0
1984-07-19	1984	Jul	storetDwr	180.0
1985-09-24	1985	Sep	storetDwr	195.0

DATE	YEAR	MONTH	SOURCE	VALUE
1988-06-01	1988	Jun	storetDwr	225.0
2007-08-09	2007	Aug	storetDwr	230.0
1985-06-12	1985	Jun	storetDwr	235.0
1986-07-16	1986	Jul	storetDwr	235.0
1986-06-24	1986	Jun	storetDwr	270.0
1984-08-15	1984	Aug	storetDwr	290.0
1986-07-16	1986	Jul	storetDwr	295.0

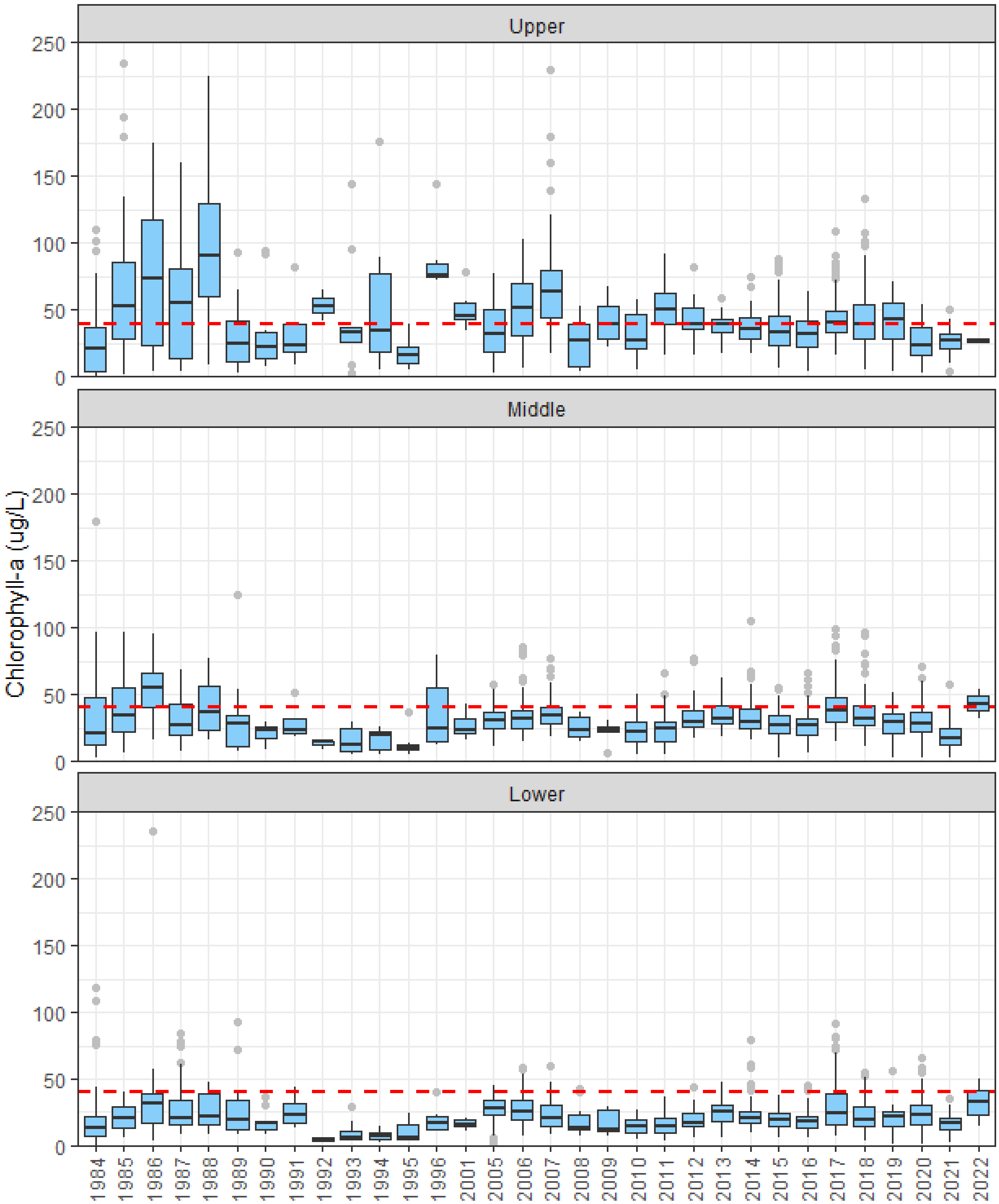
3.3.3.3 Annual Variance

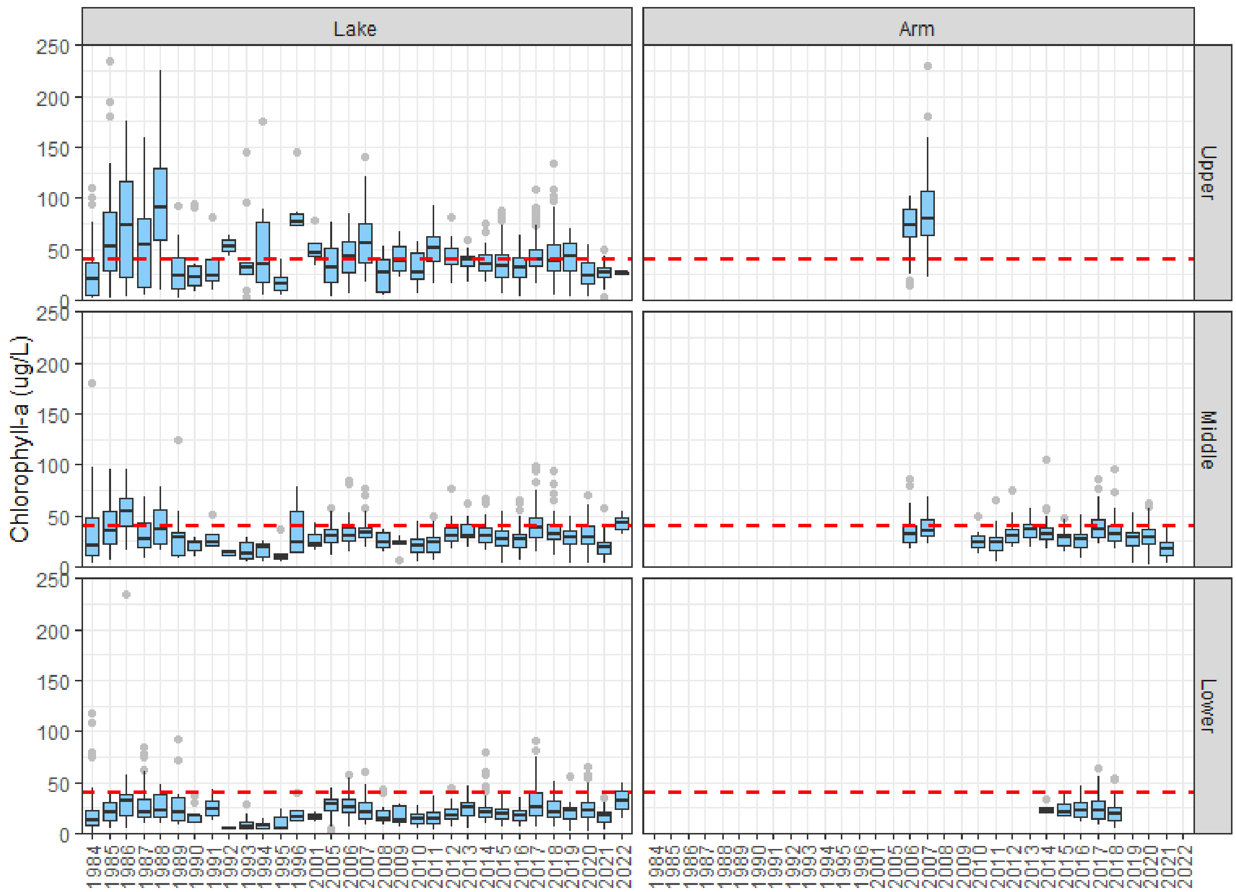
If we can use data from the lake arms, it increases our overall sample size. But if the lake arms are too different from the main lake body, the arm data will add noise to our analysis. We show the data as a full set (by lake unit) and split into the lake (thalweg) versus arm observations.


Upper
Middle
Lower
Chlorophyll-a (ug/L)
0
50
100
150
200
250
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
2001
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022



Lake
Arm
Upper
Middle
Lower
Chlorophyll-a (ug/L)
0
50
100
150
200
250
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
2001
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022


Upper
Middle
Lower
Chlorophyll-a (ug/L)
0
50
100
150
200
250
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
2001
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022



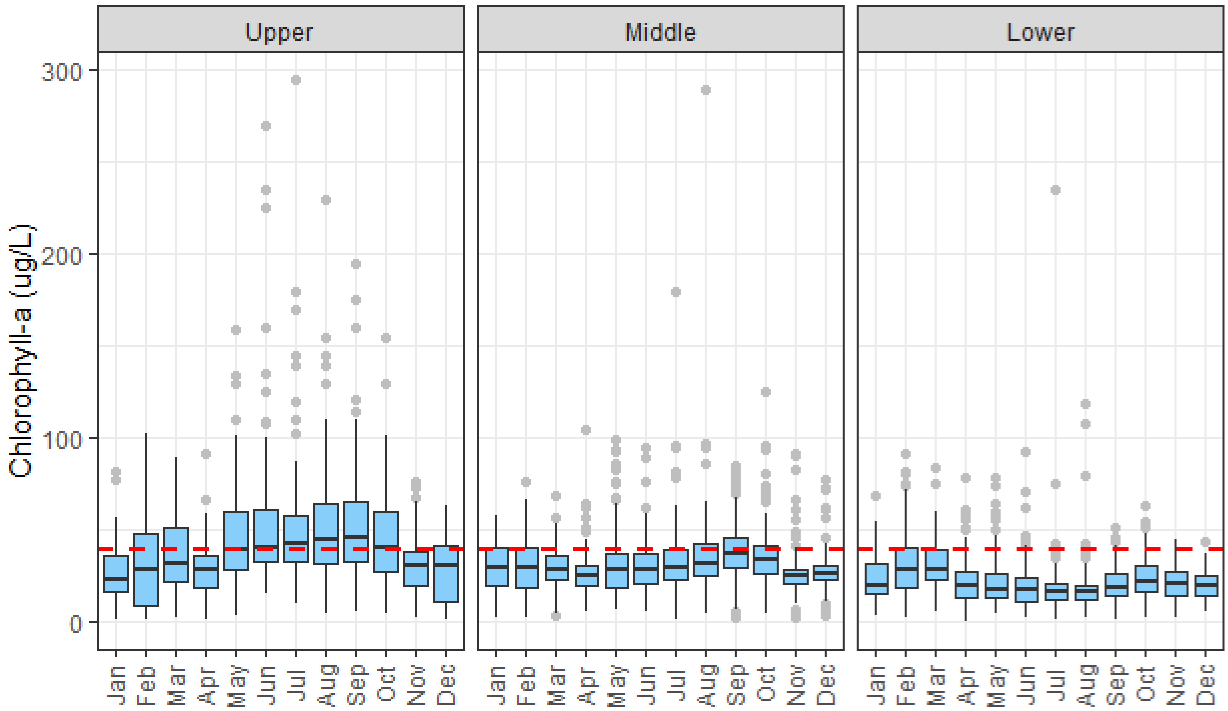
Values not shown in the cropped plot:

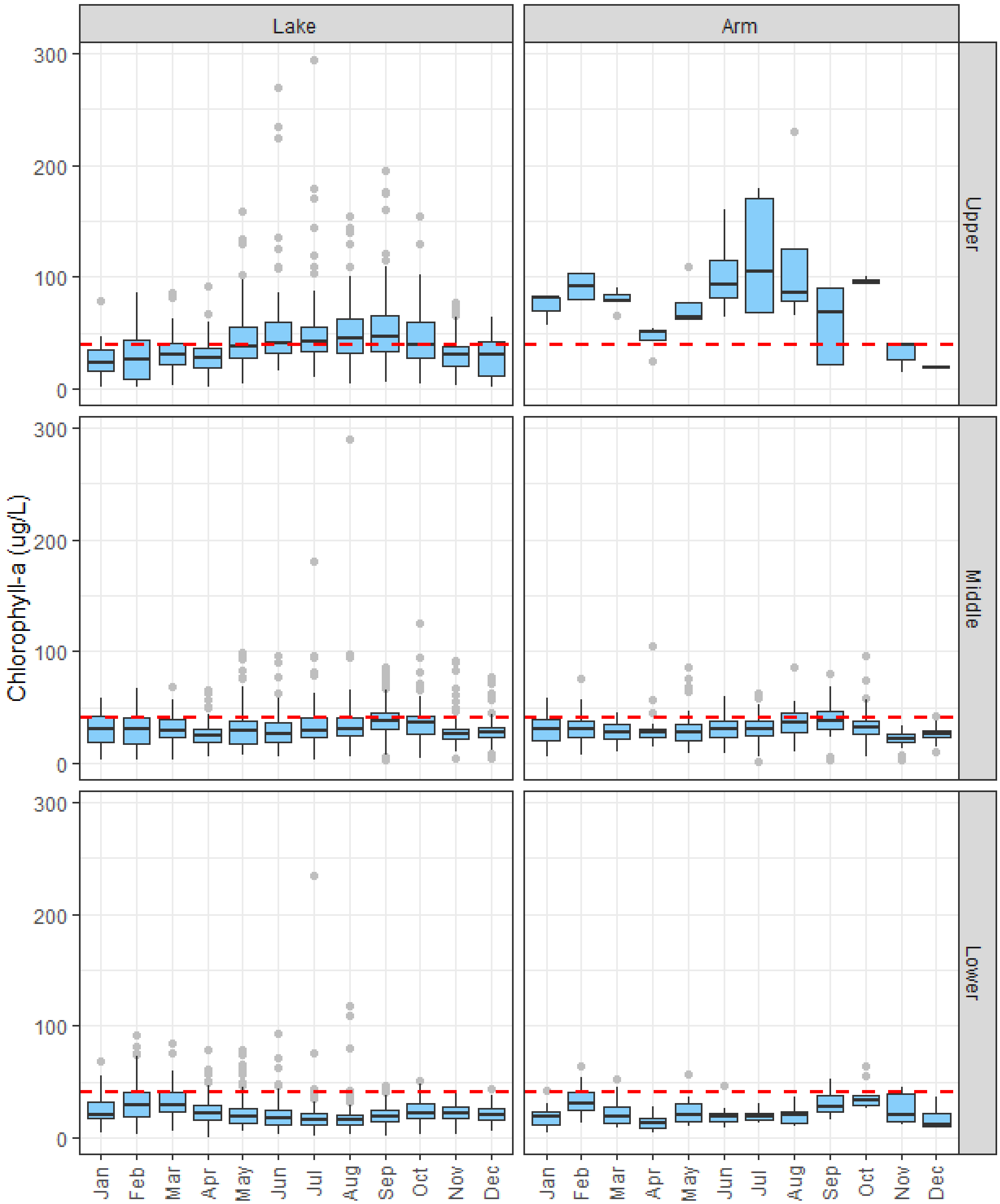
LAKEUNIT	YEAR	MONTH	VALUE
Middle	1984	Aug	290
Upper	1985	Jun	235
Upper	1986	Jun	270
Upper	1986	Jul	295
Lower	1986	Jul	235
Upper	2007	Aug	230

3.3.3.4 Historic versus Recent Comparison

```
## # A tibble: 3 × 3
##   LAKEUNIT HISTORIC RECENT
##   <ord>       <dbl>  <dbl>
## 1 Upper        51.7   37.6
## 2 Middle       33.2   31.2
## 3 Lower        22.9   23.8
```

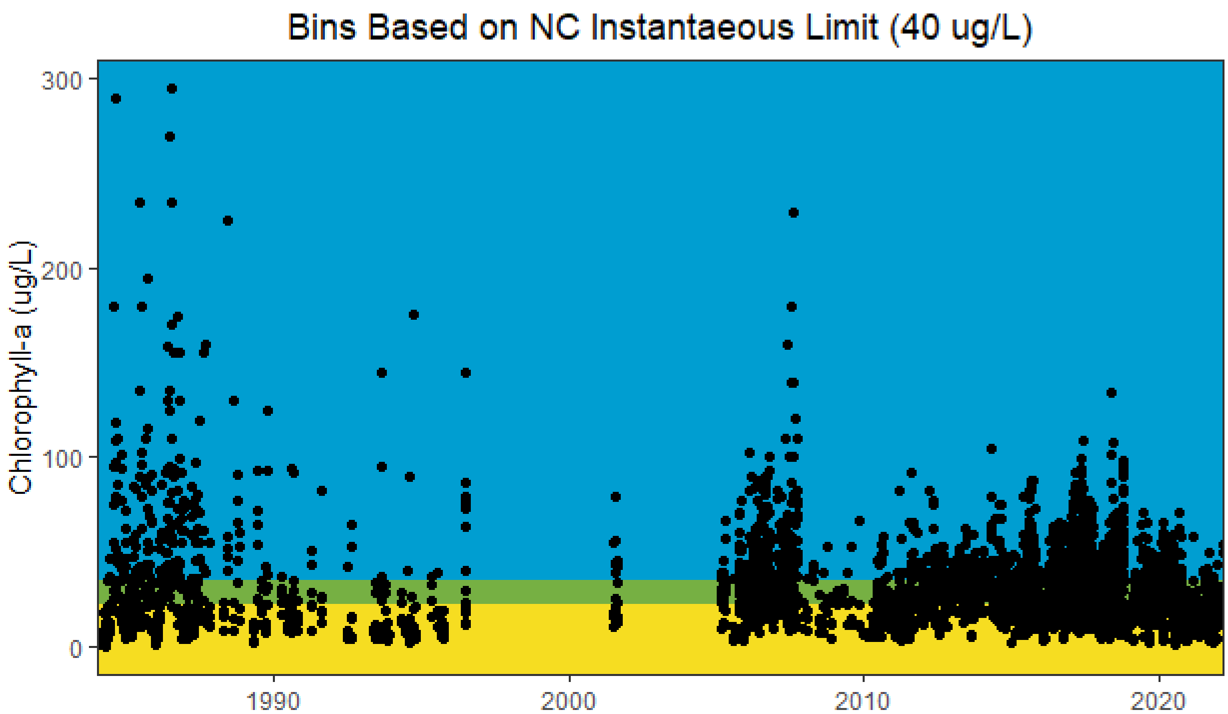
3.3.3.5 Seasonal Trends

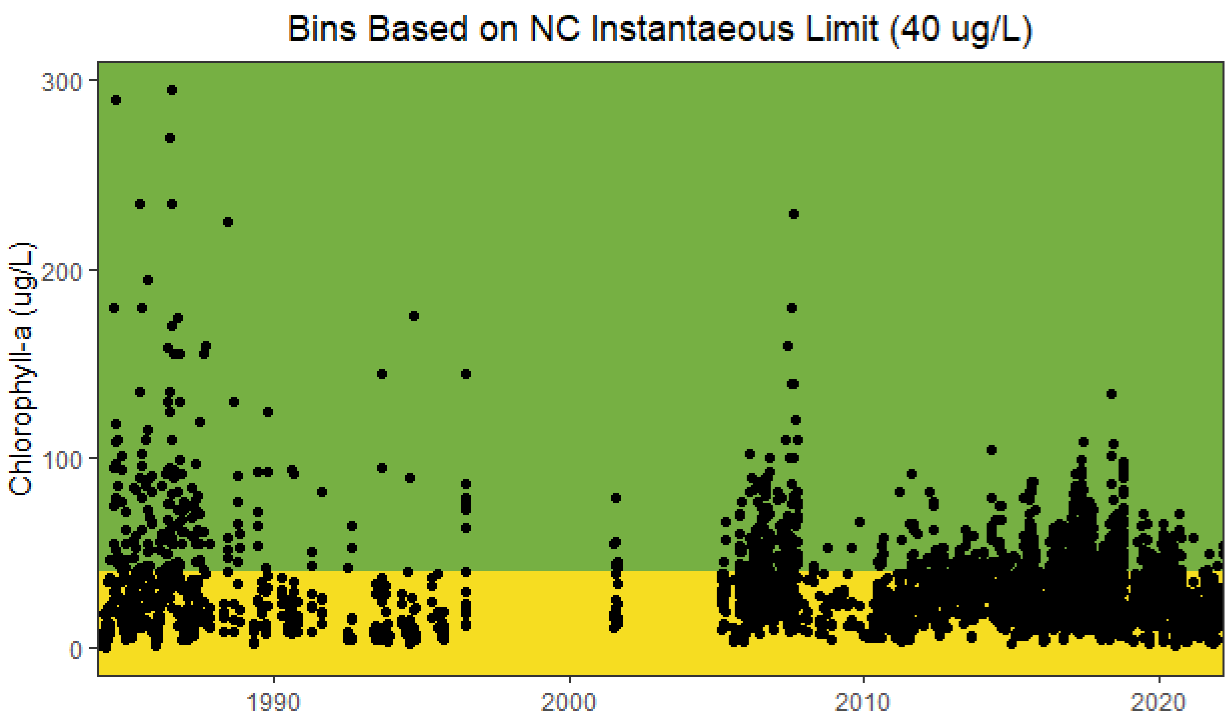

Upper
Middle
Lower
Chlorophyll-a (ug/L)
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

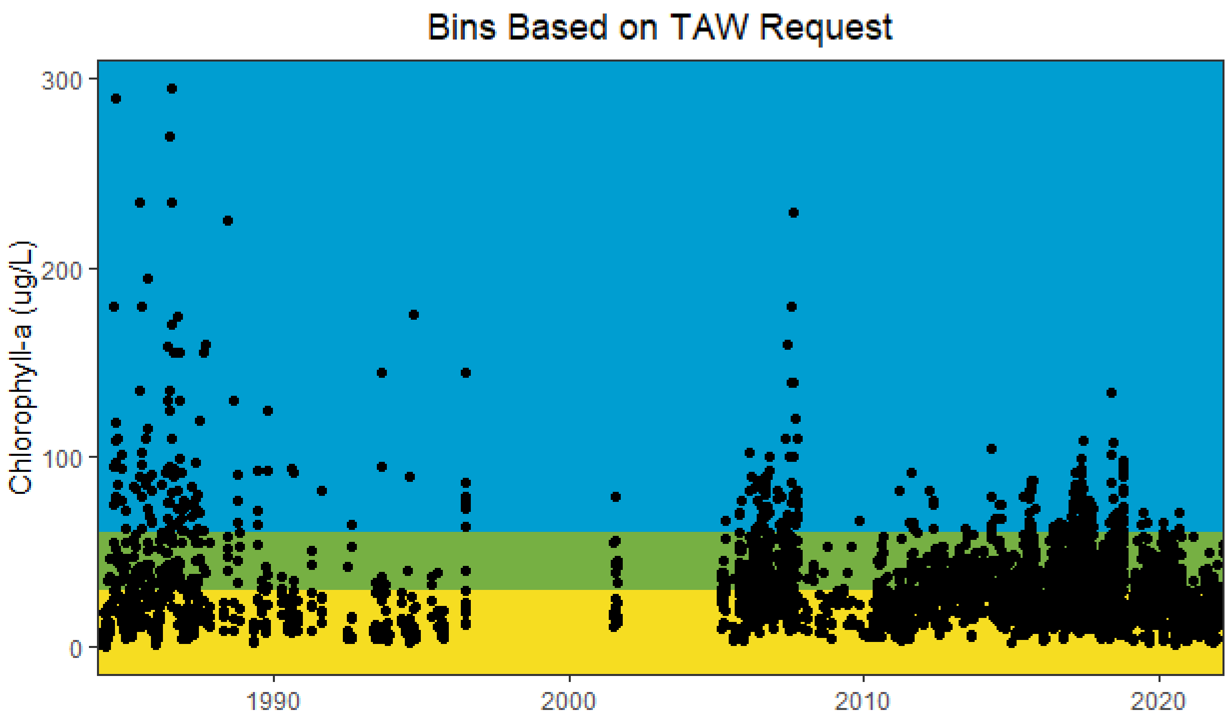


Lake
Arm
Upper
Middle
Lower
Chlorophyll-a (ug/L)
0
100
200
300
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

3.3.3.6 Alternative Bins


Bins Based on NC Instantaeous Limit (40 ug/L)
Chlorophyll-a (ug/L)
300
200
100
0
1990
2000
2010
2020


Bins Based on NC Instantaeous Limit (40 ug/L)
Chlorophyll-a (ug/L)
300
200
100
0
1990
2000
2010
2020



3.3.4 Export Merged Data

The merged data files represent all data gathered to date for this variable. We drop some of the information that was used as qaqc during prep and merging steps: SOURCETYPE, DEPTHTYPE, VARTYPE, VARLABEL, PRIORITY. The final merged data are saved as: **tidy_chla.rds** (data) and **tidy_chla_summary.rds** (summary states for LAKEUNIT by MONTH: N, NYears, Mean, SD). Both are also saved to Excel.

The final data include data received from: emilyToxins, ralpud, deqAlgae, durmCity, caae, storetDwr, storetUsgs.

Code authored by KDV Decision Analysis LLC and last run 2024-09-19 with R version 4.4.1 (2024-06-14 ucrt).

3.4 Merging Data for Dissolved Oxygen (DO)

Dissolved oxygen is measured both as a site variable (DO in-situ) and as modeled values (DO volume <1 mg/L, 1-3.999 mg/L, and >=4 mg/L). Here we handle the DO in-situ measurements.

DO is a regulated parameter. Values lower than 4 mg/L are considered indicative of poor water quality and raise concerns for the designated uses of aquatic life and recreational fisheries.

3.4.1 Gather Data Resources

3.4.1.1 List Associated Files

Dissolved Oxygen data are identified by the **_do** suffix.

The available Dissolved Oxygen data sources are: caae_do.rds, durmCity_do.rds, ralpud_do.rds, storetDwr_do.rds, storetUsgs_do.rds.

3.4.1.2 City of Durham (durmCity)

```
##
##    FL-DS4 FL-SR1801
##       568       528

##
##      Upper     Middle      Lower Other Lake
##       1096          0          0          0

##
## 2015 2016 2017 2018
##  288  274  242  292

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##   0   0   0 139 174 163 183 141 142 154   0   0
```

This source provides 1096 Dissolved Oxygen records for 2 station ids and 4 years spanning 2015 to 2018.

3.4.1.3 City of Raleigh (ralpud)

```
##
##    Honeycutt Creek        Intake 223        Intake 233        Intake 243
##                 69                60                60                60
##     Intake Surface Lower Barton Creek    New Light Creek Upper Barton Creek
##                 69                69                69                69
##         US Hwy 98
##                 69

##
##      Upper     Middle      Lower Other Lake
##          0          0        594          0

##
## 2013 2014 2015 2016 2017 2018
##  108  108   99  108  111   60

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##  51  42  51  51  51  51  51  54  51  51  45  45
```

This source provides 594 Dissolved Oxygen records for 9 station ids and 6 years spanning 2013 to 2018.

3.4.1.4 Center for Applied Aquatic Ecology NCSU (caae)

```
##
## Falls Lake 1 Falls Lake 2 Lick Creek 1
##            1            1            3
```

```
##
##     Upper    Middle     Lower Other Lake
##         0         4         1         0

##
## 2014 2015 2016 2018
##    1    2    1    1

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##   1   0   0   1   0   0   0   1   0   1   1   0
```

This source provides 5 Dissolved Oxygen records for 3 station ids and 4 years spanning 2014 to 2018.

3.4.1.5 Storet DWR (storetDwr)

```
## [1] TRUE

## [1] TRUE

##
## J1250000 J1370000 J1430000 J1590000 J1670000 J1675000 J1690000 J1715000
##      301      304      278      285        7      297        2      307
## J1725000 J1727000 J1740000     LC01     LI01    LLC01   NEU010   NEU013
##      309      321      320      656      458      647      314      607
##  NEU013B NEU0171B  NEU018C  NEU018E  NEU019E  NEU019L  NEU019P  NEU020D
##      692      803      237      853      847      837      846      861
## NEUELL10
##      108

##
##     Upper    Middle     Lower Other Lake
##      2604      5399      3494         0

##
## 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 2000 2001 2005 2006 2007
##  486  505  526  391  179  209  202   88   49   51   45  115  167  825 1169  900
## 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
##  360  529  631  627  639  684  692  668  512  128  120

##
##  Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec
##  709  812  915 1105  989 1140 1044 1369 1015  923  771  705
```

This source provides 11497 Dissolved Oxygen records for 25 station ids and 27 years spanning 1984 to 2020.

3.4.1.6 Storet USGS (storetUsgs)

```
## [1] TRUE
```

```
## [1] TRUE

##
##   2086920 208703650 208708905 208717595 208718195
##       94        87        49         2        52

##
##     Upper    Middle     Lower Other Lake
##        94        87       103          0

##
## 1993 1994 1995 2005 2006 2007 2008 2009 2010 2011
##   16   20    7   20   33   39   43   43   41   22

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##   0  20   8  43   7  47  11  59   4  58   4  23
```

This source provides 284 Dissolved Oxygen records for 5 station ids and 10 years spanning 1993 to 2011.

3.4.2 Merge Data Sources

```
## # A tibble: 4 × 6
##   SOURCE        N NStations NYears MinYear MaxYear
##   <chr>     <int>     <int>  <int>   <dbl>   <dbl>
## 1 caae          5         3      4    2014    2018
## 2 ralpud      594         9      6    2013    2018
## 3 storetDwr 11497        25     27    1984    2020
## 4 storetUsgs  284         5     10    1993    2011
```

In total, we assembled 12380 Dissolved Oxygen records into a single tidy dataframe. This included data from the City of Durham (1096 records), City of Raleigh (594 records), CAAE (5 records), StoretDWR (11497 records), and StoretUSGS (284).

Merged data were qaqc'd to confirm:

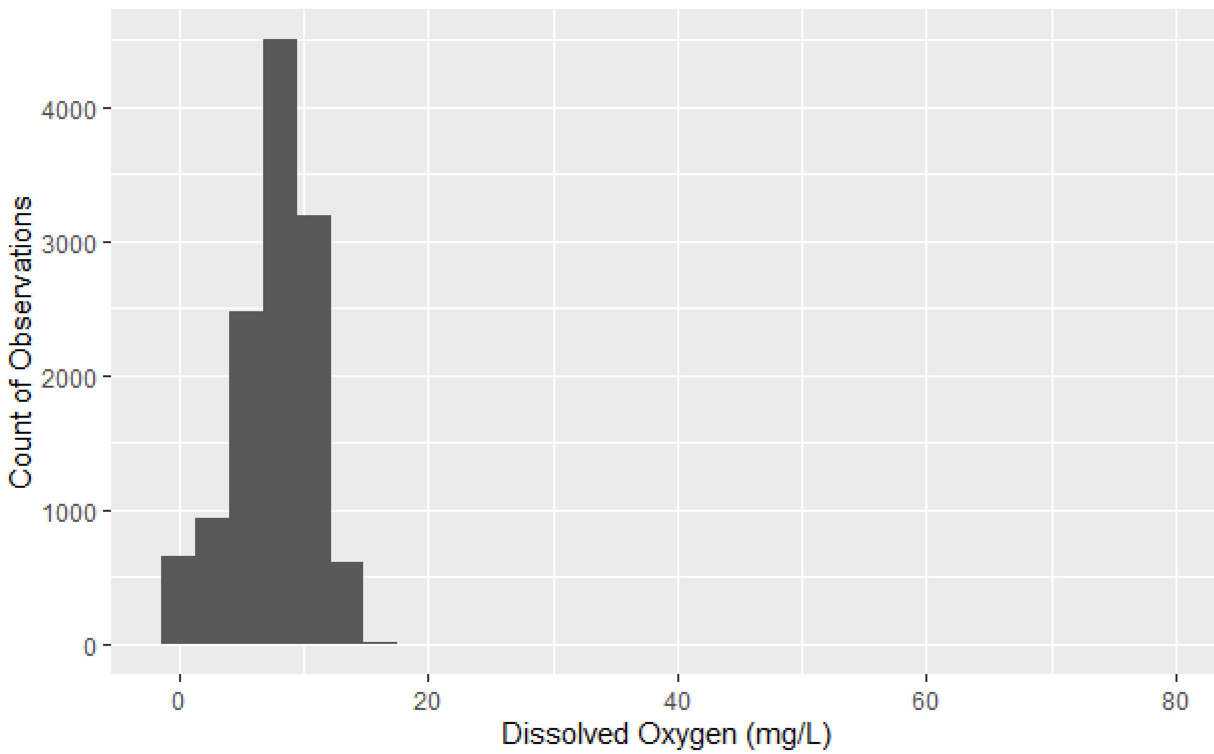
- only one variable is present
- no NA values are present
- only one measurement unit is present (OR if more than one is present, additional processing is required)

3.4.2.1 Check for and Remove Errors

There were some implausibly high data values. These data had no values that could be flagged as obvious data errors. There are some extreme values, but we retain these pending review by the SME and TAW teams.

Quantiles	DOvalue
0%	0.0
10%	3.3

Quantiles	DOvalue
20%	5.3
30%	6.5
40%	7.3
50%	8.1
60%	8.8
70%	9.5
80%	10.4
90%	11.4
100%	78.5



Some looked like they might be unit errors (ug/L instead of mg/L), but others could be simple key errors. Given there were very few, we chose to simply delete these bad entries. The deleted values were:

```
##   LAKEUNIT YEAR MONTH VALUE
## 1   Middle 2014   Aug  40.0
## 2   Middle 2019   Oct  78.5
## 3   Middle 2019   Oct  51.9
## 4    Lower 2019   Oct  49.4
## 5    Lower 2019   Oct  53.9
## 6    Lower 2019   Oct  31.9
```

3.4.2.2 Check for and Remove Duplicates

All records with equal DATE, STATIONID, DEPTHM, and VALUE are treated as duplicates are dropped. With the removal of the older data resources (from earlier 2019 UNRBA data summary report) in favor of updated DWR with more qaqc, there are very few duplicated values.

```
##
##      caae     ralpud  storetDwr storetUsgs
##        5       594     11470       284
```

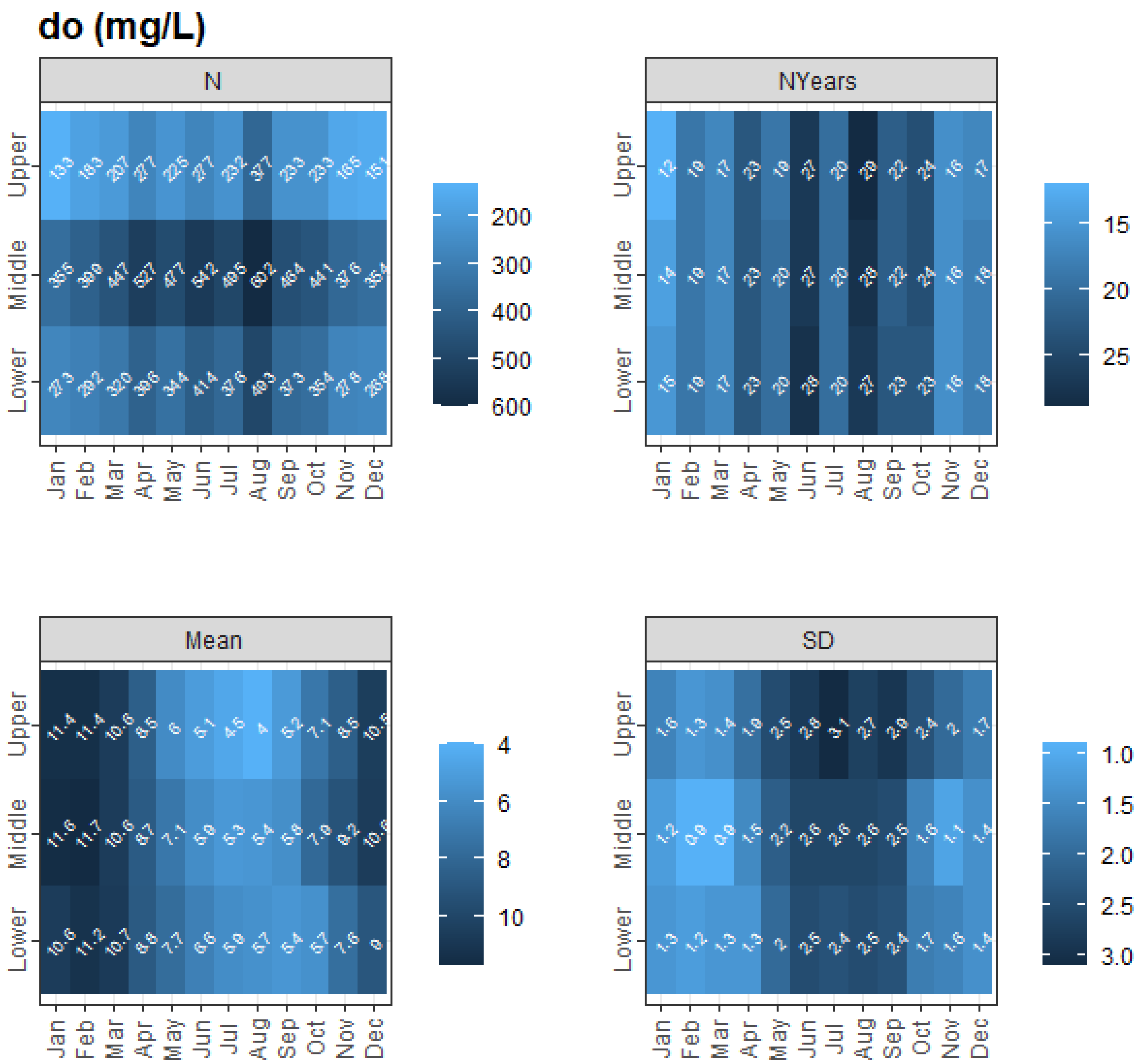
Of all data received (12374 records), there are 21 duplicates (shared DATE, STATIONID, DEPTHM, and measured VALUE). There are 12353 remaining observations.

```
## # A tibble: 4 × 6
##   SOURCE        N NStations NYears MinYear MaxYear
##   <chr>     <int>     <int>  <int>   <dbl>   <dbl>
## 1 caae          5         3      4    2014    2018
## 2 ralpud      594         9      6    2013    2018
## 3 storetDwr 11470        25     27    1984    2020
## 4 storetUsgs  284         5     10    1993    2011
```

3.4.3 Data Summaries

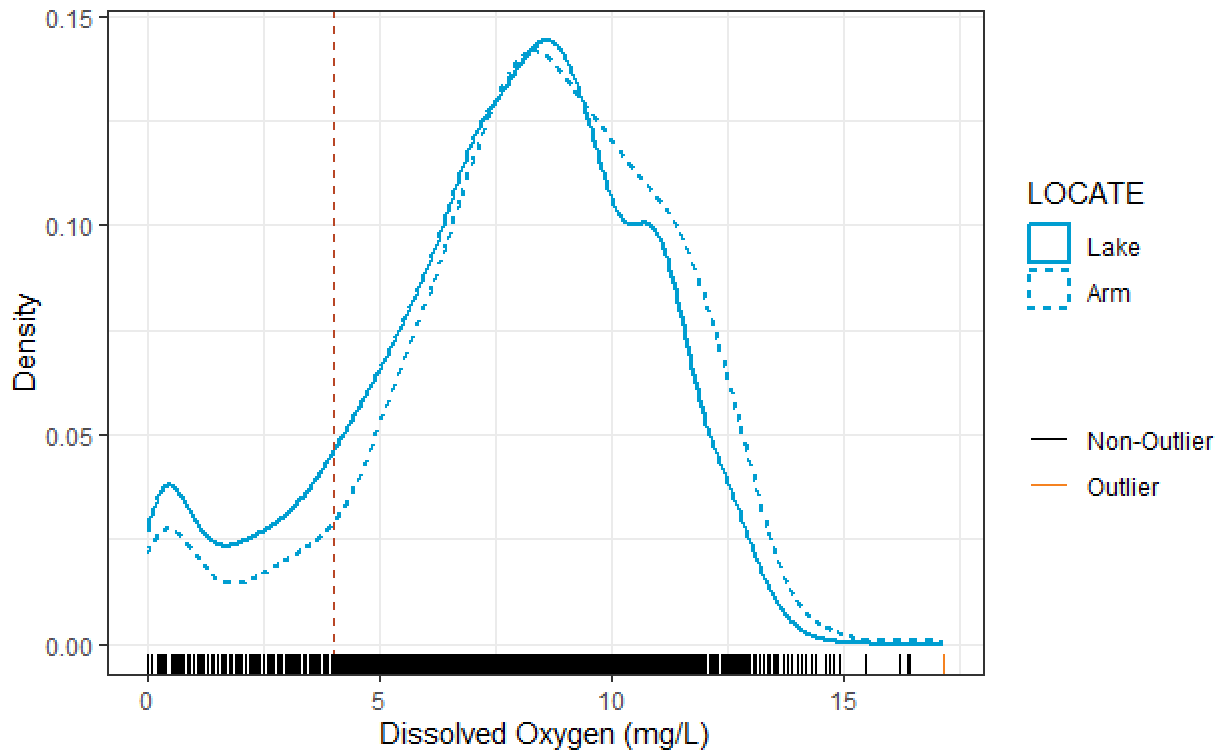
The merged data provide 12353 Dissolved Oxygen records for 42 station ids and 30 years spanning 1984 to 2020.

3.4.3.1 Sample Effort and Values



3.4.3.2 Density Plot and Outliers

The distribution of all lake (thalweg) values is shown as the blue solid line and the lake arm values are shown as the blue dashed line. Below the density plot are rug marks for each observed value. The orange rug marks are values greater than three standard deviations from the overall mean (7.716444). The SD of all data, thalweg and arms, is 3.0823315. The extreme values (+/- 3SD) are retained for our model project as true, but unusual, values - unless our TAW or SME teams indicate these are data errors.

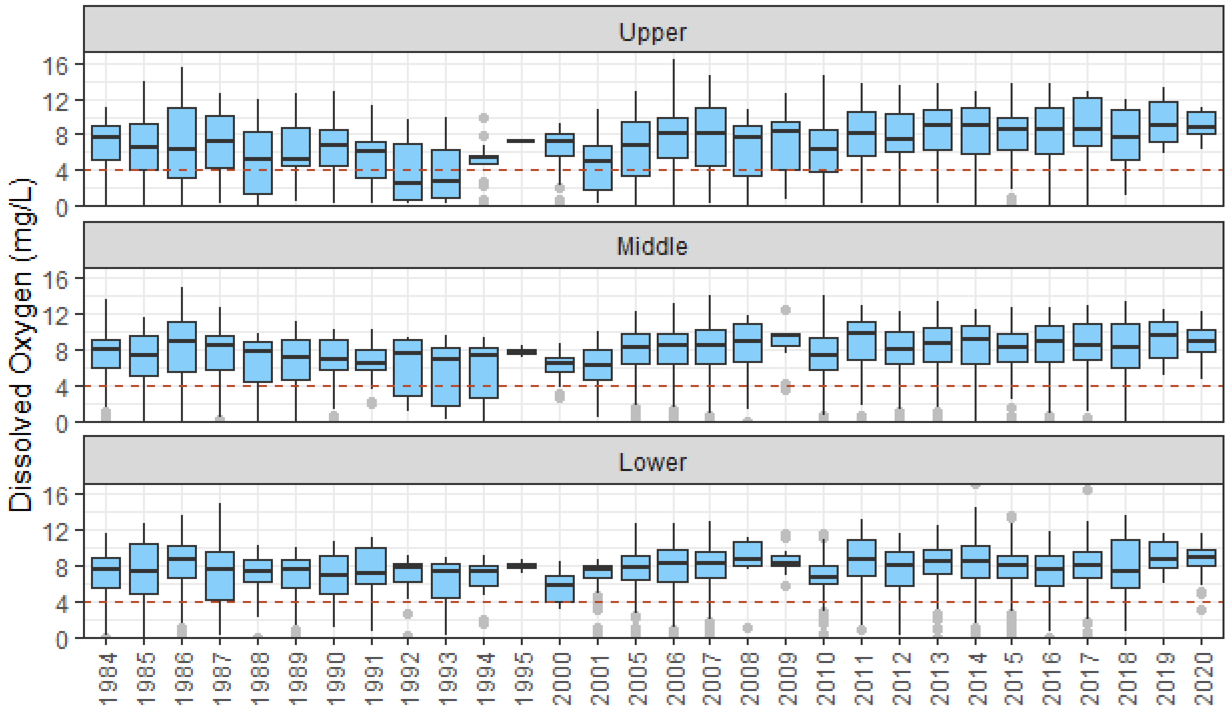


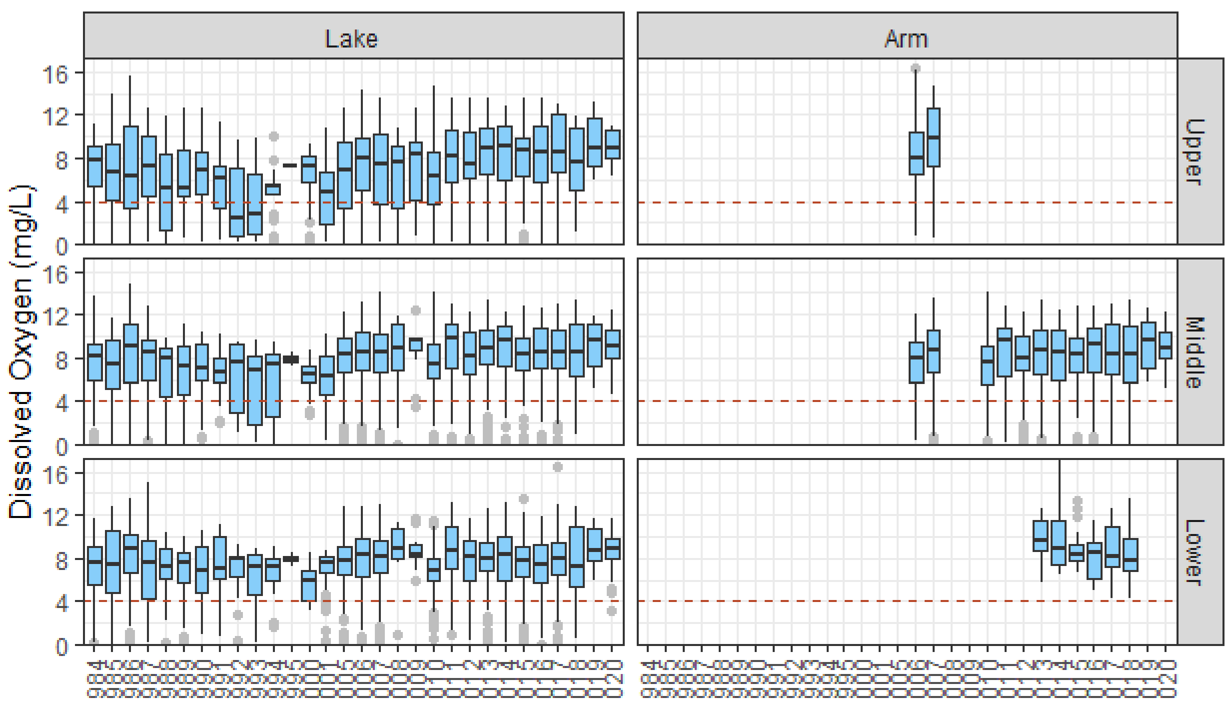
The 3 SD outlier values identified in this plot are:

DATE	YEAR	MONTH	SOURCE	VALUE
2014-02-26	2014	Feb	ralpud	17.15

3.4.3.3 Annual Variance

Boxplot summarizing all data by year to check for long term overall trends.





3.4.3.4 Historic versus Recent Comparison

We compare the data from early years (1986 to 1995) to recent years (2011 to 2020).

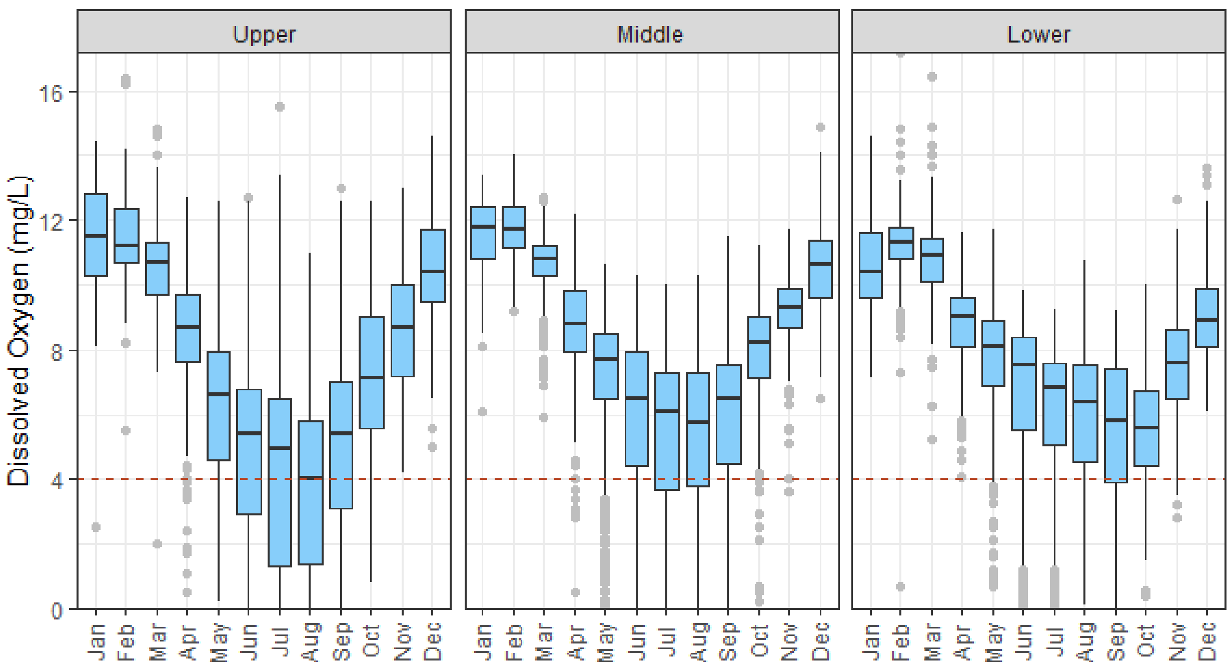
3.4.3.4.1 Mean Values

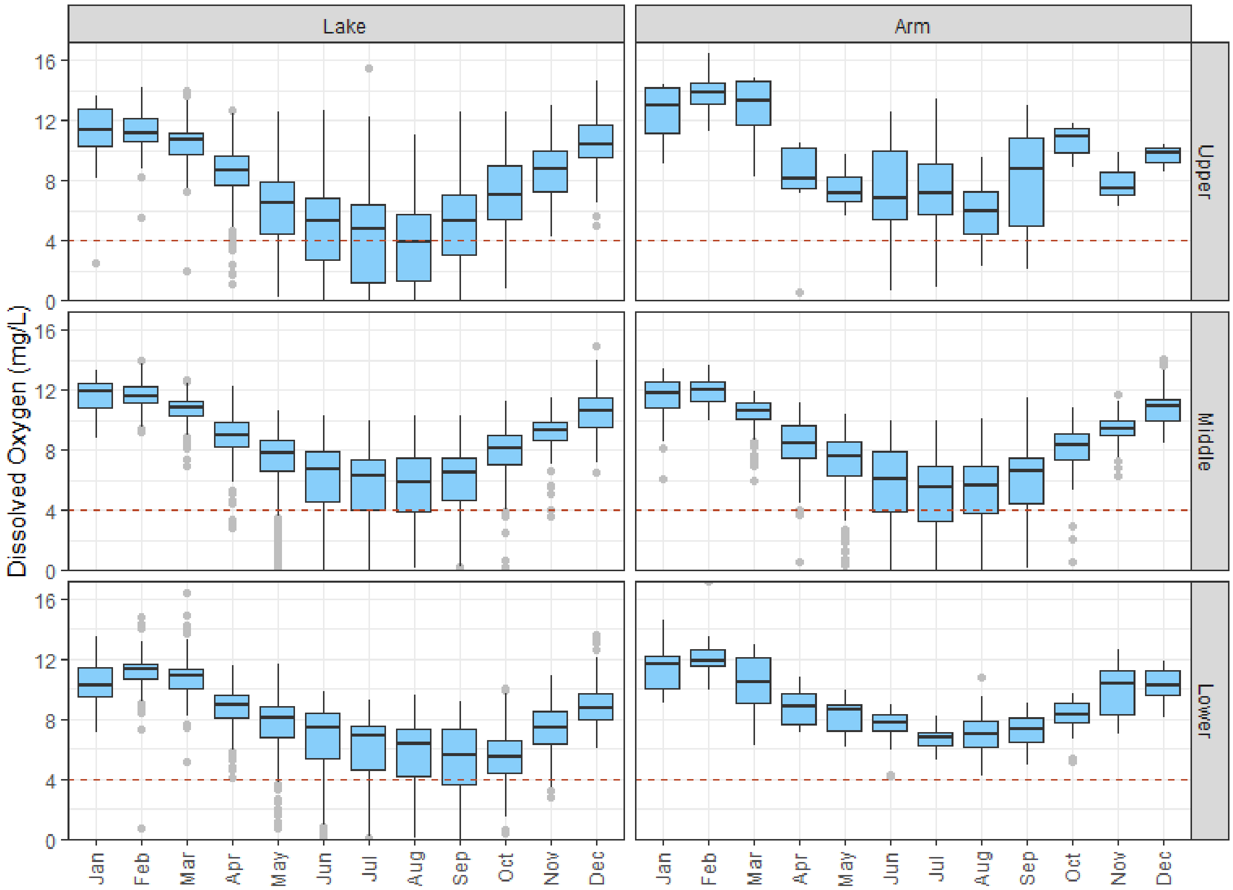
```
## # A tibble: 3 × 3
##   LAKEUNIT HISTORIC RECENT
##   <ord>       <dbl>  <dbl>
## 1 Upper        6.26   8.2
## 2 Middle       7.24   8.34
## 3 Lower        7.18   7.97
```

3.4.3.4.2 SD Values

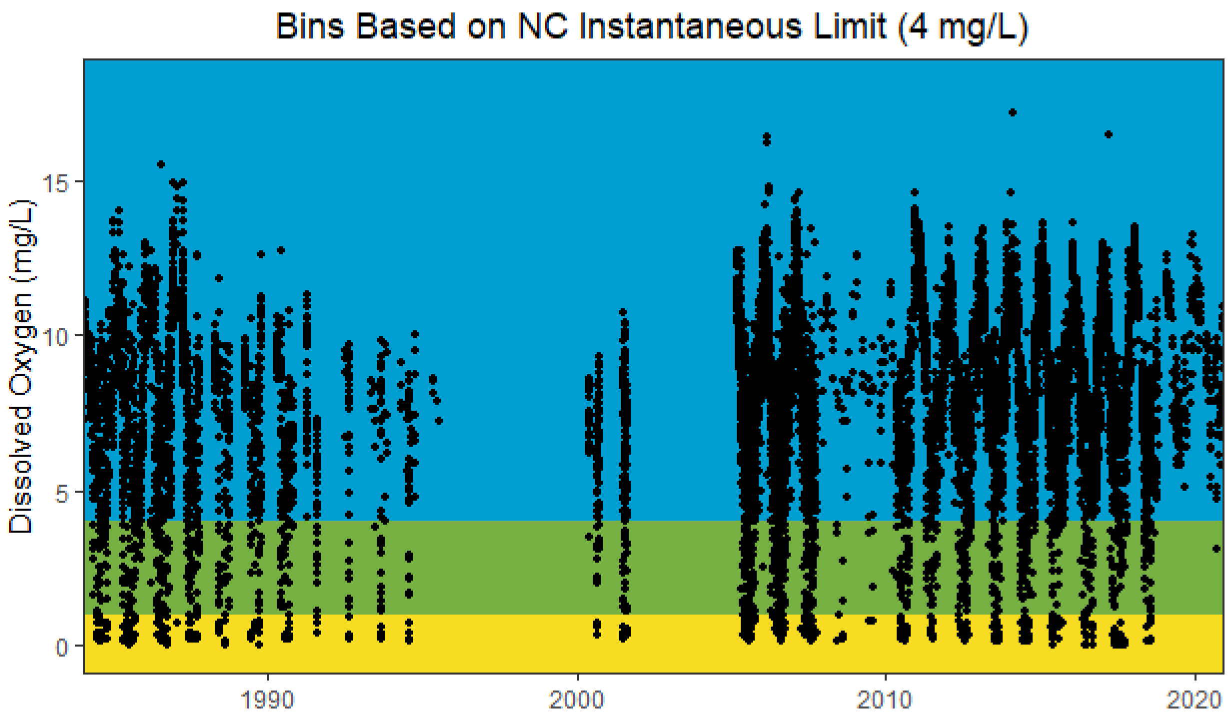
```
## # A tibble: 3 × 3
##   LAKEUNIT HISTORIC RECENT
##   <ord>       <dbl>  <dbl>
## 1 Upper        3.61   3.22
## 2 Middle       3.25   2.98
## 3 Lower        3.11   2.7
```

3.4.3.5 Seasonal Trends




Lake
Arm
Upper
Middle
Lower
Dissolved Oxygen (mg/L)
0
4
8
12
16
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

3.4.3.6 Proposed Bins



3.4.4 Export Merged Data

The merged data files represent all data gathered to date for this variable. We drop some of the information that was used as qaqc during prep and merging steps: SOURCETYPE, DEPTHTYPE, VARTYPE, VARLABEL. The final merged data are saved as: **tidy_do.rds** and **tidy_do_summary.rds** (summary states for LAKEUNIT by MONTH: N, NYears, Mean, SD). Both are also saved to Excel.

The final data include data received from: ralpud, caae, storetDwr, storetUsgs.

Code authored by KDV Decision Analysis LLC and last run 2024-09-19 with R version 4.4.1 (2024-06-14 ucrt).

3.5 Merging Data for Manganese (mang)

3.5.1 Gather Data Resources

3.5.1.1 List Associated Files

Manganese data are identified by the **_mang** suffix.

The available Manganese data sources are: ralpud_mang.rds, storetDwr_mangtot.rds, storetUsgs_mangrec.rds, with records.

3.5.1.2 City of Raleigh Data (ralpud)

```
##
## 2013 2014 2015 2016 2017 2018
##   96   96   98  108  114   87
```

```
##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##  45  36  57  57  57  57  45  49  56  51  45  44

##
##    Honeycutt Creek        Intake 223        Intake 233        Intake 243
##                 70                61                61                61
##     Intake Surface Lower Barton Creek    New Light Creek Upper Barton Creek
##                 70                70                69                68
##          US Hwy 98
##                 69

##
##      Upper     Middle      Lower Other Lake
##          0          0        599          0
```

This source provides 599 Manganese records for

9 station ids and 6 years spanning 2013 to 2018.

This source only provides samples from the lower section of the lake.

3.5.1.3 Storet DWR Data

Storet data has been converted from ug/L to mg/L to match Raleigh data MEASUNIT.

```
##
## 1984 1985 1986 1987 1988 1989 1990 1991 1992 1994 2000 2001
##  108   37  106   69   25   30   30   12    6    6    8    4

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##  22  36  27  59  27  44  37  61  46  40  26  16

##
## J1250010 J1370010 J1430010 J1590010 J1675010 J1715010 J1725010 J1727010
##       48       56       35       34       55       56       34       54
## J1740010   NEU010   NEU013  NEU018E  NEU019E  NEU019P  NEU020D
##       57        1        1        1        1        1        7

##
##      Upper     Middle      Lower Other Lake
##        141        147        153          0
```

This source provides 441 Manganese records for 15 station ids and 12 years spanning 1984 to 2001. (1984-1992, 1994, 2000-2001)

This source only provides samples from all sections (upper, middle and lower) of the lake.

3.5.1.4 Storet USGS data

Storet data has been converted from ug/L to mg/L to match Raleigh data MEASUNIT.

```
##
## 1993 1994 1995 2005 2006 2007 2008 2009 2010 2011
##   16   20    7   20   33   39   43   43   41   22

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##   0  20   8  43   8  46  11  59   4  58   4  23

##
##   2086920 208703650 208708905 208717595 208718195
##        95        87        49         2        51

##
##      Upper     Middle      Lower Other Lake
##         95         87        102          0
```

This source provides 284 Manganese records for 5 station ids and 10 years spanning 1993 to 2011. (1993-1995 and 2005-2011)

This source only provides samples from the middle and lower section of the lake.

3.5.2 Merge Data Sources

In total, we assembled 1324 Manganese records into a single tidy dataframe. This included data from the City of Raleigh (599 records), Storet NCDENR/DWR (441 records), and Storet USGS (284 records.)

Data were qaqc'd to confirm:

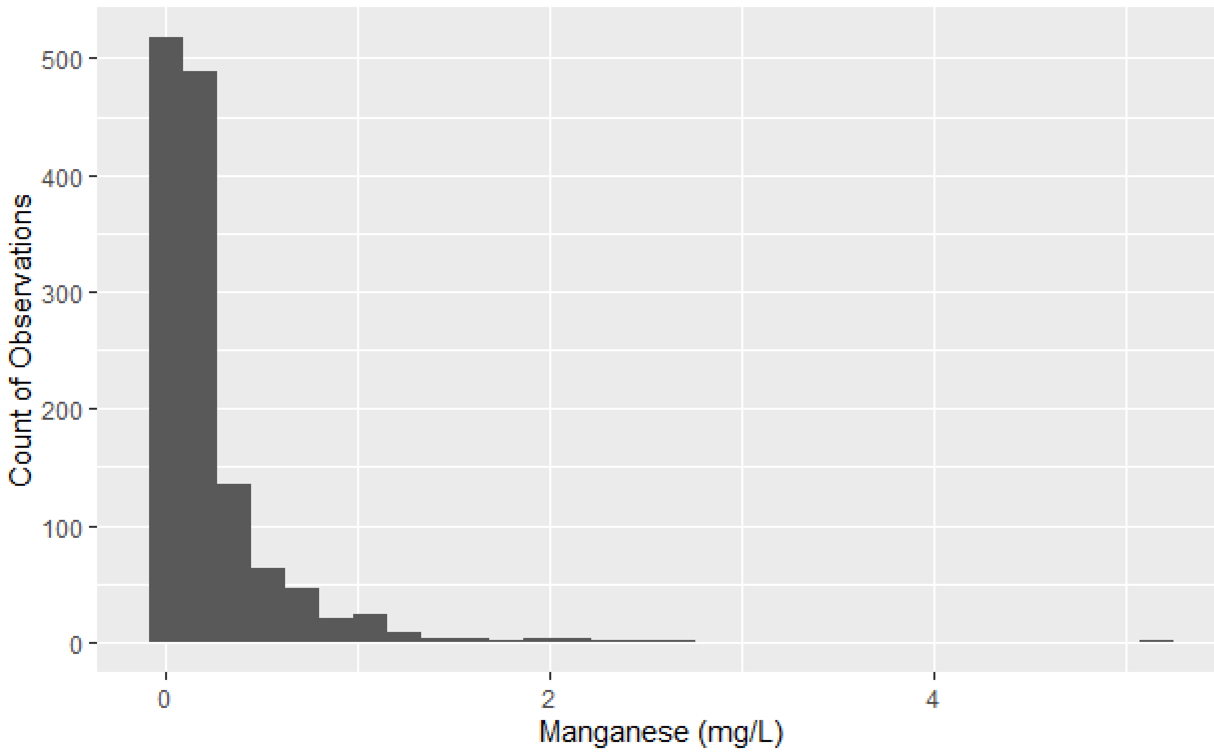
- only one variable is present
- no NA values are present
- only one measurement unit is present (OR if more than one is present, additional processing is required)

```
## # A tibble: 3 × 6
##   SOURCE        N NStations NYears MinYear MaxYear
##   <chr>     <int>     <int>  <int>   <dbl>   <dbl>
## 1 ralpud      599         9      6    2013    2018
## 2 storetDwr   441        15     12    1984    2001
## 3 storetUsgs  284         5     10    1993    2011
```

3.5.2.1 Check for and Remove Error Entries

Quantiles	MANG.value
0%	0.0000
10%	0.0450
20%	0.0600
30%	0.0731
40%	0.0900
50%	0.1100

Quantiles	MANG.value
60%	0.1410
70%	0.2001
80%	0.3200
90%	0.5828
100%	5.1600



3.5.2.2 Check for and Remove Duplicates

All records with equal DATE, STATIONID, DEPTHM, and VALUE are treated as duplicates values and are dropped.

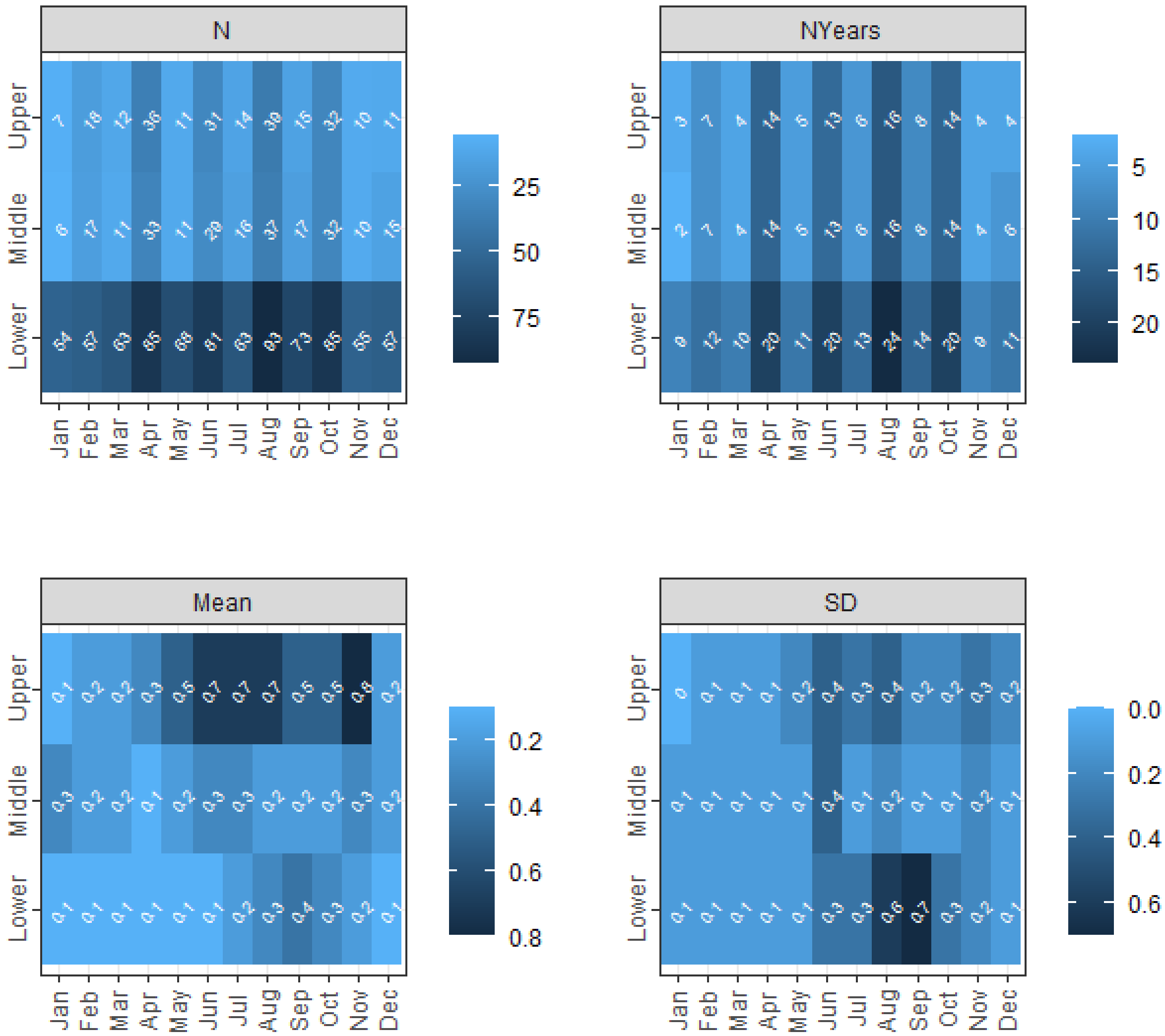
```
##
##    ralpud  storetDwr storetUsgs
##       579        441        284
```

Of all data received (1324 records), there are 20 duplicates (shared DATE, STATIONID, DEPTHM, and measured VALUE). There are 1304 remaining observations.

3.5.3 Data Summaries

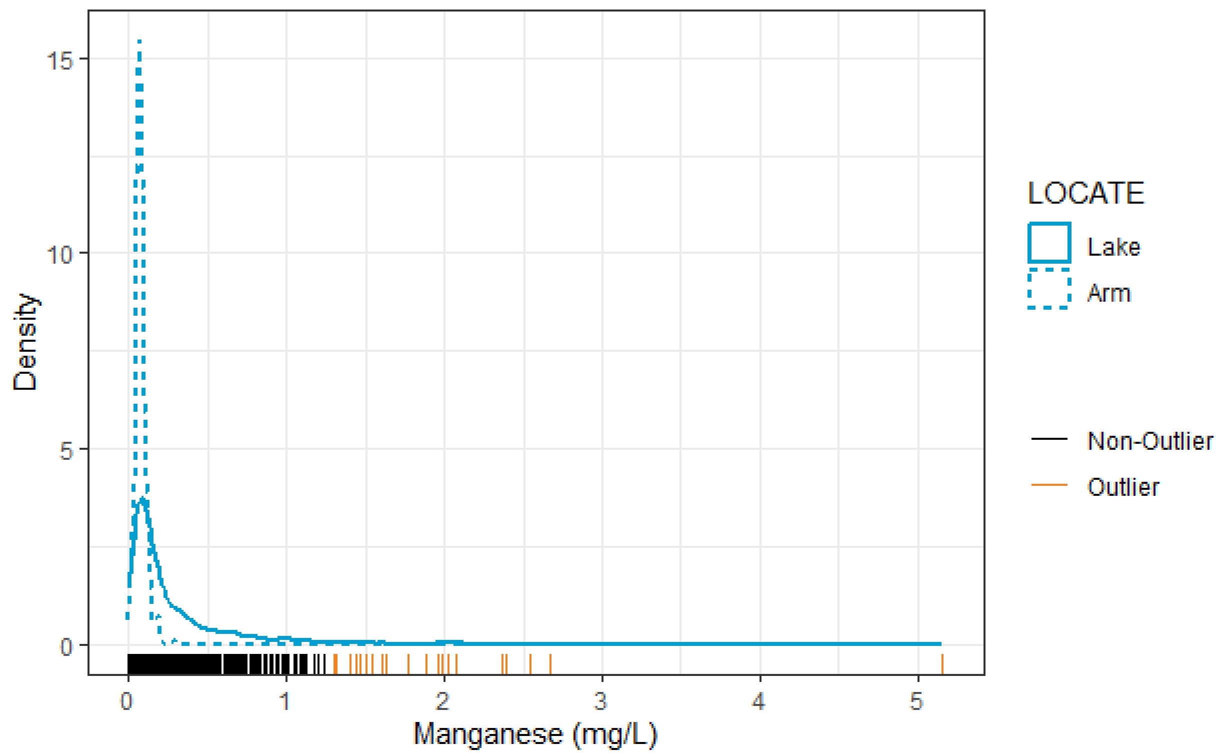
The merged data provide 1304 Manganese records for 29 station ids and 27 years spanning 1984 to 2018.

3.5.3.1 Sample Effort and Values



3.5.3.2 Density Plot and Outliers

The distribution of all lake (thalweg) values is shown as the blue solid line and the lake arm values are shown as the blue dashed line. Below the density plot are rug marks for each observed value. The orange rug marks are values greater than three standard deviations from the overall mean (0.2357076). The SD of all data, thalweg and arms, is 0.3430829. The extreme values (+/- 3SD) are retained for our model project as true, but unusual, values - unless our TAW or SME teams indicate these are data errors.



The 3 SD outlier values identified in this plot are:

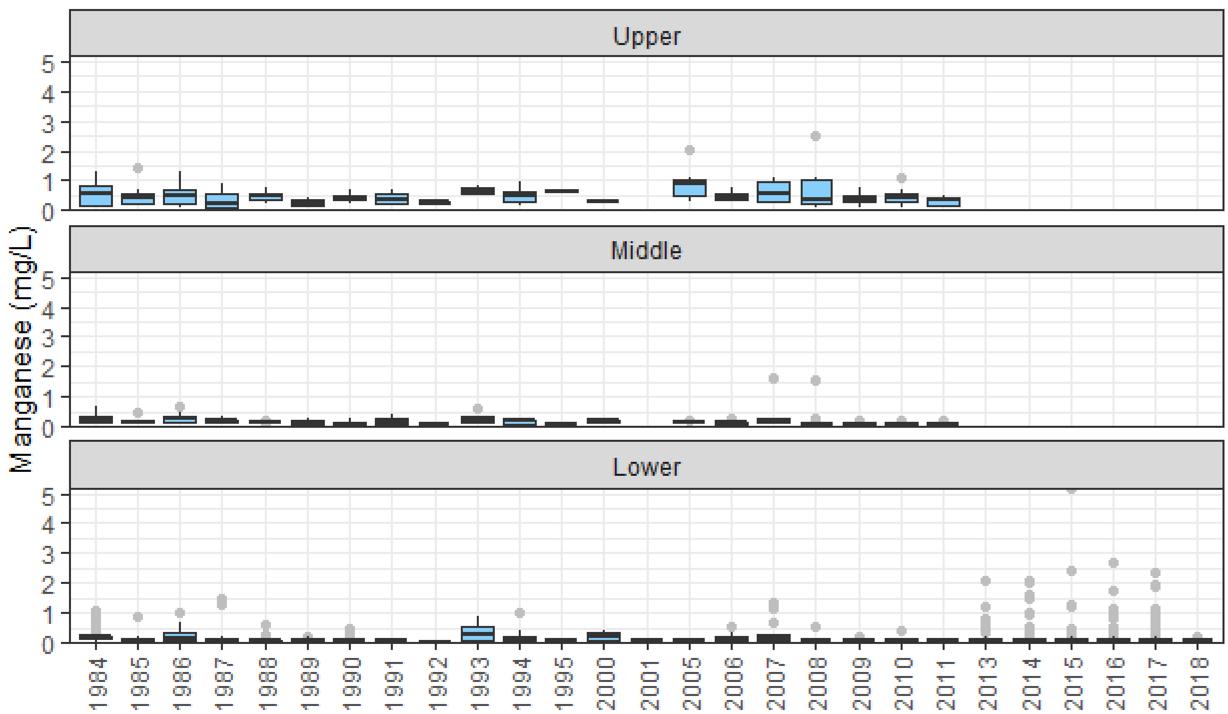
DATE	YEAR	MONTH	SOURCE	VALUE
2015-07-28	2015	Jul	ralpud	1.300
1984-06-14	1984	Jun	storetDwr	1.300
1986-11-18	1986	Nov	storetDwr	1.300
1987-10-14	1987	Oct	storetDwr	1.300
2007-10-04	2007	Oct	storetUsgs	1.320
1985-07-10	1985	Jul	storetDwr	1.400
2014-07-28	2014	Jul	ralpud	1.445
2014-09-30	2014	Sep	ralpud	1.470
1987-10-14	1987	Oct	storetDwr	1.500
2008-06-17	2008	Jun	storetUsgs	1.540
2007-06-13	2007	Jun	storetUsgs	1.610
2014-06-30	2014	Jun	ralpud	1.634
2016-08-30	2016	Aug	ralpud	1.776
2017-08-23	2017	Aug	ralpud	1.880
2017-09-14	2017	Sep	ralpud	1.960
2014-08-25	2014	Aug	ralpud	1.992
2014-09-30	2014	Sep	ralpud	2.020
2005-08-04	2005	Aug	storetUsgs	2.070

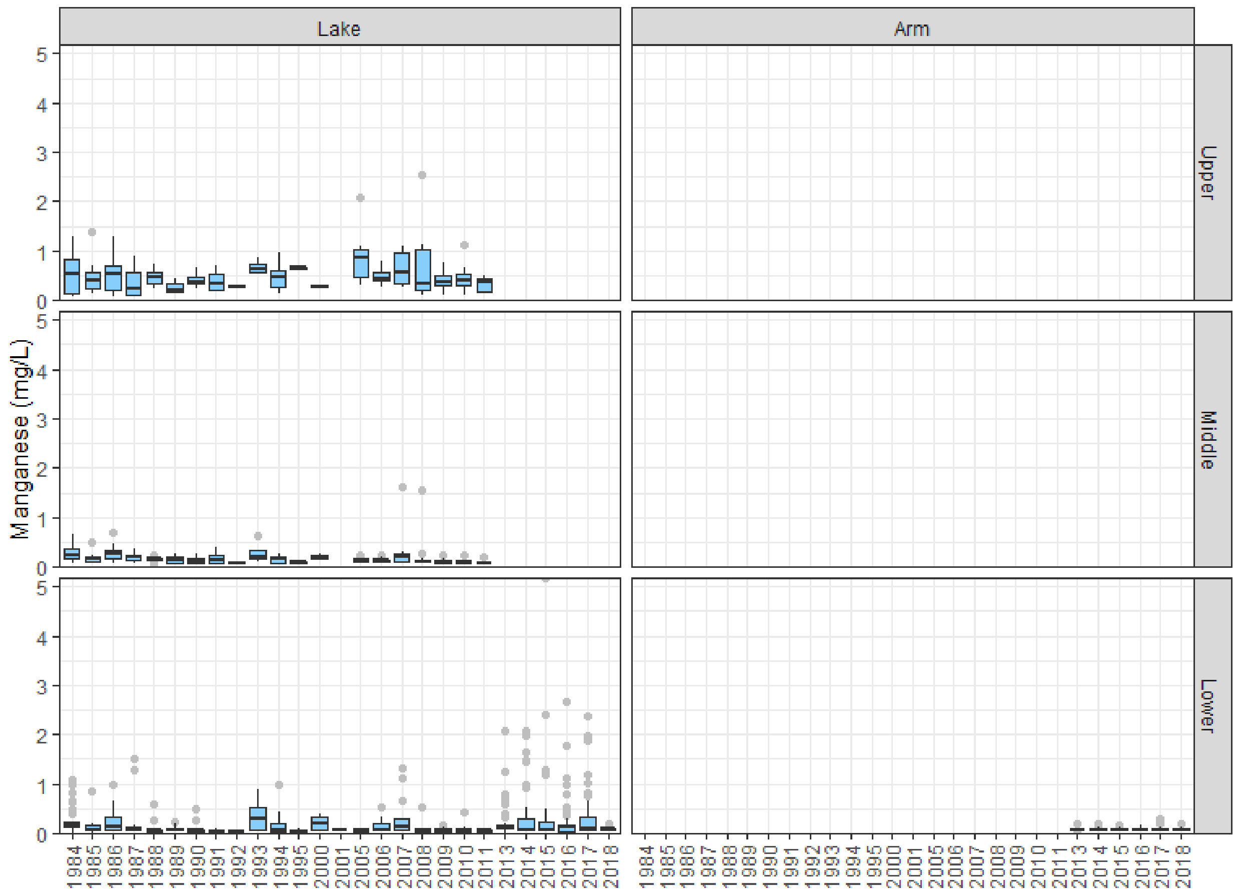
DATE	YEAR	MONTH	SOURCE	VALUE
2013-08-26	2013	Aug	ralpud	2.073
2014-08-25	2014	Aug	ralpud	2.078
2017-08-23	2017	Aug	ralpud	2.370
2015-08-25	2015	Aug	ralpud	2.390
2008-06-17	2008	Jun	storetUsgs	2.540
2016-08-30	2016	Aug	ralpud	2.675
2015-09-29	2015	Sep	ralpud	5.160

3.5.3.3 Annual Variance

If we can use data from the lake arms, it increases our overall sample size. But if the lake arms are too different from the main lake body, the arm data will add noise to our analysis. We show the data as a full set (by lake unit) and split into the lake (thalweg) versus arm observations.

3.5.3.3.1 Full Y-axis

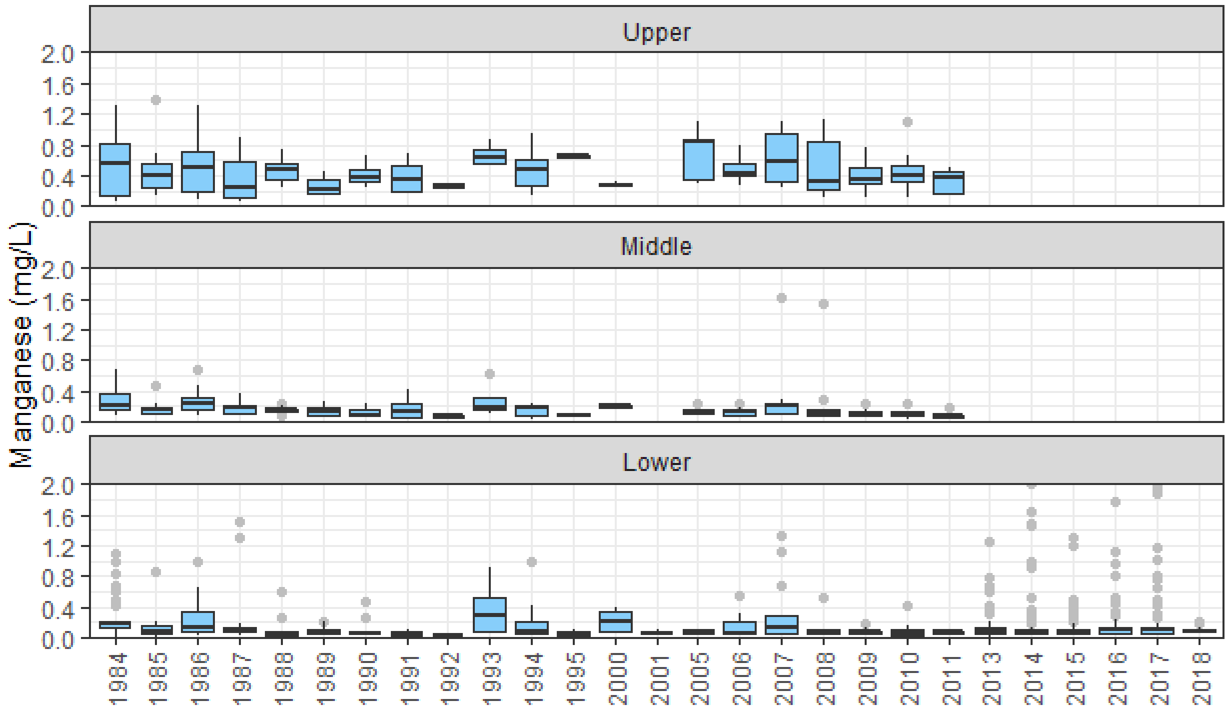


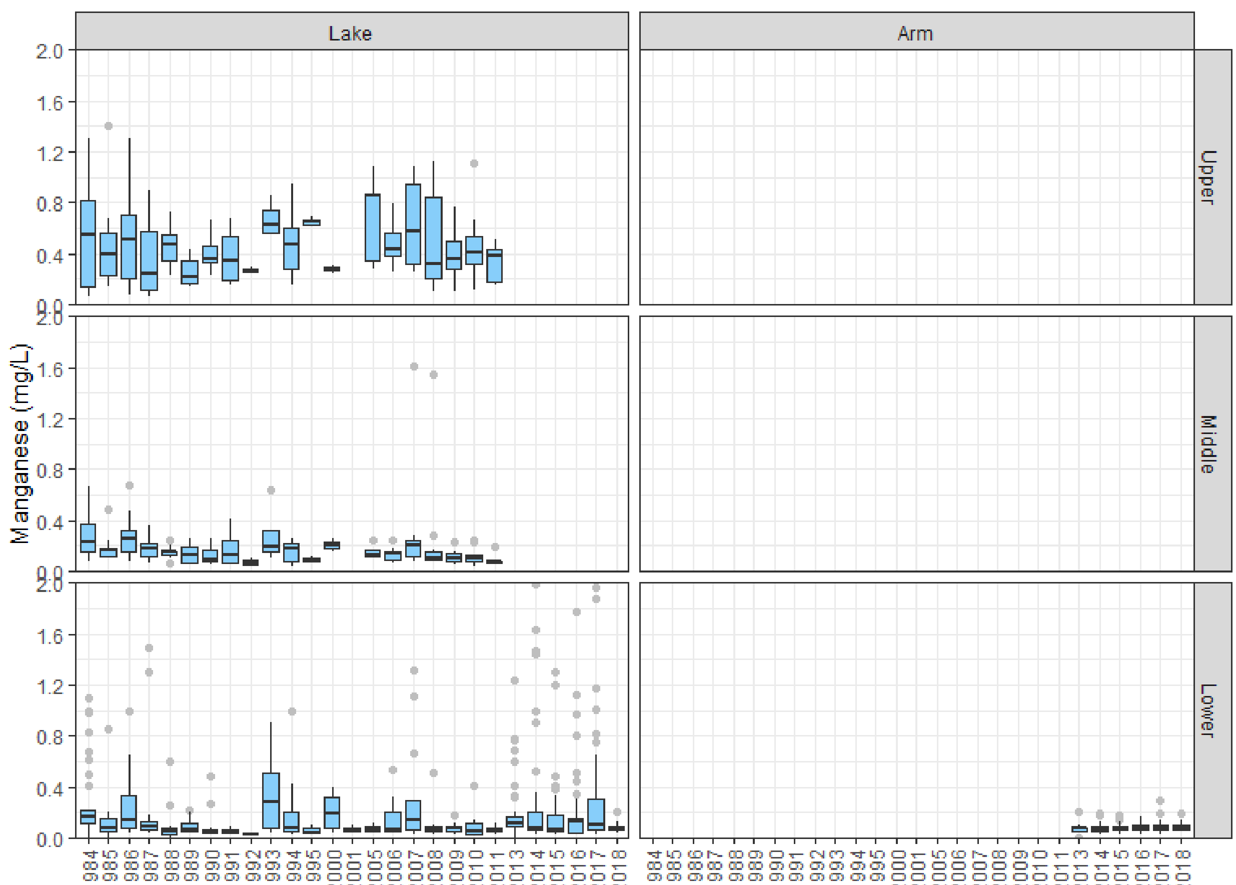


3.5.3.3.2 Clipped Y-axis

Given the wide range of data values, it is difficult to see trends in the typical values. Therefore, we also created a series of plots with a clipped y-axis. No underlying data are removed - so the distributions presented in the box plots remain the same. The plots below are clipped on the y-axis at the value 2.

LAKEUNIT	LOCATE	DATE	VALUE
Upper	Lake	2005-08-04	2.070
Upper	Lake	2008-06-17	2.540
Lower	Lake	2013-08-26	2.073
Lower	Lake	2014-08-25	2.078
Lower	Lake	2014-09-30	2.020
Lower	Lake	2015-08-25	2.390
Lower	Lake	2015-09-29	5.160
Lower	Lake	2016-08-30	2.675
Lower	Lake	2017-08-23	2.370


Upper
Middle
Lower
Manganese (mg/L)
2.0
1.6
1.2
0.8
0.4
0.0
1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 2000 2001 2005 2006 2007 2008 2009 2010 2011 2013 2014 2015 2016 2017 2018

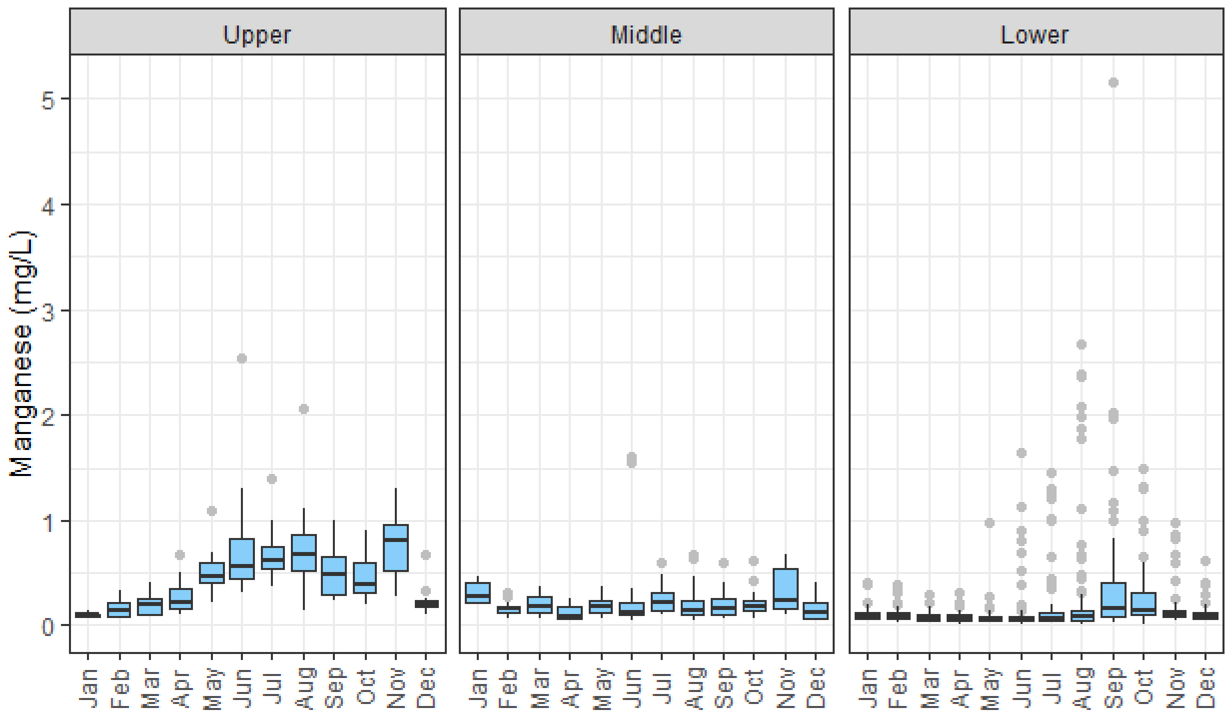

Lake
Arm
Upper
Middle
Lower
Manganese (mg/L)
2.0
1.6
1.2
0.8
0.4
0.0
1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 2000 2001 2005 2006 2007 2008 2009 2010 2011 2013 2014 2015 2016 2017 2018

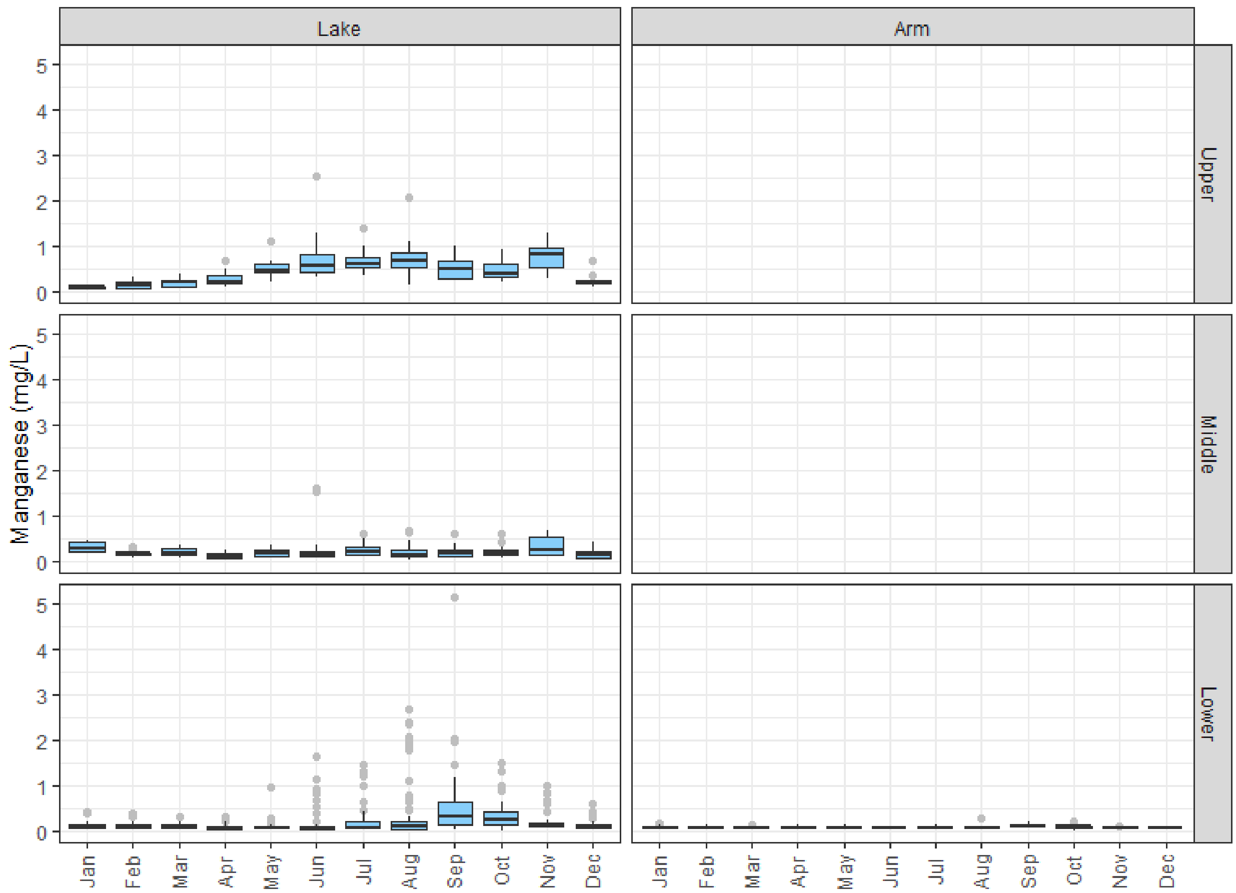
3.5.3.4 Historic versus Recent Comparison

```
## # A tibble: 3 × 3
##   LAKEUNIT HISTORIC RECENT
##   <ord>       <dbl>  <dbl>
## 1 Upper        0.49   0.4
## 2 Middle       0.22   0.1
## 3 Lower        0.19   0.17
```

3.5.3.5 Seasonal Trends

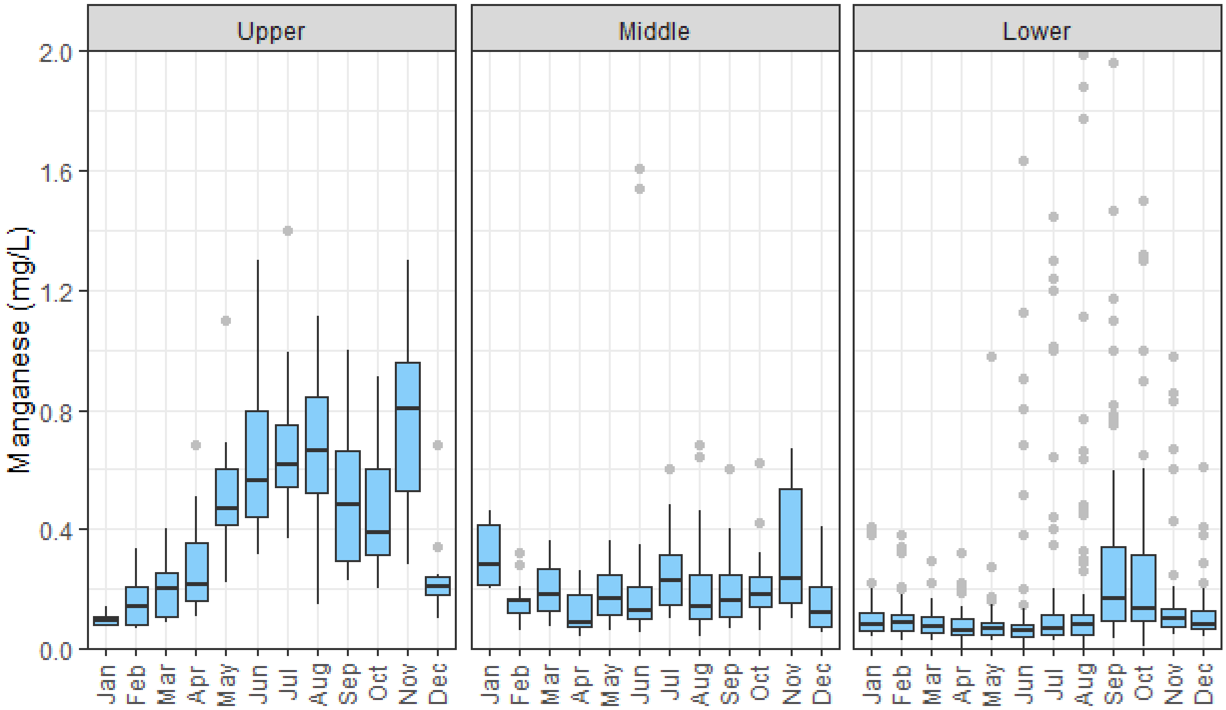
3.5.3.5.1 Full Y-axis

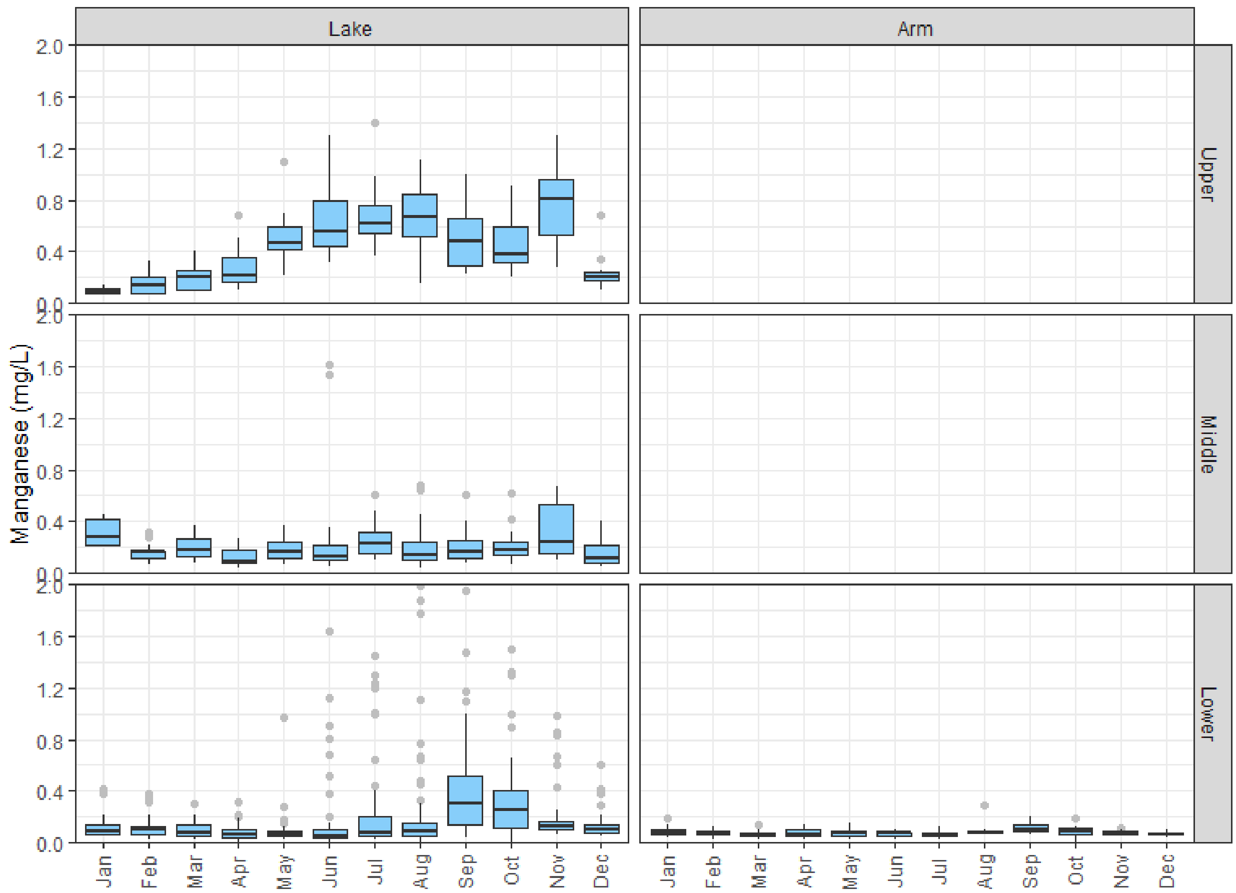




Lake
Arm
Upper
Middle
Lower
Manganese (mg/L)
0
1
2
3
4
5
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

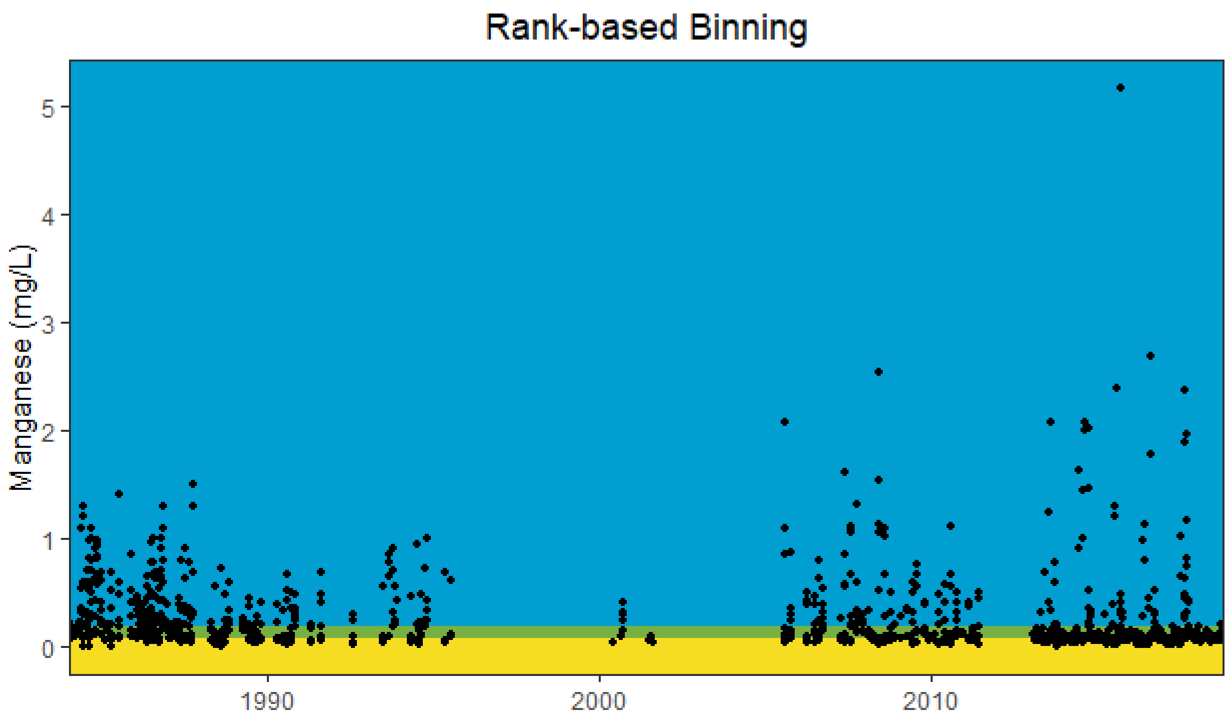
3.5.3.5.2 Clipped Y-axis





3.5.4 Proposed Bins

In the absence of lake water criteria, we propose rank-based bins.



The cut points for the rank based bins are: -, 0.0792, 0.1825, . Each bin contains an equal number of observations.

3.5.5 Export Merged Data

The merged data files represent all data gathered to date for this variable. We drop some of the information that was used as qaqc during prep and merging steps: SOURCEID, SOURCETYPE, DEPTHTYPE, VARTYPE, VARLABEL. The final merged data are saved as: **tidy_mang.rds** (data) and **tidy_mang_summary.rds** (summary states for LAKEUNIT by MONTH: N, NYears, Mean, SD). Both are also saved to Excel.

The final data include data received from: ralpud, storetDwr, storetUsgs.

Code authored by KDV Decision Analysis LLC and last run 2024-09-19 with R version 4.4.1 (2024-06-14 ucrt).

3.6 Data Merge for N:P Ratio

This data merge step starts with the final merged (tidy) Total N and Total P data files.

3.6.1 Gather Data Resources

The ratio is calculated based on the existing tidy Total Nitrogen (mg/L) and Total Phosphorus (mg/L) values.

We prepared nrow(totaln) Total Nitrogen records and nrow(totalp) records.

3.6.2 Match N and P data by DATE, STATIONID, and SOURCE

After matching on SOURCE, DATE, and STATIONID, we had nrow(nuts) with both nutrient measurements.

```
##
##   2086920 208703650 208708905 208718195       FL1       FL2       FL4       FL5
##       123       42       21       33       38       44       39       33
##     FL50C      FL6     FL85C     FLINC      LC01      LI01     LLC01    NEU010
##        87       47       70       74      185      124      182       76
##    NEU013   NEU013B  NEU0171B   NEU018C   NEU018E   NEU019E   NEU019L   NEU019P
##       179      218      286       51      278      278      202      219
##   NEU020D  NEUELL10
##       219       43

##
##     Upper     Middle      Lower Other Lake
##       828      1557       806          0

##
## 1993 1994 1995 2000 2001 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
##    6    8    1   19   69  203  410  335   42   56  116  171  142  141  146  163
## 2016 2017 2018 2019 2020
##  320  329  243  129  142

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
## 202 279 286 302 258 278 312 309 253 271 201 240
```

The combined nutrient data provide 3191 N:P Ratio records for 26 station ids and 21 years spanning 1993 to 2020.

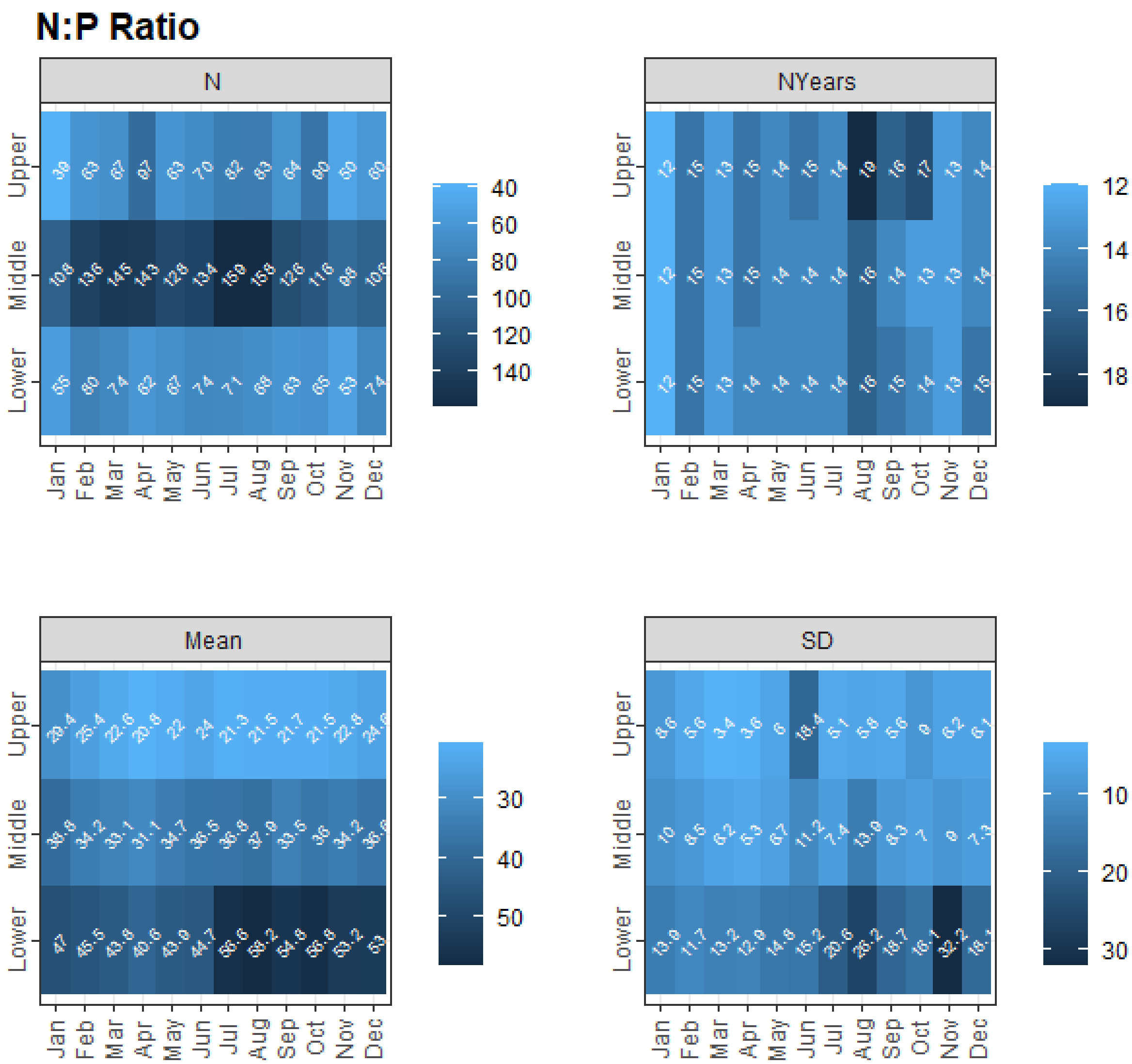
3.6.3 Calculate Molar Ratio

N:P = (mol N) / (mol P)

“Take N in mg/L, divide by P in mg/L, multiply by 30.97, divide by 14” - per Alix email April 17 2023

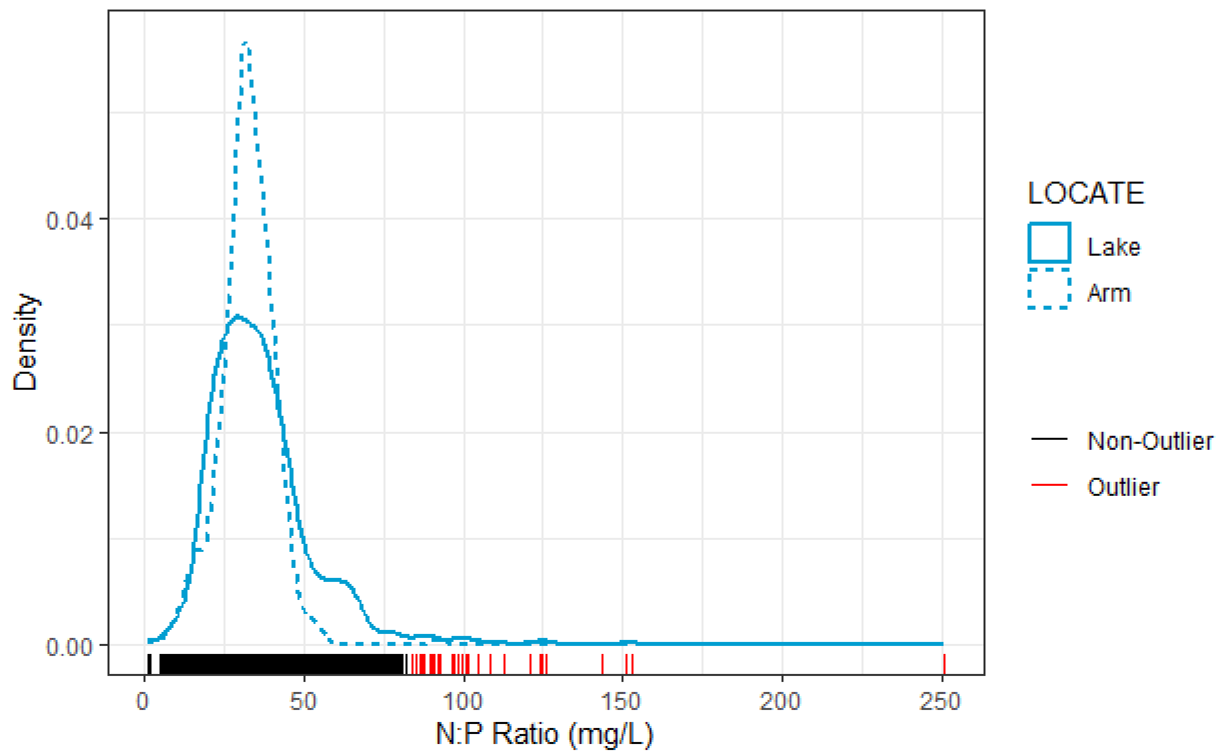
3.6.4 Data Summaries

3.6.4.1 Sample Effort and Values



3.6.4.2 Density Plot and Outliers

The distribution of all lake (thalweg) values is shown as the blue solid line and the lake arm values are shown as the blue dashed line. Below the density plot are rug marks for each observed value. The orange rug marks are values greater than three standard deviations from the overall mean (35.6686622). The SD of all data, thalweg and arms, is 15.5726147. The extreme values (+/- 3SD) are retained for our model project as true, but unusual, values - unless our TAW or SME teams indicate these are data errors.



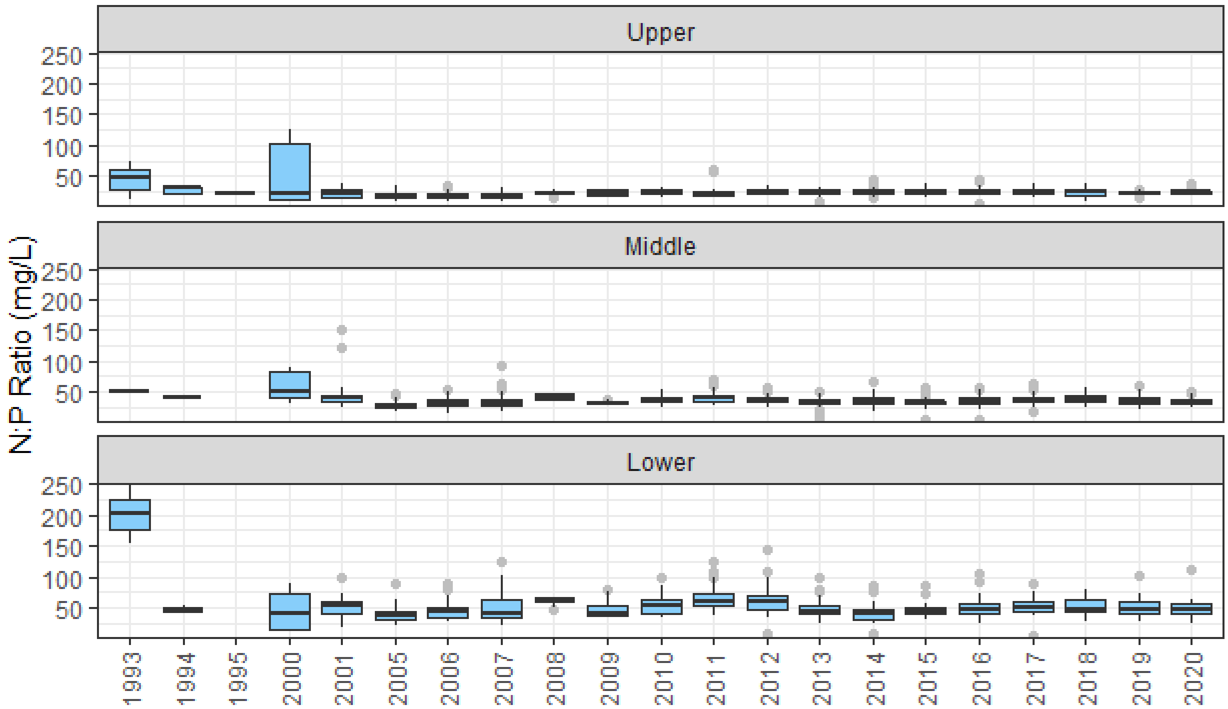
The 3 SD outlier values identified in this plot are:

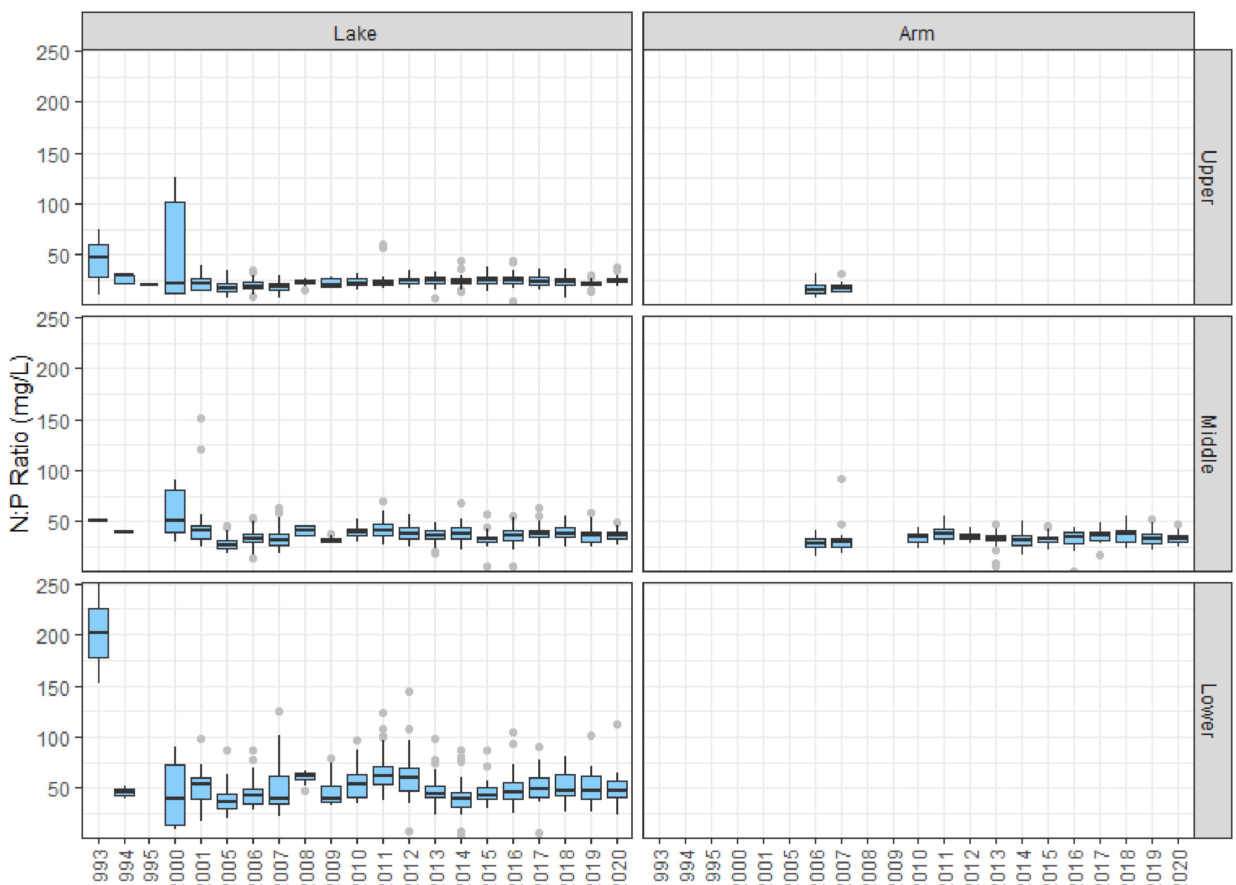
DATE	YEAR	MONTH	SOURCE	VALUE
2010-08-05	2010	Aug	storetDwr	84.06143
2010-11-08	2010	Nov	storetDwr	84.06143
2010-10-12	2010	Oct	storetDwr	85.16750
2011-10-20	2011	Oct	storetDwr	85.16750
2010-07-08	2010	Jul	storetDwr	86.27357
2015-07-16	2015	Jul	storetDwr	86.27357
2014-10-28	2014	Oct	storetDwr	86.82661
2005-06-20	2005	Jun	storetDwr	87.37964
2006-03-07	2006	Mar	storetDwr	87.37965
2011-11-08	2011	Nov	storetDwr	87.93268
2000-06-07	2000	Jun	storetDwr	89.59179
2000-06-07	2000	Jun	storetDwr	89.59179
2000-09-28	2000	Sep	storetDwr	89.59179
2000-09-28	2000	Sep	storetDwr	89.59179
2017-09-13	2017	Sep	caae	89.66722
2017-09-13	2017	Sep	caae	89.86805
2012-12-18	2012	Dec	storetDwr	90.69786
2012-12-18	2012	Dec	storetDwr	90.69786

DATE	YEAR	MONTH	SOURCE	VALUE
2007-01-30	2007	Jan	storetDwr	91.80393
2016-12-14	2016	Dec	storetDwr	92.91000
2016-12-14	2016	Dec	storetDwr	92.91000
2007-07-25	2007	Jul	storetDwr	96.22822
2011-10-20	2011	Oct	storetDwr	96.78125
2012-10-10	2012	Oct	storetDwr	97.33429
2010-12-21	2010	Dec	storetDwr	97.33429
2001-08-27	2001	Aug	storetDwr	98.44036
2013-01-14	2013	Jan	storetDwr	98.44036
2011-07-12	2011	Jul	storetDwr	99.54643
2007-08-21	2007	Aug	storetDwr	100.65250
2019-12-10	2019	Dec	storetDwr	100.65250
2011-07-12	2011	Jul	storetDwr	101.75857
2011-11-08	2011	Nov	storetDwr	101.75857
2011-06-14	2011	Jun	storetDwr	101.75857
2016-05-11	2016	May	caae	104.42408
2016-05-11	2016	May	caae	104.57873
2011-08-09	2011	Aug	storetDwr	108.39500
2012-08-29	2012	Aug	storetDwr	108.39500
2020-07-22	2020	Jul	storetDwr	112.81929
2001-08-27	2001	Aug	storetDwr	120.78300
2011-08-09	2011	Aug	storetDwr	123.88000
2007-08-21	2007	Aug	storetDwr	124.98607
2007-08-21	2007	Aug	storetDwr	124.98607
2000-06-07	2000	Jun	storetDwr	125.72345
2000-06-07	2000	Jun	storetDwr	125.72345
2012-07-17	2012	Jul	storetDwr	143.78929
2001-08-27	2001	Aug	storetDwr	150.97875
1993-08-24	1993	Aug	storetUsgs	152.63786
1993-11-09	1993	Nov	storetUsgs	250.70952

3.6.4.3 Annual Variance

If we can use data from the lake arms, it increases our overall sample size. But if the lake arms are too different from the main lake body, the arm data will add noise to our analysis. We show the data as a full set (by lake unit) and split into the lake (thalweg) versus arm observations.


Upper
Middle
Lower
N:P Ratio (mg/L)
250
200
150
100
50
1993
1994
1995
2000
2001
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020


Lake
Arm
Upper
Middle
Lower
N:P Ratio (mg/L)
250
200
150
100
50
1993
1994
1995
2000
2001
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

3.6.4.4 Historic versus Recent Comparison

We compare fthe data from early years (1986 to 1995) to recent years (2011 to 2020).

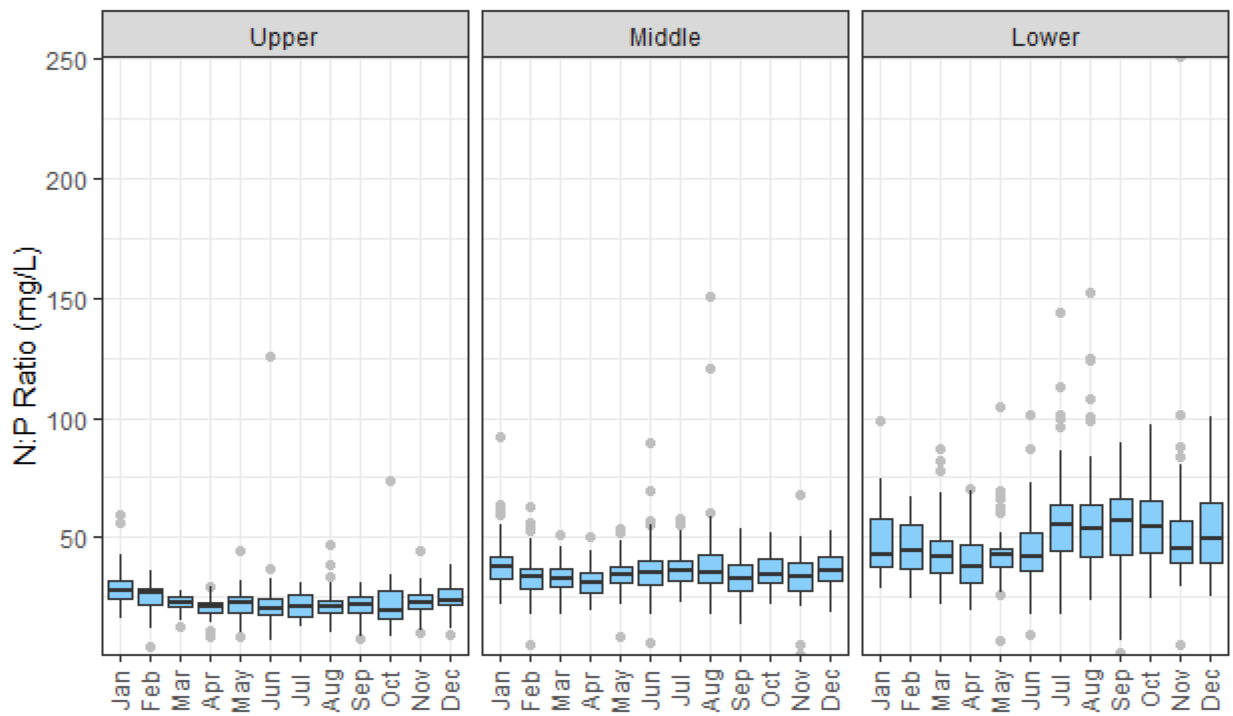
3.6.4.4.1 Mean Values

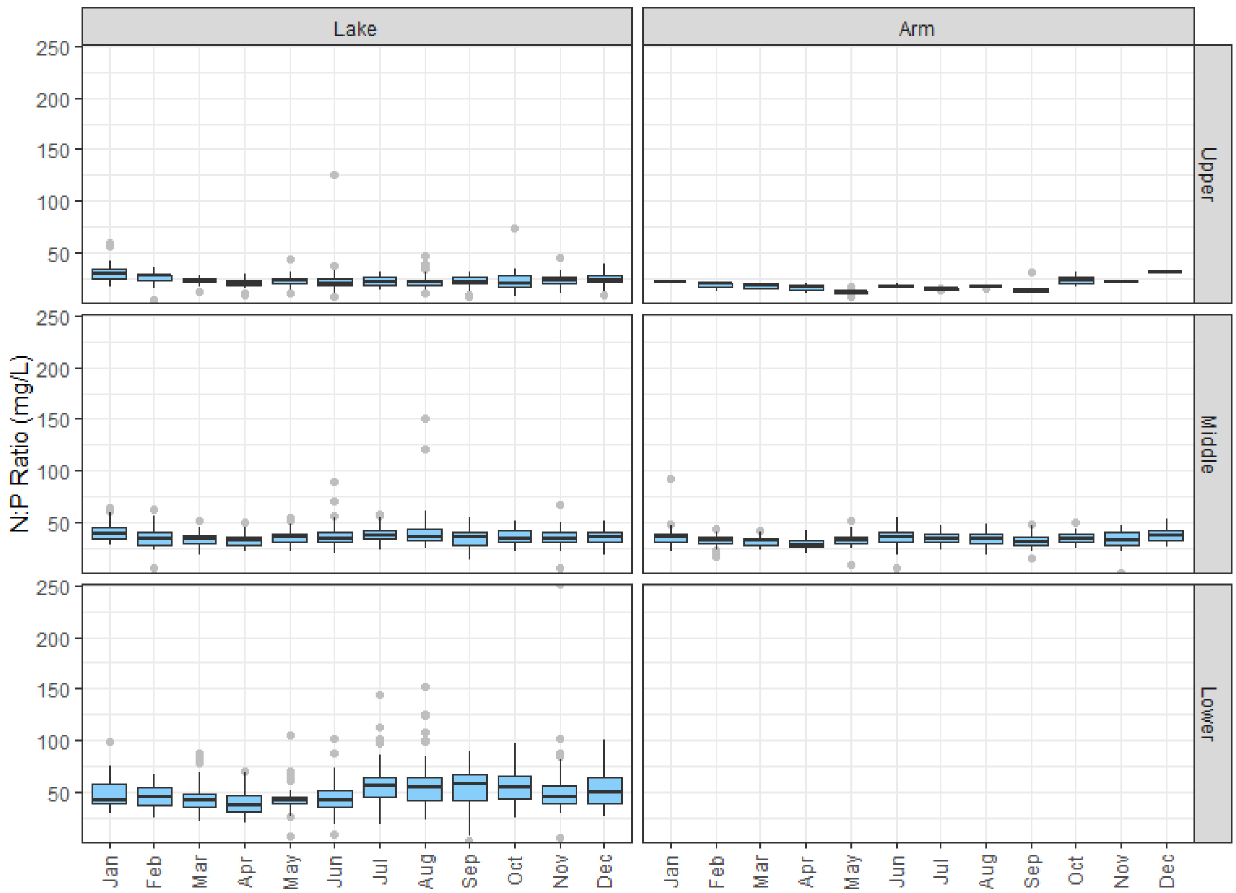
LAKEUNIT	HISTORIC	RECENT
Upper	32.06	24.35
Middle	44.98	36.23
Lower	123.42	51.04

3.6.4.4.2 SD Values

LAKEUNIT	HISTORIC	RECENT
Upper	18.63	5.46
Middle	7.30	7.53
Lower	98.97	17.11

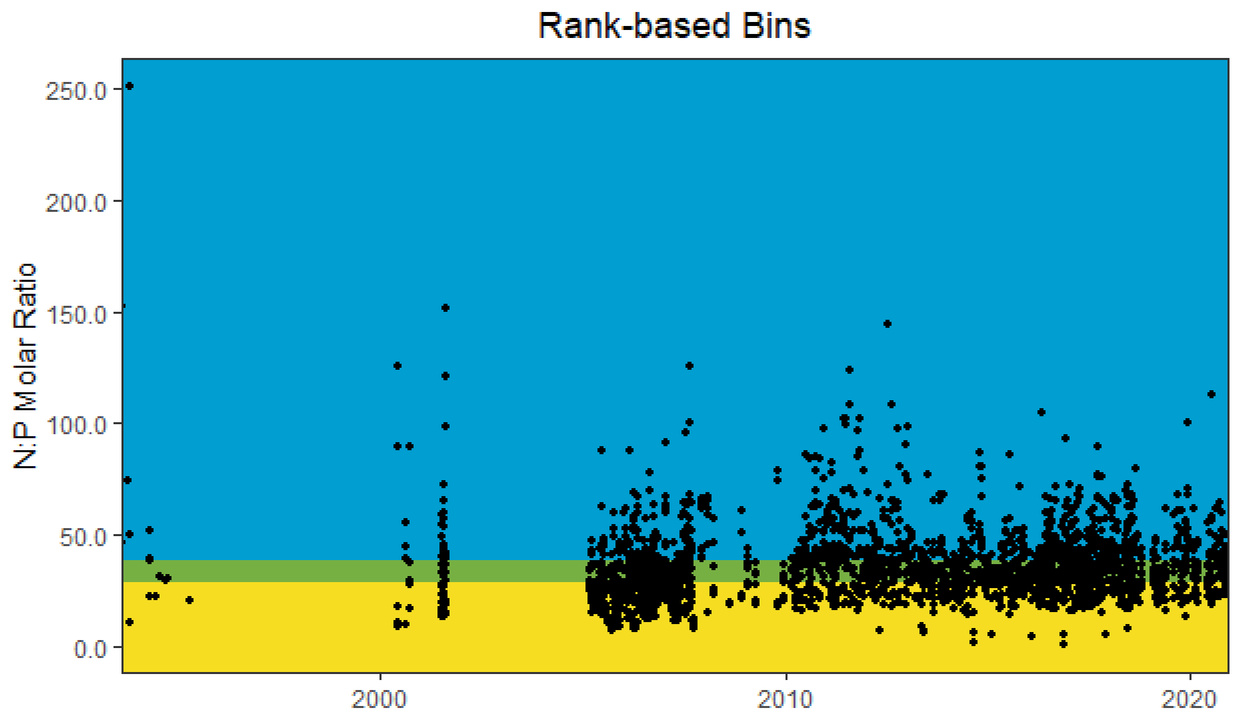
3.6.4.5 Seasonal Trends





Lake
Arm
Upper
Middle
Lower
N:P Ratio (mg/L)
250
200
150
100
50
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

3.6.5 Proposed Bins



The cut points for the rank based bins are: -, 28.6518285, 38.4912853, . The median of all data is 33.1821432.

3.6.6 Export Merged Data

The merged data files represent all data gathered to date for this variable. We drop some of the information that was used as qaqc during prep and merging steps: SOURCETYPE, DEPTHTYPE, VARTYPE, VARLABEL. The final merged data are saved as: **tidy_npratio.rds** (data) and **tidy_npratio_summary.rds** (summary states for LAKEUNIT by MONTH: N, NYears, Mean, SD). Both are also saved to Excel.

Code authored by KDV Decision Analysis LLC and last run 2024-09-19 with R version 4.4.1 (2024-06-14 ucrt).

3.7 Merging Data for pH (ph)

3.7.1 Gather Data Resources

3.7.1.1 List Associated Files

pH data are identified by the **_ph** suffix.

The available pH data sources are: caae_ph.rds, durmCity_ph.rds, ralpud_ph.rds, storetDwr_ph.rds, storetUsgs_ph.rds.

3.7.1.2 City of Raleigh Data (ralpud)

```
## 
## Honeycutt Creek      Intake 223      Intake 233      Intake 243 
##              69              60              60              61 
```

```
##    Intake Surface Lower Barton Creek    New Light Creek Upper Barton Creek
##               69                 69                 69                 69
##        US Hwy 98
##               69

##
##     Upper     Middle      Lower Other Lake
##         0          0        595          0

##
## 2013 2014 2015 2016 2017 2018
##  108  106   99  108  114   60

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##  51  42  51  51  51  51  51  54  54  49  45  45
```

This source provides 595 pH records for 9 station ids and 6 years spanning 2013 to 2018.

3.7.1.3 Center for Applied Aquatic Ecology NCSU (caae)

```
##
## Falls Lake 1 Falls Lake 2 Lick Creek 1
##           1            1            4

##
##     Upper     Middle      Lower Other Lake
##         0          5          1          0

##
## 2014 2015 2016 2018
##    2    2    1    1

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##   1   0   0   1   0   0   0   1   0   1   1   1
```

This source provides 6 pH records for 3 station ids and 4 years spanning 2014 to 2018.

3.7.1.4 City of Durham

```
##
##    FL-DS4 FL-SR1801
##       569       528

##
##     Upper     Middle      Lower Other Lake
##      1097          0          0          0

##
## 2015 2016 2017 2018
##  289  274  242  292
```

```
##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##   0   0   0 139 174 163 183 141 142 155   0   0
```

This source provides 1097 pH records for 2 station ids and 4 years spanning 2015 to 2018.

3.7.1.5 Storet DWR (storetDwr)

```
##
## J1250000 J1250010 J1370000 J1370010 J1430000 J1430010 J1590000 J1590010
##      304        2      306        2      274        3      286        2
## J1670000 J1675000 J1675010 J1690000 J1715000 J1715010 J1725000 J1725010
##        7      299        2        1      302        2      304        2
## J1727000 J1727010 J1740000 J1740010     LC01     LI01    LLC01   NEU010
##      312        2      312        2      551      351      536      314
##   NEU013  NEU013B NEU0171B  NEU018C  NEU018E  NEU019E  NEU019L  NEU019P
##      542      610      719      169      743      743      732      741
##  NEU020D NEUELL10
##      750      108

##
##      Upper     Middle      Lower Other Lake
##       2465       4713       3157          0

##
## 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 2000 2001 2005 2006
##  464  516  527  393  179  209  203   88   49   50   45    3  115  167  825 1169
## 2007 2010 2011 2012 2013 2015 2016 2017 2018 2019 2020
##  900  360  571  631  642  109  692  668  512  128  120

##
##  Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec
##  607  691  809  998  881 1044  945 1323  914  812  663  648
```

This source provides 10335 pH records for 34 station ids and 27 years spanning 1984 to 2020.

3.7.1.6 Storet USGS (storetUsgs)

```
##
##   2086920 208703650 208708905 208717595 208718195
##       105        98        60         2        62

##
##      Upper     Middle      Lower Other Lake
##        105         98        124          0

##
## 1993 1994 1995 2005 2006 2007 2008 2009 2010 2011
##   31   40   15   20   33   39   43   43   41   22
```

```
##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##   0  20   8  43  15  56  14  67   8  65   8  23
```

This source provides 327 pH records for 5 station ids and 10 years spanning 1993 to 2011.

This source provides no samples from the upper section of the lake.

3.7.2 Merge Data Sources

In total, we assembled 12360 pH records into a single tidy dataframe. This included data from the City of Raleigh (595 records), CAAE (6 records), City of Durham (1097 records), Storet DWR (10335 records), and Storet USGS (327 records).

Merged data were qaqc'd to confirm:

- only one variable is present
- no NA values are present
- only one measurement unit is present (OR if more than one is present, additional processing is required)

```
## # A tibble: 5 × 6
##   SOURCE          N NStations NYears MinYear MaxYear
##   <chr>       <int>     <int>  <int>   <dbl>   <dbl>
## 1 caae            6         3      4    2014    2018
## 2 durmCity     1097         2      4    2015    2018
## 3 ralpud        595         9      6    2013    2018
## 4 storetDwr   10335        34     27    1984    2020
## 5 storetUsgs    327         5     10    1993    2011
```

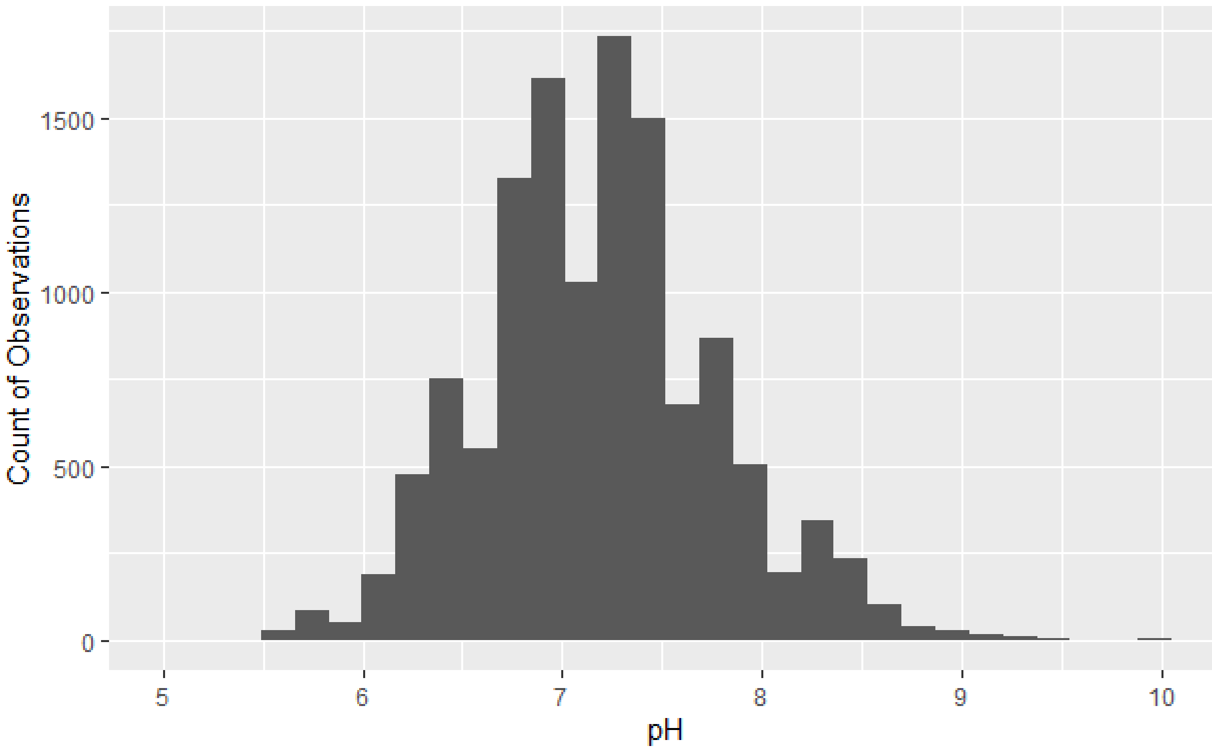
3.7.2.1 Check for and Remove Error

These data had no values that could be flaged as obvious data errors. There are some extreme values, but we retain these pending review by the SME and TAW teams.

```
##       SOURCE SOURCEID VARIABLE MEASUNIT     VALUE
## 1 storetDwr    20629       pH       pH       1.7
## 2 storetDwr    24142       pH       pH   99999.0
## 3 storetDwr    27775       pH       pH  999999.0
## 4 storetDwr    28739       pH       pH  999999.0
## 5 storetDwr    29472       pH       pH 9999999.0
## 6 storetDwr    30213       pH       pH 9999999.0
## 7 storetDwr    30963       pH       pH   99999.0
```

Quantiles	pH.value
0%	5.10
10%	6.50
20%	6.70
30%	6.90
40%	7.00

Quantiles	pH.value
50%	7.20
60%	7.30
70%	7.44
80%	7.60
90%	7.90
100%	10.00



There are a 6 records with pH values greater than 14. All extreme high values are 99999 entries that are likely placeholders for NA values. We deleted these records. We also found one record for a value of 1.7 which is impossibly acidic, so we also removed this one value. The remaining values range from 5.1 to 10. This range still seems quite wide (6.5-9 is typical of lake waters), but we will leave these values in for discussion with UNRBA.

3.7.2.2 Check for and Remove Duplicates

All records with equal DATE, STATIONID, DEPTHM, and VALUE are treated as duplicates values and are dropped. With the removal of the older data resources (from earlier 2019 UNRBA data summary report) in favor of updated DWR with more qaqc, there are very few duplicated values.

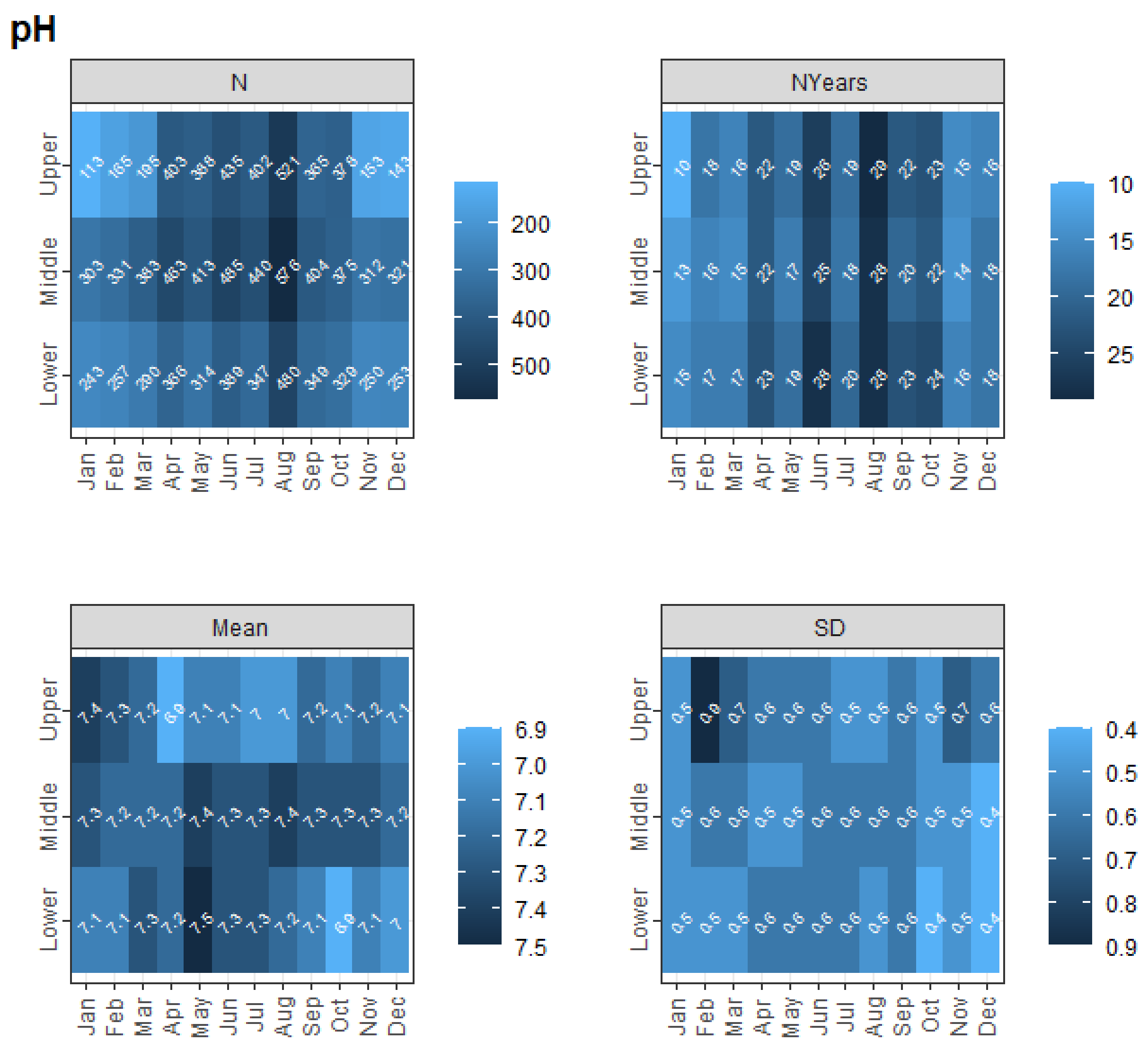
```
##
##    caae  durmCity    ralpud  storetDwr storetUsgs
##       6      1097       595      10309        327
```

Of all data received (12353 records), there are 19 duplicates (shared DATE, STATIONID, DEPTHM, and measured VALUE). There are 12334 remaining observations.

3.7.3 Data Summaries

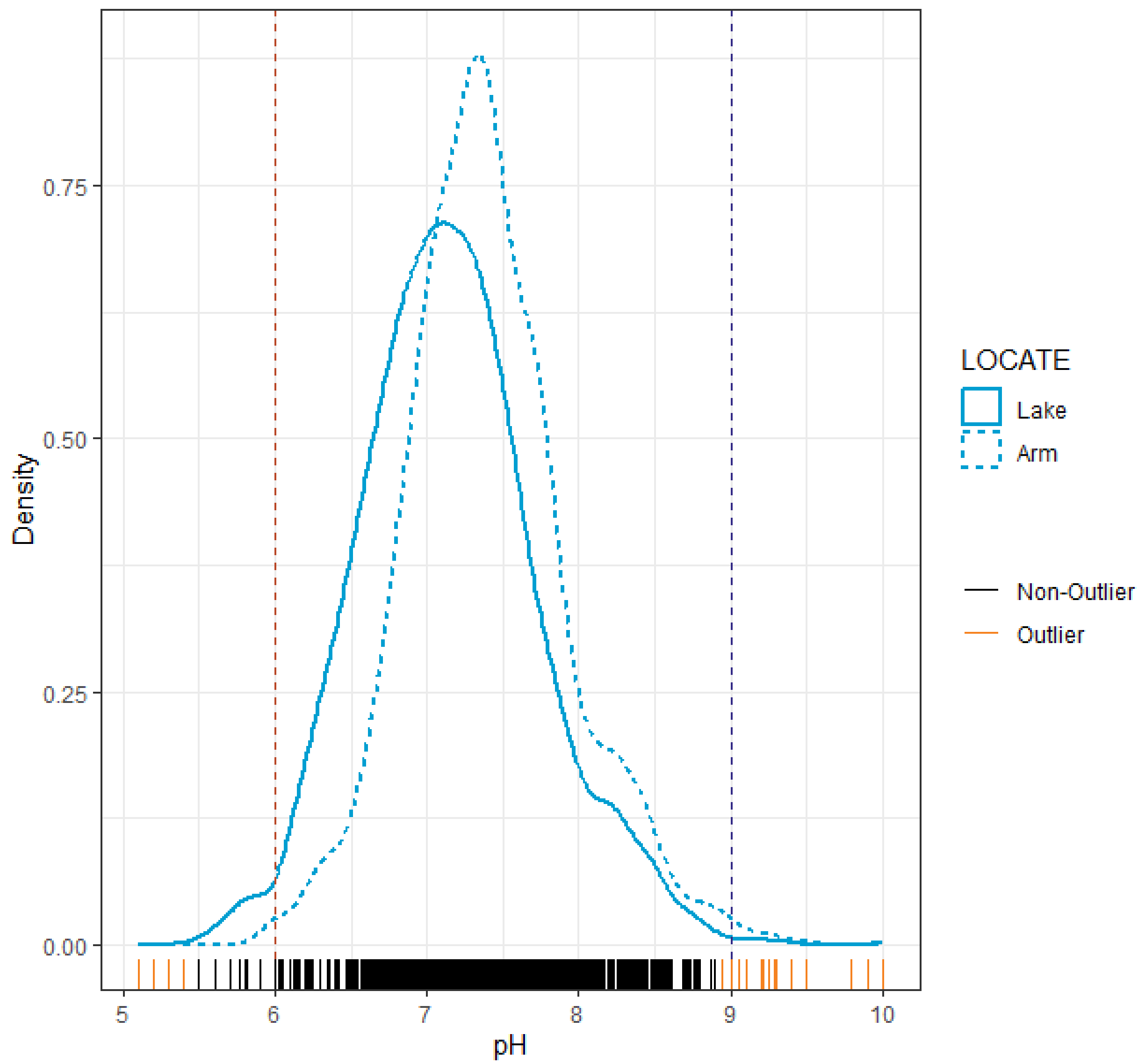
The merged data provide 12334 pH records for 53 station ids and 30 years spanning 1984 to 2020.

3.7.3.1 Sample Effort and Values



3.7.3.2 Density Plot and Outliers

The distribution of all lake (thalweg) values is shown as the blue solid line and the lake arm values are shown as the blue dashed line. Below the density plot are rug marks for each observed value. The orange rug marks are values greater than three standard deviations from the overall mean (7.1884055). The SD of all data, thalweg and arms, is 0.5845479. The extreme values (+/- 3SD) are retained for our model project as true, but unusual, values - unless our TAW or SME teams indicate these are data errors.



The 3 SD outlier values identified in this plot are:

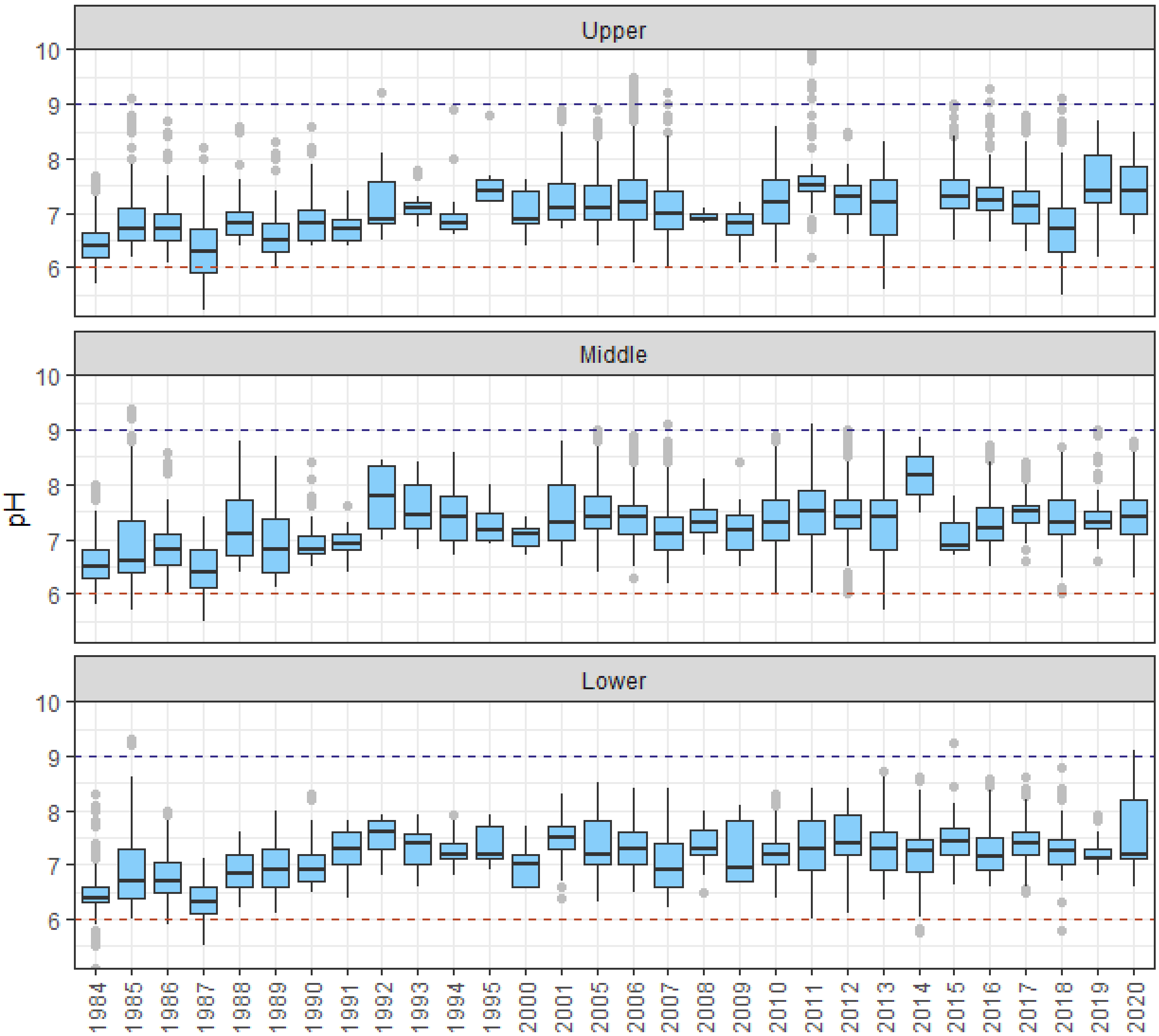
DATE	YEAR	MONTH	SOURCE	VALUE
1984-09-17	1984	Sep	storetDwr	5.10
1987-06-04	1987	Jun	storetDwr	5.20
1987-06-04	1987	Jun	storetDwr	5.30
1987-06-04	1987	Jun	storetDwr	5.40
2015-05-04	2015	May	durmCity	8.95
2012-08-29	2012	Aug	storetDwr	9.00
2019-09-10	2019	Sep	storetDwr	9.00
2015-08-13	2015	Aug	storetDwr	9.00
2006-02-23	2006	Feb	storetDwr	9.00
2005-11-03	2005	Nov	storetDwr	9.00

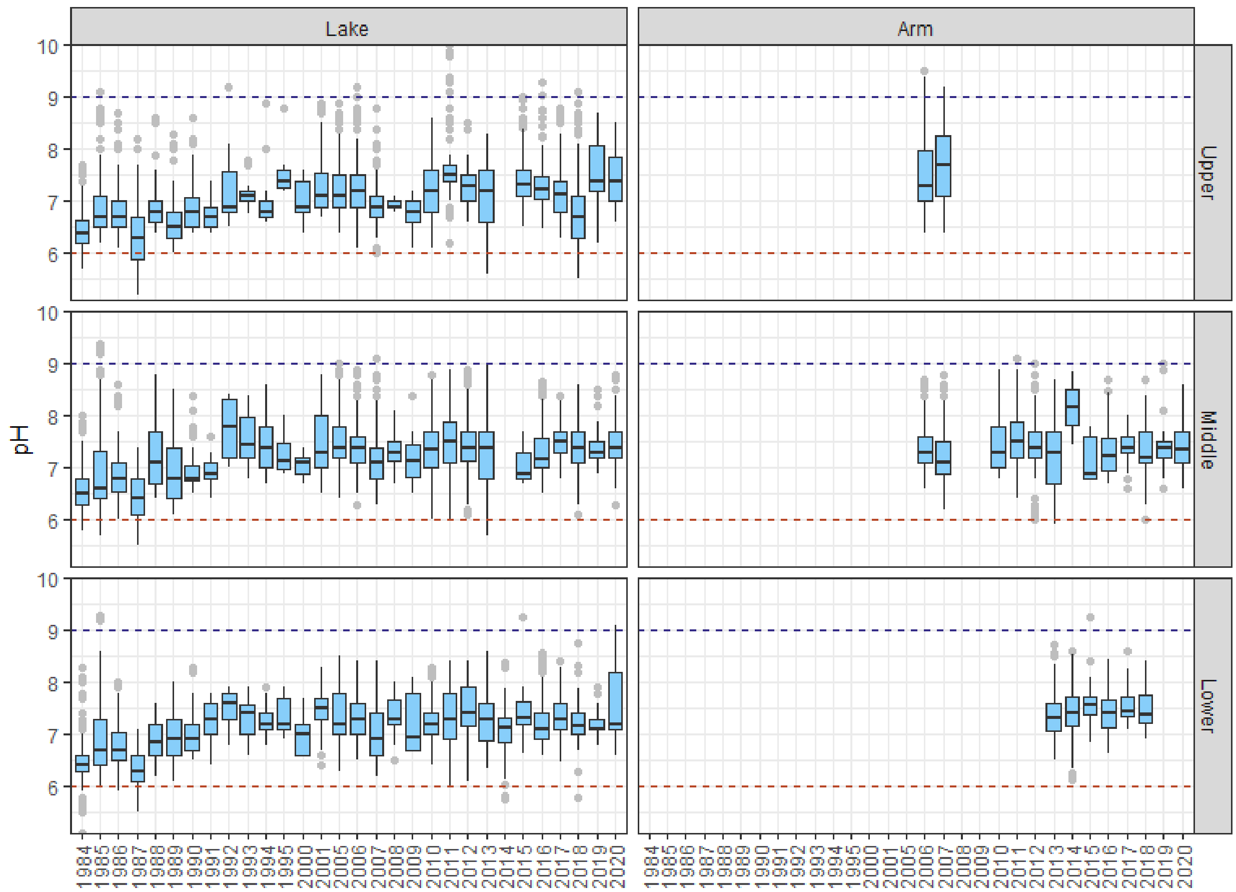
DATE	YEAR	MONTH	SOURCE	VALUE
2013-07-17	2013	Jul	storetDwr	9.00
2006-03-28	2006	Mar	storetDwr	9.00
2007-06-07	2007	Jun	storetDwr	9.00
2007-06-21	2007	Jun	storetDwr	9.00
2016-10-17	2016	Oct	durmCity	9.06
2018-08-27	2018	Aug	durmCity	9.10
1985-08-13	1985	Aug	storetDwr	9.10
2011-09-13	2011	Sep	storetDwr	9.10
2011-02-17	2011	Feb	storetDwr	9.10
2011-02-17	2011	Feb	storetDwr	9.10
2007-07-11	2007	Jul	storetDwr	9.10
2020-06-24	2020	Jun	storetDwr	9.10
2006-03-09	2006	Mar	storetDwr	9.10
1985-05-01	1985	May	storetDwr	9.20
1985-05-01	1985	May	storetDwr	9.20
2006-02-02	2006	Feb	storetDwr	9.20
2006-03-09	2006	Mar	storetDwr	9.20
2007-07-26	2007	Jul	storetDwr	9.20
1992-06-30	1992	Jun	storetDwr	9.21
2015-05-26	2015	May	ralpud	9.25
2015-05-26	2015	May	ralpud	9.25
2016-01-26	2016	Jan	storetDwr	9.29
1985-05-01	1985	May	storetDwr	9.30
1985-05-01	1985	May	storetDwr	9.30
1985-05-01	1985	May	storetDwr	9.30
2011-02-17	2011	Feb	storetDwr	9.30
2006-03-09	2006	Mar	storetDwr	9.30
1985-05-01	1985	May	storetDwr	9.40
1985-05-01	1985	May	storetDwr	9.40
2011-02-17	2011	Feb	storetDwr	9.40
2006-02-23	2006	Feb	storetDwr	9.40
2006-02-23	2006	Feb	storetDwr	9.50
2011-02-17	2011	Feb	storetDwr	9.80
2011-02-17	2011	Feb	storetDwr	9.90
2011-02-17	2011	Feb	storetDwr	10.00

DATE	YEAR	MONTH	SOURCE	VALUE
2011-02-17	2011	Feb	storetDwr	10.00

3.7.3.3 Annual Variance

If we can use data from the lake arms, it increases our overall sample size. But if the lake arms are too different from the main lake body, the arm data will add noise to our analysis. We show the data as a full set (by lake unit) and split into the lake (thalweg) versus arm observations.





3.7.3.4 Historic vs Recent Comparison

We compare the data from early years (1986 to 1995) to recent years (2011 to 2020).

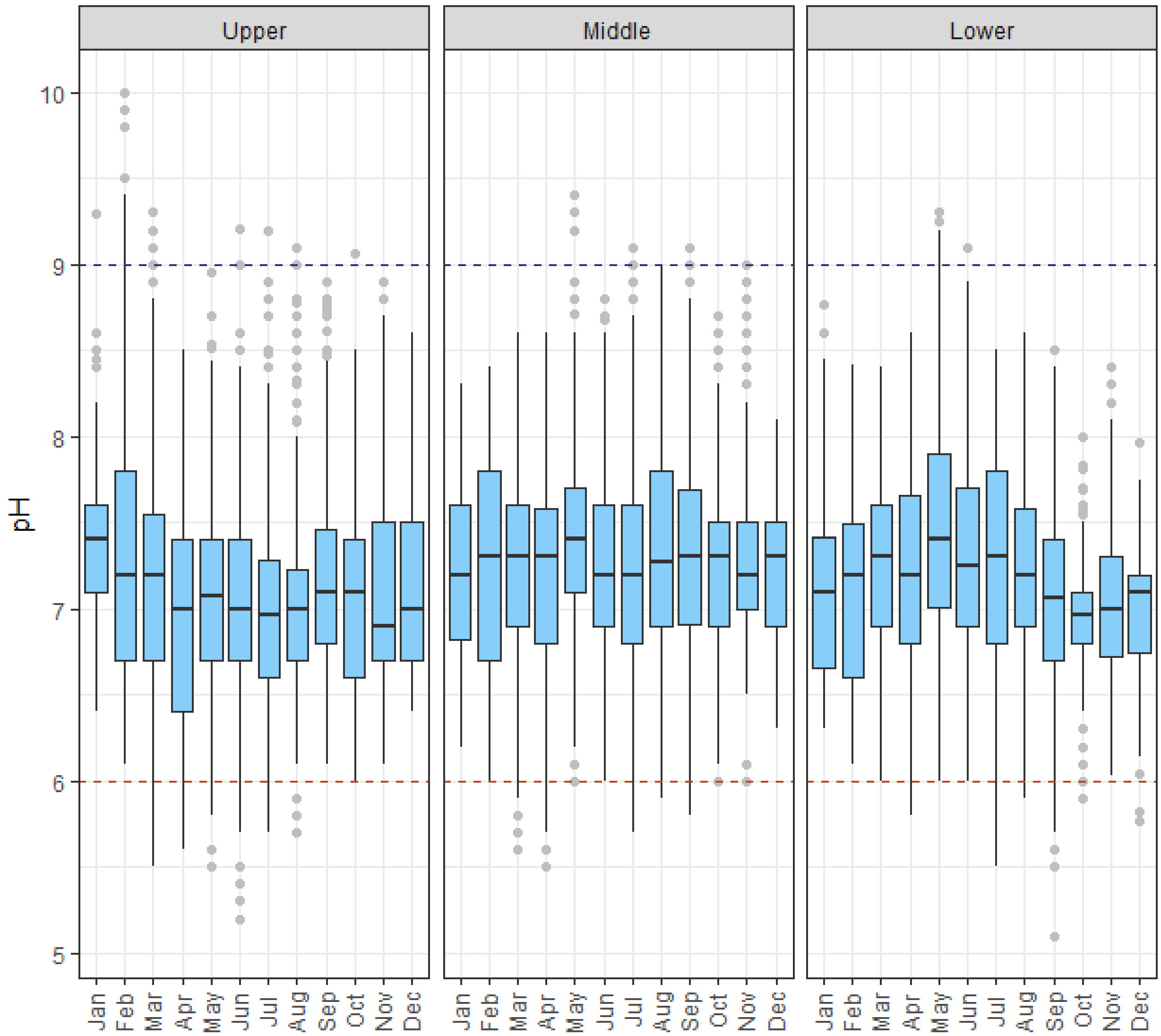
3.7.3.4.1 Mean Values

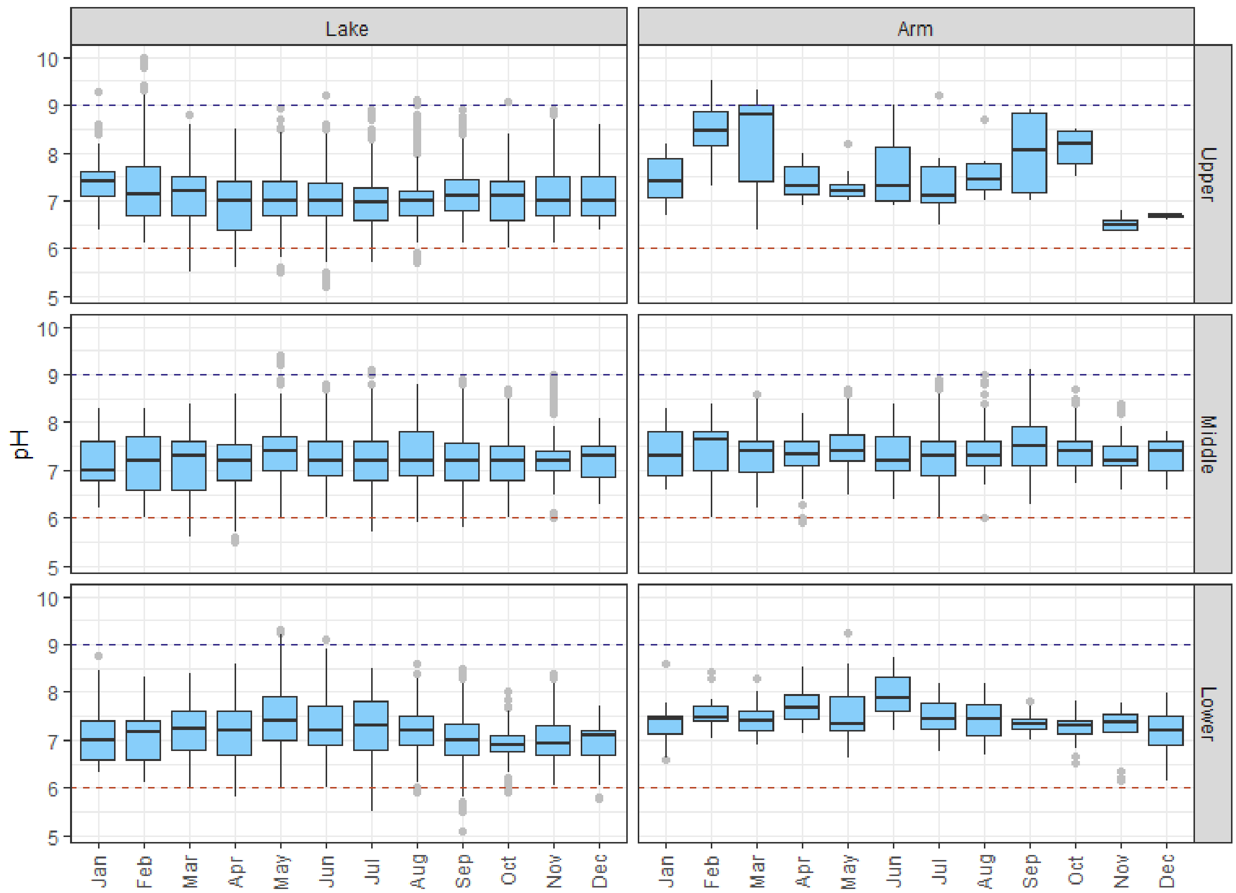
```
## # A tibble: 3 × 3
##   LAKEUNIT HISTORIC RECENT
##   <ord>       <dbl>  <dbl>
## 1 Upper        6.74   7.19
## 2 Middle       6.91   7.4
## 3 Lower        6.85   7.34
```

3.7.3.4.2 SD Values

```
## # A tibble: 3 × 3
##   LAKEUNIT HISTORIC RECENT
##   <ord>       <dbl>  <dbl>
## 1 Upper        0.55   0.58
## 2 Middle       0.61   0.5
## 3 Lower        0.51   0.49
```

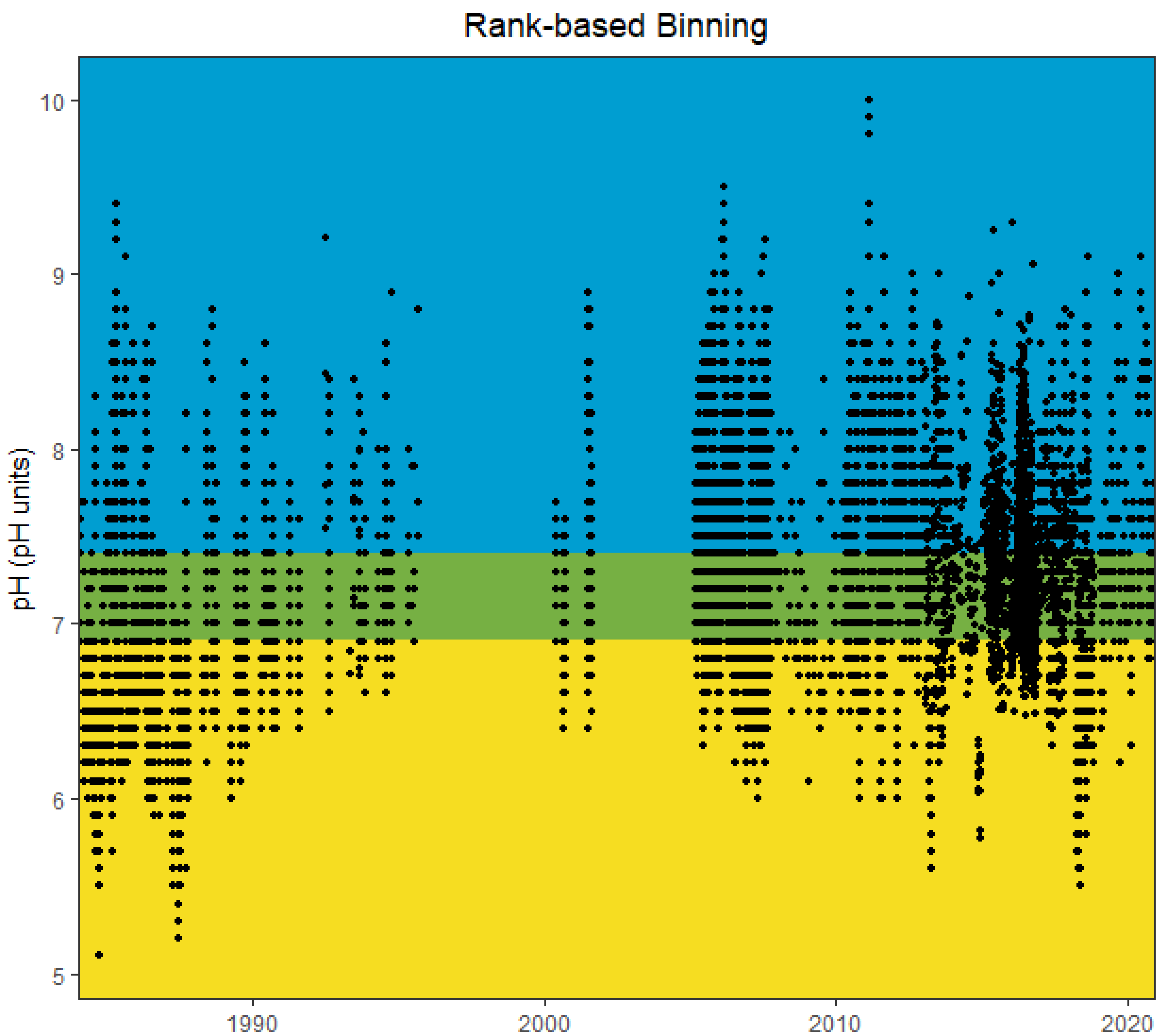
3.7.3.5 Seasonal Trends





3.7.4 Proposed Bins

In the absence of lake water criteria, we propose rank-based bins.



3.7.5 Export Merged Data

The merged data files represent all data gathered to date for this variable. We drop some of the information that was used as qaqc during prep and merging steps: SOURCETYPE, DEPTHTYPE, VARTYPE, VARLABEL. The final merged data are saved as: **tidy_ph.rds** (data) and **tidy_ph_summary.rds** (summary states for LAKEUNIT by MONTH: N, NYears, Mean, SD). Both are also saved to Excel.

The final data include data received from: ralpud, caae, durmCity, storetDwr, storetUsgs.

Code authored by KDV Decision Analysis LLC and last run 2024-09-19 with R version 4.4.1 (2024-06-14 ucrt).

3.8 Data Merge for Secchi Depth

3.8.1 Gather Data Resources

3.8.1.1 List associated files

Secchi Depth data are identified by the **_secchi** suffix.

The available Secchi Depth sources are: caae_secchi.rds, durmCity_secchi.rds, storetDwr_secchi.rds, storetUsgs_secchi.rds.

All data filtered for Falls Lake only

3.8.1.2 CAAE Data

```
##
## 2014 2015 2016 2017 2018
##   81  191  297  296  240

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##  72  75  81  95 104 107 104 118 104  92  84  69

##
##            Falls Lake 1      Falls Lake 1 Channel     Falls Lake 10 Channel
##                      49                        50                        49
##     Falls Lake 11 Channel              Falls Lake 2              Falls Lake 4
##                      50                        48                        48
##            Falls Lake 5              Falls Lake 6      Falls Lake 6 Channel
##                      43                        56                        48
##      Falls Lake 7 Channel      Falls Lake 8 Channel      Falls Lake 9 Channel
##                      49                        49                        50
## Falls Lake Hwy 50 Channel    Falls Lake I85 Channel Falls Lake Intake Channel
##                     180                       164                       168
##            Lick Creek 1
##                       4

##
##      Upper     Middle      Lower Other Lake
##        359        331        415          0
```

This source provides 1105 Secchi Depth records for 16 station ids and 5 years spanning 2014 to 2018.

3.8.1.3 City of Durham

```
##
## 2015 2016 2017 2018
##   57   62   47   57

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##   0   0   0  26  34  32  36  28  29  38   0   0
```

```
##
##    FL-DS4 FL-SR1801
##       113       110

##
##      Upper     Middle      Lower Other Lake
##        223         0         0         0
```

This source provides 223 Secchi Depth records for 2 station ids and 4 years spanning 2015 to 2018.

3.8.1.4 Storet Dwr Data

This source provides 13604 Secchi Depth records for 25 station ids and 25 years spanning 1984 to 2018.

```
##
## 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 2000 2001 2005 2006 2007
##  621  608  628  462  199  239  232  100   51   49   51   98  211  996 1457 1131
## 2010 2011 2012 2013 2014 2015 2016 2017 2018
##  439  694  761  766  805  837  834  811  524

##
##  Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec
##  874  980 1084 1306 1175 1323 1243 1643 1185 1034  915  842

##
## J1250000 J1370000 J1430000 J1590000 J1670000 J1675000 J1715000 J1725000
##      365      368      324      331        9      363      368      351
## J1725010 J1727000 J1740000     LC01     LI01    LLC01   NEU010   NEU013
##        1      382      378      768      523      762      379      708
##  NEU013B NEU0171B  NEU018C  NEU018E  NEU019E  NEU019L  NEU019P  NEU020D
##      823      961      280     1022     1020      973      998     1001
## NEUELL10
##      146

##
##      Upper     Middle      Lower Other Lake
##       3113       6407       4084         0
```

3.8.1.5 Storet USGS Data

This source provides 170 Secchi Depth records for 5 station ids and 10 years spanning 1993 to 2011.

```
##
## 1993 1994 1995 2005 2006 2007 2008 2009 2010 2011
##   16   20    8    9   16   19   24   24   23   11

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##   0  12   4  24   8  28   7  33   4  32   4  14
```

```
##
##   2086920 208703650 208708905 208717595 208718195
##        41        43        43         1        42

##
##      Upper    Middle     Lower Other Lake
##        41        43        86         0
```

3.8.2 Merge Data Sources

In total, we assembled 15102 Secchi Depth records into a single tidy dataframe. This included data from CAAE (1105 records), City of Durham (223 records), Storet DWR (13604 records), and Storet USGS (170 records).`

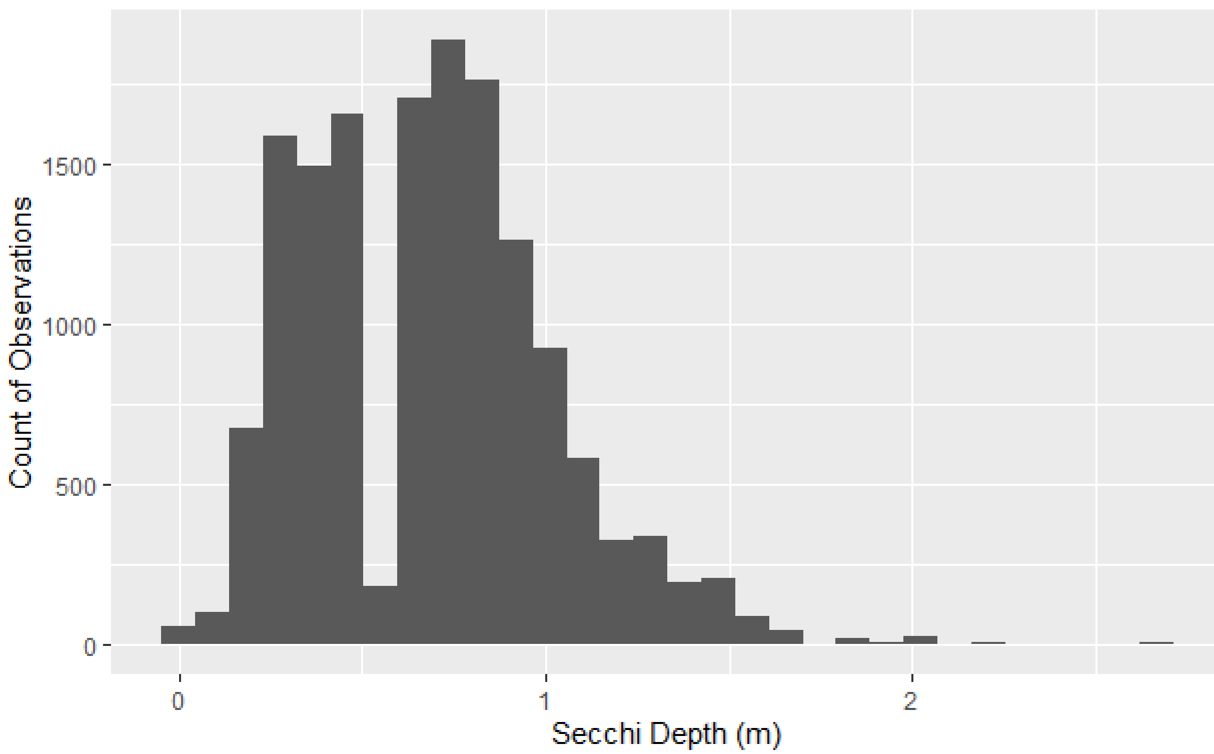
Merge data were qaqc'ed to confirm:

-only one variable is present -no NA values are present -only one measurement unit is present (OR if more that one is present, additional processing is required)

3.8.2.1 Check for and Remove Errors

These data had no values that could be flagged as obvious data errors. There are some extreme values, but we retain these pending review by the SME and TAW teams.

Quantiles	Secchi.value
0%	0.000
10%	0.300
20%	0.400
30%	0.500
40%	0.600
50%	0.700
60%	0.700
70%	0.800
80%	0.900
90%	1.100
100%	2.667



3.8.2.2 Check and Remove Duplicates

All records with duplicate STATIONID, DATE, DEPTHM, and VALUE were treated as duplicated values and one was dropped. With the removal of the older data resources (from earlier 2019 UNRBA data summary report) in favor of updated DWR with more qaqc, there are very few duplicated values.

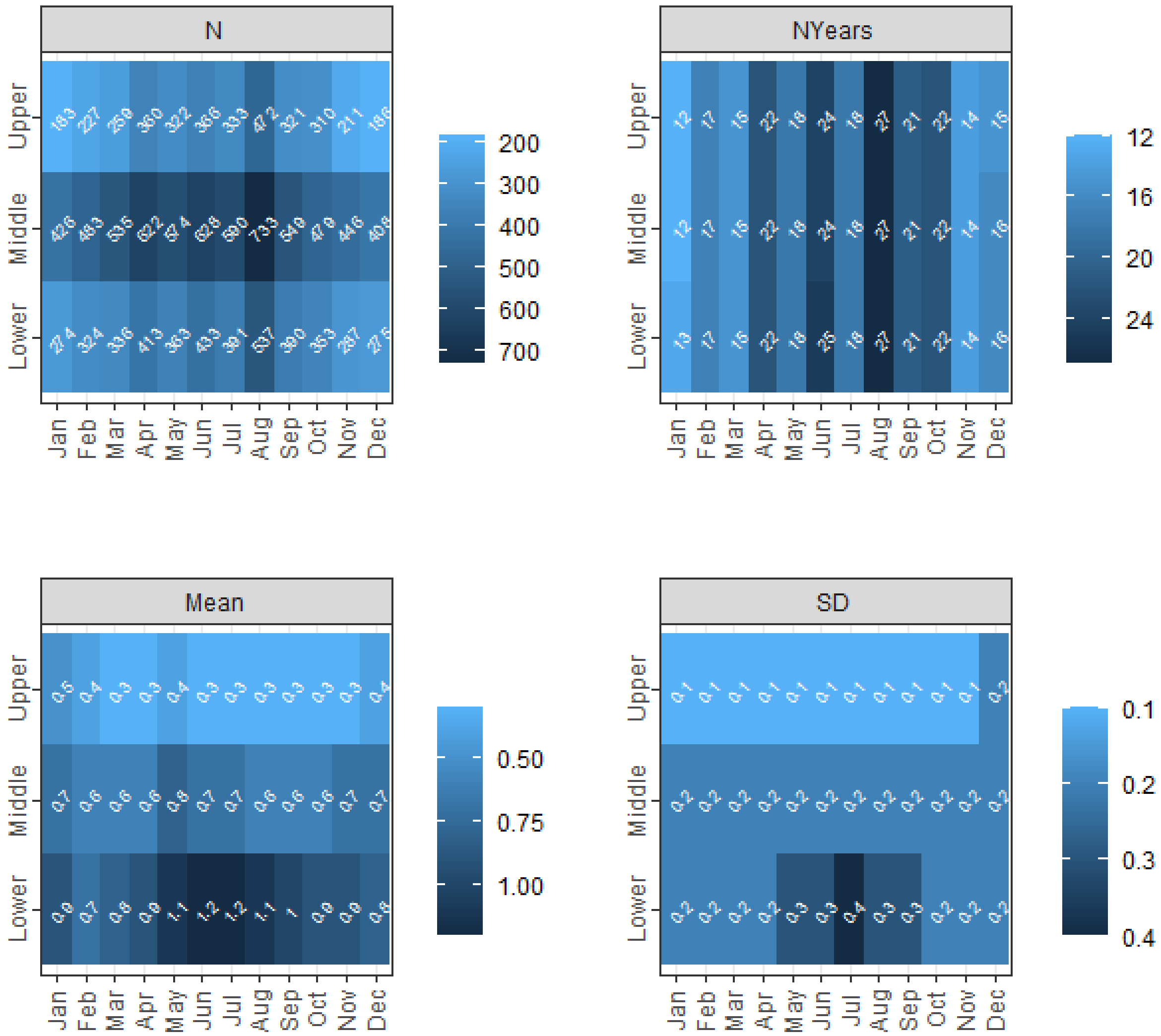
```
##
##      caae  durmCity  storetDwr storetUsgs
##       853       223      13153        170
```

Of all data received (15102 records), after removing easy duplicates there remain 14399.

3.8.3 Data Summaries

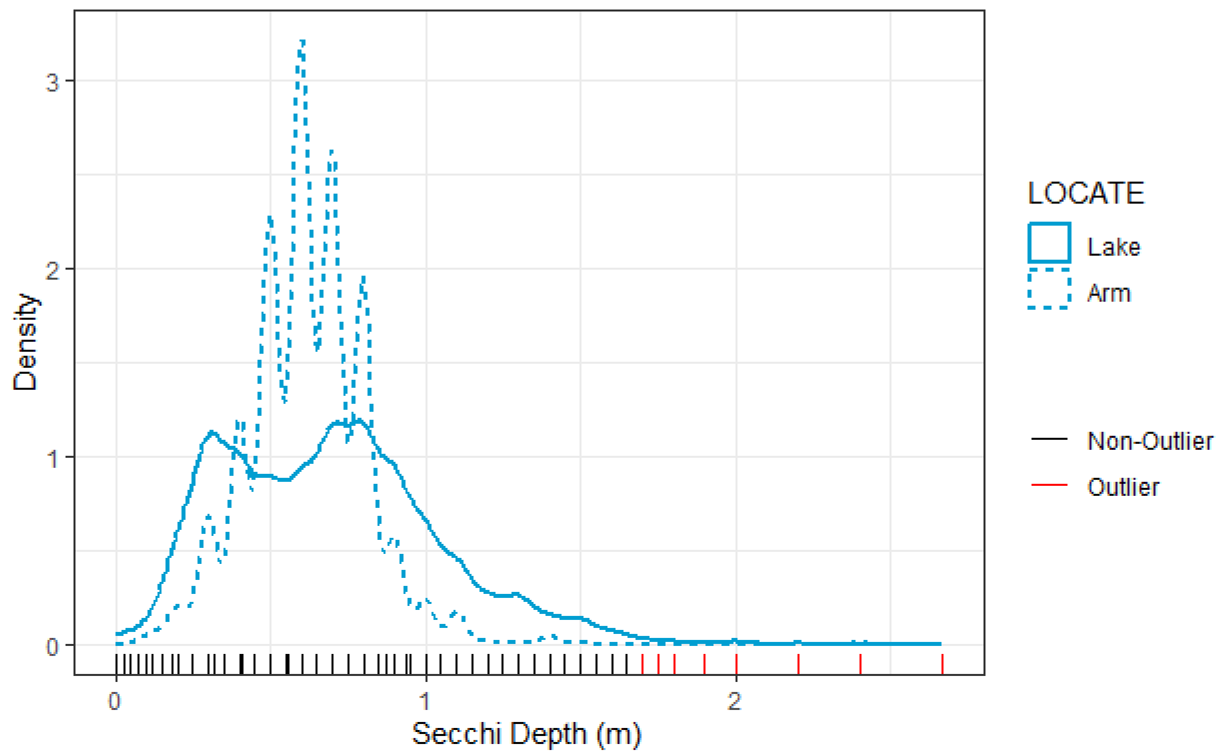
The merged data provide 14399 Secchi Depth records for 48 station ids and 28 years spanning 1984 to 2018.

3.8.3.1 Sample Effort and Values



3.8.3.2 Density Plot and Outliers

The distribution of all lake (thalweg) values is shown as the blue solid line and the lake arm values are shown as the blue dashed line. Below the density plot are rug marks for each observed value. The orange rug marks are values greater than three standard deviations from the overall mean (0.6804979). The SD of all data, thalweg and arms, is 0.3272238. The extreme values (+/- 3SD) are retained for our model project as true, but unusual, values - unless our TAW or SME teams indicate these are data errors.



The 3 SD outlier values identified in this plot are:

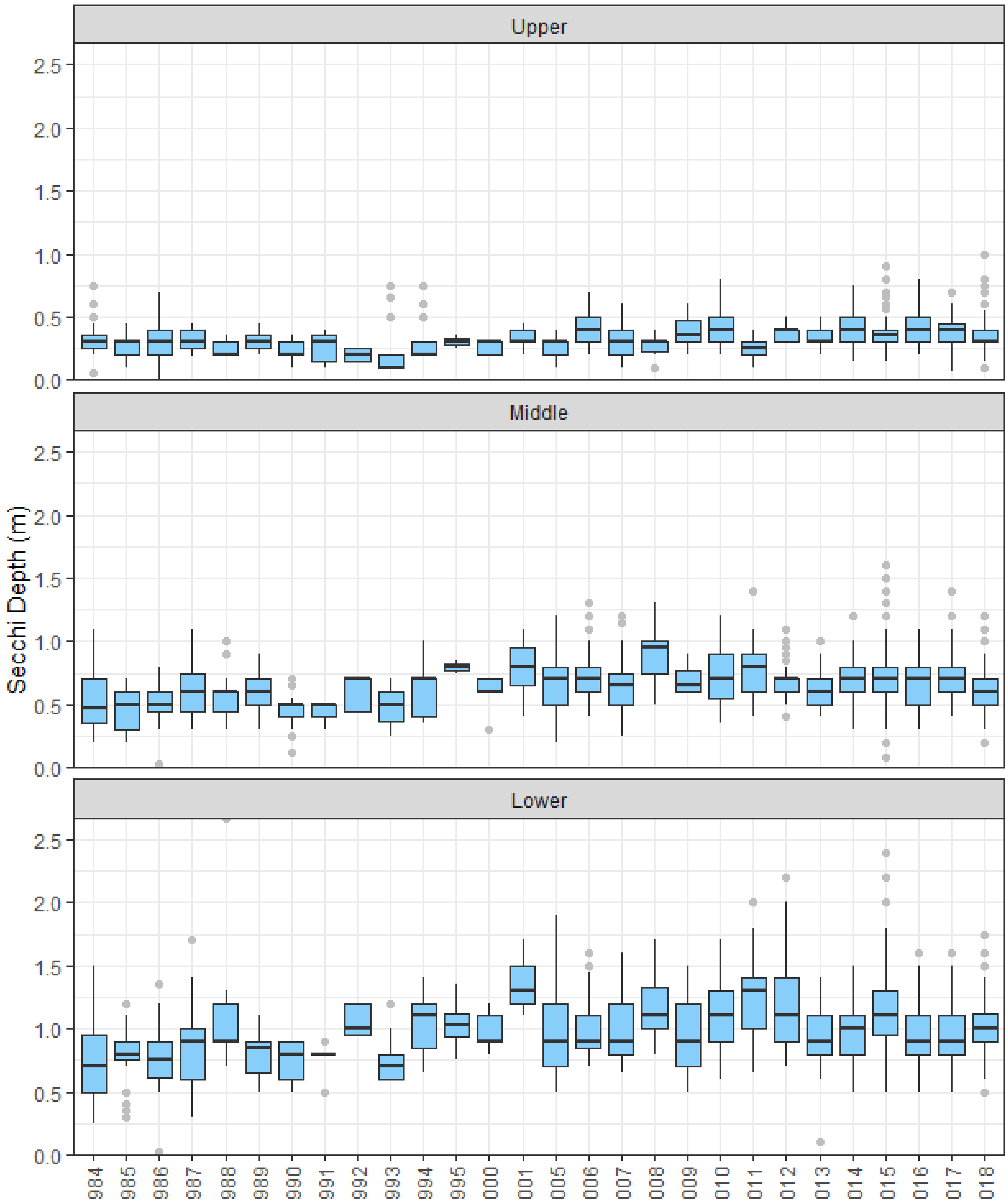
DATE	YEAR	MONTH	SOURCE	VALUE
2015-06-11	2015	Jun	storetDwr	1.700
2015-06-11	2015	Jun	storetDwr	1.700
1987-06-04	1987	Jun	storetDwr	1.700
1987-06-04	1987	Jun	storetDwr	1.700
1987-06-04	1987	Jun	storetDwr	1.700
1987-06-04	1987	Jun	storetDwr	1.700
1987-06-04	1987	Jun	storetDwr	1.700
1987-06-04	1987	Jun	storetDwr	1.700
2015-06-11	2015	Jun	storetDwr	1.700
2015-06-11	2015	Jun	storetDwr	1.700
2015-06-11	2015	Jun	storetDwr	1.700
2015-06-11	2015	Jun	storetDwr	1.700
2015-06-11	2015	Jun	storetDwr	1.700
2015-06-11	2015	Jun	storetDwr	1.700
2015-06-11	2015	Jun	storetDwr	1.700
2015-06-11	2015	Jun	storetDwr	1.700
2015-06-11	2015	Jun	storetDwr	1.700
2015-06-11	2015	Jun	storetDwr	1.700

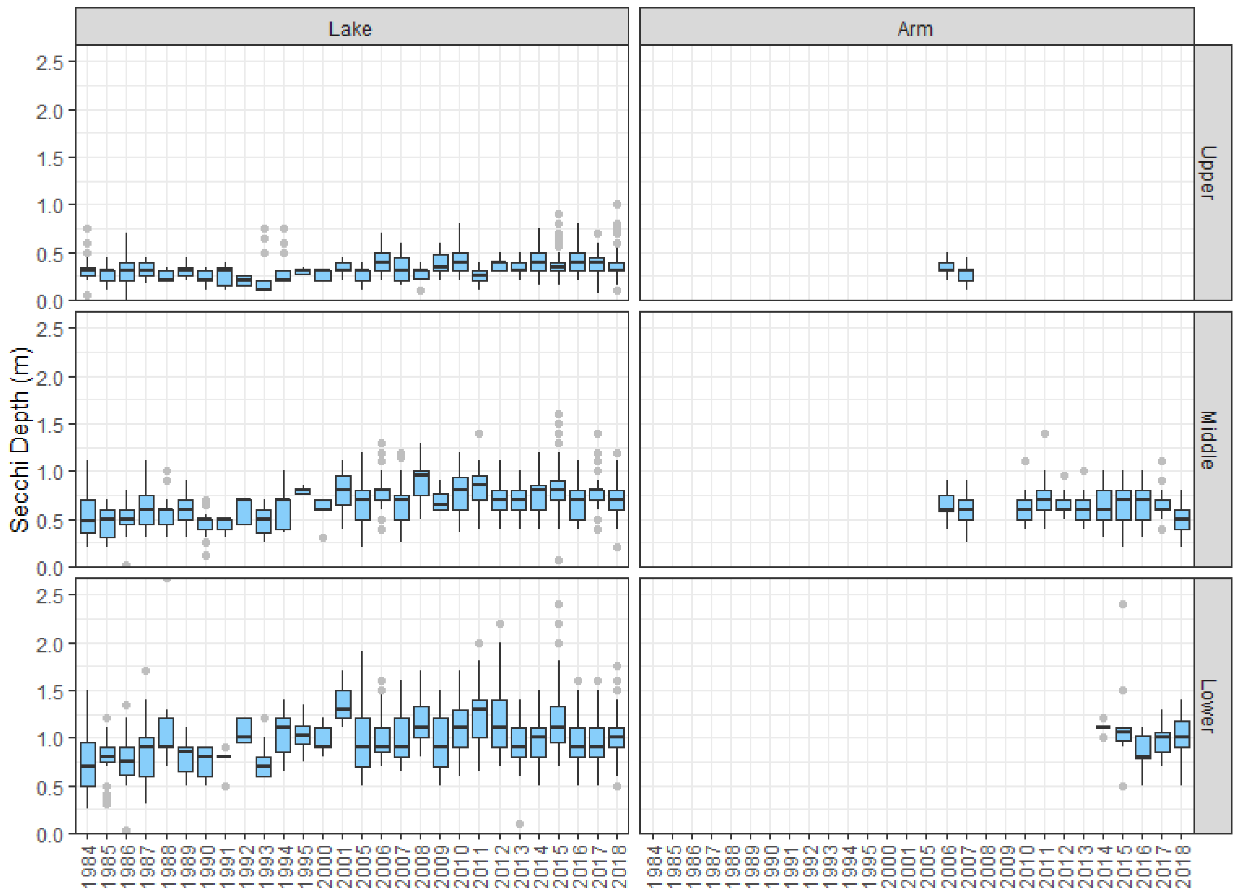
DATE	YEAR	MONTH	SOURCE	VALUE
2005-08-02	2005	Aug	storetUsgs	1.700
2008-06-18	2008	Jun	storetUsgs	1.700
2008-08-19	2008	Aug	storetUsgs	1.700
2010-08-11	2010	Aug	storetUsgs	1.700
2001-07-25	2001	Jul	storetDwr	1.700
2001-07-25	2001	Jul	storetDwr	1.700
2001-07-25	2001	Jul	storetDwr	1.700
2001-07-25	2001	Jul	storetDwr	1.700
2001-07-25	2001	Jul	storetDwr	1.700
2001-07-25	2001	Jul	storetDwr	1.700
2018-07-25	2018	Jul	caae	1.750
2005-08-16	2005	Aug	storetDwr	1.800
2005-08-16	2005	Aug	storetDwr	1.800
2005-08-16	2005	Aug	storetDwr	1.800
2005-08-16	2005	Aug	storetDwr	1.800
2005-08-16	2005	Aug	storetDwr	1.800
2005-08-16	2005	Aug	storetDwr	1.800
2011-05-10	2011	May	storetDwr	1.800
2015-06-11	2015	Jun	storetDwr	1.800
2011-05-10	2011	May	storetDwr	1.800
2011-05-10	2011	May	storetDwr	1.800
2011-05-10	2011	May	storetDwr	1.800
2011-05-10	2011	May	storetDwr	1.800
2011-05-10	2011	May	storetDwr	1.800
2015-06-11	2015	Jun	storetDwr	1.800
2015-06-11	2015	Jun	storetDwr	1.800
2015-06-11	2015	Jun	storetDwr	1.800
2015-06-11	2015	Jun	storetDwr	1.800
2015-06-11	2015	Jun	storetDwr	1.800
2005-07-06	2005	Jul	storetDwr	1.900
2005-07-06	2005	Jul	storetDwr	1.900
2005-07-06	2005	Jul	storetDwr	1.900
2005-07-06	2005	Jul	storetDwr	1.900
2005-07-06	2005	Jul	storetDwr	1.900
2005-07-06	2005	Jul	storetDwr	1.900

DATE	YEAR	MONTH	SOURCE	VALUE
2015-07-09	2015	Jul	caae	2.000
2015-10-01	2015	Oct	caae	2.000
2015-07-09	2015	Jul	caae	2.000
2015-10-01	2015	Oct	caae	2.000
2015-06-24	2015	Jun	caae	2.000
2015-07-09	2015	Jul	caae	2.000
2012-09-11	2012	Sep	storetDwr	2.000
2012-09-11	2012	Sep	storetDwr	2.000
2011-07-12	2011	Jul	storetDwr	2.000
2012-09-11	2012	Sep	storetDwr	2.000
2012-09-11	2012	Sep	storetDwr	2.000
2012-09-11	2012	Sep	storetDwr	2.000
2012-09-11	2012	Sep	storetDwr	2.000
2012-09-11	2012	Sep	storetDwr	2.000
2012-09-11	2012	Sep	storetDwr	2.000
2012-09-11	2012	Sep	storetDwr	2.000
2012-09-11	2012	Sep	storetDwr	2.000
2011-07-12	2011	Jul	storetDwr	2.000
2011-07-12	2011	Jul	storetDwr	2.000
2011-07-12	2011	Jul	storetDwr	2.000
2011-07-12	2011	Jul	storetDwr	2.000
2015-10-01	2015	Oct	caae	2.200
2012-09-11	2012	Sep	storetDwr	2.200
2012-09-11	2012	Sep	storetDwr	2.200
2012-09-11	2012	Sep	storetDwr	2.200
2012-09-11	2012	Sep	storetDwr	2.200
2012-09-11	2012	Sep	storetDwr	2.200
2015-10-01	2015	Oct	caae	2.400
2015-10-01	2015	Oct	caae	2.400
1988-06-01	1988	Jun	storetDwr	2.667
1988-06-01	1988	Jun	storetDwr	2.667
1988-06-01	1988	Jun	storetDwr	2.667
1988-06-01	1988	Jun	storetDwr	2.667
1988-06-01	1988	Jun	storetDwr	2.667

3.8.3.3 Annual Variance

If we can use data from the lake arms, it increases our overall sample size. But if the lake arms are too different from the main lake body, the arm data will add noise to our analysis. We show the data as a full set (by lake unit) and split into the lake (thalweg) versus arm observations.

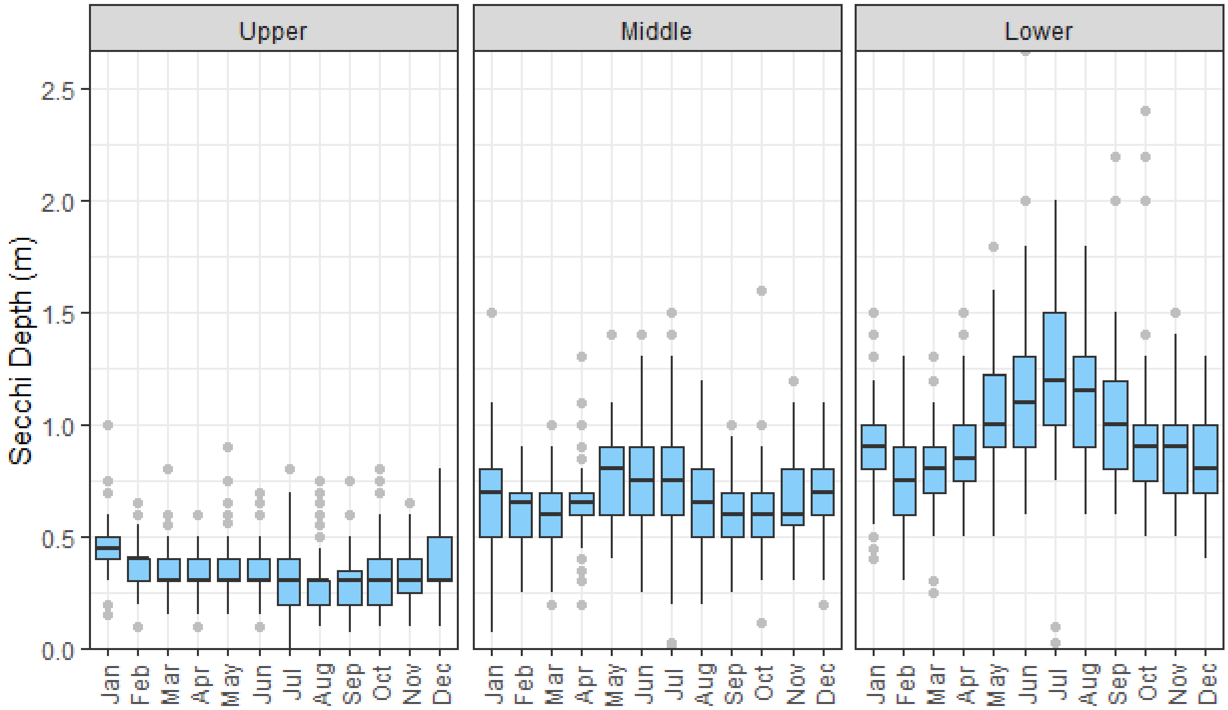


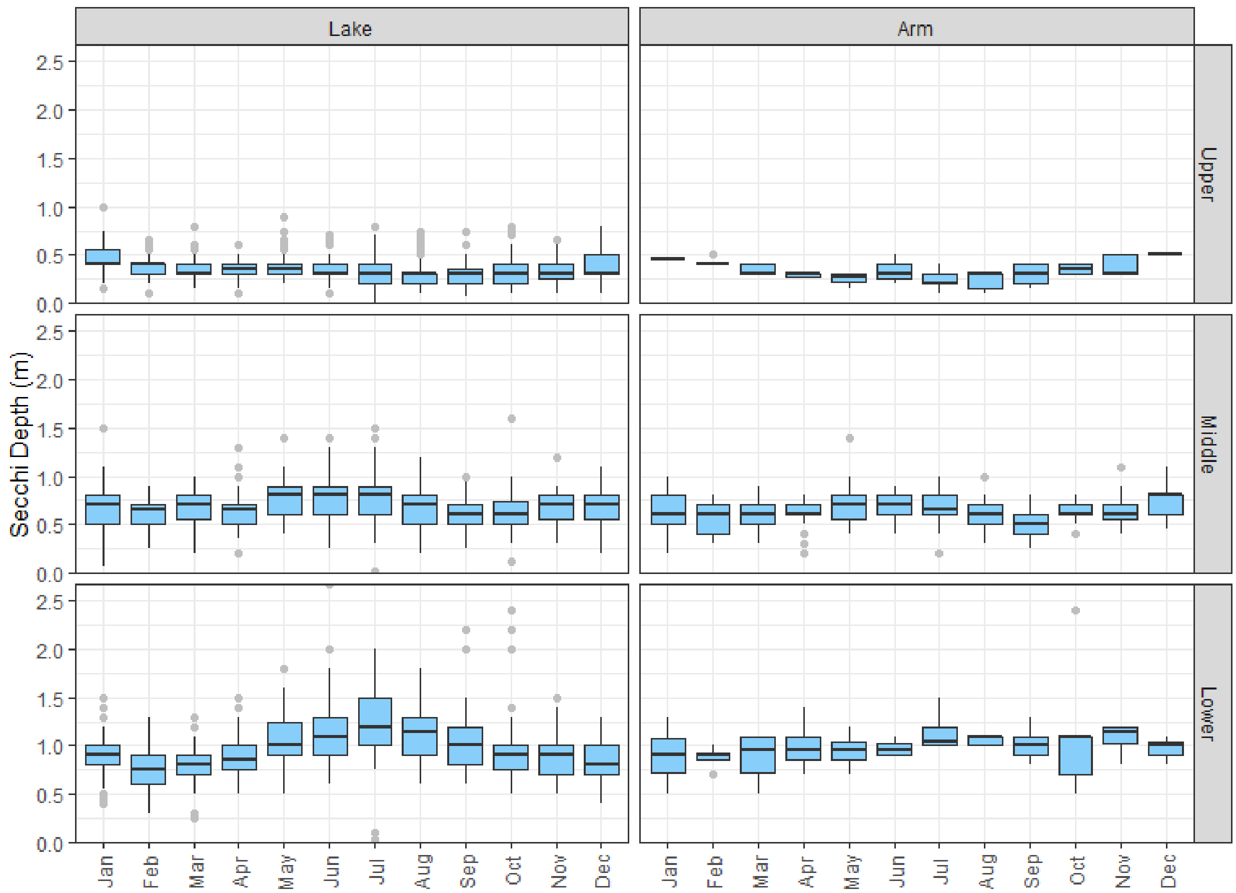


3.8.3.4 Historic versus Recent Comparison

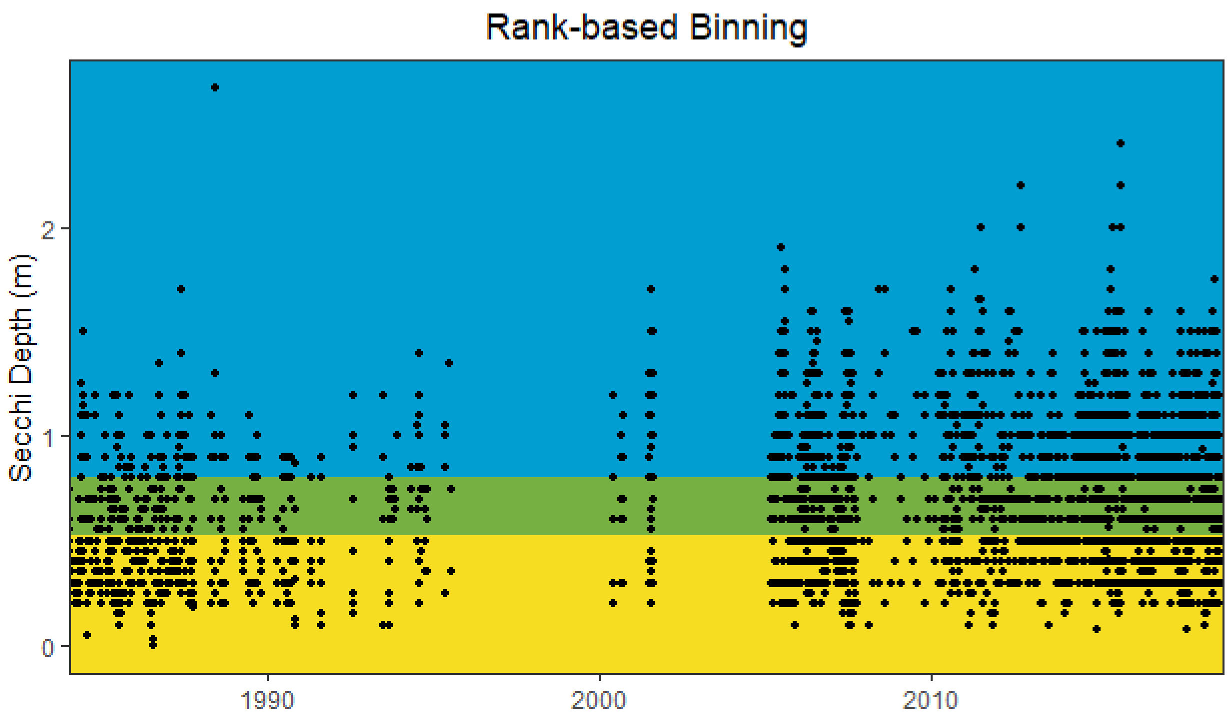
```
## # A tibble: 3 × 5
##   LAKEUNIT MEAN.historical SD.historical MEAN.recent SD.recent
##   <ord>              <dbl>         <dbl>       <dbl>     <dbl>
## 1 Upper               0.28          0.12        0.37      0.13
## 2 Middle              0.53          0.18        0.7       0.19
## 3 Lower               0.82          0.29        1.05      0.3
```

3.8.3.5 Seasonal Trends





Alternative Bins



The rank based bins use cut-points: -, 0.525, 0.8, .

3.8.4 Export Merged Data

The merged data files represent all data gathered to date for this variable. We drop some of the information that was used as qaqc during prep and merging steps: SOURCETYPE, DEPTHTYPE, VARTYPE, VARLABEL. The final merged data are saved as: **tidy_secchi.rds** (data) and **tidy_secchi_summary.rds** (summary states for LAKEUNIT by MONTH: N, NYears, Mean, SD). Both are also saved to Excel.

The final data include data received from: caae, durmCity, storetDwr, storetUsgs.

Code authored by KDV Decision Analysis LLC and last run 2024-09-19 with R version 4.4.1 (2024-06-14 ucrt).

3.9 Data of Merge Total Organic Carbon

3.9.1 Gather Data Resources

3.9.1.1 List Associated Files

Total Organic Carbon data are identified by the **_toc** suffix.

```
## [1] "caae_toc.rds"      "durmCity_toc.rds"   "extraToc_toc.rds"
## [4] "ralpud_toc.rds"     "raltoc_toc.rds"     "storetDwr_toc.rds"
## [7] "storetUsgs_toc.rds"
```

The available Total Organic Carbon data sources are: caae_toc.rds, durmCity_toc.rds, extraToc_toc.rds, ralpud_toc.rds, raltoc_toc.rds, storetDwr_toc.rds, storetUsgs_toc.rds.

3.9.1.2 City of Raleigh (ralpud and raltoc)

Raleigh data came in a number of files at different times.

3.9.1.3 Extra TOC (extratoc_raltoc)

3.9.1.4 Merge Raleigh Data

```
## [1] TRUE

## [1] TRUE

##
##   Honeycutt Creek        Intake 223        Intake 233        Intake 243
##               69                61                61                61
##    Intake Surface Lower Barton Creek    New Light Creek Upper Barton Creek
##             1785                69                68                69
##         US Hwy 98
##               68

##
##     Upper     Middle      Lower Other Lake
##         0         0       2311          0

##
## 2000 2001 2002 2003 2004 2007 2008 2009 2010 2011 2013 2014 2015 2016 2017 2018
##   11   11   11   12   11    1   10    5   10    9  115  118  112  121  126  424
## 2019 2020 2021 2022
##  365  373  379   87

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
## 216 193 200 185 188 190 191 195 193 192 182 186
```

This source provides 2311 Total Organic Carbon records for 9 station ids and 20 years spanning 2000 to 2022.

3.9.1.5 Center for Applied Aquatic Ecology NCSU (caae)

```
##
##          Falls Lake 1            Falls Lake 2            Falls Lake 4
##                    24                      24                      24
##          Falls Lake 5            Falls Lake 6 Falls Lake Hwy 50 Channel
##                    22                      28                      48
##   Falls Lake I85 Channel Falls Lake Intake Channel
##                    41                      42

##
##     Upper     Middle      Lower Other Lake
##       115         72         66          0
```

```
##
## 2016 2017 2018
##   83   97   73

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##  14  15  15  24  29  31  29  28  23  15  17  13
```

This source provides 253 Total Organic Carbon records for 8 station ids and 3 years spanning 2016 to 2018.

3.9.1.6 City of Durham (durmCity)

```
##
##    FL-DS4 FL-SR1801
##       117       118

##
##      Upper     Middle      Lower Other Lake
##        235          0          0          0

##
## 2015 2016 2017 2018
##   63   58   52   62

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##   0   0   0  29  37  36  40  31  31  31   0   0
```

This source provides 235 Total Organic Carbon records for 2 station ids and 4 years spanning 2015 to 2018.

3.9.1.7 Storet DWR data (storetDwr)

```
##
##     LC01     LI01    LLC01   NEU010   NEU013  NEU013B NEU0171B  NEU018C
##      126       88      125       59      111      146      172       47
##  NEU018E  NEU019E  NEU019L  NEU019P  NEU020D NEUELL10
##      167      168      147      148      146       36

##
##      Upper     Middle      Lower Other Lake
##        352        893        441          0

##
## 2005 2006 2007 2011 2012 2013 2014 2015 2016 2017 2018
##  171  272  231   93  130  125  130  141  142  144  107

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
## 122 129 147 154 159 160 146 164 141 131 122 111
```

This source provides 1686 Total Organic Carbon records for 14 station ids and 11 years spanning 2005 to 2018.

3.9.1.8 Storet USGS data (storetUsgs)

```
##
##   2086920 208703650 208708905 208717595 208718195
##        41        43        43         1        42
##
##     Upper    Middle     Lower Other Lake
##        41        43        86          0
##
## 1993 1994 1995 2005 2006 2007 2008 2009 2010 2011
##   16   19    8    9   16   19   24   24   23   12
##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##   0  12   4  24   8  28   7  33   4  32   4  14
```

3.9.1.9 Extra TOC (extratoc_raltoc and extratoc_storetUsgs)

```
##
##   2086920 208703650 208708905 208717595 208718195      LC01      LI01     LLC01
##         5        17        21         1        20        15         3        13
##    NEU010    NEU013   NEU013B  NEU0171B   NEU018E   NEU019E   NEU019L   NEU019P
##         5         3         8        20        23        28        29        27
##   NEU020D  NEUELL10
##        28         2
##
##     Upper    Middle     Lower Other Lake
##        23       119       126          0
##
## 1993 1994 1995 2005 2006 2007 2011 2012 2013 2014 2015 2016 2017 2018
##   13   14    6   53   83   78    1    2    1    2    2    1    6    6
##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##  15  24  28  30  22  31  18  32  17  28  14   9
```

This source provides 268 Total Organic Carbon records for 18 station ids and 14 years spanning 1993 to 2018.

```
## [1] TRUE

## [1] TRUE
```

The full USGS datasource provides 438 Total Organic Carbon records for 18 station ids and 17 years spanning 1993 to 2018.

3.9.2 Merge Data Sources

In total, we assembled 4923 Total Organic Carbon records. into a single tidy dataframe. This included data from the City of Raleigh (2311 records), CAAE (253 records), City of Durham (235 records), Storet DWR (1686 records), Storet USGS (438 records).

Merged data were qaqc'd to confirm:

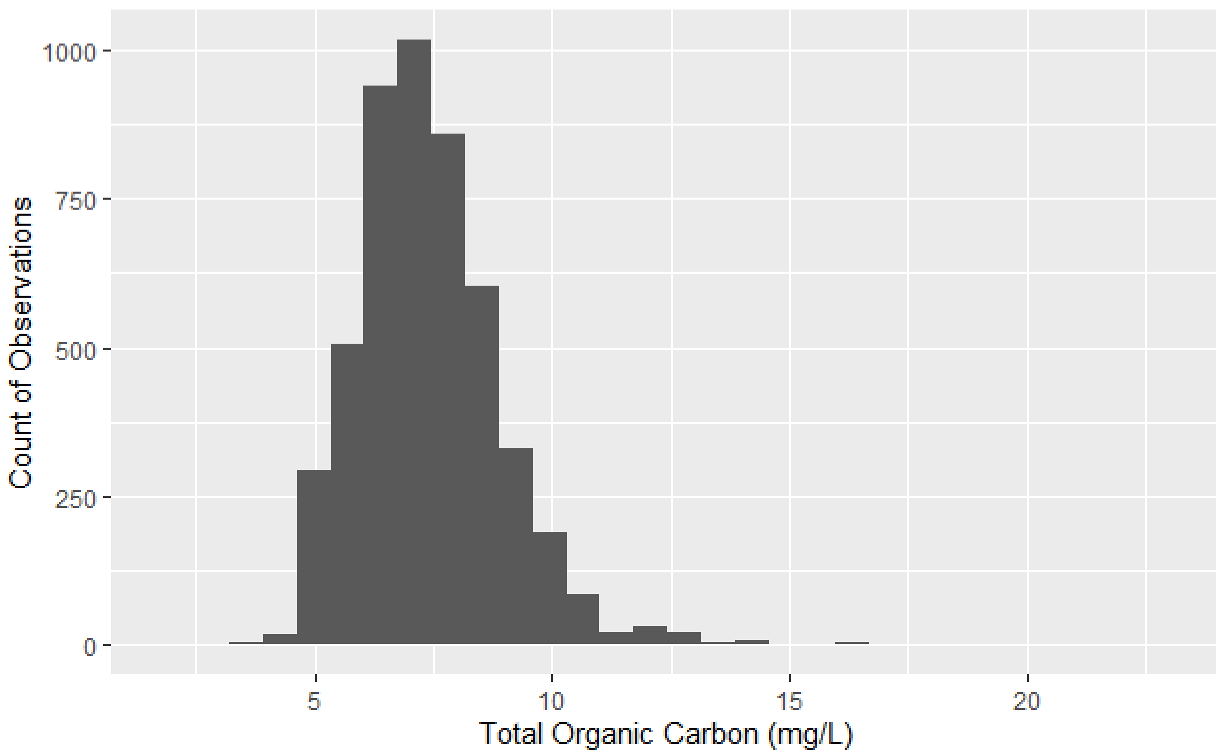
- only one variable is present
- no NA values are present
- only one measurement unit is present (OR if more than one is present, additional processing is required)

```
## # A tibble: 8 × 6
##   SOURCE                  N NStations NYears MinYear MaxYear
##   <chr>               <int>     <int>  <int>   <dbl>   <dbl>
## 1 caae                  253         8      3    2016    2018
## 2 durmCity              235         2      4    2015    2018
## 3 extratoc_raltoc       215         1     20    2000    2022
## 4 extratoc_storetUsgs   268        18     14    1993    2018
## 5 ralpud                595         9      6    2013    2018
## 6 raltoc               1501         1      5    2018    2022
## 7 storetDwr            1686        14     11    2005    2018
## 8 storetUsgs            170         5     10    1993    2011
```

3.9.2.1 Check for and Remove Error Entries

We examined the distribution and highest values to check for data entry errors appearing as implausibly high values.

Quantiles	TOC.value
0%	2.40
10%	5.63
20%	6.20
30%	6.56
40%	6.90
50%	7.22
60%	7.60
70%	8.00
80%	8.47
90%	9.20
100%	23.00




```
##   LAKEUNIT YEAR MONTH VALUE
## 1    Upper 1994   Jun  16.0
## 2    Upper 1994   Sep  23.0
## 3    Upper 2007   Aug  16.0
## 4    Upper 2008   Aug  15.3
## 5    Lower 2018   Apr  20.0
## 6    Lower 2019   Feb  16.0
```

Based on a quick examination of the data, none of these data values were removed.

3.9.2.2 Check for and Remove Duplicates

All records with equal DATE, STATIONID, DEPTHM, and VALUE are treated as duplicates are dropped. With the removal of the older data resources (from earlier 2019 UNRBA data summary report) in favor of updated DWR with more qaqc, there were very few duplicated values. However, with the addition of the mixed source extraToc data, there are numerous duplicated values from the extratoc_storetUsgs source. These data came from the 3rd sheet of the file FallsLakeTOC.xlsx, titled "WQPortal".

```
## 
##                caae            durmCity     extratoc_raltoc extratoc_storetUsgs 
##                 253                 235                 204                 138 
##              ralpud              raltoc           storetDwr          storetUsgs 
##                 595                1501                1686                 170
```

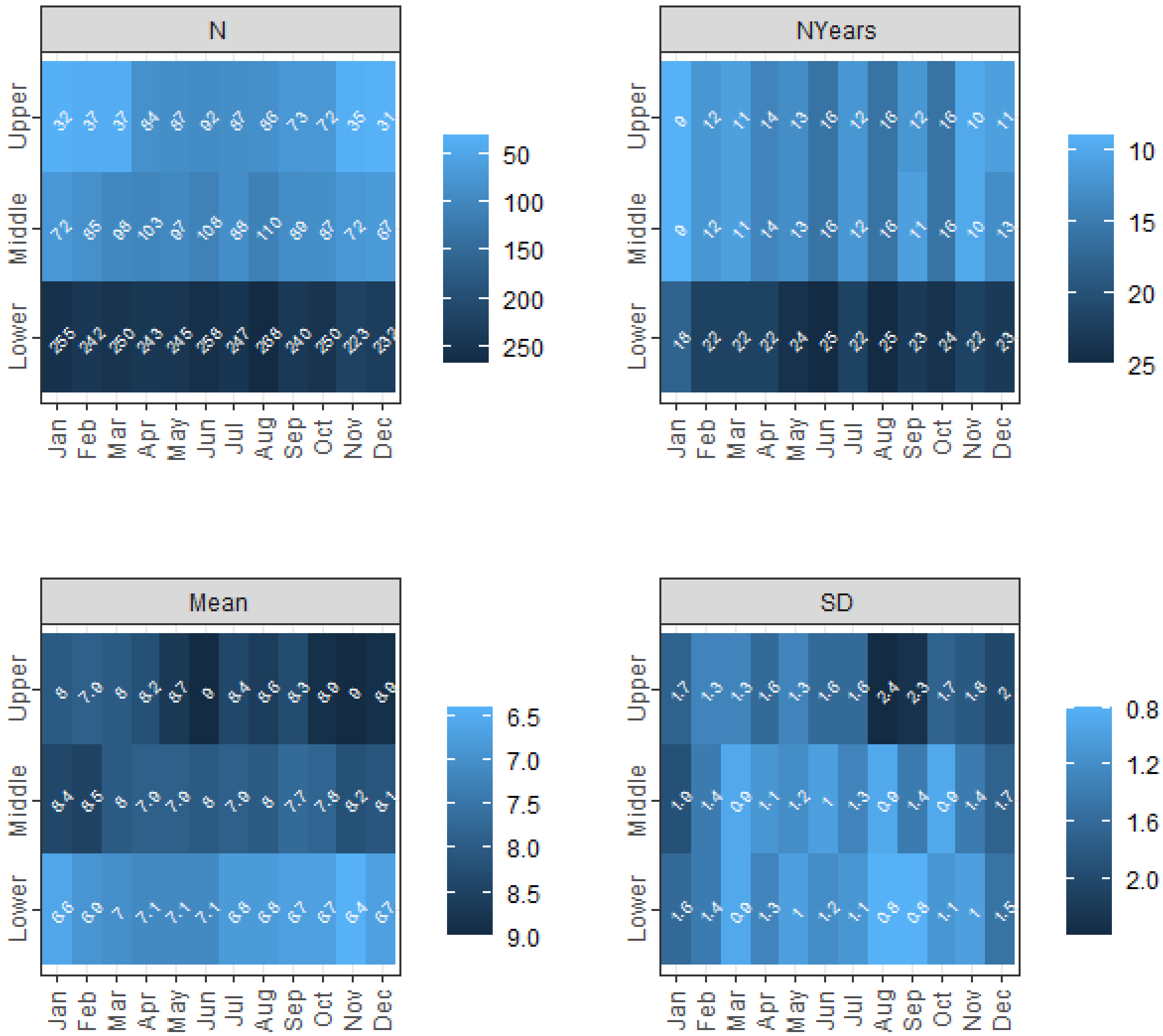
Of all data received (4923 records), there are 141 duplicates (shared DATE, STATIONID, DEPTHM, and measured VALUE). There are 4782 remaining observations.

```
## # A tibble: 8 × 6
##   SOURCE                 N NStations NYears MinYear MaxYear
##   <chr>              <int>     <int>  <int>   <dbl>   <dbl>
## 1 caae                 253         8      3    2016    2018
## 2 durmCity             235         2      4    2015    2018
## 3 extratoc_raltoc      204         1     20    2000    2022
## 4 extratoc_storetUsgs  138        11      3    2005    2007
## 5 ralpud               595         9      6    2013    2018
## 6 raltoc              1501         1      5    2018    2022
## 7 storetDwr           1686        14     11    2005    2018
## 8 storetUsgs           170         5     10    1993    2011
```

3.9.3 Data Summaries

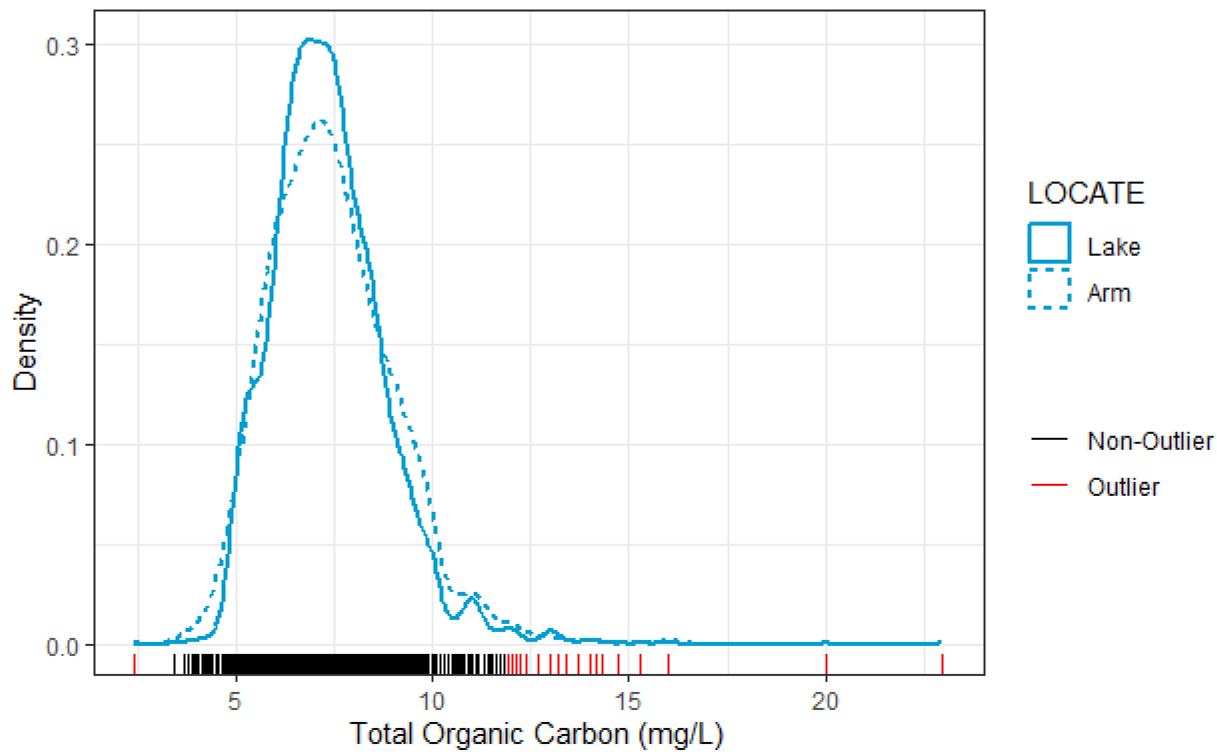
The merged data provide 4782 Total Organic Carbon records for 38 station ids and 26 years spanning 1993 to 2022.

3.9.3.1 Sample Effort and Values



3.9.3.2 Density Plot and Outliers

The distribution of all lake (thalweg) values is shown as the blue solid line and the lake arm values are shown as the blue dashed line. Below the density plot are rug marks for each observed value. The orange rug marks are values greater than three standard deviations from the overall mean (7.3680159). The SD of all data, thalweg and arms, is 1.4888556. The extreme values (+/- 3SD) are retained for our model project as true, but unusual, values - unless our TAW or SME teams indicate these are data errors.



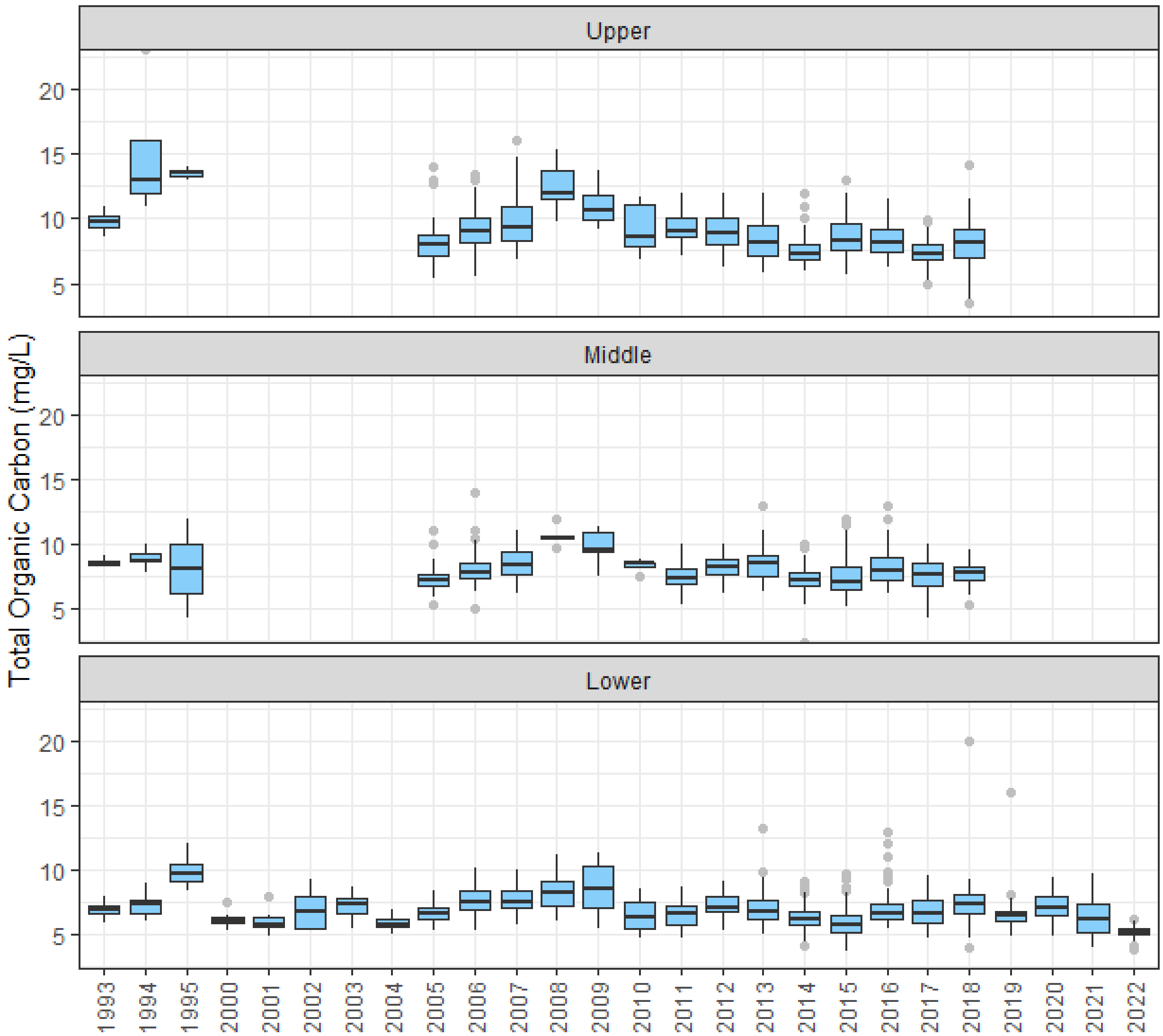
The 3 SD outlier values identified in this plot are:

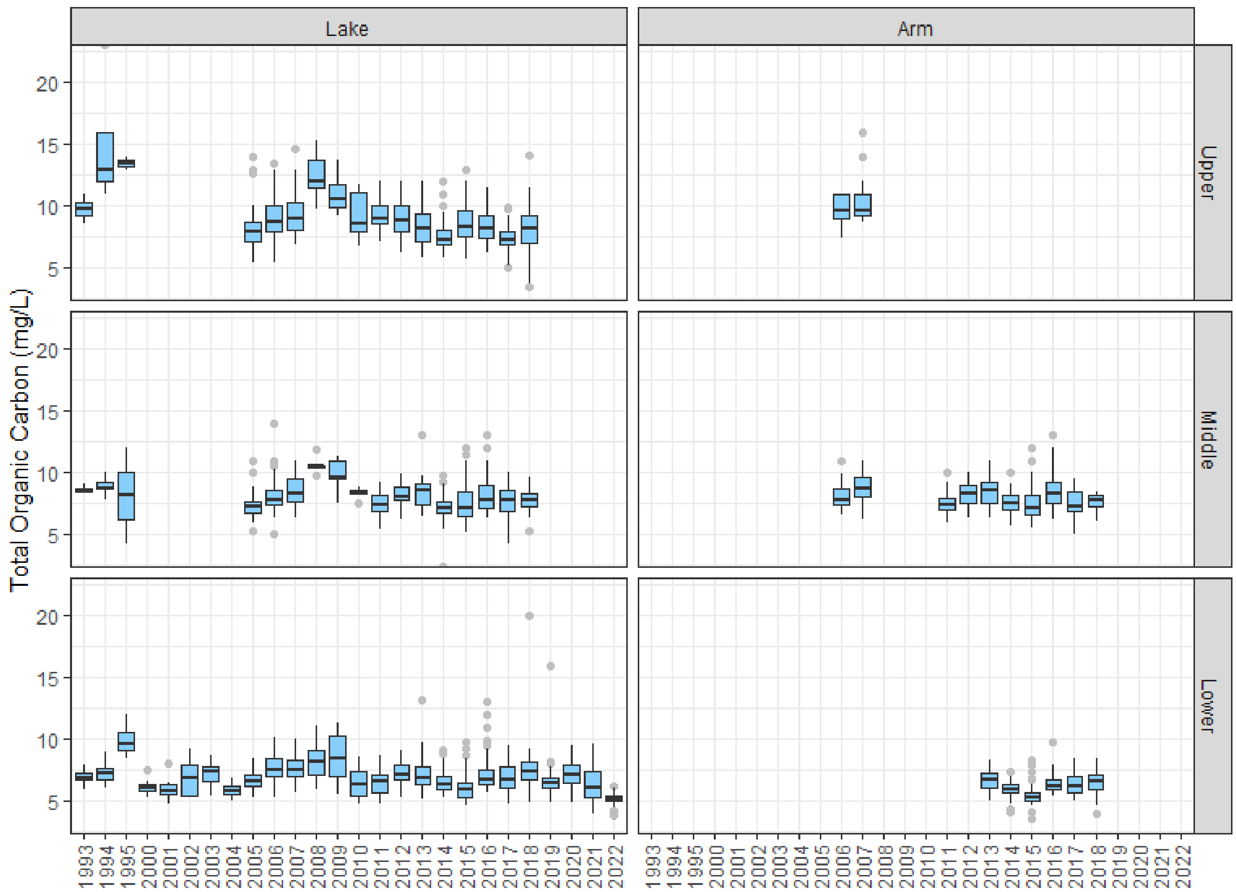
DATE	YEAR	MONTH	SOURCE	VALUE
2014-02-24	2014	Feb	storetDwr	2.40
2008-10-14	2008	Oct	storetUsgs	11.90
2015-09-10	2015	Sep	durmCity	12.00
2016-02-09	2016	Feb	storetDwr	12.00
2016-02-09	2016	Feb	storetDwr	12.00
2015-11-16	2015	Nov	storetDwr	12.00
2015-12-01	2015	Dec	storetDwr	12.00
2016-01-26	2016	Jan	storetDwr	12.00
2012-04-03	2012	Apr	storetDwr	12.00
2013-07-17	2013	Jul	storetDwr	12.00
2007-08-09	2007	Aug	storetDwr	12.00
2014-06-05	2014	Jun	storetDwr	12.00
2015-12-01	2015	Dec	storetDwr	12.00
2016-02-09	2016	Feb	storetDwr	12.00
2016-02-09	2016	Feb	storetDwr	12.00
2007-01-04	2007	Jan	storetDwr	12.00
2007-06-13	2007	Jun	storetUsgs	12.00
1994-05-04	1994	May	storetUsgs	12.00

DATE	YEAR	MONTH	SOURCE	VALUE
2011-06-22	2011	Jun	storetUsgs	12.00
1995-07-12	1995	Jul	storetUsgs	12.00
1995-07-12	1995	Jul	storetUsgs	12.00
2009-06-23	2009	Jun	storetUsgs	12.10
2008-06-17	2008	Jun	storetUsgs	12.20
2006-07-11	2006	Jul	storetUsgs	12.40
2005-08-04	2005	Aug	storetUsgs	12.70
2016-01-26	2016	Jan	storetDwr	13.00
2016-01-26	2016	Jan	storetDwr	13.00
2005-12-06	2005	Dec	storetDwr	13.00
2006-06-05	2006	Jun	storetDwr	13.00
2007-08-09	2007	Aug	storetDwr	13.00
2015-11-16	2015	Nov	storetDwr	13.00
2005-12-06	2005	Dec	storetDwr	13.00
2015-11-16	2015	Nov	storetDwr	13.00
2016-01-26	2016	Jan	storetDwr	13.00
2016-01-26	2016	Jan	storetDwr	13.00
2013-07-17	2013	Jul	storetDwr	13.00
2016-01-26	2016	Jan	storetDwr	13.00
2016-01-26	2016	Jan	storetDwr	13.00
2016-01-26	2016	Jan	storetDwr	13.00
1995-05-05	1995	May	storetUsgs	13.00
1994-08-09	1994	Aug	storetUsgs	13.00
2013-06-24	2013	Jun	ralpud	13.18
2006-08-24	2006	Aug	storetUsgs	13.40
2009-08-10	2009	Aug	storetUsgs	13.70
2005-12-06	2005	Dec	storetDwr	14.00
2006-09-06	2006	Sep	storetDwr	14.00
2007-07-26	2007	Jul	storetDwr	14.00
1995-07-17	1995	Jul	storetUsgs	14.00
2018-04-25	2018	Apr	storetDwr	14.15
2008-10-14	2008	Oct	storetUsgs	14.30
2007-08-15	2007	Aug	storetUsgs	14.70
2008-08-20	2008	Aug	storetUsgs	15.30
2019-02-01	2019	Feb	raltoc	16.00

DATE	YEAR	MONTH	SOURCE	VALUE
2007-08-09	2007	Aug	storetDwr	16.00
1994-06-30	1994	Jun	storetUsgs	16.00
2018-04-25	2018	Apr	storetDwr	20.00
1994-09-29	1994	Sep	storetUsgs	23.00

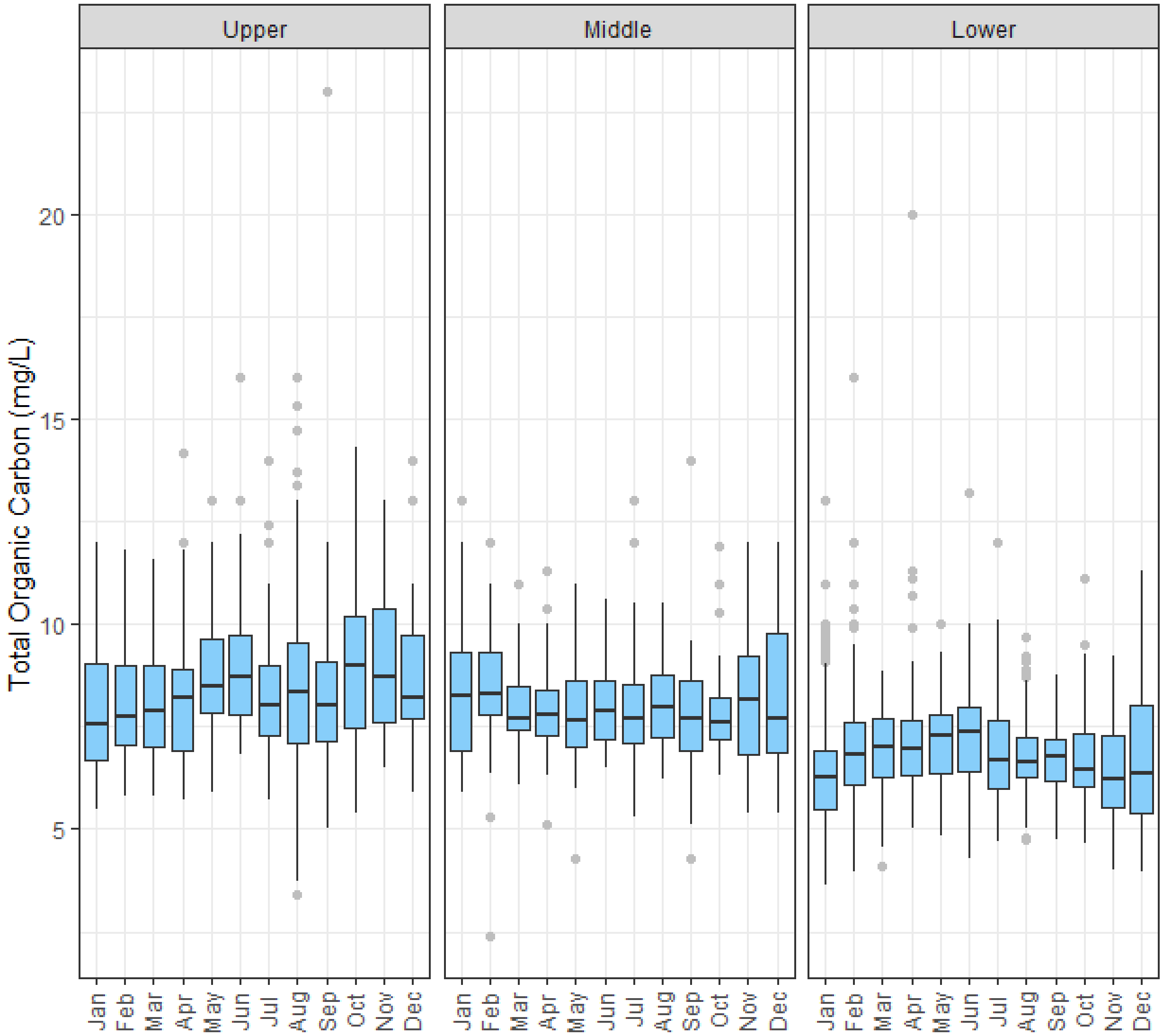
3.9.3.3 Annual Variance

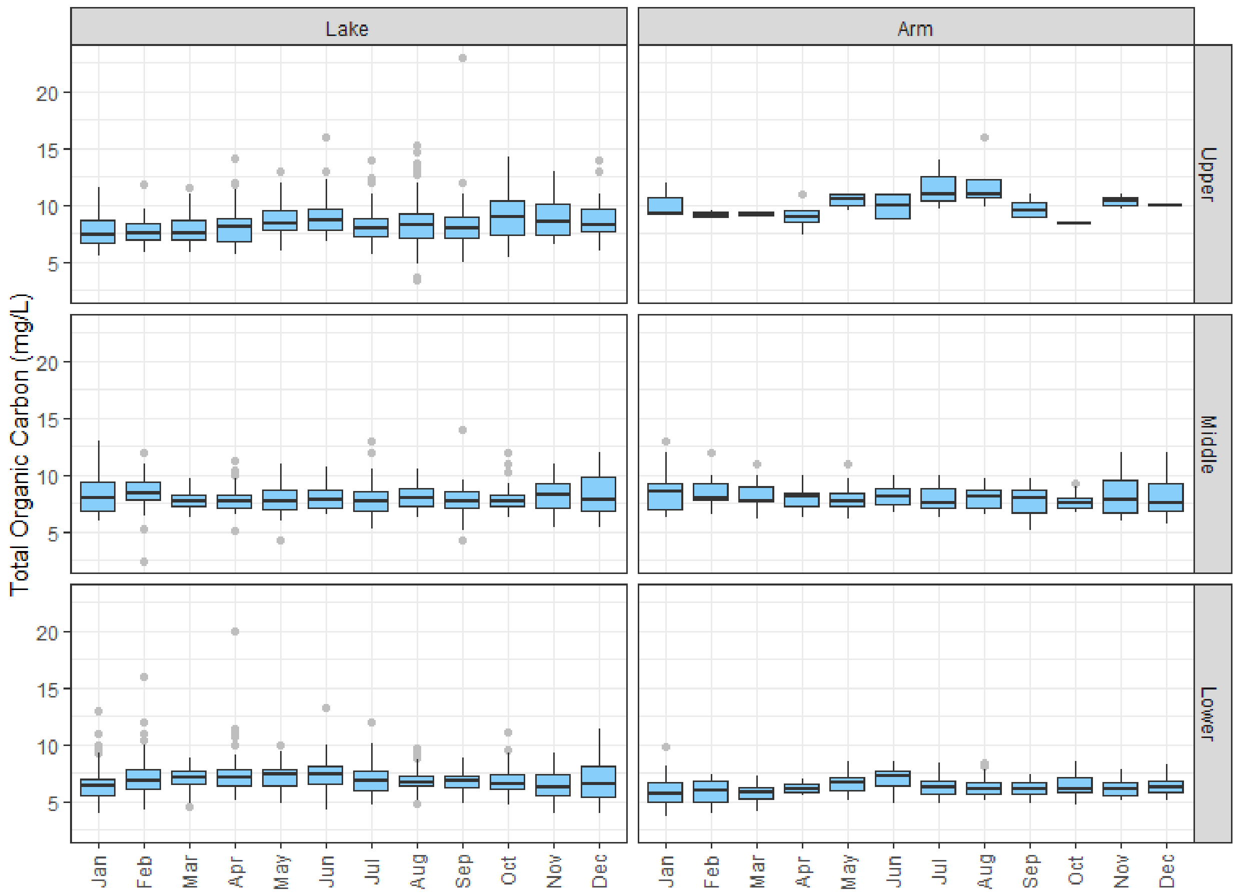





```
## # A tibble: 3 × 3
##   LAKEUNIT HISTORIC RECENT
##   <ord>       <dbl>  <dbl>
## 1 Upper        9.03   7.77
## 2 Middle       8.04   7.7
## 3 Lower        6.83   6.82
```

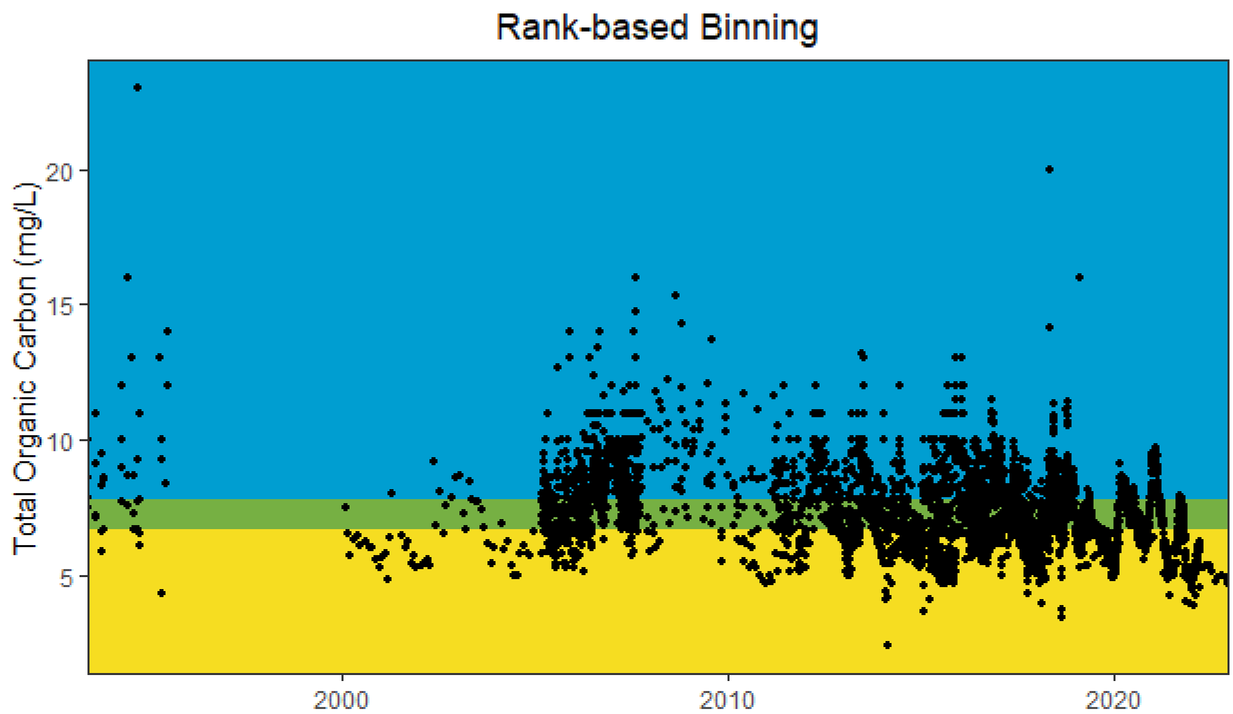
3.9.3.4 Seasonal Trends





3.9.4 Proposed Bins

In the absence of lake water criteria, we propose rank-based bins.



The cut points for the rank based bins are: -, 6.665, 7.8000001, . Each bin contains an equal number of observations. The overall median value (all data pooled) is 7.2

3.9.5 Export Merged Data

The merged data files represent all data gathered to date for this variable. We drop some of the information that was used as qaqc during prep and merging steps: SOURCETYPE, DEPTHTYPE, VARTYPE, VARLABEL. The final merged data are saved as: **tidy_toc.rds** (data) and **tidy_toc_summary.rds** (summary states for LAKEUNIT by MONTH: N, NYears, Mean, SD). Both are also saved to Excel.

The final data include data received from: raltoc, durmCity, ralpud, extratoc_raltoc, caae, storetDwr, storetUsgs, extratoc_storetUsgs.

Code authored by KDV Decision Analysis LLC and last run 2024-09-19 with R version 4.4.1 (2024-06-14 ucrt).

3.10 Data Merge for Total Nitrogen

3.10.1Gather Data Resources

Some sources provide the calculated values, others only provide the component values and the calculation must be completed as part of the data merge step.

3.10.1.1 List associated files

Total Nitrogen data sources are identified by the **_totaln** suffix.

The available data sources which provide a calculated value are: caae_totaln.rds, durmCity_totaln.rds, storetDwr_totaln.rds, storetUsgs_totaln.rds.

To facilitate removal of duplicates, each data source was assigned a priority. When duplicate observations are filtered out, the record from the lower priority data is the record which is removed.

3.10.1.2 Storet USGS data (storetUSGS) Total Nitrogen

```
##
##   2086920 208703650 208708905 208718195
##        50        21        18        24

##
##      Upper     Middle      Lower Other Lake
##         50         21         42          0

##
## 1993 1994 1995 2005 2006 2007 2008 2009 2010 2011
##    7    8    1    5    8   10   20   26   16   12

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##   0  20   7  29   5   1   1   4   1  22   4  19
```

StoretUSGS provides 113 Total Nitrogen records for 4 station ids and 10 years spanning 1993 to 2011.

No samples within StoretUSGS occur in the upper section of the lake.

3.10.1.3 Storet DWR (storetDwr) Total Nitrogen

```
##
## J1250000 J1370000 J1430000 J1590000 J1670000 J1675000 J1715000 J1715030
##       61       68       45       45        2       66       68        1
## J1725000 J1727000 J1740000     LC01     LI01    LLC01   NEU010   NEU013
##       46       65       62      150      108      145       53      148
##  NEU013B NEU0171B  NEU018C  NEU018E  NEU019E  NEU019L  NEU019P  NEU020D
##      169      167       46      171      177      171      173      172
## NEUELL10
##       31

##
##      Upper     Middle      Lower Other Lake
##        575       1146        689          0

##
## 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 2000 2001 2005
##  105  101  108   64   25   30   30   12    6    6    6   18   18   17   43  147
## 2006 2007 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
##  181  151   78  123  130  121  130  140  142  144  106  107  121

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
## 157 181 199 205 193 231 228 272 212 200 168 164
```

StoretUSGS provides 2410 Total Nitrogen records for 25 station ids and 29 years spanning 1984 to 2020.

3.10.1.4 Center for Applied Aquatic Ecology NCSU (caae) Total Nitrogen

```
##
##          Falls Lake 1          Falls Lake 2          Falls Lake 4
##                    24                    24                    24
##          Falls Lake 5          Falls Lake 6 Falls Lake Hwy 50 Channel
##                    21                    28                    48
##   Falls Lake I85 Channel Falls Lake Intake Channel
##                    41                    42

##
##      Upper     Middle      Lower Other Lake
##        114         72         66          0

##
## 2016 2017 2018
##   83   96   73

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##  14  15  15  24  29  31  29  27  23  15  17  13
```

CAAE provided Total Nitrogen data in the resource referenced as source: caae.

CAAE provides 252 Total Nitrogen records for 8 station ids and 3 years spanning 2016 to 2018.

3.10.1.5 City of Durham (durmCity) Total Nitrogen

```
##
##   FL-DS4 FL-SR1801
##        7         9

##
##      Upper     Middle      Lower Other Lake
##         16          0          0          0

##
## 2015
##   16

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##   0   0   0   0   0   0   0   7   5   4   0   0
```

Durham provides 16 Total Nitrogen records for 2 station ids and 1 years spanning 2015 to 2015.

Within the Durham data, all samples were gathered August-October. No samples take place in the lower section of the lake.

3.10.2 Data sources which provide components of Total Nitrogen

As stated above, some sources provide only components of Total Nitrogen. In the following section we calculate Total Nitrogen using the following equation:

Nitrate-Nitrite + (Keldahl N | (Ammonia + Total Organic N)) = Total Nitrogen

The following data sources contain all the necessary components to calculate Total Nitrogen:

```
## [1] "caae"     "durmCity"  "storetDwr"
```

The following do not have all the required components and will be left out as Total Nitrogen incalculable:

```
## [1] "ralpud"    "storetUsgs"
```

3.10.2.1 CAAE Total Nitrogen Components

```
##                                                            path
## 1 C:/KDV/P_Falls/FallsBayesAnalysis/./data/tidy/dataPrep/caae_ammonia.rds
## 2  C:/KDV/P_Falls/FallsBayesAnalysis/./data/tidy/dataPrep/caae_nitnit.rds
## 3  C:/KDV/P_Falls/FallsBayesAnalysis/./data/tidy/dataPrep/caae_nkjeld.rds
## 4     C:/KDV/P_Falls/FallsBayesAnalysis/./data/tidy/dataPrep/caae_ton.rds
##   component
## 1   ammonia
## 2    nitnit
## 3    nkjeld
## 4       ton
```

3.10.2.2 CAAE Component Observation Summary

Number of records provided by source for each component:

- Nitrate-Nitrite: 252
- Kjeldahl Nitrogen: 252
- Ammonia: 253
- Total Organic Nitrogen: 252

Number of observations within calcuated output (for each method):

- Nitrate-Nitrite + Kjeldahl: 252
- Nitrate-Nitrite + Ammonia + Total Organic Nitrogen: 252

Here we see that the difference in results between the two methods of calculating total nitrogen are very small. Differences of this level can likely be attributed to rounding error.

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.4145  0.7052  0.8169  0.8244  0.9289  1.7759

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.4129  0.7060  0.8167  0.8252  0.9289  1.7785
```

3.10.2.3 Durham Total Nitrogen Components

City of Durham Component files:

```
##                                                        path
## 1 C:/KDV/P_Falls/FallsBayesAnalysis/./data/tidy/dataPrep/durmCity_ammonia.rds
## 2  C:/KDV/P_Falls/FallsBayesAnalysis/./data/tidy/dataPrep/durmCity_nitnit.rds
## 3  C:/KDV/P_Falls/FallsBayesAnalysis/./data/tidy/dataPrep/durmCity_nkjeld.rds
##   component
## 1   ammonia
## 2    nitnit
## 3    nkjeld
```

3.10.2.4 Durham Component Summary

Number of observations for each component:

- Nitrate-Nitrite: 215
- Kjeldahl Nitrogen: 201

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
##  0.3000  0.8555  0.9700  1.0188  1.1410  2.6800
```

3.10.2.5 storetDwr Total Nitrogen Components

Ensure no NA values have been introduced in the VALUE column.

3.10.2.6 Storet DWR Component Summary

Number of observations for each component:

- Nitrate-Nitrite: 2641
- Kjeldahl Nitrogen: 2592
- Ammonia: 2641
- Total Organic Nitrogen: 2592

Number of observations within calcuated output (for each method):

- Nitrate-Nitrite + Kjeldahl: 2596
- Nitrate-Nitrite + Ammonia + Total Organic Nitrogen: 2604

Again, the difference in results between the two methods of calculating total nitrogen are very small. Differences of this level can likely be attributed to rounding error.

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
##  0.0700  0.6488  0.7600  0.8067  0.8800  6.6000

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
##  0.0700  0.6450  0.7600  0.8069  0.8800  6.6000
```

3.10.3 Merge Data Sources

3.10.3.1 Merge Calculated Sources

All sources with the minimum components to calculate total nitrogen had the components to calculate by adding Nitrate-Nitrite and Kjedahl Nitrogen. Some sources *did not* have the components necessary to calculate by combining nitrate-nitrite, ammonia, and total organic nitrogen. Therefor, we will use data resources calculated with Kjedahl in the merged data.

3.10.3.2 Merge All Sources

In total, we assembled 5846 Total Nitrogen records into a single tidy dataframe. This included data from CAAE (504 records), the city of Durham (223 records), StoretUSGS (113 records), and StoretDWR (5006 records).

Merged data were qaqc'd to confirm:

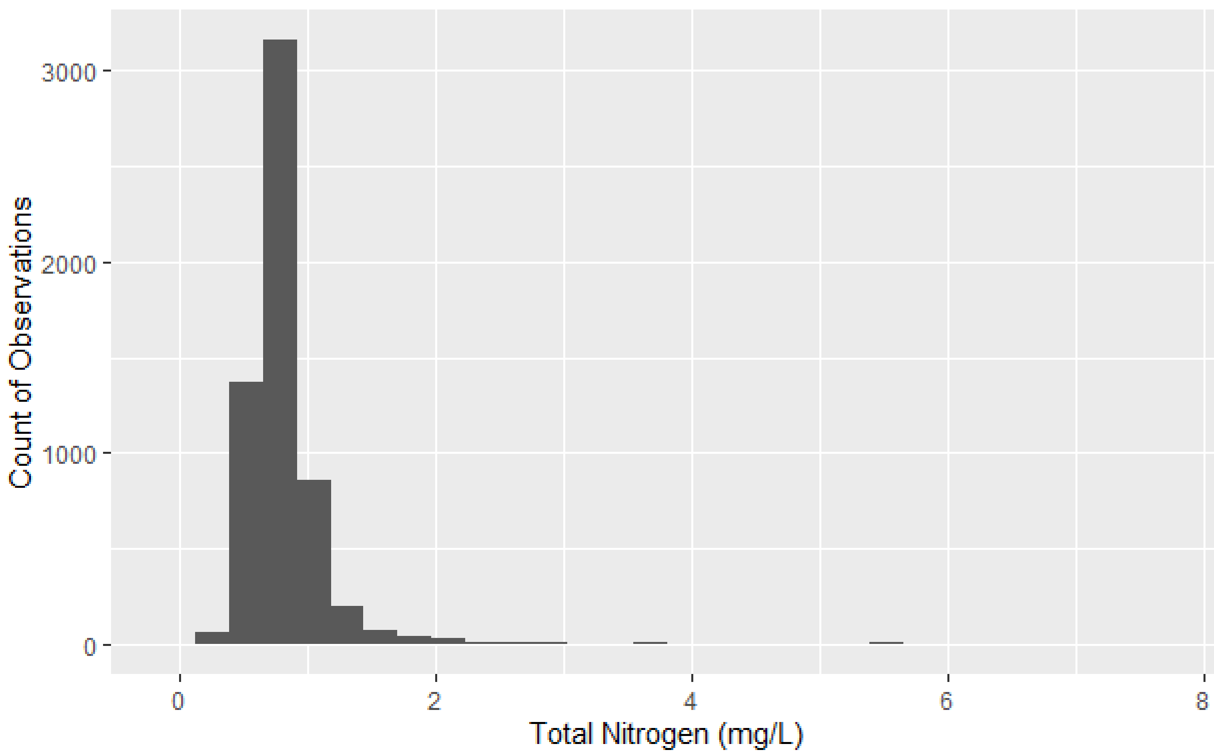
- only one variable is present
- no NA values are present
- only one measurement unit is present (OR if more than one is present, additional processing is required)

The merged data have the following characteristics:

3.10.3.3 Check for and Remove Errors

These data had no values that could be flagged as obvious data errors. There are some extreme values, but we retain these pending review by the SME and TAW teams.

Quantiles	Total.N.value
0%	0.070000
10%	0.530000
20%	0.620000
30%	0.690000
40%	0.730000
50%	0.773405
60%	0.820000
70%	0.870000
80%	0.935000
90%	1.080000
100%	7.700000



3.10.3.4 Check for and Remove Duplicates

Due to the shared structure, all total nitrogen data can be merged into a single dataframe. We have to check for duplicates because some data resources overlap.

All records with equal DATE, STATIONID, DEPTHM, and VALUE are treated as duplicated values and are dropped. With the removal of the older data resources (from earlier 2019 UNRBA data summary report) in favor of updated DWR with more qaqc, there are fewer duplicated values. However, some of our calculated values overlap with provided previously calculated data - and these duplicates are identified and dropped

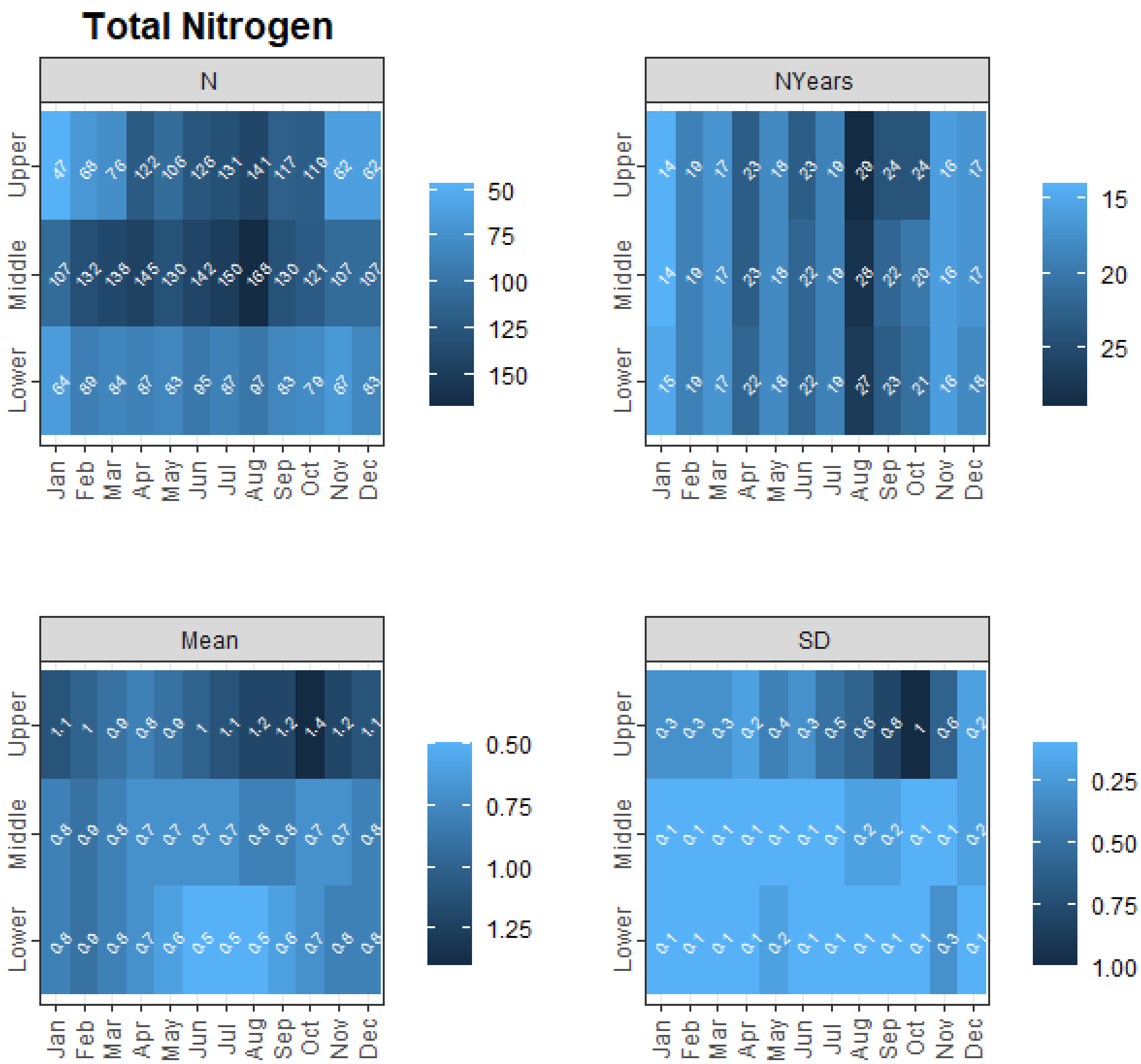
```
##
##    caae  durmCity  storetDwr storetUsgs
##     434       223       2982        113
```

Of all data received (5846 records), 2094 are clear duplicates (shared DATE, STATIONID, DEPTHM, and measured VALUE) and are dropped. There are 3752 remaining observations.

3.10.4 Data Summaries

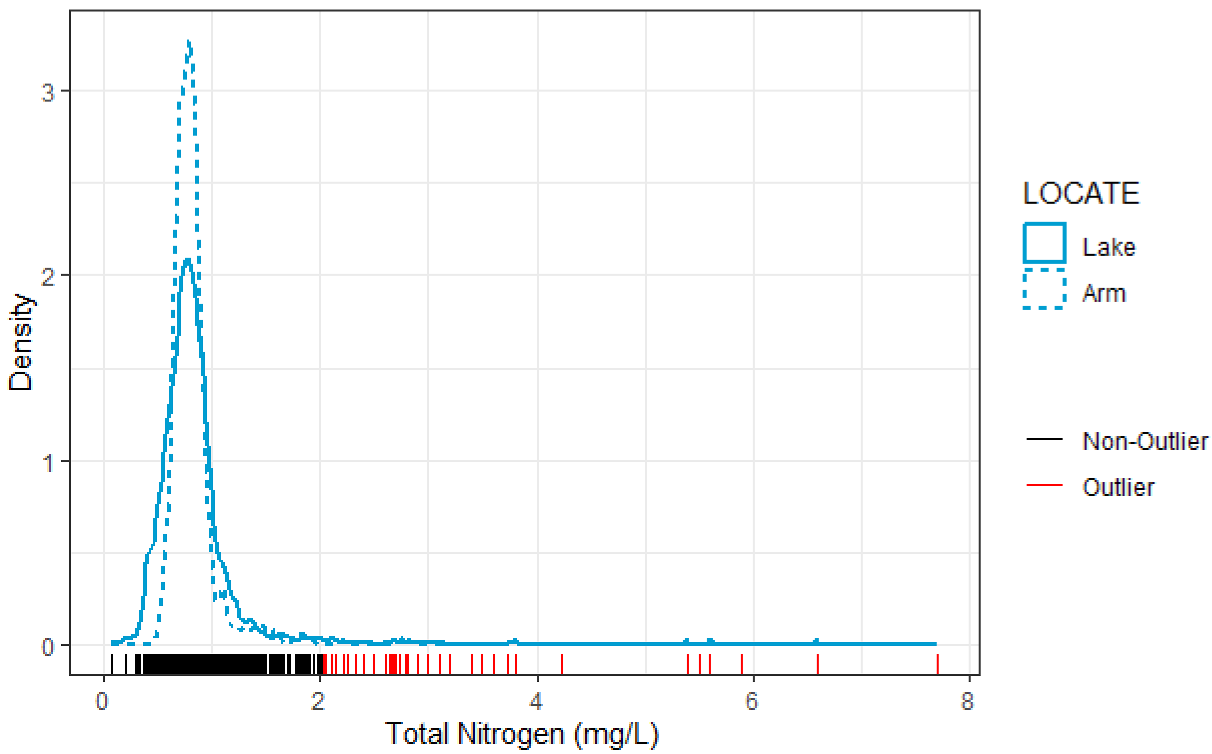
The merged data provide 3752 Total Nitrogen records for 39 station ids and 31 years spanning 1984.

3.10.4.1 Sample Effort and Values



3.10.4.2 Density Plot and Outliers

The distribution of all lake (thalweg) values is shown as the blue solid line and the lake arm values are shown as the blue dashed line. Below the density plot are rug marks for each observed value. The orange rug marks are values greater than three standard deviations from the overall mean (0.8383979). The SD of all data, thalweg and arms, is 0.3907364. The extreme values (+/- 3SD) are retained for our model project as true, but unusual, values - unless our TAW or SME teams indicate these are data errors.



The 3 SD outlier values identified in this plot are:

DATE	YEAR	MONTH	SOURCE	VALUE
2015-09-10	2015	Sep	durmCity	2.041
2015-09-23	2015	Sep	durmCity	2.057
1988-09-29	1988	Sep	storetDwr	2.100
1984-11-15	1984	Nov	storetDwr	2.100
2011-03-02	2011	Mar	storetUsgs	2.100
1988-09-29	1988	Sep	storetDwr	2.100
2007-09-06	2007	Sep	storetDwr	2.105
2007-09-06	2007	Sep	storetDwr	2.105
2017-06-26	2017	Jun	durmCity	2.110
2011-11-08	2011	Nov	storetDwr	2.140
2011-11-08	2011	Nov	storetDwr	2.140
2011-01-27	2011	Jan	storetDwr	2.150
2011-08-09	2011	Aug	storetDwr	2.210
2006-10-24	2006	Oct	storetDwr	2.220
2005-11-15	2005	Nov	storetDwr	2.260
2017-05-30	2017	May	durmCity	2.320
1994-08-09	1994	Aug	storetUsgs	2.400
1985-07-10	1985	Jul	storetDwr	2.400

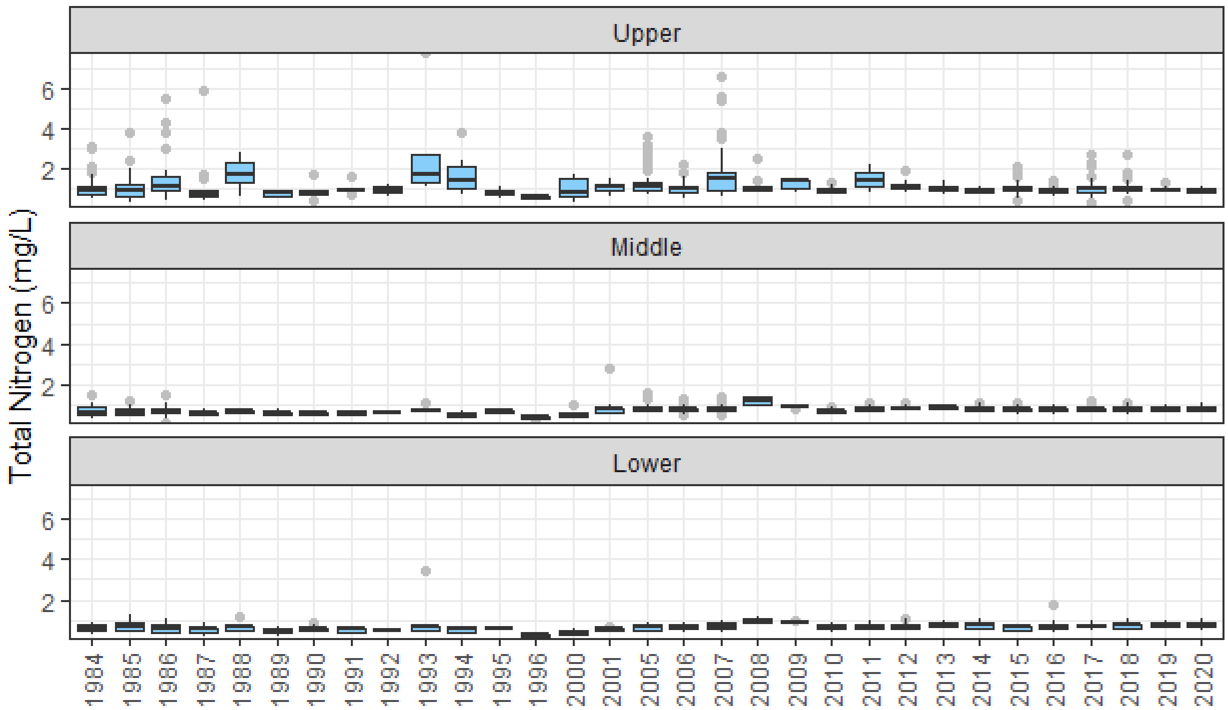
DATE	YEAR	MONTH	SOURCE	VALUE
1985-07-10	1985	Jul	storetDwr	2.400
2008-02-13	2008	Feb	storetUsgs	2.500
2005-11-03	2005	Nov	storetDwr	2.600
2018-07-09	2018	Jul	durmCity	2.650
2007-09-20	2007	Sep	storetDwr	2.660
2017-05-30	2017	May	durmCity	2.680
1993-08-30	1993	Aug	storetDwr	2.700
2005-10-18	2005	Oct	storetDwr	2.700
2001-08-27	2001	Aug	storetDwr	2.730
2007-07-26	2007	Jul	storetDwr	2.790
2007-07-26	2007	Jul	storetDwr	2.790
1988-10-25	1988	Oct	storetDwr	2.800
1988-10-25	1988	Oct	storetDwr	2.800
2005-10-04	2005	Oct	storetDwr	2.900
2007-10-03	2007	Oct	storetUsgs	2.900
2005-10-24	2005	Oct	storetUsgs	2.900
1984-10-24	1984	Oct	storetDwr	3.000
1986-11-18	1986	Nov	storetDwr	3.000
2007-10-03	2007	Oct	storetUsgs	3.000
1984-11-15	1984	Nov	storetDwr	3.100
1984-11-15	1984	Nov	storetDwr	3.100
2005-10-24	2005	Oct	storetUsgs	3.200
1993-11-09	1993	Nov	storetUsgs	3.400
2007-10-03	2007	Oct	storetUsgs	3.500
2005-10-24	2005	Oct	storetUsgs	3.600
1986-07-16	1986	Jul	storetDwr	3.730
1985-08-13	1985	Aug	storetDwr	3.800
1994-09-29	1994	Sep	storetUsgs	3.800
2007-08-09	2007	Aug	storetDwr	3.800
1986-05-27	1986	May	storetDwr	4.230
2007-09-06	2007	Sep	storetDwr	5.400
1986-10-28	1986	Oct	storetDwr	5.500
2007-08-22	2007	Aug	storetDwr	5.600
1987-10-14	1987	Oct	storetDwr	5.900
2007-09-20	2007	Sep	storetDwr	6.600

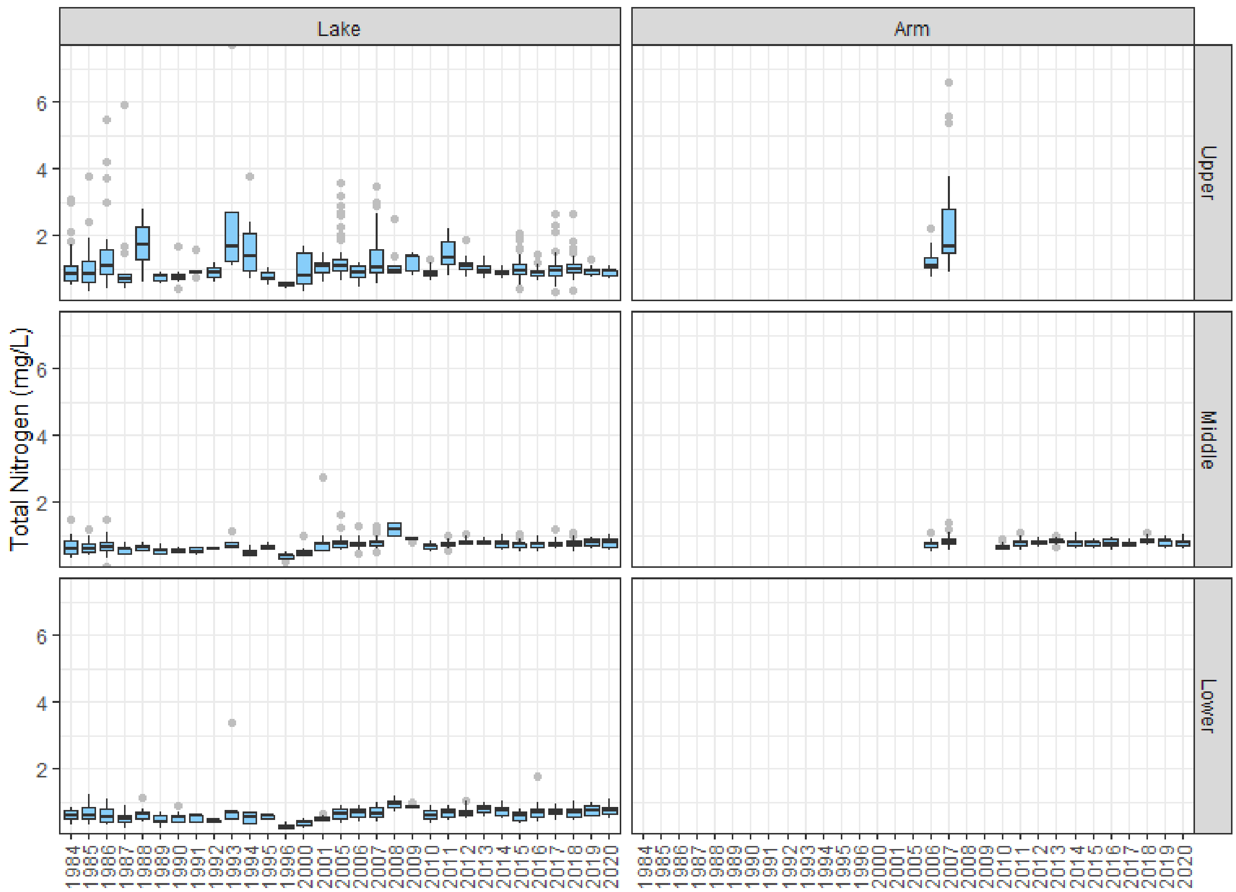
DATE	YEAR	MONTH	SOURCE	VALUE
1993-10-22	1993	Oct	storetUsgs	7.700

3.10.4.3 Annual Variance

If we can use data from the lake arms, it increases our overall sample size. But if the lake arms are too different from the main lake body, the arm data will add noise to our analysis. We show the data as a full set (by lake unit) and split into the lake (thalweg) versus arm observations.

3.10.4.3.1 Full Y-axis



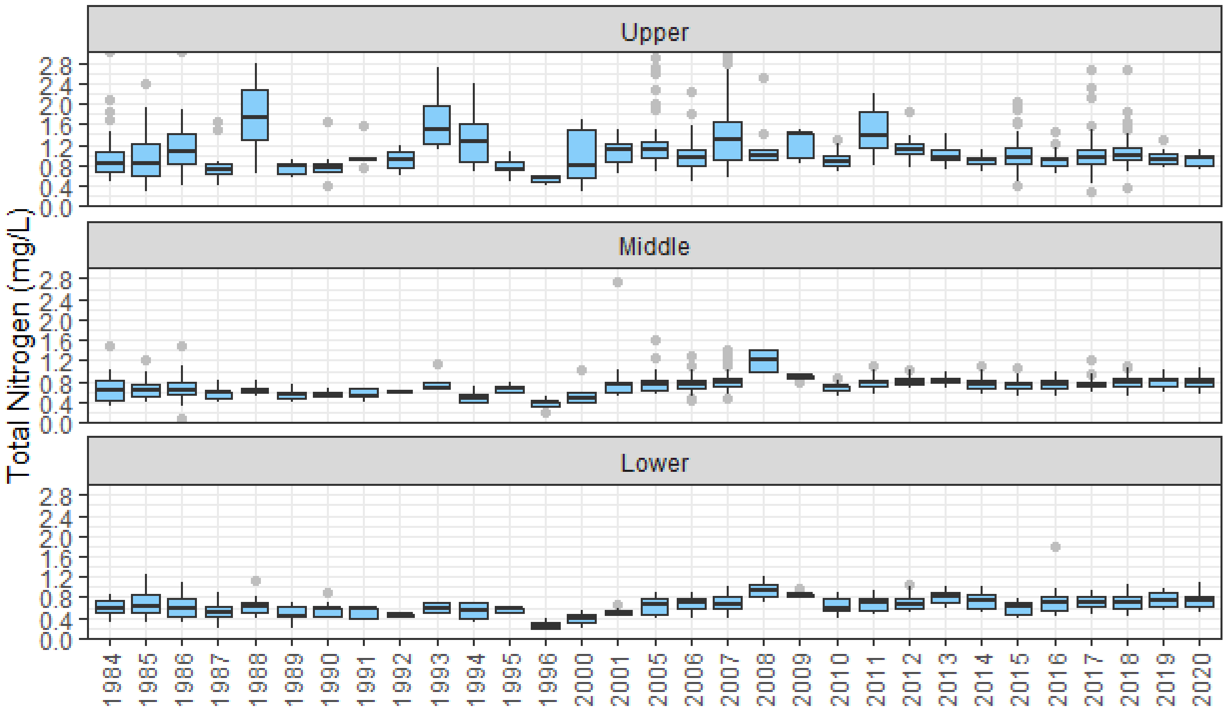


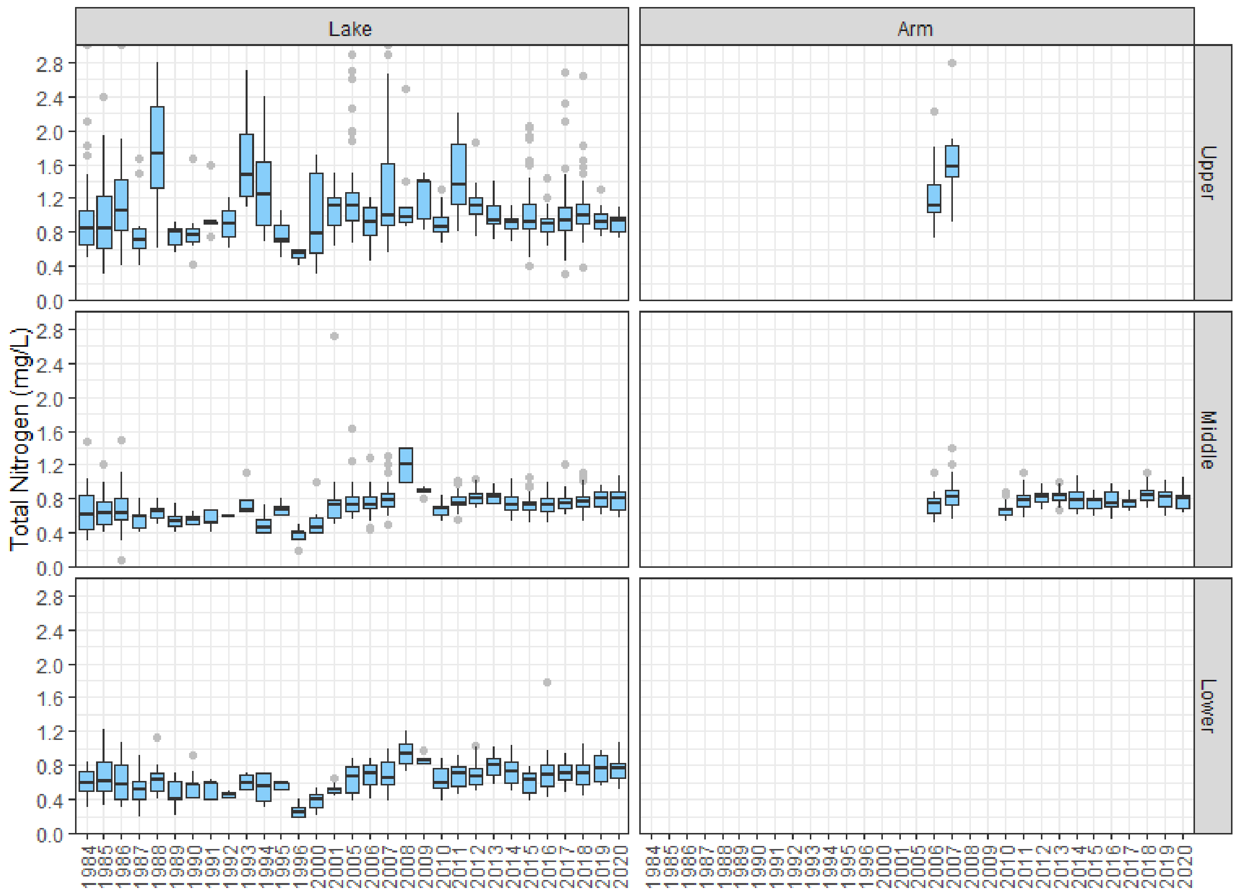
3.10.4.3.2 Clipped Y-axis

Given the wide range of data values, it is difficult to see trends in the typical values. Therefore, we also created a series of plots with a clipped y-axis. No underlying data are removed - so the distributions presented in the box plots remain the same. The plots below are clipped on the y-axis at the value (3).

LAKEUNIT	LOCATE	DATE	VALUE
Upper	Lake	1984-11-15	3.10
Upper	Lake	1984-11-15	3.10
Upper	Lake	1985-08-13	3.80
Upper	Lake	1986-05-27	4.23
Upper	Lake	1986-07-16	3.73
Upper	Lake	1986-10-28	5.50
Upper	Lake	1987-10-14	5.90
Upper	Lake	1993-10-22	7.70
Lower	Lake	1993-11-09	3.40
Upper	Lake	1994-09-29	3.80
Upper	Lake	2005-10-24	3.60

LAKEUNIT	LOCATE	DATE	VALUE
Upper	Lake	2005-10-24	3.20
Upper	Arm	2007-08-09	3.80
Upper	Arm	2007-08-22	5.60
Upper	Arm	2007-09-06	5.40
Upper	Arm	2007-09-20	6.60
Upper	Lake	2007-10-03	3.50





3.10.4.4 Historic versus Recent Comparison

We compare fthe data from early years (1986 to 1995) to recent years (2011 to 2020).

3.10.4.4.1 Mean Values

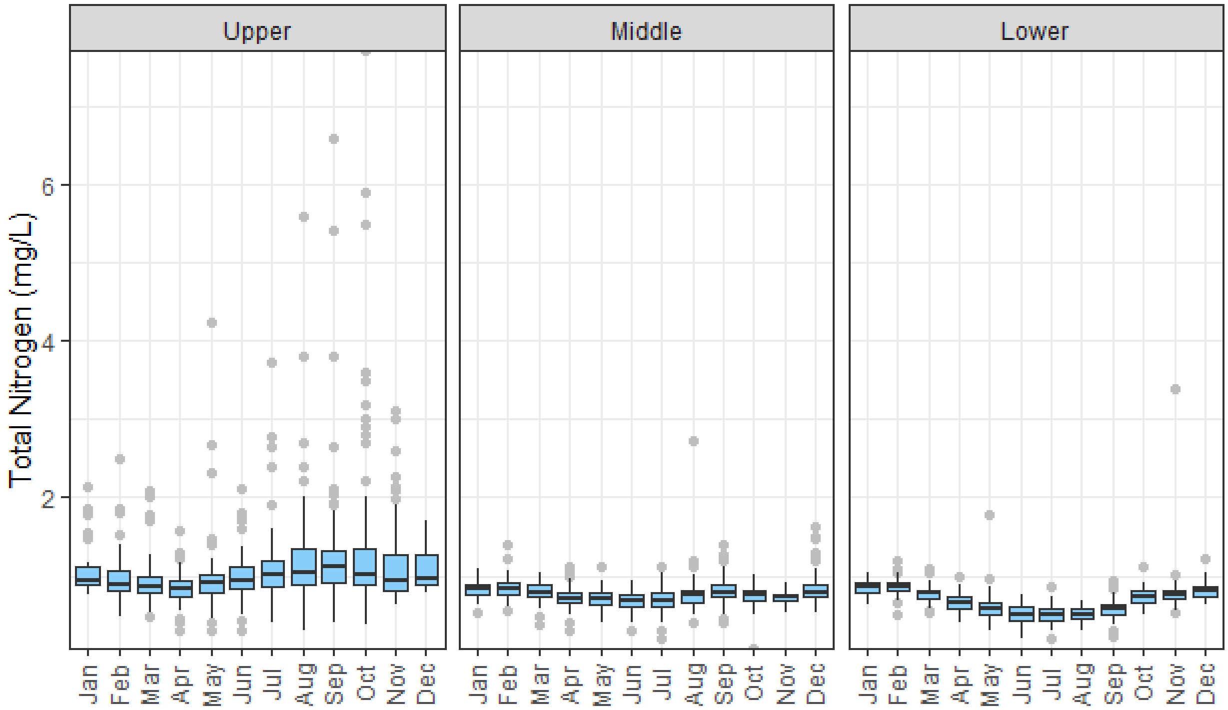
LAKEUNIT	HISTORIC	RECENT
Upper	1.23	1.00
Middle	0.62	0.78
Lower	0.60	0.71

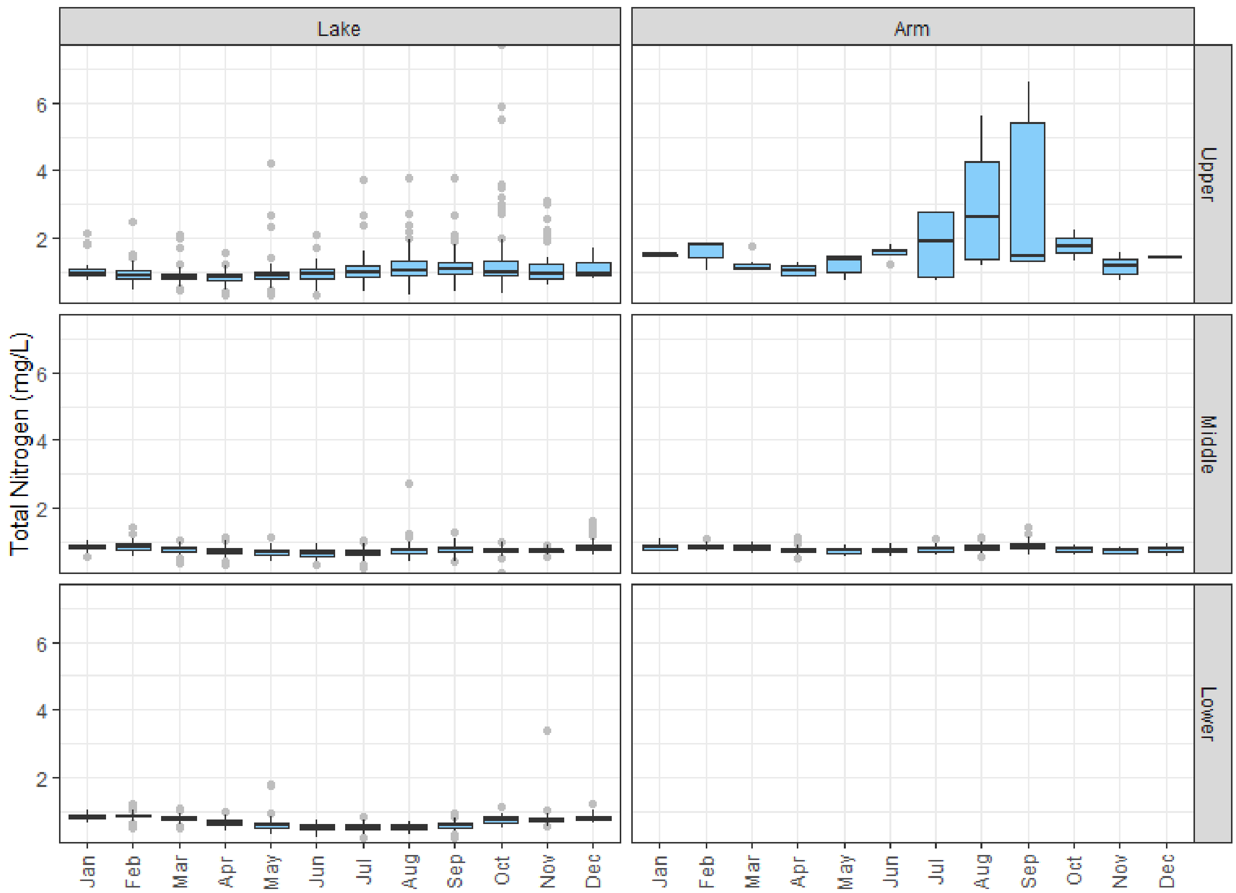
3.10.4.4.2 SD Values

LAKEUNIT	HISTORIC	RECENT
Upper	1.05	0.27
Middle	0.18	0.10
Lower	0.32	0.16

3.10.4.5 Seasonal Trends

3.10.4.5.1 Full Y-axis

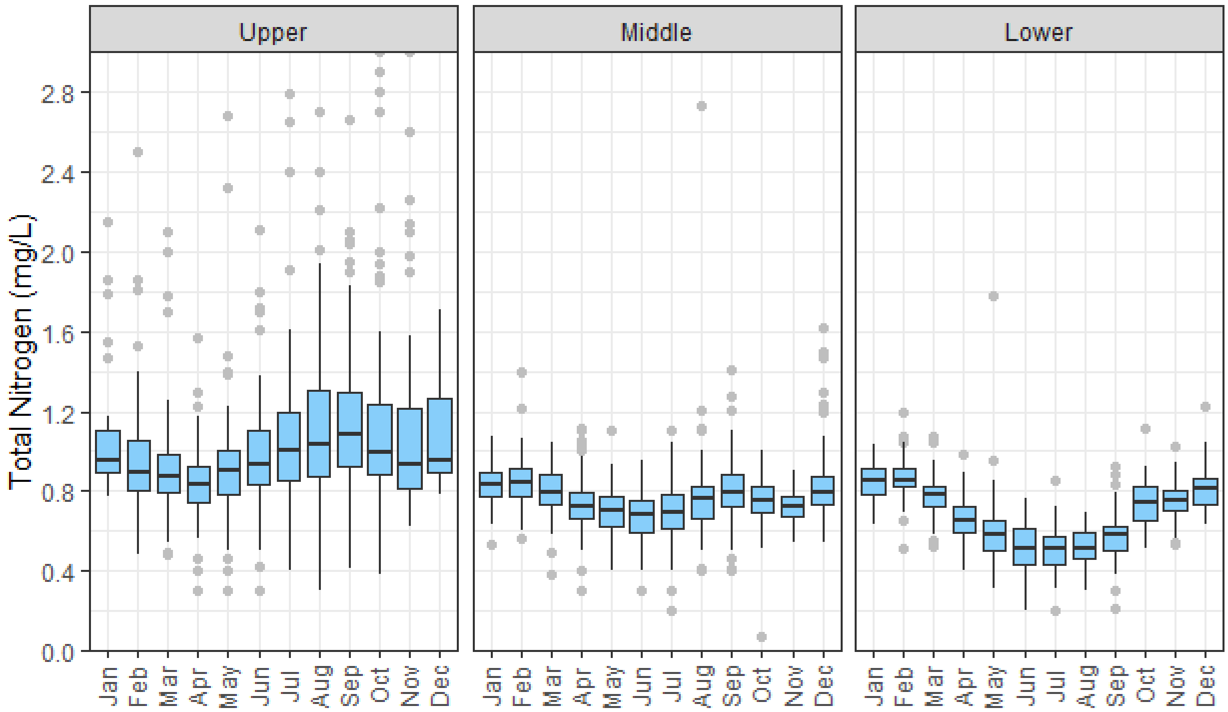


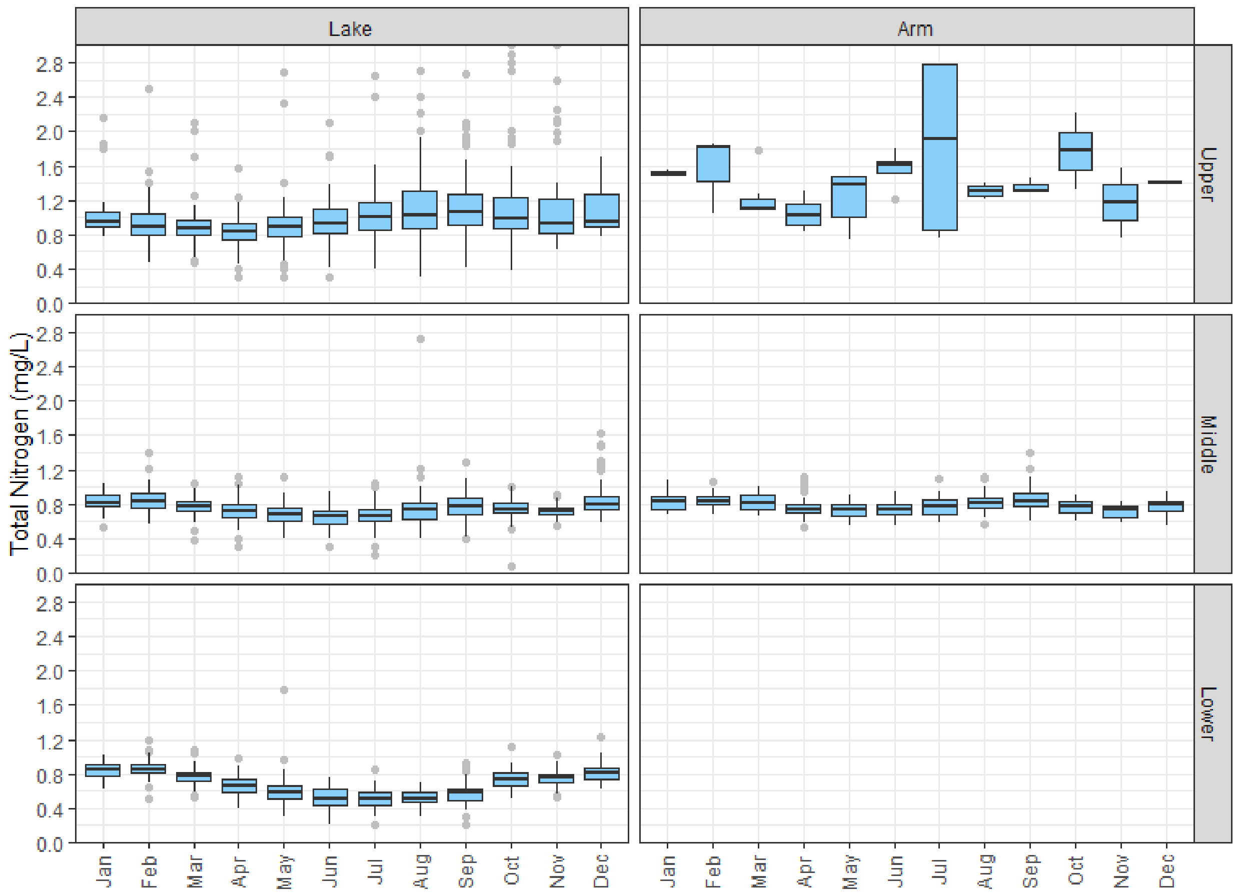


3.10.4.5.2 Clipped Y-axis

LAKEUNIT	LOCATE	DATE	VALUE
Upper	Lake	1984-11-15	3.10
Upper	Lake	1984-11-15	3.10
Upper	Lake	1985-08-13	3.80
Upper	Lake	1986-05-27	4.23
Upper	Lake	1986-07-16	3.73
Upper	Lake	1986-10-28	5.50
Upper	Lake	1987-10-14	5.90
Upper	Lake	1993-10-22	7.70
Lower	Lake	1993-11-09	3.40
Upper	Lake	1994-09-29	3.80
Upper	Lake	2005-10-24	3.60
Upper	Lake	2005-10-24	3.20
Upper	Arm	2007-08-09	3.80
Upper	Arm	2007-08-22	5.60

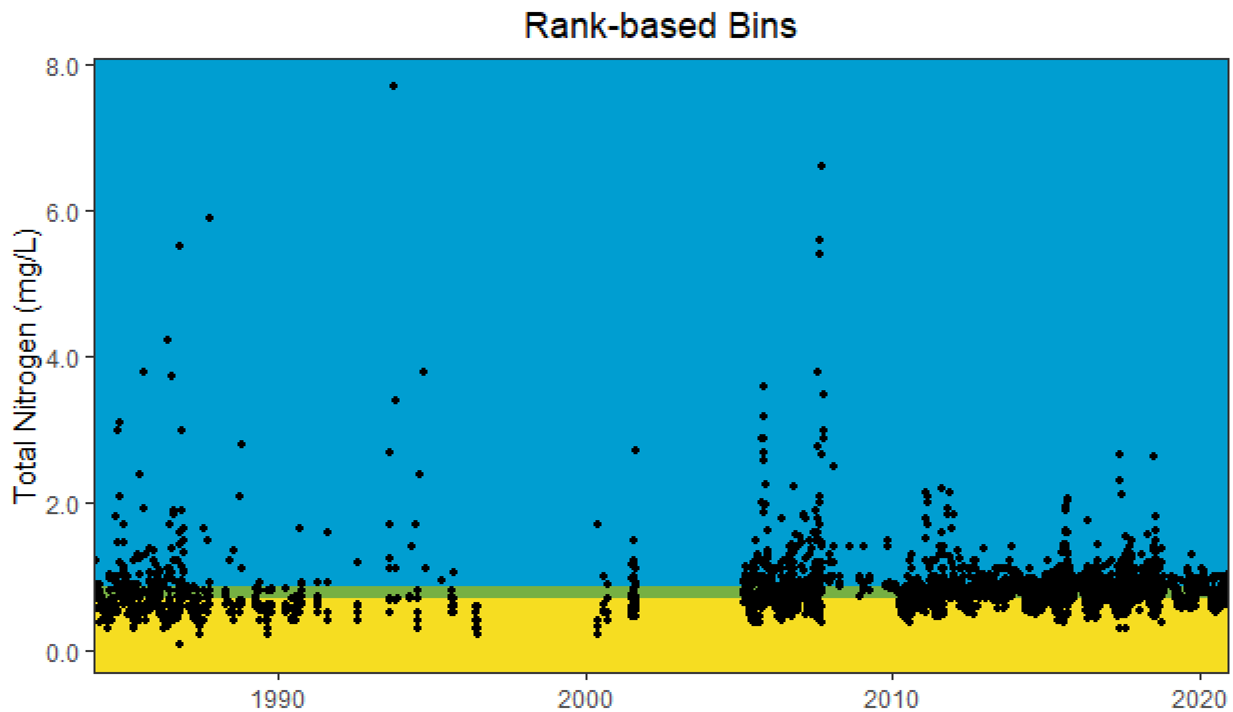
LAKEUNIT	LOCATE	DATE	VALUE
Upper	Arm	2007-09-06	5.40
Upper	Arm	2007-09-20	6.60
Upper	Lake	2007-10-03	3.50





Lake
Arm
Upper
Middle
Lower
Total Nitrogen (mg/L)
0.0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

3.10.5 Proposed Bins



The cut points for the rank based bins are: -, 0.71, 0.86, . The median of all data is 0.79.

3.10.6 Export Merged Data

The merged data files represent all data gathered to date for this variable. We drop some of the information that was used as qaqc during prep and merging steps: SOURCETYPE, DEPTHTYPE, VARTYPE, VARLABEL. The final merged data are saved as: **tidy_totaln.rds** (data) and **tidy_totaln_summary.rds** (summary states for LAKEUNIT by MONTH: N, NYears, Mean, SD). Both are also saved to Excel.

The final data include data received from: durmCity, caae, storetDwr, storetUsgs.

Code authored by KDV Decision Analysis LLC and last run 2024-09-19 with R version 4.4.1 (2024-06-14 ucrt).

3.11 Data Merge of Total Phosphorus

3.11.1 Gather Data Resources

3.11.1.1 List Associated Files

Total Phosphorus data are identified by the **_totalp** suffix.

The available Total Phosphorus data sources are: caae_totalp.rds, durmCity_totalp.rds, ralpud_totalp.rds, storetDwr_totalp.rds, storetUsgs_totalp.rds.

3.11.1.2 Center for Applied Aquatic Ecology NCSU (caae)

```
##
##          Falls Lake 1          Falls Lake 2          Falls Lake 4
```

```
##                    24                    24                    24
##           Falls Lake 5           Falls Lake 6 Falls Lake Hwy 50 Channel
##                    21                    28                    48
##    Falls Lake I85 Channel Falls Lake Intake Channel
##                    41                    42
```

```
##
##      Upper     Middle      Lower Other Lake
##        114        72        66         0
```

```
##
## 2016 2017 2018
##   83   97   72
```

```
##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##  14  15  15  24  29  31  29  28  23  14  17  13
```

This source provides 252 Total Phosphorus records for 8 station ids and 3 years spanning 2016 to 2018.

3.11.1.3 City of Durham (durmCity)

```
##
##    FL-DS4 FL-SR1801
##      104       109
```

```
##
##      Upper     Middle      Lower Other Lake
##        213          0          0          0
```

```
##
## 2015 2016 2017 2018
##   61   58   40   54
```

```
##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##   0   0   0  29  32  33  40  30  23  26   0   0
```

This source provides 213 Total Phosphorus records for 2 station ids and 4 years spanning 2015 to 2018.

3.11.1.4 City of Raleigh (ralpud)

```
##
##    Honeycutt Creek     Intake Surface Lower Barton Creek    New Light Creek
##                 58                 58                 58                 58
## Upper Barton Creek          US Hwy 98
##                 58                 58
```

```
##
##     Upper     Middle      Lower Other Lake
##         0          0        348          0

##
## 2013 2014 2015 2016 2017 2018
##   72   49   66   65   60   36

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##  30  18  22  29  35  36  31  36  27  30  24  30
```

This source provides 348 Total Phosphorus records for 6 station ids and 6 years spanning 2013 to 2018.

All samples occurred in the lower section of the lake.

3.11.1.5 Storet DWR (storetDwr)

```
##
##    LC01     LI01    LLC01   NEU010   NEU013  NEU013B NEU0171B  NEU018C
##     160      110      160       64      152      186      213       46
##  NEU018E  NEU019E  NEU019L  NEU019P  NEU020D NEUELL10
##     211      213      185      188      186       37

##
##     Upper     Middle      Lower Other Lake
##       439       1113        559          0

##
## 2000 2001 2005 2006 2007 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
##   17   44  171  288  227   78  123  130  121  130  140  142  144  106  129  121

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
## 153 161 179 165 177 205 211 218 179 166 154 143
```

This source provides 2111 Total Phosphorus records for 14 station ids and 16 years spanning 2000 to 2020.

3.11.1.6 Storet USGS (storetUsgs)

```
##
##   2086920 208703650 208708905 208717595 208718195
##        95        85        46         2        47

##
##     Upper     Middle      Lower Other Lake
##        95         85         95          0

##
## 1993 1994 1995 2005 2006 2007 2008 2009 2010 2011
##   14   16    5   20   33   39   43   43   41   21
```

```
##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##   0  20   8  43   5  46  11  59   2  55   3  23
```

This source provides 275 Total Phosphorus records for 5 station ids and 10 years spanning 1993 to 2011.

3.11.2 Merge Data Sources

In total, we assembled 3199 Total Phosphorus records. into a single tidy dataframe. This included data from CAAE (252 records), City of Durham (213 records), Raleigh PUD (348 records), StoretDWR (2111 records), and Storet USGS (275 records).

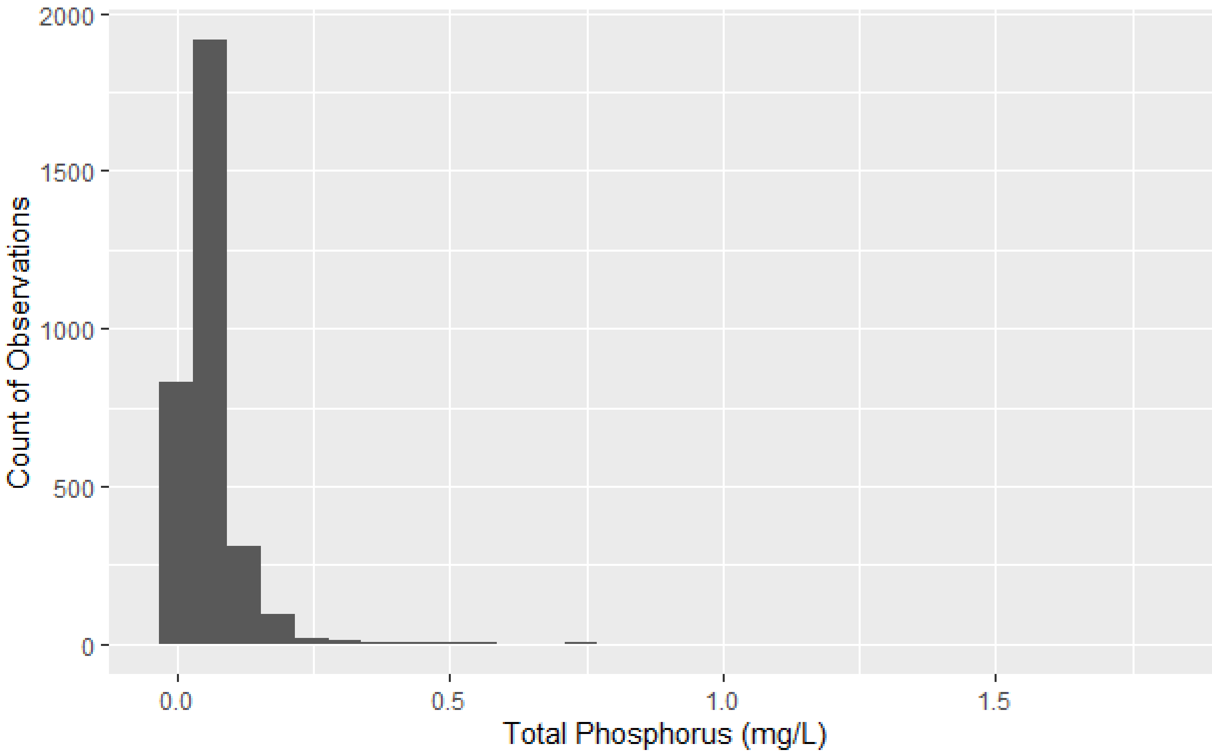
Merged data were qaqc'd to confirm:

- only one variable is present
- no NA values are present
- only one measurement unit is present (OR if more than one is present, additional processing is required)

3.11.2.1 Check for and Remove Errors

These data had no values that could be flagged as obvious data errors. There are some extreme values, but we retain these pending review by the SME and TAW teams.

Quantiles	Total.P.value
0%	0.010000
10%	0.025000
20%	0.030000
30%	0.040000
40%	0.040000
50%	0.050000
60%	0.054762
70%	0.060000
80%	0.080000
90%	0.110000
100%	1.800000



3.11.2.2 Check for and Remove Duplicates

All records with equal DATE, STATIONID, DEPTHM, and VALUE were treated as duplicates values and are dropped. With the removal of the older data resources (from earlier 2019 UNRBA data summary report) in favor of updated DWR with more qaqc, there are very few duplicated values.

```
##
##      caae   durmCity     ralpud  storetDwr storetUsgs
##       252       213       348       2110       274
```

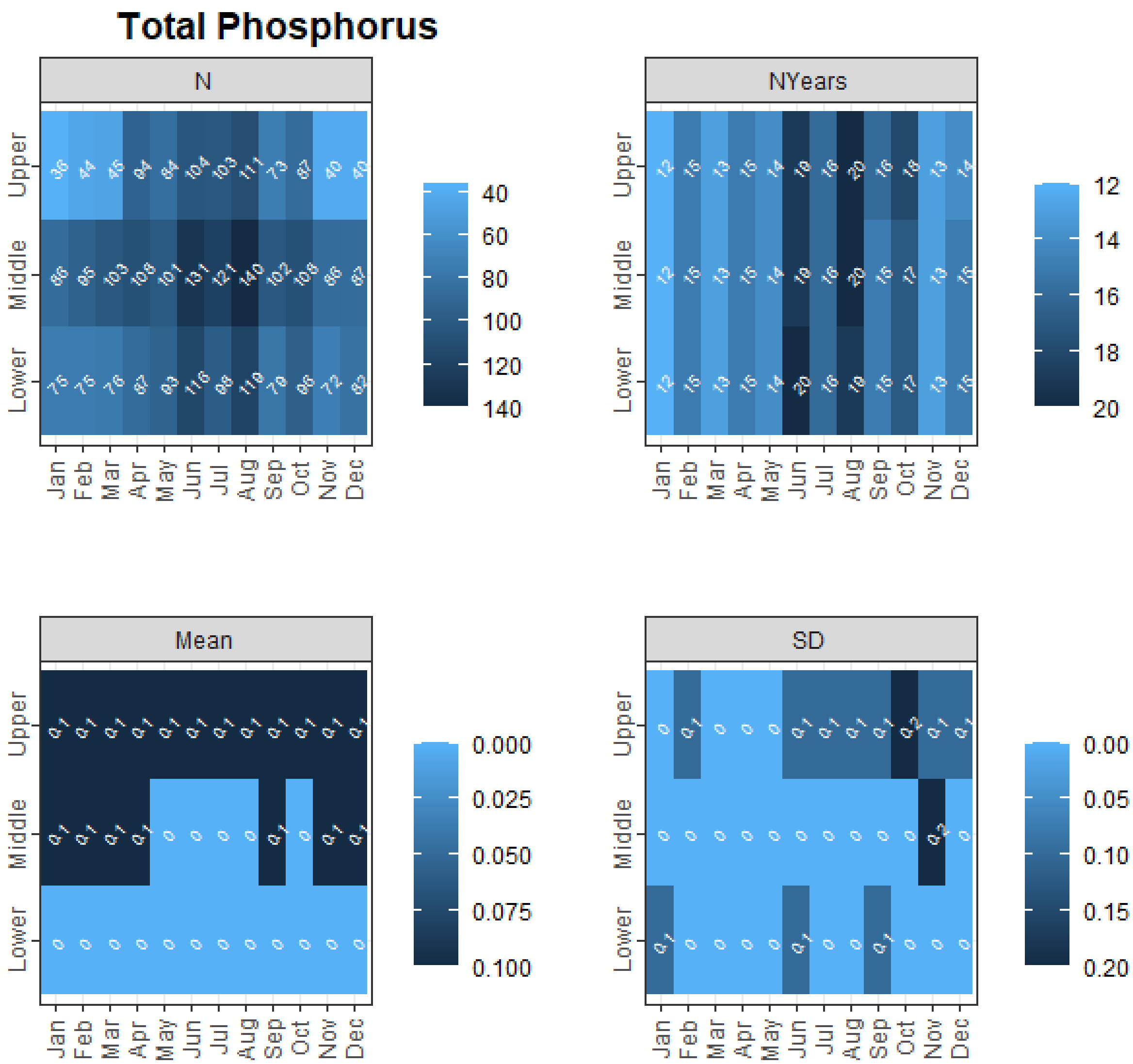
Of all data received (3199 records), there are 2 duplicates (shared DATE, STATIONID, DEPTHM, and measured VALUE). There are 3197 remaining observations.

```
## # A tibble: 5 × 6
##   SOURCE        N NStations NYears MinYear MaxYear
##   <chr>     <int>     <int>  <int>   <dbl>   <dbl>
## 1 caae        252         8      3    2016    2018
## 2 durmCity    213         2      4    2015    2018
## 3 ralpud      348         6      6    2013    2018
## 4 storetDwr  2110        14     16    2000    2020
## 5 storetUsgs  274         5     10    1993    2011
```

3.11.3 Data Summaries

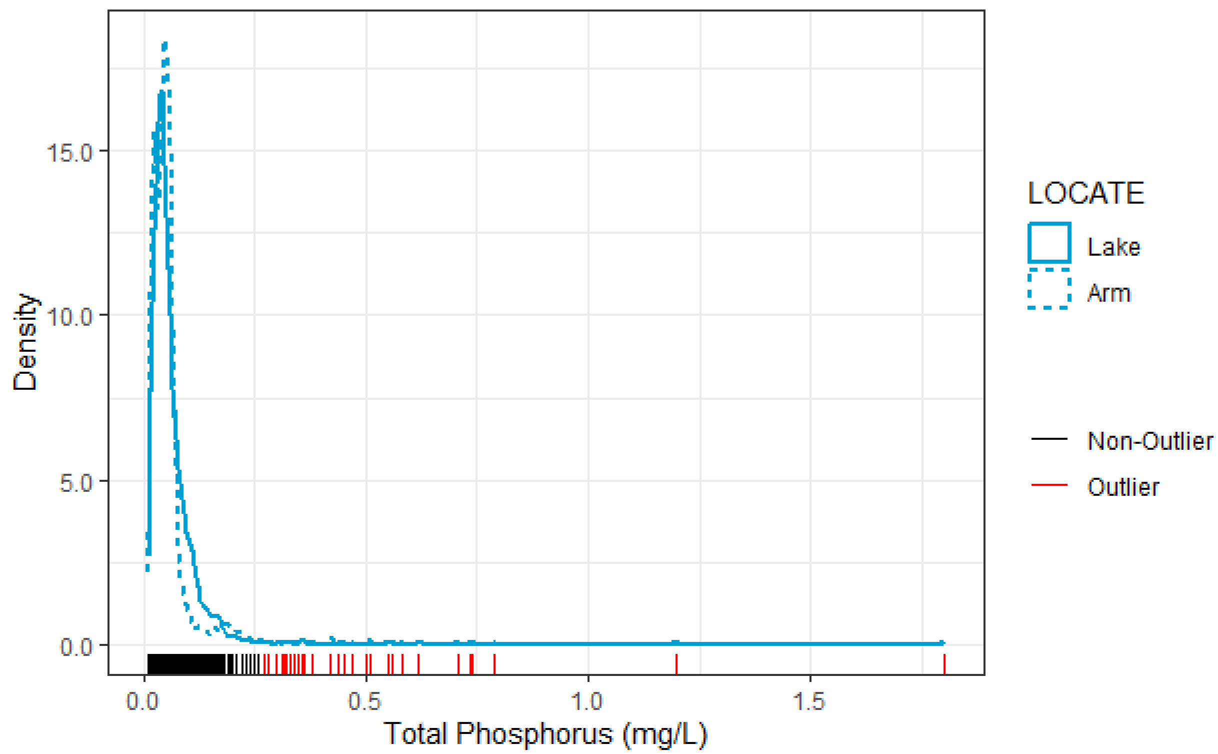
The merged data provide 3197 Total Phosphorus records for 35 station ids and 21 years spanning 1993 to 2020.

3.11.3.1 Sample Effort and Values



3.11.3.2 Density Plot and Outliers

The distribution of all lake (thalweg) values is shown as the blue solid line and the lake arm values are shown as the blue dashed line. Below the density plot are rug marks for each observed value. The orange rug marks are values greater than three standard deviations from the overall mean (0.0628744). The SD of all data, thalweg and arms, is 0.0677933. The extreme values (+/- 3SD) are retained for our model project as true, but unusual, values - unless our TAW or SME teams indicate these are data errors.



The 3 SD outlier values identified in this plot are:

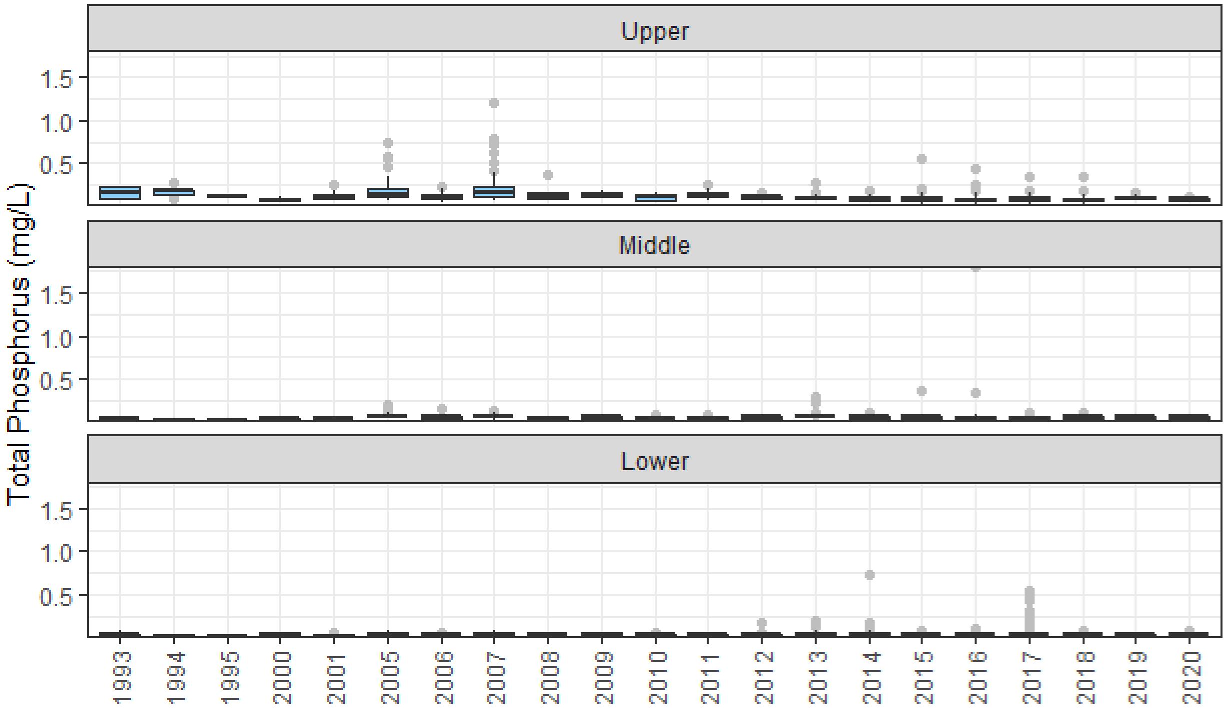
DATE	YEAR	MONTH	SOURCE	VALUE
2013-06-13	2013	Jun	storetDwr	0.270
2007-05-09	2007	May	storetDwr	0.270
2007-07-12	2007	Jul	storetDwr	0.270
2005-11-15	2005	Nov	storetDwr	0.280
1994-09-29	1994	Sep	storetUsgs	0.280
2013-06-13	2013	Jun	storetDwr	0.300
2005-12-06	2005	Dec	storetDwr	0.300
2017-11-29	2017	Nov	storetDwr	0.310
2007-08-15	2007	Aug	storetUsgs	0.315
2005-11-15	2005	Nov	storetDwr	0.320
2016-11-16	2016	Nov	storetDwr	0.330
2017-07-31	2017	Jul	durmCity	0.337
2007-08-15	2007	Aug	storetUsgs	0.338
2005-11-03	2005	Nov	storetDwr	0.350
2018-06-27	2018	Jun	storetDwr	0.350
2007-08-15	2007	Aug	storetUsgs	0.359
2015-02-03	2015	Feb	storetDwr	0.360
2008-02-13	2008	Feb	storetUsgs	0.360

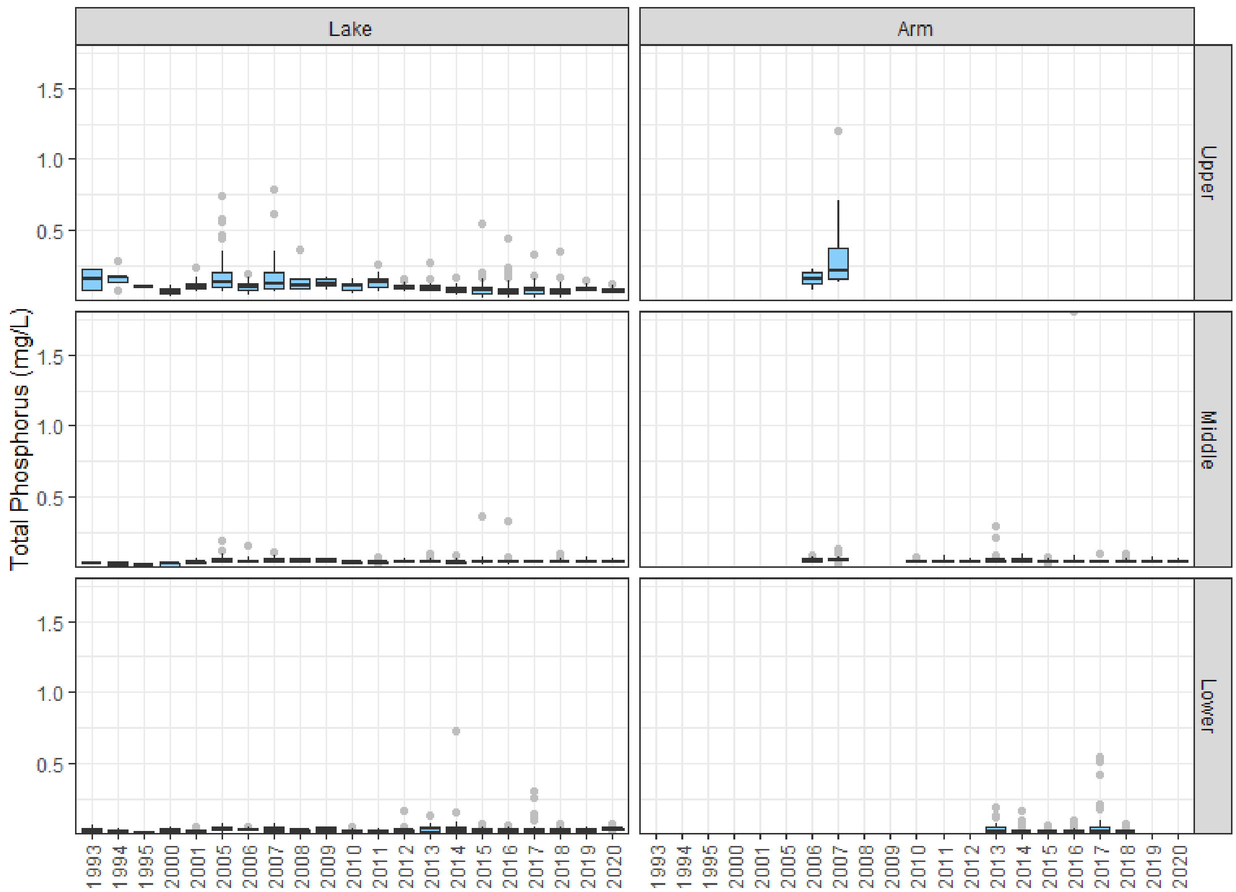
DATE	YEAR	MONTH	SOURCE	VALUE
2007-09-06	2007	Sep	storetDwr	0.380
2007-07-26	2007	Jul	storetDwr	0.420
2017-06-27	2017	Jun	ralpud	0.420
2016-02-09	2016	Feb	storetDwr	0.440
2005-10-18	2005	Oct	storetDwr	0.450
2005-10-24	2005	Oct	storetUsgs	0.470
2007-08-09	2007	Aug	storetDwr	0.500
2017-06-27	2017	Jun	ralpud	0.510
2017-01-25	2017	Jan	ralpud	0.550
2015-10-26	2015	Oct	durmCity	0.550
2005-11-03	2005	Nov	storetDwr	0.560
2005-10-24	2005	Oct	storetUsgs	0.580
2007-10-03	2007	Oct	storetUsgs	0.620
2007-10-03	2007	Oct	storetUsgs	0.620
2007-08-22	2007	Aug	storetDwr	0.710
2014-09-04	2014	Sep	storetDwr	0.735
2005-10-24	2005	Oct	storetUsgs	0.740
2007-10-03	2007	Oct	storetUsgs	0.790
2007-09-20	2007	Sep	storetDwr	1.200
2016-11-16	2016	Nov	storetDwr	1.800

3.11.3.3 Annual Variance

If we can use data from the lake arms, it increases our overall sample size. But if the lake arms are too fifferent from the main lake body, the arm data will add noise to our analysis. We show the data as a full set (by lake unit) and split into the lake (thalweg) versus arm observations.

3.11.3.3.1 Full Y-axis



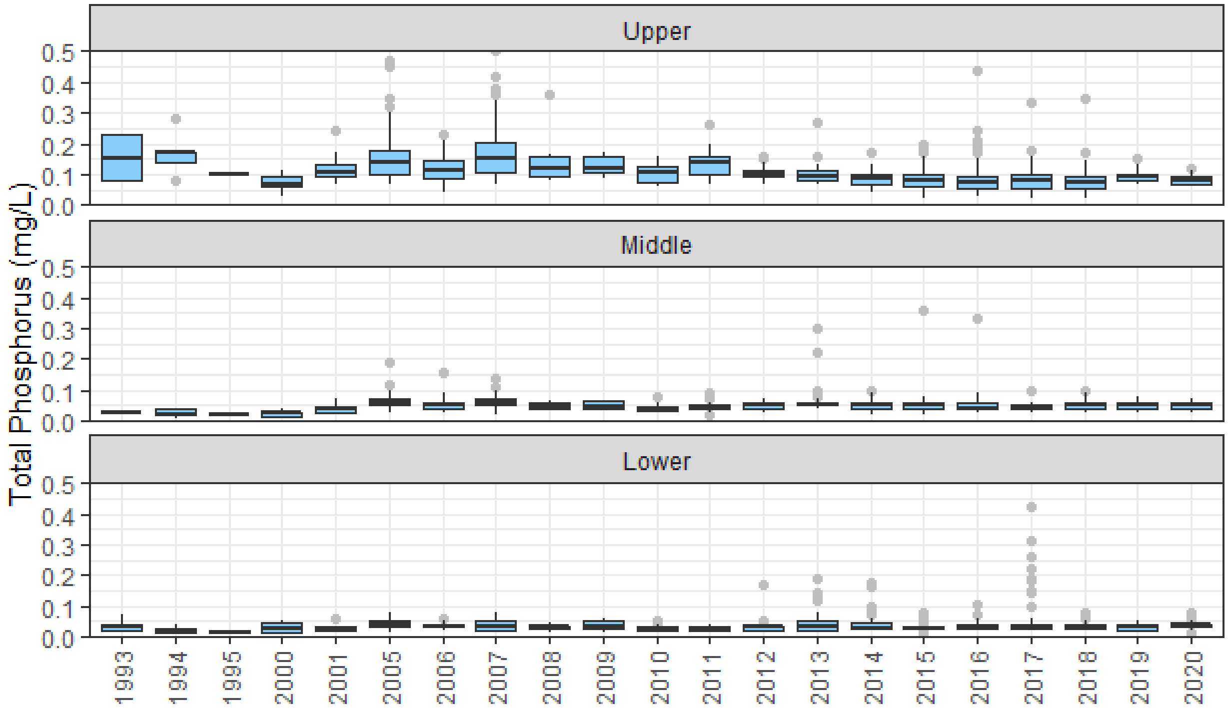


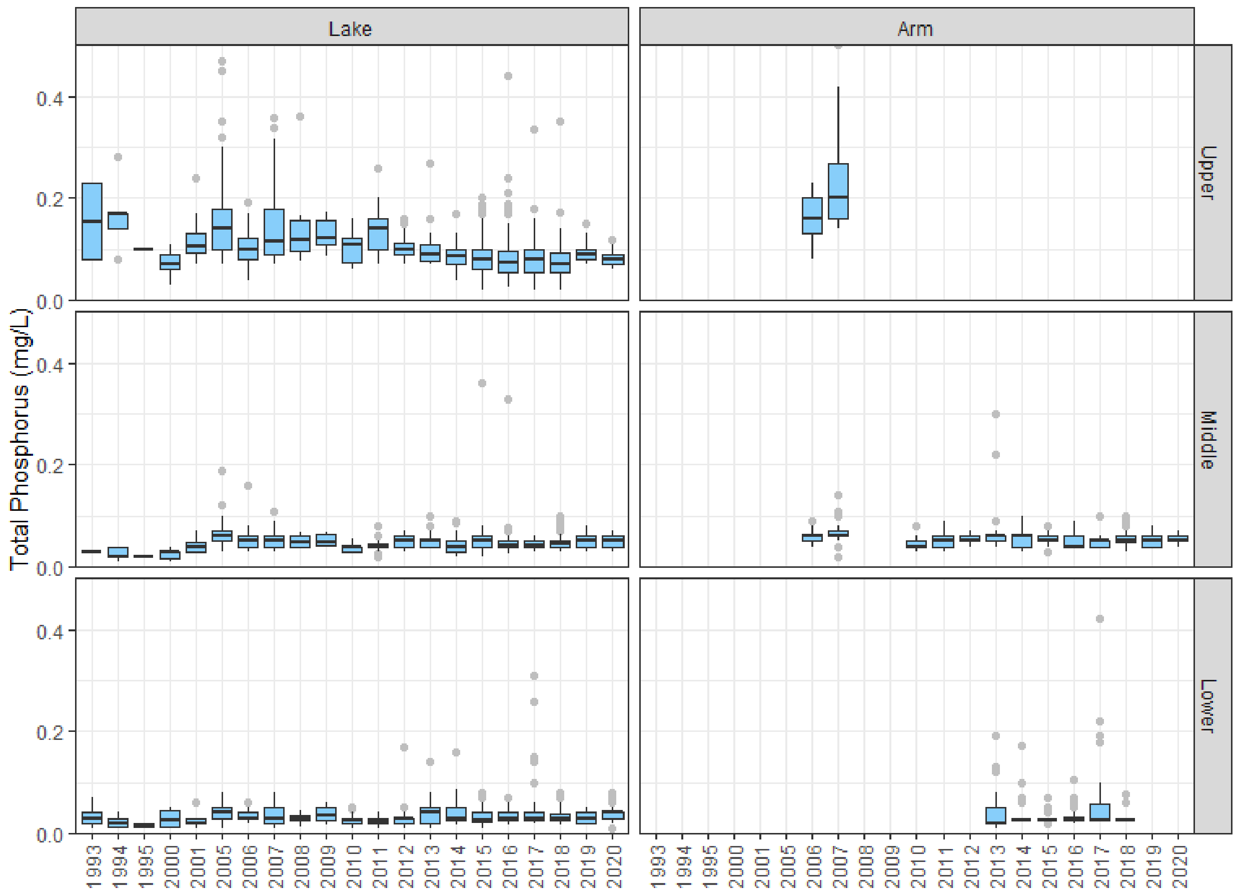
3.11.3.3.2 Clipped Y-axis

Given the wide range of data values, it is difficult to see trends in the typical values. Therefore, we also created a series of plots with a clipped y-axis. No underlying data are removed - so the distributions presented in the box plots remain the same. The plots below are clipped on the y-axis at the value (0.5).

LAKEUNIT	LOCATE	DATE	VALUE
Upper	Lake	2005-10-24	0.740
Upper	Lake	2005-10-24	0.580
Upper	Lake	2005-11-03	0.560
Upper	Arm	2007-08-22	0.710
Upper	Arm	2007-09-20	1.200
Upper	Lake	2007-10-03	0.620
Upper	Lake	2007-10-03	0.790
Upper	Lake	2007-10-03	0.620
Lower	Lake	2014-09-04	0.735
Upper	Lake	2015-10-26	0.550
Middle	Arm	2016-11-16	1.800

LAKEUNIT	LOCATE	DATE	VALUE
Lower	Arm	2017-01-25	0.550
Lower	Arm	2017-06-27	0.510





3.11.3.4 Historic versus Recent Comparison

We compare the data from early years (1993 to 2009) to recent years (2011 to 2020).

3.11.3.4.1 Mean Values

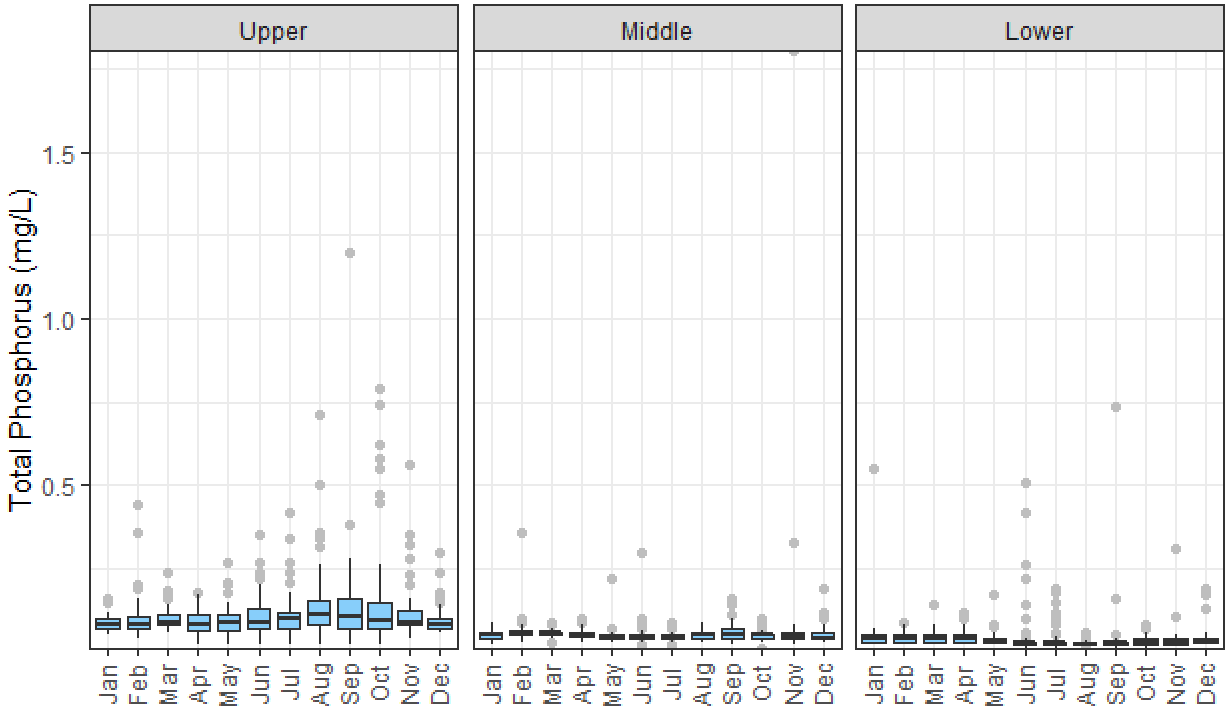
LAKEUNIT	HISTORIC	RECENT
Upper	0.16	0.09
Middle	0.05	0.05
Lower	0.03	0.04

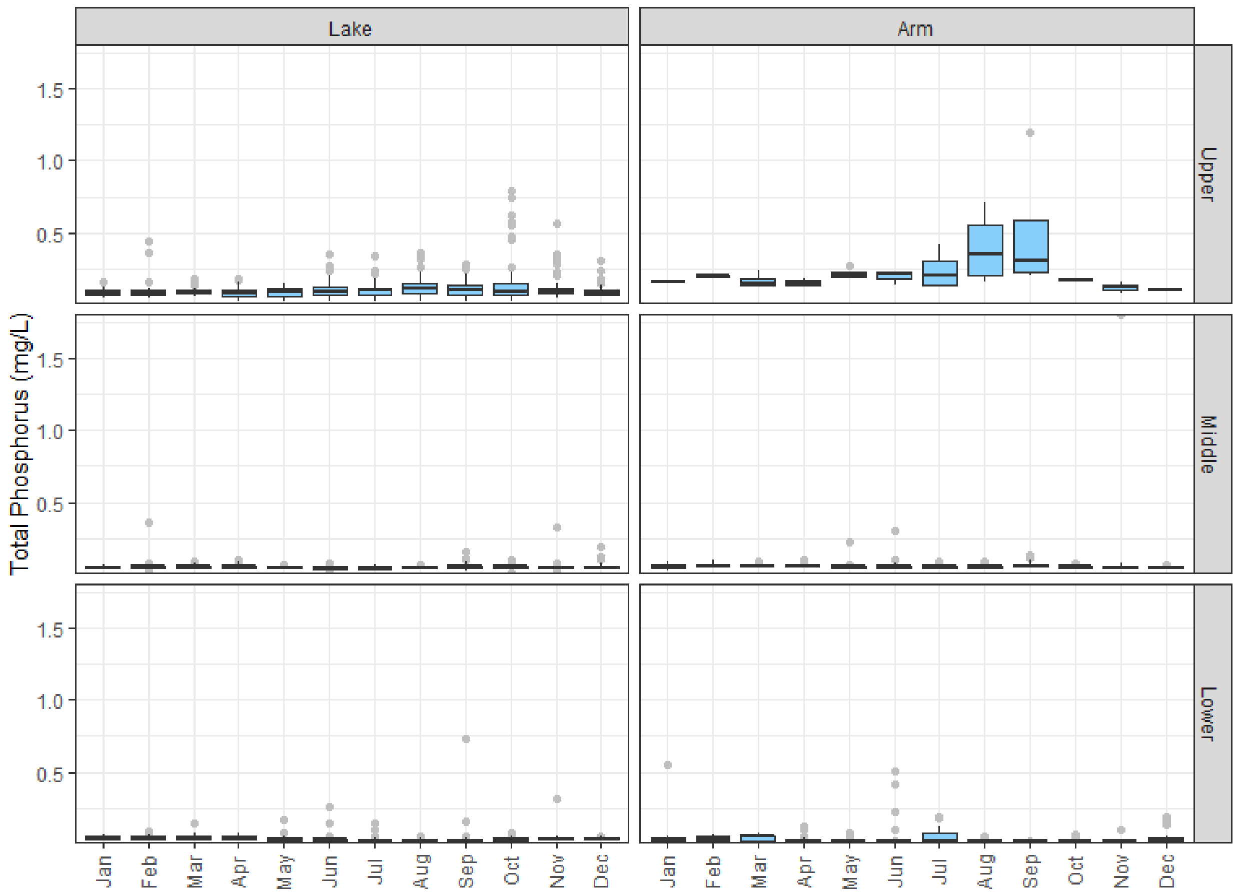
3.11.3.4.2 SD Values

LAKEUNIT	HISTORIC	RECENT
Upper	0.13	0.05
Middle	0.02	0.07
Lower	0.01	0.05

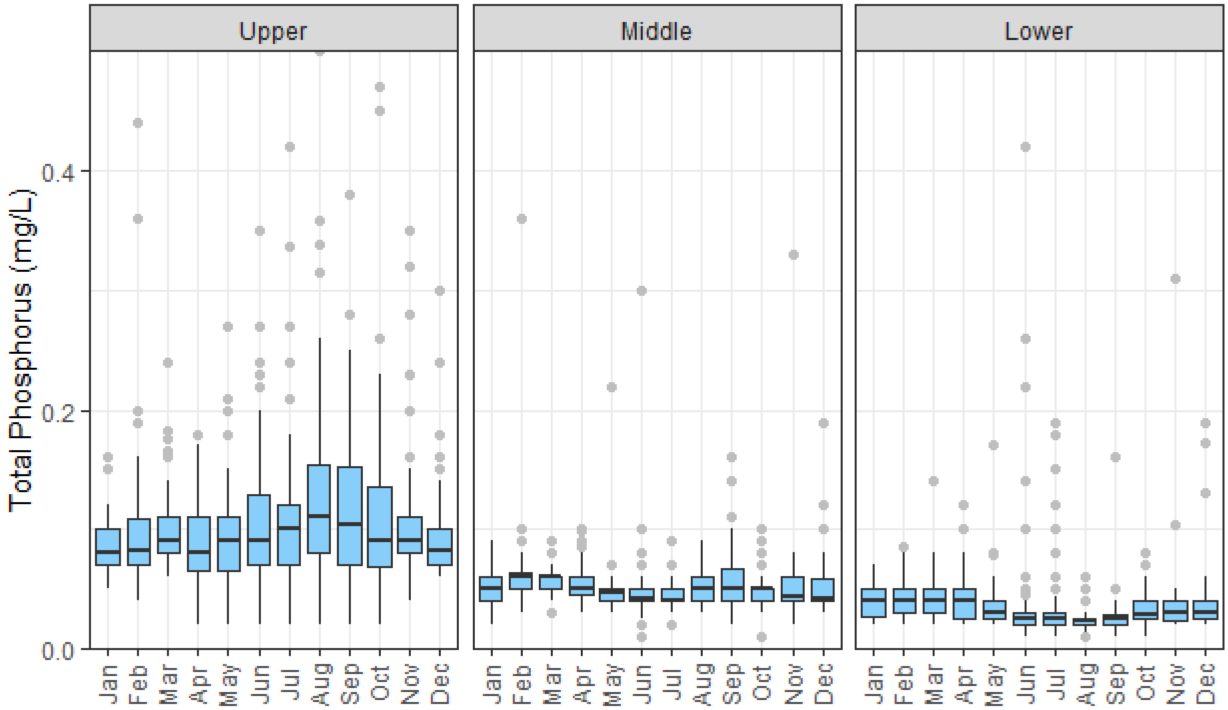
3.11.3.5 Seasonal Trends

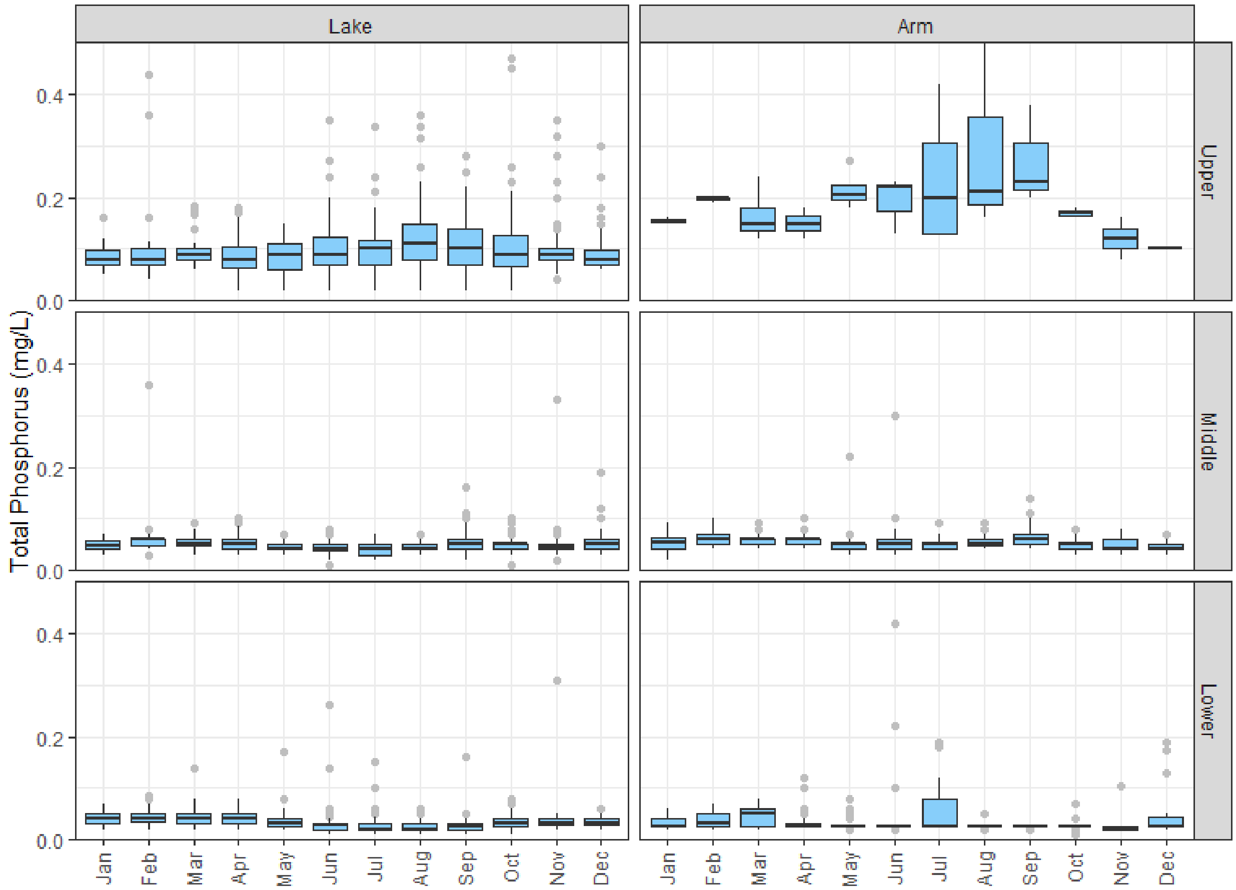
3.11.3.5.1 Full Y-axis



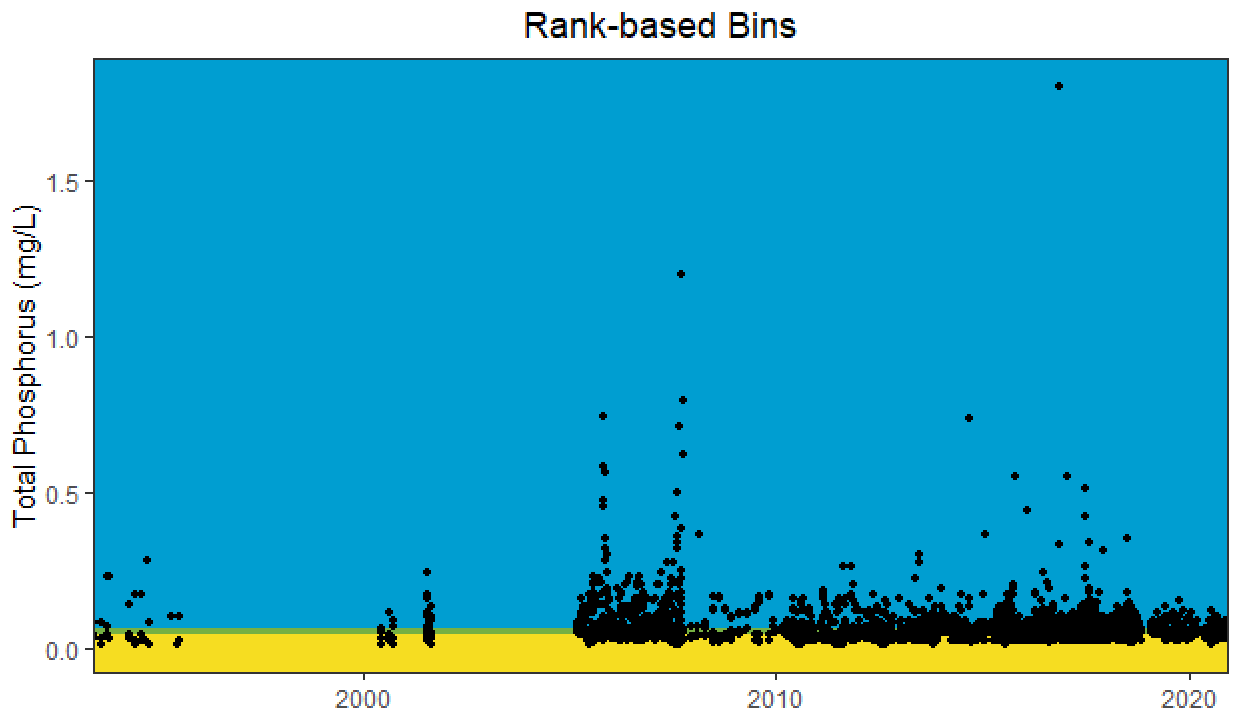

Lake
Arm
Upper
Middle
Lower
Total Phosphorus (mg/L)
1.5
1.0
0.5
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

3.11.3.5.2 Clipped Y-axis




Lake
Arm
Upper
Middle
Lower
Total Phosphorus (mg/L)
0.0
0.2
0.4
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

3.11.4 Proposed Bins



The cut points for the rank based bins are: -, 0.03989, 0.0604, . The median of all data is 0.05.

3.11.5 Export Merged Data

The merged data files represent all data gathered to date for this variable. We drop some of the information that was used as qaqc during prep and merging steps: SOURCETYPE, DEPTHTYPE, VARTYPE, VARLABEL. The final merged data are saved as: **tidy_totalp.rds** (data) and **tidy_totalp_summary.rds** (summary states for LAKEUNIT by MONTH: N, NYears, Mean, SD). Both are also saved to Excel.

The final data include data received from: ralpud, caae, durmCity, storetDwr, storetUsgs.

Code authored by KDV Decision Analysis LLC and last run 2024-09-19 with R version 4.4.1 (2024-06-14 ucrt).

3.12 Merge All Toxin Data

3.12.1 Gather Data Resources

Files exported from dataPrep with the “_ana”, “_cyl”, or “_mic” suffices, but excluding OHHABS data:

3.12.1.1 City of Raleigh Data

We had two sources of City of Raleigh toxin data, referenced as sources **raltoxin** and **ralpud**. Together these covered the years 2016 to 2018. Both were from the same collection events by the City of Raleigh, but contained different subsets of the data. Here we compare and merge the two sources. This process requires checking for duplicate entries, a process complicated by their use of different station ids. Once the data are merged, we apply the SOURCE label: **raleigh**

3.12.1.1.1 H5Anatoxin-a

```
##
##       Honeycutt Creek Intake Surface Lower Barton Creek New Light Creek
##   2017               8            10                  8              8
##   2018              10             9                 10             10
##
##       Upper Barton Creek US Hwy 98
##   2017                  8        8
##   2018                 10       10

##
##       Honeycutt Creek Intake Surface Lower Barton Creek New Light Creek
##   2016              12            12                 11             12
##   2017               8            10                  8              8
##   2018              10             9                 10             10
##
##       Upper Barton Creek US Hwy 98
##   2016                 12       12
##   2017                  8        8
##   2018                 10       10
```

Comparison of the two Raleigh data sources show duplication of years, but differences in site names. The **ralpud** data report for years 2017 and 2018 and the **raltoxin** data report for years 2018, 2017, and 2016. After adjusting station names, we identified and removed duplicates based on matching DATE + STATION + VALUE. This assumes there cannot be two identically valued samples taken from the same site on the same date.

The anatoxin-a data contributed by City of Raleigh:

```
##
##    Honeycutt Creek     Intake Surface Lower Barton Creek    New Light Creek
##                 48                 50                 47                 48
## Upper Barton Creek          US Hwy 98
##                 48                 48

##
##      Upper     Middle      Lower Other Lake
##          0          0        289          0

##
## 2016 2017 2018
##   71  100  118

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##  18  30  30  30  28  30  29  20  20  18  18  18
```

3.12.1.1.2 H5Cylindrospermopsin

The Raleigh data structure and sample effort for cylindrospermopsin was identical to that of anatoxin-a shown above.

```
##
##   Honeycutt Creek    Intake Surface Lower Barton Creek    New Light Creek
##                48                50                47                48
## Upper Barton Creek         US Hwy 98
##                48                48

##
##      Upper     Middle      Lower Other Lake
##          0          0        289          0

##
## 2016 2017 2018
##   71  100  118

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##  18  30  30  30  28  30  29  20  20  18  18  18
```

3.12.1.1.3 H5Microcystin

The Raleigh data structure and sample effort for microcystin was identical to that of anatoxin-a shown above.

```
##
##   Honeycutt Creek    Intake Surface Lower Barton Creek    New Light Creek
##                48                50                47                48
## Upper Barton Creek         US Hwy 98
##                48                48

##
##      Upper     Middle      Lower Other Lake
##          0          0        289          0

##
## 2016 2017 2018
##   71  100  118

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##  18  30  30  30  28  30  29  20  20  18  18  18
```

3.12.1.2 EC Toxin Data

These data cover 2007 to 2012 and are assumed to have been collected from the Falls Lake intake. The majority of the samples are non-detects, but there are some detections. Given the years are non-overlapping with the City of Raleigh data, these are not duplicated records and we merge them directly in.

The sample effort is identical for anatoxin-a, cylindrospermopsin, and microcystin.

3.12.1.2.1 H5anatoxin-a

```
##
##   Honeycutt Creek    Intake Surface Lower Barton Creek   New Light Creek
##              48              90              47              48
## Upper Barton Creek        US Hwy 98
##              48              48

##
##     Upper    Middle     Lower Other Lake
##         0         0       329         0

##
## 2007 2008 2009 2010 2011 2012 2016 2017 2018
##    3    4    7   12   11    3   71  100  118

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##  21  33  33  32  30  33  34  25  25  21  21  21
```

3.12.1.2.2 H5cylindrospermopsin

```
##
##   Honeycutt Creek    Intake Surface Lower Barton Creek   New Light Creek
##              48              90              47              48
## Upper Barton Creek        US Hwy 98
##              48              48

##
##     Upper    Middle     Lower Other Lake
##         0         0       329         0

##
## 2007 2008 2009 2010 2011 2012 2016 2017 2018
##    3    4    7   12   11    3   71  100  118

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##  21  33  33  32  30  33  34  25  25  21  21  21
```

3.12.1.2.3 H5microcystin

```
##
##   Honeycutt Creek    Intake Surface Lower Barton Creek   New Light Creek
##              48              90              47              48
## Upper Barton Creek        US Hwy 98
##              48              48

##
##     Upper    Middle     Lower Other Lake
##         0         0       329         0
```

```
##
## 2007 2008 2009 2010 2011 2012 2016 2017 2018
##    3    4    7   12   11    3   71  100  118

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##  21  33  33  32  30  33  34  25  25  21  21  21
```

3.12.1.3 NCSU Toxin Data

These data (emilyToxin), a collection from Emily Pierce's doctoral research with Astrid Schnetzer, cover the years 2019 to 2021. They are not duplicated within other data resources and can be merged directly. Emily measured dissolved, particulate, and accumulated dissolved (SPATT) samples. In the data prep step, we merged the dissolved and particulate to report total toxin per sample. Not all dates had both measures; only dates with both measures could be included with a calculated total. The SPATT data are ignored here (and handled elsewhere).

Sample effort and available data differ across the toxins.

3.12.1.3.1 H5Anatoxin-a Data

```
##
## emilyToxins
##          74

##
##      Upper     Middle      Lower Other Lake
##         26         22         26          0

##
## 2019 2020 2021
##   15   29   30

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##   3   3   3   5   3   7   6   8   9   9   9   9
```

3.12.1.3.2 YH5Microcystin Data

```
##
## emilyToxins
##         290

##
##      Upper     Middle      Lower Other Lake
##         50        162         78          0

##
## 2019 2020 2021
##   57  124  109
```

```
##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##  10   8  20  22  10  32  27  30  33  32  33  33
```

3.12.1.3.3 H5Cylindrospermopsin Data

```
##
## emilyToxins
##         101

##
##      Upper     Middle      Lower Other Lake
##         19         62         20          0

##
## 2019 2020 2021
##   25   46   30

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##   4   4   8  10   3  16   8   9  10   9  10  10
```

3.12.2 Merge Data Sources

We assembled 403 of Anatoxin-a records into a single tidy dataframe. This included data from Raleigh (289 records), EC Toxin Data (40 records), and NCSU Toxin Data (74 records)

We assembled 430 of cylindrospermopsin records into a single tidy dataframe. Raleigh data (289 records), EC Toxin Data (40 records), and NCSU Toxin Data (101 records).

We assembled 619 of microcystin records into a single tidy dataframe. Raleigh (289 records), EC Toxin Data (40 records), and NCSU Toxin Data (290 records).

The merged data were qaqc'ed to confirm:

-only one variable is present -no NA values are present -only one measurement unit is present (OR if more that one is present, additional processing is required)

```
##
##     ecToxin emilyToxins      ralpud    raltoxin
##          40          74         109         180

##
##      Upper     Middle      Lower Other Lake
##         26         22        355          0

##
## 2007 2008 2009 2010 2011 2012 2016 2017 2018 2019 2020 2021
##    3    4    7   12   11    3   71  100  118   15   29   30

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##  24  36  36  37  33  40  40  33  34  30  30  30
```

```
##
##     ecToxin emilyToxins      ralpud    raltoxin
##          40        101         109         180

##
##      Upper     Middle      Lower Other Lake
##         19         62        349          0

##
## 2007 2008 2009 2010 2011 2012 2016 2017 2018 2019 2020 2021
##    3    4    7   12   11    3   71  100  118   25   46   30

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##  25  37  41  42  33  49  42  34  35  30  31  31

##
##     ecToxin emilyToxins      ralpud    raltoxin
##          40        290         109         180

##
##      Upper     Middle      Lower Other Lake
##         50        162        407          0

##
## 2007 2008 2009 2010 2011 2012 2016 2017 2018 2019 2020 2021
##    3    4    7   12   11    3   71  100  118   57  124  109

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##  31  41  53  54  40  65  61  55  58  53  54  54
```

3.12.2.1 Inspect Merged Data

These toxin data cover all months, but not all lake units. We have no toxin data from the upper lake. Middle lake, the samples all come from sites labelled as “arm”, while the lower lake samples are equally distributed between “arm” and “lake” samples.

These data had no values that could be flagged as obvious data errors. There are some extreme values, but we retain these pending review by the SME and TAW teams.

3.12.2.2 Value Sets

The unique values found in key columns (across all toxins):

- **SOURCE**: ecToxin, emilyToxins, ralpud, and raltoxin
- **STATIONID**: Honeycutt Creek, Intake Surface, LC01, LI01, LLC01, Lower Barton Creek, NEU013, NEU013B, NEU0171B, NEU018E, NEU019E, NEU019L, NEU019P, NEU020D, New Light Creek, Upper Barton Creek, and US Hwy 98
- **YEARS**: 2007, 2008, 2009, 2010, 2011, 2012, 2016, 2017, 2018, 2019, 2020, and 2021

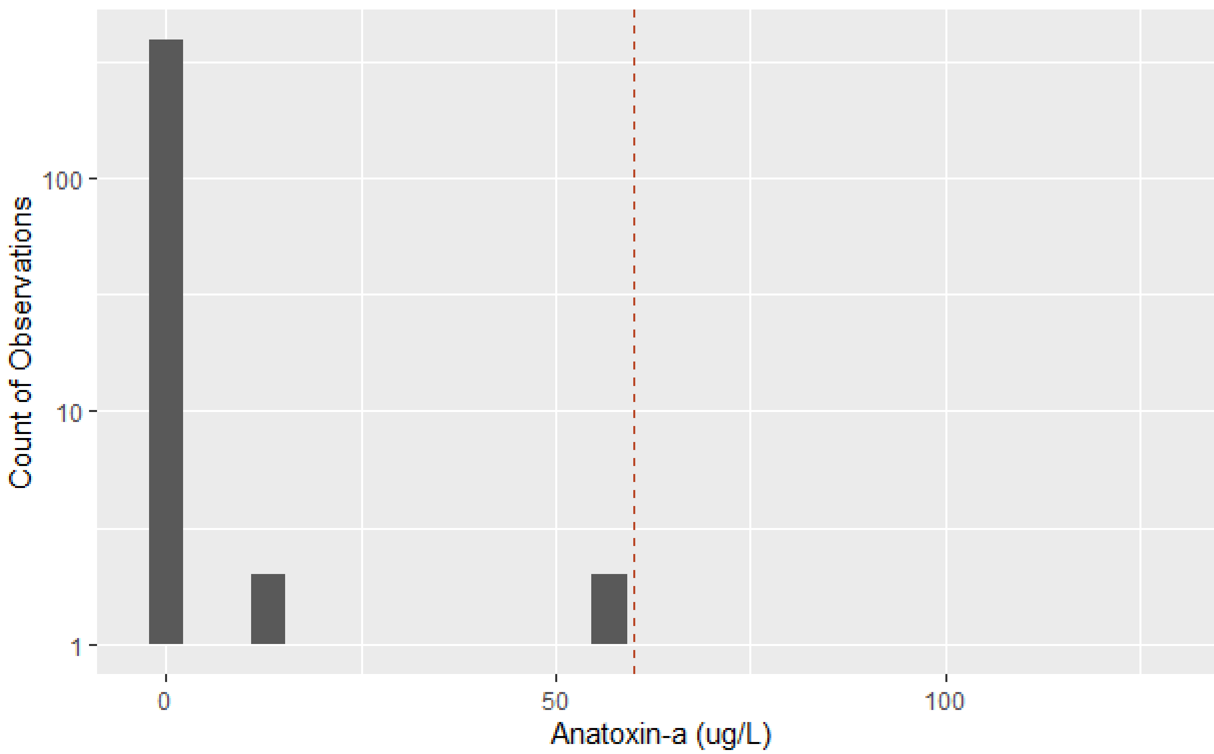
3.12.3 Data Summarries

3.12.3.1 Anatoxin-a

3.12.3.1.1 Check for and Remove Errors

These data had no values that could be flagged as obvious data errors. There are some extreme values, but we retain these pending review by the SME and TAW teams.

Quantiles	ana.value
0%	0.01575
10%	0.02775
20%	0.05000
30%	0.05000
40%	0.05000
50%	0.05000
60%	0.05000
70%	0.05000
80%	0.10000
90%	0.18000
100%	127.00000



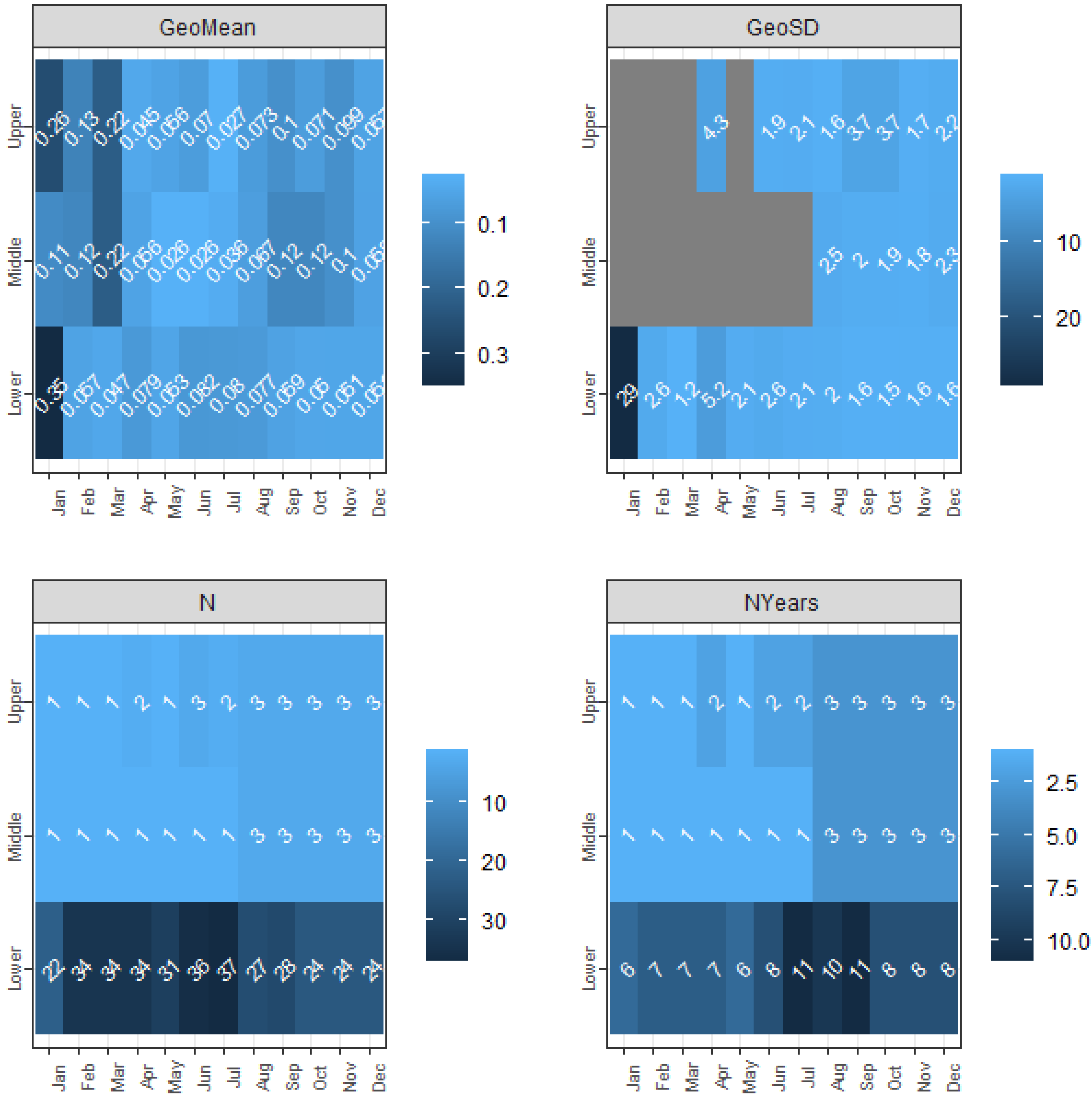
Check for and Remove Duplicates

All records with equal DATE, STATIONID, and VALUE are treated as duplicates are dropped.

```
##
##    ecToxin emilyToxins      ralpud    raltoxin
##        40         74         109          71
```

Of all data received (403 records), there are 109 duplicates (shared DATE, STATIONID, and measured VALUE). There are 294 remaining observations.

3.12.3.1.2 Sample Effort and Values



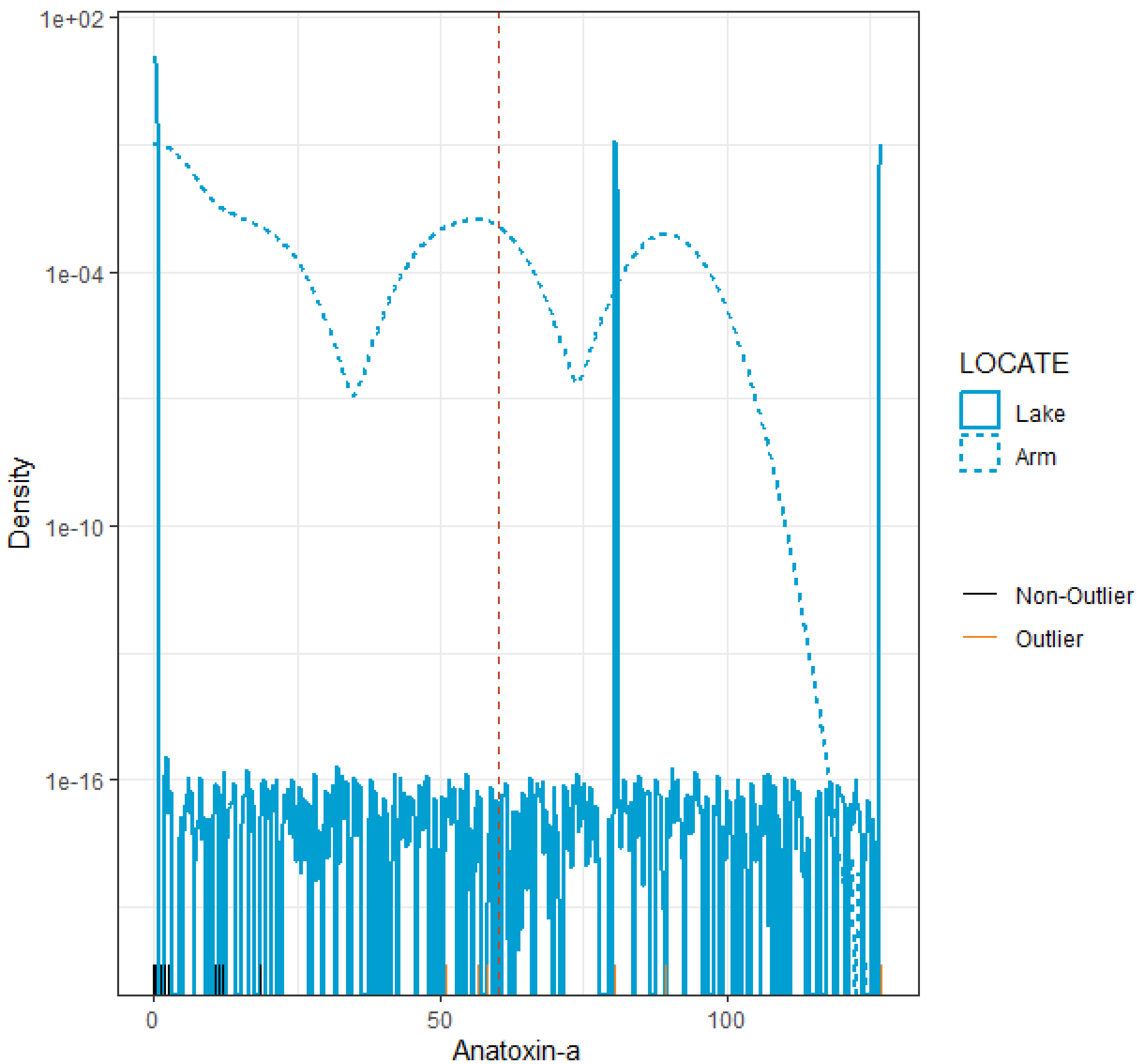
Of all available anatoxin-a samples (N = 294), 3 exceed the critical value of 60 ug/L.

```
##         DATE        STATION LAKEUNIT VALUE
## 1 2016-01-26  Intake Surface    Lower  80.5
## 2 2016-01-26 Honeycutt Creek    Lower  89.4
## 3 2016-01-26       US Hwy 98    Lower 127.0
```

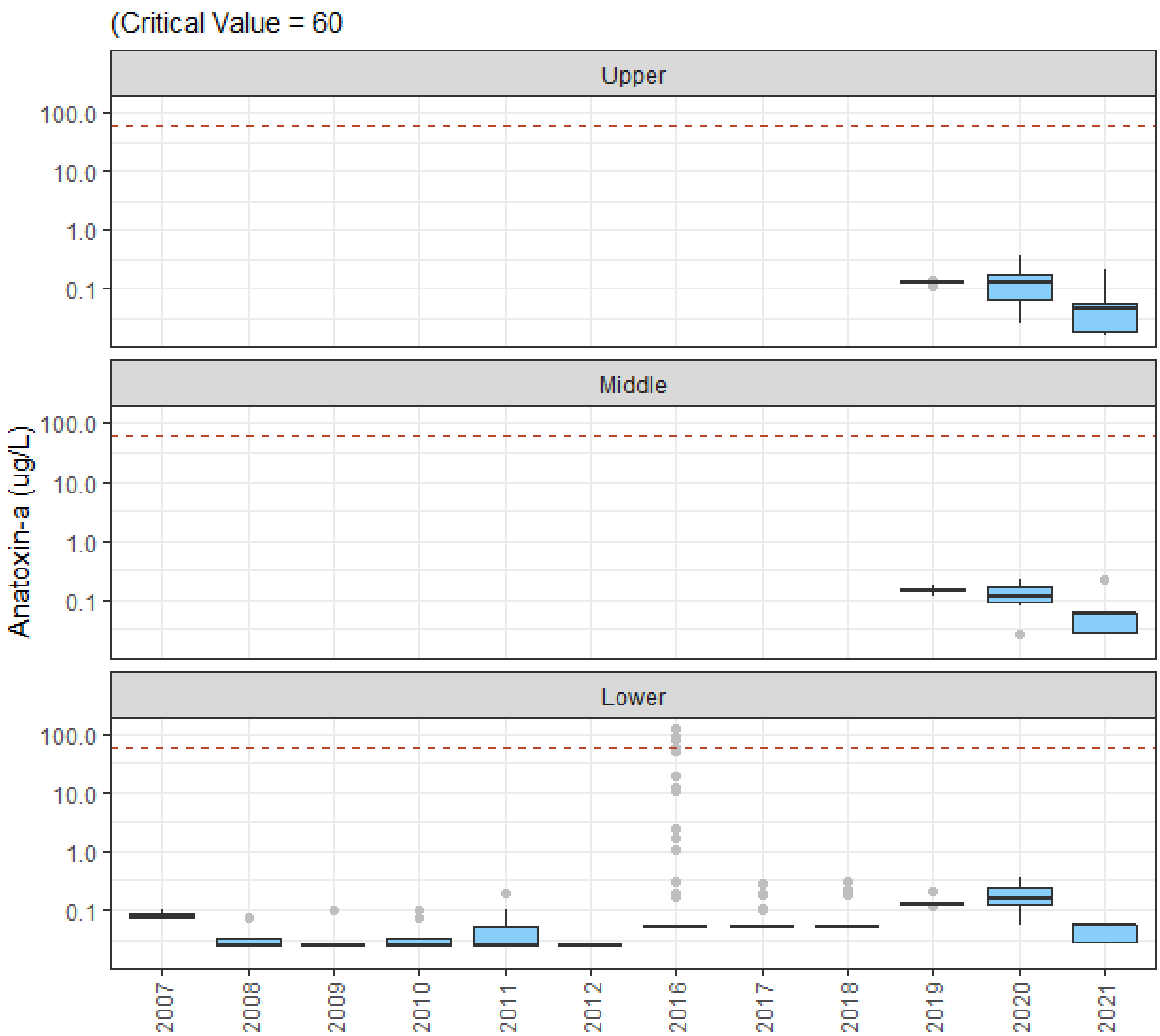
Except for this one date, anatoxin-a measures have been low for all months, all years, and all stations in our data. However, the upper lake is extremely undersampled. Also, January, the only month with documented anatoxin-a exceedance, has the least samples of all months.

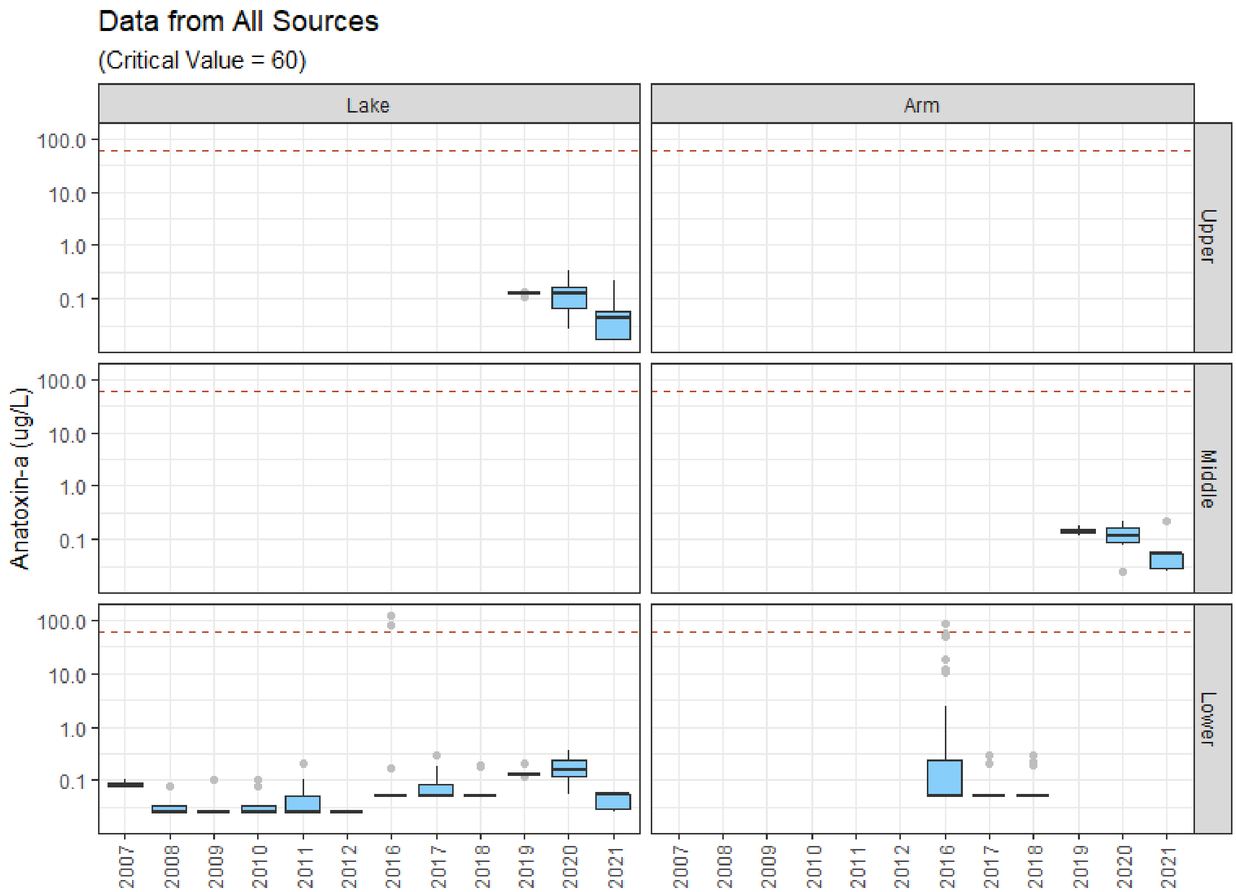
3.12.3.1.3 Density Plot and Outliers

The distribution of all lake (thalweg) values is shown as the blue solid line and the lake arm values are shown as the blue dashed line. Below the density plot are rug marks for each observed value. The orange rug marks are values greater than three standard deviations from the overall mean (1.8409481). The SD of all data, thalweg and arms, is 11.6167858. The extreme values (+/- 3SD) are retained for our model project as true, but unusual, values - unless our TAW or SME teams indicate these are data errors.

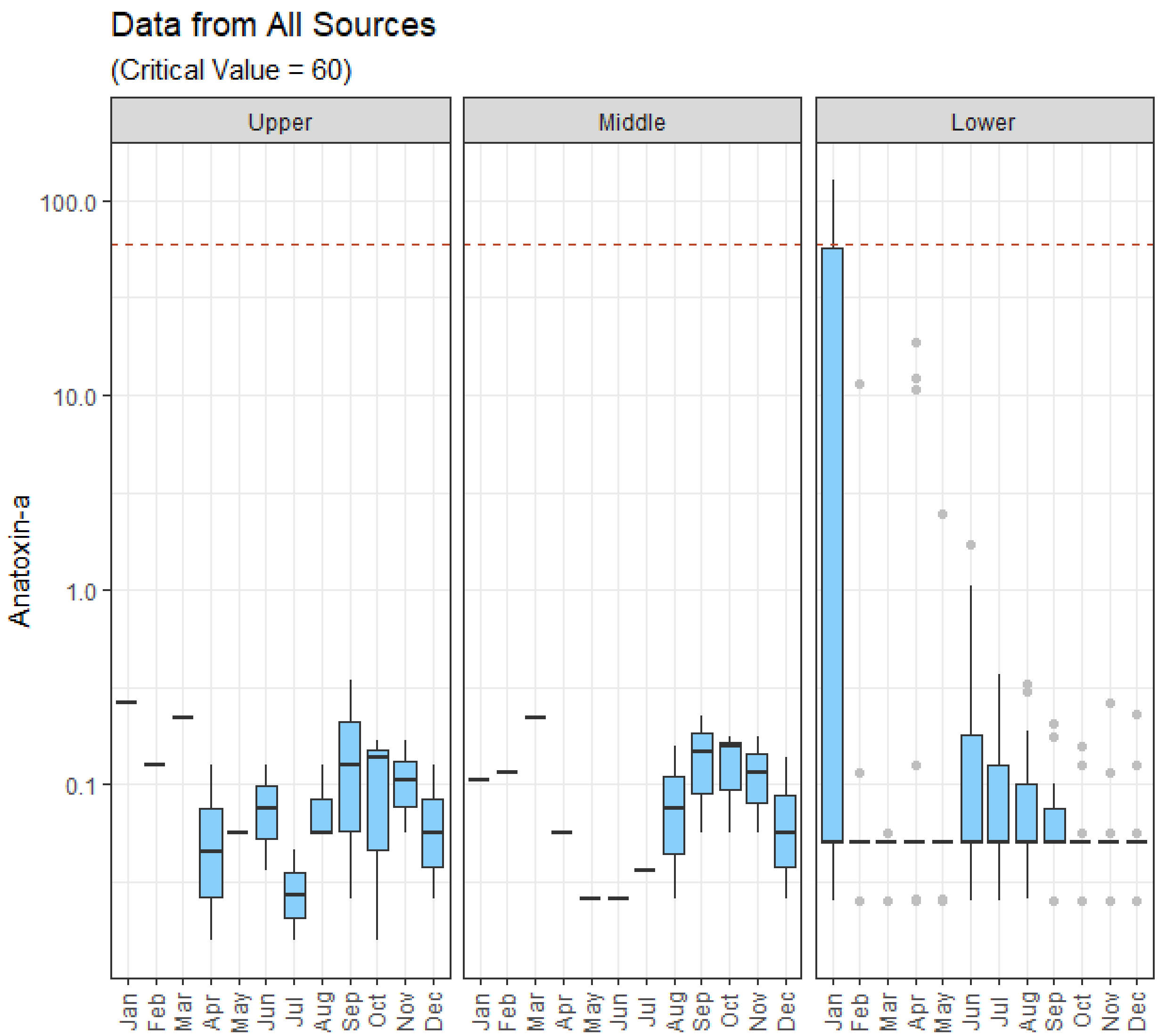


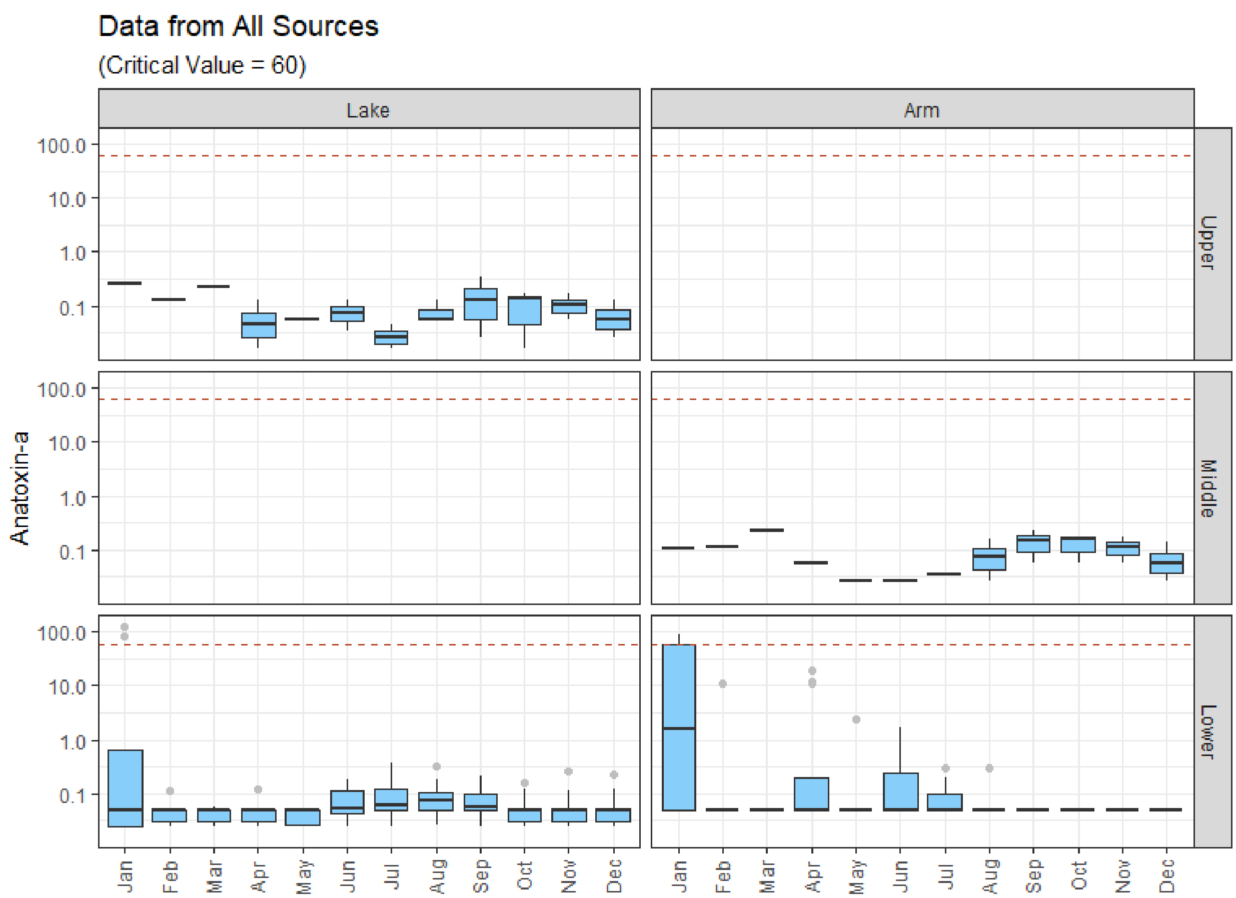
3.12.3.2 Annual Variance



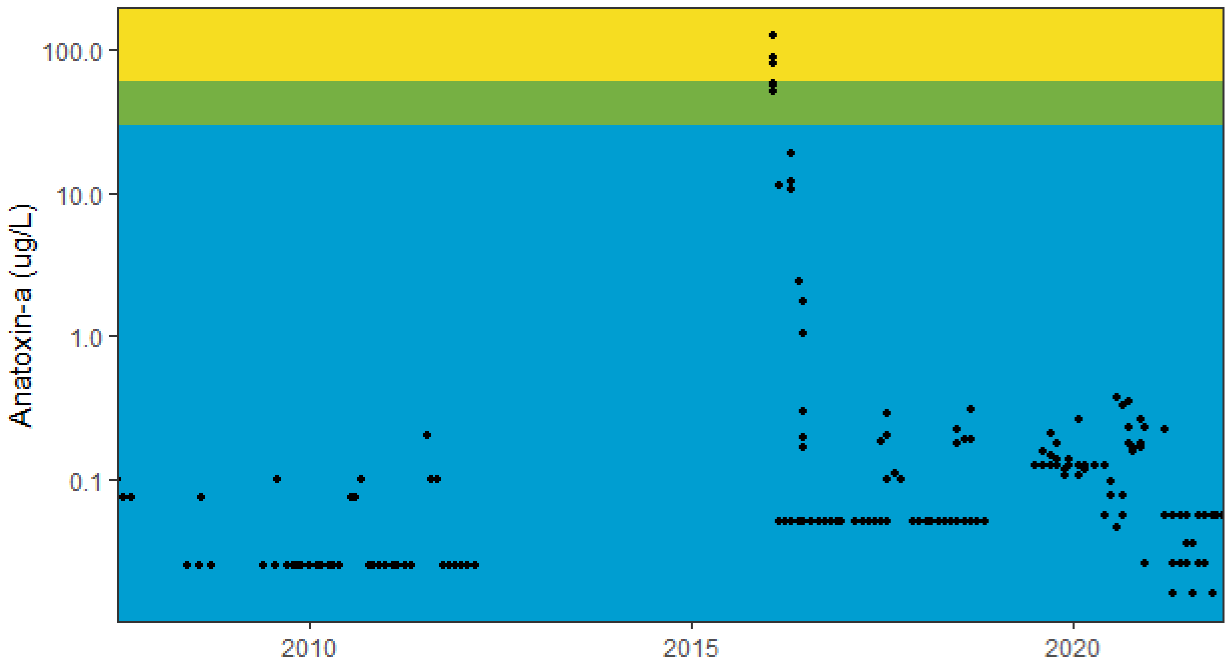

Data from All Sources
(Critical Value = 60)
Lake
Arm
Upper
Middle
Lower
Anatoxin-a (ug/L)
100.0
10.0
1.0
0.1
2007
2008
2009
2010
2011
2012
2016
2017
2018
2019
2020
2021

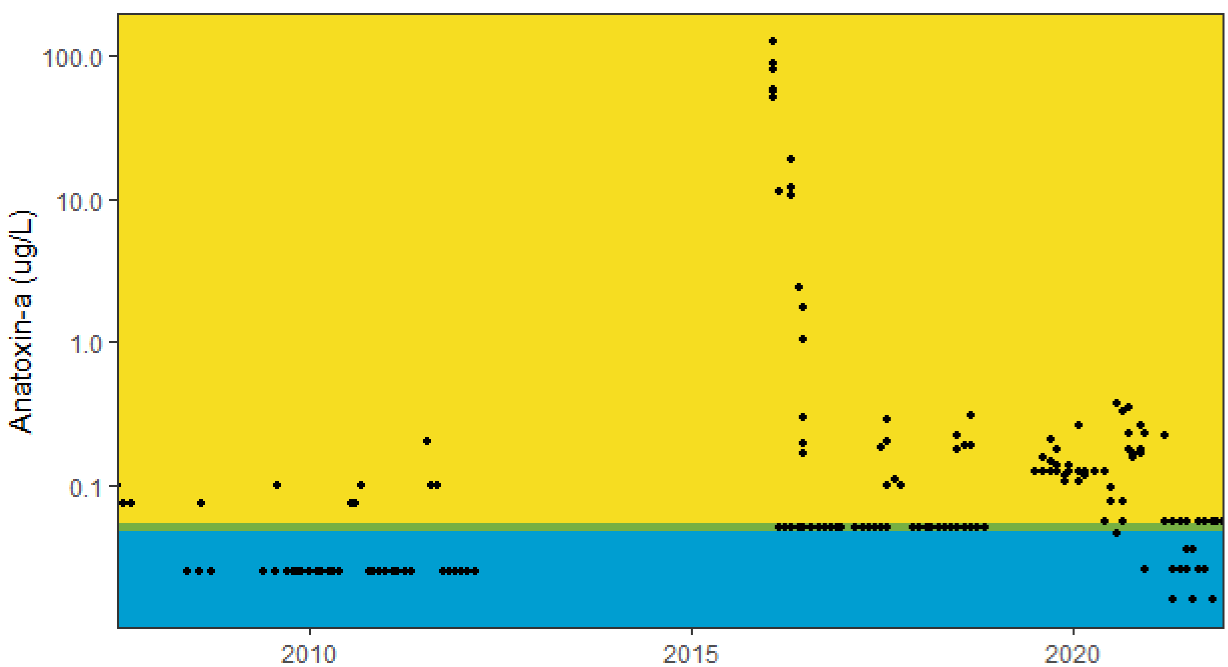
3.12.3.3 Seasonal Trends

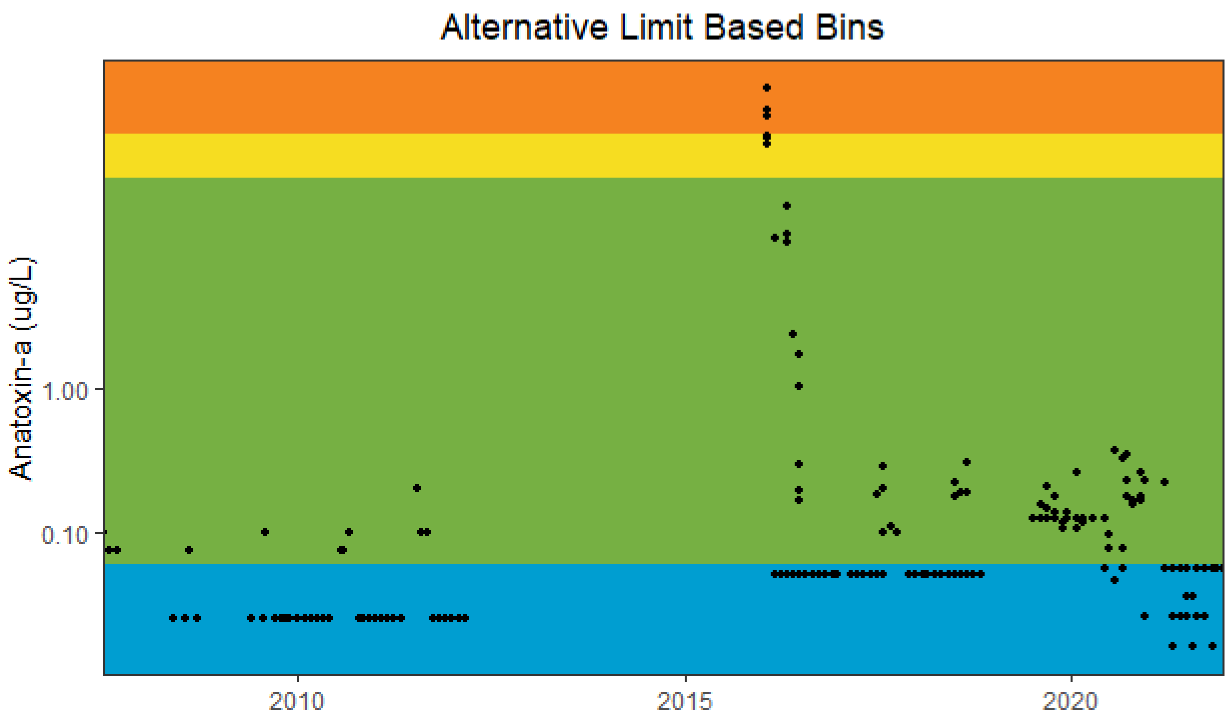




Proposed Bins


100.0
10.0
1.0
0.1
Anatoxin-a (ug/L)
2010
2015
2020


100.0
10.0
1.0
0.1
Anatoxin-a (ug/L)
2010
2015
2020



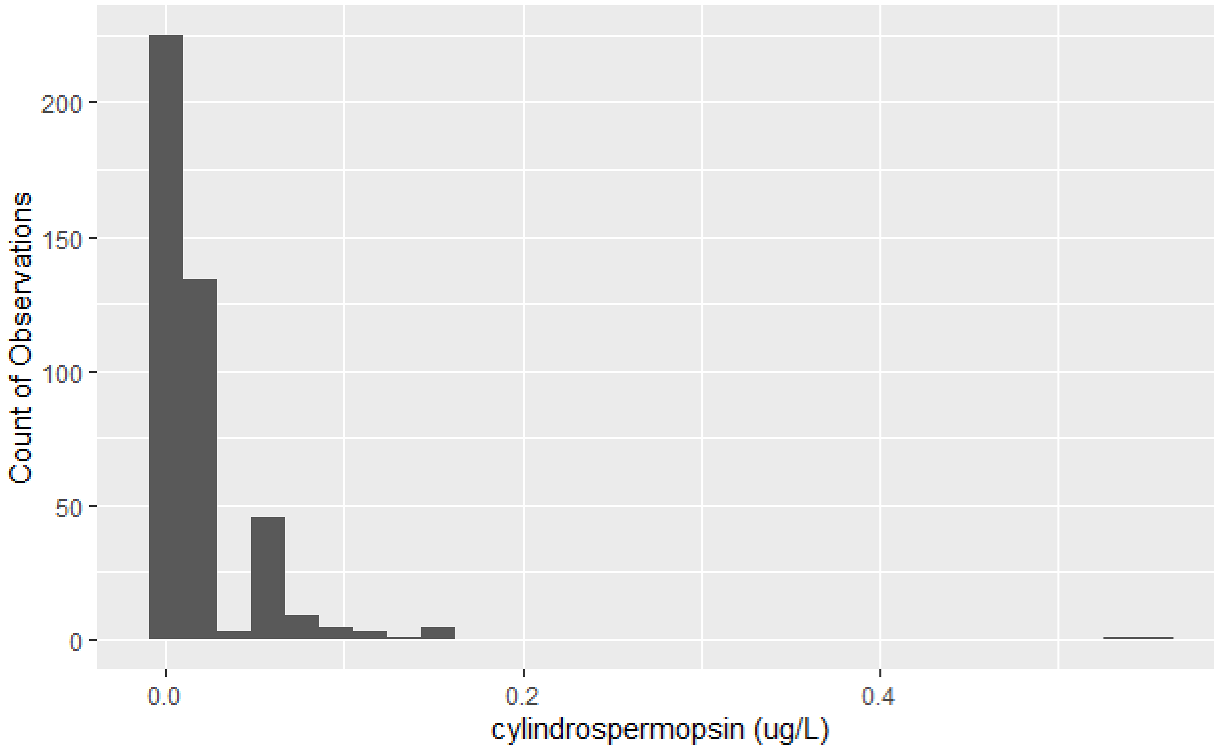
One option is limit based bins (ND to 30, 30 to 60, > 60). Another is rank based bins with cut points: -, 0.047875, 0.052875, .

3.12.3.4 Cylindrospermopsin

3.12.3.4.1 Check for and Remove Errors

These data had no values that could be flagged as obvious data errors. There are some extreme values, but we retain these pending review by the SME and TAW teams.

Quantiles	ChlA.value
0%	0.0050
10%	0.0050
20%	0.0050
30%	0.0050
40%	0.0050
50%	0.0050
60%	0.0130
70%	0.0223
80%	0.0223
90%	0.0500
100%	0.5600



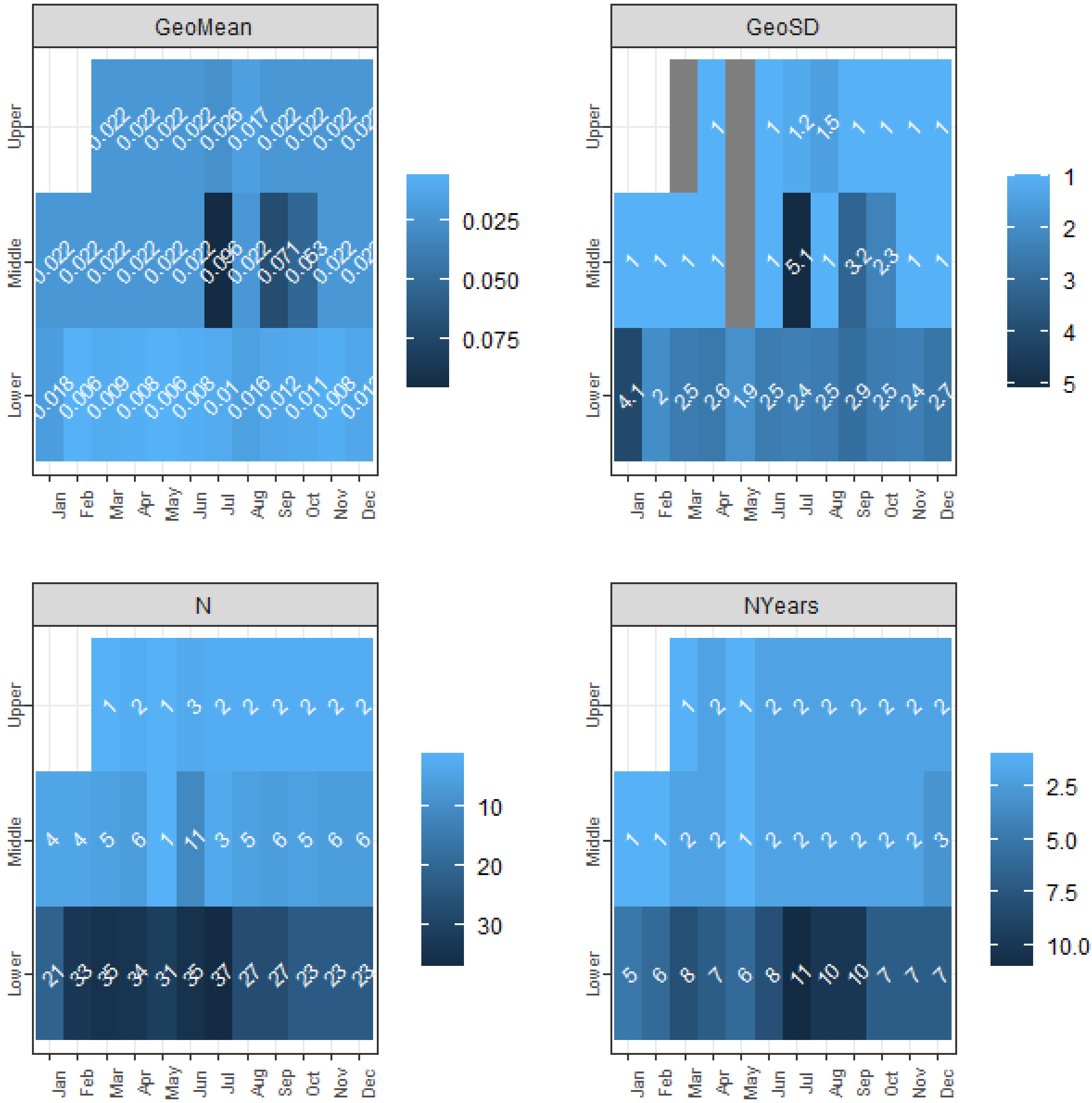
Check for and Remove Duplicates

All records with equal DATE, STATIONID, and VALUE are treated as duplicates are dropped.

```
##
##    ecToxin emilyToxins      ralpud    raltoxin
##         40         101         109          71
```

Of all data received (430 records), there are 109 duplicates (shared DATE, STATIONID, and measured VALUE). There are 321 remaining observations.

3.12.3.4.2 Sample Effort and Values

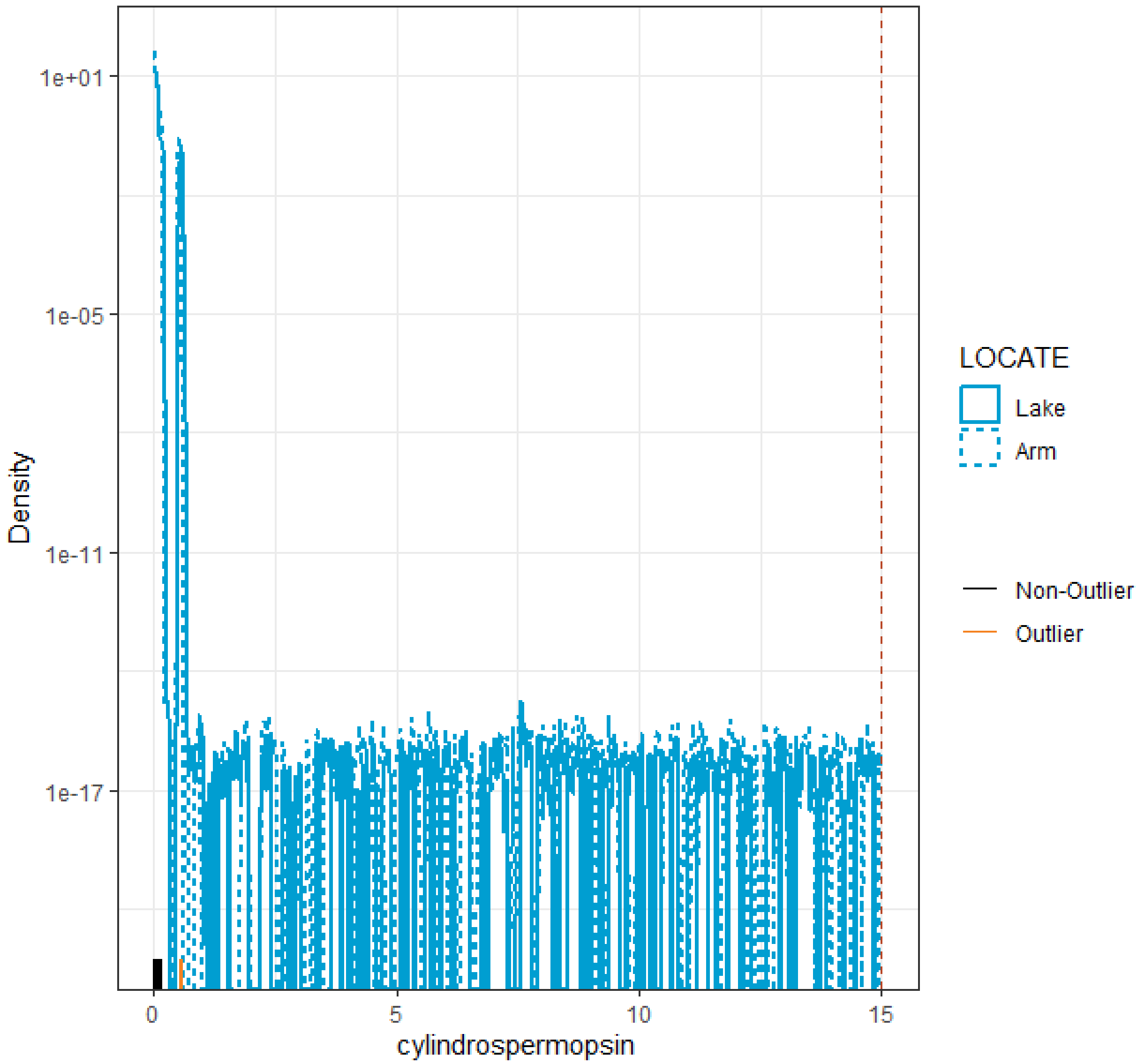


Of all available cylindrospermopsin samples (N = 321), 0 exceed the critical value of 15 ug/L.

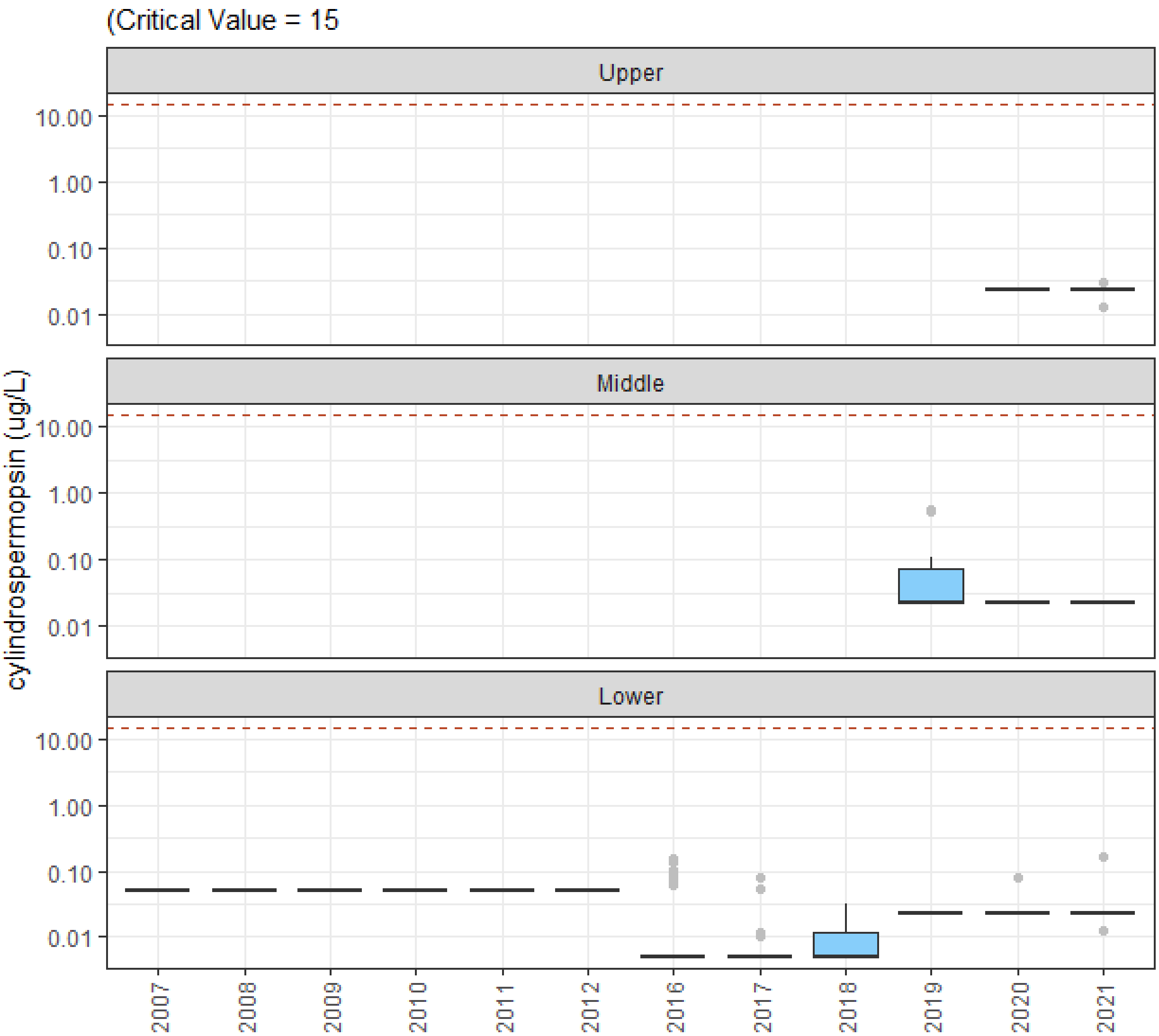
The figure data look odd (highest geometric mean values in upper lake unit) due to (1) almost all measures are below detection and (2) detection limits for samples in upper lake were higher than elsewhere. Notice higher variance in middle and lower lakes where more samples have been taken and some measures have been above detection limits.

3.12.3.5 Density Plot and Outliers

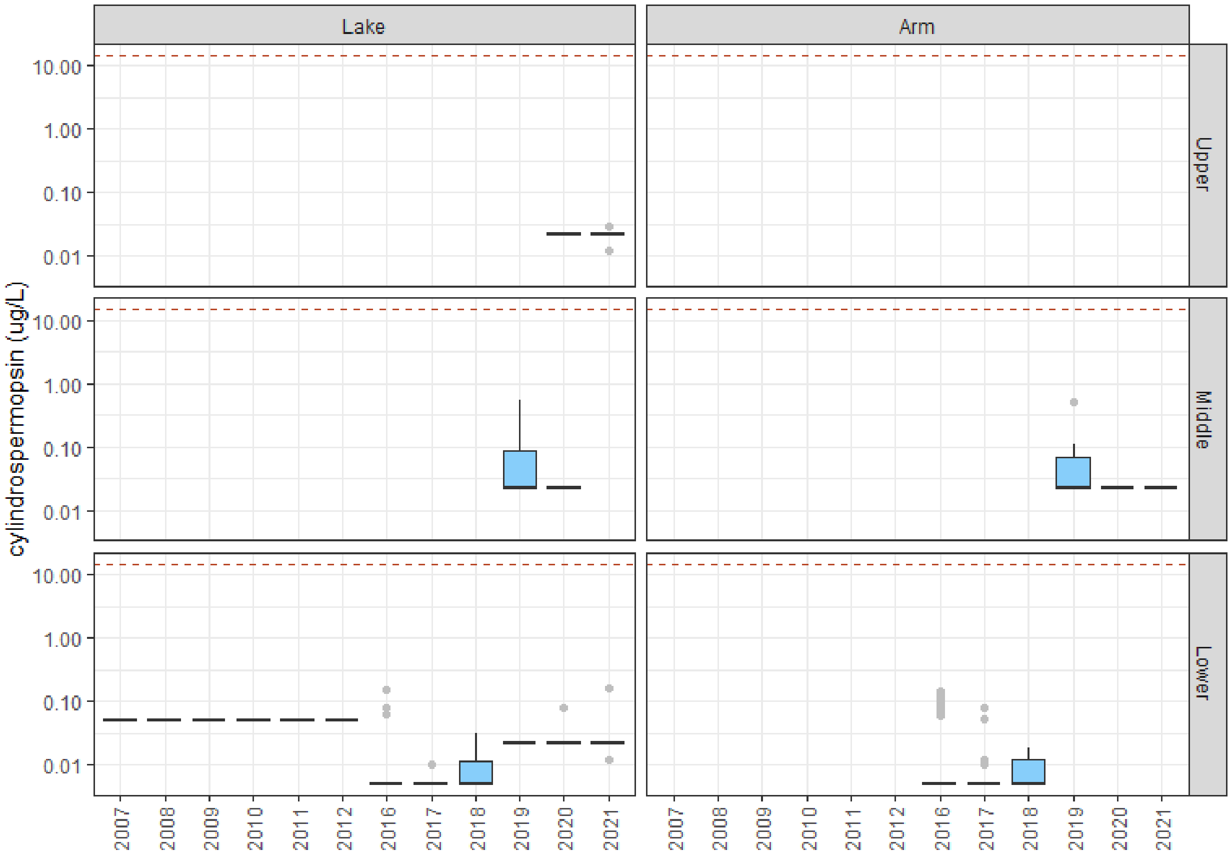
The distribution of all lake (thalweg) values is shown as the blue solid line and the lake arm values are shown as the blue dashed line. Below the density plot are rug marks for each observed value. The orange rug marks are values greater than three standard deviations from the overall mean (0.0261882). The SD of all data, thalweg and arms, is 0.0490077. The extreme values (+/- 3SD) are retained for our model project as true, but unusual, values - unless our TAW or SME teams indicate these are data errors.



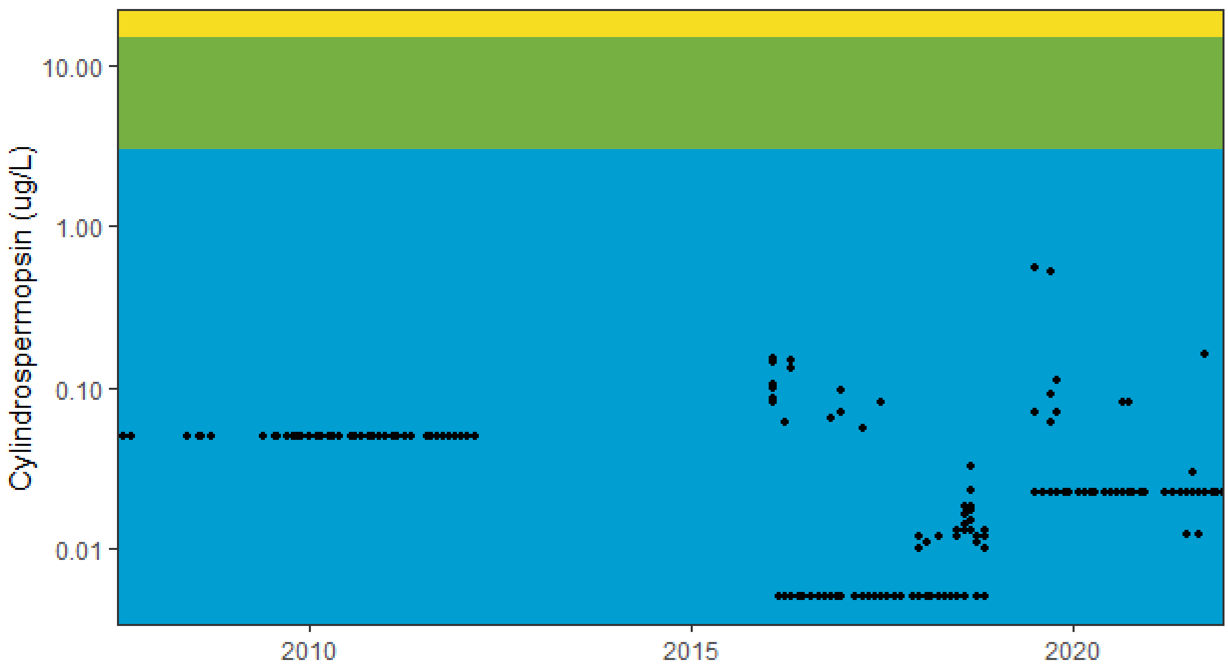
3.12.3.6 Annual Variance



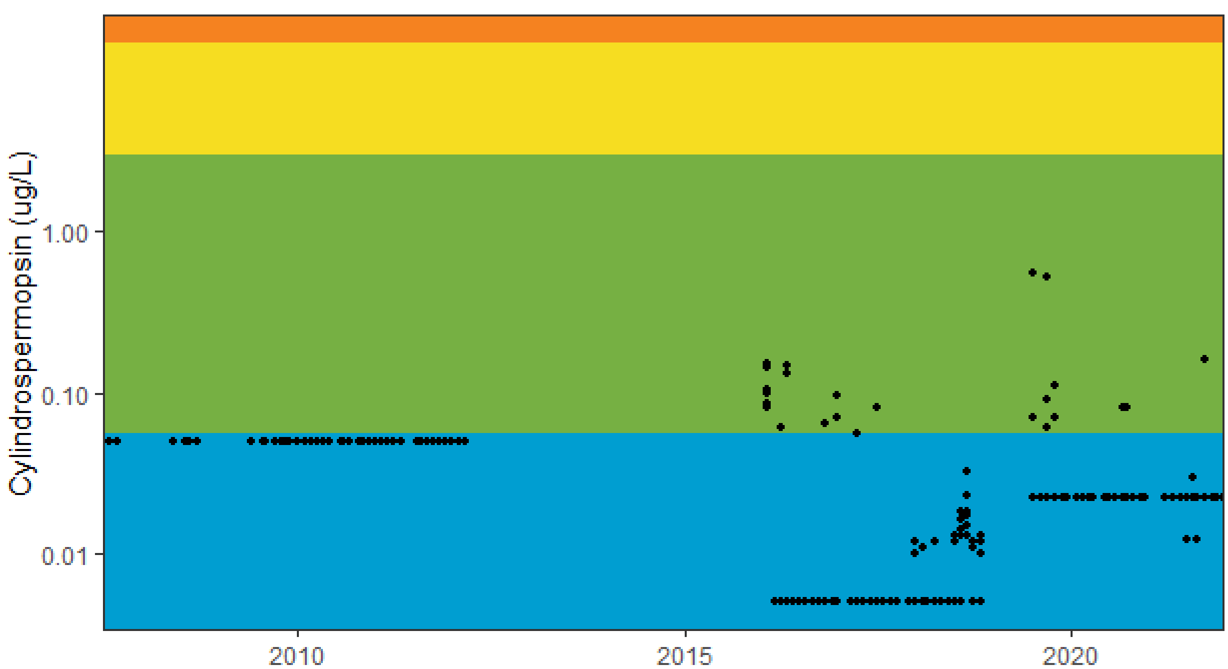
(Critical Value = 15



3.12.3.6.1 Proposed Bins



Alternative Limit Based Bins

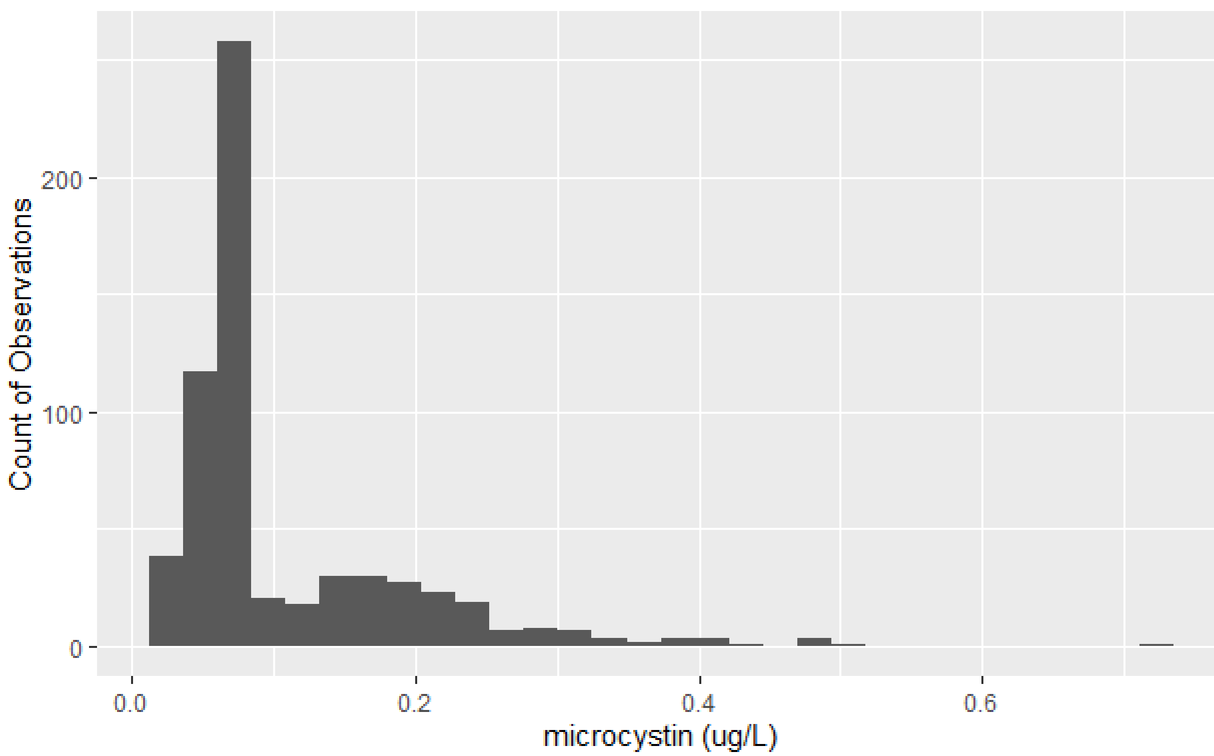


3.12.3.7 Microcystin

3.12.3.7.1 Check for and Remove Errors

These data had no values that could be flagged as obvious data errors. There are some extreme values, but we retain these pending review by the SME and TAW teams.

Quantiles	ChlA.value
0%	0.01575
10%	0.05000
20%	0.05575
30%	0.07500
40%	0.07500
50%	0.07500
60%	0.07500
70%	0.11100
80%	0.16700
90%	0.22440
100%	0.71400



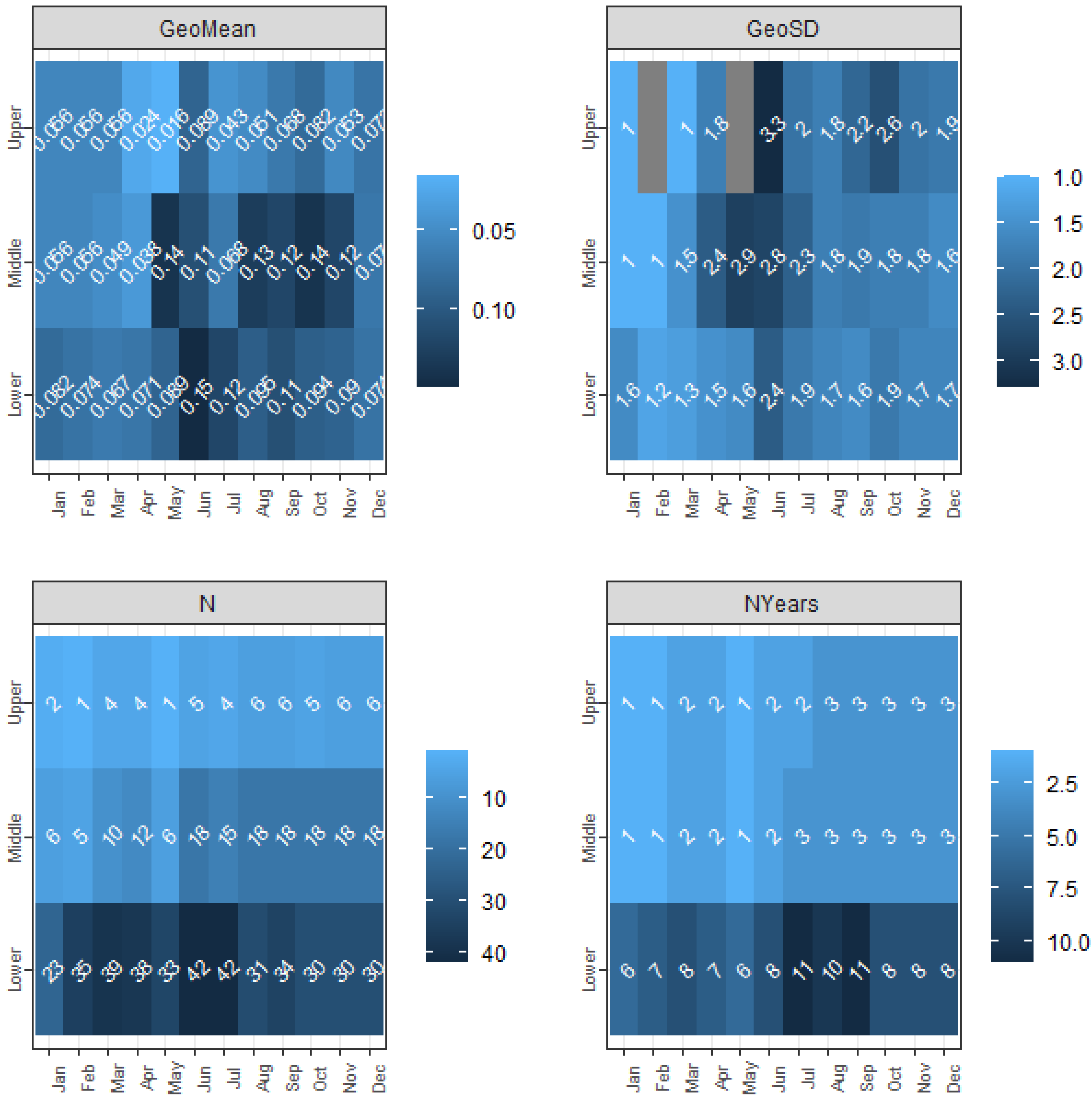
3.12.3.7.2 Check for and Remove Duplicates

All records with equal DATE, STATIONID, and VALUE are treated as duplicates are dropped.

```
##
##    ecToxin emilyToxins      ralpud    raltoxin
##        40        290         109          71
```

Of all data received (619 records), there are 109 duplicates (shared DATE, STATIONID, and measured VALUE). There are 510 remaining observations.

3.12.3.8 Sample Effort and Values

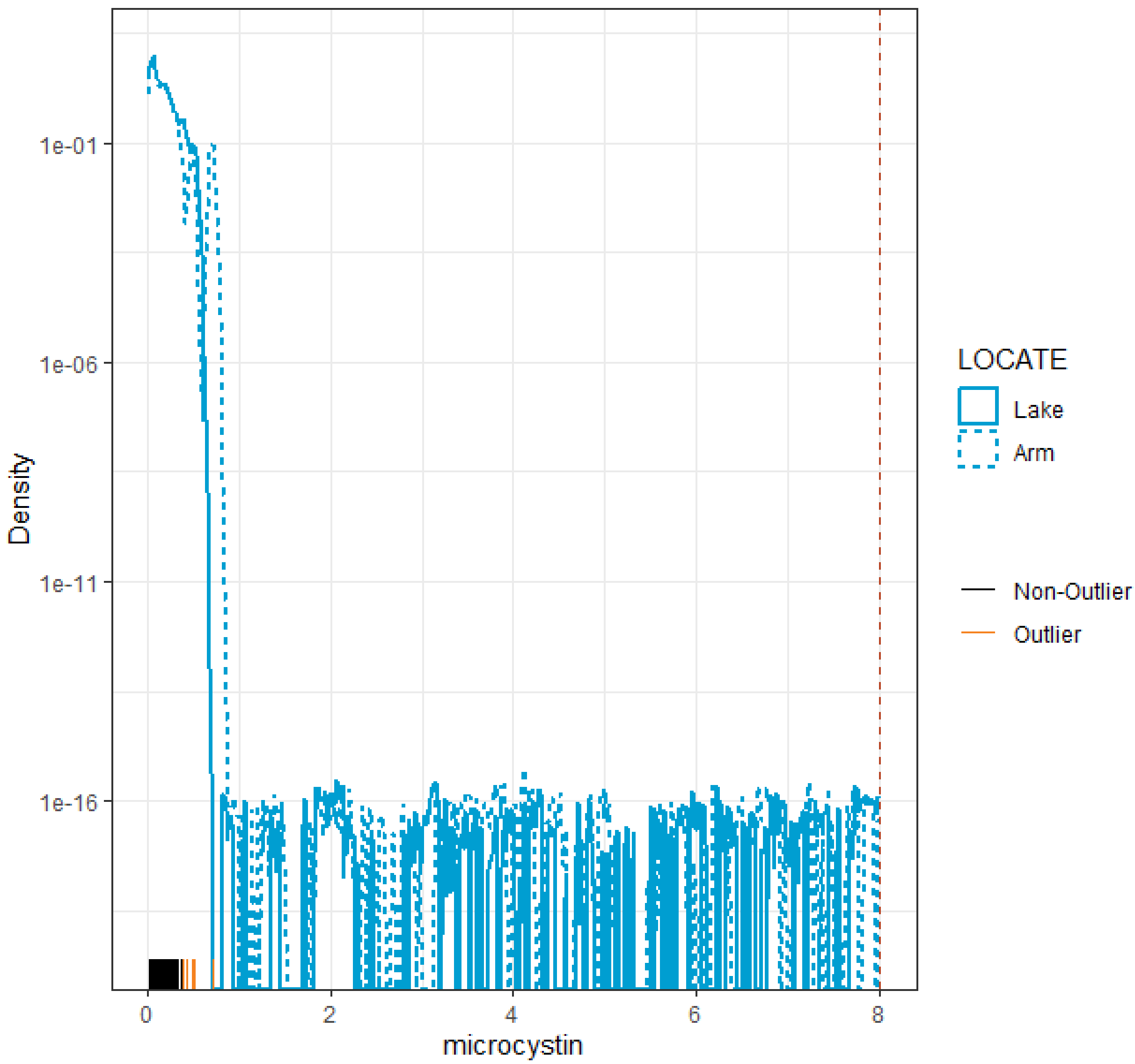


Of all available microcystin samples (N = 510), 0 exceed the critical value of 8 ug/L.

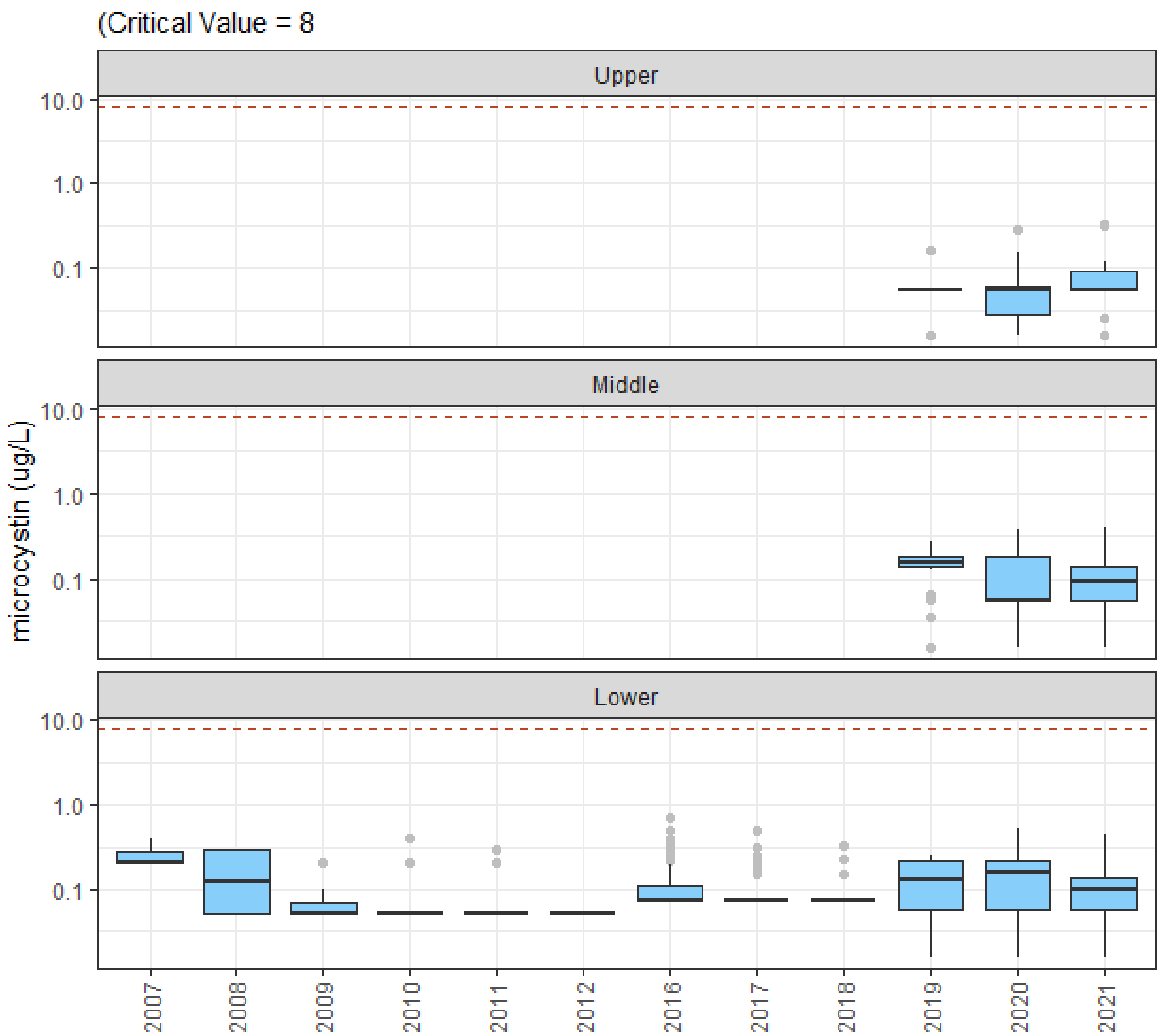
3.12.3.9 Density Plot and Outliers

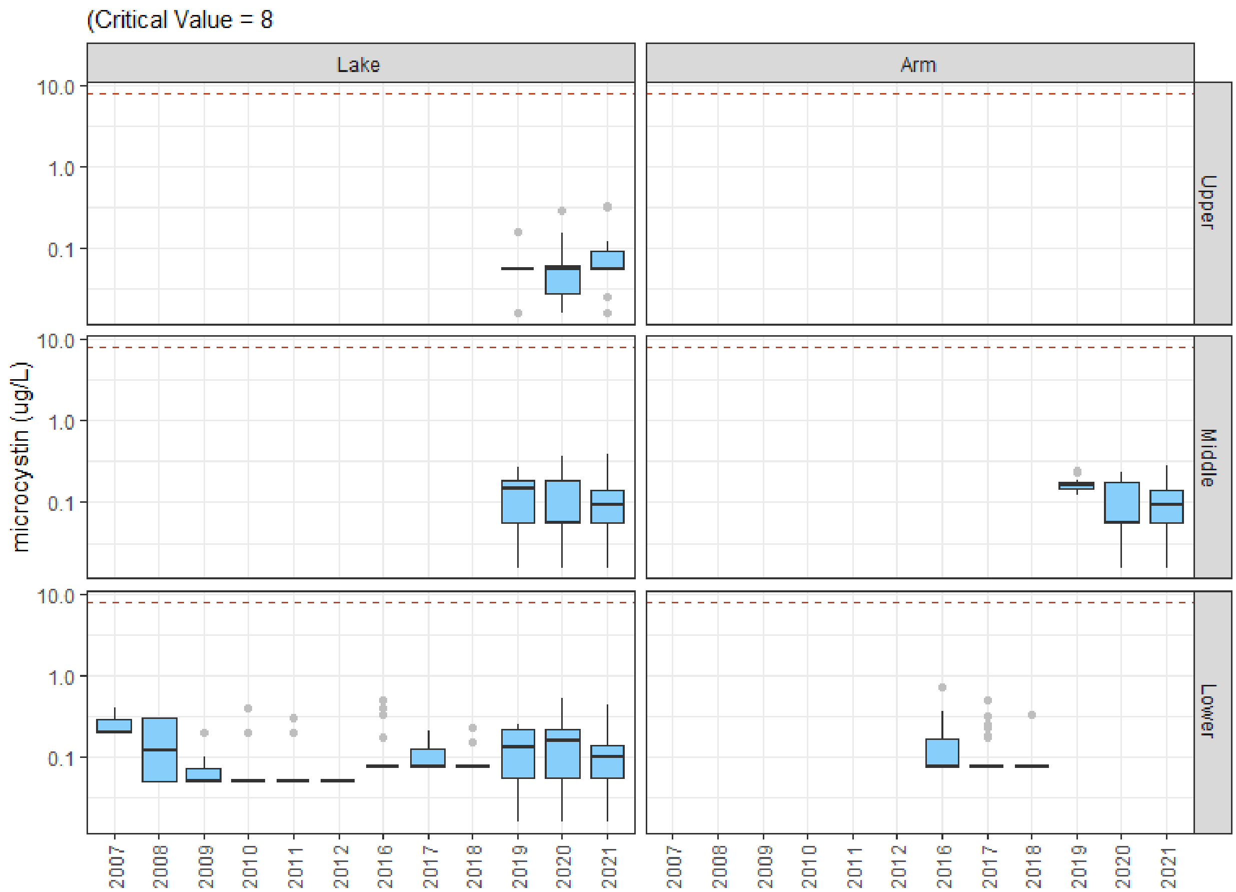
The distribution of all lake (thalweg) values is shown as the blue solid line and the lake arm values are shown as the blue dashed line. Below the density plot are rug marks for each observed value.

The orange rug marks are values greater than three standard deviations from the overall mean (0.1135495). The SD of all data, thalweg and arms, is 0.0888112. The extreme values (+/- 3SD) are retained for our model project as true, but unusual, values - unless our TAW or SME teams indicate these are data errors.



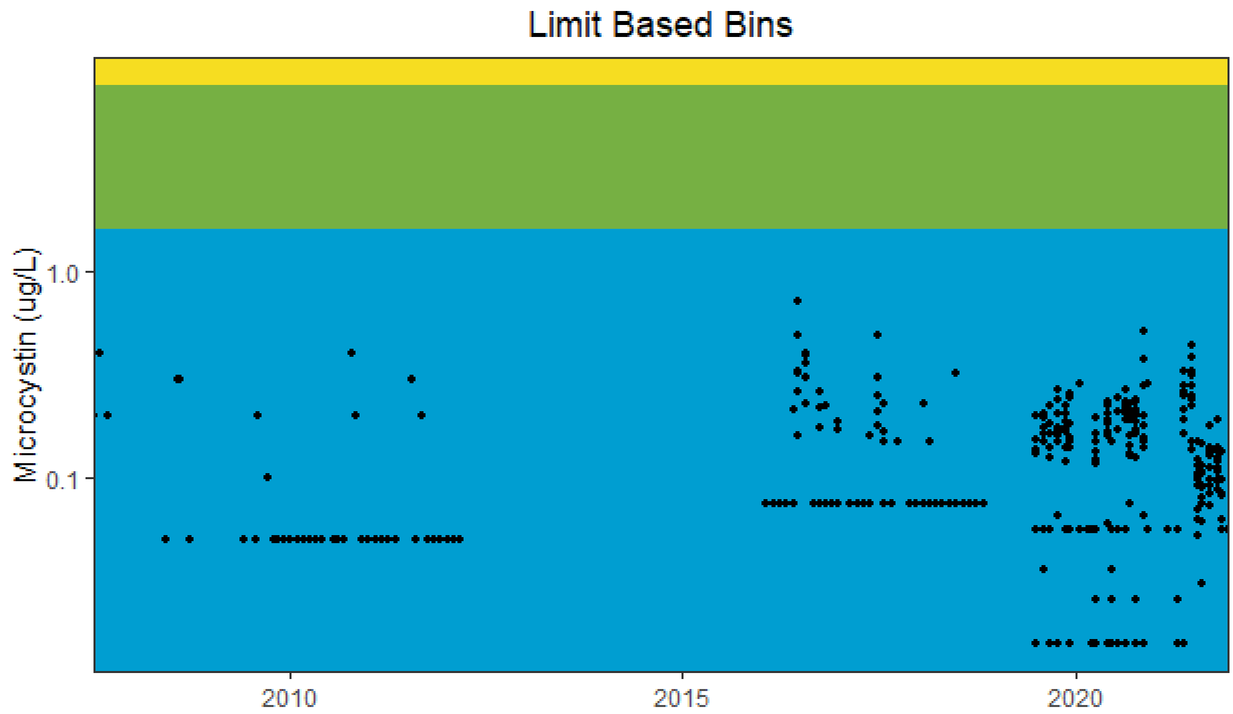
3.12.3.10 Annual Variance

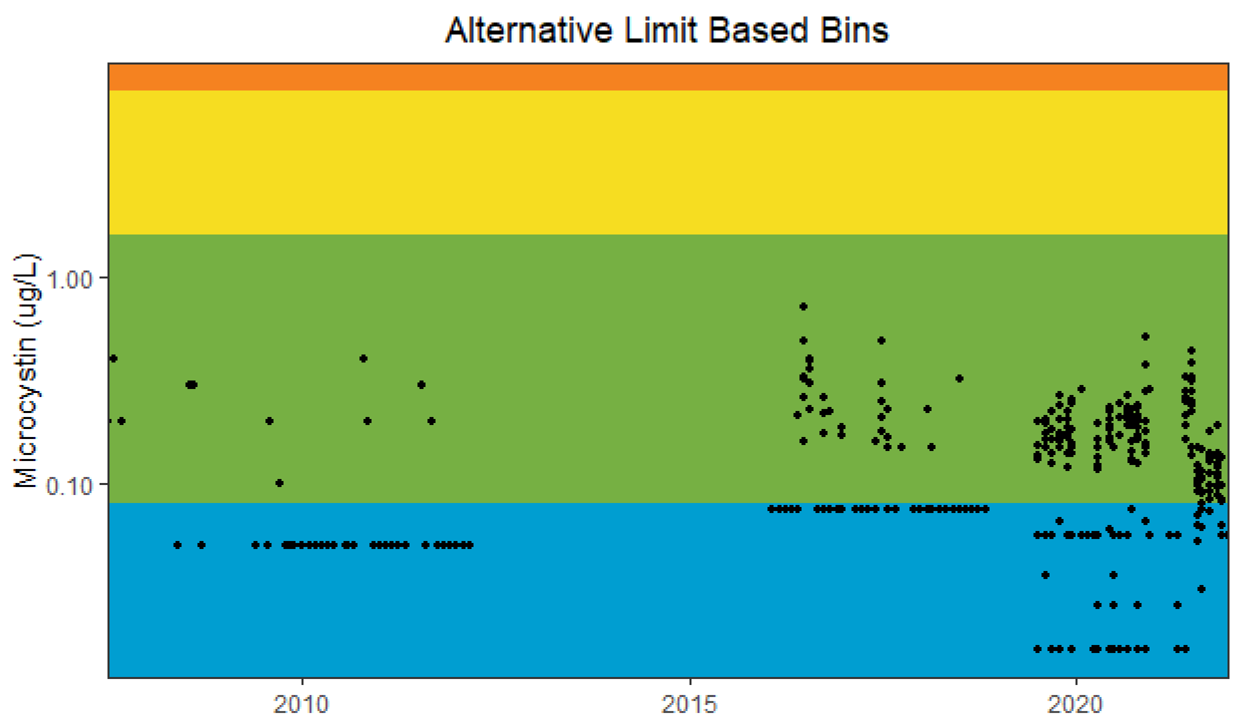




Microcystin are often measured (above detection limits), but have never been measured at levels above (or even approaching) the critical limits. They have been present in all months, all years, and all lake units. Within the available data, the highest observed values are in the Summer-Fall seasons and in the Upper Lake.

3.12.3.10.1 Proposed Bins





3.12.4 Save merged tidy data

The tidy merged data are saved as:

- Merged/tidy_ana.rds (N = 294)

- **Merged/tidy_mic.rds** (N = 510)
- **Merged/tidy_cyl.rds** (N = 321)

Code authored by KDV Decision Analysis LLC and last run 2024-09-20 with R version 4.4.1 (2024-06-14 ucrt).

3.13 Merge All Water Temperature Data

3.13.1 Gather Data Resources

3.13.1.1 List Associated Files

Water Temperature data are identified by the **_wtemp** suffix.

The available Water Temperature data sources are: caae_wtemp.rds, durmCity_wtemp.rds, ralpud_wtemp.rds, storetDwr_wtemp.rds, storetUsgs_wtemp.rds.

3.13.1.2 City of Raleigh Data (ralpud)

```
##
##   Honeycutt Creek        Intake 223        Intake 233        Intake 243
##                69                61                61                61
##    Intake Surface Lower Barton Creek    New Light Creek Upper Barton Creek
##                69                69                69                69
##         US Hwy 98
##                69

##
##      Upper     Middle      Lower Other Lake
##          0          0        597          0

##
## 2013 2014 2015 2016 2017 2018
##  108  108   99  108  114   60

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##  51  42  51  51  51  51  51  54  54  51  45  45
```

This source provides 597 Water Temperature records for 9 station ids and 6 years spanning 2013 to 2018.

3.13.1.3 Center for Applied Aquatic Ecology NCSU (caae)

```
##
## Falls Lake 1 Falls Lake 2 Lick Creek 1
##            1            1            4

##
##      Upper     Middle      Lower Other Lake
##          0          5          1          0
```

```
##
## 2014 2015 2016 2018
##    2    2    1    1

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##   1   0   0   1   0   0   0   1   0   1   1   1
```

This source provides 6 Water Temperature records for 3 station ids and 4 years spanning 2014 to 2018.

3.13.1.4 City of Durham

```
##
##    FL-DS4 FL-SR1801
##       569       528

##
##      Upper     Middle      Lower Other Lake
##       1097          0          0          0

##
## 2015 2016 2017 2018
##  289  274  242  292

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##   0   0   0 139 174 163 183 141 142 155   0   0
```

This source provides 1097 Water Temperature records for 2 station ids and 4 years spanning 2015 to 2018.

3.13.1.5 Storet DWR (storetDwr)

```
##
## J1250000 J1370000 J1430000 J1590000 J1670000 J1675000 J1690000 J1715000
##      308      310      283      290        7      301        3      307
## J1725000 J1727000 J1740000     LC01     LI01    LLC01   NEU010   NEU013
##      309      321      321      660      461      651      314      607
##  NEU013B NEU0171B  NEU018C  NEU018E  NEU019E  NEU019L  NEU019P  NEU020D
##      692      808      237      858      858      847      856      866
## NEUELL10
##      108

##
##      Upper     Middle      Lower Other Lake
##       2622       5441       3520          0

##
## 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 2000 2001 2005 2006 2007
##  511  506  526  393  179  209  202   88   49   52   45  115  167  825 1169  900
```

```
## 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
##  360  571  631  642  639  684  692  668  512  128  120

##
##  Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec
##  733  828  915 1105  989 1143 1044 1411 1016  923  771  705
```

This source provides 11583 Water Temperature records for 25 station ids and 27 years spanning 1984 to 2020.

3.13.1.6 Storet USGS (storetUsgs)

```
##
##   2086920 208703650 208708905 208717595 208718195
##       95        87        49         2        52

##
##     Upper    Middle     Lower Other Lake
##        95        87       103          0

##
## 1993 1994 1995 2005 2006 2007 2008 2009 2010 2011
##   16   20    8   20   33   39   43   43   41   22

##
## Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
##   0  20   8  43   8  47  11  59   4  58   4  23
```

This source provides 285 Water Temperature records for 5 station ids and 10 years spanning 1993 to 2011.

This source provides no samples from the upper section of the lake.

3.13.2 Merge Data Sources

In total, we assembled 13568 Water Temperature records into a single tidy dataframe. This included data from the City of Raleigh (597 records), CAAE (6 records), City of Durham 1097 records), Storet DWR (11583 records), and Storet USGS (285 records).

Merged data were qaqc'd to confirm:

- only one variable is present
- no NA values are present
- only one measurement unit is present (OR if more than one is present, additional processing is required)

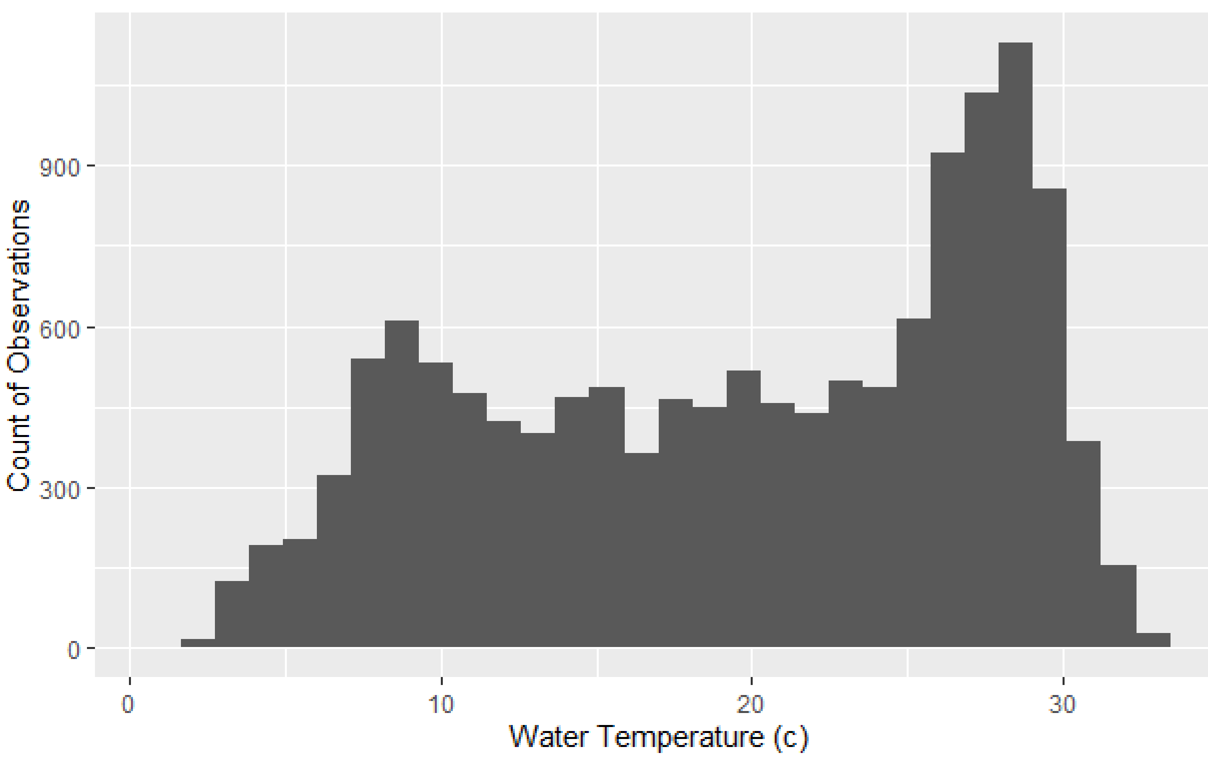
```
## # A tibble: 5 × 6
##   SOURCE        N NStations NYears MinYear MaxYear
##   <chr>     <int>     <int>  <int>   <dbl>   <dbl>
## 1 caae          6         3      4    2014    2018
## 2 durmCity   1097         2      4    2015    2018
## 3 ralpud      597         9      6    2013    2018
```

```
## 4 storetDwr  11583       25     27    1984    2020
## 5 storetUsgs   285        5     10    1993    2011
```

3.13.2.1 Check for and Remove Errors

These data had no values that could be flaged as obvious data errors. There are some extreme values, but we retain these pending review by the SME and TAW teams.

Quantiles	Wtemp.value
0%	1.600
10%	8.200
20%	10.864
30%	14.400
40%	17.700
50%	20.700
60%	24.000
70%	26.300
80%	27.800
90%	29.100
100%	33.400



3.13.2.2 Check for and Remove Duplicates

All records with equal DATE, STATIONID, DEPTHM, and VALUE are treated as duplicates values and are dropped. With the removal of the older data resources (from earlier 2019 UNRBA data summary report) in favor of updated DWR with more qaqc, there are very few duplicated values.

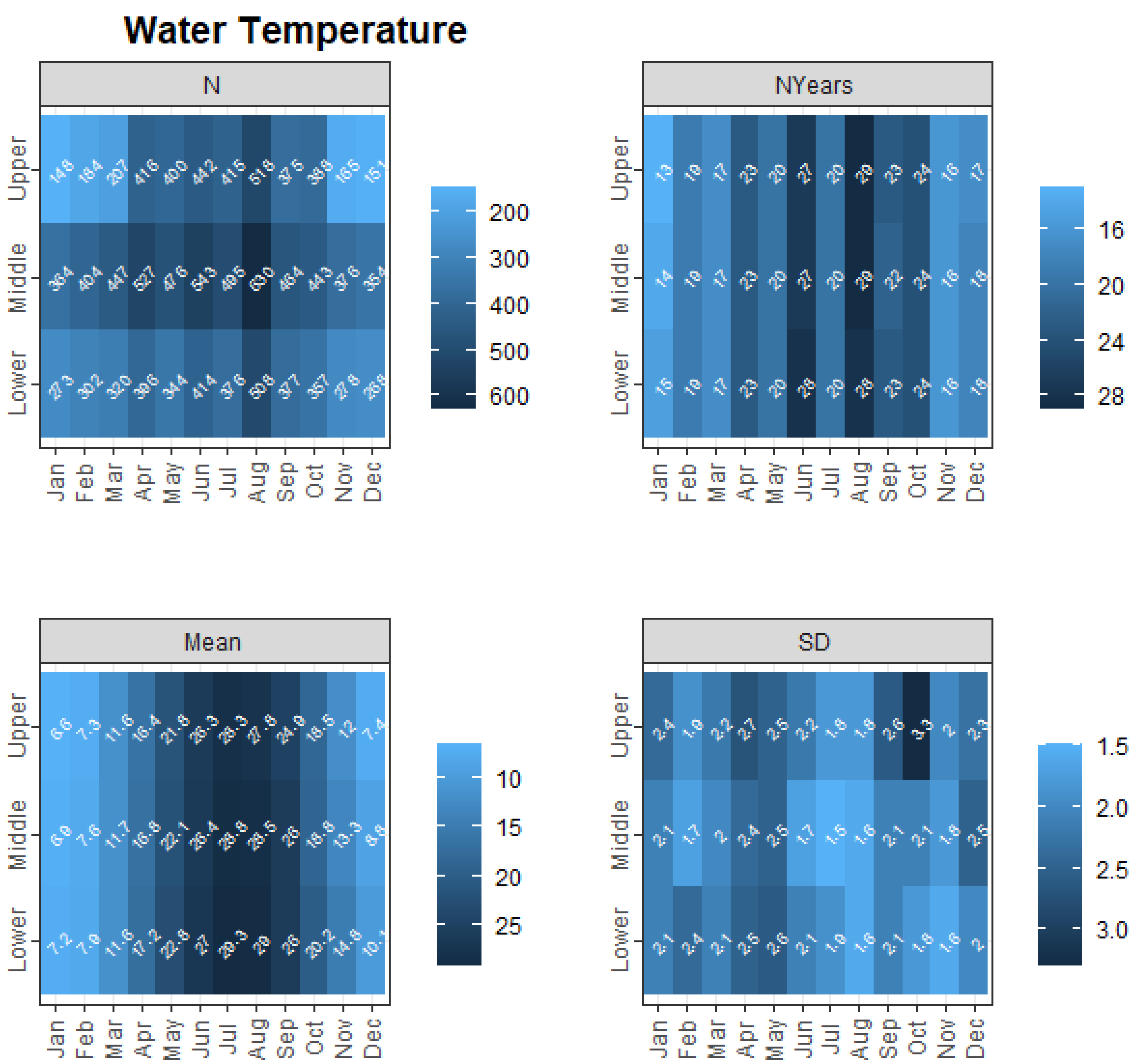
```
##
##     caae  durmCity    ralpud  storetDwr storetUsgs
##        6     1097       597      11560        285
```

Of all data received (13568 records), there are 23 duplicates (shared DATE, STATIONID, DEPTHM, and measured VALUE). There are 13545 remaining observations.

3.13.3 Data Summaries

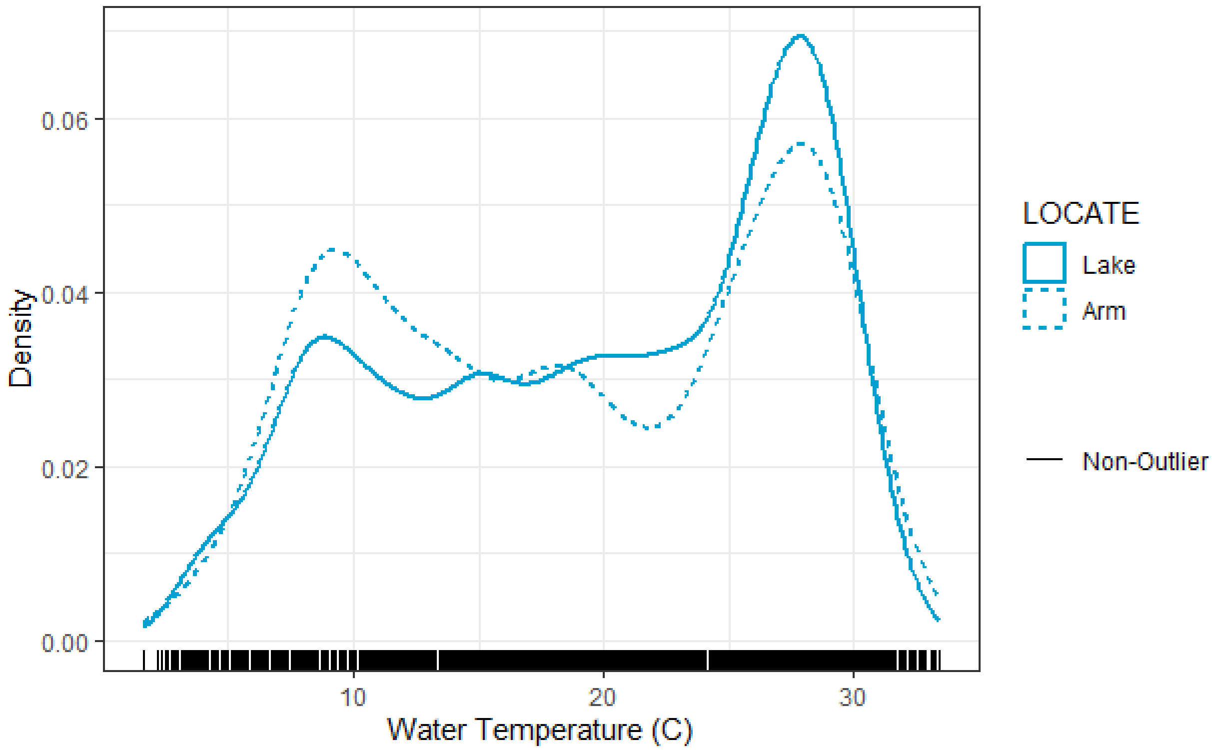
The merged data provide 13545 Water Temperature records for 44 station ids and 30 years spanning 1984 to 2020.

3.13.3.1 Sample Effort and Values



3.13.3.2 Density Plot and Outliers

The distribution of all lake (thalweg) values is shown as the blue solid line and the lake arm values are shown as the blue dashed line. Below the density plot are rug marks for each observed value. The orange rug marks are values greater than three standard deviations from the overall mean (19.665232). The SD of all data, thalweg and arms, is 7.9968091. The extreme values (+/- 3SD) are retained for our model project as true, but unusual, values - unless our TAW or SME teams indicate these are data errors.

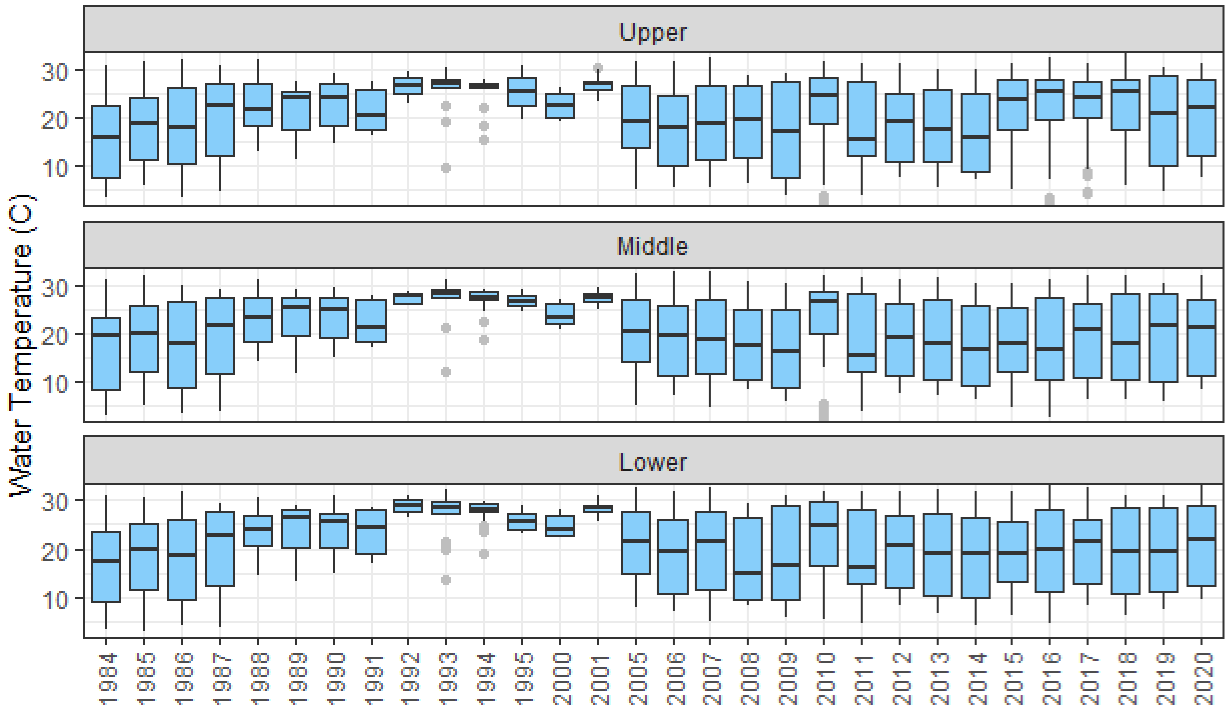


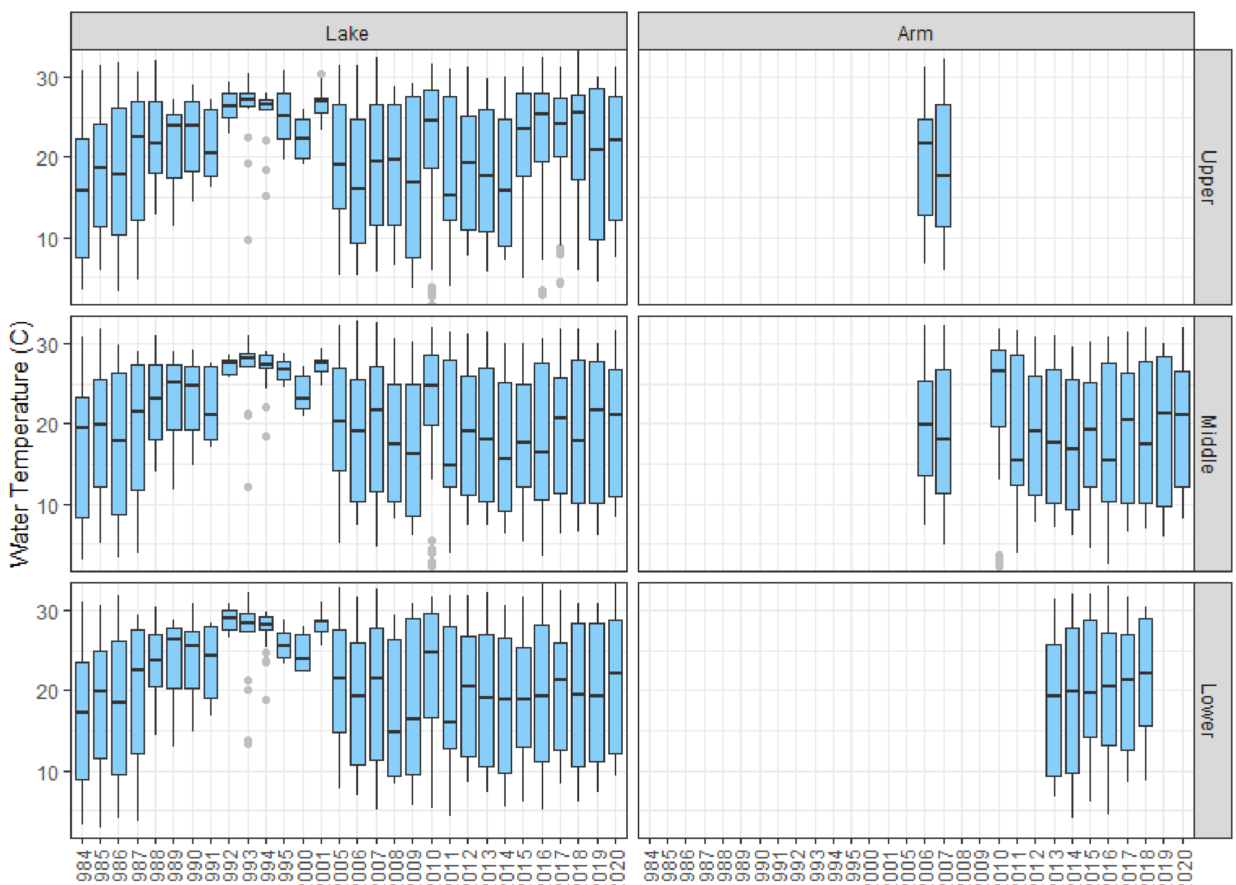
The 3 SD outlier values identified in this plot are:

DATE	YEAR	MONTH	SOURCE	VALUE

3.13.3.3 Annual Variance

If we can use data from the lake arms, it increases our overall sample size. But if the lake arms are too different from the main lake body, the arm data will add noise to our analysis. We show the data as a full set (by lake unit) and split into the lake (thalweg) versus arm observations.

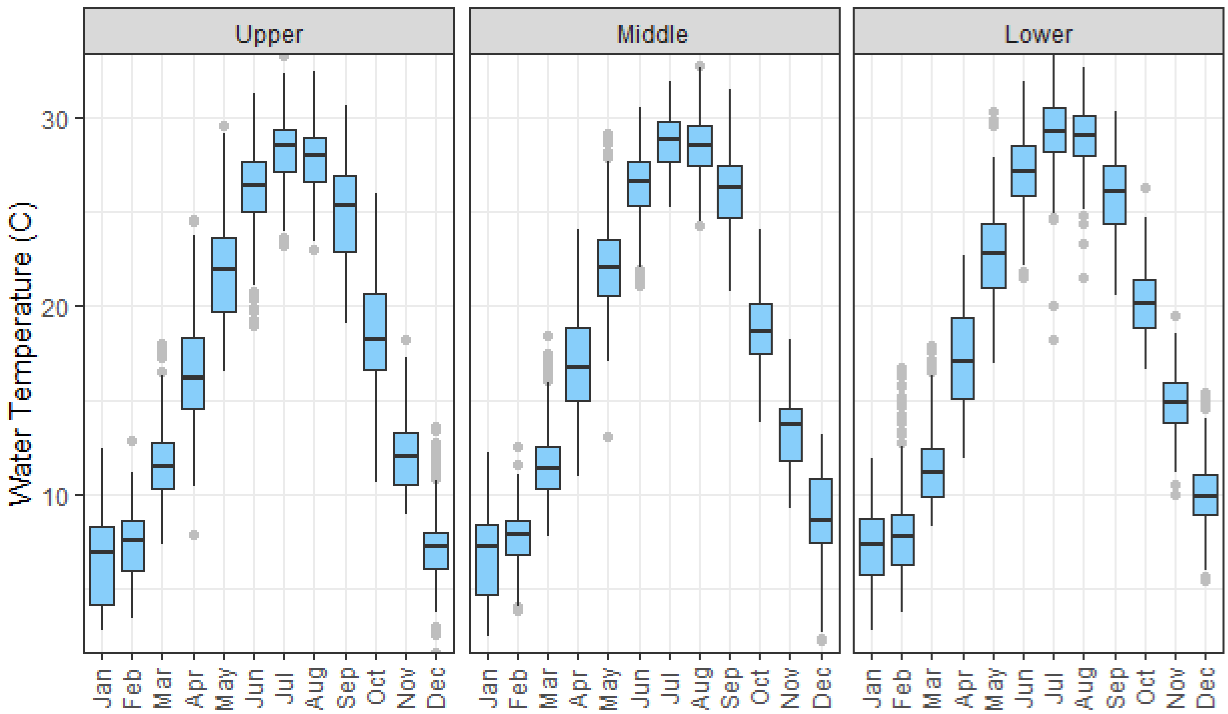

Upper
Middle
Lower
Water Temperature (C)
30
20
10
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
2000
2001
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

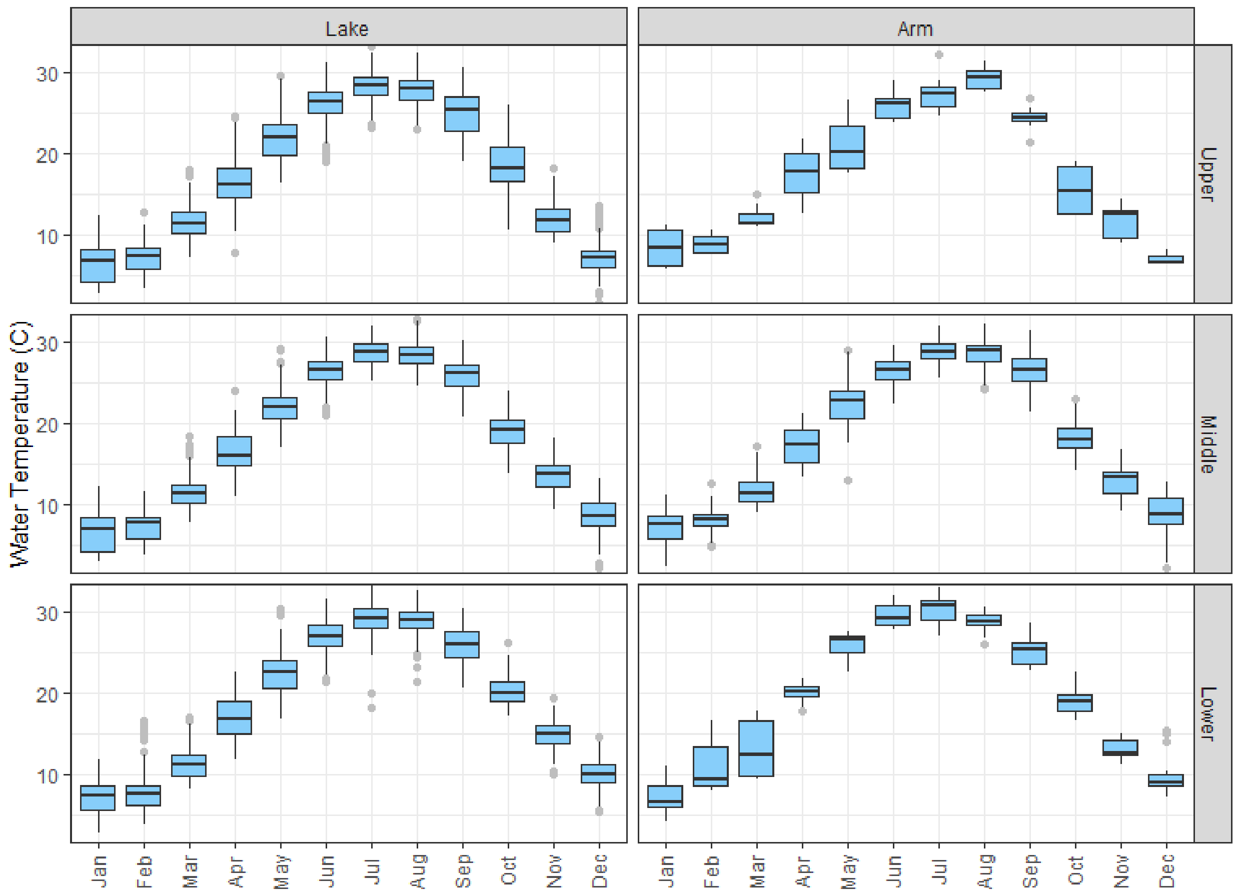

Lake
Arm
Upper
Middle
Lower
Water Temperature (C)
30
20
10

3.13.3.4 Historic versus Recent Comparison

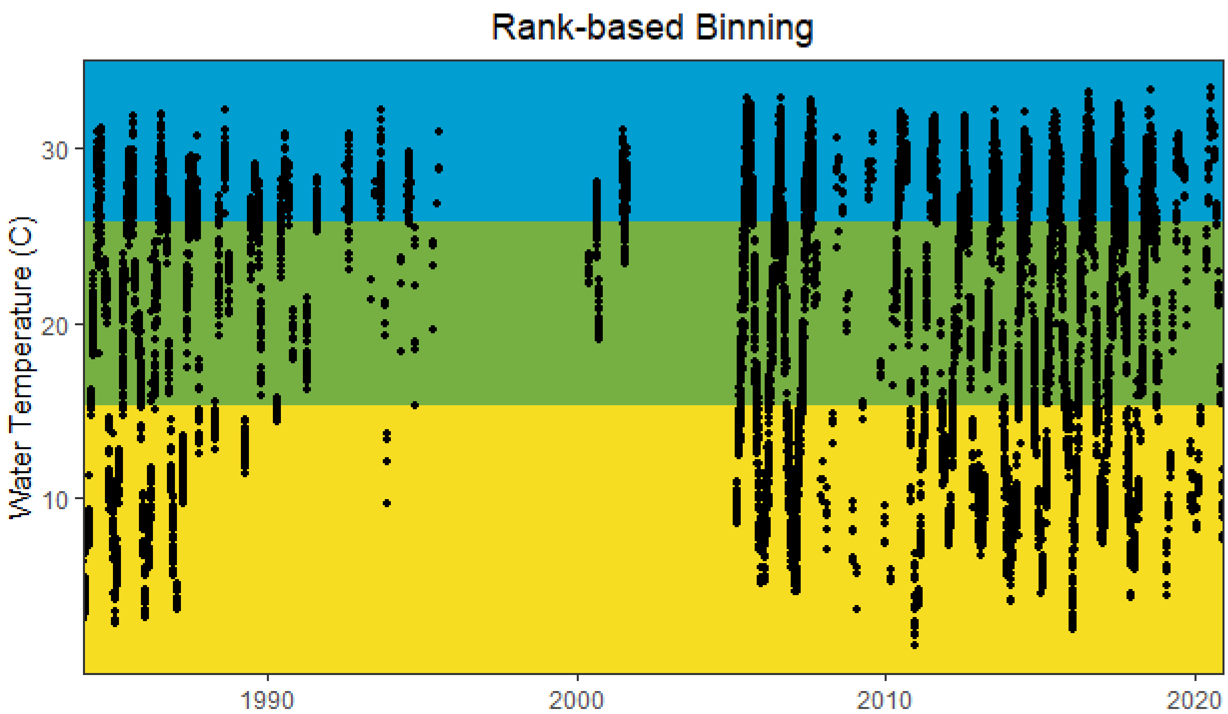
```
## # A tibble: 3 × 3
##   LAKEUNIT HISTORIC RECENT
##   <ord>       <dbl>  <dbl>
## 1 Upper        19.2   21.8
## 2 Middle       19.8   18.4
## 3 Lower        20.3   19.3
```

3.13.3.5 Seasonal Trends





Proposed Bins



The rank based bins use cut-points: -, 15.265, 25.735, . The median value is 20.7 mg/L.

3.13.4 Export Merged Data

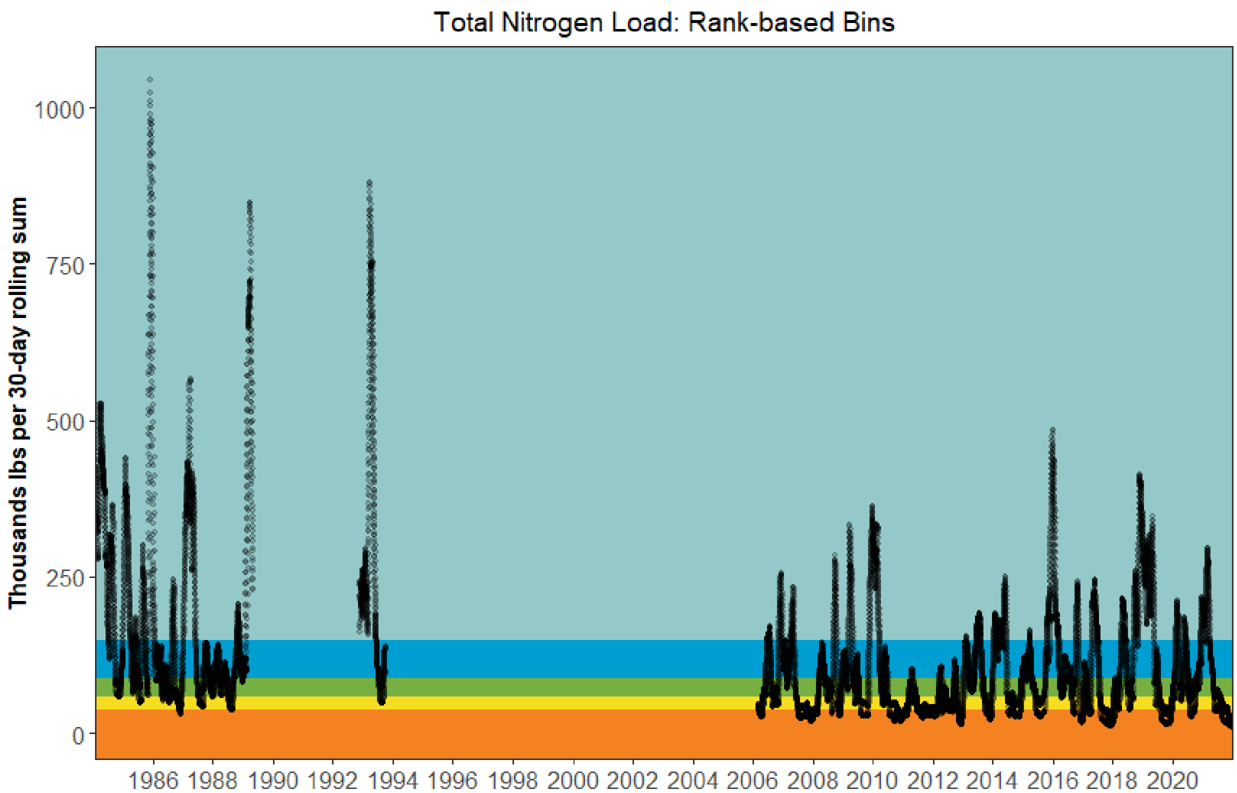
The merged data files represent all data gathered to date for this variable. We drop some of the information that was used as qaqc during prep and merging steps: SOURCETYPE, DEPTHTYPE, VARTYPE, VARLABEL. The final merged data are saved as: **tidy_wtemp.rds** (data) and **tidy_wtemp_summary.rds** (summary states for LAKEUNIT by MONTH: N, NYears, Mean, SD). Both are also saved to Excel.

The final data include data received from: ralpud, caae, durmCity, storetDwr, storetUsgs.

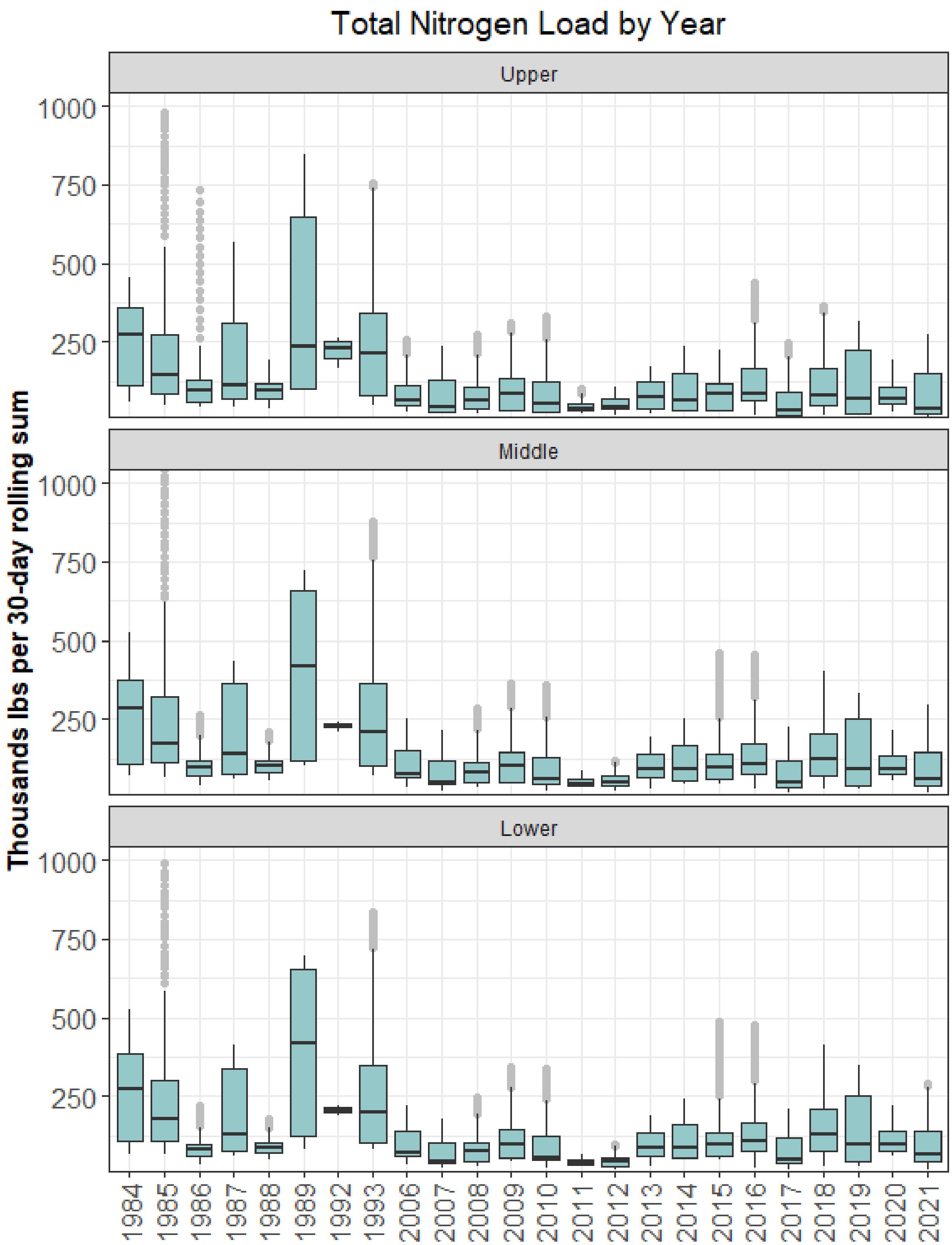
Code authored by KDV Decision Analysis LLC and last run 2024-09-20 with R version 4.4.1 (2024-06-14 ucrt).

Section 4: Data Summaries

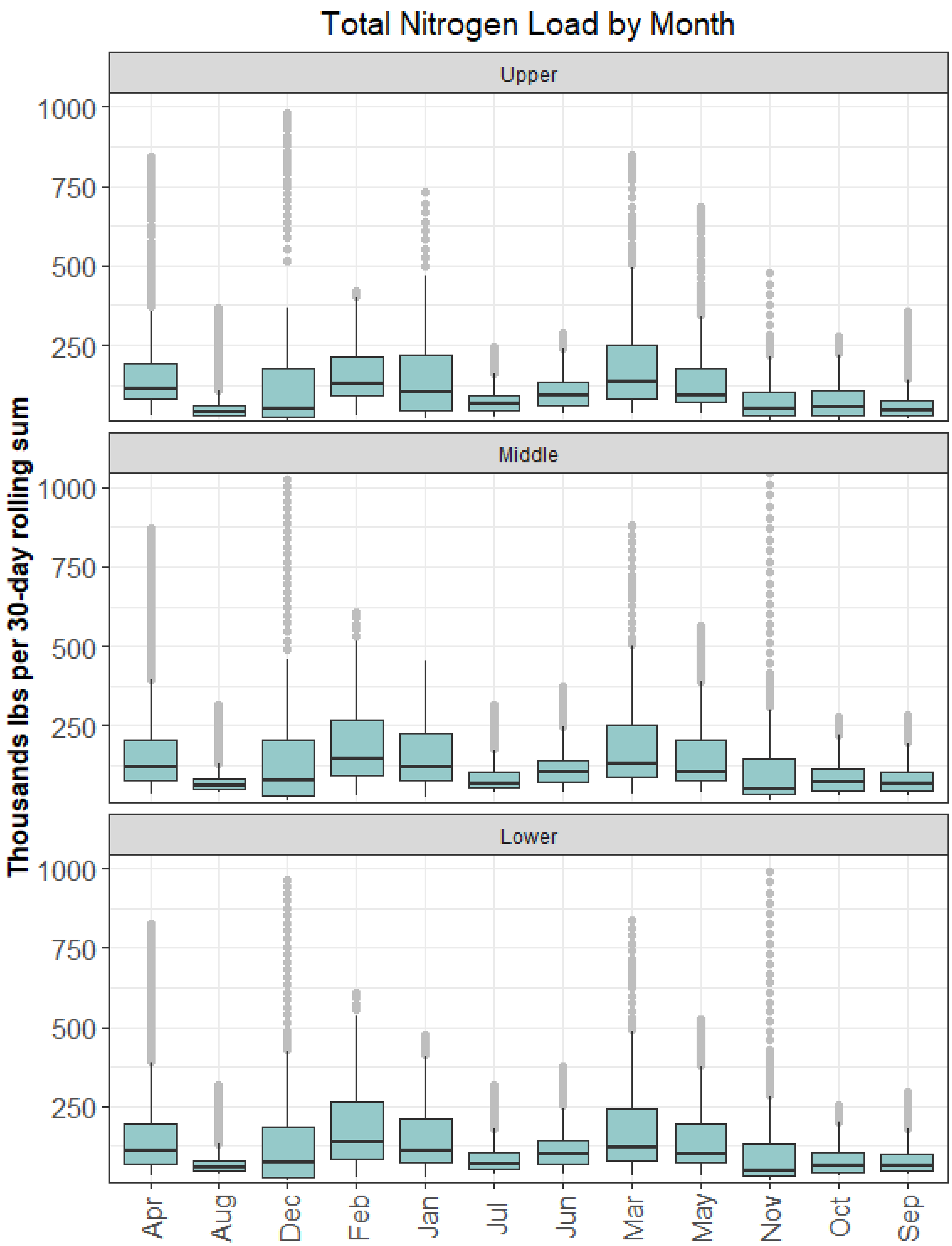
4.1 Total Nitrogen Load



Total Nitrogen Load by Model Bin

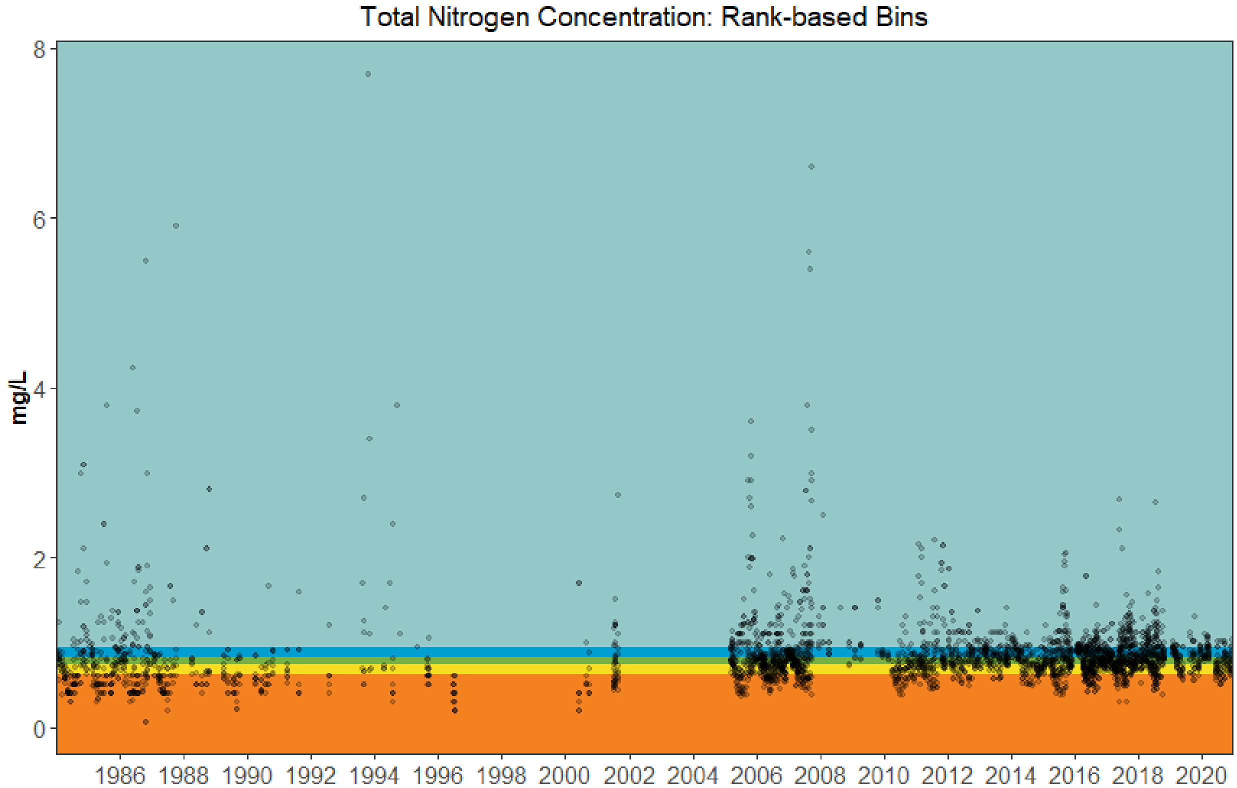


Total Nitrogen Load by Year

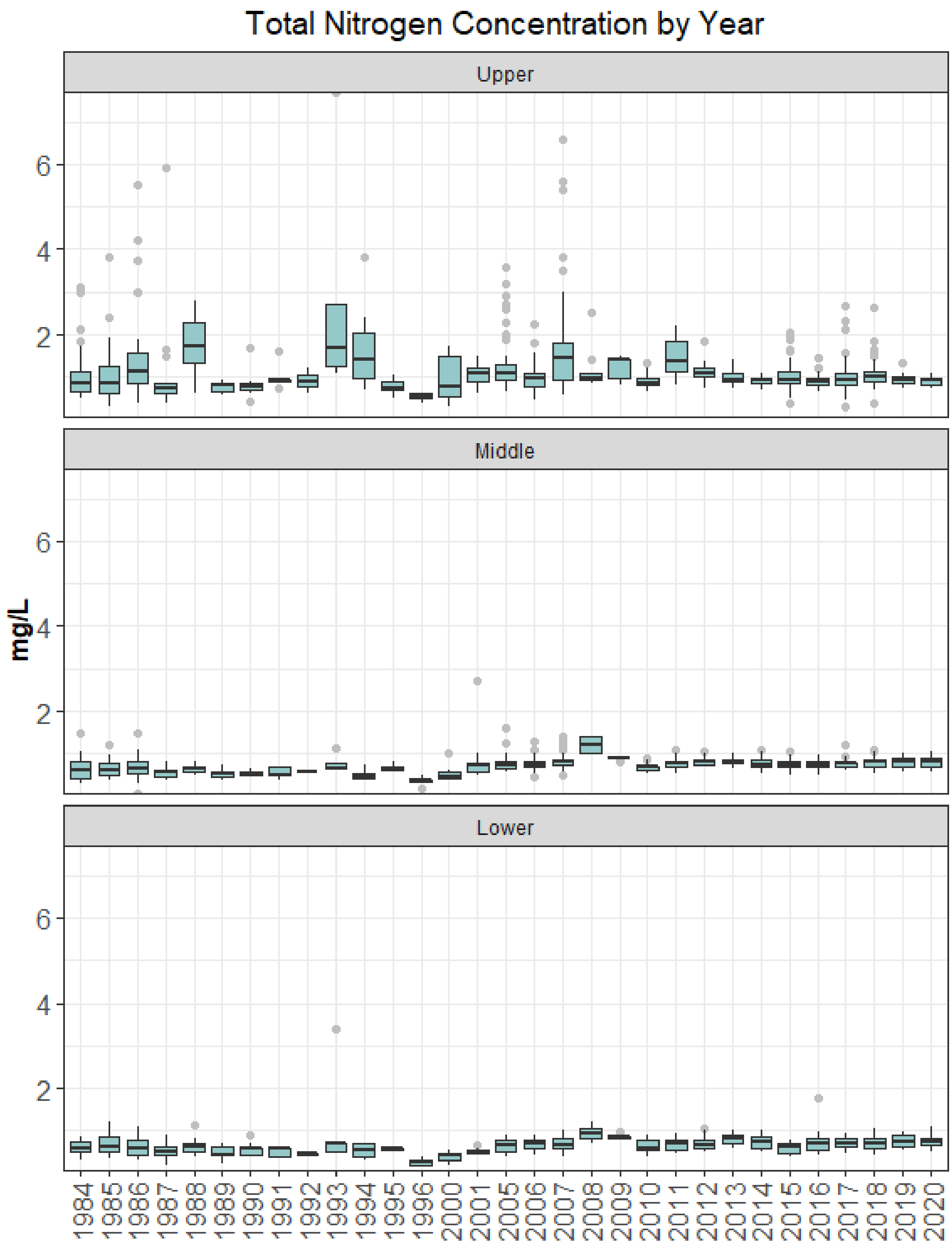


Total Nitrogen Load by Month

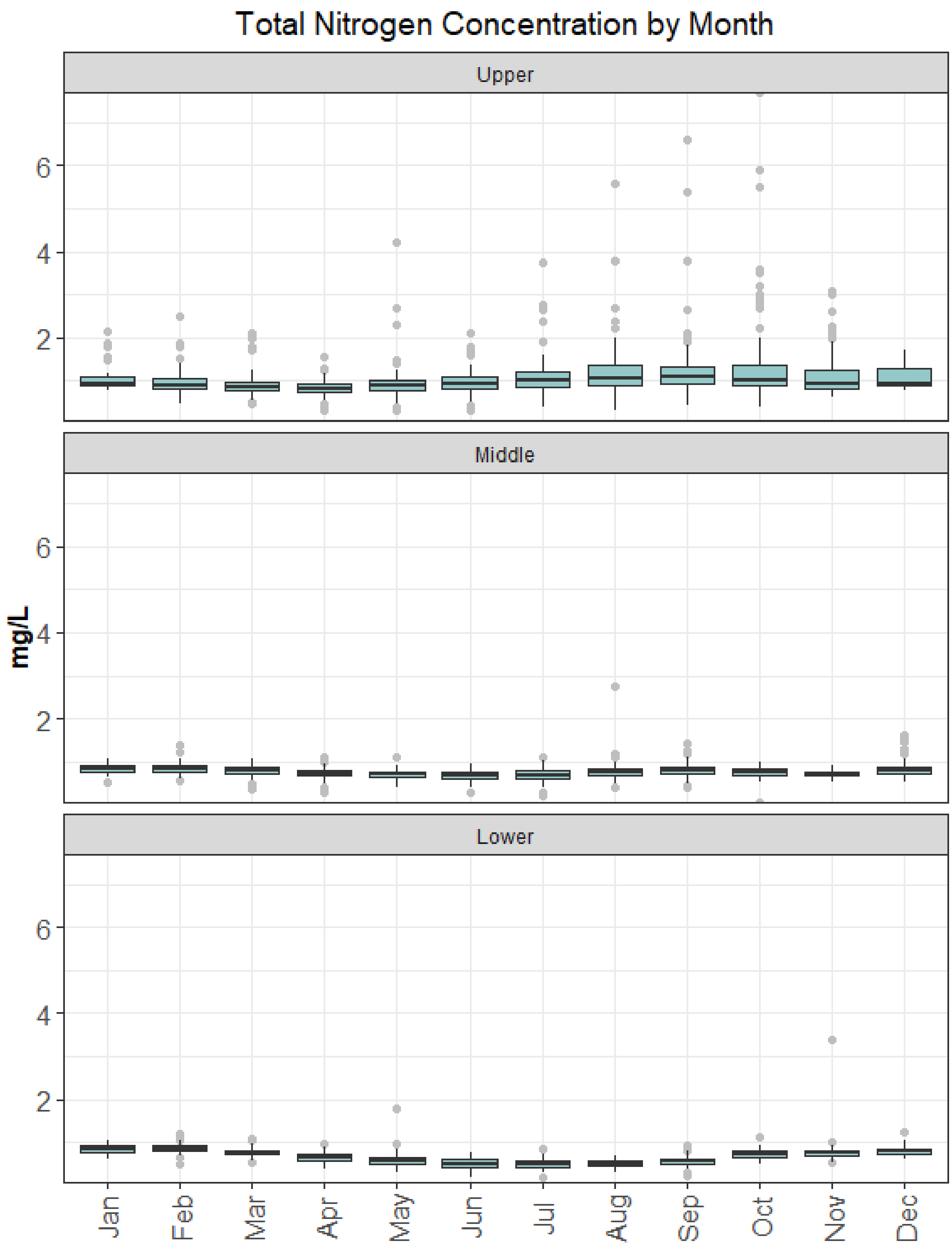
4.2 Total Nitrogen Concentration



Total Nitrogen Concentration by Model Bin

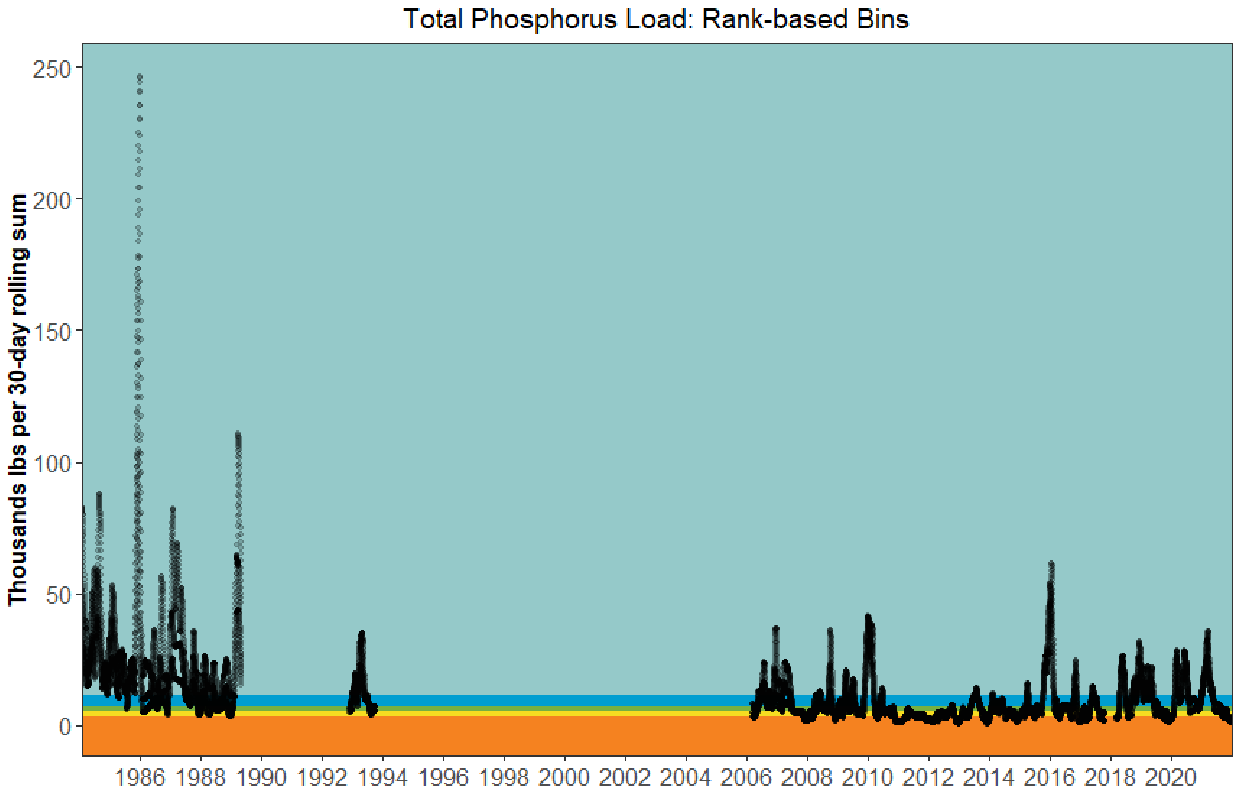


Total Nitrogen Concentration by Year

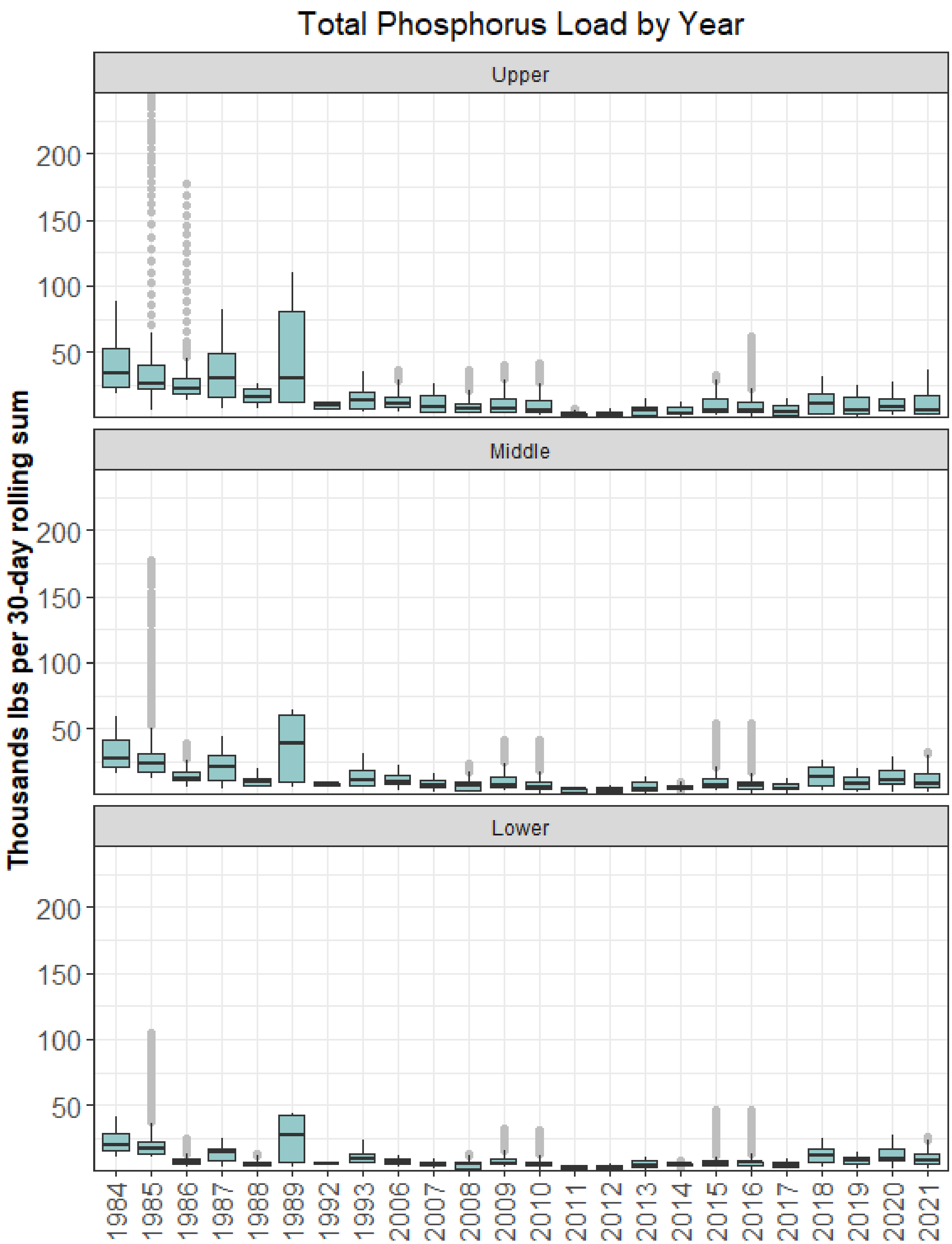


Total Nitrogen Concentration by Month

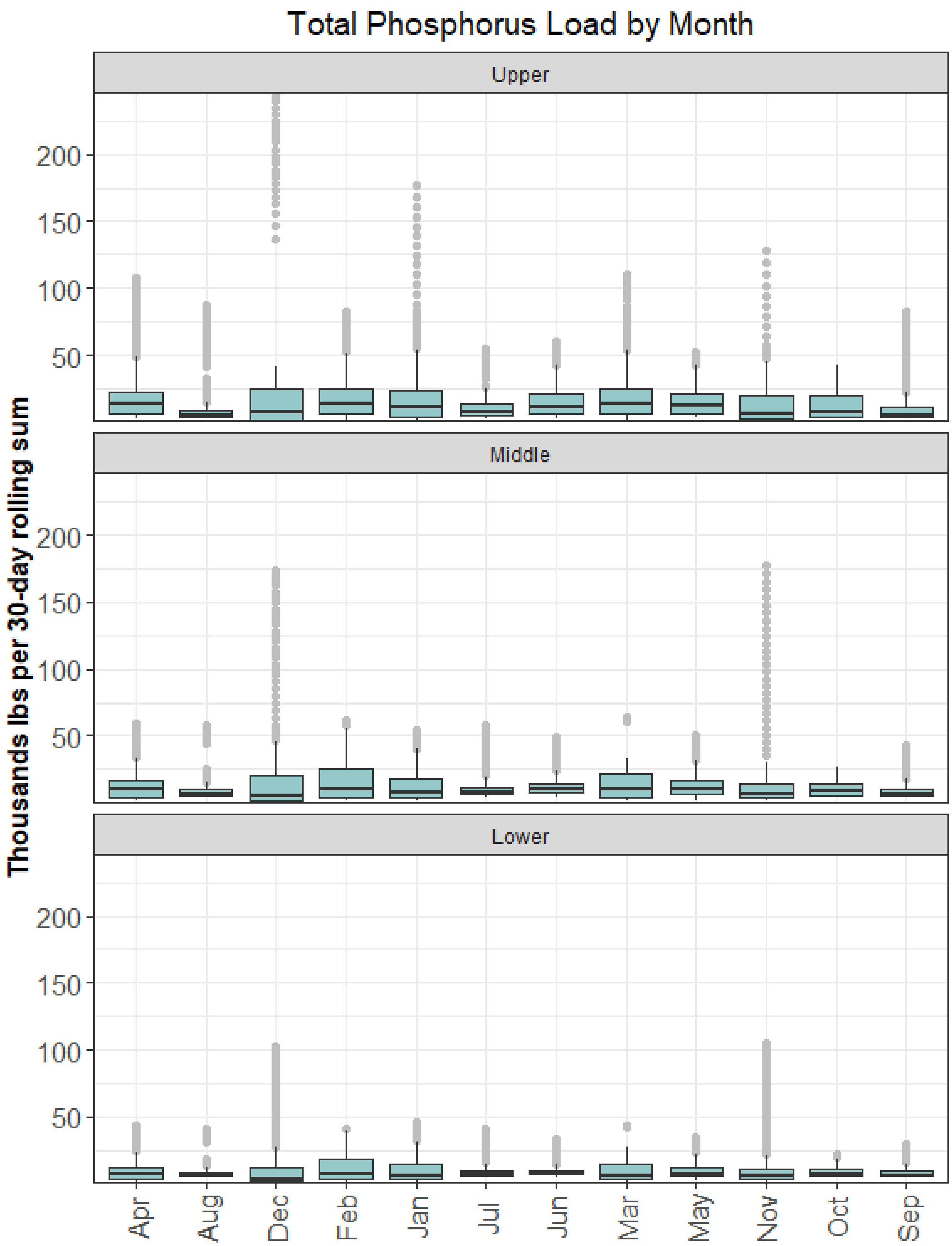
4.3 Total Phosphorus Load



Total Phosphorus Load by Model Bin

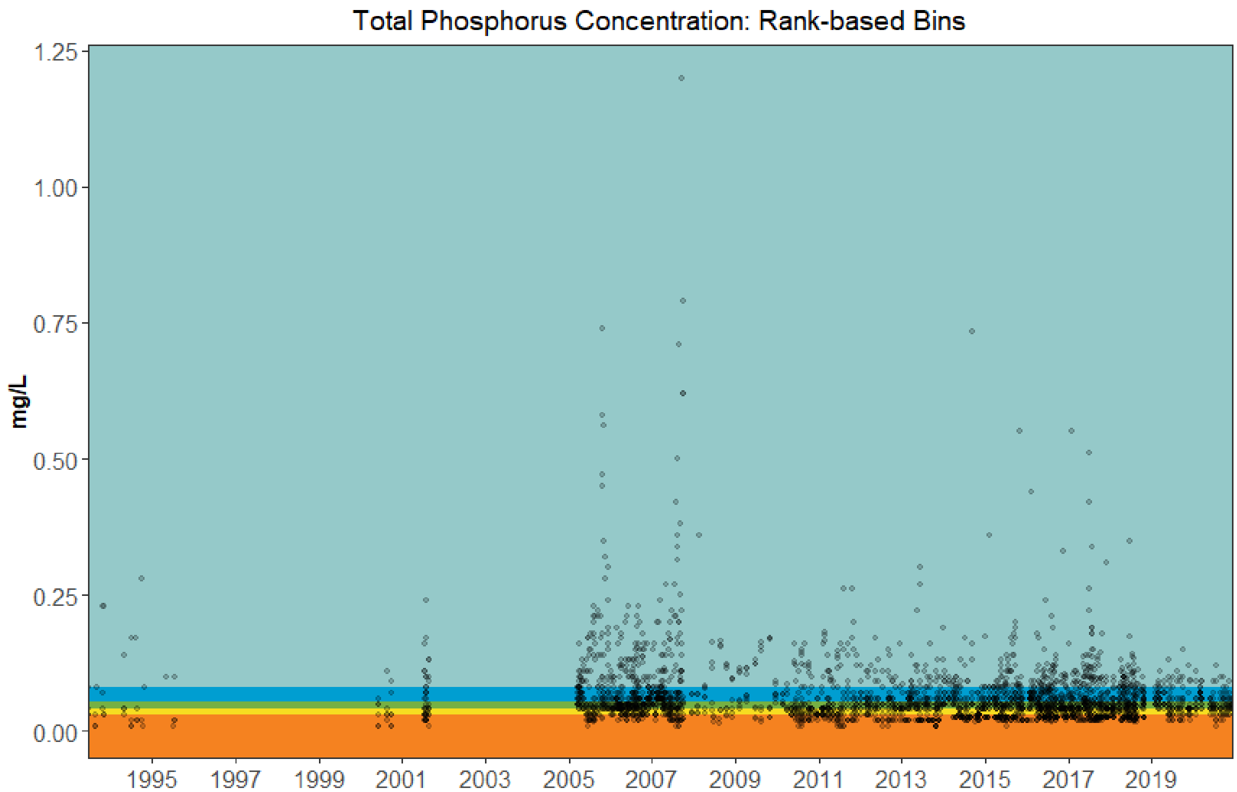


Total Phosphorus Load by Year

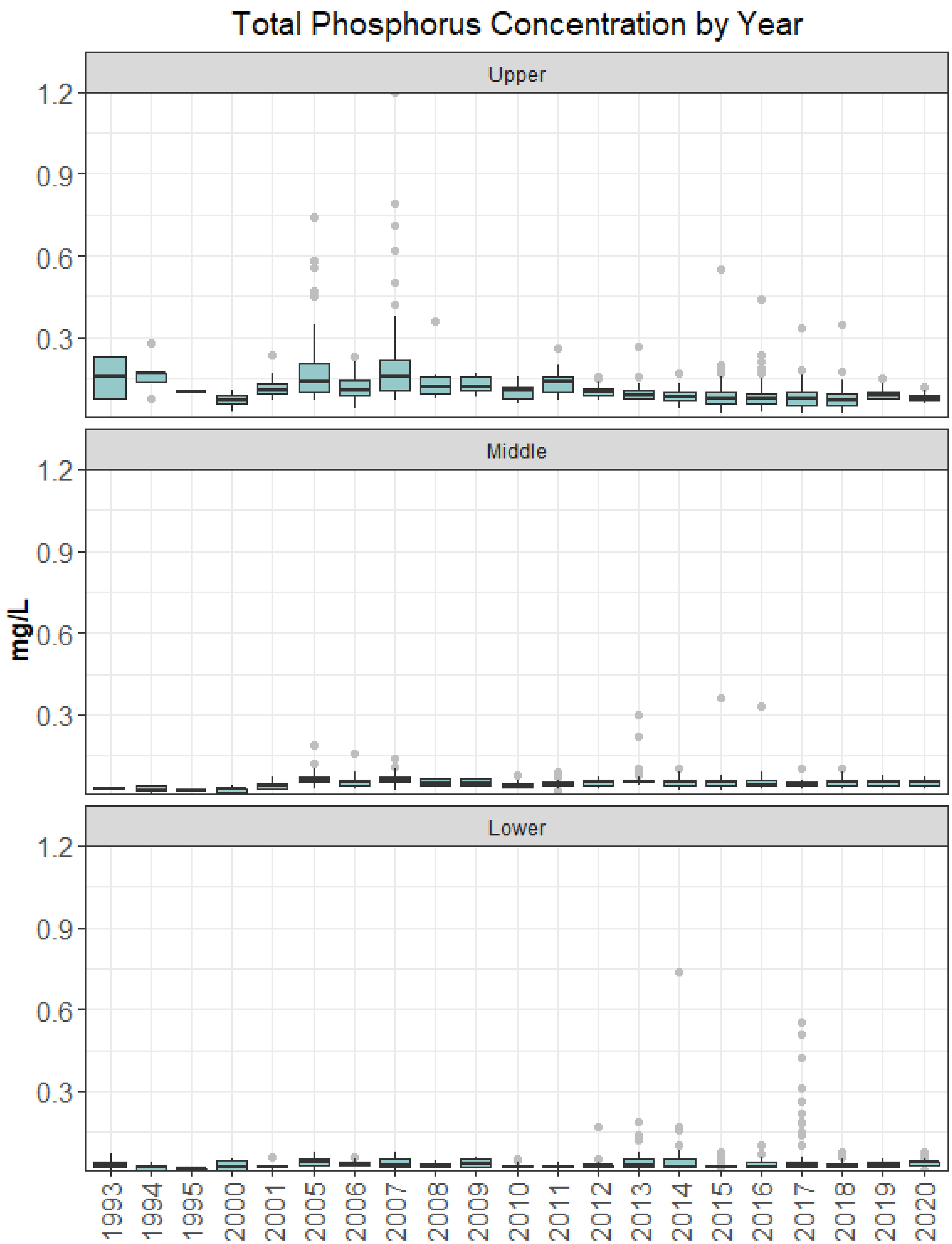


Total Phosphorus Load by Month

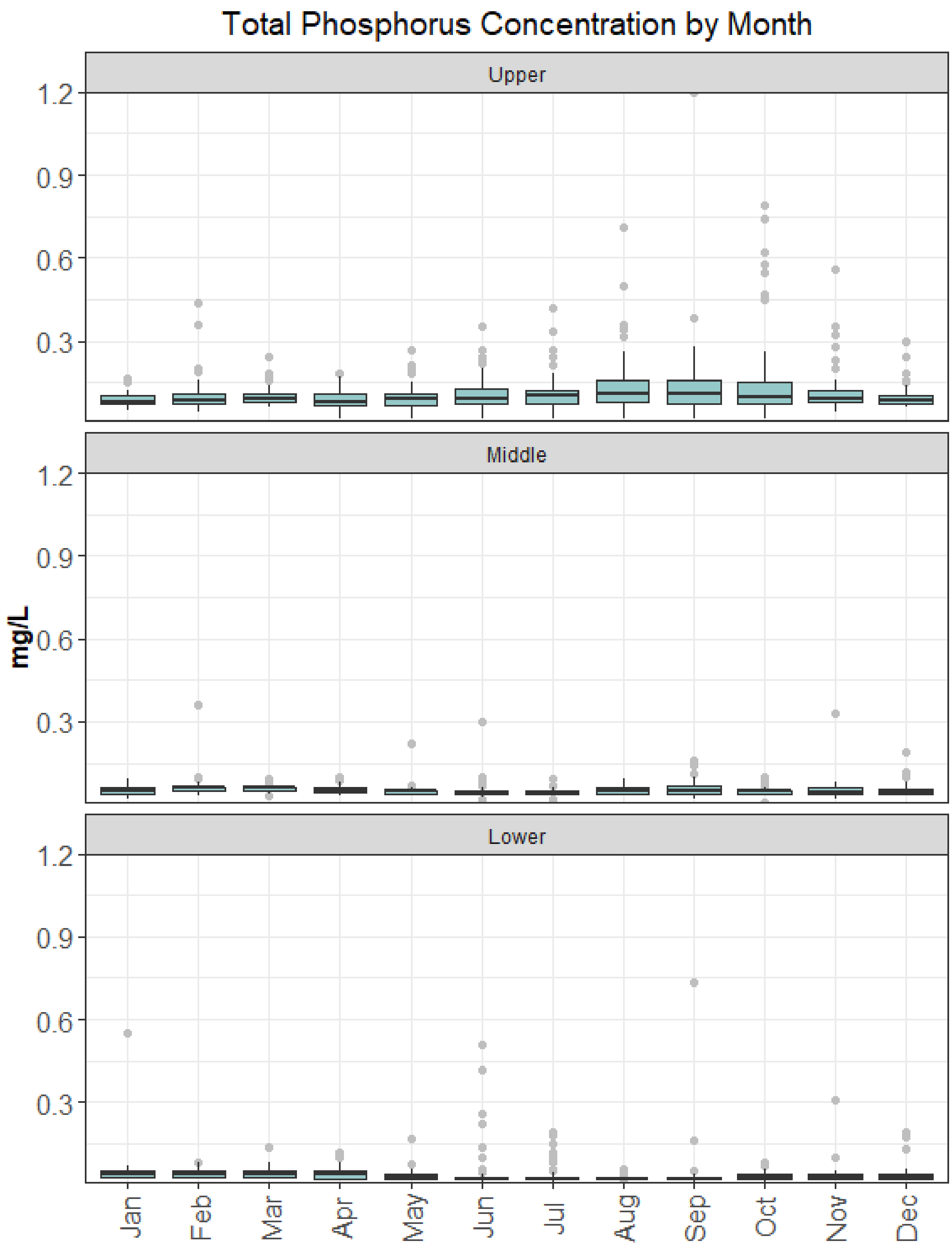
4.4 Total Phosphorus Concentration



Total Phosphorus Concentration by Model Bin

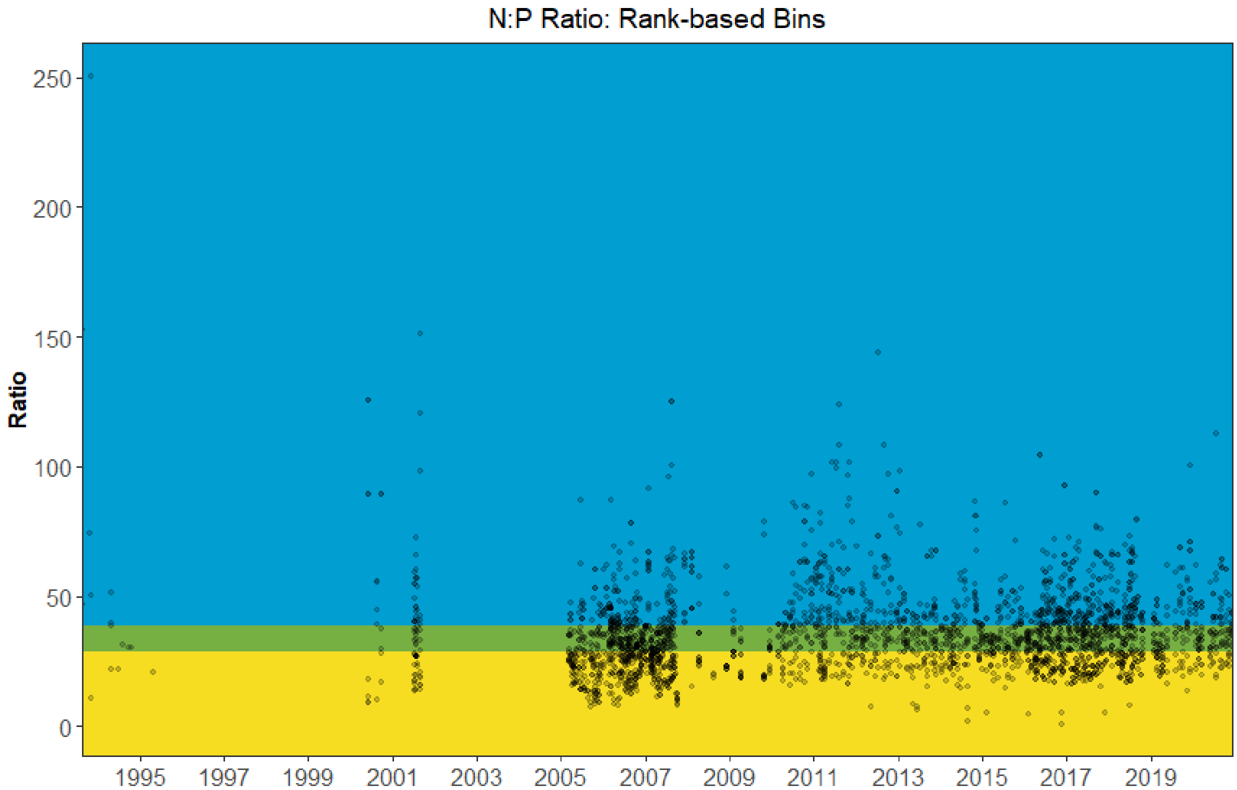


Total Phosphorus Concentration by Year

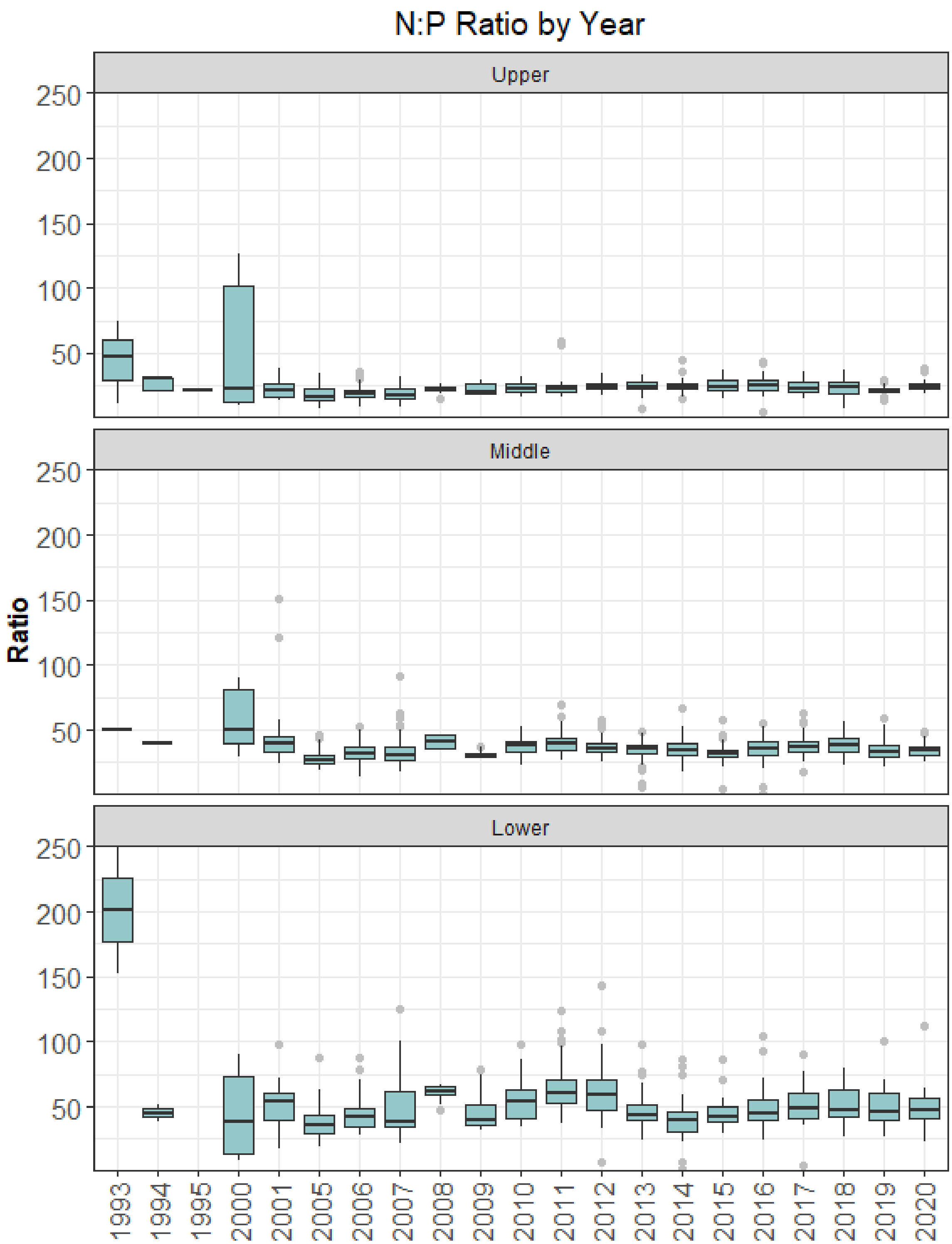


Total Phosphorus Concentration by Month

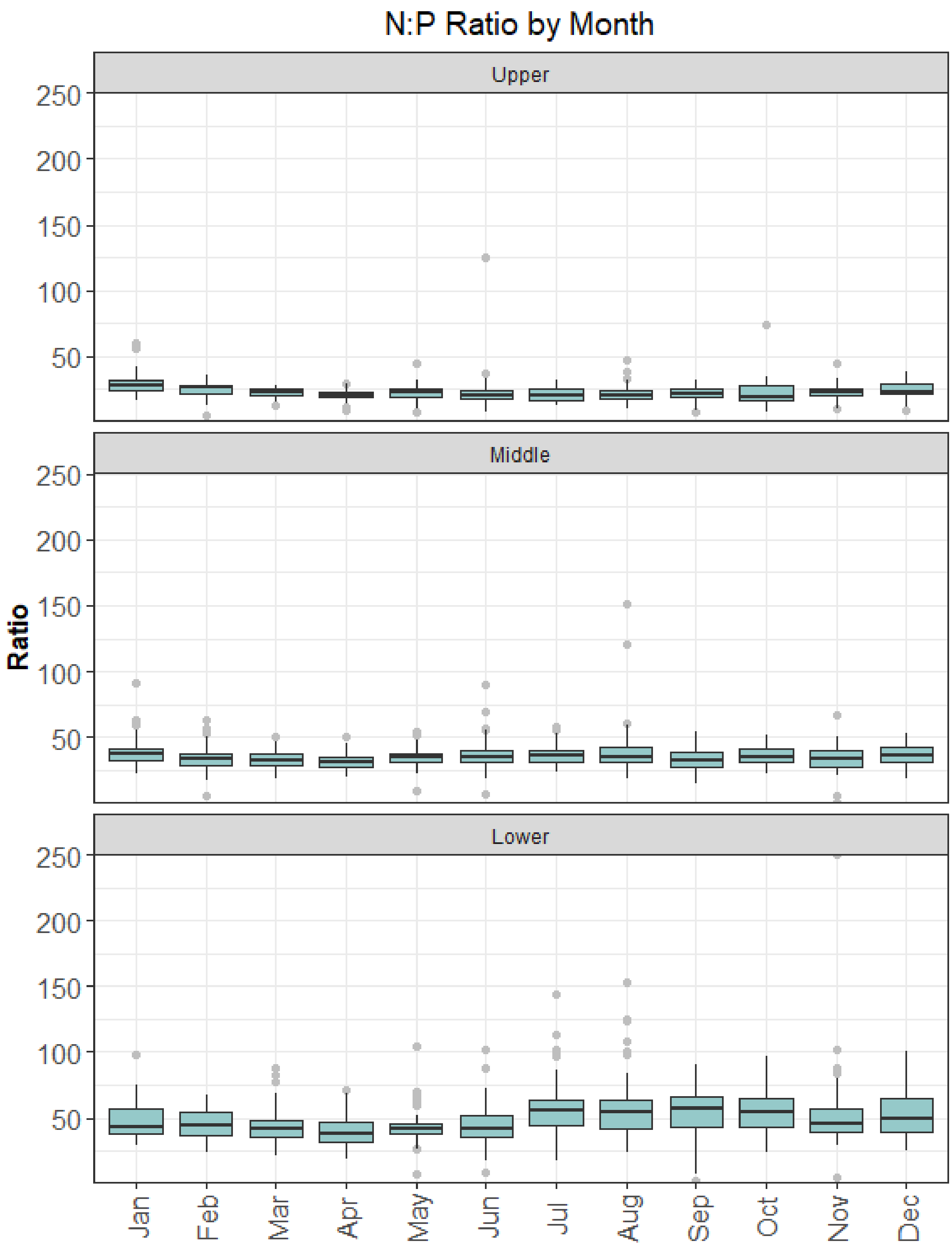
4.5 Ratio of Nitrogen Concentration to Phosphorus Concentration



Ratio of Nitrogen Concentration to Phosphorus Concentration by Model Bin

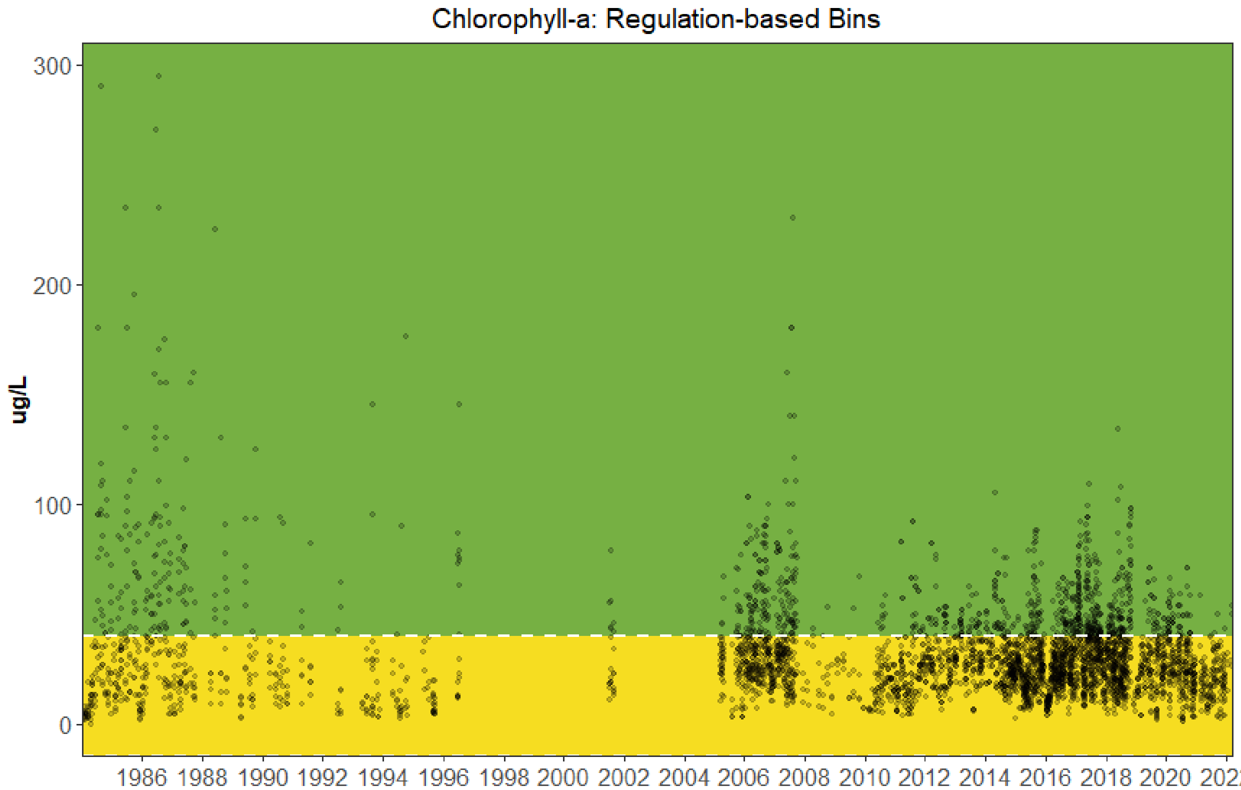


Ratio of Nitrogen Concentration to Phosphorus Concentration by Year

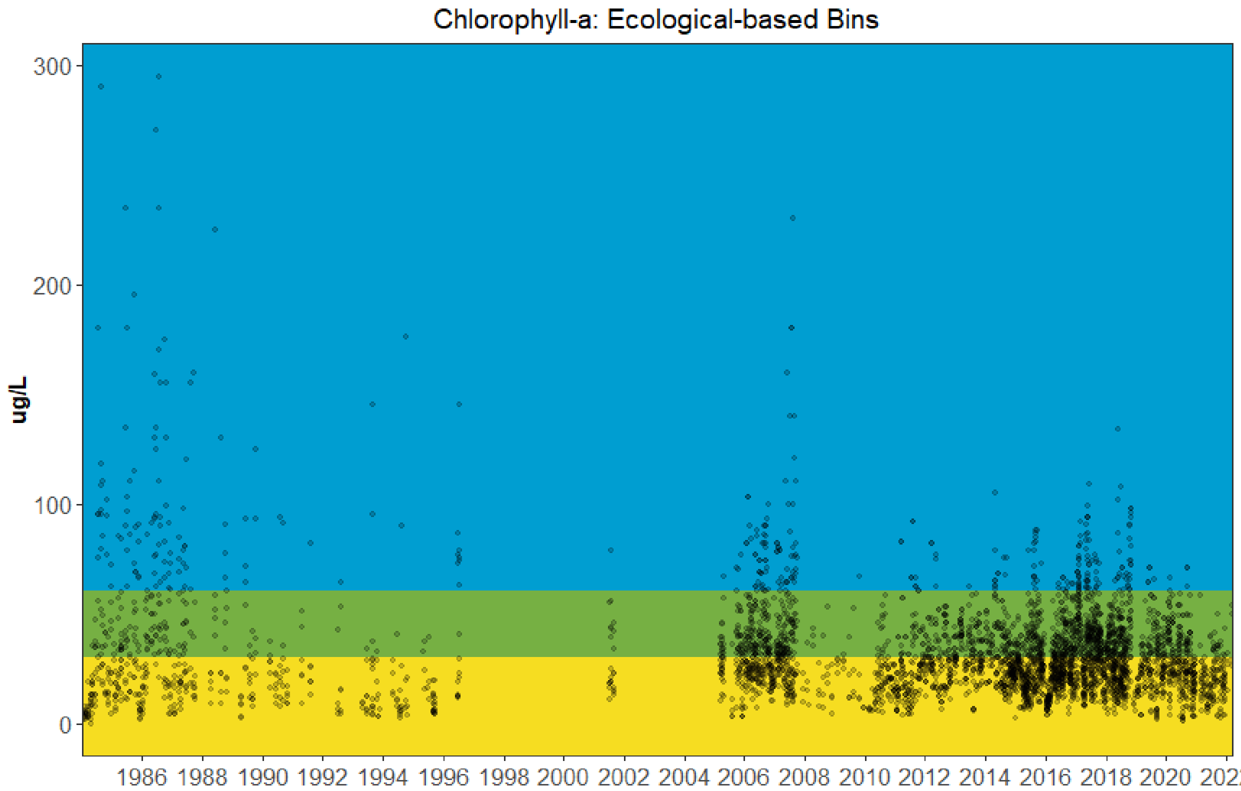


Ratio of Nitrogen Concentration to Phosphorus Concentration by Month

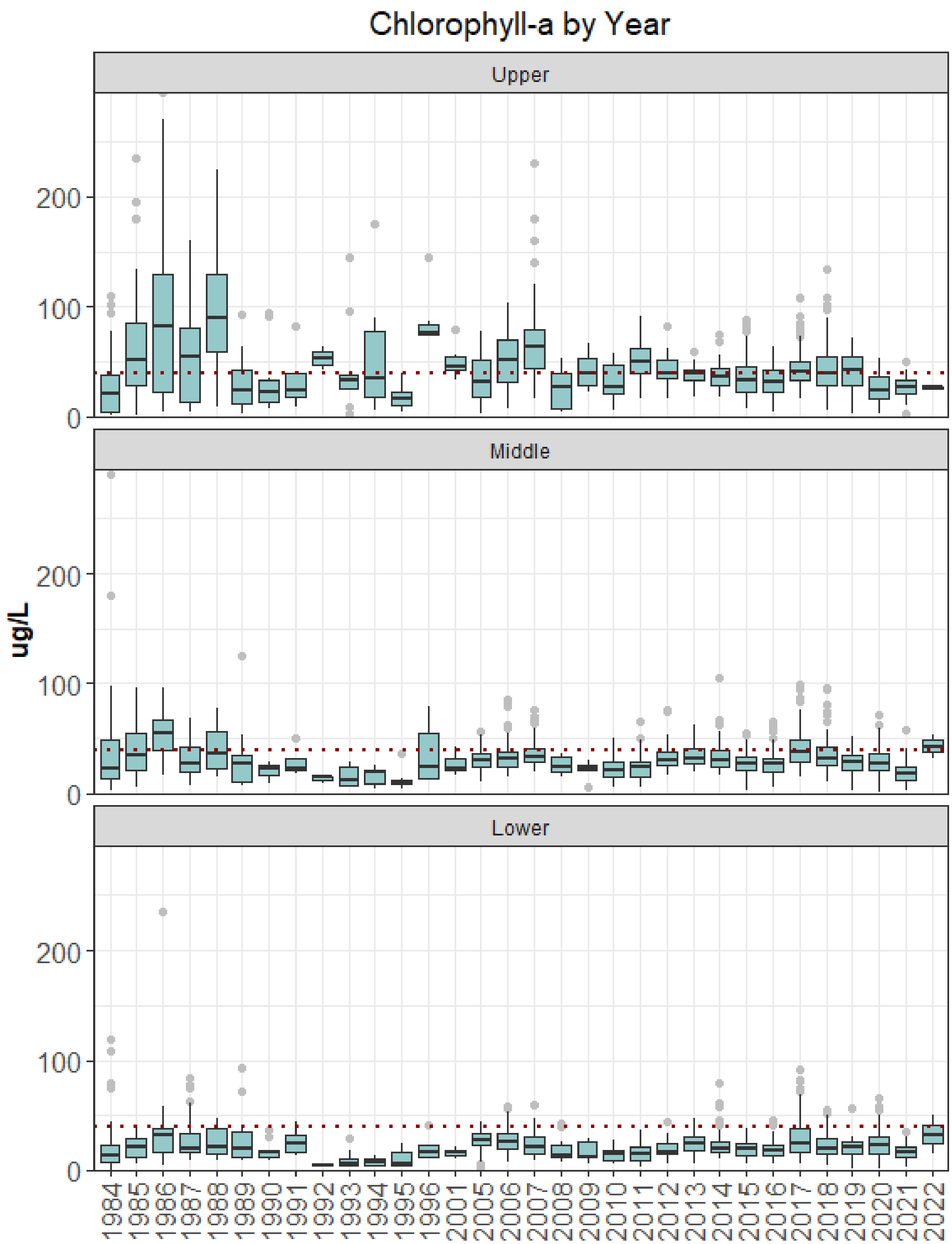
4.6 Chlorophyll-a Concentration



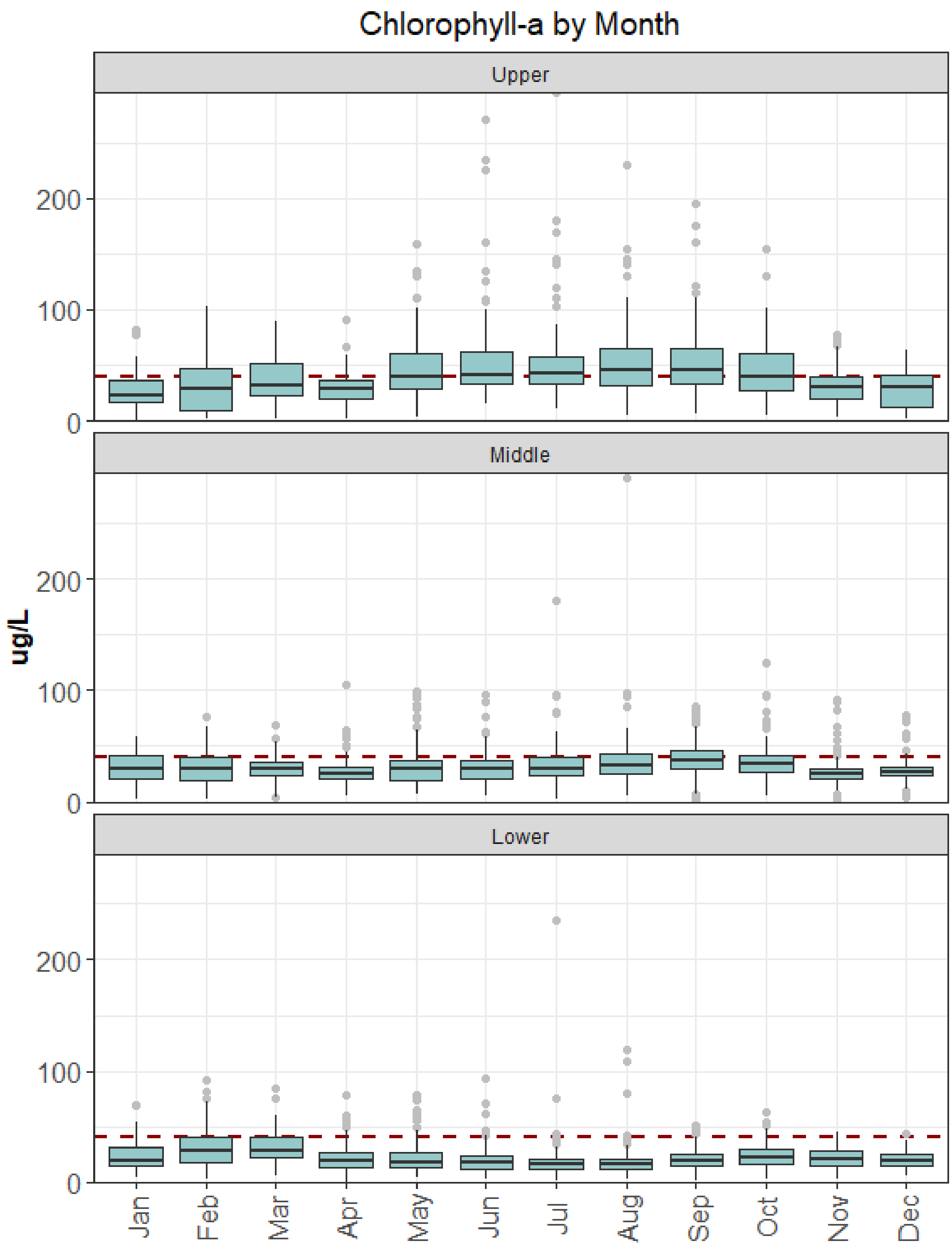
Chlorophyll-a Concentration by Regulatory Model Bin



Chlorophyll-a Concentration by Ecological Model Bin

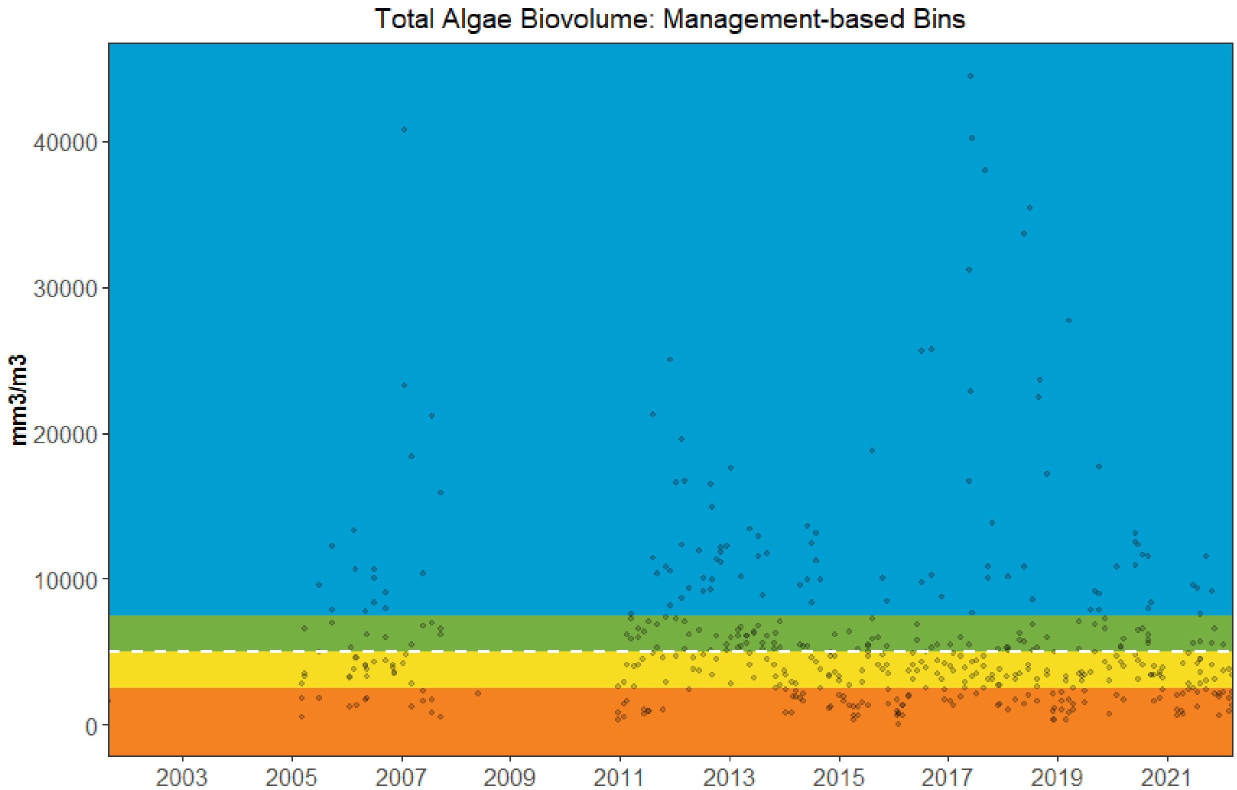


Chlorophyll-a Concentration by Year

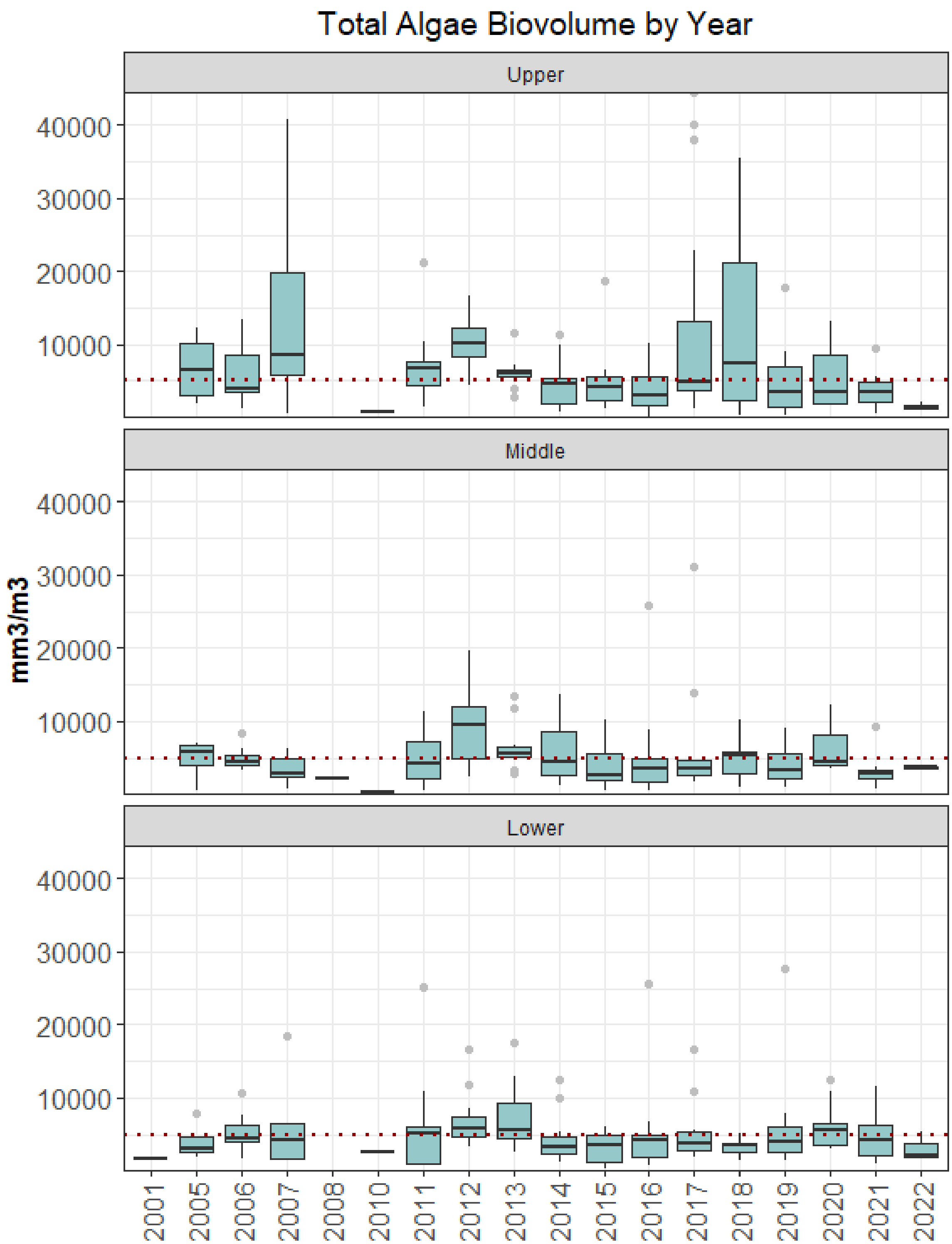


Chlorophyll-a Concentration by Month

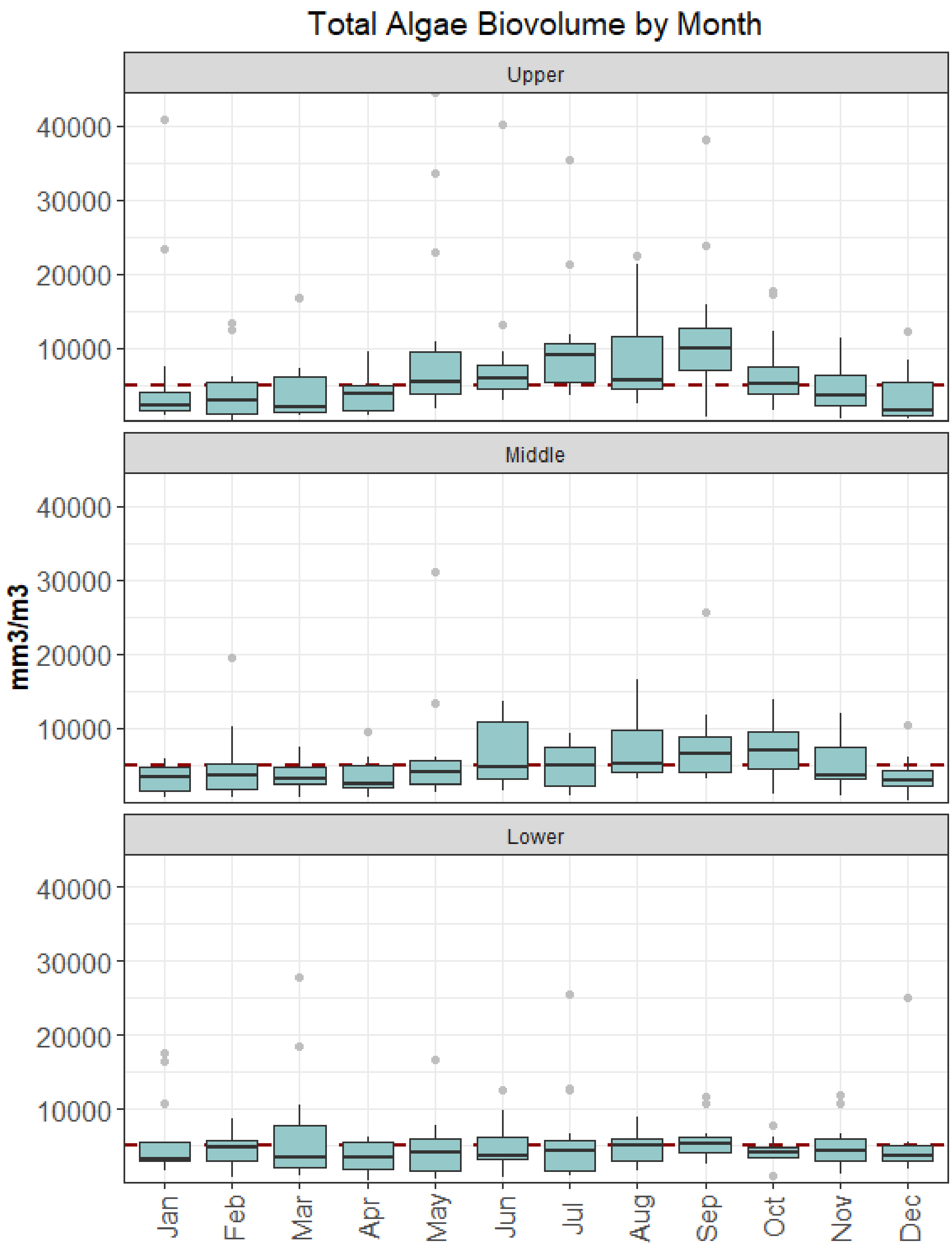
4.7 Total Algae Biovolume



Total Algae Biovolume by Model Bin

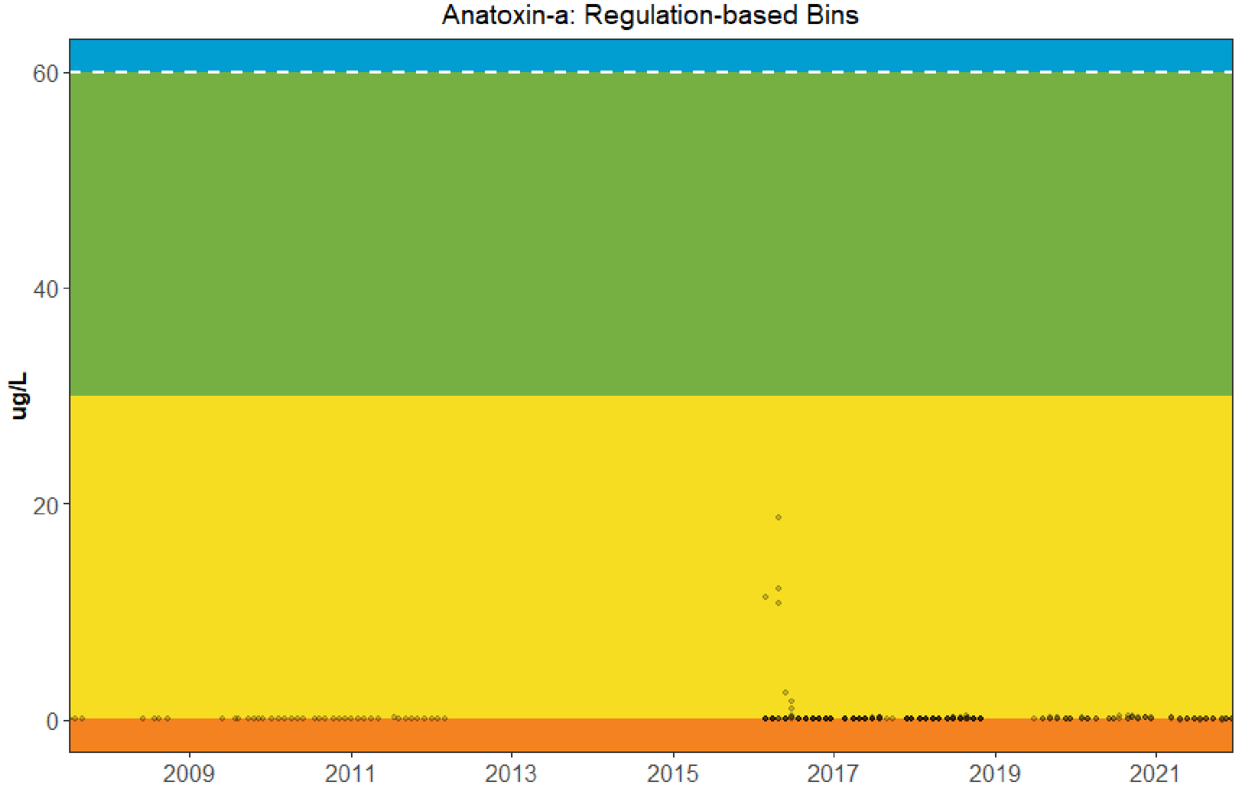


Total Algae Biovolume by Year

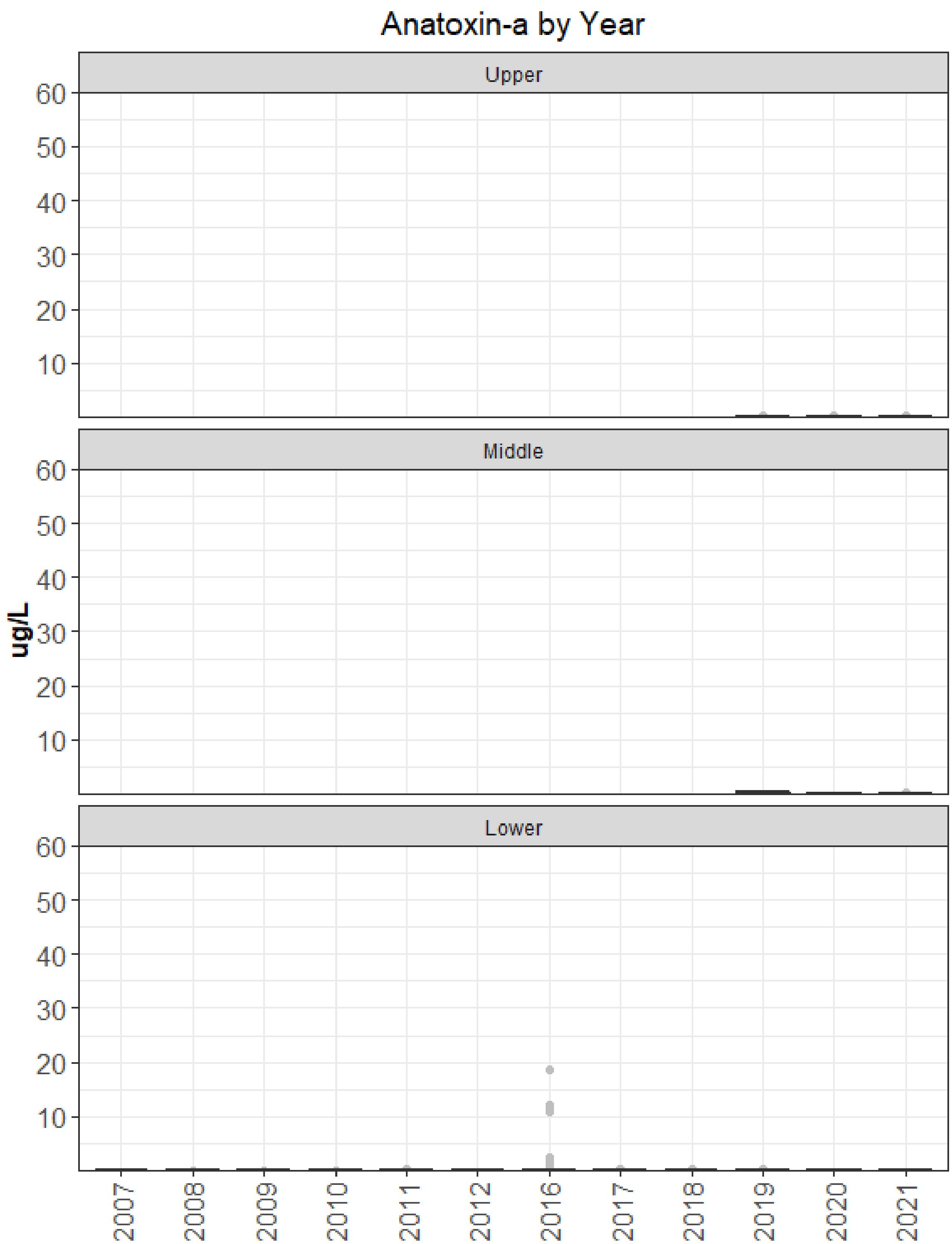


Total Algae Biovolume by Month

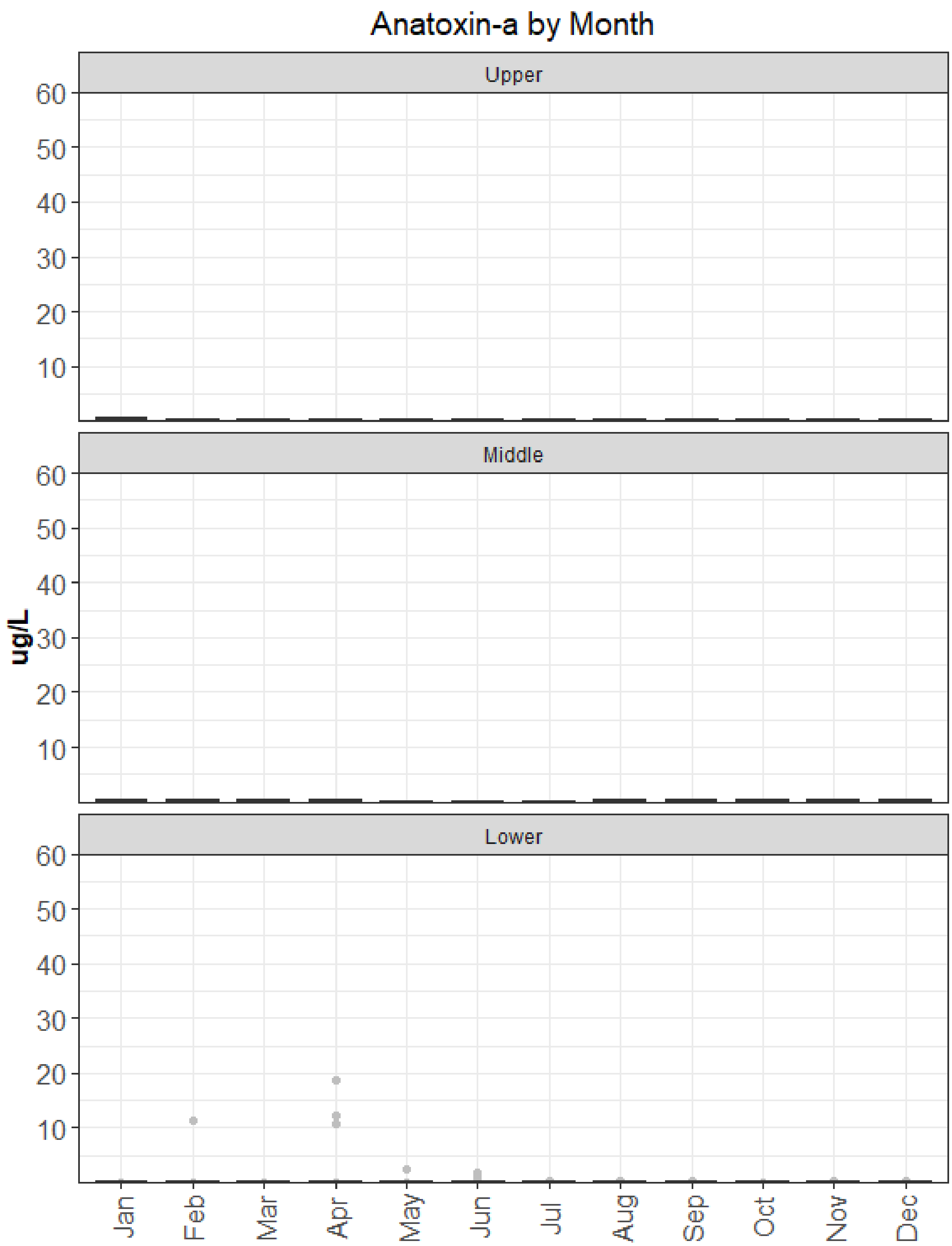
4.8 Anatoxin



Anatoxin by Model Bin

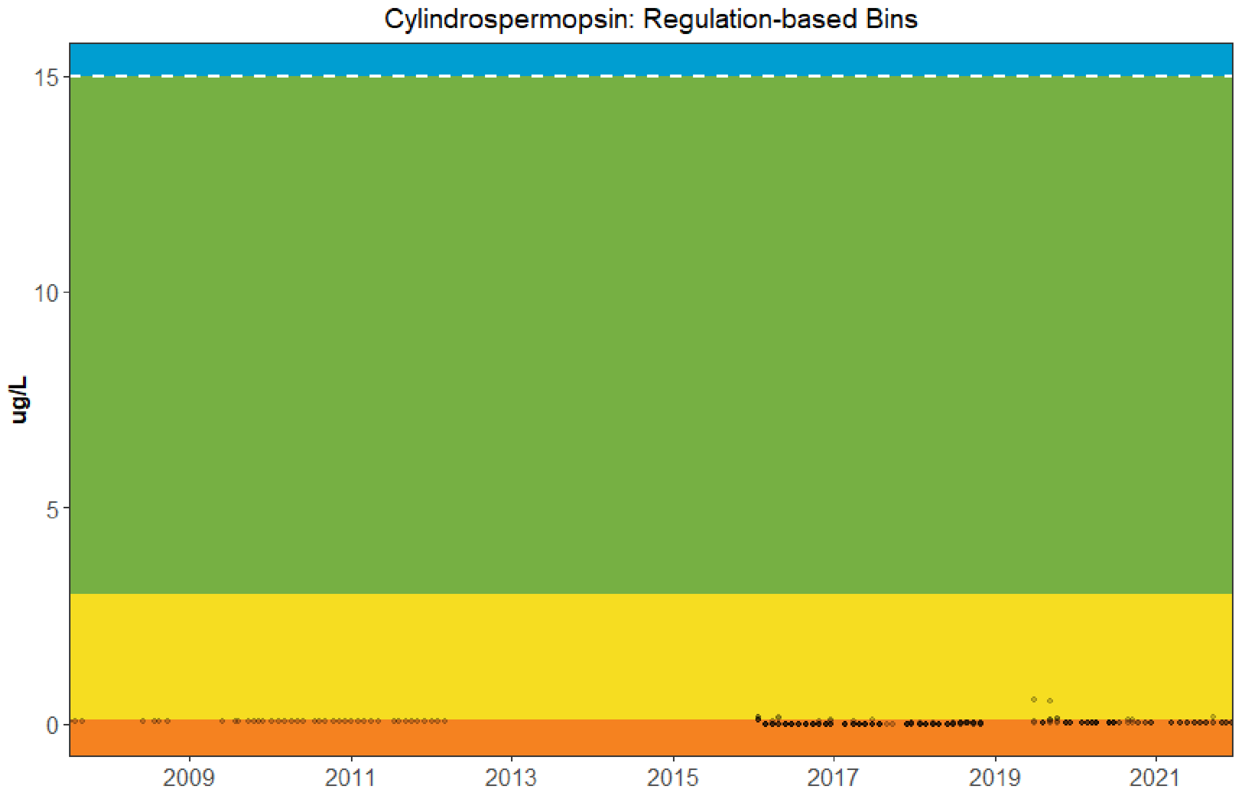


Anatoxin Concentration by Year

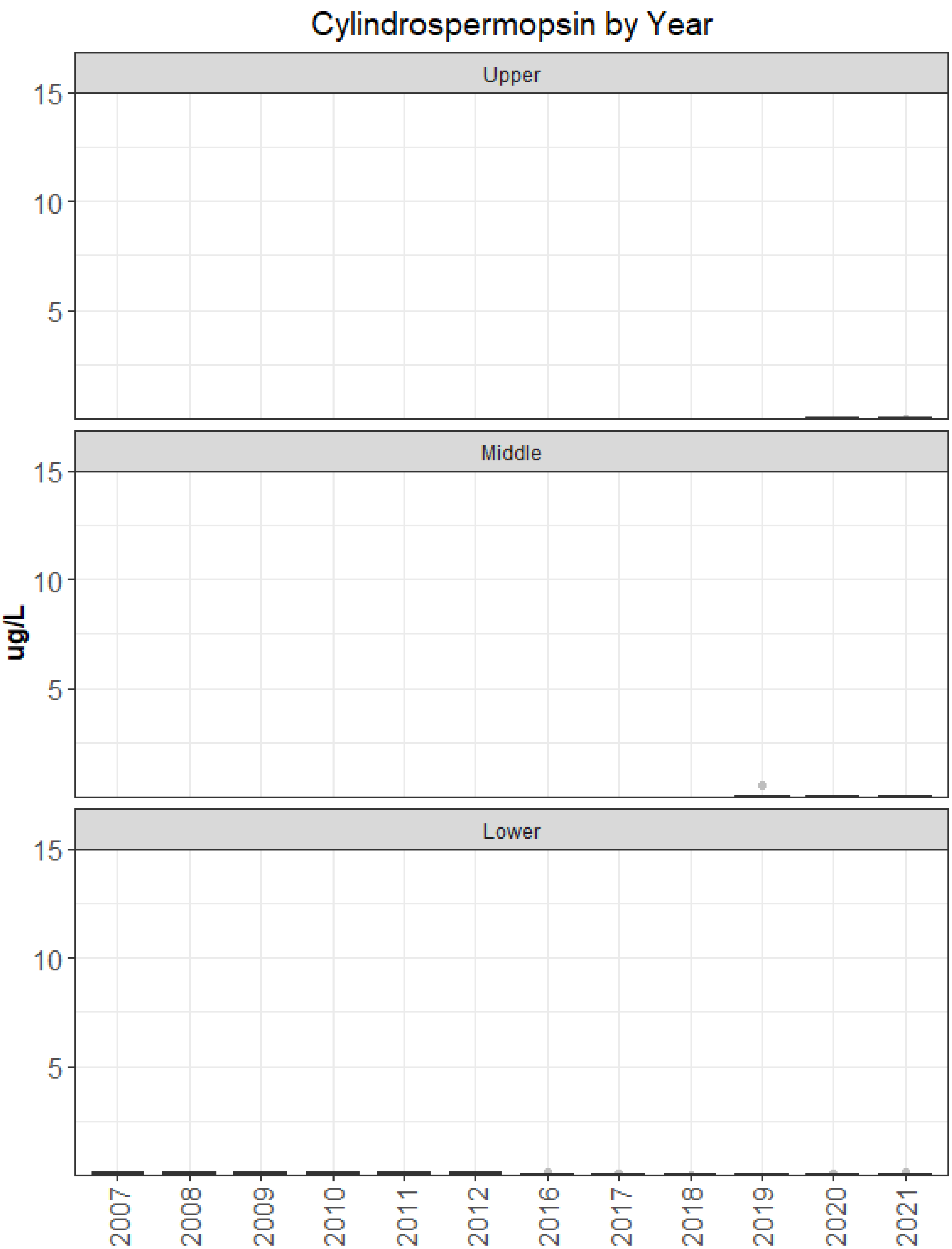


Anatoxin Concentration by Month

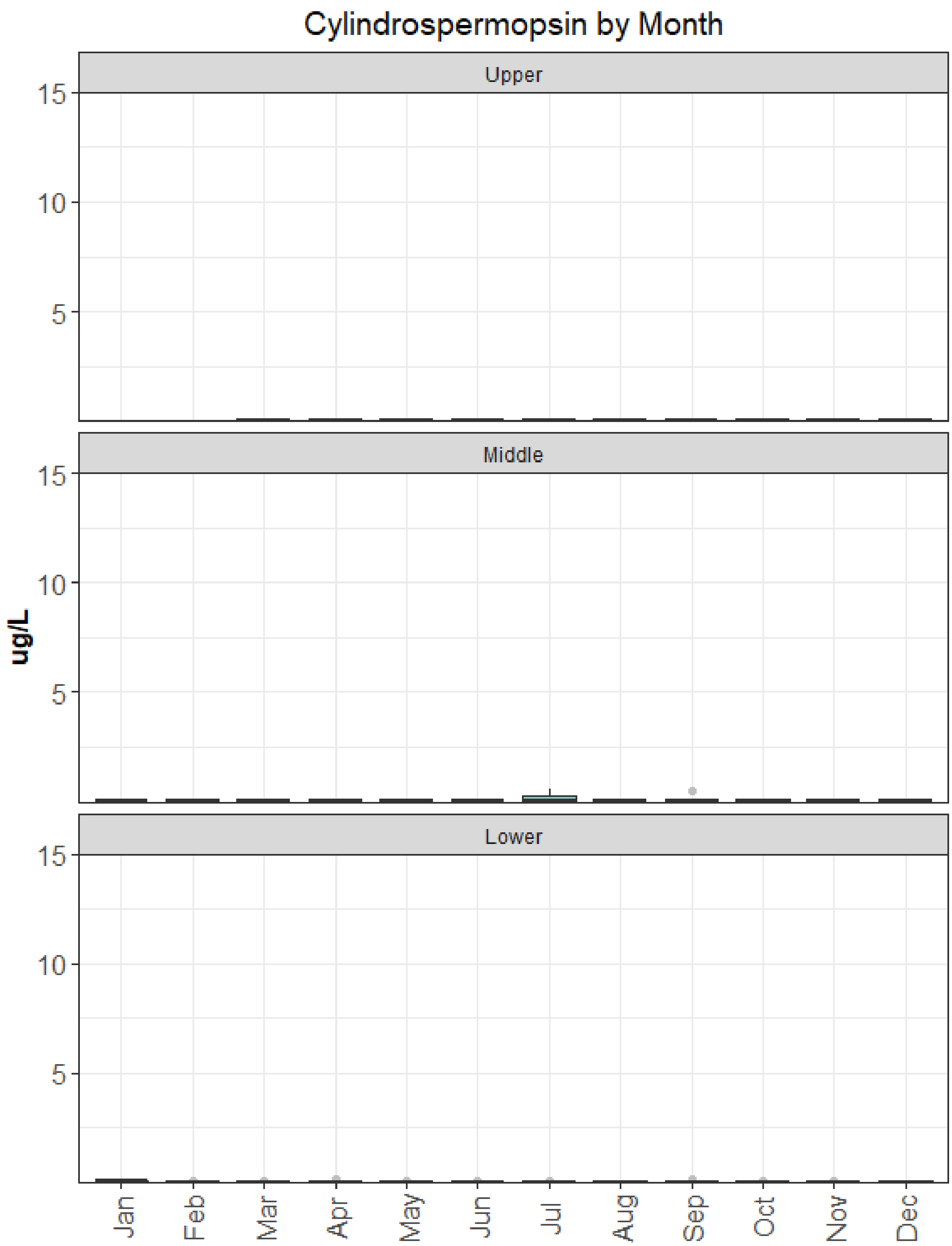
4.9 Cylindrospermopsin



Cylindrospermopsin Concentration by Model Bin

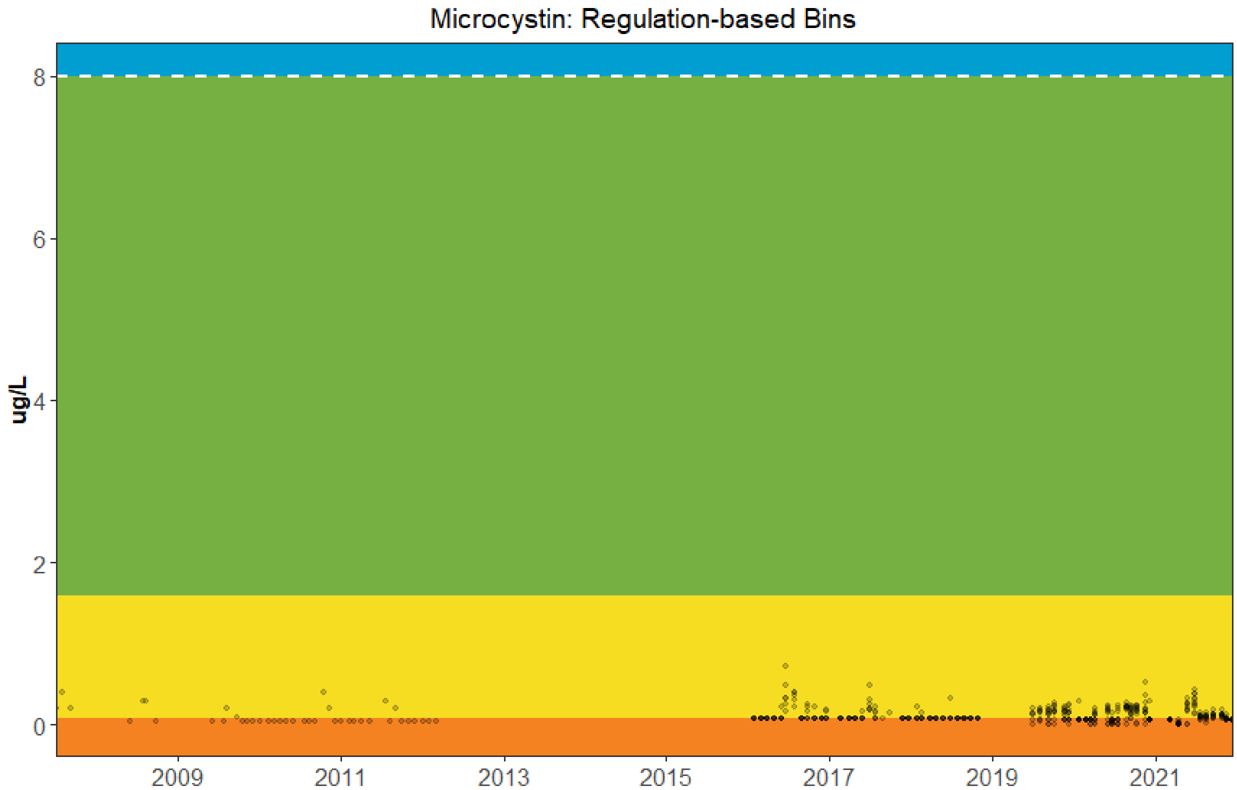


Cylindrospermopsin Concentration by Year

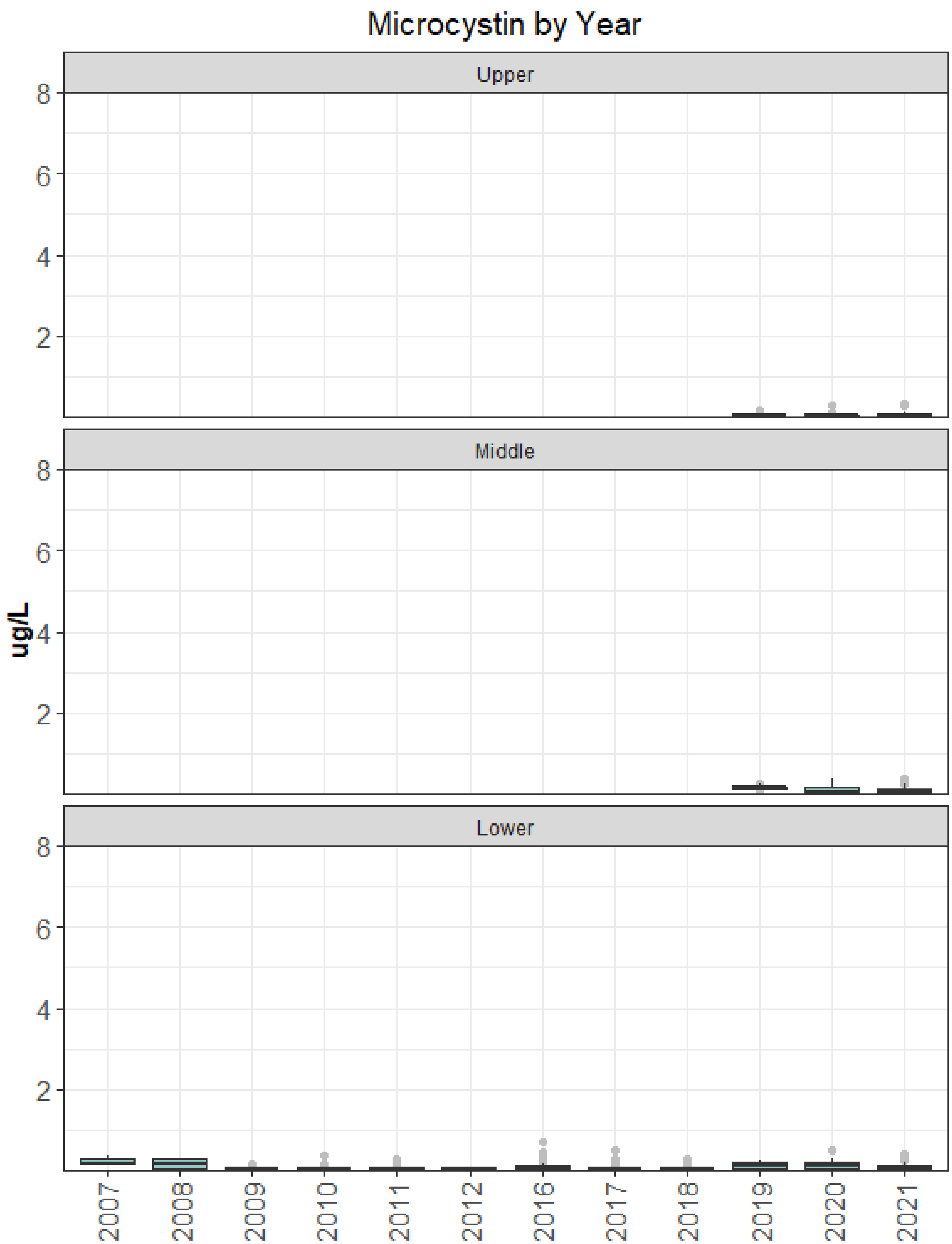


Cylindrospermopsin Concentration by Month

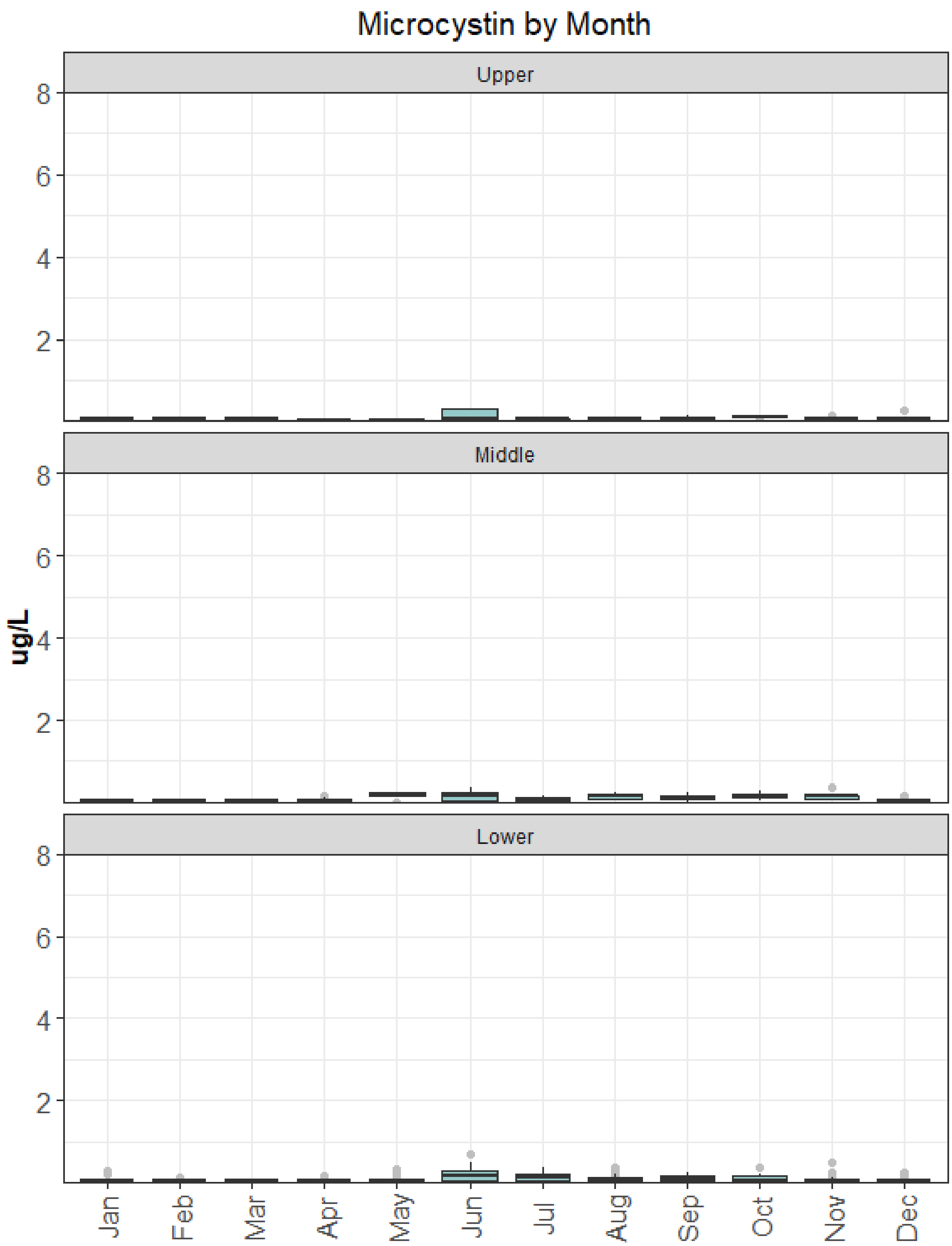
4.10 Microcystin



Microcystin Concentration by Model Bin



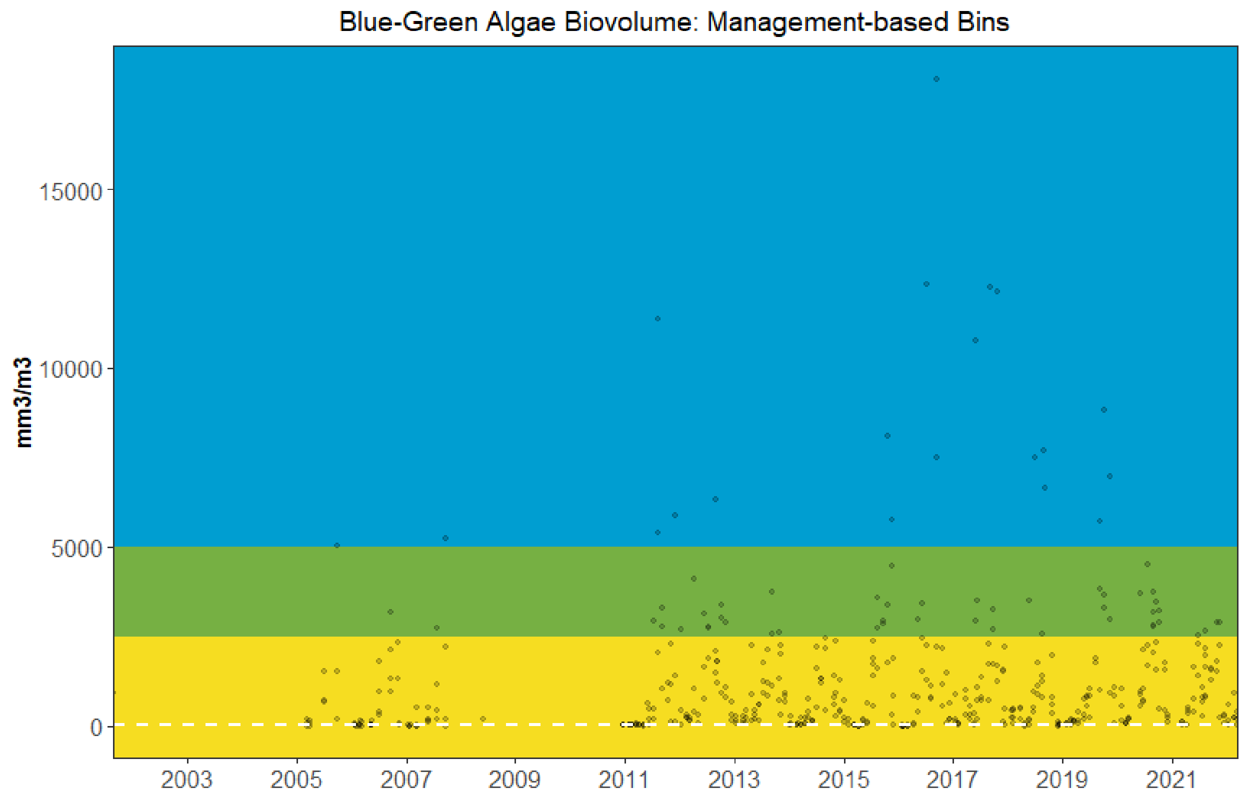
Microcystin Concentration by Year



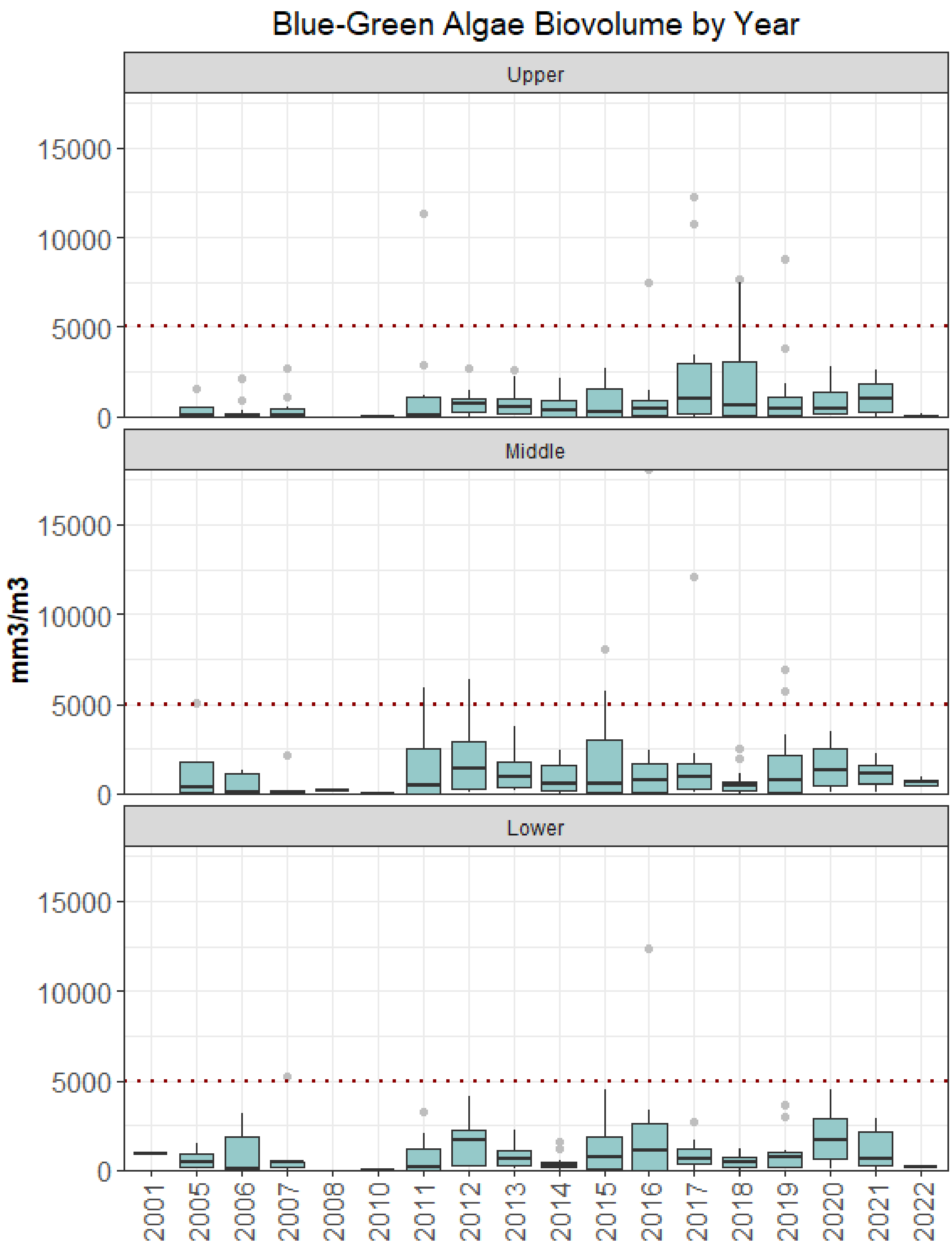
Microcystin Concentration by Month

4.11 Blue Green Algae Biovolume

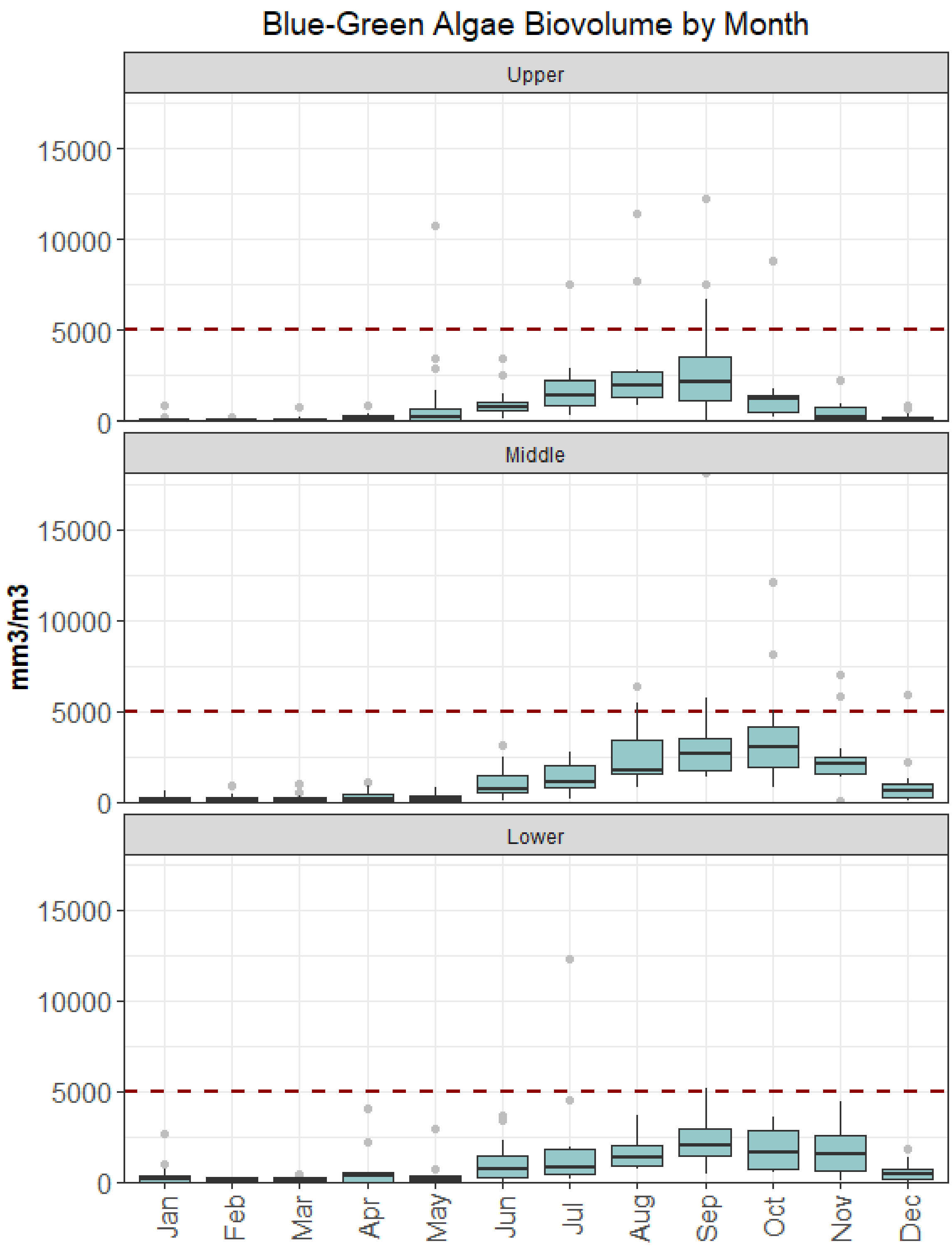
4.12



Blue Green Algae Biovolume by Model Bin

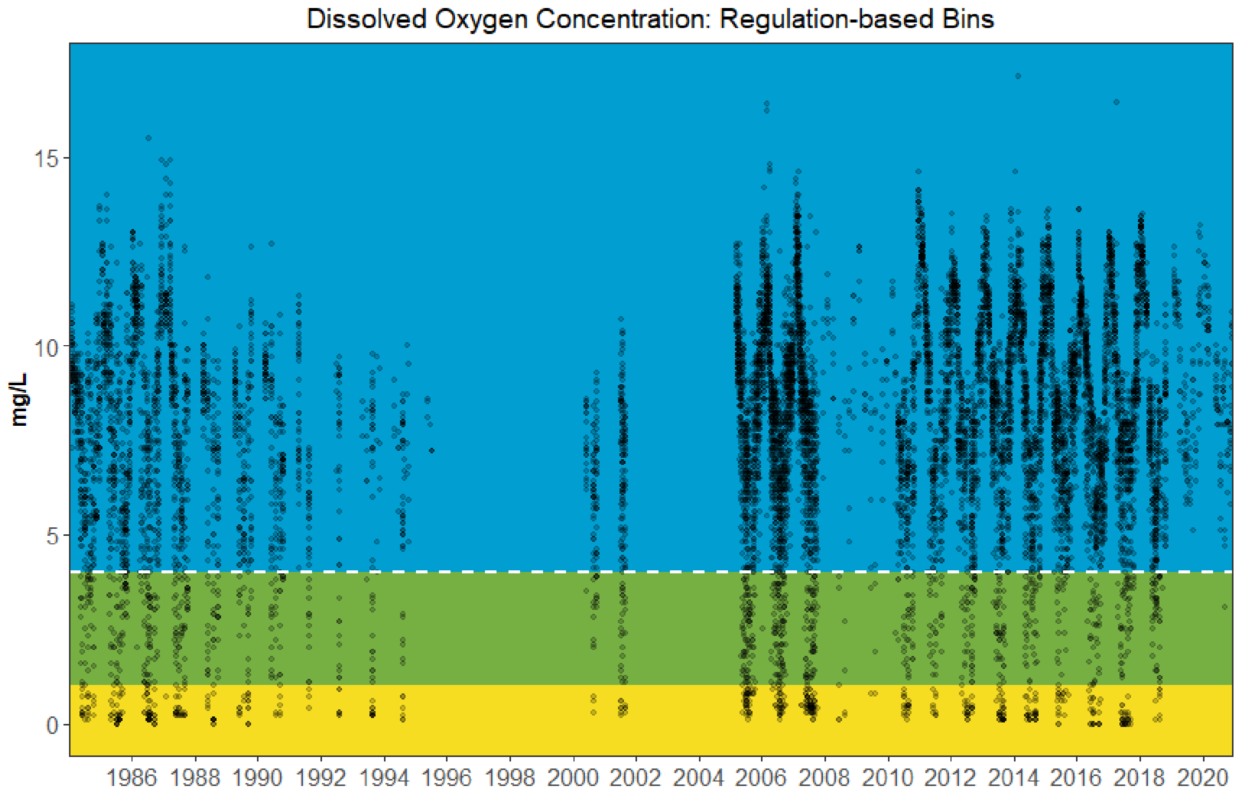


Blue-Green Algae Biovolume by Year

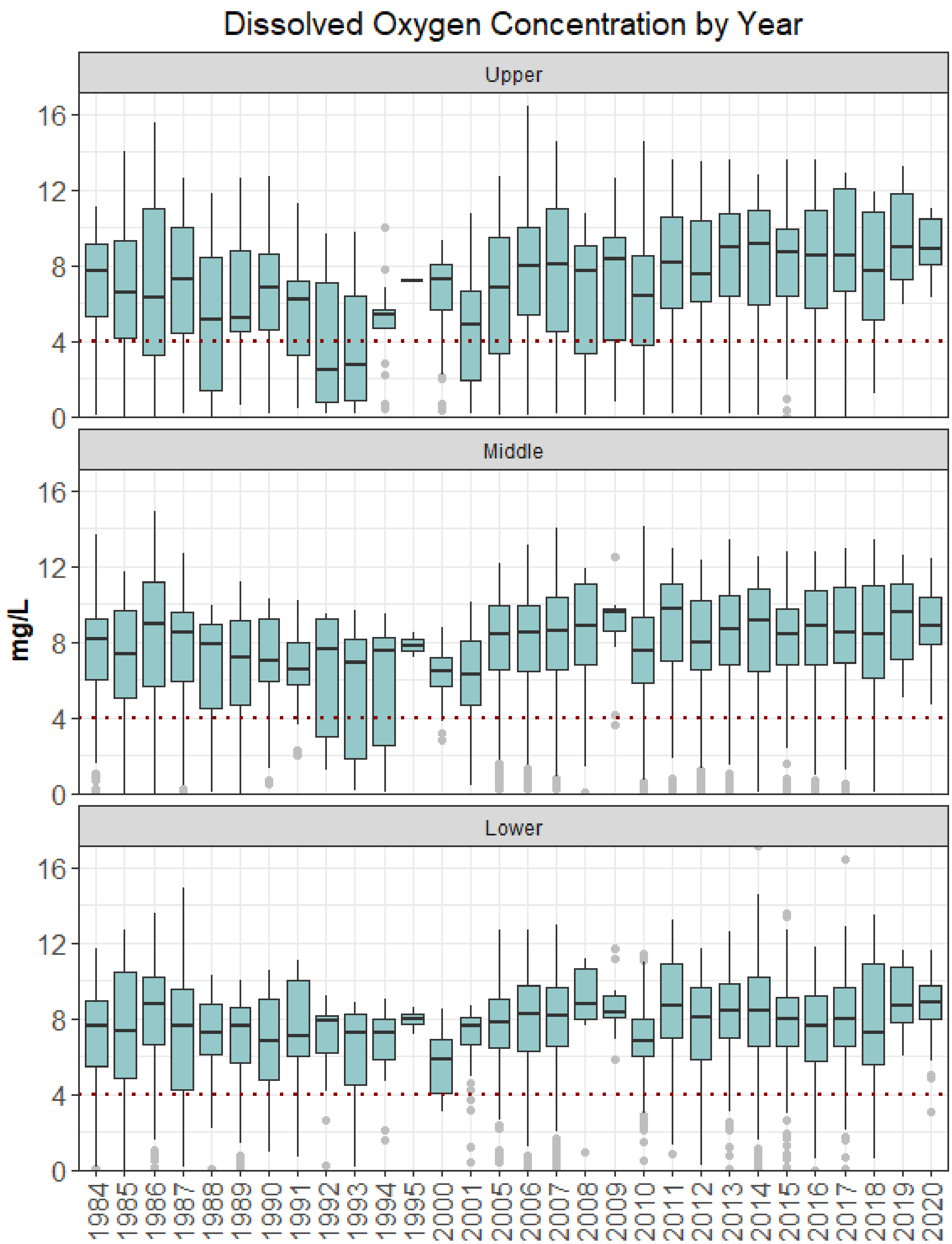


Blue-Green Algae Biovolume by Month

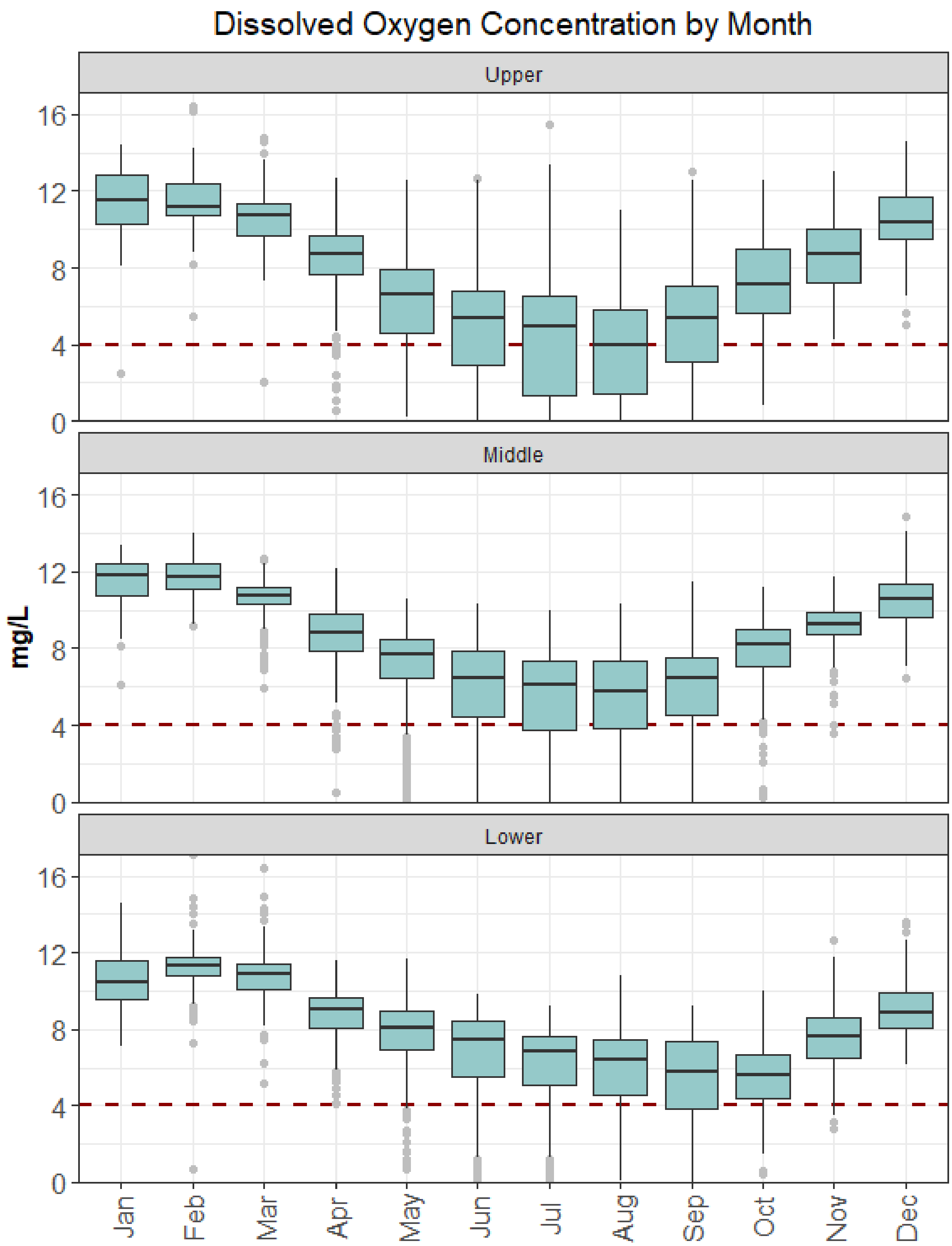
4.13 Dissolved Oxygen Concentration (Profile Measurements)



Profile Measurements of Dissolved Oxygen Concentration by Model Bin

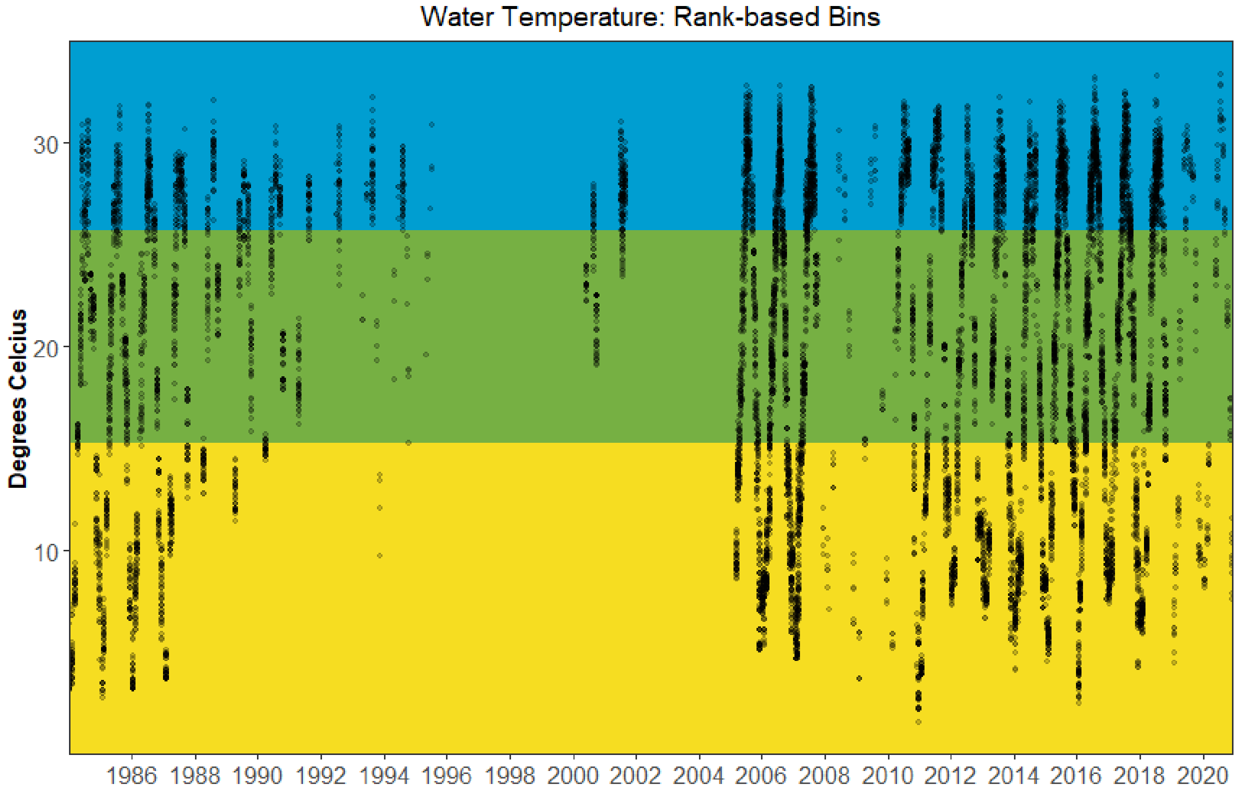


Profile Measurements of Dissolved Oxygen Concentration by Year

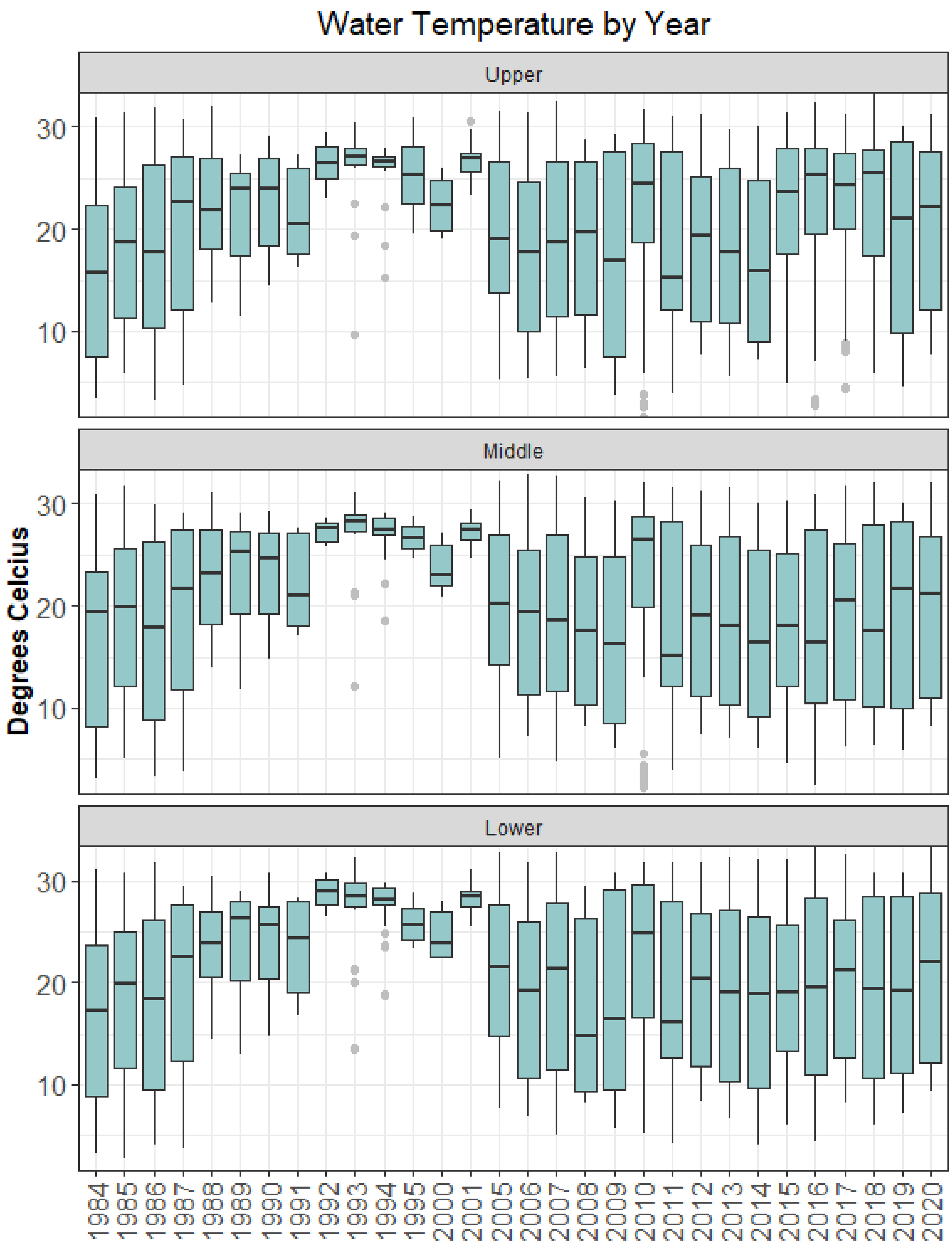


Profile Measurements of Dissolved Oxygen Concentration by Month

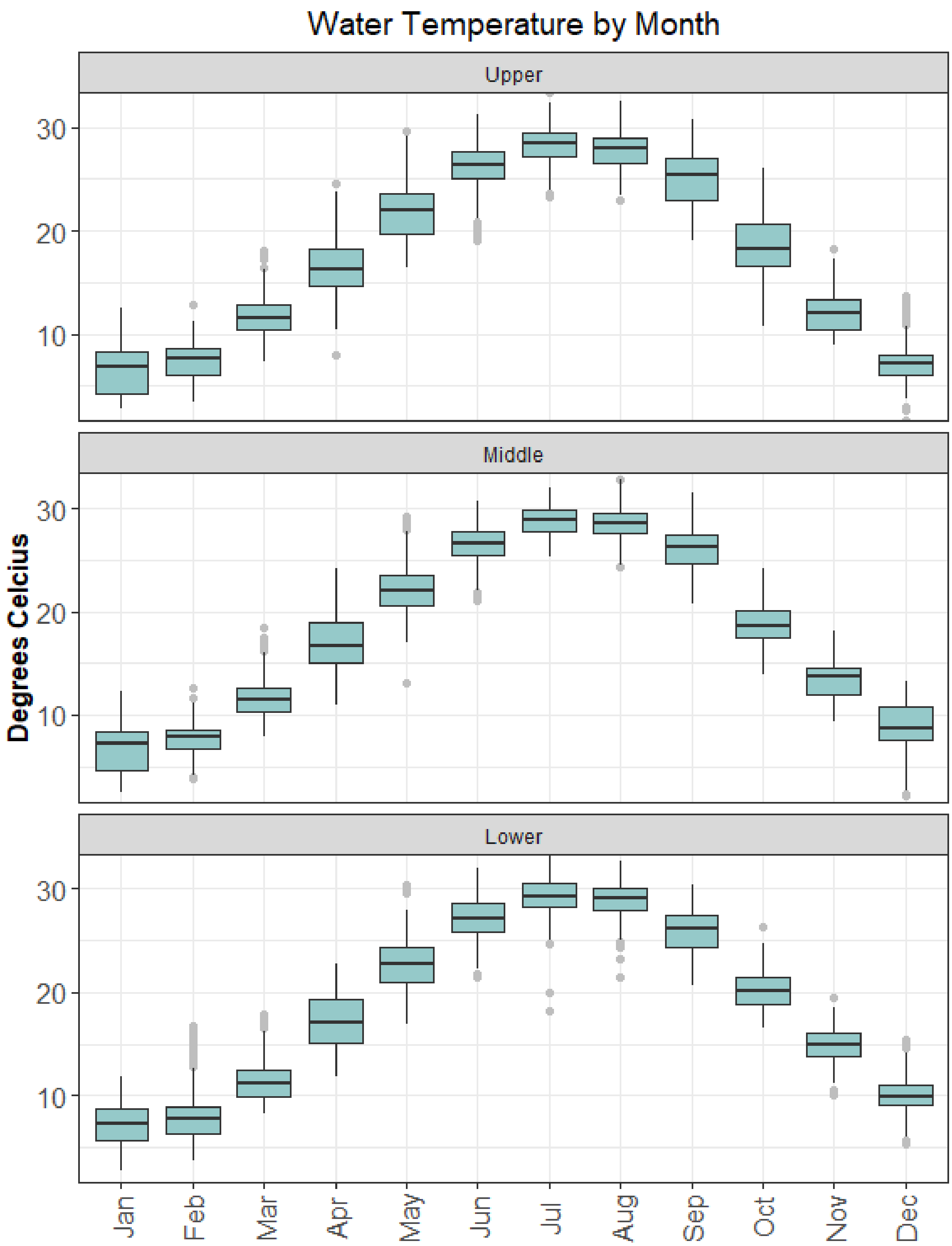
4.14 Water Temperature



Water Temperature by Model Bin

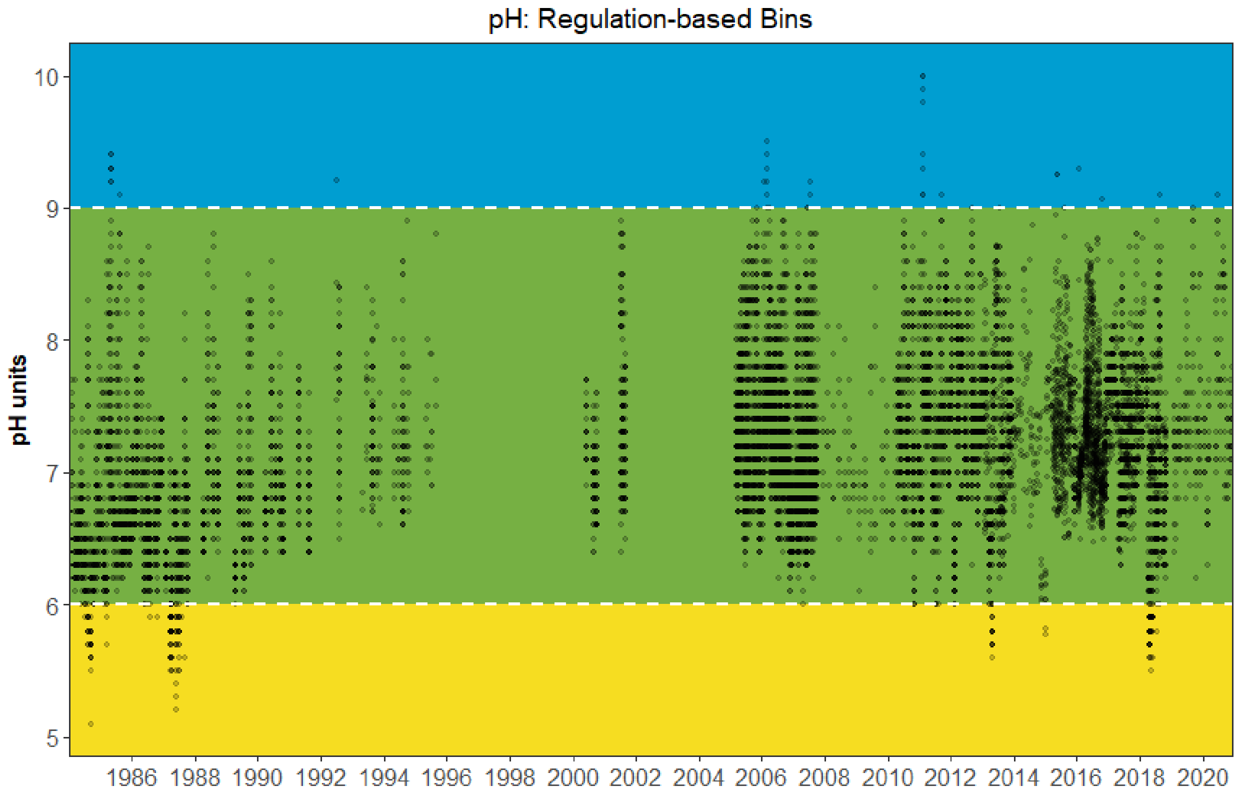


Water Temperature by Year

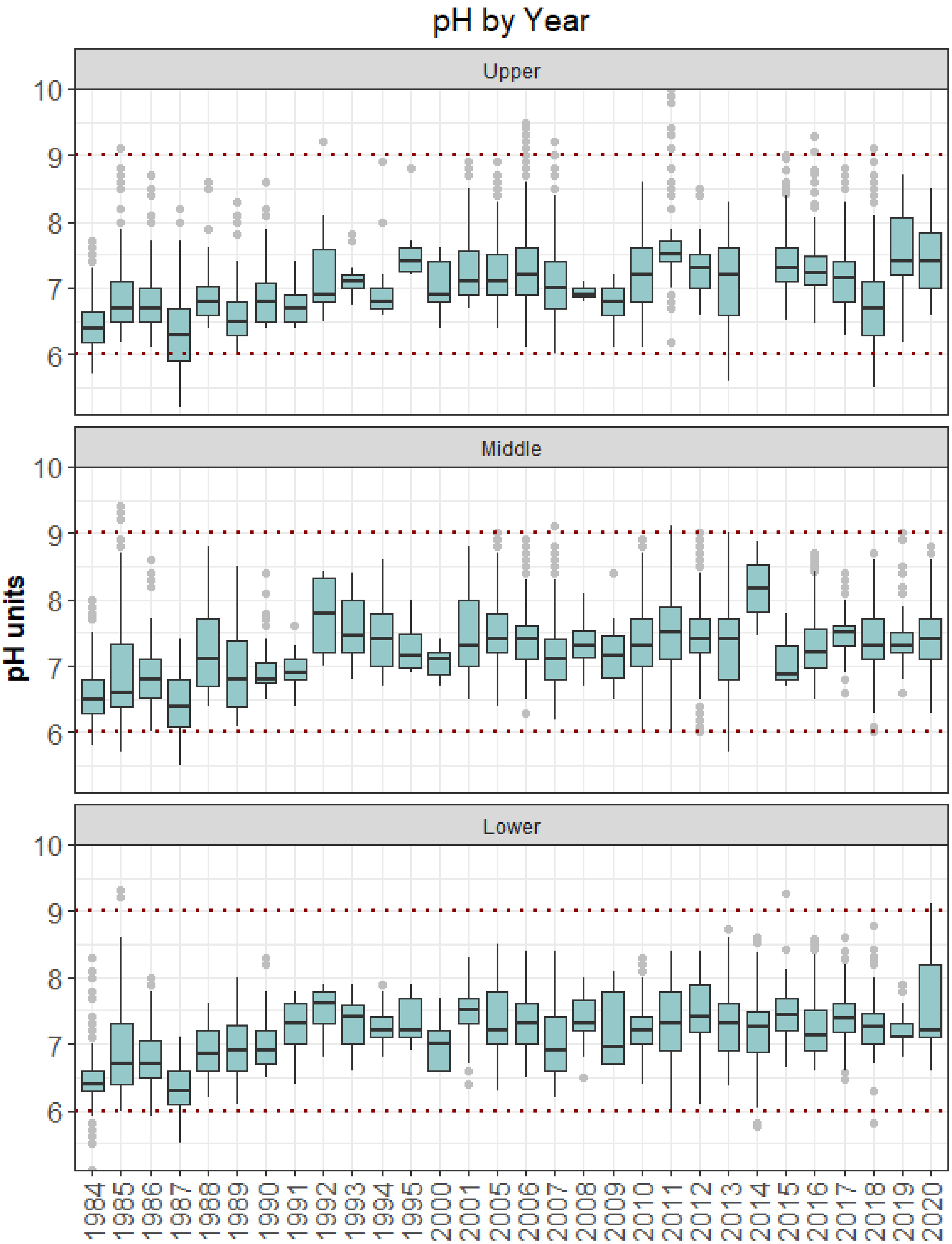


Water Temperature by Month

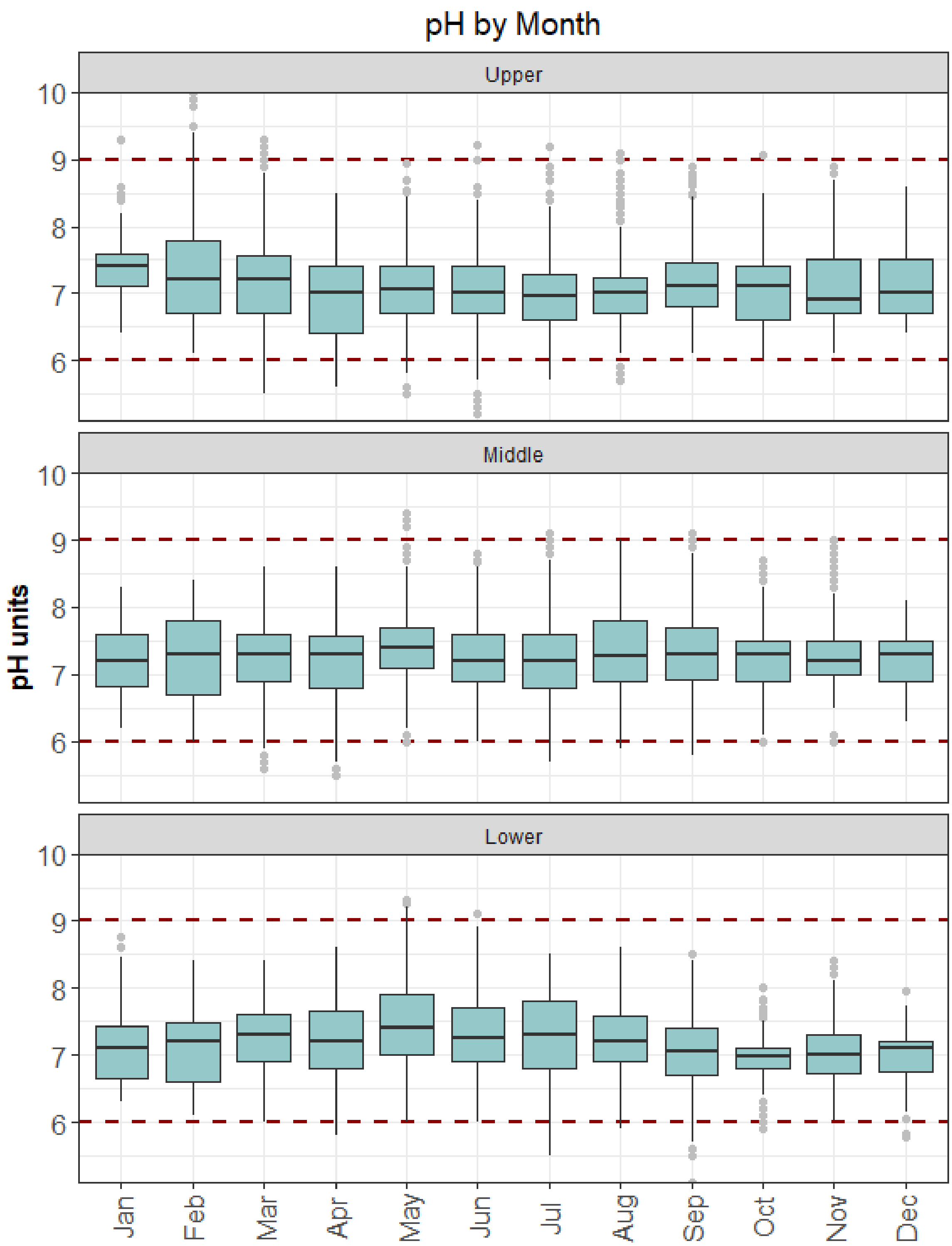
4.15 pH



pH by Model Bin

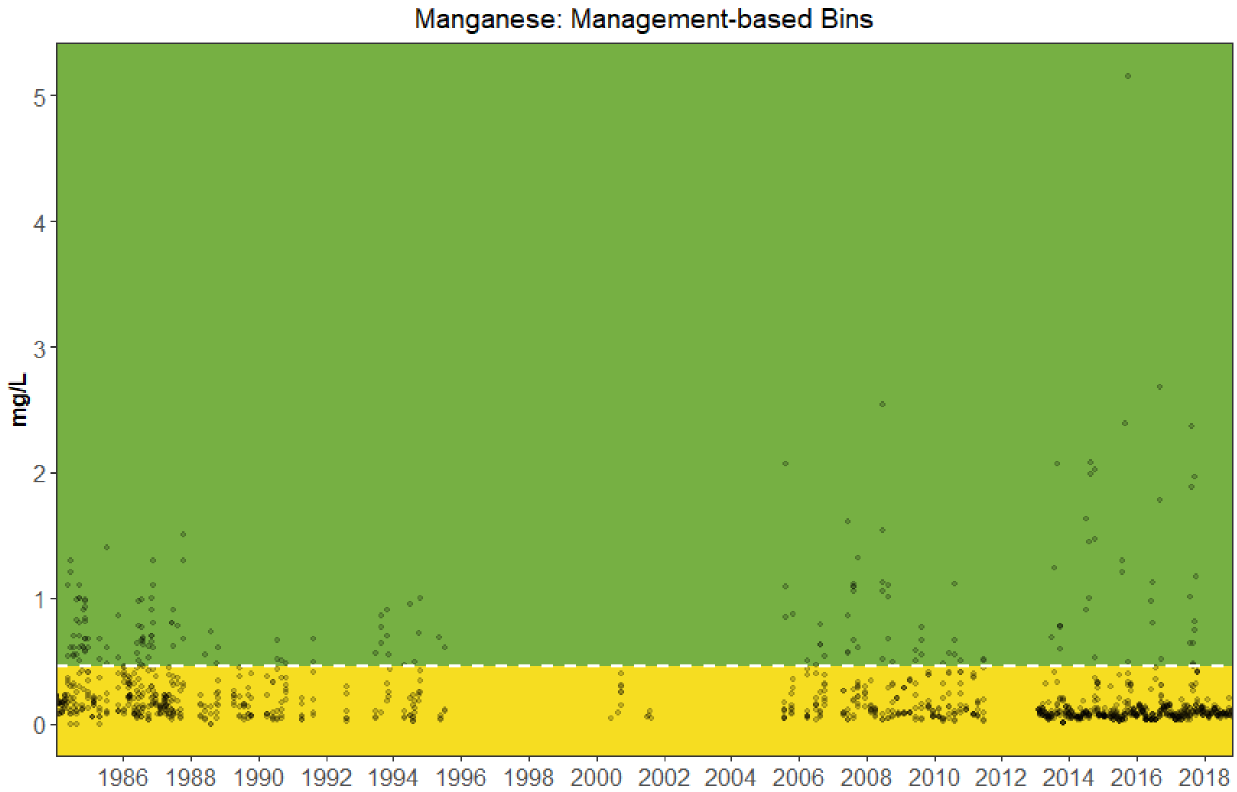

pH by Year
Upper
Middle
Lower
pH units
10
9
8
7
6
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
2000
2001
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

pH by Year

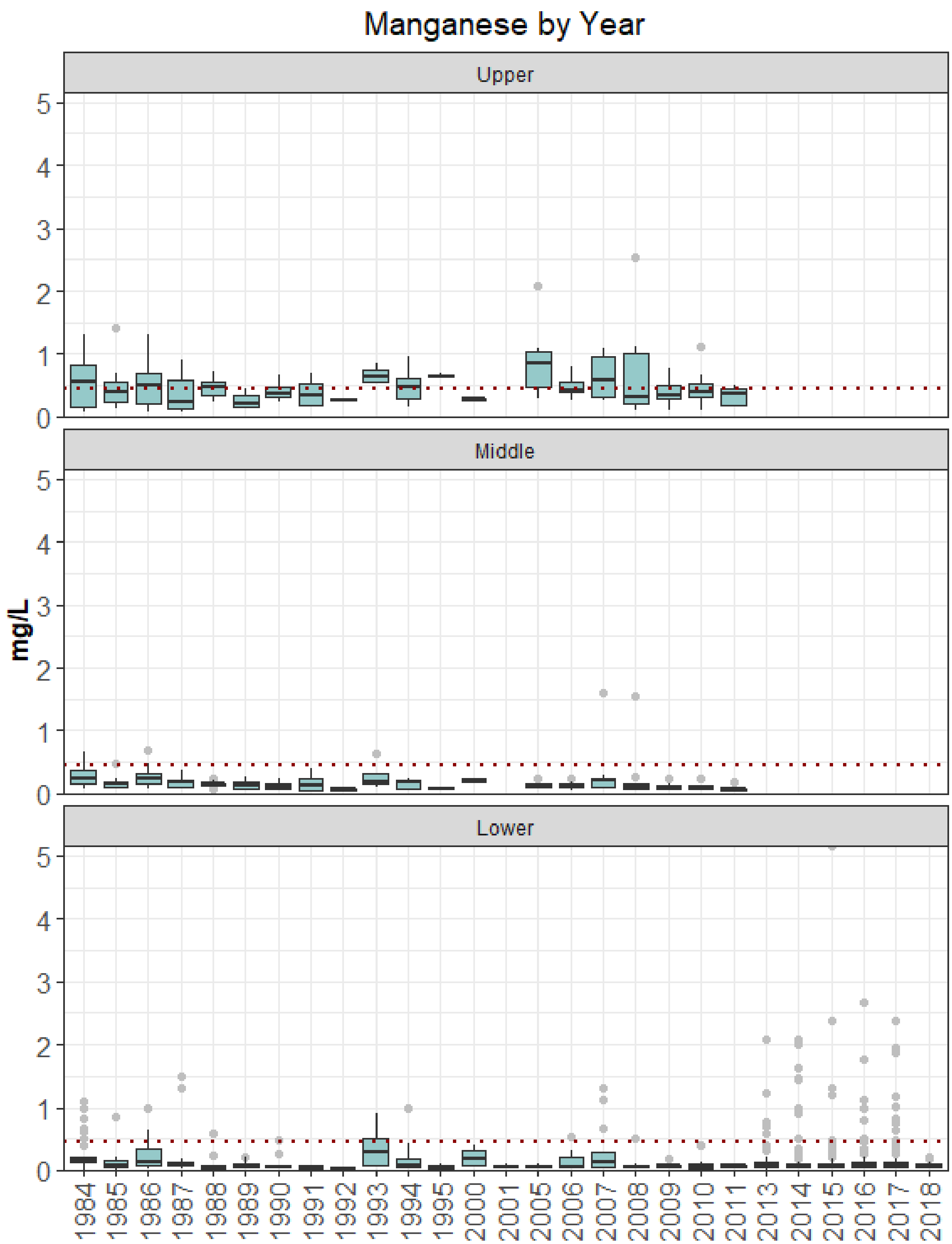

pH by Month
Upper
Middle
Lower
pH units
10
9
8
7
6
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

pH by Month

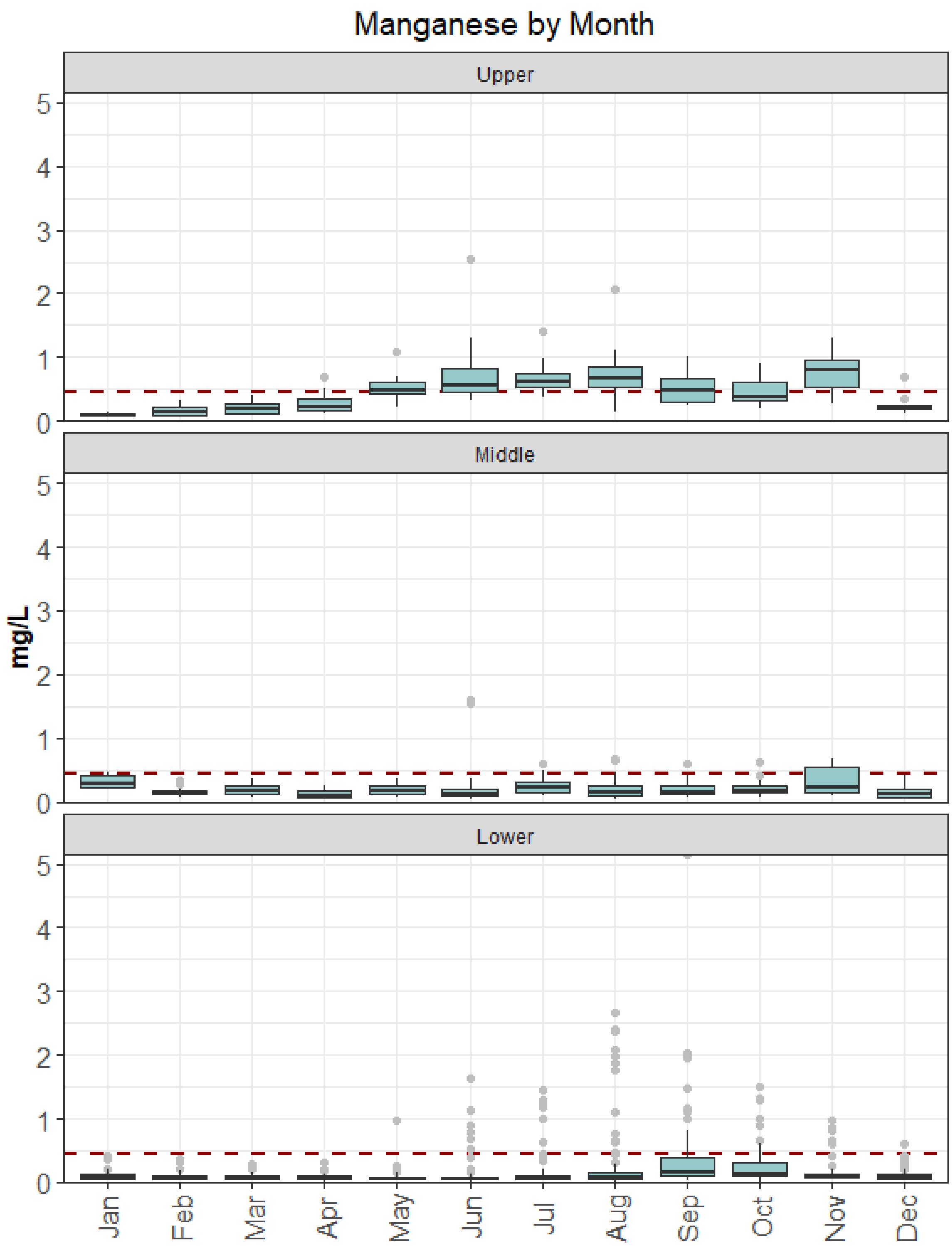
4.16 Manganese



Manganese by Model Bin

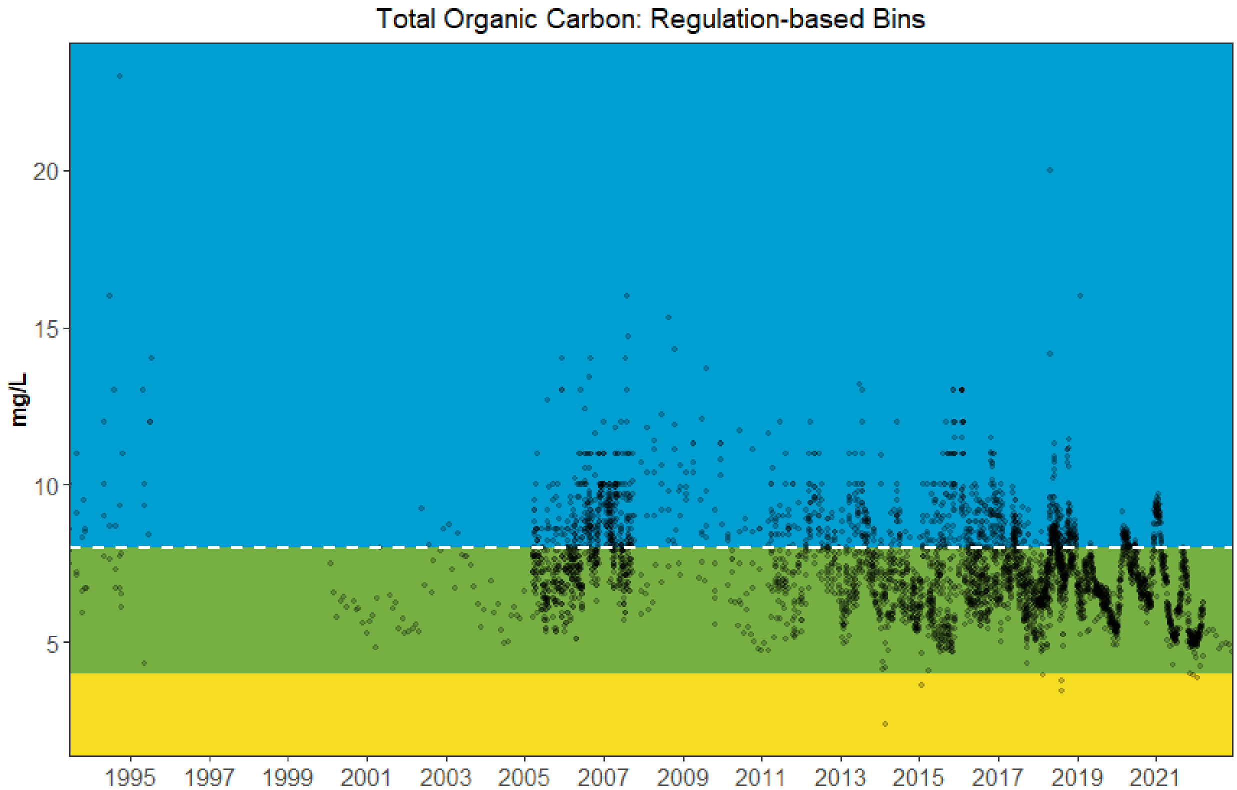


Manganese Concentration by Year

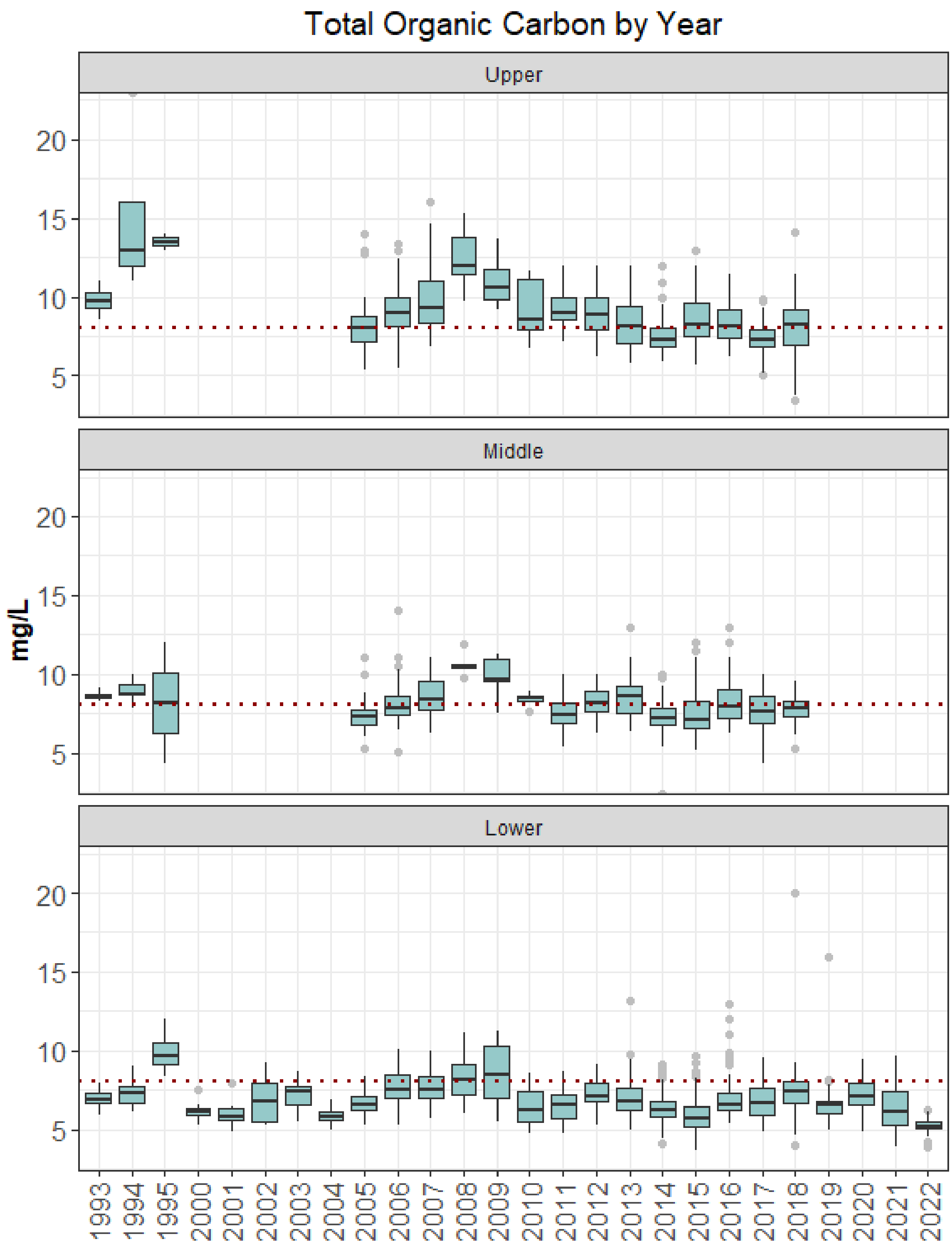


Manganese Concentration by Month

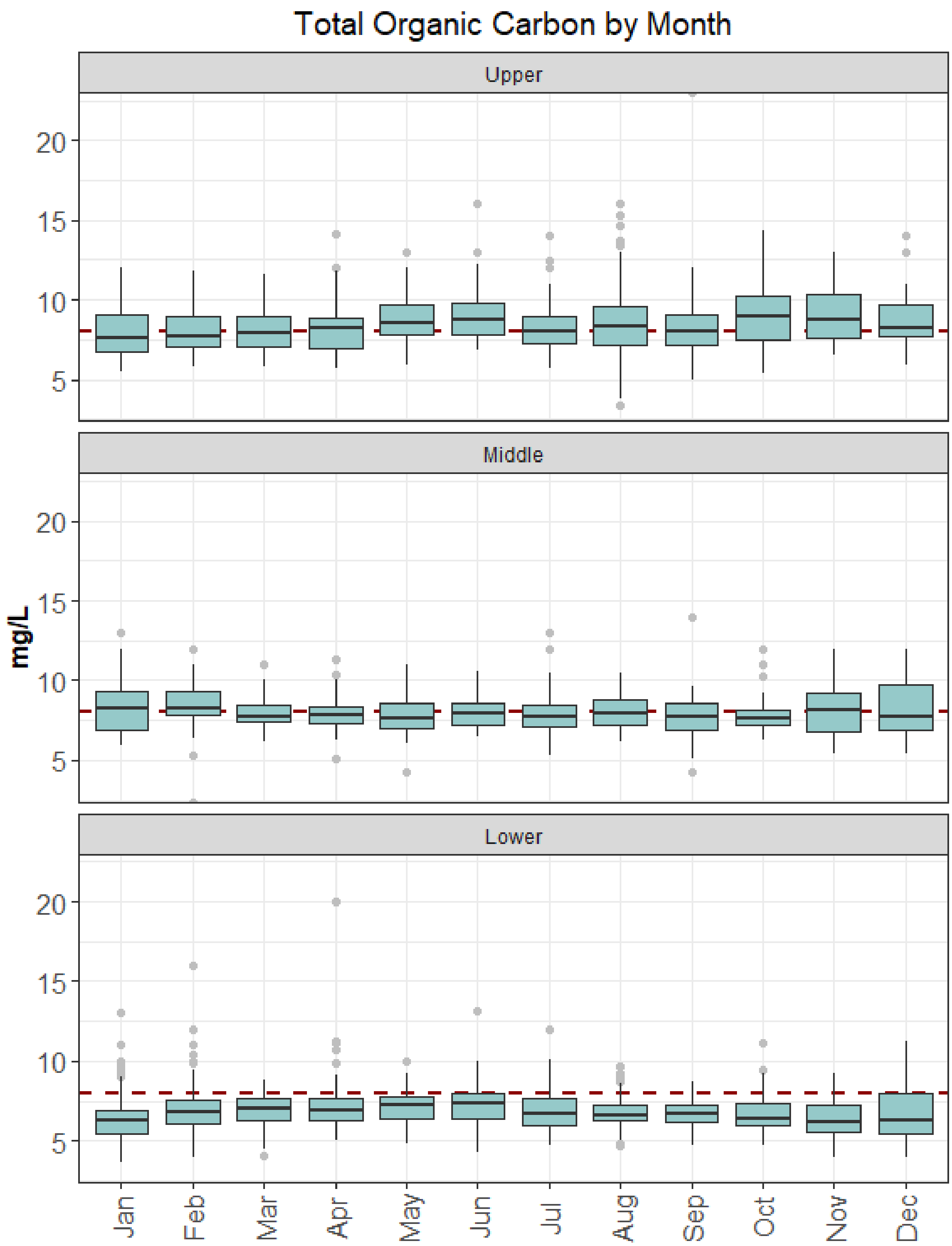
4.17 Total Organic Carbon



Total Organic Carbon by Model Bin

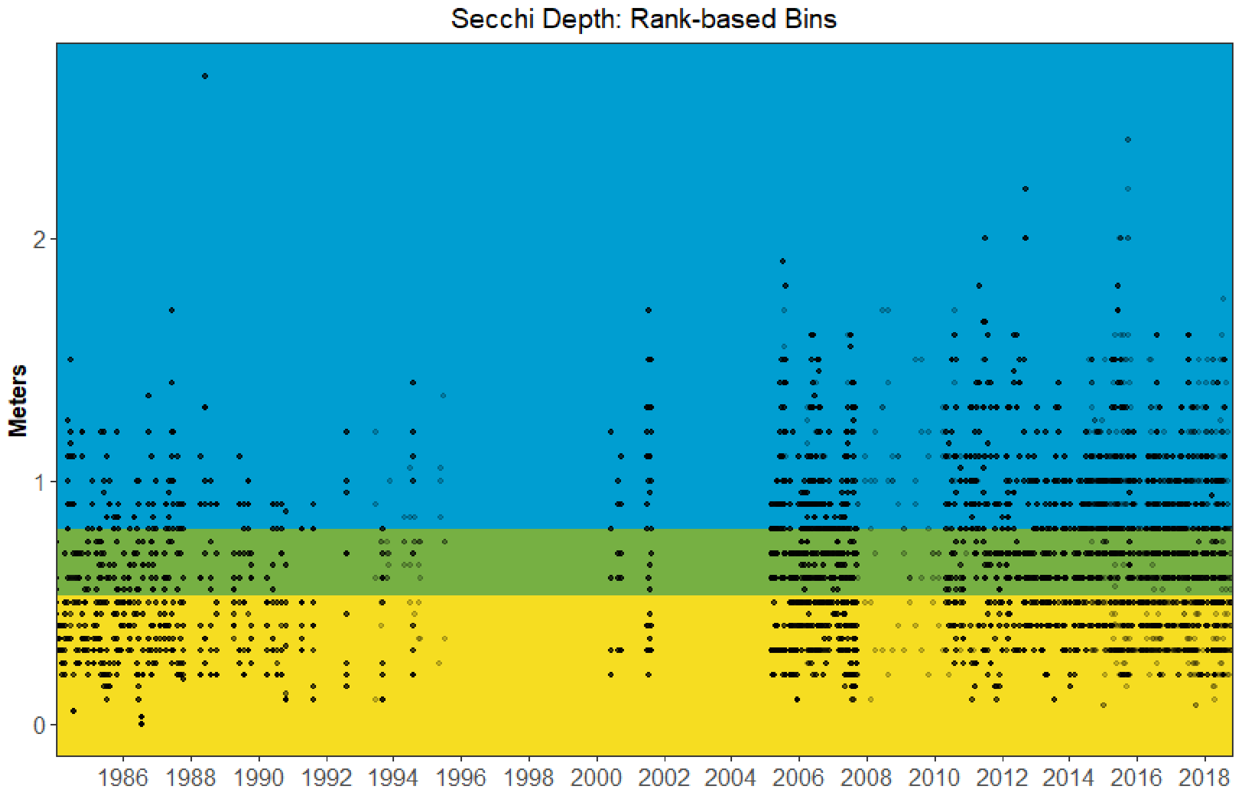


Total Organic Carbon Concentration by Year

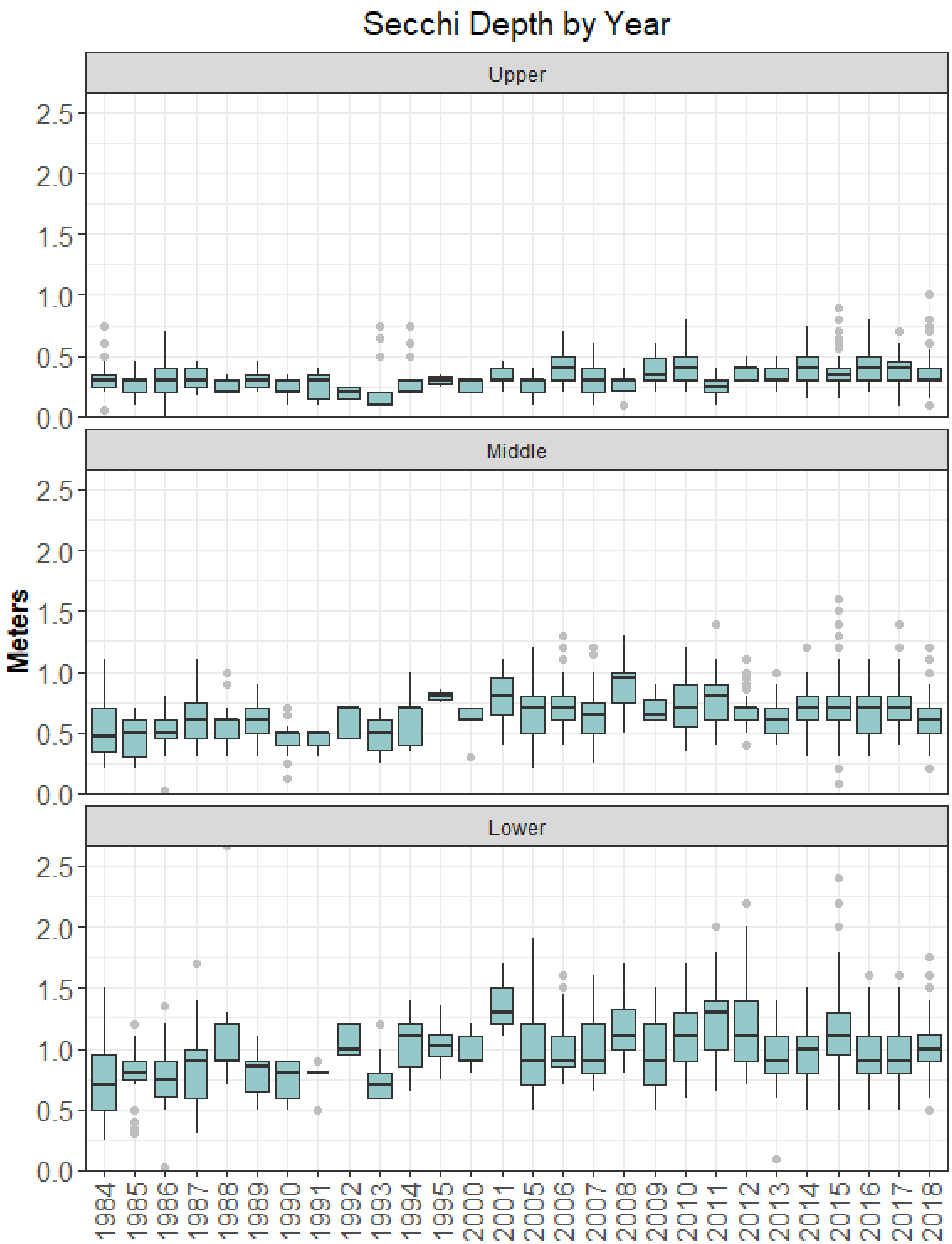


Total Organic Carbon Concentration by Month

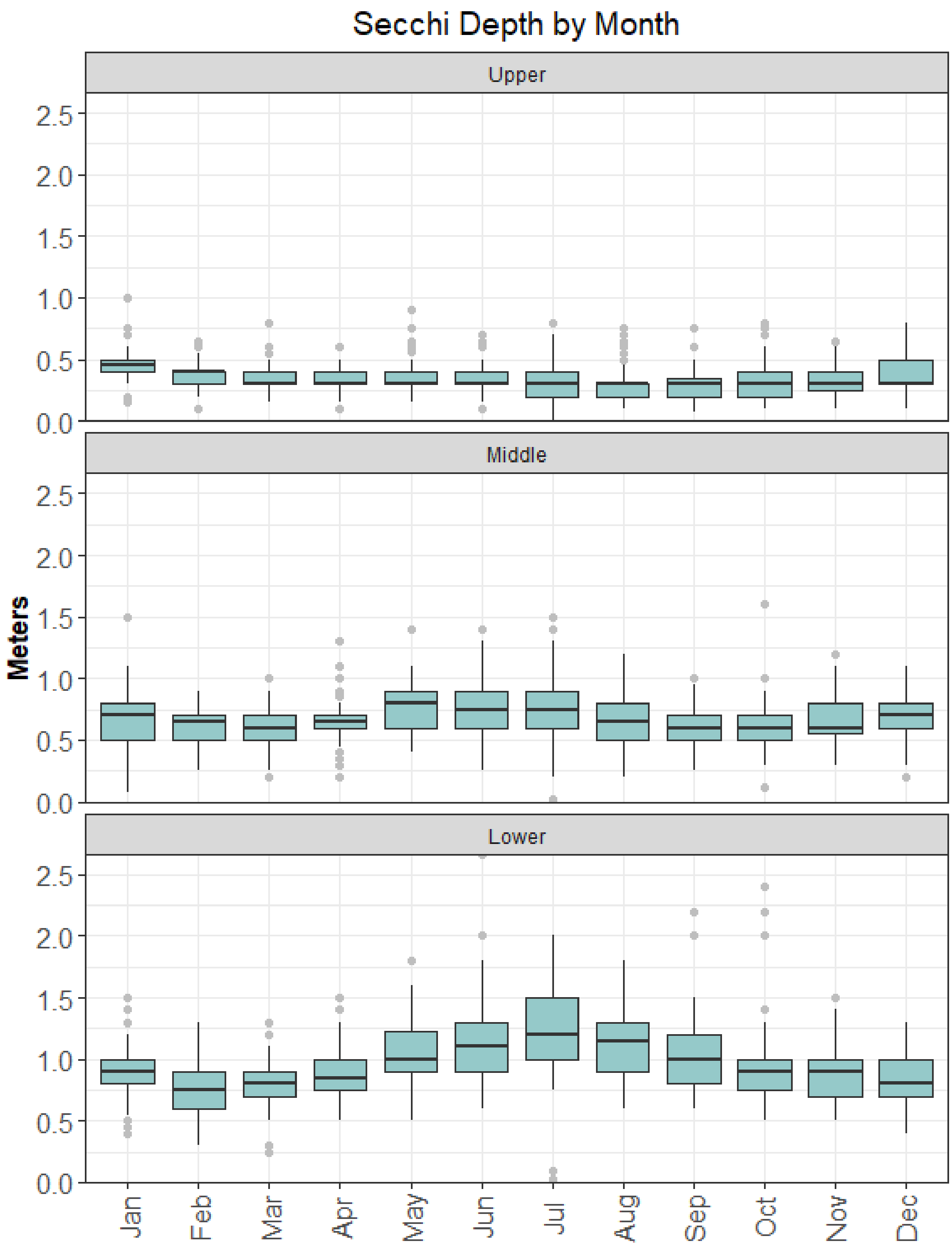
4.18 Secchi Dept



Secchi Dept by Model Bin

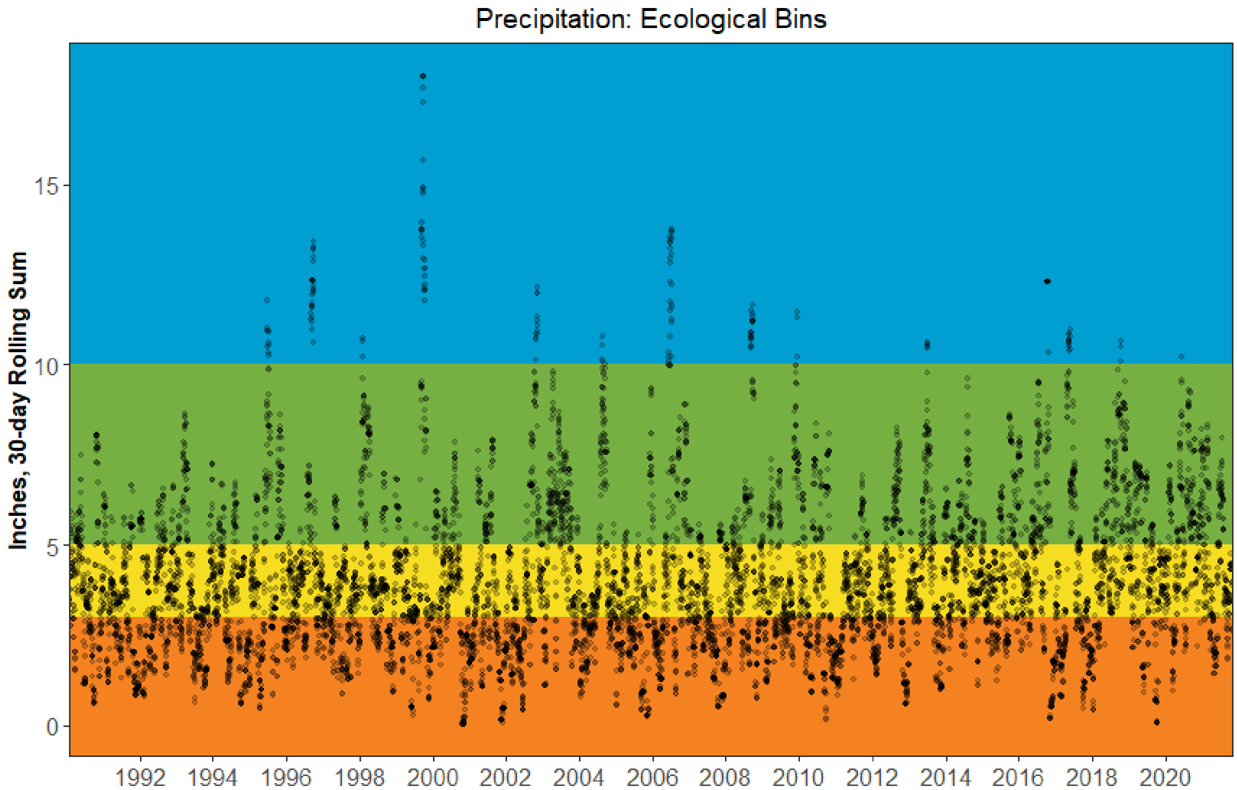


Secchi Depth by Year

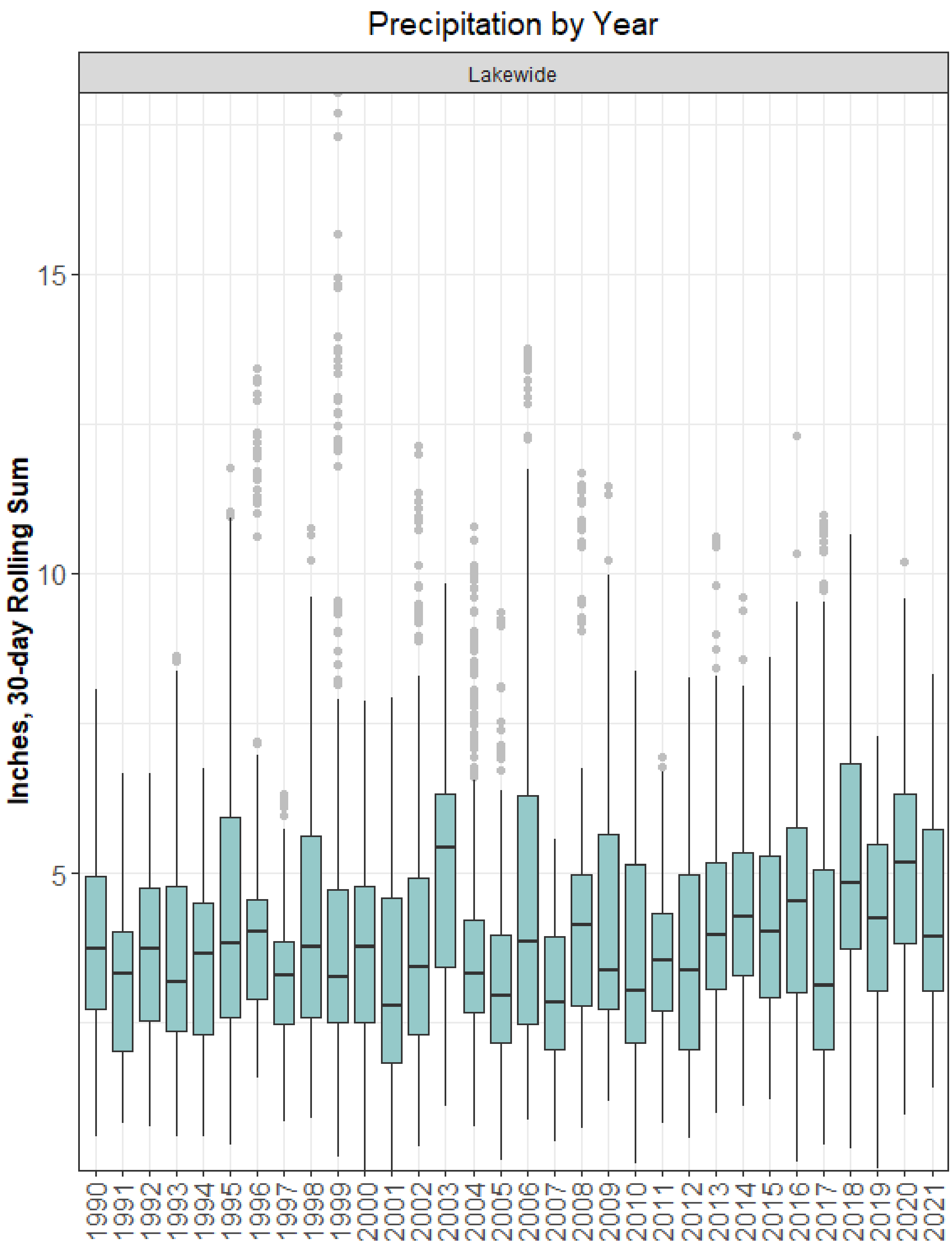


Secchi Depth by Month

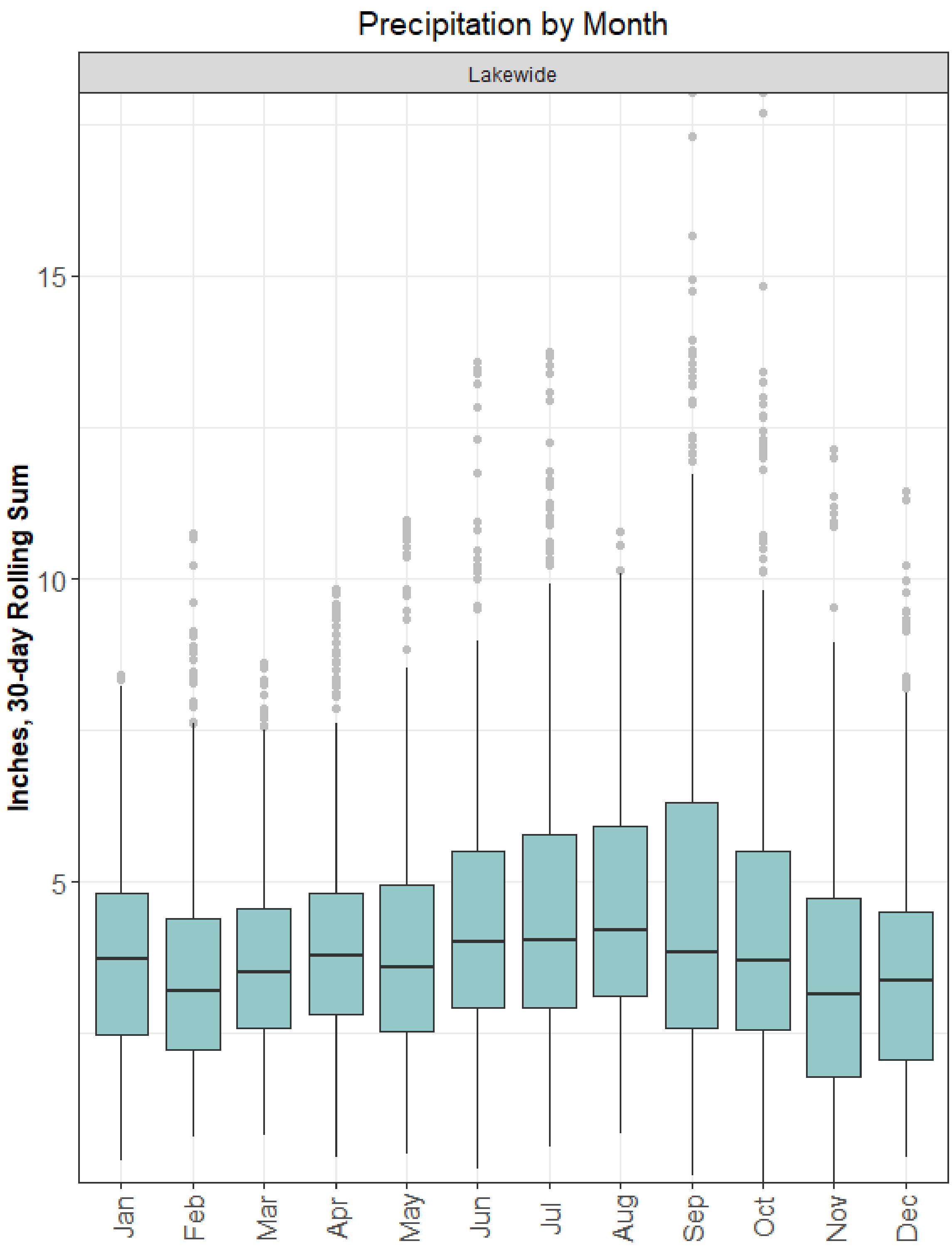
4.19 Precipitation



Precipitation by Model Bin

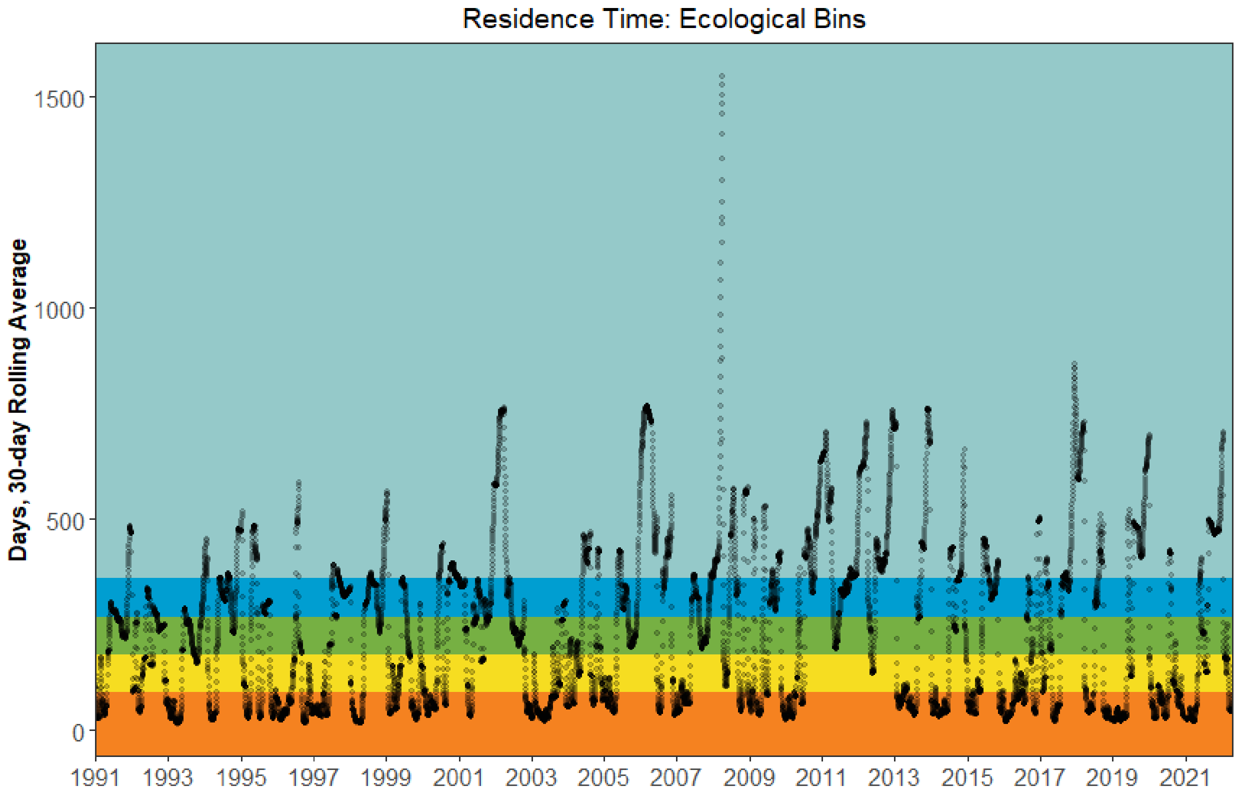


Precipitation by Year

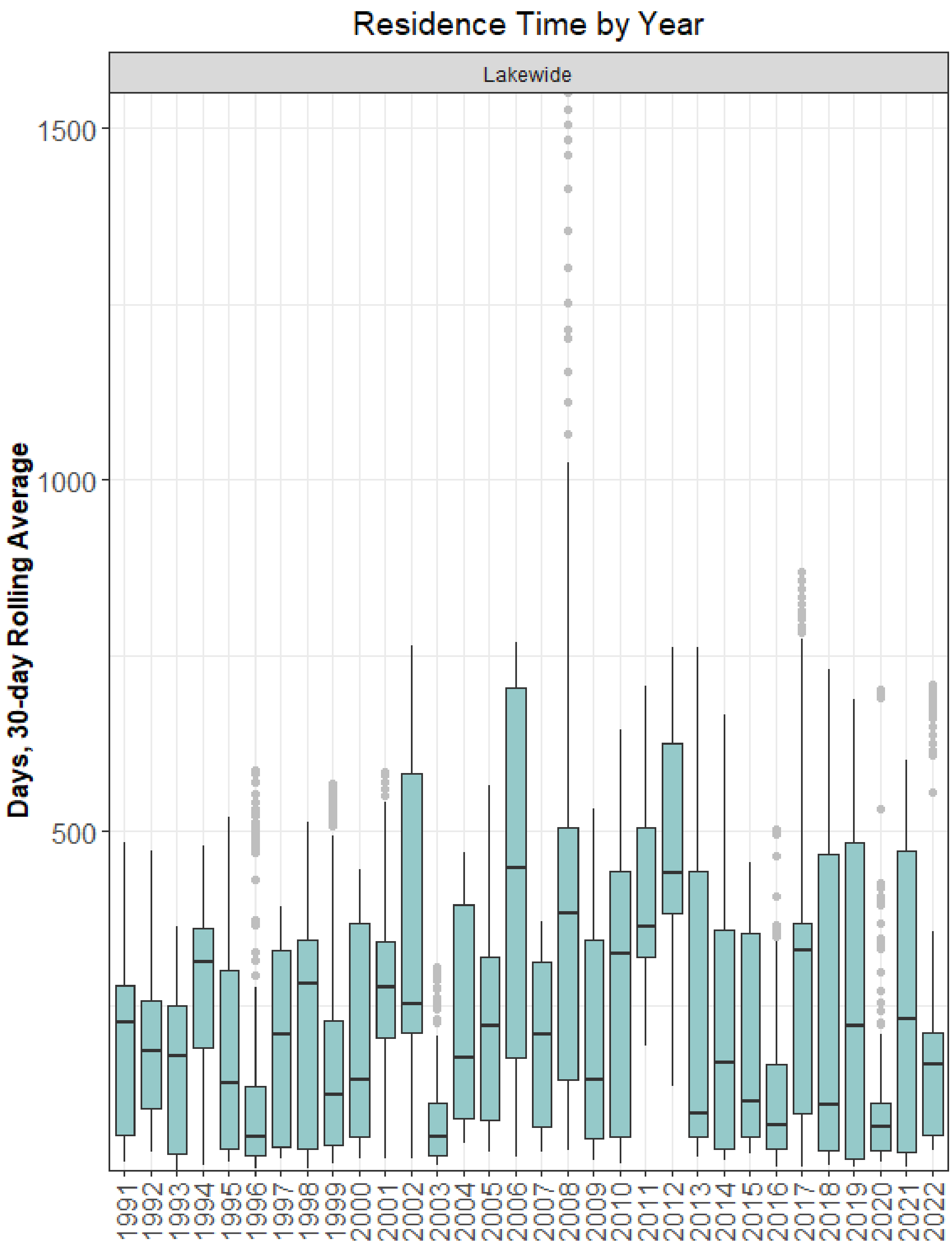


Precipitation by Month

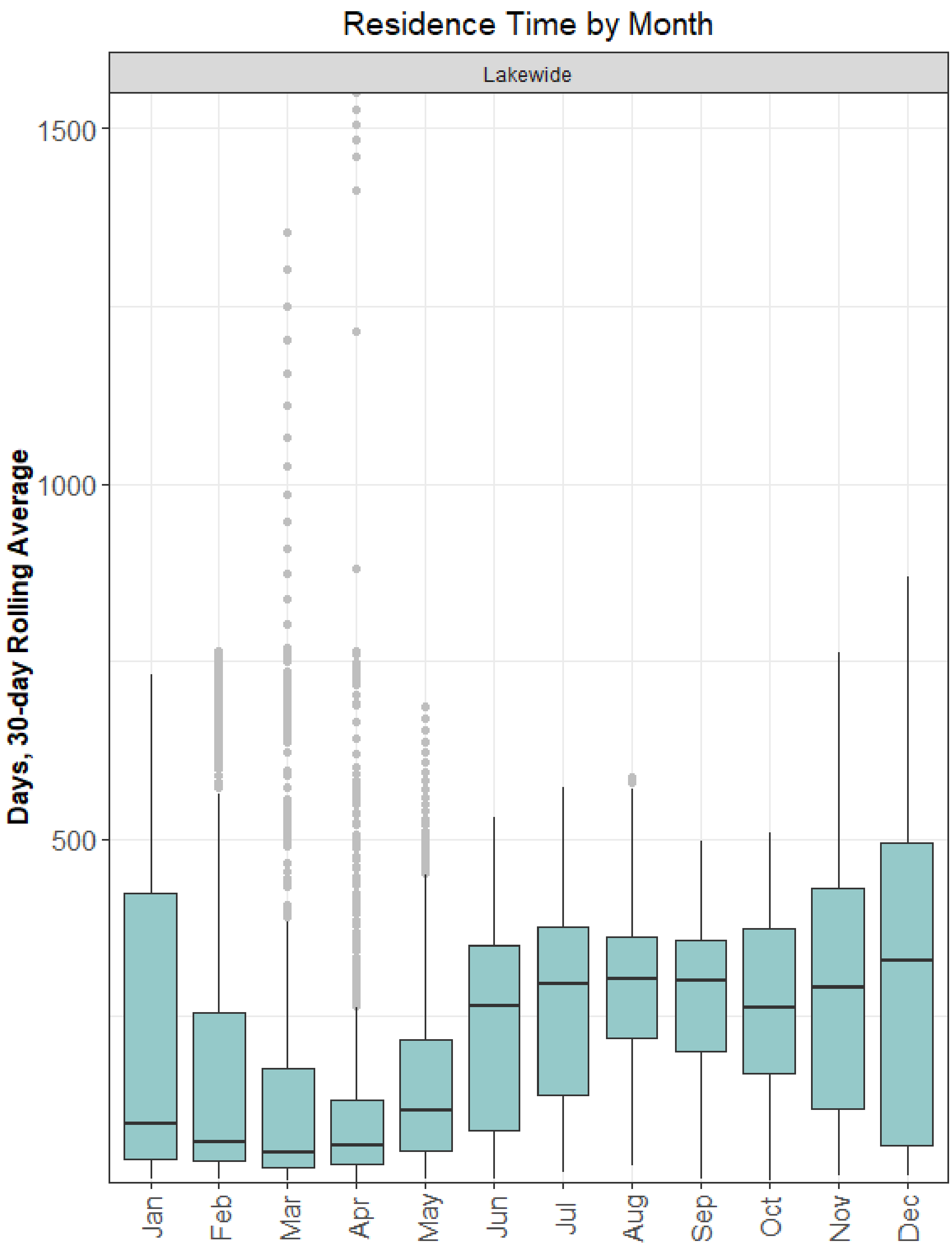
4.20 Residence Time



Residence Time by Model Bin



Residence Time by Year



Residence Time by Month

Section 5: Model Nodes and Bins

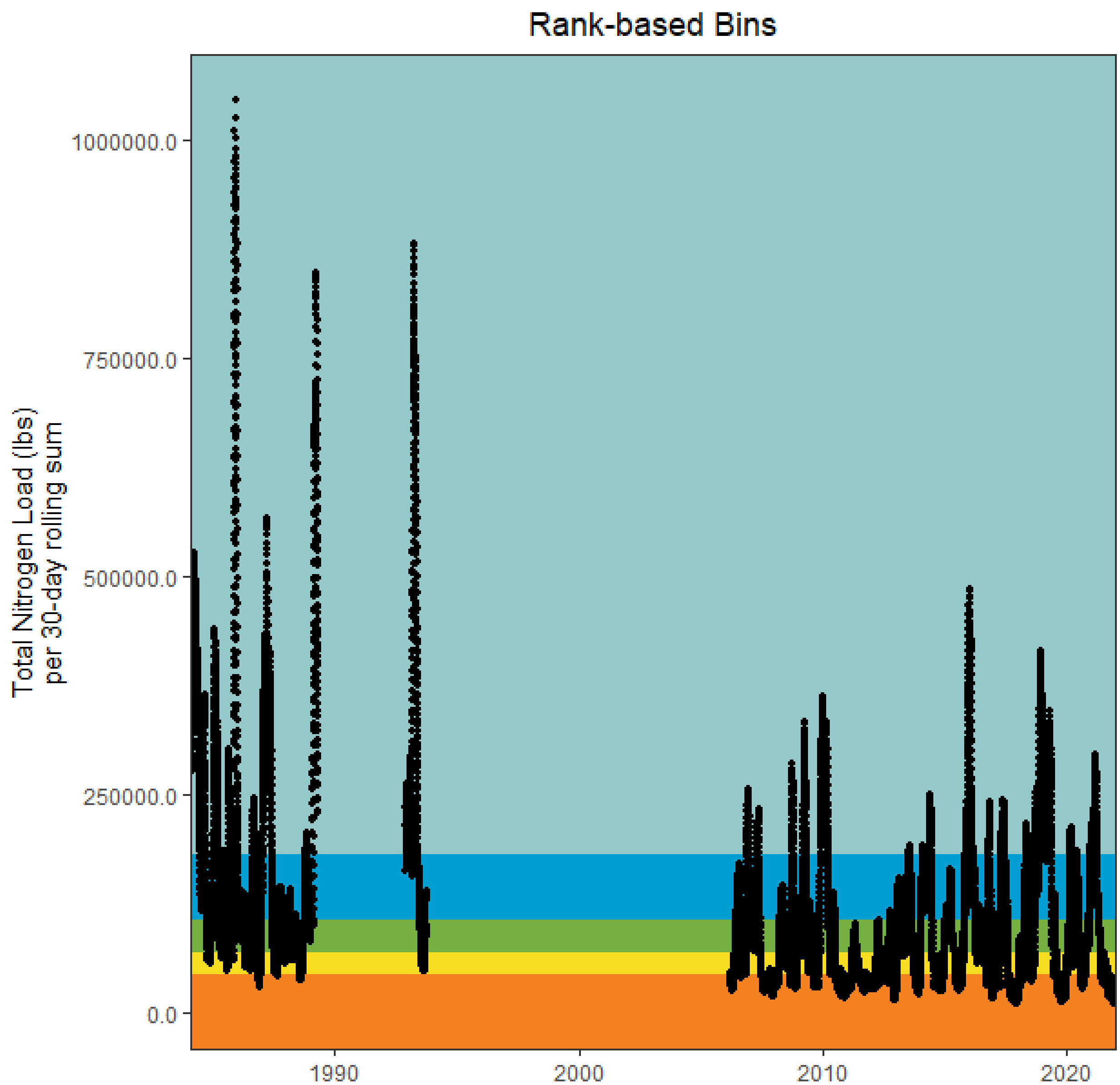
5.1 Nutrient Variables (Loads, Concentrations, and Ratio of Nitrogen to Phosphorus)

5.1.1 Lake unit Level Data

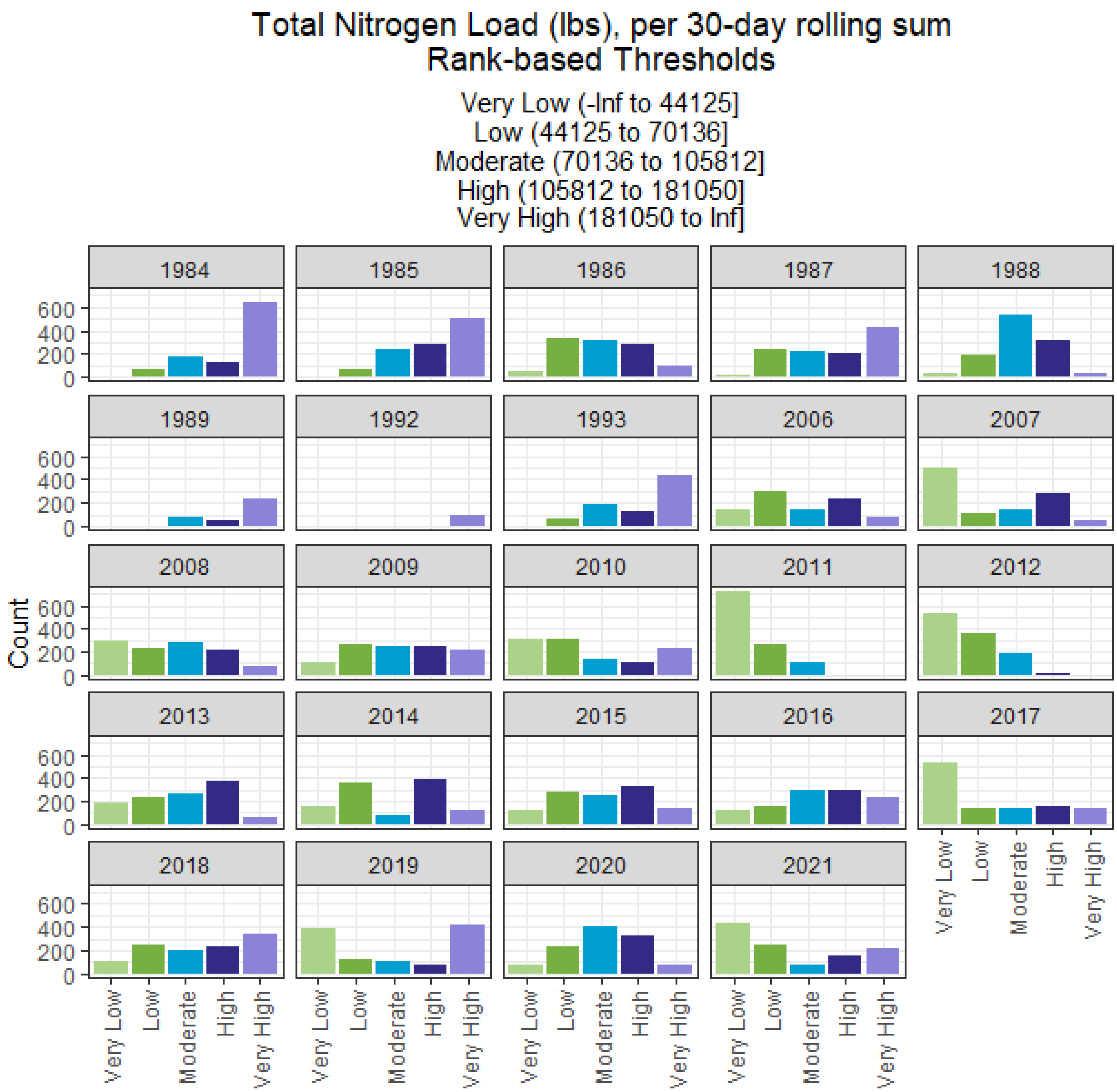
5.1.1.1 Total Nitrogen Load

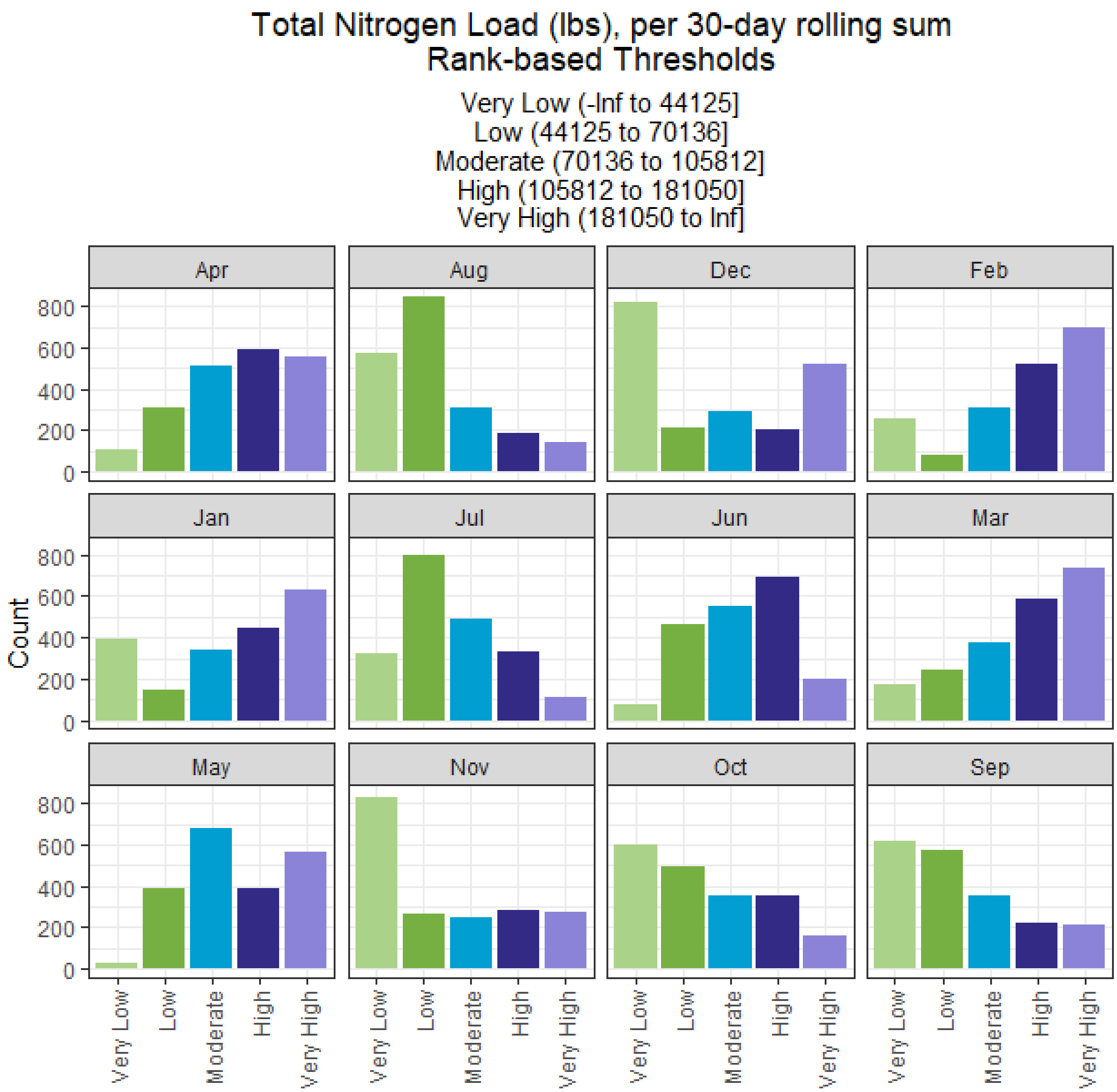
Sum of the tributary, atmospheric, and sediment loads as lbs/mo. For Middle and LOwer lake, also includes the load from the upstream segment.

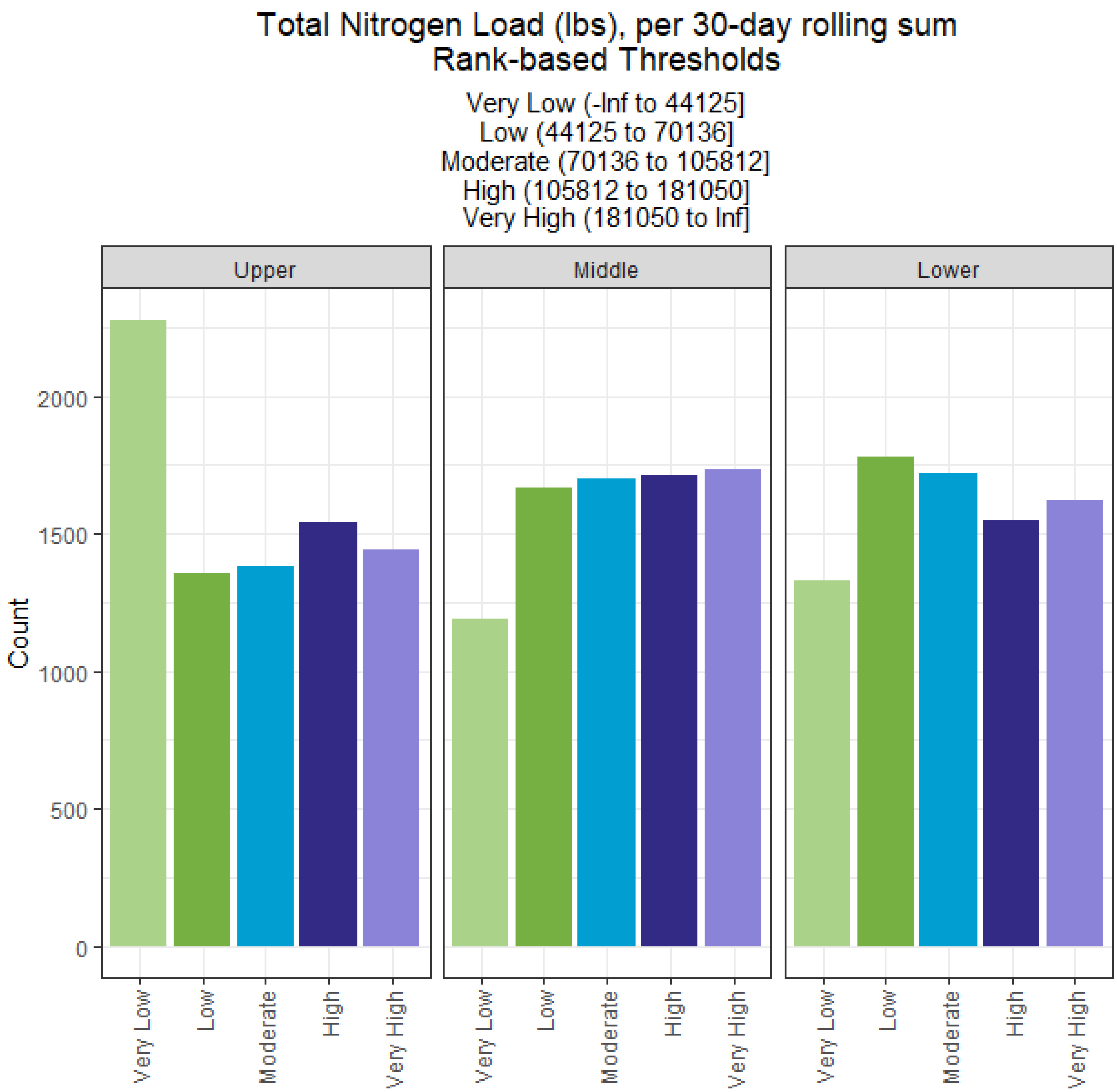
Monthly total nitrogen load (tributary + sediment + atmospheric sources) values are classified into five bins (Very Low, Low, Moderate, High, Very High) using the “rank bin” method. There are no identified regulatory or critical values identified for this variable. The observed data values across the three lake units range from 1.0811866^{4} to 1.0451421^{6}.

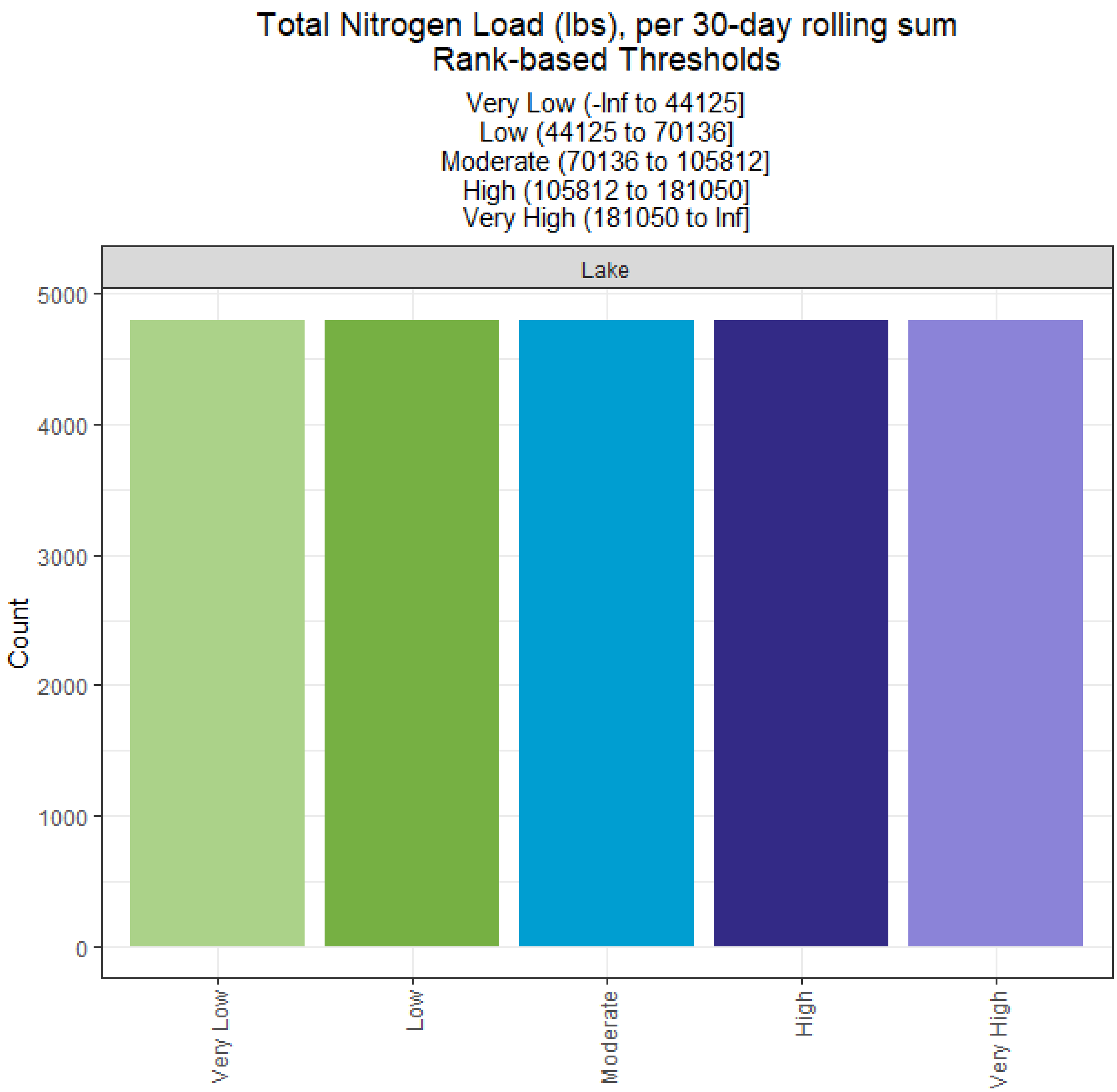


BIN	N	MIN	MAX	LABELS
Very Low	4798	10811.9	44119.6	Very Low (-Inf to 44125]
Low	4799	44131.2	70134.5	Low (44125 to 70136]
Moderate	4799	70138.1	105810.1	Moderate (70136 to 105812]
High	4799	105814.4	181034.4	High (105812 to 181050]
Very High	4799	181065.5	1045142.1	Very High (181050 to Inf]


Total Nitrogen Load (lbs), per 30-day rolling sum
Rank-based Thresholds
Very Low (-Inf to 44125]
Low (44125 to 70136]
Moderate (70136 to 105812]
High (105812 to 181050]
Very High (181050 to Inf]
1984
1985
1986
1987
1988
1989
1992
1993
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Count
0
200
400
600
Very Low
Low
Moderate
High
Very High


Total Nitrogen Load (lbs), per 30-day rolling sum
Rank-based Thresholds
Very Low (-Inf to 44125]
Low (44125 to 70136]
Moderate (70136 to 105812]
High (105812 to 181050]
Very High (181050 to Inf]
Apr
Aug
Dec
Feb
Jan
Jul
Jun
Mar
May
Nov
Oct
Sep
Count
0
200
400
600
800
Very Low
Low
Moderate
High
Very High

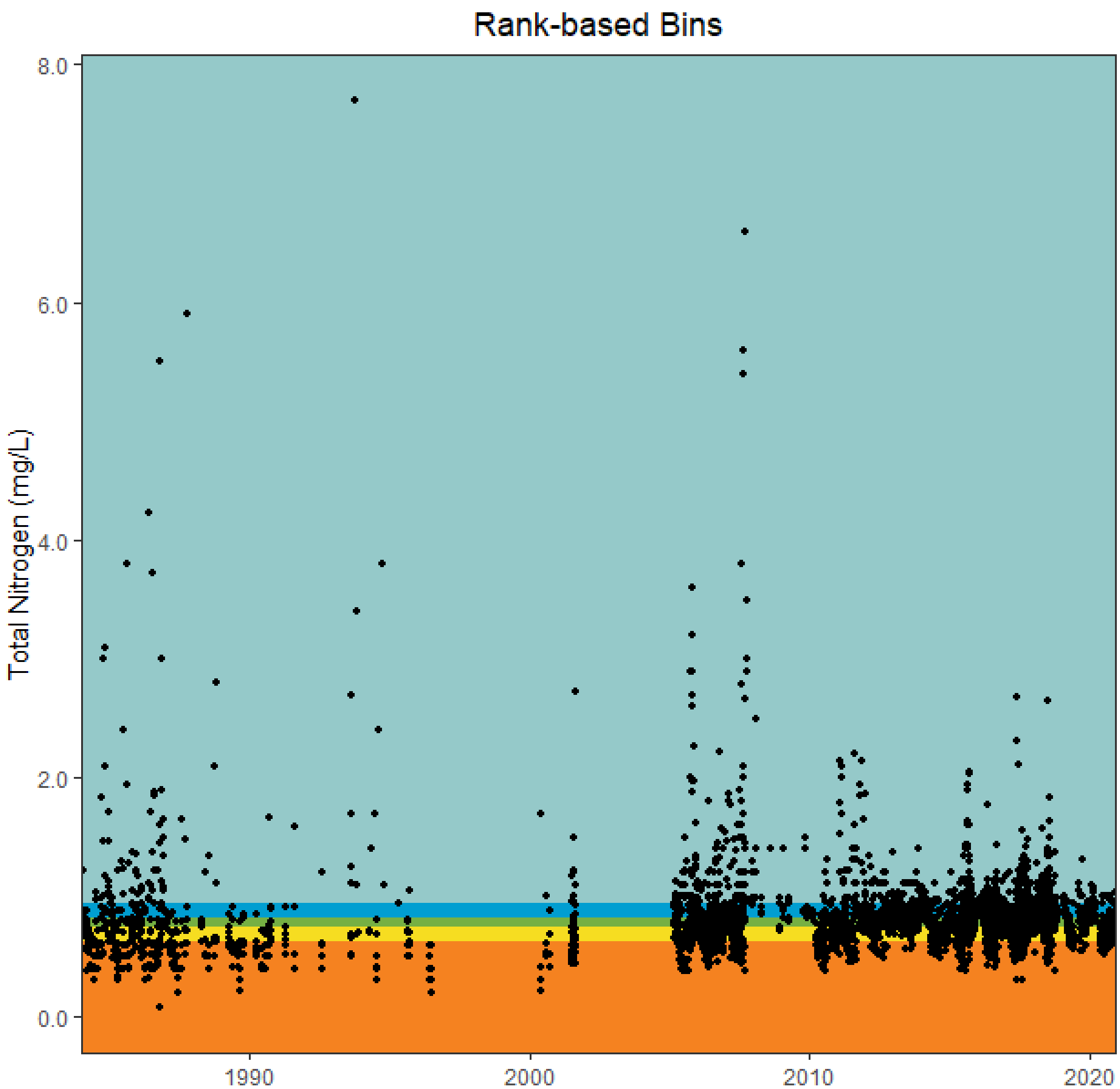

Total Nitrogen Load (lbs), per 30-day rolling sum
Rank-based Thresholds
Very Low (-Inf to 44125]
Low (44125 to 70136]
Moderate (70136 to 105812]
High (105812 to 181050]
Very High (181050 to Inf]
Upper
Middle
Lower
Count
0
500
1000
1500
2000
Very Low
Low
Moderate
High
Very High



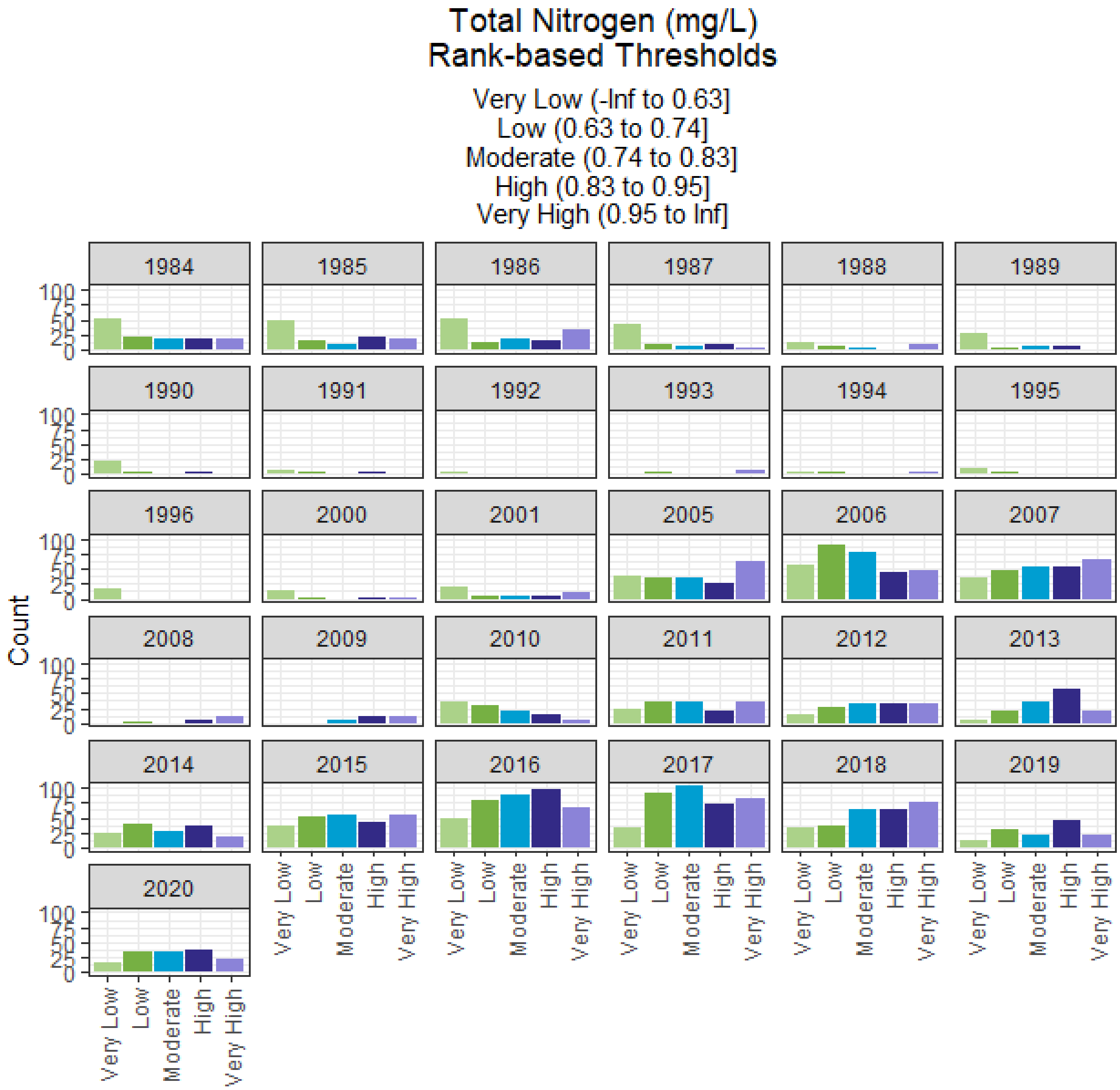
5.1.1.2 Total Nitrogen Concentration

Total nitrogen data are reported at the level of Site-Date. We received multiple data resources that included some empirical total nitrogen data (or component measure sthat we used to calculate total nitrogen). The data are assembled in the **dataMerge_totaln** file (rmd/docx).

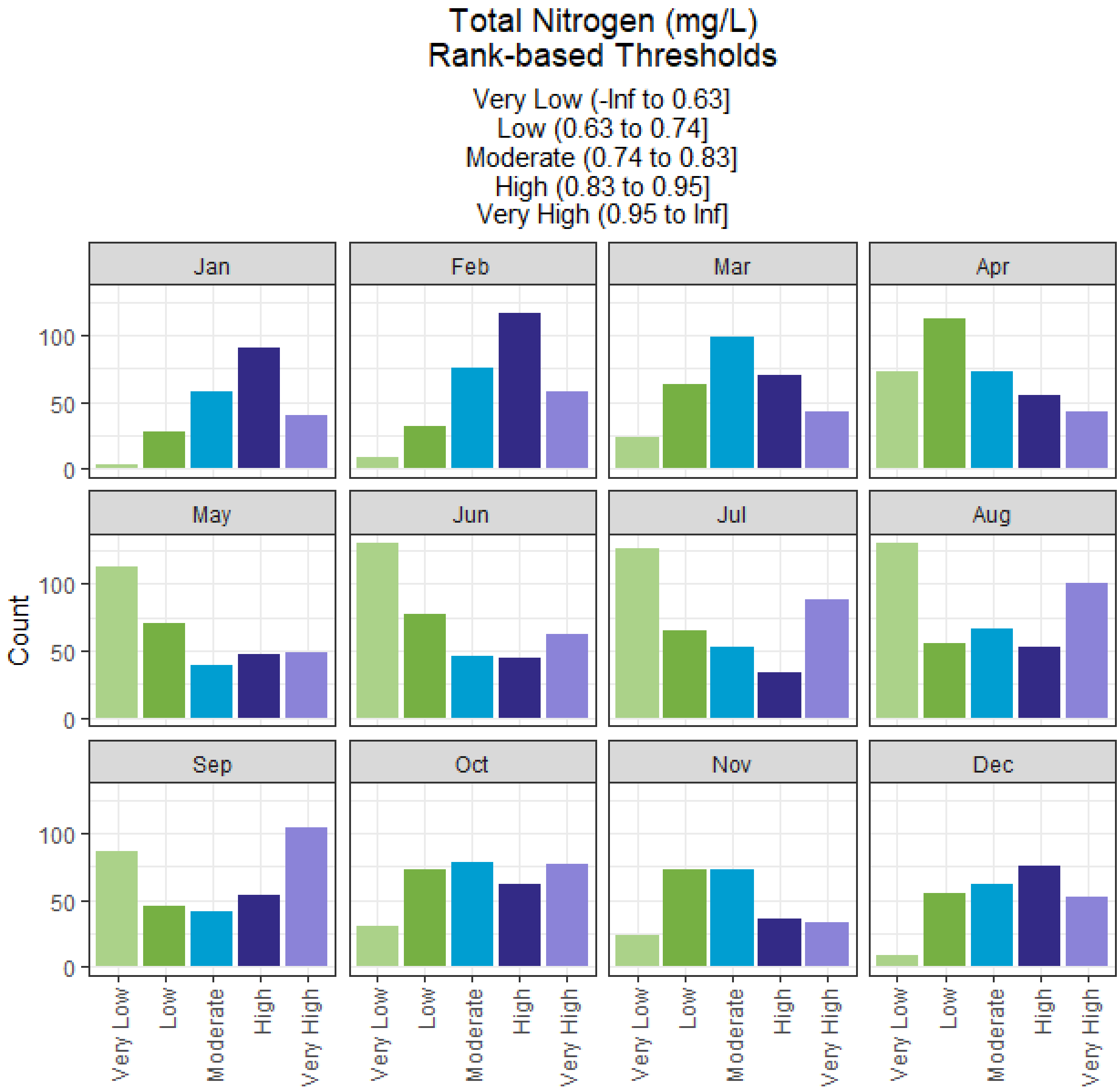
Nitrogen values are classified into five bins (Very Low, Low, Moderate, High, Very High) using the "rank bin" method. There are no identified regulatory or critical values identified for this variable. The observed data values range from 0.07 to 7.7.



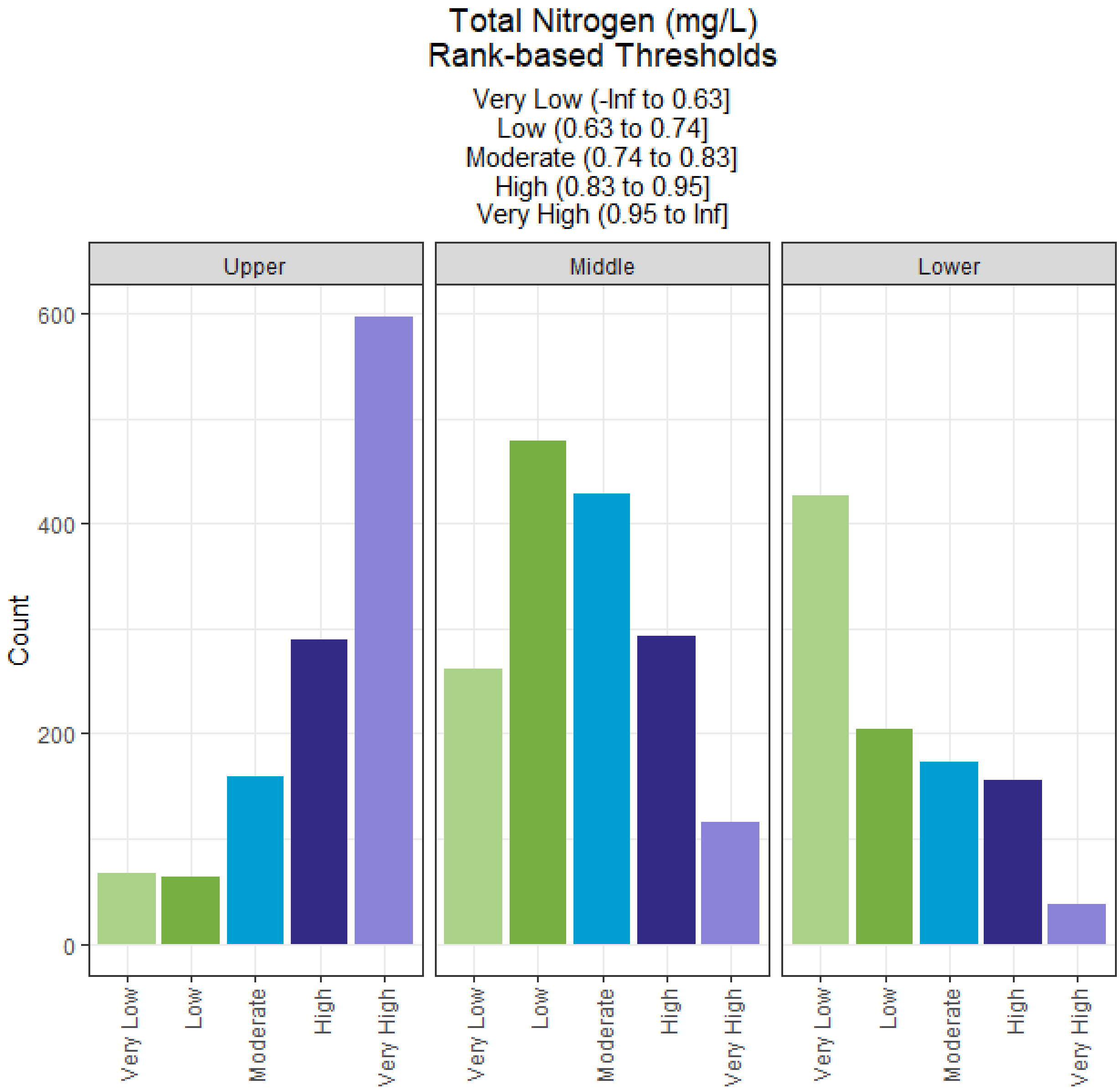
BIN	N	MIN	MAX	LABELS
Very Low	755	0.1	0.6	Very Low (-Inf to 0.63]
Low	746	0.6	0.7	Low (0.63 to 0.74]
Moderate	762	0.7	0.8	Moderate (0.74 to 0.83]
High	739	0.8	0.9	High (0.83 to 0.95]
Very High	750	0.9	7.7	Very High (0.95 to Inf]

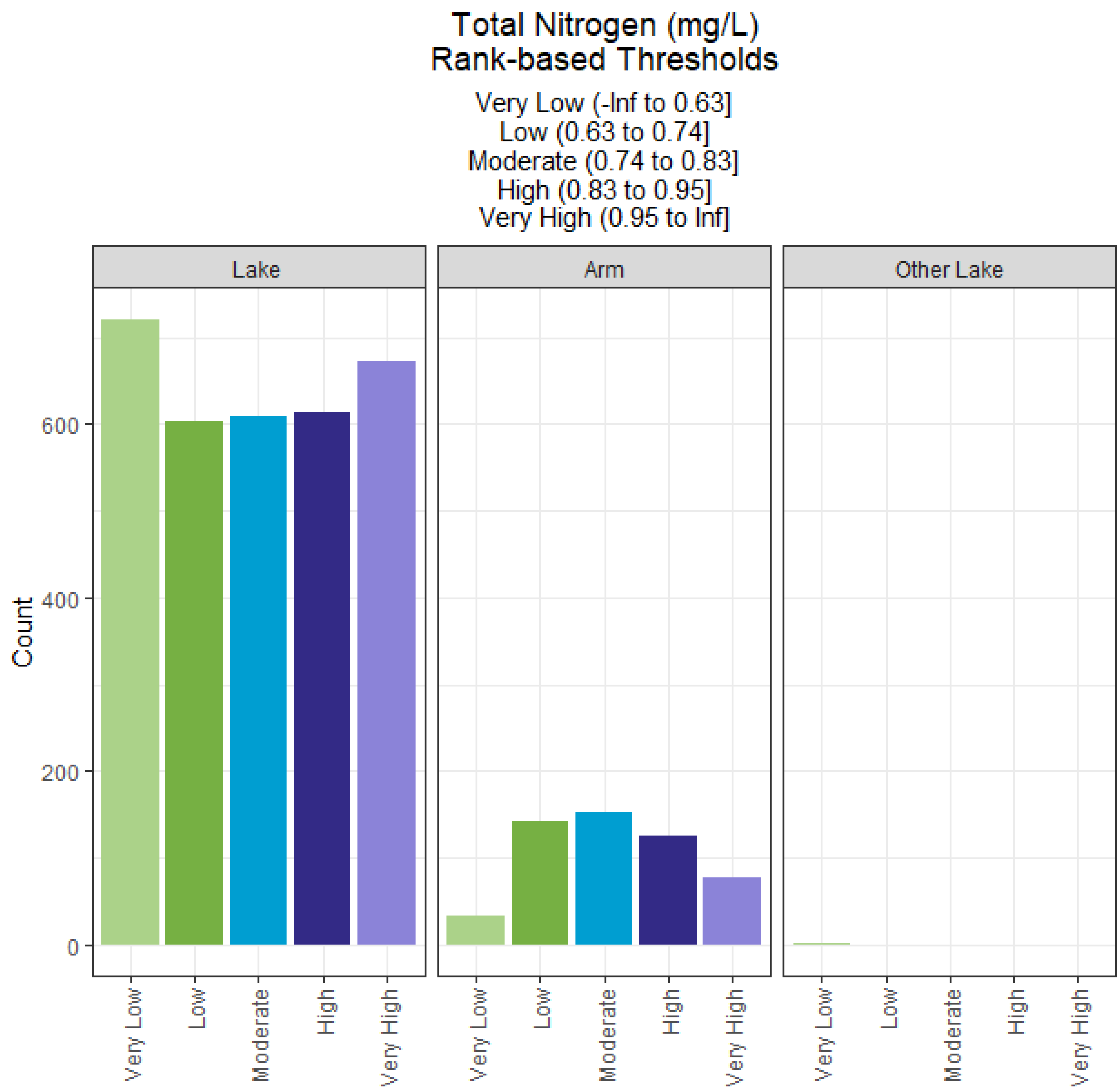


Total Nitrogen (mg/L)
Rank-based Thresholds
Very Low (-Inf to 0.63]
Low (0.63 to 0.74]
Moderate (0.74 to 0.83]
High (0.83 to 0.95]
Very High (0.95 to Inf]
Count
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
2000
2001
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
0
25
50
75
100
Very Low
Low
Moderate
High
Very High



Total Nitrogen (mg/L)
Rank-based Thresholds
Very Low (-Inf to 0.63]
Low (0.63 to 0.74]
Moderate (0.74 to 0.83]
High (0.83 to 0.95]
Very High (0.95 to Inf]
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Count
0
50
100
Very Low
Low
Moderate
High
Very High

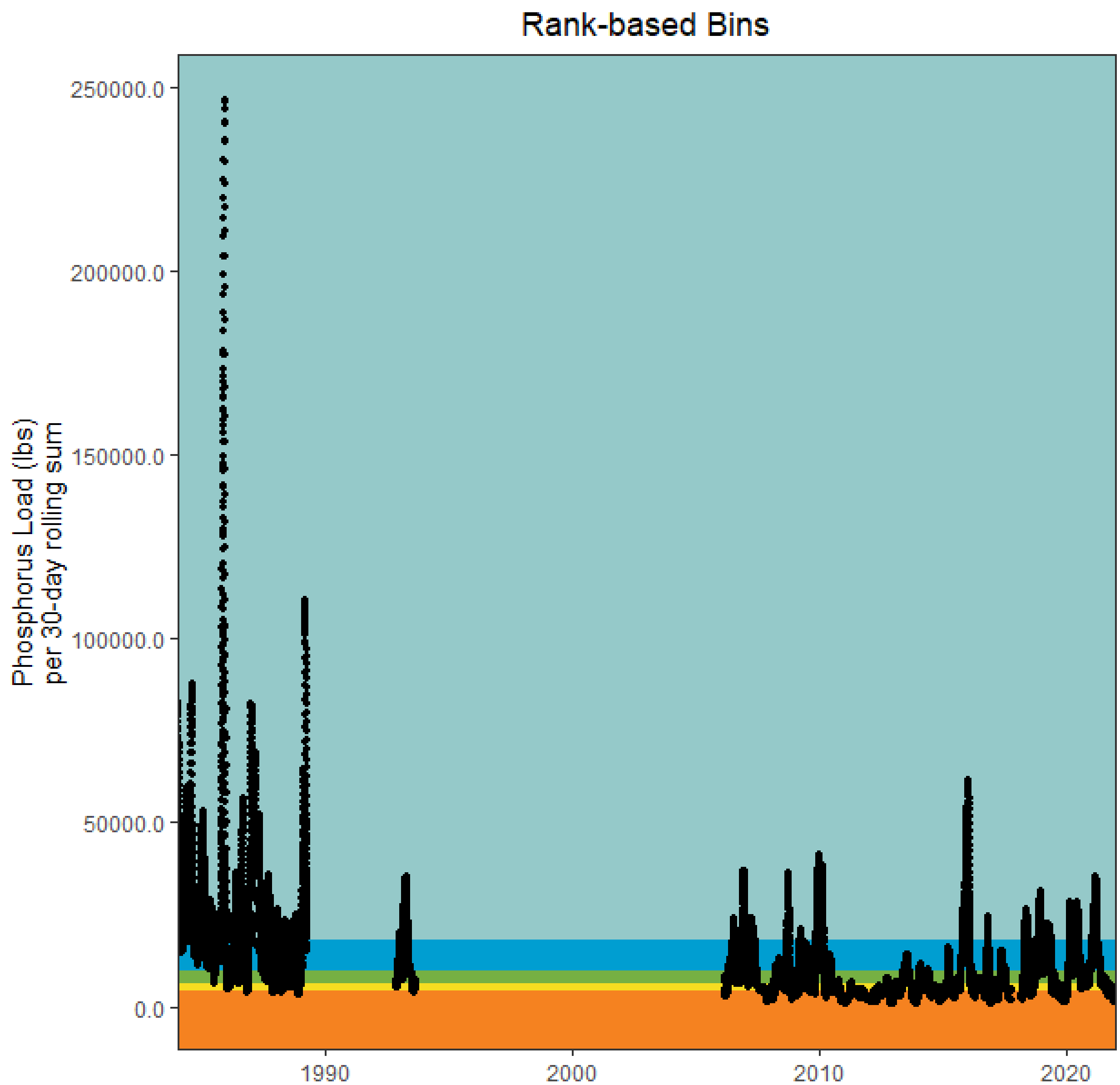

Total Nitrogen (mg/L)
Rank-based Thresholds
Very Low (-Inf to 0.63]
Low (0.63 to 0.74]
Moderate (0.74 to 0.83]
High (0.83 to 0.95]
Very High (0.95 to Inf]
Upper
Middle
Lower
Count
0
200
400
600
Very Low
Low
Moderate
High
Very High



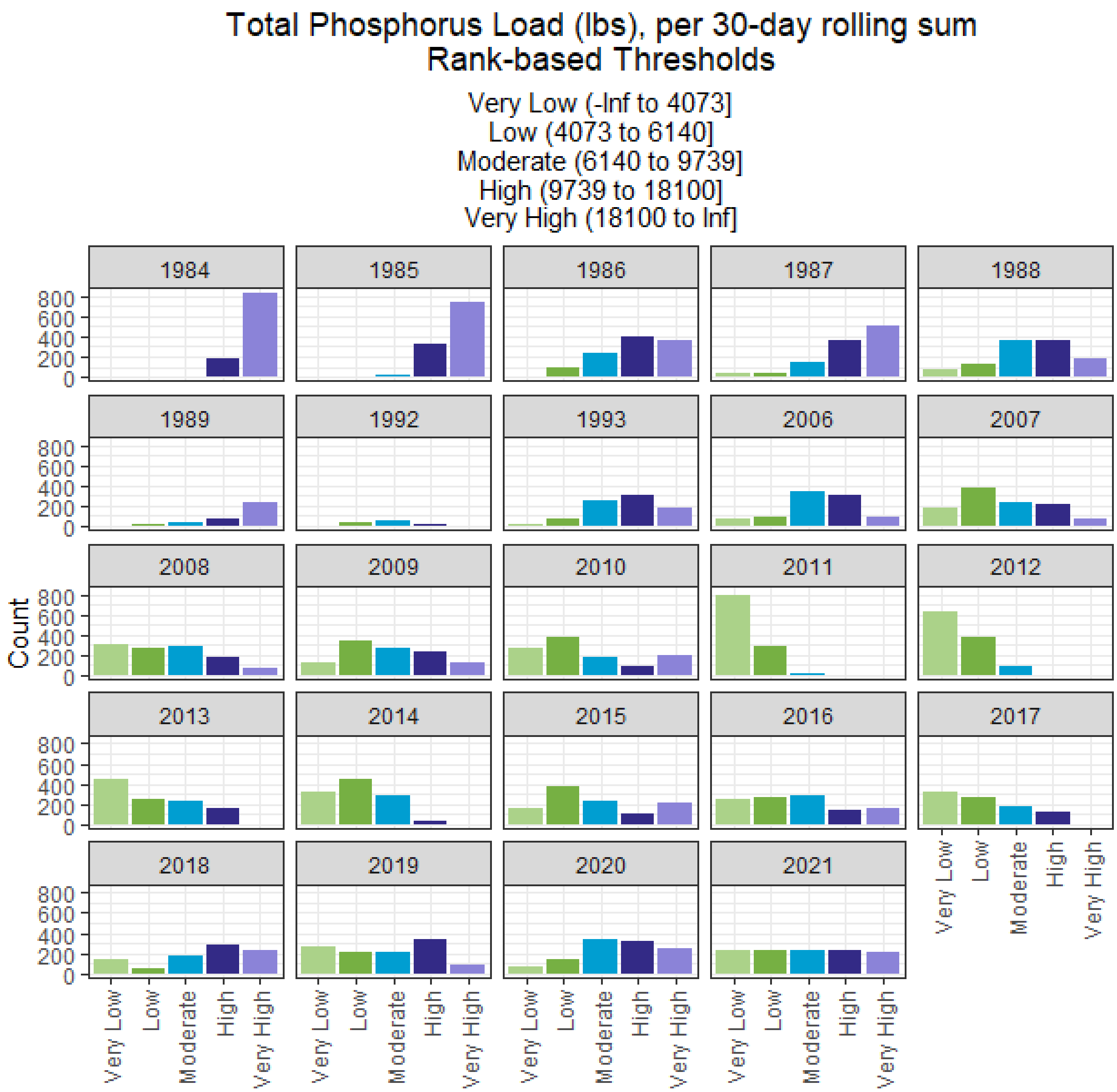
5.1.1.3 Total Phosphorus Load

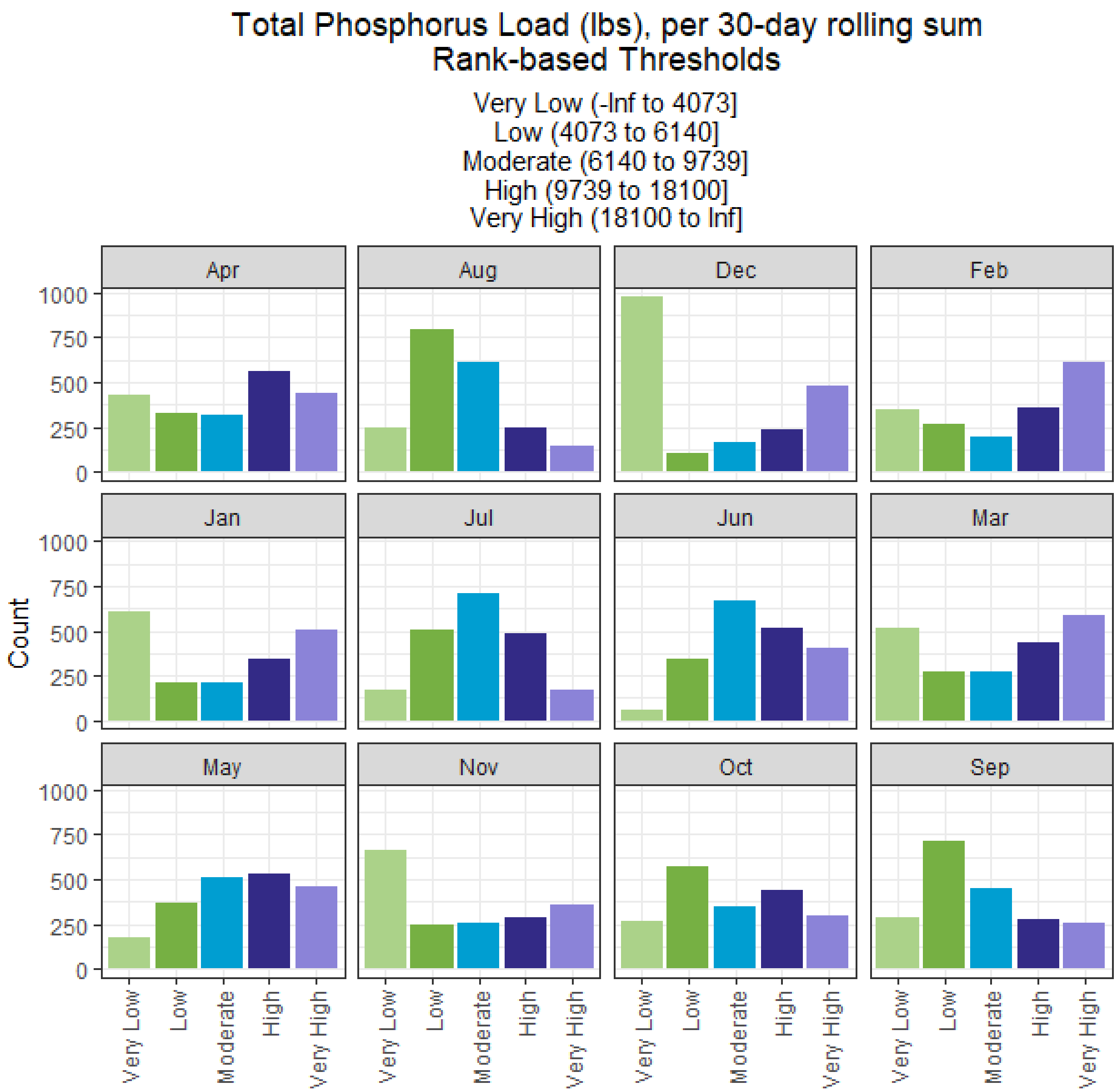
Sum of the extrapolated tributary, atmospheric, sediment, and if relevant, pass-through loads as lbs/mo.

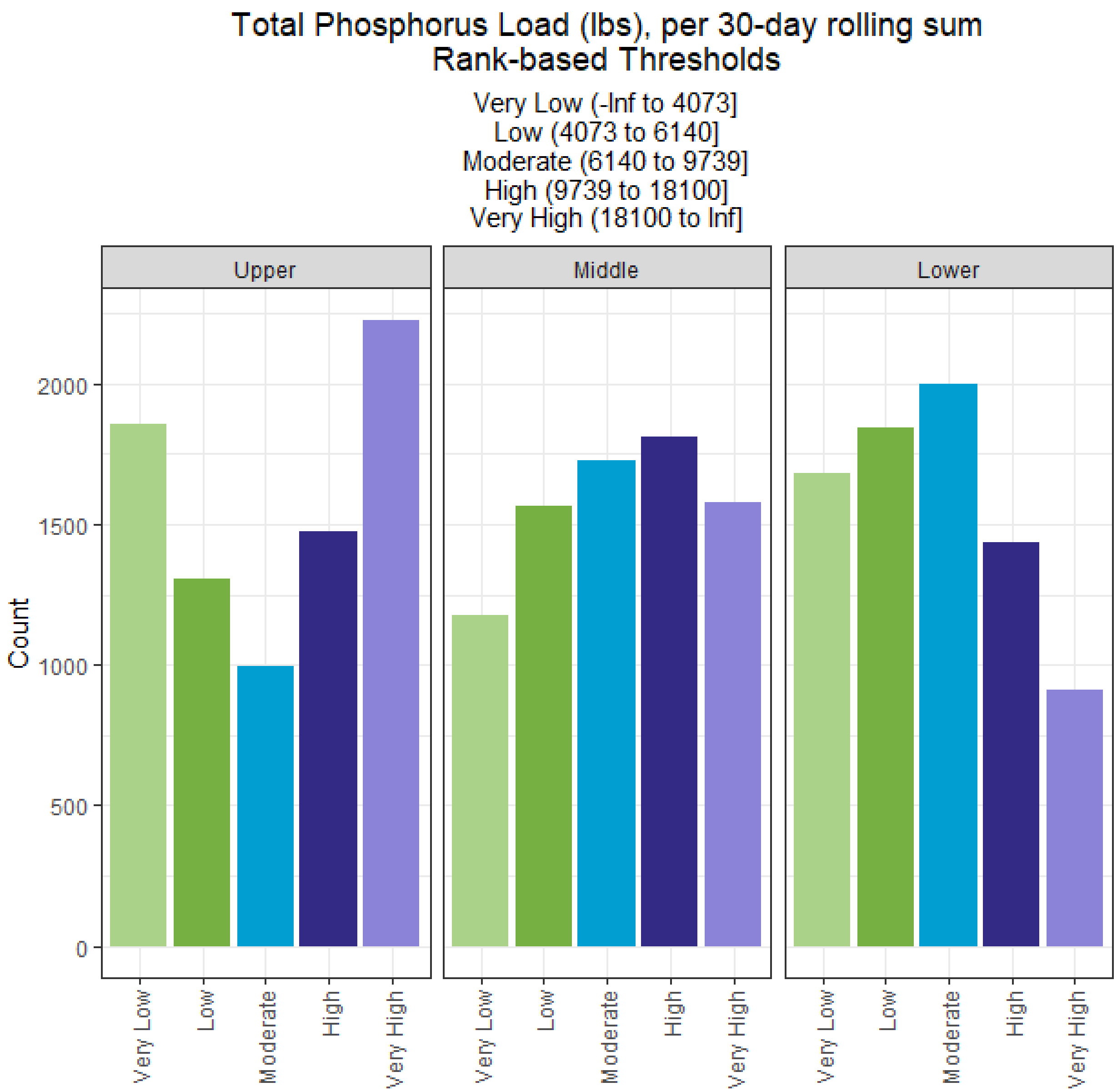
Monthly total phosphorus load (tributary + sediment + atmospheric sources) values are classified into five bins (Very Low, Low, Moderate, High, Very High) using the “rank bin” method. There are no identified regulatory or critical values identified for this variable. The observed data values across the three lake units range from 715.796285 to 2.4646572^{5}.

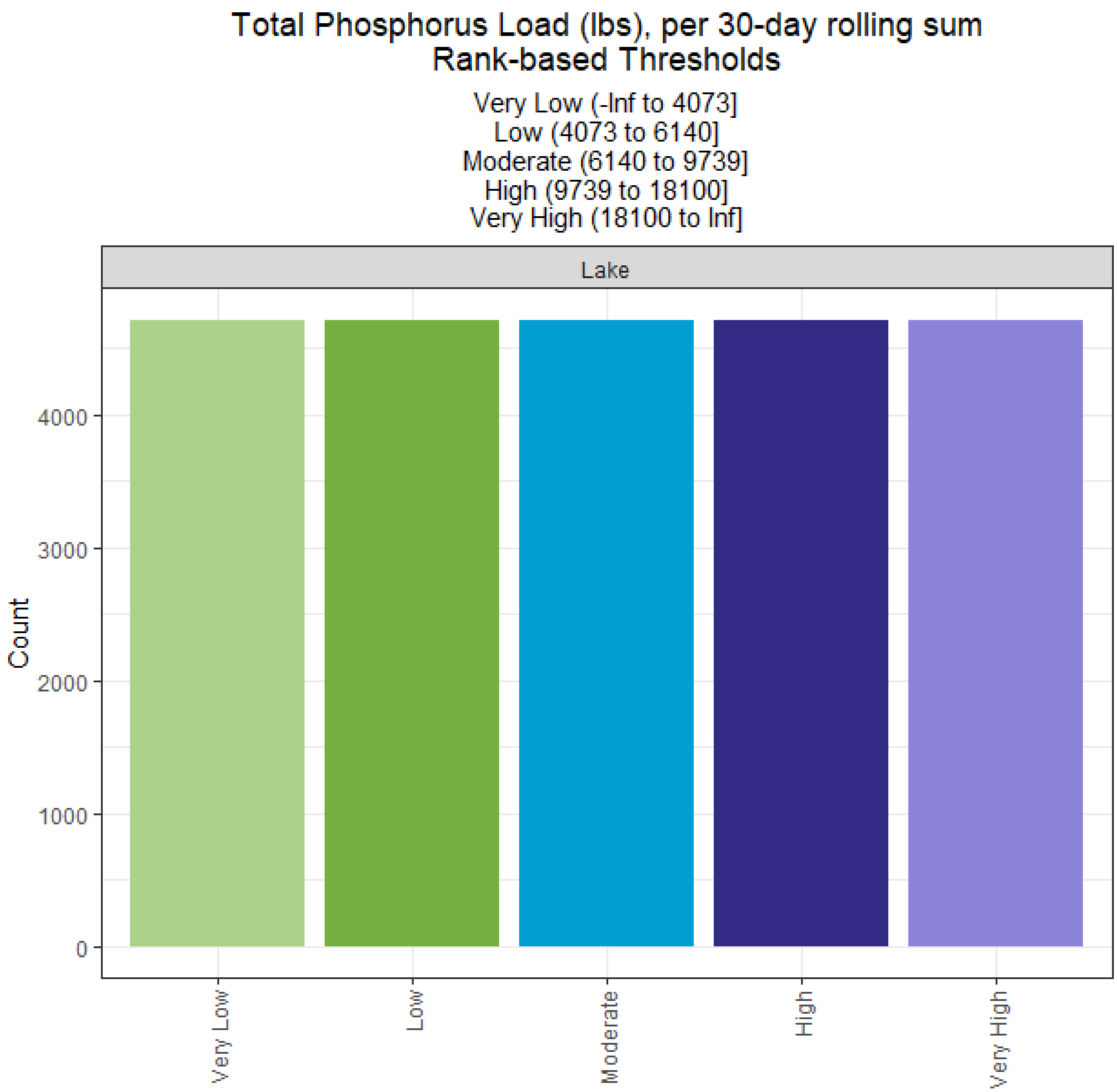


BIN	N	MIN	MAX	LABELS
Very Low	4713	715.8	4072.2	Very Low (-Inf to 4073]
Low	4714	4073.5	6139.8	Low (4073 to 6140]
Moderate	4714	6140.4	9738.6	Moderate (6140 to 9739]
High	4714	9739.6	18100.2	High (9739 to 18100]
Very High	4713	18100.8	246465.7	Very High (18100 to Inf]


Total Phosphorus Load (lbs), per 30-day rolling sum
Rank-based Thresholds
Very Low (-Inf to 4073]
Low (4073 to 6140]
Moderate (6140 to 9739]
High (9739 to 18100]
Very High (18100 to Inf]
1984
1985
1986
1987
1988
1989
1992
1993
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Count
0
200
400
600
800
Very Low
Low
Moderate
High
Very High


Total Phosphorus Load (lbs), per 30-day rolling sum
Rank-based Thresholds
Very Low (-Inf to 4073]
Low (4073 to 6140]
Moderate (6140 to 9739]
High (9739 to 18100]
Very High (18100 to Inf]
Apr
Aug
Dec
Feb
Jan
Jul
Jun
Mar
May
Nov
Oct
Sep
Count
0
250
500
750
1000
Very Low
Low
Moderate
High
Very High

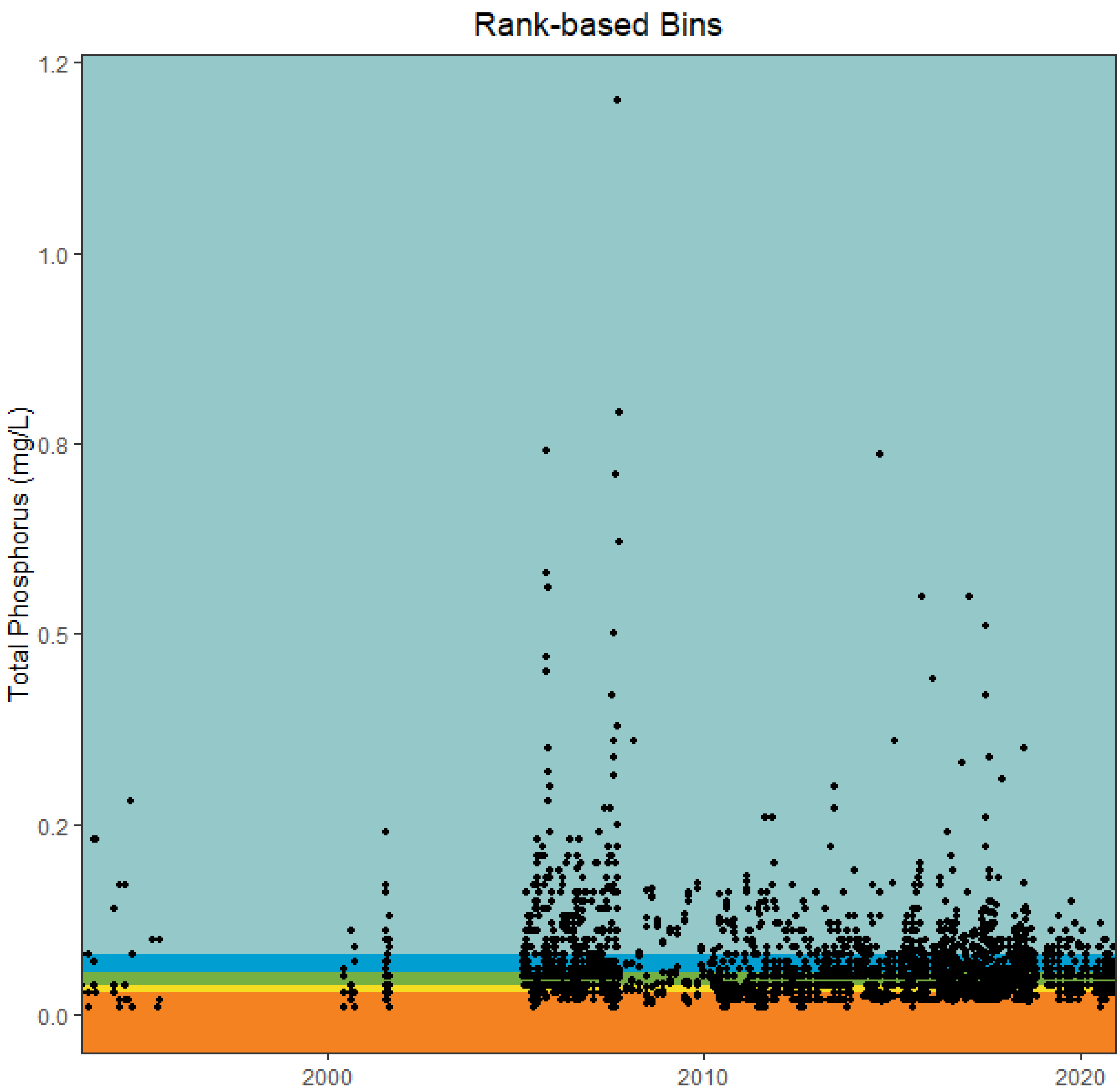

Total Phosphorus Load (lbs), per 30-day rolling sum
Rank-based Thresholds
Very Low (-Inf to 4073]
Low (4073 to 6140]
Moderate (6140 to 9739]
High (9739 to 18100]
Very High (18100 to Inf]
Upper
Middle
Lower
Count
2000
1500
1000
500
0
Very Low
Low
Moderate
High
Very High



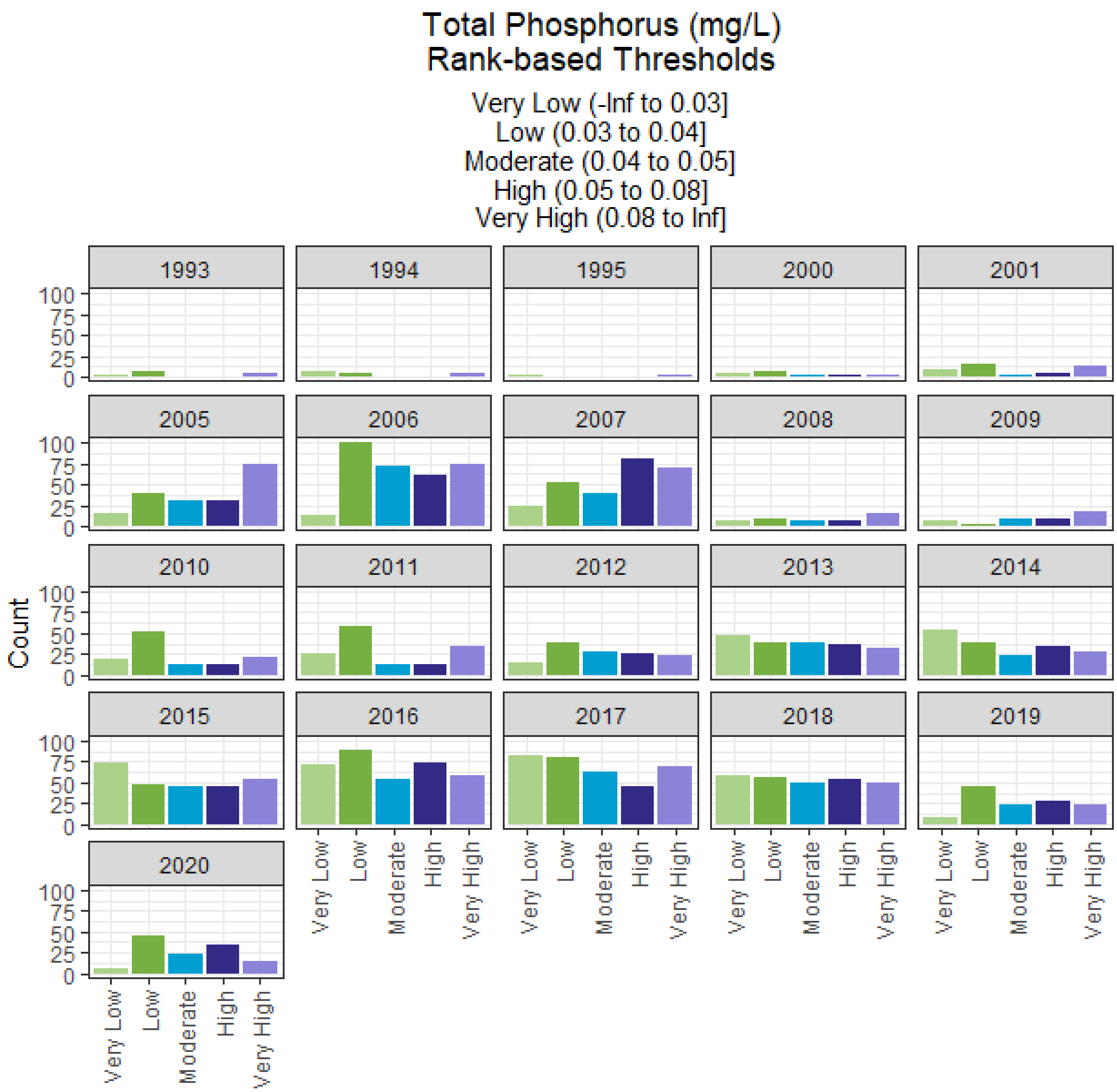
5.1.1.4 Total Phosphorus Concentration

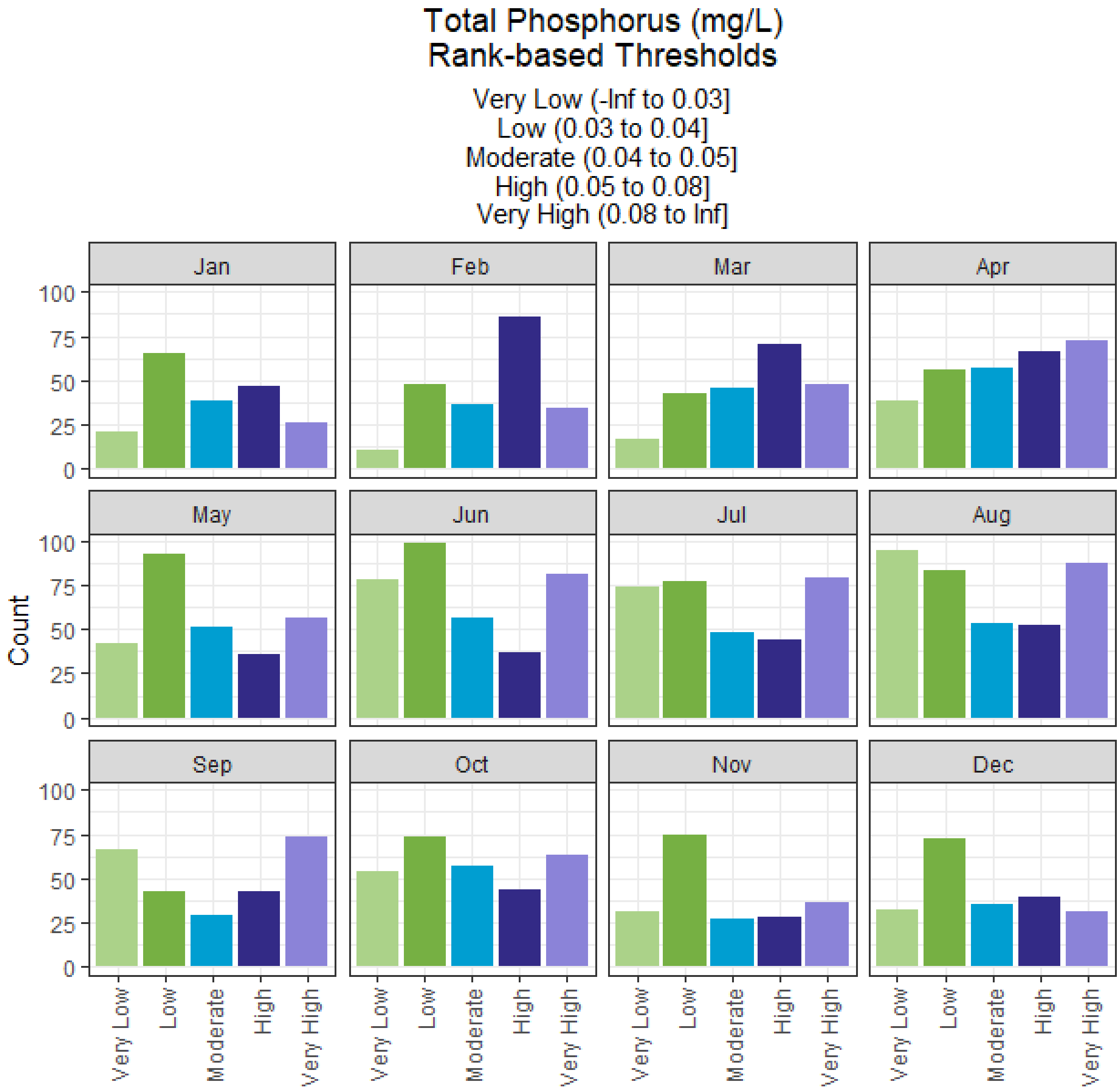
Total phosphorus data are reported at the level of Site-Date. We received multiple data resources that included some empirical total phosphorus data (or component measures that we used to calculate total phosphorus). The data are assembled in the **dataMerge_totalp** file (rmd/docx).

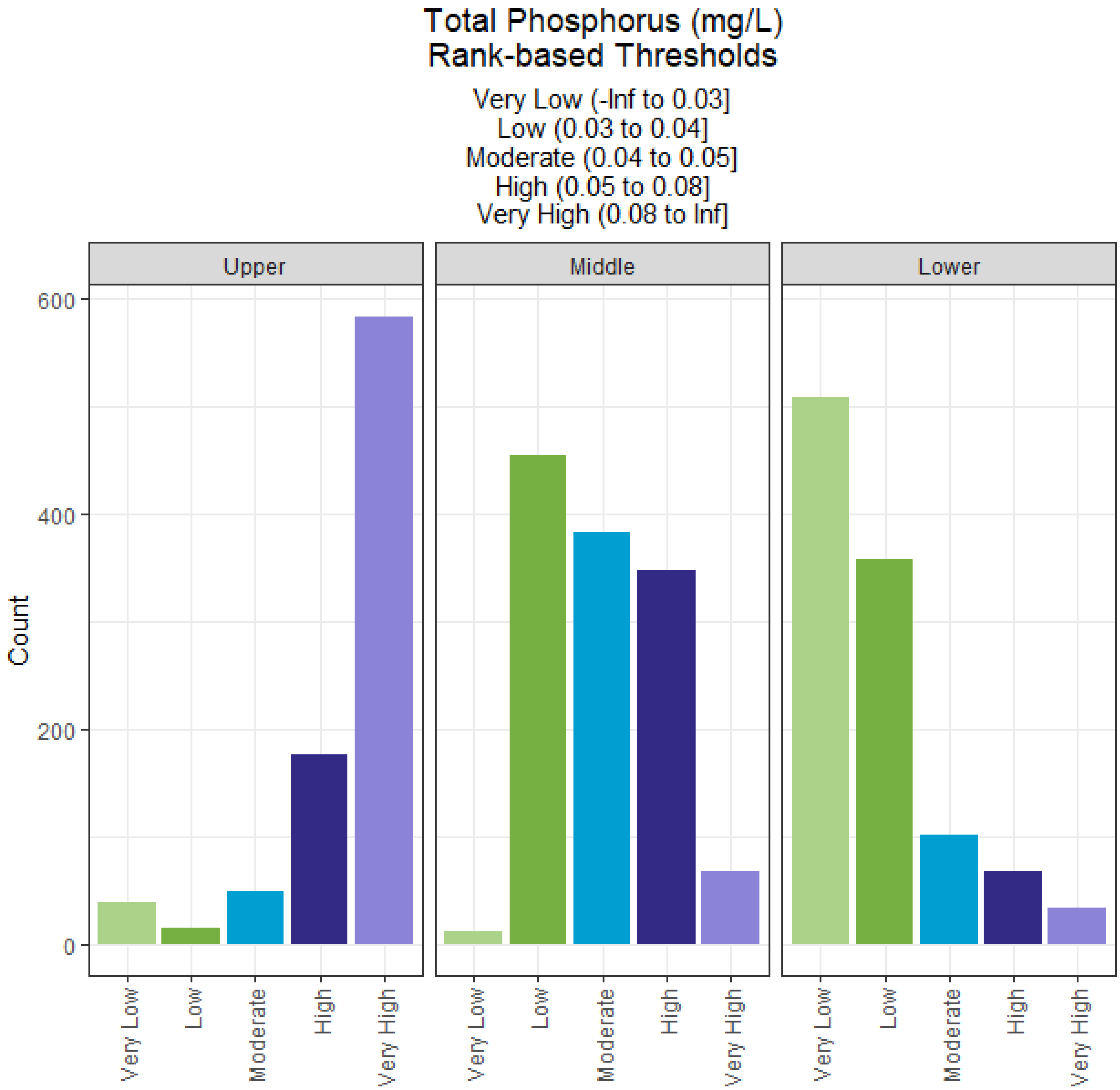
Phosphorus values are classified into five bins (Very Low, Low, Moderate, High, Very High) using the "rank bin" method. There are no identified regulatory or critical values identified for this variable. The observed data values range from 0.01 to 1.2000001.

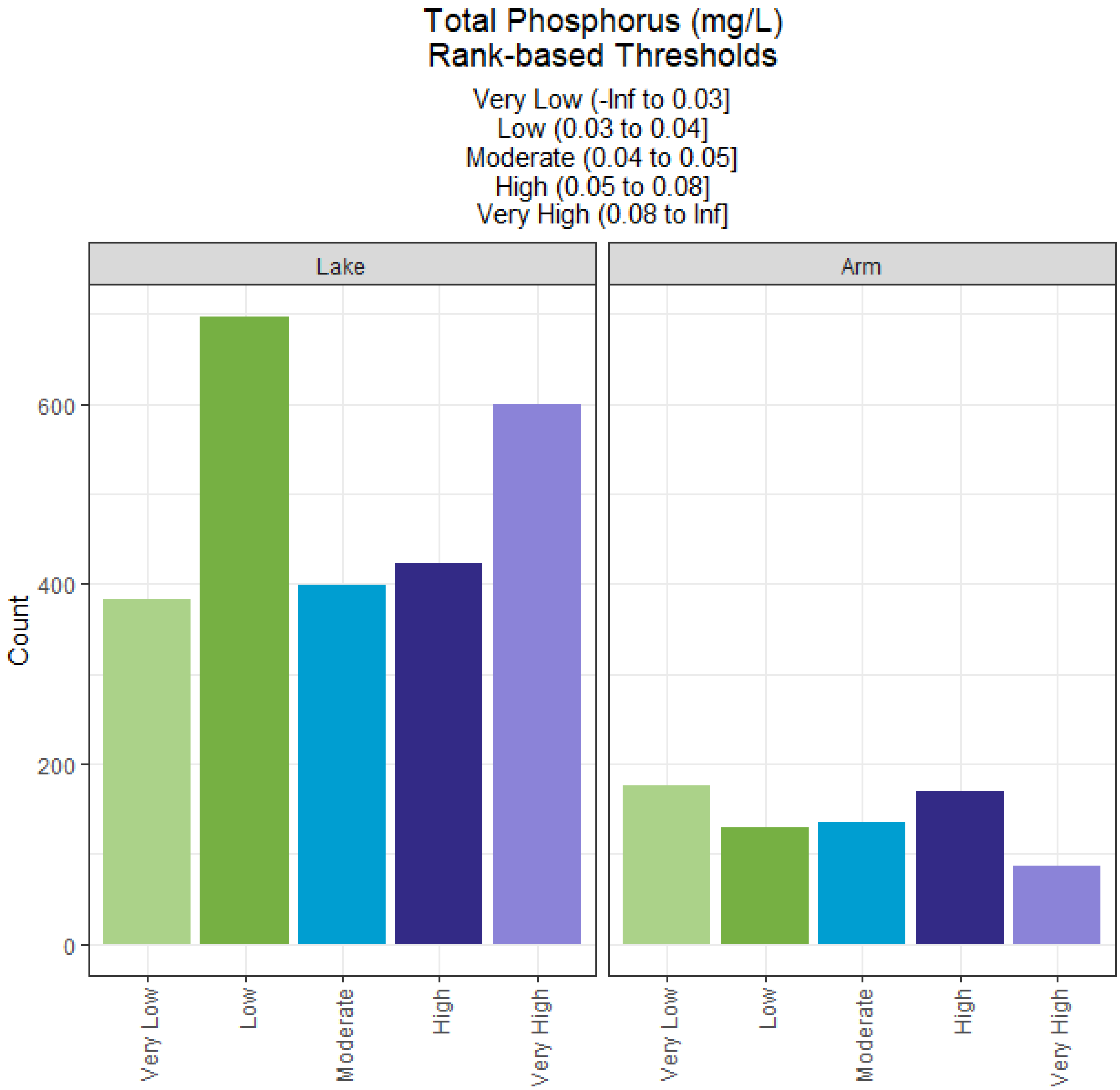


BIN	N	MIN	MAX	LABELS
Very Low	558	0.0	0.0	Very Low (-Inf to 0.03]
Low	827	0.0	0.0	Low (0.03 to 0.04]
Moderate	533	0.0	0.1	Moderate (0.04 to 0.05]
High	592	0.1	0.1	High (0.05 to 0.08]
Very High	686	0.1	1.2	Very High (0.08 to Inf]


Total Phosphorus (mg/L)
Rank-based Thresholds
Very Low (-Inf to 0.03]
Low (0.03 to 0.04]
Moderate (0.04 to 0.05]
High (0.05 to 0.08]
Very High (0.08 to Inf]
1993
1994
1995
2000
2001
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Count
100
75
50
25
0
Very Low
Low
Moderate
High
Very High


Total Phosphorus (mg/L)
Rank-based Thresholds
Very Low (-Inf to 0.03]
Low (0.03 to 0.04]
Moderate (0.04 to 0.05]
High (0.05 to 0.08]
Very High (0.08 to Inf]
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Count
0
25
50
75
100
Very Low
Low
Moderate
High
Very High

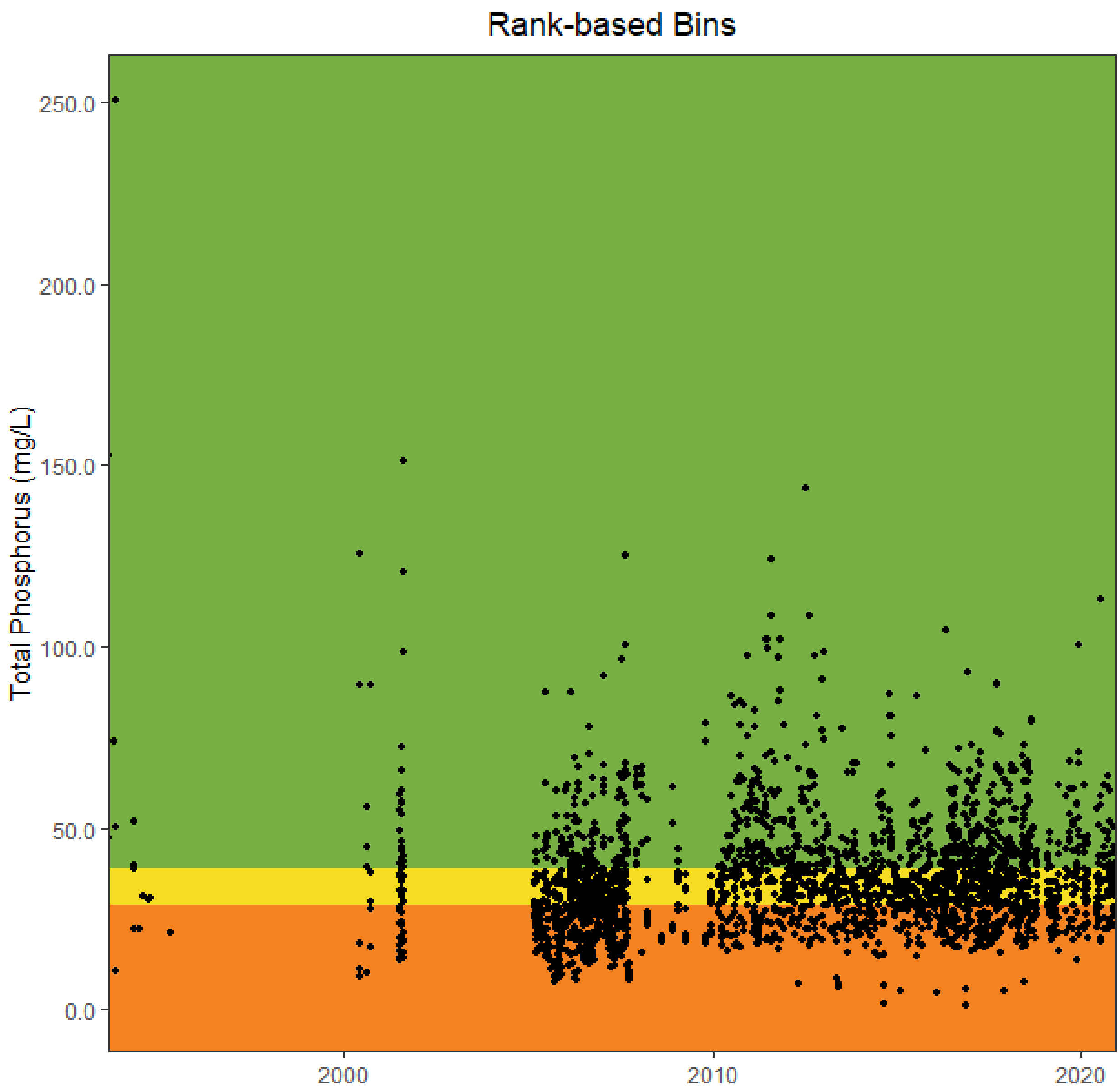

Total Phosphorus (mg/L)
Rank-based Thresholds
Very Low (-Inf to 0.03]
Low (0.03 to 0.04]
Moderate (0.04 to 0.05]
High (0.05 to 0.08]
Very High (0.08 to Inf]
Upper
Middle
Lower
Count
0
200
400
600
Very Low
Low
Moderate
High
Very High



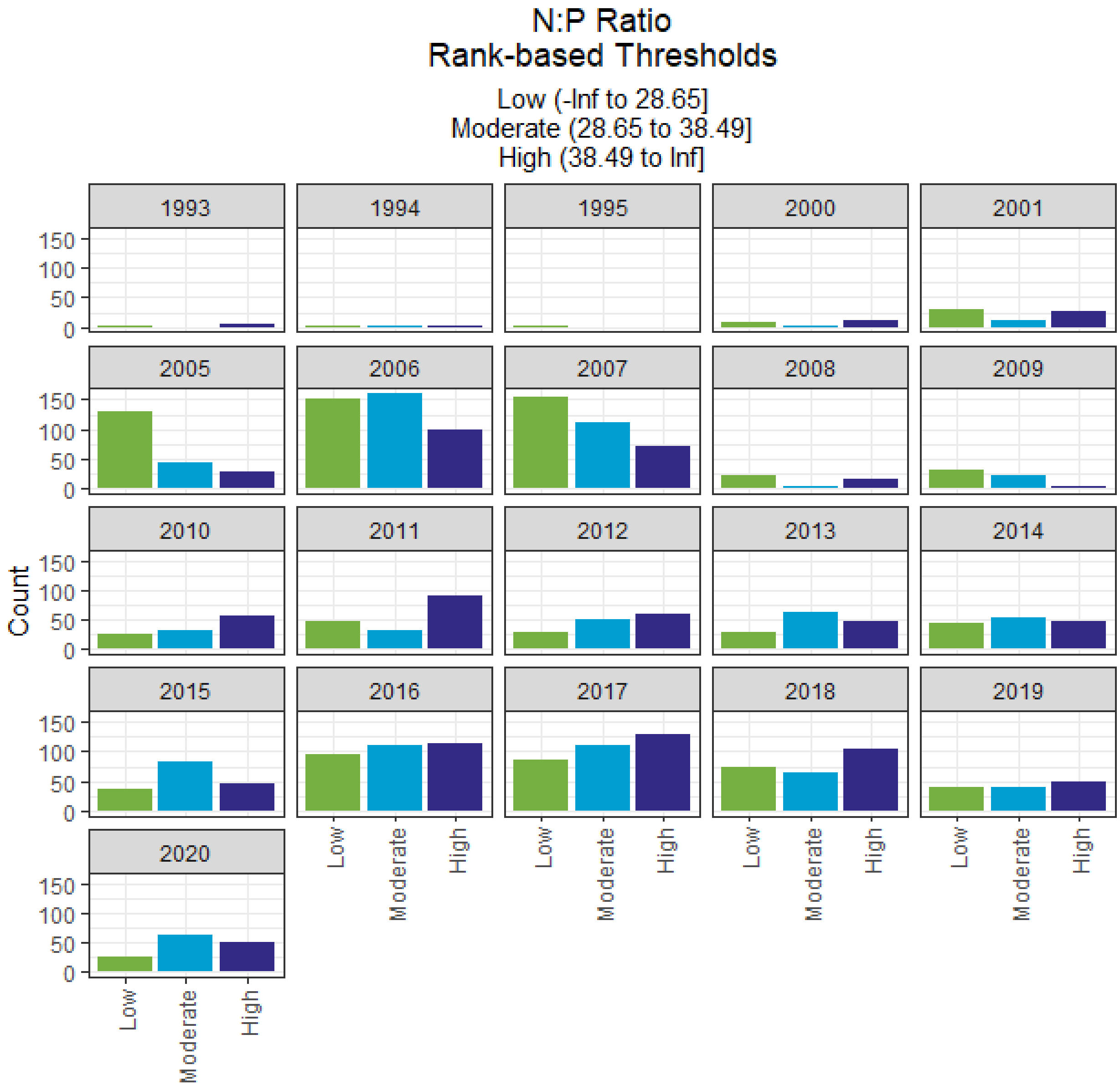
5.1.1.5 N:P Ratio

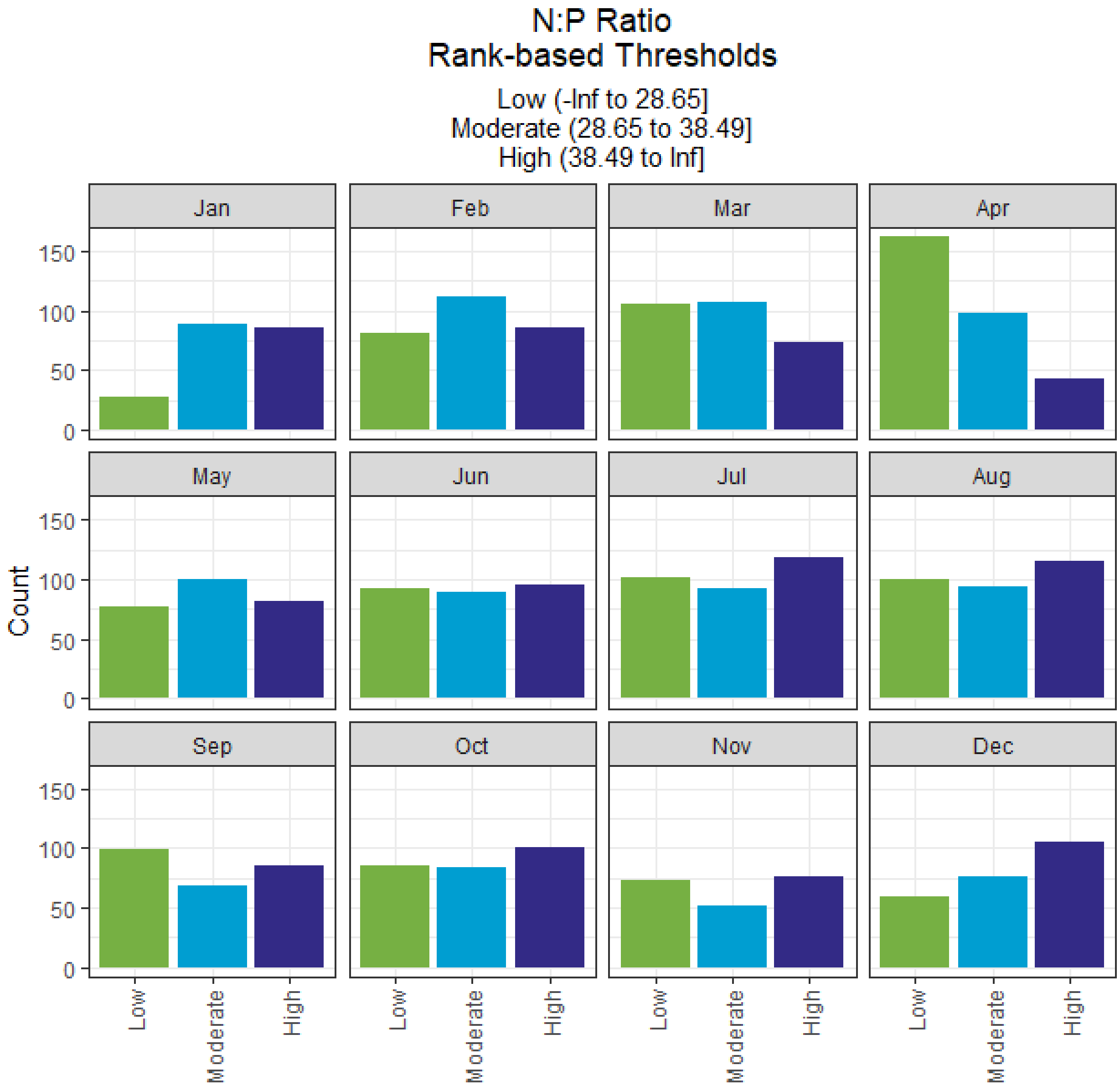
Phosphorus values are classified into five bins (Very Low, Low, Moderate, High, Very High) using the "rank bin" method. There are no identified regulatory or critical values identified for this variable. The observed data values range from 0.9708849 to 250.7095238.

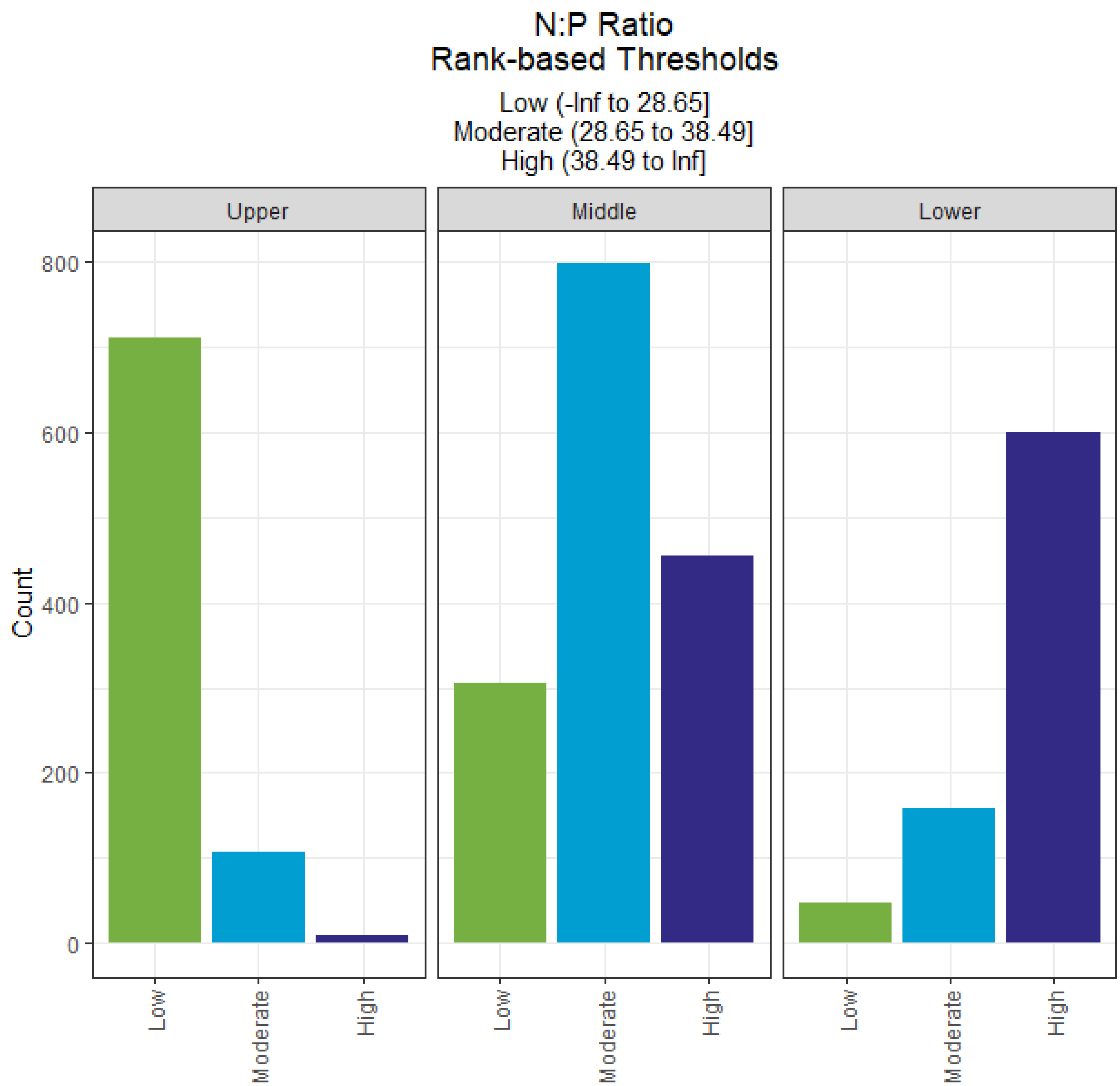
The 'npratio' data is read from the 'data_prepped_for_models' directory. We remove an unrealistic observation prior to modeling and save the modified data separately. This allows us to retain the unrealistic observation through the other data steps without affecting the model.

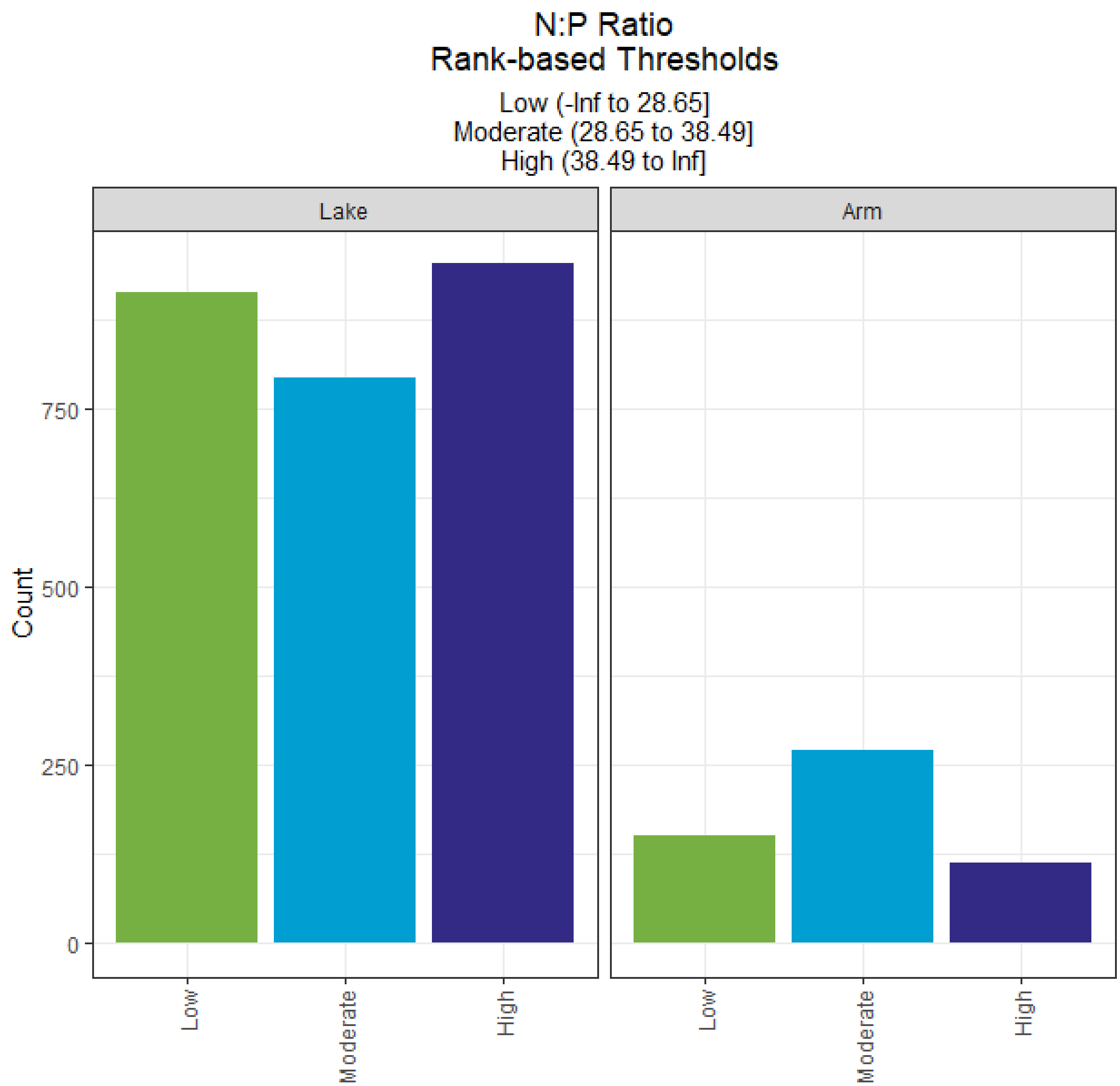


BIN	N	MIN	MAX	LABELS
Low	1063	1.0	28.6	Low (-Inf to 28.65]
Moderate	1064	28.7	38.5	Moderate (28.65 to 38.49]
High	1064	38.5	250.7	High (38.49 to Inf]


N:P Ratio
Rank-based Thresholds
Low (-Inf to 28.65]
Moderate (28.65 to 38.49]
High (38.49 to Inf]
1993
1994
1995
2000
2001
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Count
0
50
100
150
Low
Moderate
High


N:P Ratio
Rank-based Thresholds
Low (-Inf to 28.65]
Moderate (28.65 to 38.49]
High (38.49 to Inf]
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Count
0
50
100
150
Low
Moderate
High


N:P Ratio
Rank-based Thresholds
Low (-Inf to 28.65]
Moderate (28.65 to 38.49]
High (38.49 to Inf]
Upper
Middle
Lower
Count
800
600
400
200
0
Low
Moderate
High



5.1.2 Lakewide LEVEL DATA

There are no lake wide algal variables to report.

5.2 Chlorophyll-a, Algae, and Toxin Data

5.2.1 Lake Unit Level Data

5.2.1.1 Chlorophyll-a

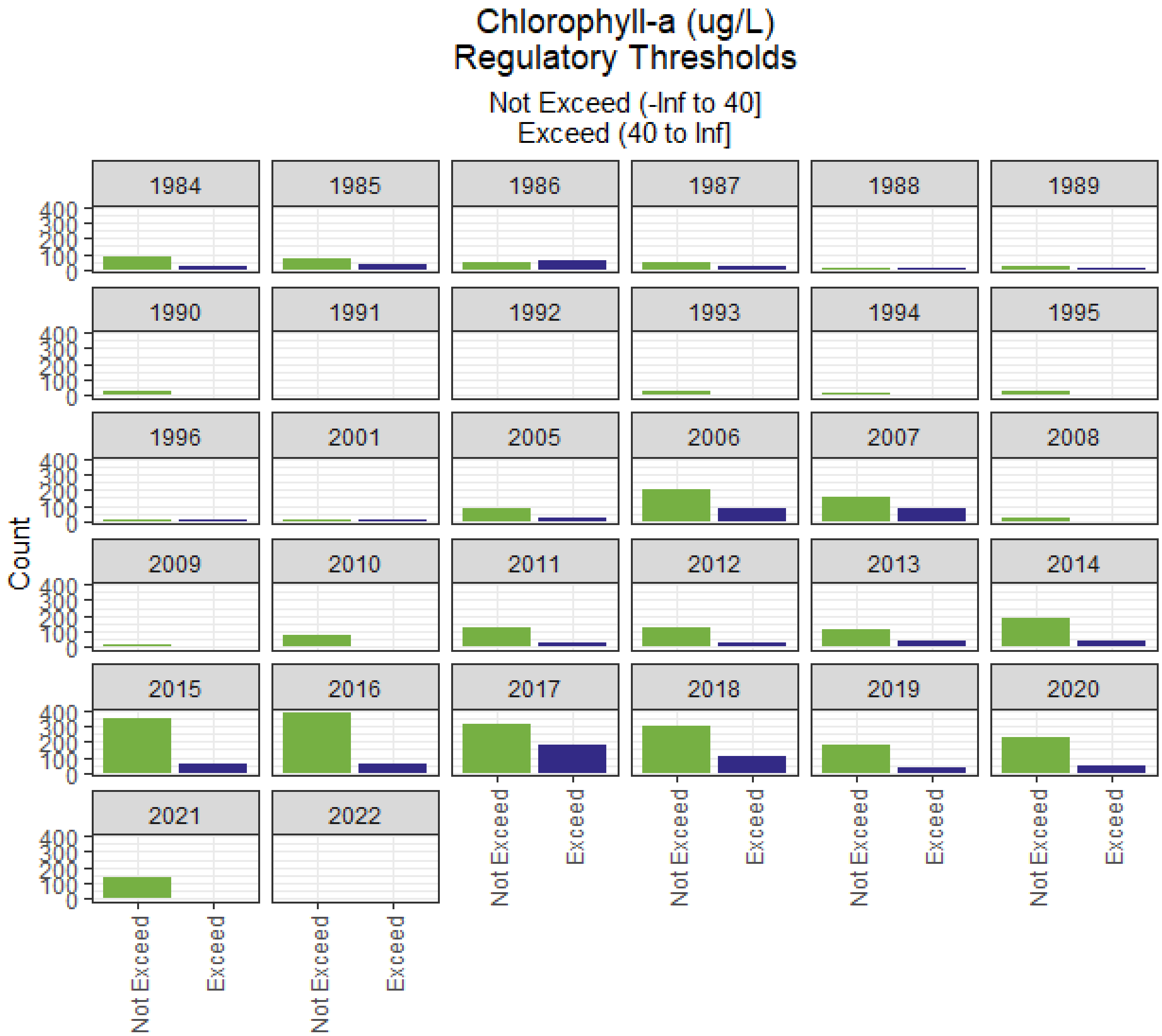
Chlorophyll-a data are reported at the level of Site-Date. The observed data values range from 0 to 295.

Chlorophyll-a has a regulatory limit of 40 ug/L. The lake is often above this level without apparent negative impact to the designated uses. There have been no documented closures or warnings issued dues to toxic algal blooms. The intake depth is varied to avoid clogging or additional treatment, but this action has been possible and effective to-date. To better understand how chlorophyll-a levels may vary as nutrient loads and algal communities vary, we include a second “ecological” scale for chlorophyll-a measures.

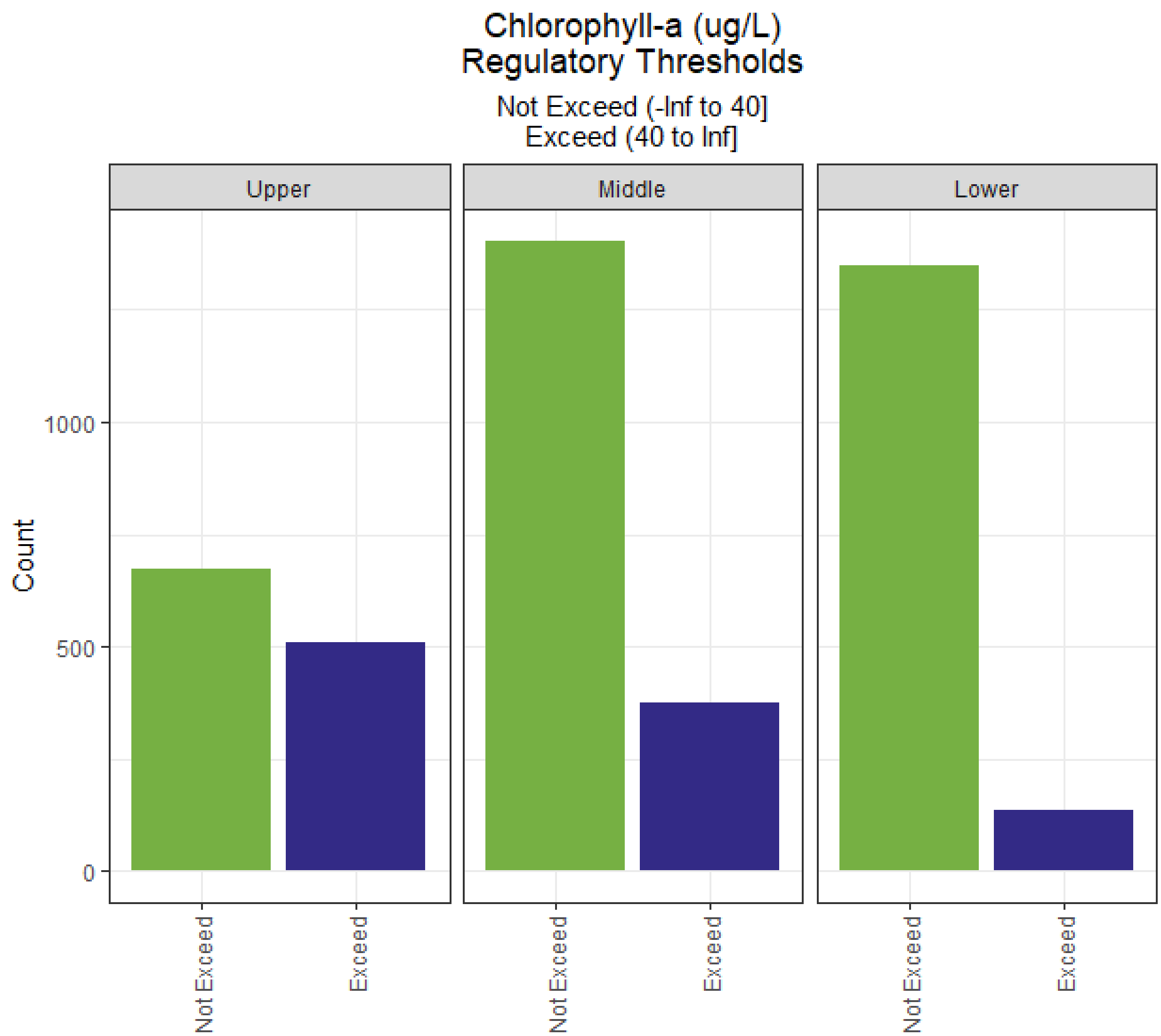
5.2.1.1.1 Regulatory Node

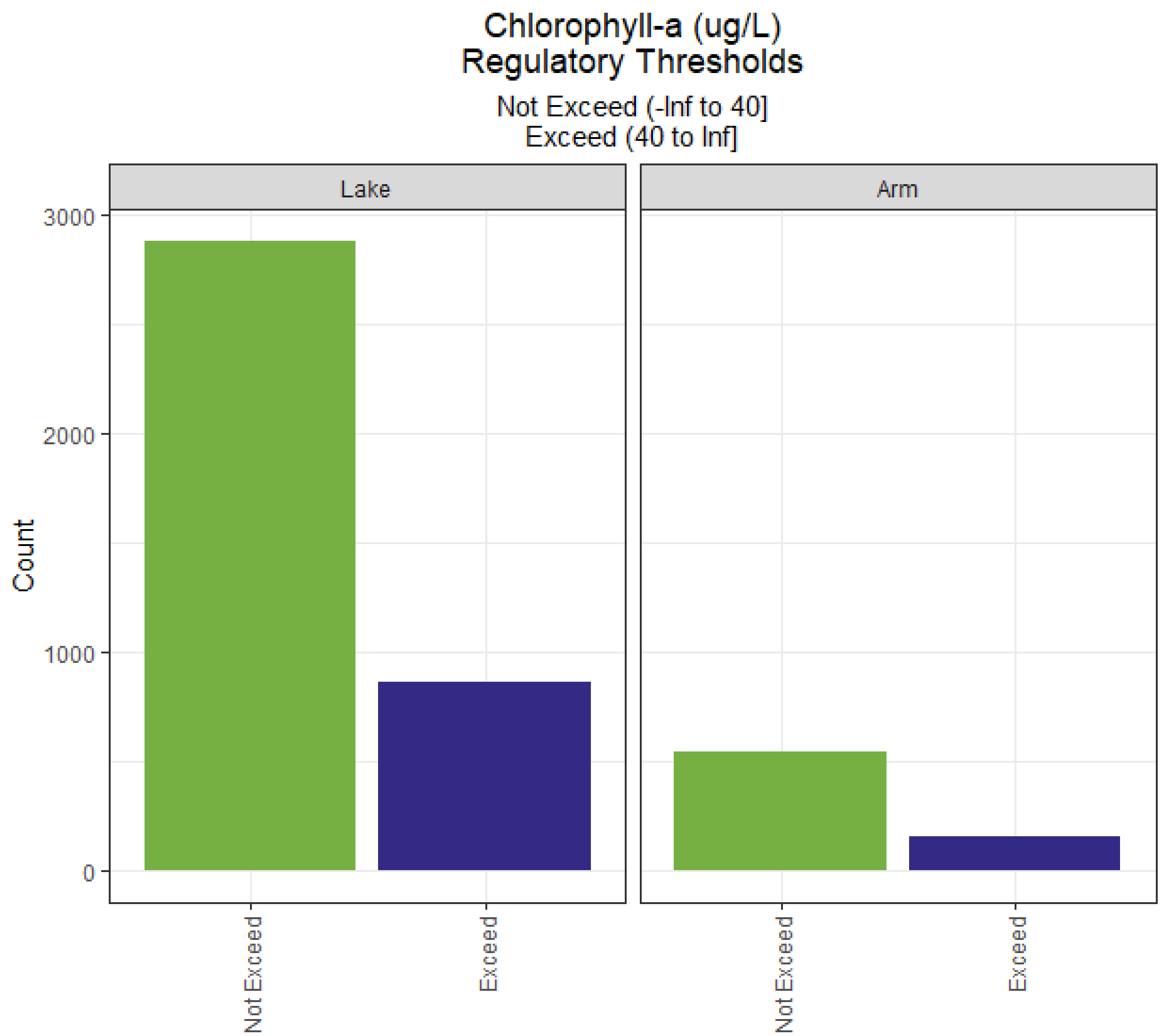
- Not Exceed: < 40 ug/L
- Exceed: >= 40 ug/L

BIN	N	MIN	MAX	LABELS
Not Exceed	3426	0.0	40	Not Exceed (-Inf to 40]
Exceed	1020	40.1	295	Exceed (40 to Inf]


Chlorophyll-a (ug/L)
Regulatory Thresholds
Not Exceed (-Inf to 40]
Exceed (40 to Inf]
Count
0
100
200
300
400
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
2001
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Not Exceed
Exceed

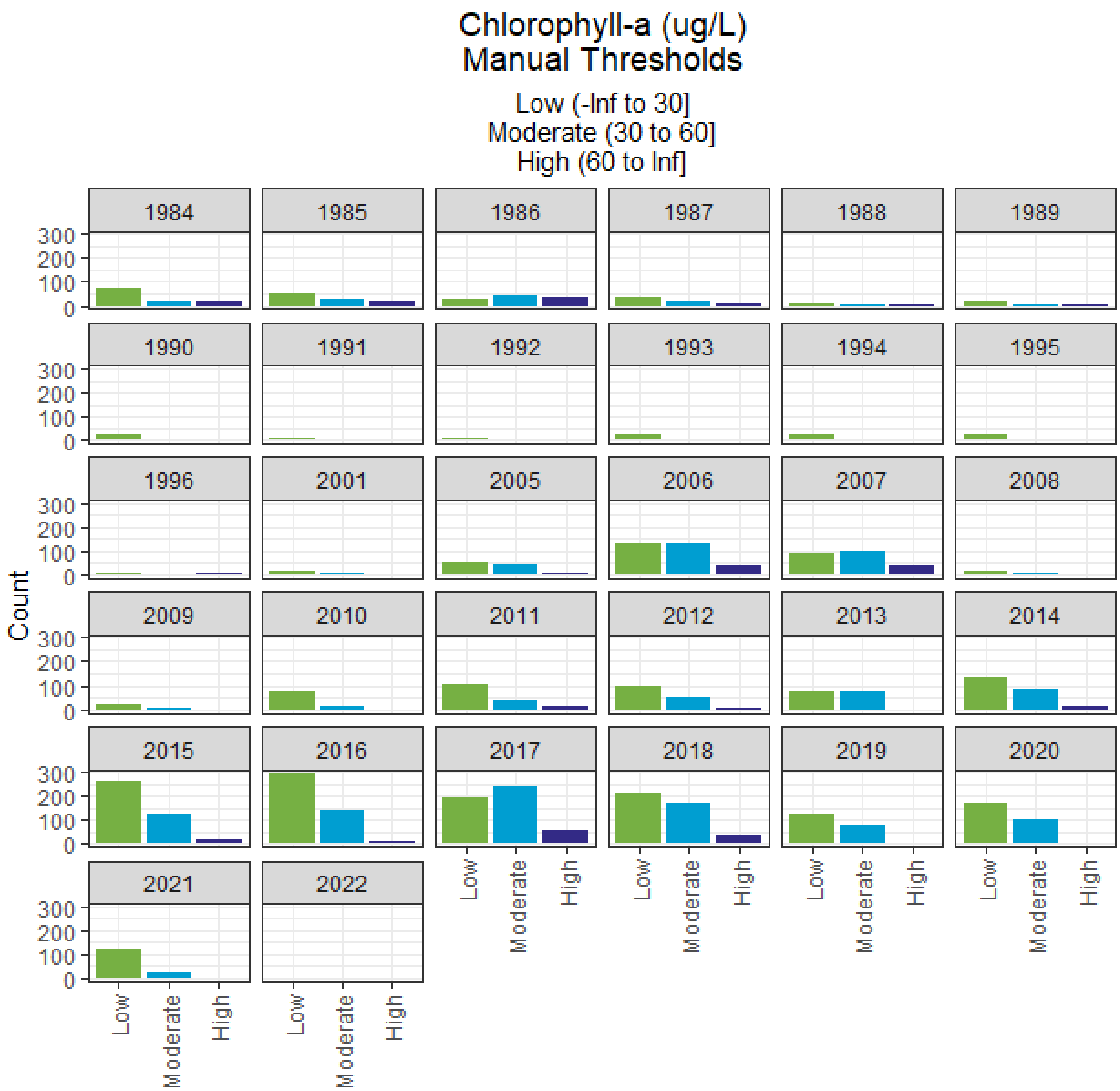

Chlorophyll-a (ug/L)
Regulatory Thresholds
Not Exceed (-Inf to 40]
Exceed (40 to Inf]
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Count
0
100
200
300
Not Exceed
Exceed

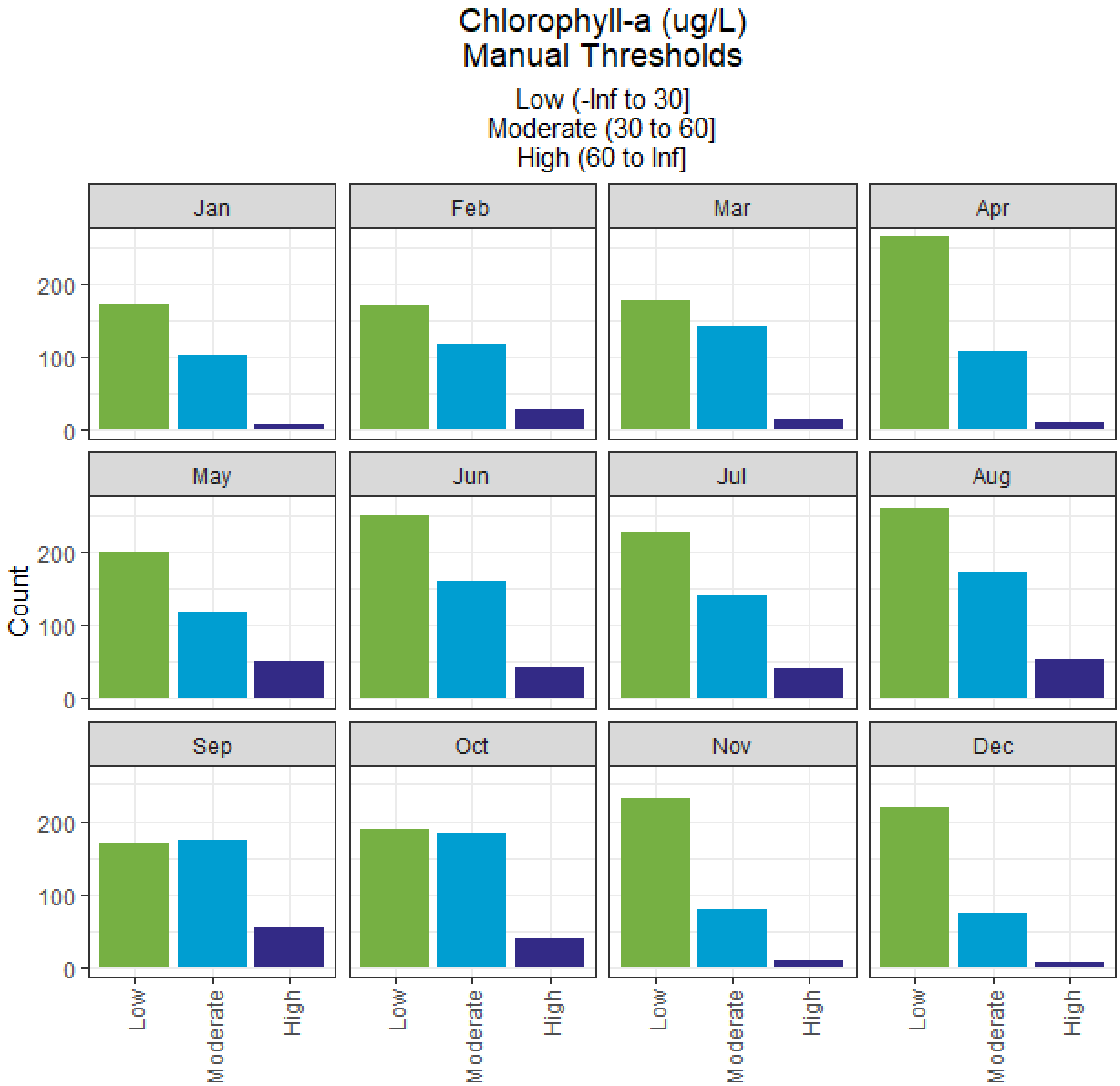

Chlorophyll-a (ug/L)
Regulatory Thresholds
Not Exceed (-Inf to 40]
Exceed (40 to Inf]
Upper
Middle
Lower
Count
1000
500
0
Not Exceed
Exceed
Not Exceed
Exceed
Not Exceed
Exceed



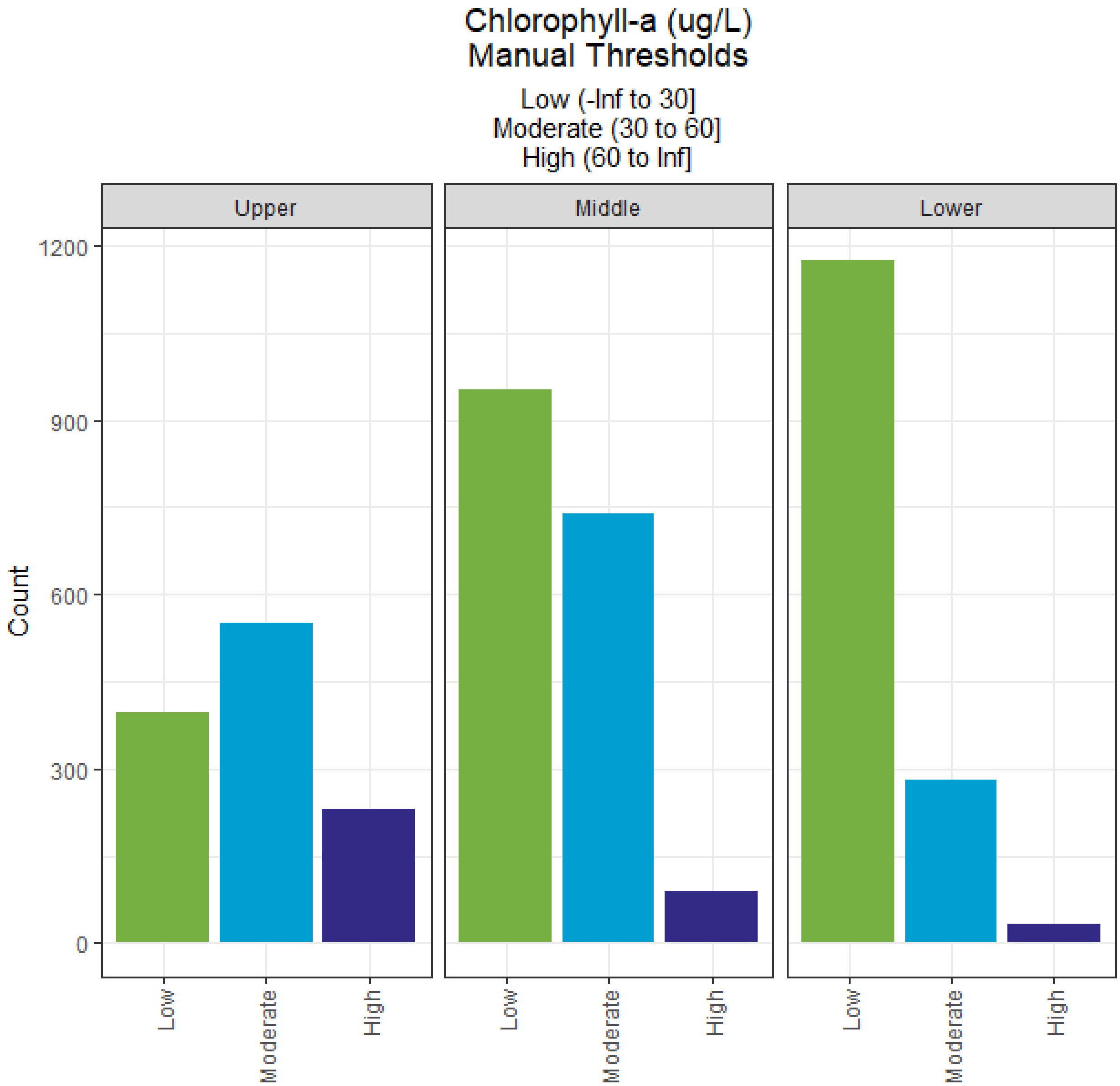
5.2.1.1.2 Ecological Node

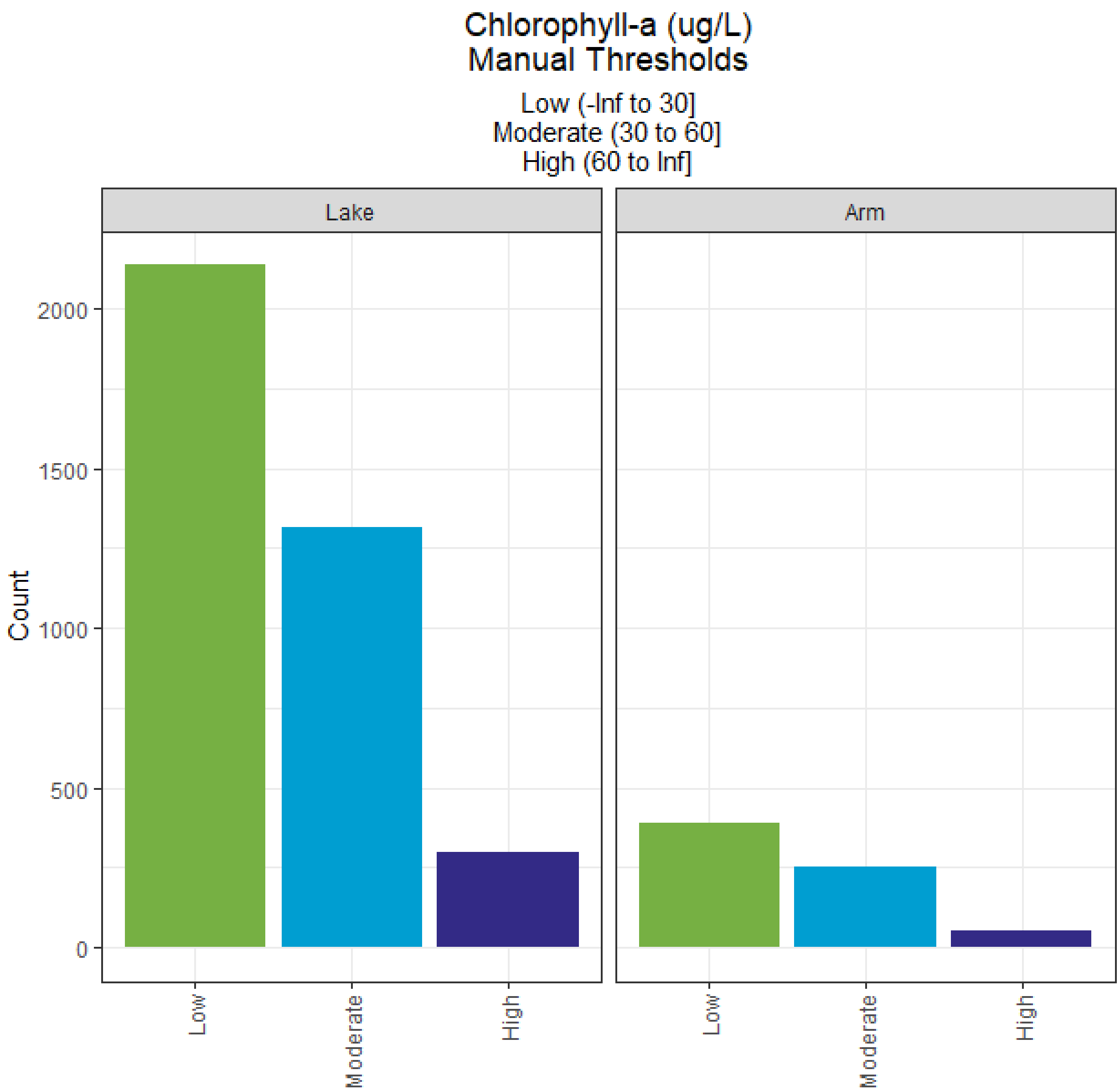
BIN	N	MIN	MAX	LABELS
Low	2524	0.0	30	Low (-Inf to 30]
Moderate	1568	30.0	60	Moderate (30 to 60]
High	354	60.1	295	High (60 to Inf]


Chlorophyll-a (ug/L)
Manual Thresholds
Low (-Inf to 30]
Moderate (30 to 60]
High (60 to Inf]
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
2001
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Count
300
200
100
0
Low
Moderate
High



Chlorophyll-a (ug/L)
Manual Thresholds
Low (-Inf to 30]
Moderate (30 to 60]
High (60 to Inf]
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Count
0
100
200
Low
Moderate
High


Chlorophyll-a (ug/L)
Manual Thresholds
Low (-Inf to 30]
Moderate (30 to 60]
High (60 to Inf]
Upper
Middle
Lower
Count
1200
900
600
300
0
Low
Moderate
High

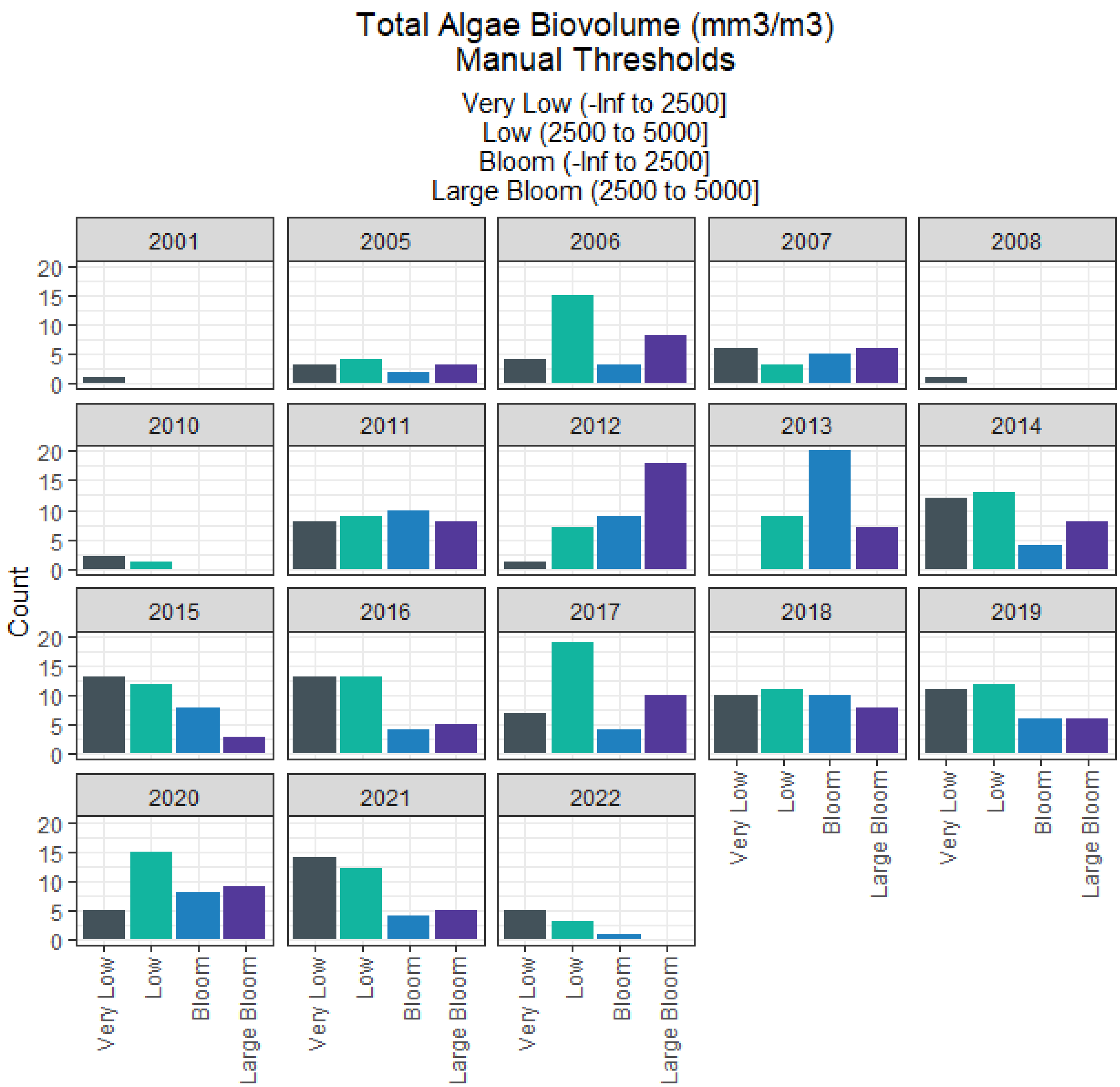


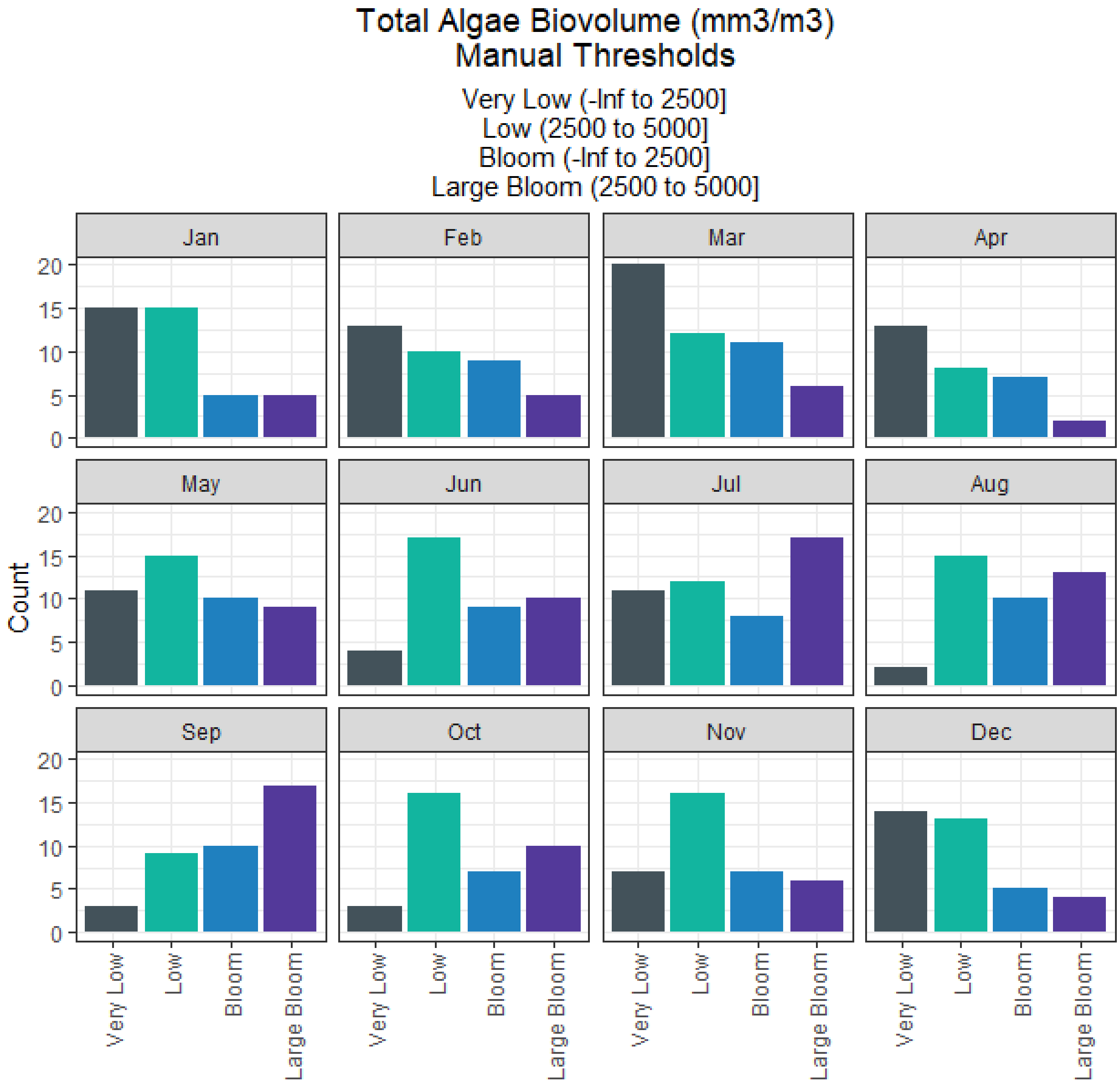
5.2.1.2 Total Algal Biovolume

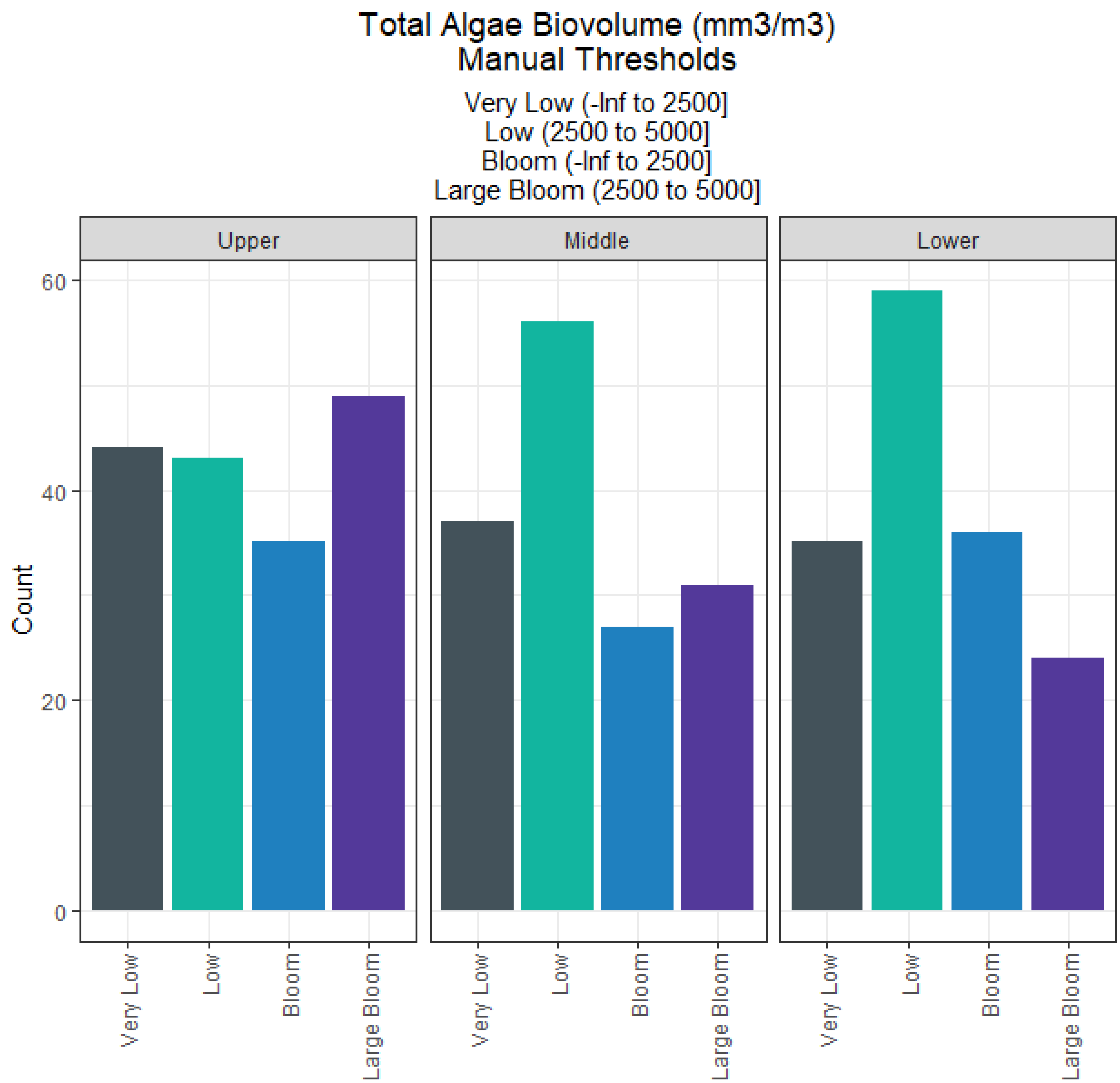
Total algal biovolume data are reported at the level of Site-Date. We received multiple data resources that included algal biovolume by taxa group (at various levels). The total across all species per day and station were summed. There are no identified regulatory or critical values identified for this variable, but the state considers values >5,000 mm3/m3 to be a bloom event which can trigger additional sampling. The observed data values range from 75 to 4.4489355^{4}. The data are assembled in the **dataMerge_totbiov** file (rmd/docx).

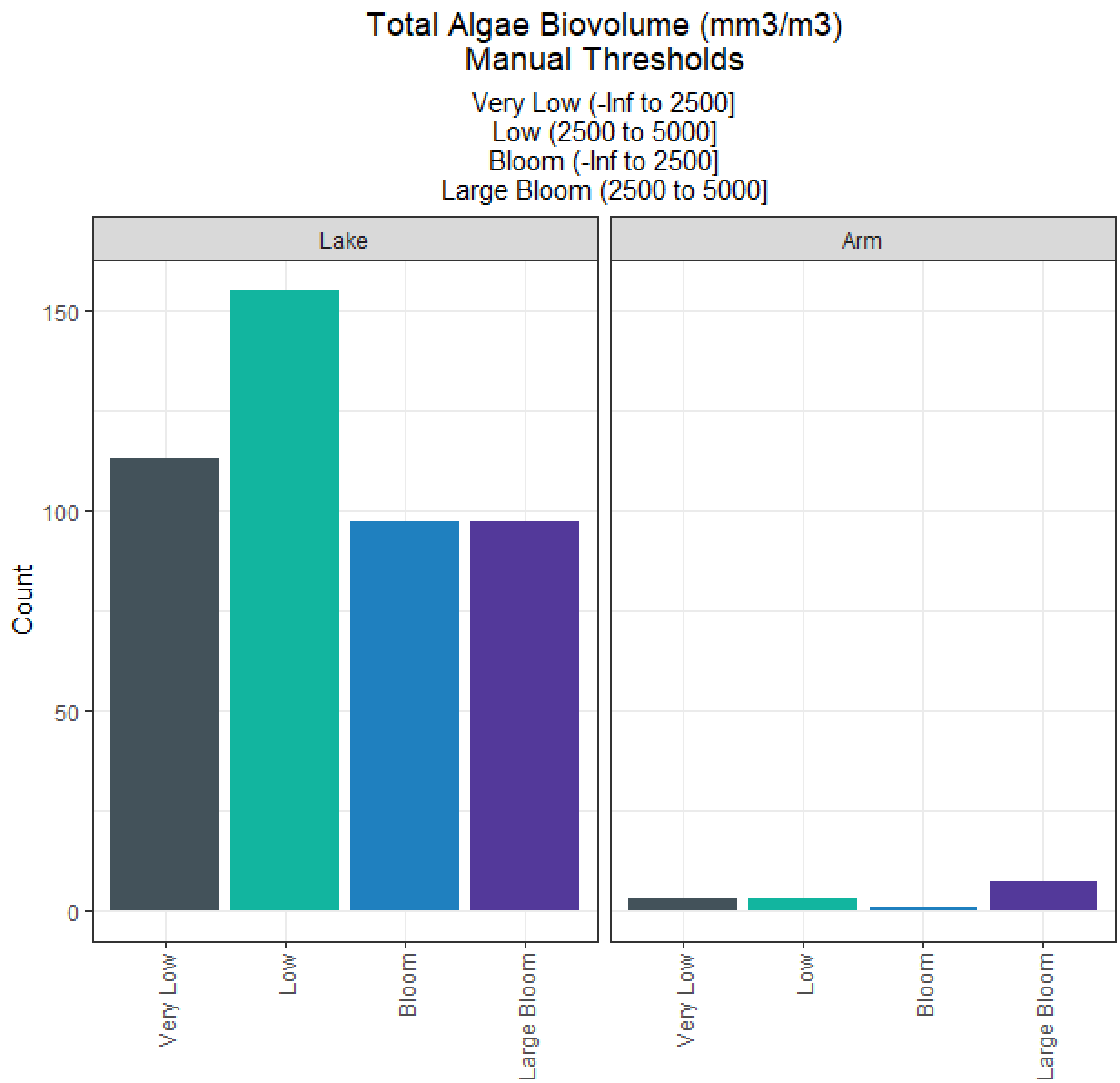
BIN	N	MIN	MAX	LABELS
Very Low	116	75	2491.0	Very Low (-Inf to 2500]
Low	158	2505	4989.0	Low (2500 to 5000]
Bloom	98	5007	7415.0	Bloom (-Inf to 2500]

BIN	N	MIN	MAX	LABELS
Large Bloom	104	7547	44489.4	Large Bloom (2500 to 5000]


Total Algae Biovolume (mm3/m3)
Manual Thresholds
Very Low (-Inf to 2500]
Low (2500 to 5000]
Bloom (-Inf to 2500]
Large Bloom (2500 to 5000]
2001
2005
2006
2007
2008
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Count
0
5
10
15
20
Very Low
Low
Bloom
Large Bloom


Total Algae Biovolume (mm3/m3)
Manual Thresholds
Very Low (-Inf to 2500]
Low (2500 to 5000]
Bloom (-Inf to 2500]
Large Bloom (2500 to 5000]
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Count
0
5
10
15
20
Very Low
Low
Bloom
Large Bloom


Total Algae Biovolume (mm3/m3)
Manual Thresholds
Very Low (-Inf to 2500]
Low (2500 to 5000]
Bloom (-Inf to 2500]
Large Bloom (2500 to 5000]
Upper
Middle
Lower
Count
60
40
20
0
Very Low
Low
Bloom
Large Bloom



5.2.1.3 Anatoxin-a

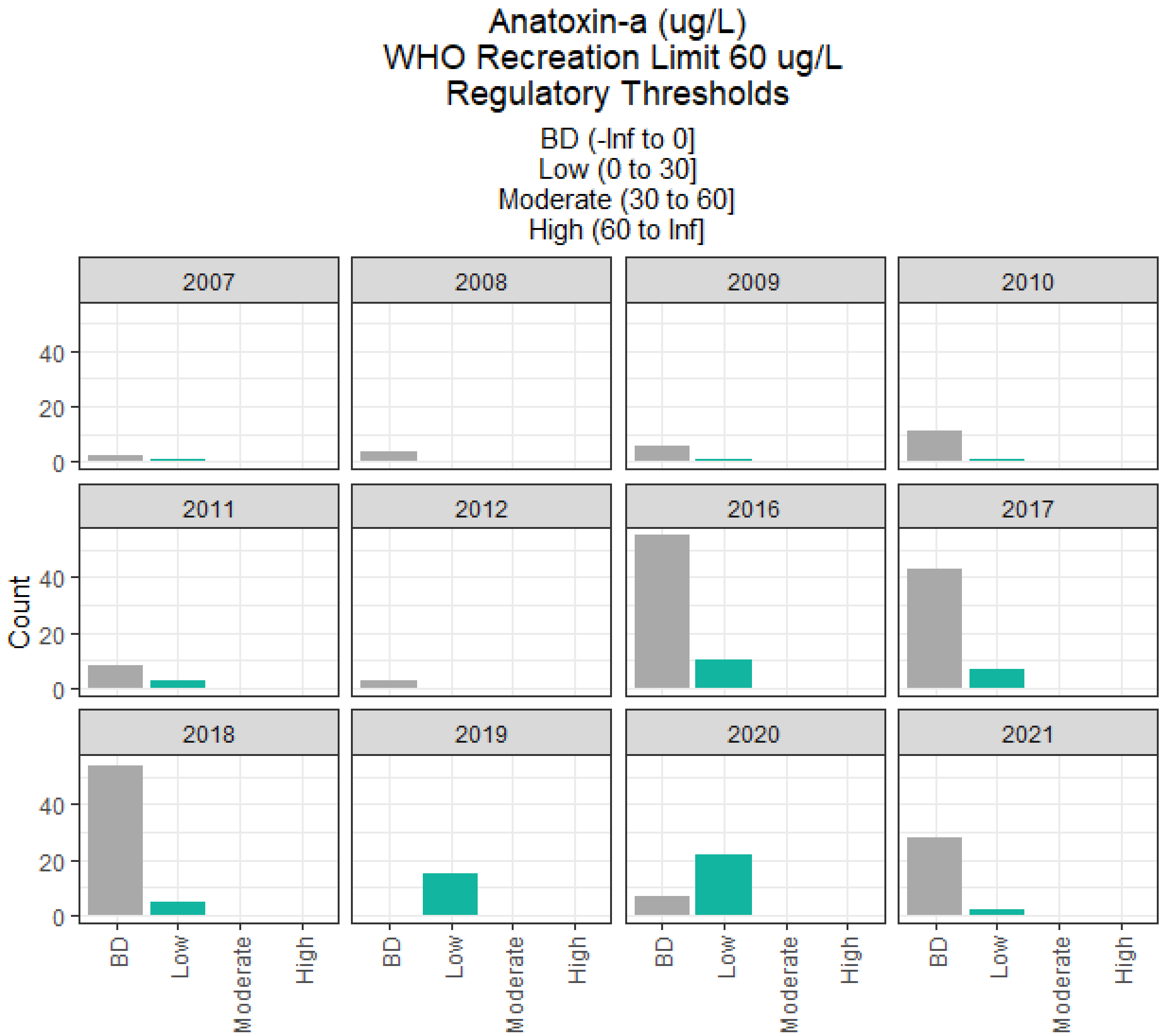
Anatoxin-a data are reported at the level of Site-Date. The observed data values range from 0.01575 to 18.7.

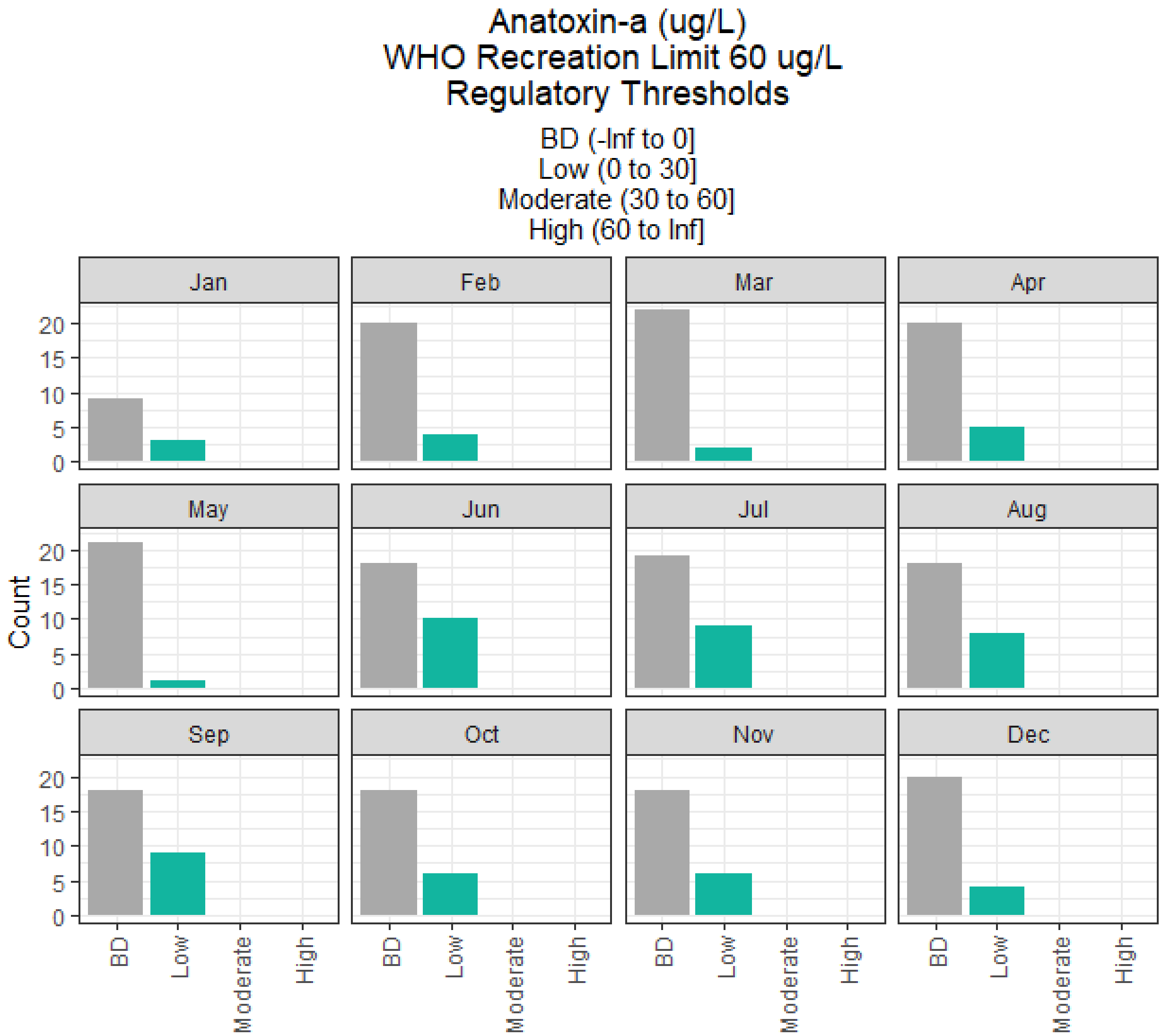
WHO provides recommended limits for anatoxin-a:

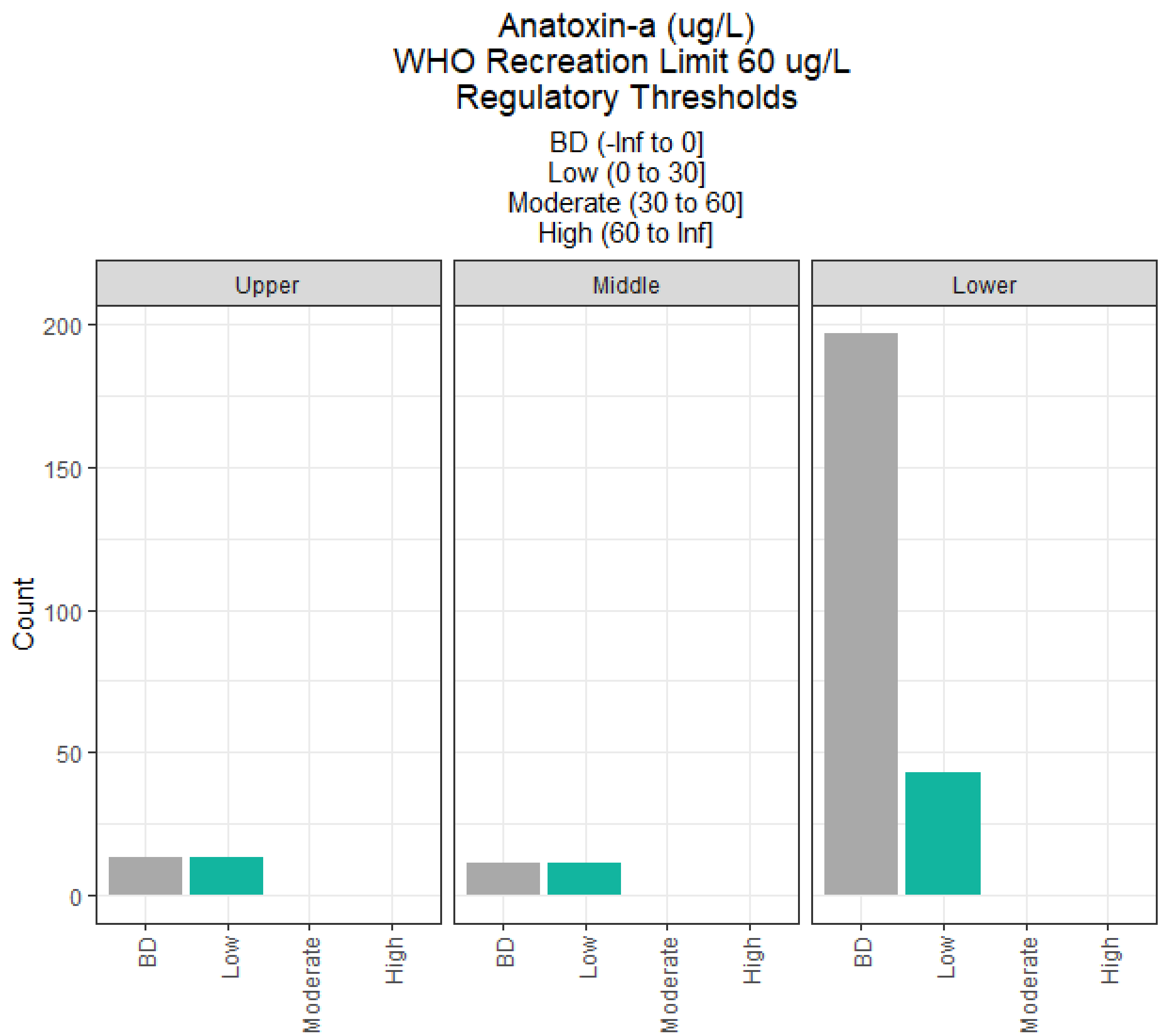
- 30 µg/L: WHO drinking water limit
- 60 µg/L: WHO recreational limit

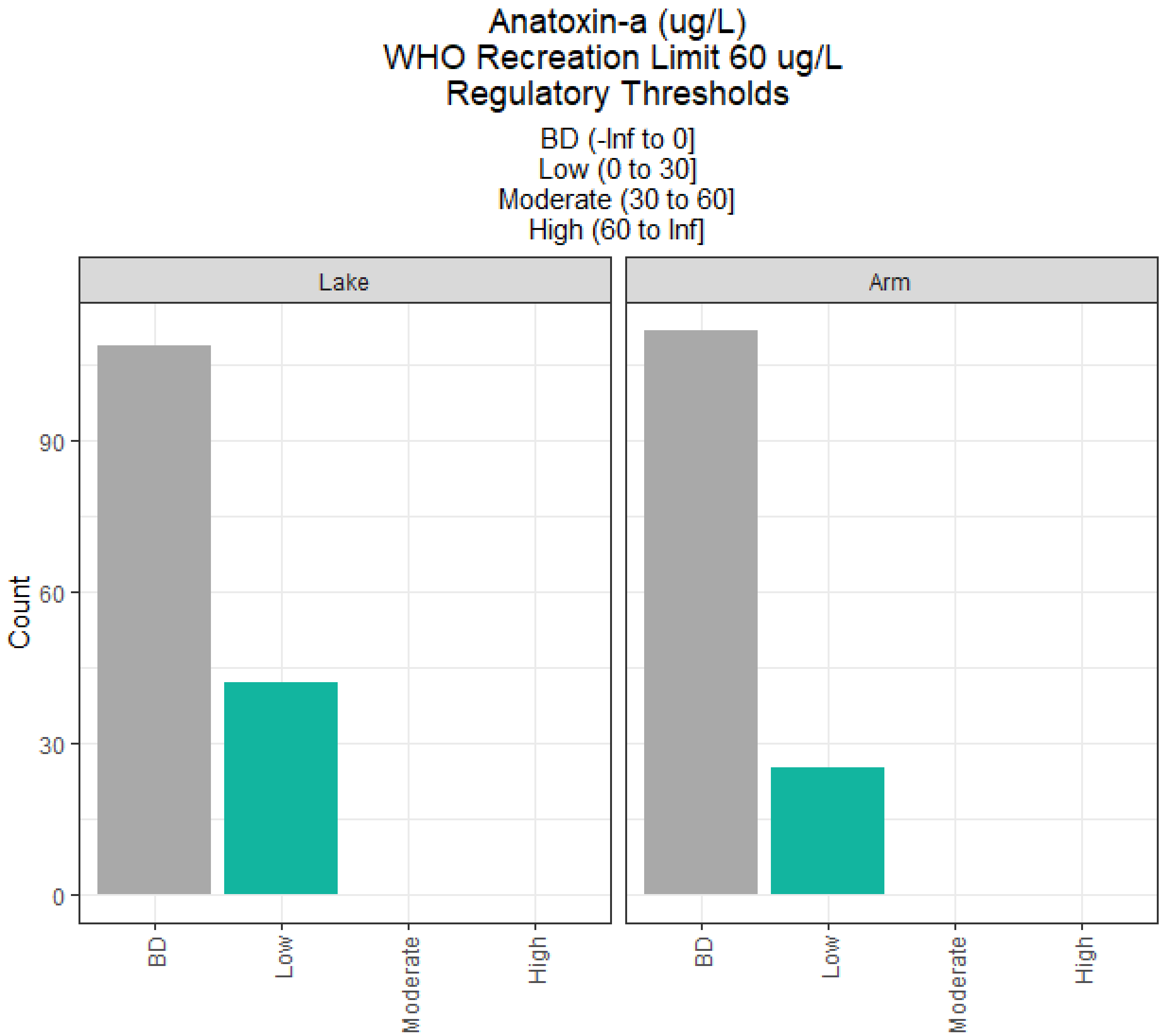
BIN	N	MIN	MAX	LABELS
BD	221	0.0	0.1	BD (-Inf to 0]
Low	67	0.1	18.7	Low (0 to 30]

BIN	N	MIN	MAX	LABELS
Moderate	NA	NA	NA	Moderate (30 to 60]
High	NA	NA	NA	High (60 to Inf]


Anatoxin-a (ug/L)
WHO Recreation Limit 60 ug/L
Regulatory Thresholds
BD (-Inf to 0]
Low (0 to 30]
Moderate (30 to 60]
High (60 to Inf]
2007
2008
2009
2010
2011
2012
2016
2017
2018
2019
2020
2021
Count
0
20
40
BD
Low
Moderate
High


Anatoxin-a (ug/L)
WHO Recreation Limit 60 ug/L
Regulatory Thresholds
BD (-Inf to 0]
Low (0 to 30]
Moderate (30 to 60]
High (60 to Inf]
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Count
0
5
10
15
20
BD
Low
Moderate
High


Anatoxin-a (ug/L)
WHO Recreation Limit 60 ug/L
Regulatory Thresholds
BD (-Inf to 0]
Low (0 to 30]
Moderate (30 to 60]
High (60 to Inf]
Upper
Middle
Lower
Count
200
150
100
50
0
BD
Low
Moderate
High



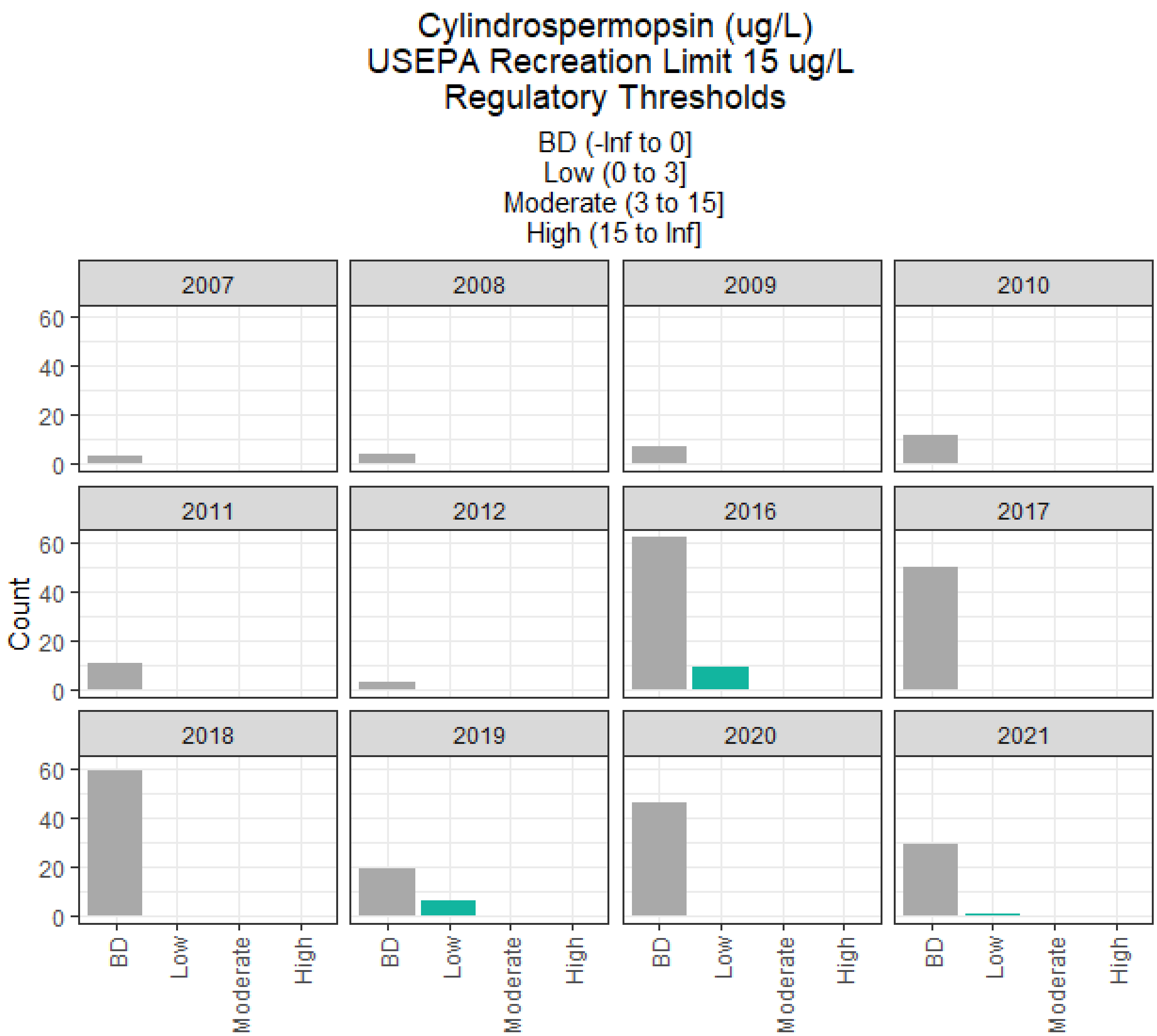
5.2.1.4 Cylindrospermopsin

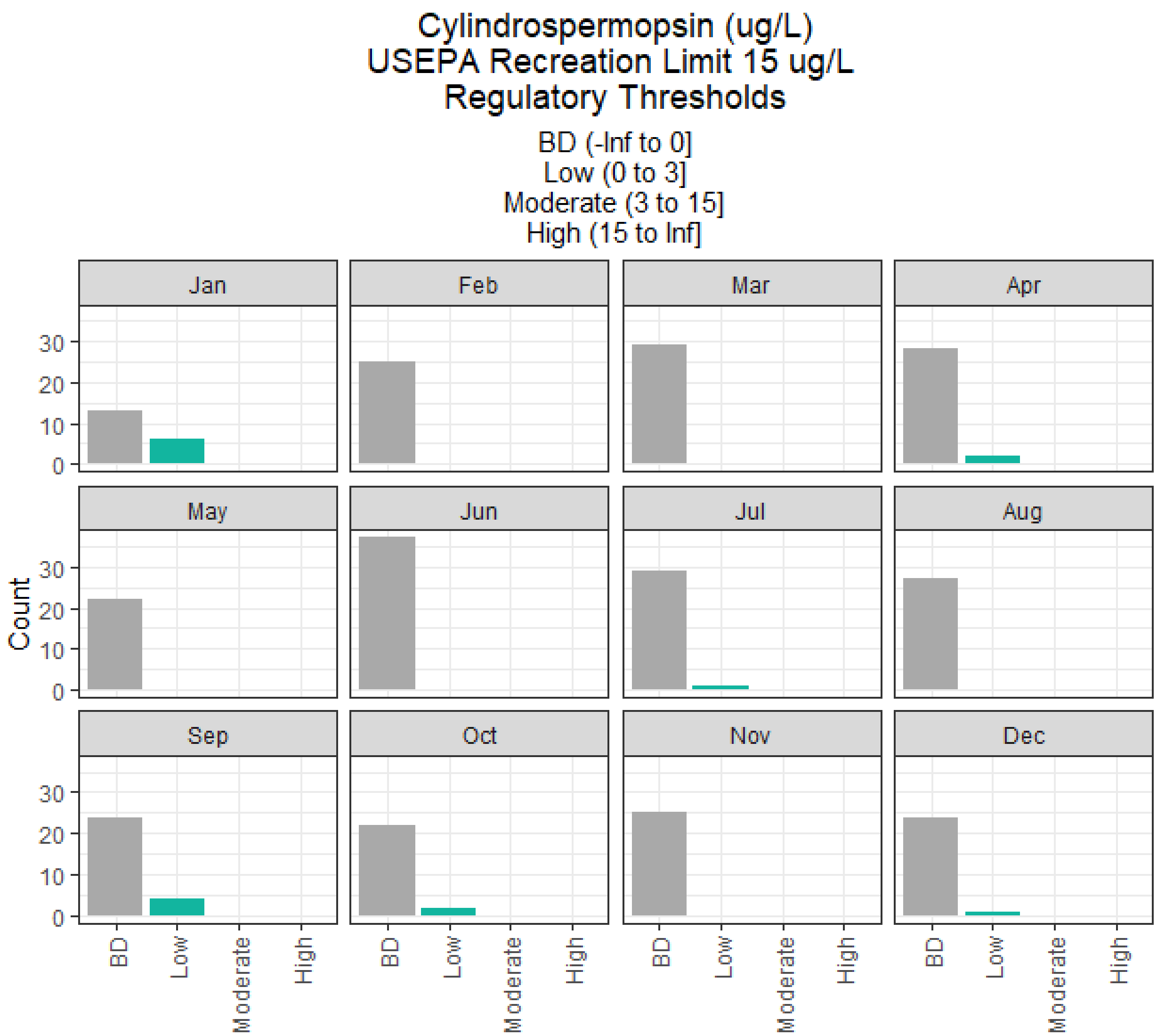
Cylindrospermopsin data are reported at the level of Site-Date. The observed data values range from 0.005 to 0.56.

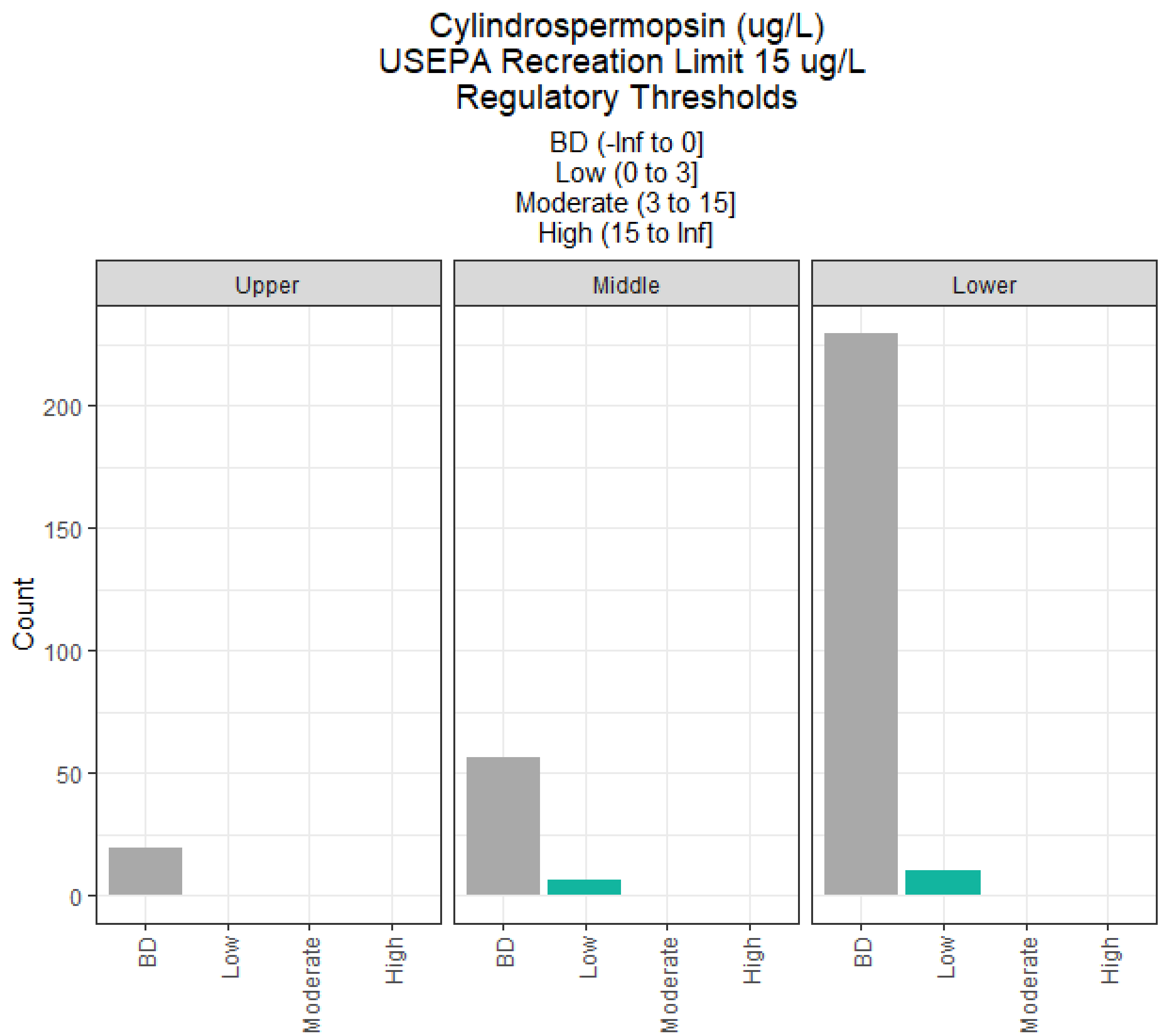
WHO provides recommended limits for cylindrospermopsin:
- 3 µg/L: USEPA drinking water limit

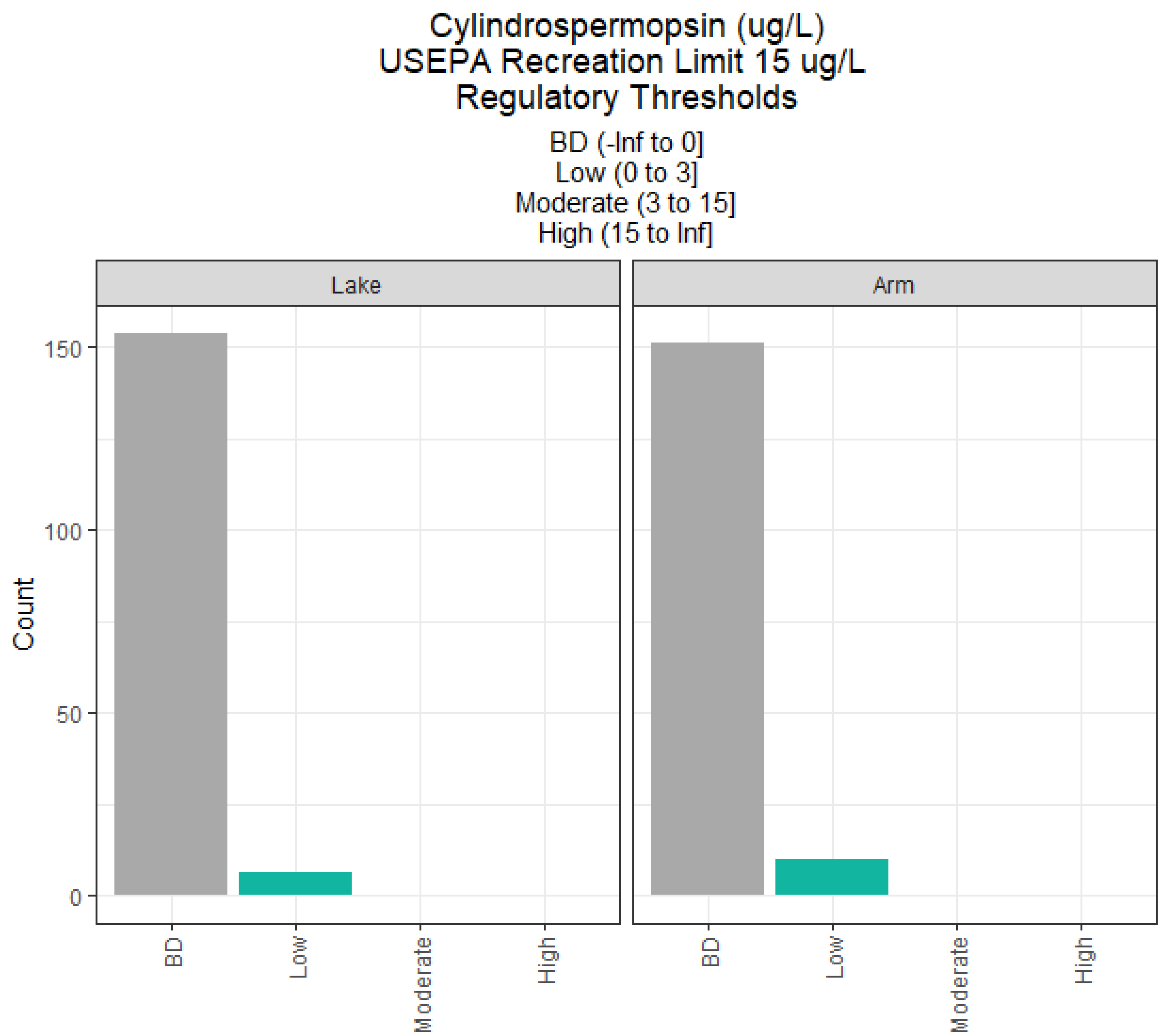
- 15 µg/L: USEPA recreational limit

BIN	N	MIN	MAX	LABELS
BD	305	0.0	0.1	BD (-Inf to 0]
Low	16	0.1	0.6	Low (0 to 3]
Moderate	NA	NA	NA	Moderate (3 to 15]
High	NA	NA	NA	High (15 to Inf]


Cylindrospermopsin (ug/L)
USEPA Recreation Limit 15 ug/L
Regulatory Thresholds
BD (-Inf to 0]
Low (0 to 3]
Moderate (3 to 15]
High (15 to Inf]
2007
2008
2009
2010
2011
2012
2016
2017
2018
2019
2020
2021
Count
0
20
40
60
BD
Low
Moderate
High


Cylindrospermopsin (ug/L)
USEPA Recreation Limit 15 ug/L
Regulatory Thresholds
BD (-Inf to 0]
Low (0 to 3]
Moderate (3 to 15]
High (15 to Inf]
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Count
0
10
20
30
BD
Low
Moderate
High


Cylindrospermopsin (ug/L)
USEPA Recreation Limit 15 ug/L
Regulatory Thresholds
BD (-Inf to 0]
Low (0 to 3]
Moderate (3 to 15]
High (15 to Inf]
Upper
Middle
Lower
Count
0
50
100
150
200
BD
Low
Moderate
High



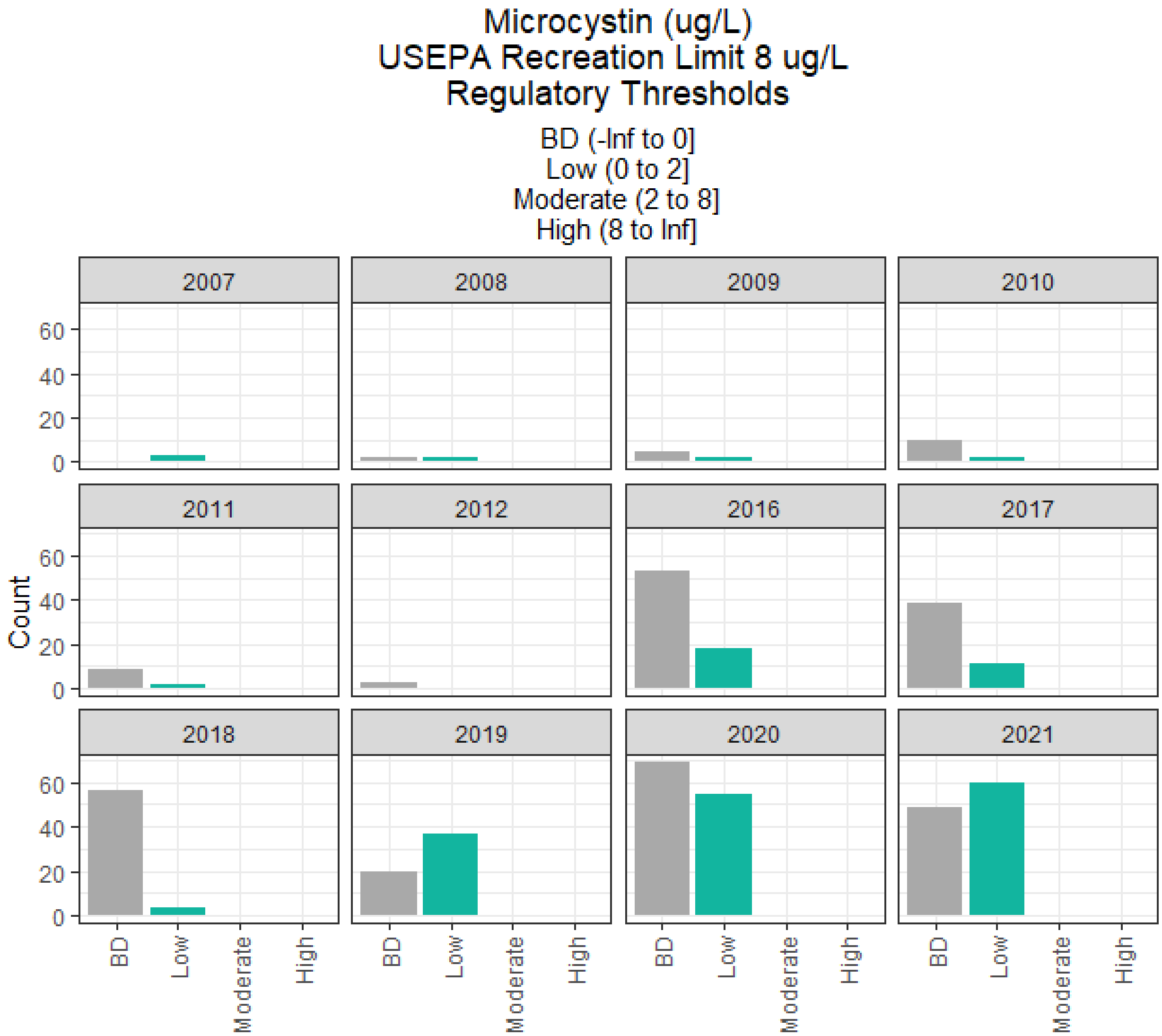
5.2.1.5 Microcystin

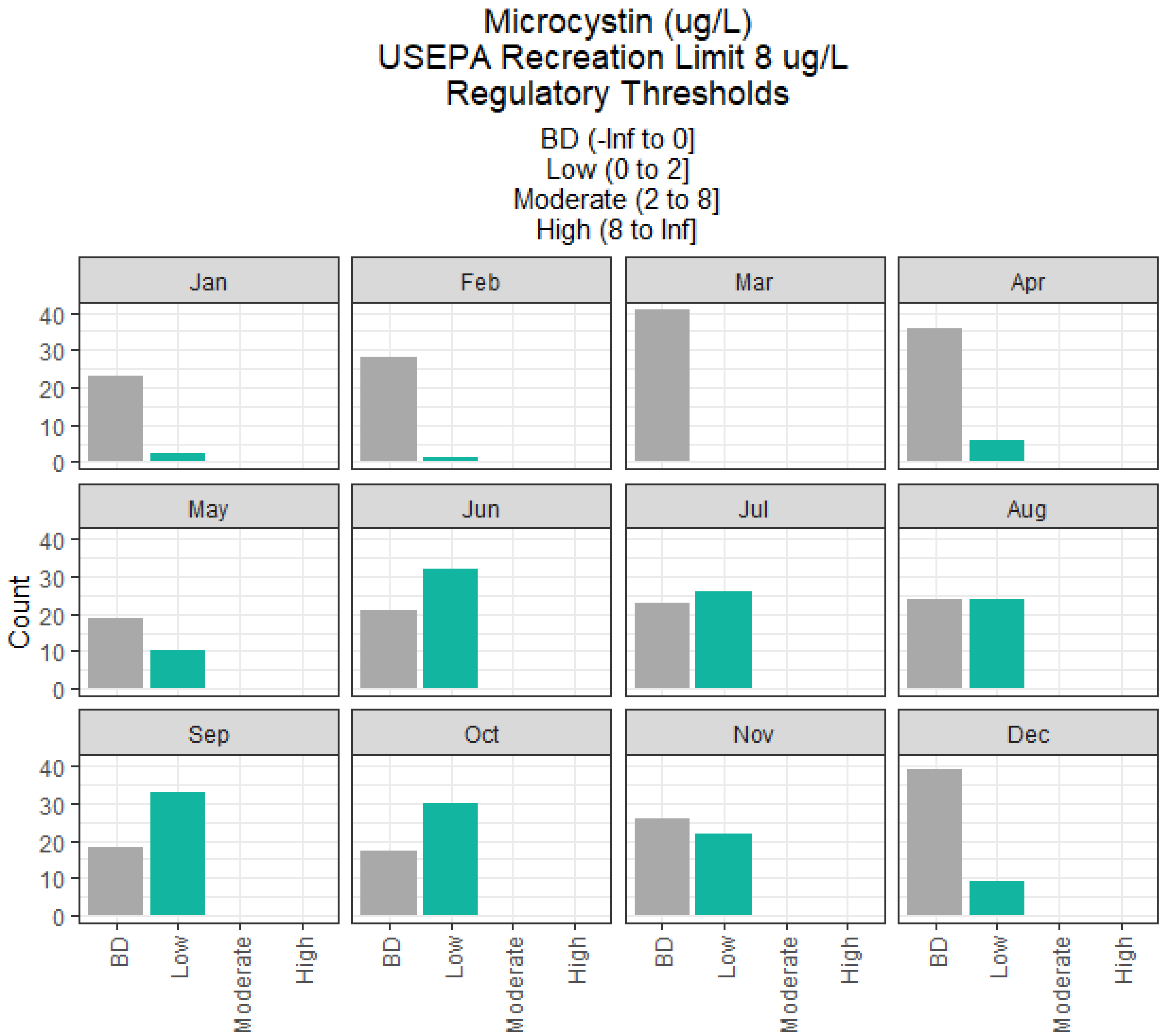
Microcystin data are reported at the level of Site-Date. The observed data values range from 0.01575 to 0.714.

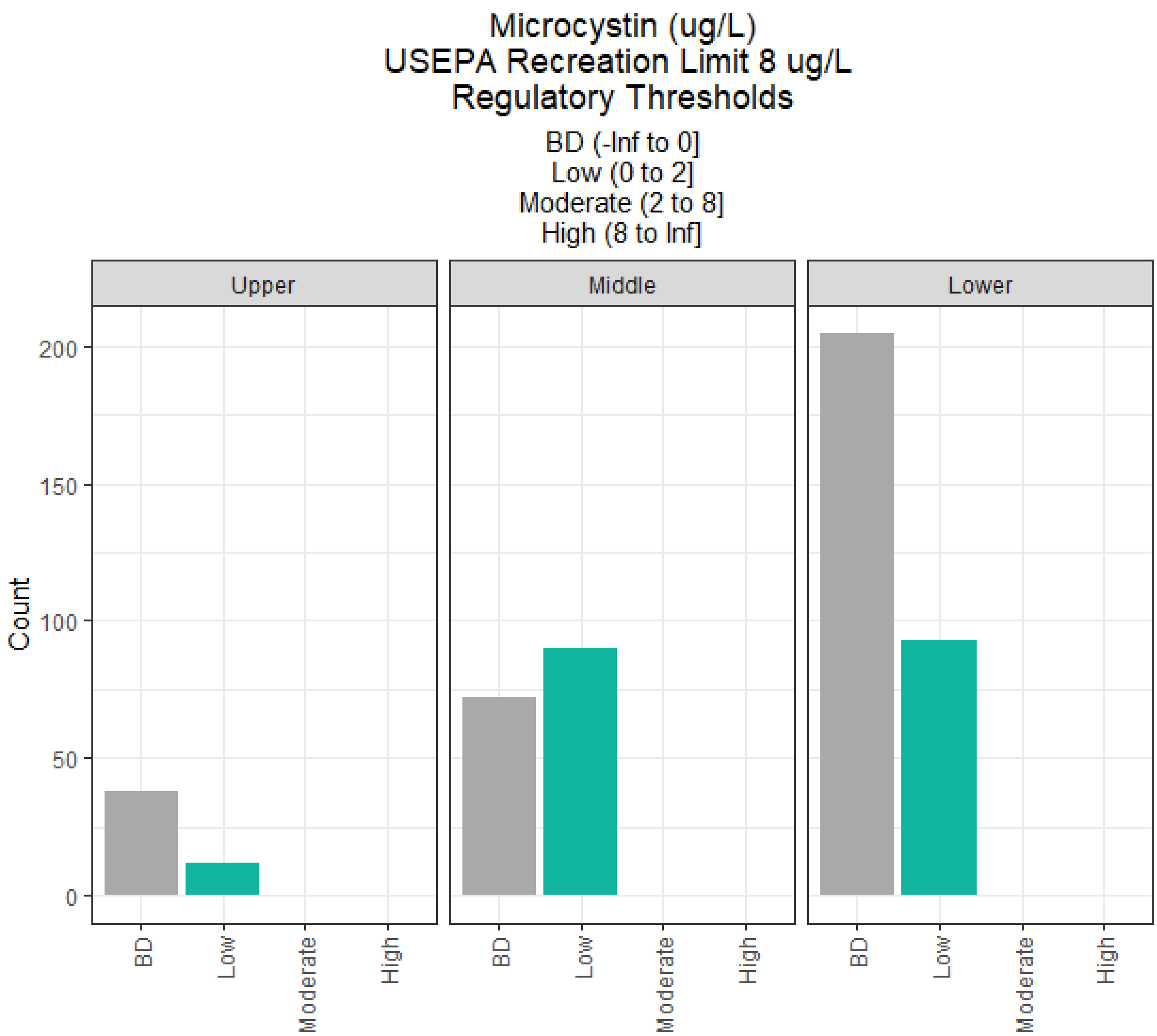
USEPA provides recommended limits for microcystin:
- 1.6 µg/L: USEPA drinking water limit

- 8 µg/L: USEPA recreational limit

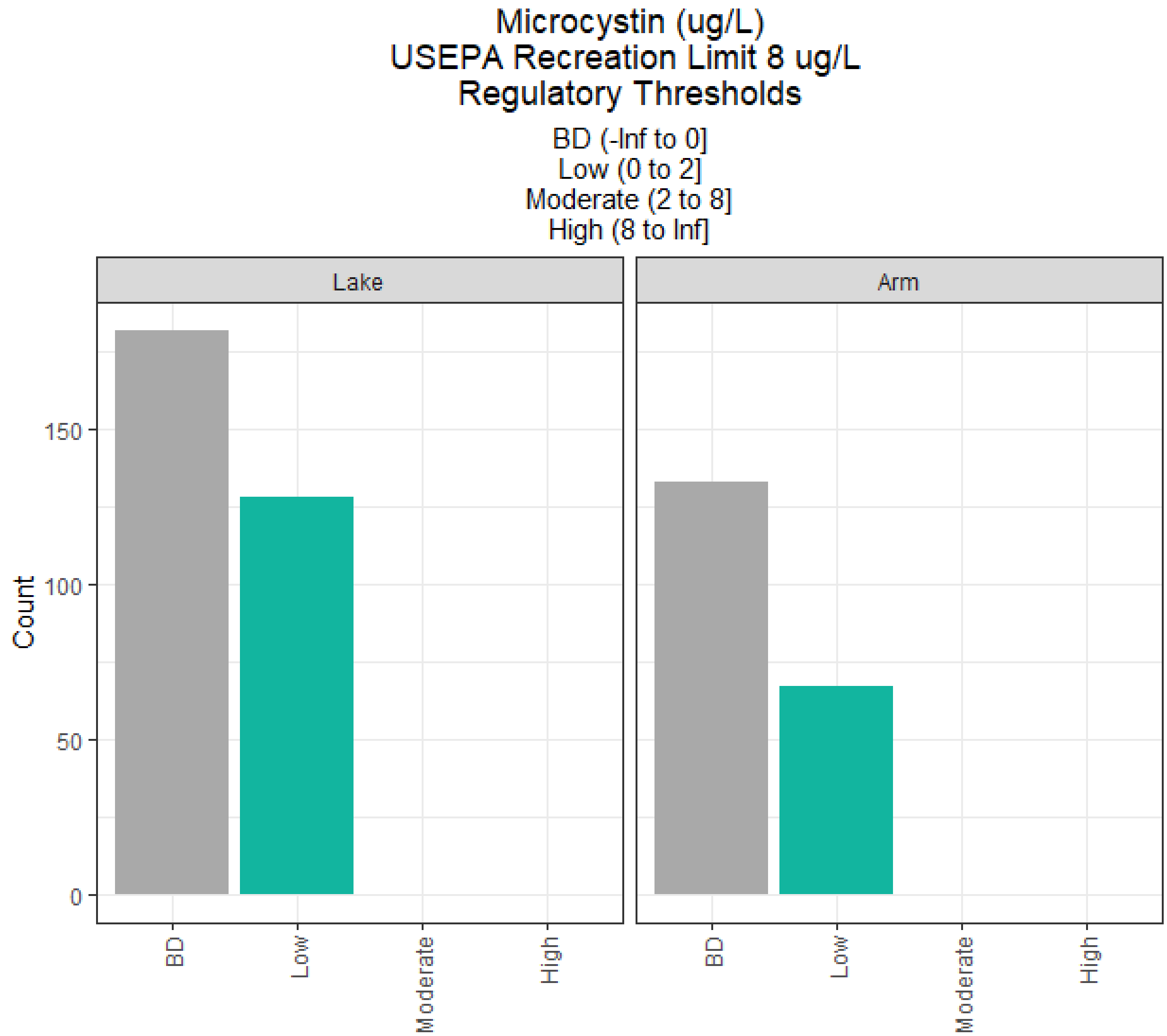
BIN	N	MIN	MAX	LABELS
BD	315	0.0	0.1	BD (-Inf to 0]
Low	195	0.1	0.7	Low (0 to 2]
Moderate	NA	NA	NA	Moderate (2 to 8]
High	NA	NA	NA	High (8 to Inf]


Microcystin (ug/L)
USEPA Recreation Limit 8 ug/L
Regulatory Thresholds
BD (-Inf to 0]
Low (0 to 2]
Moderate (2 to 8]
High (8 to Inf]
2007
2008
2009
2010
2011
2012
2016
2017
2018
2019
2020
2021
Count
0
20
40
60
BD
Low
Moderate
High


Microcystin (ug/L)
USEPA Recreation Limit 8 ug/L
Regulatory Thresholds
BD (-Inf to 0]
Low (0 to 2]
Moderate (2 to 8]
High (8 to Inf]
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Count
0
10
20
30
40
BD
Low
Moderate
High



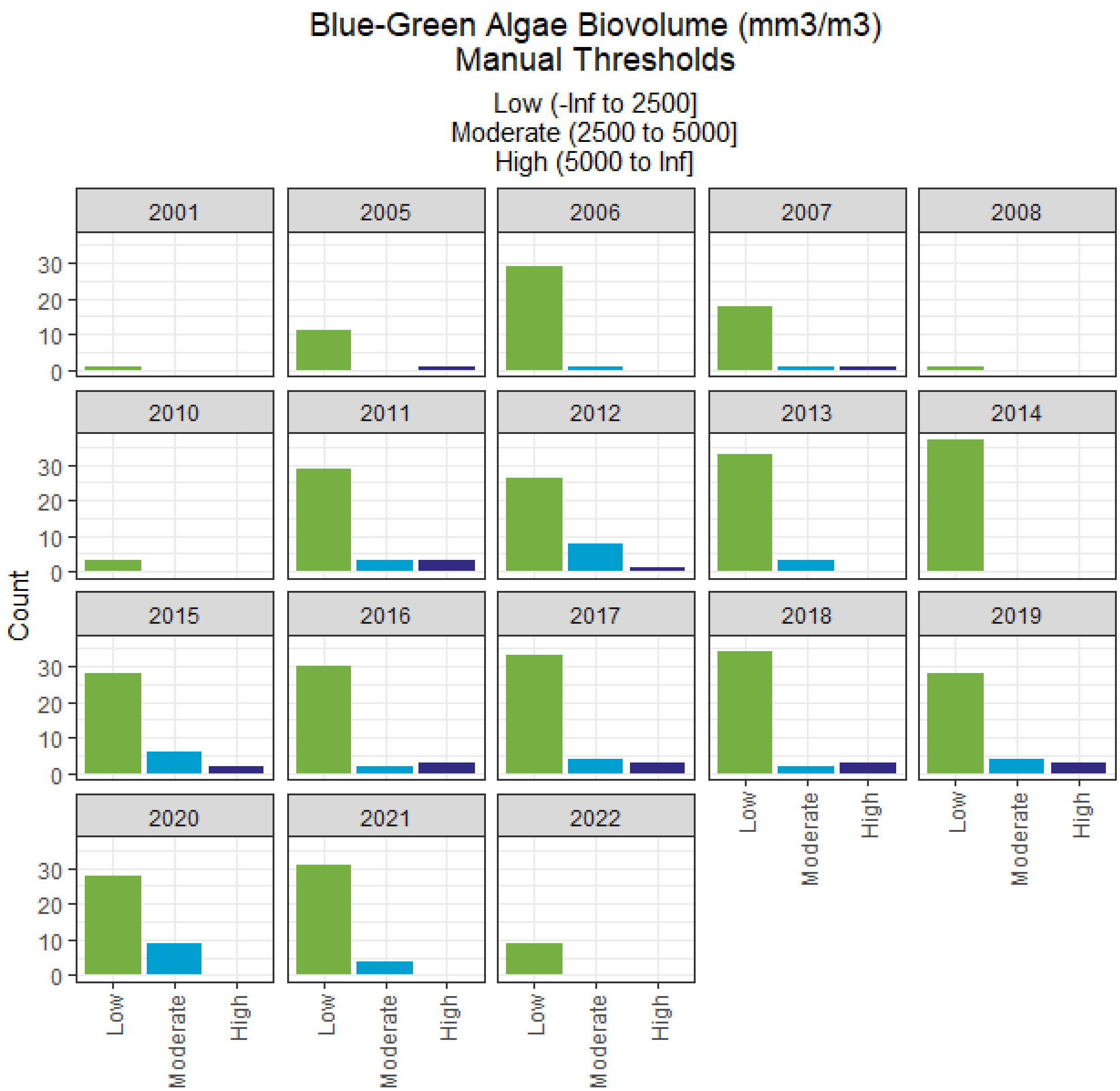
Microcystin (ug/L)
USEPA Recreation Limit 8 ug/L
Regulatory Thresholds
BD (-Inf to 0]
Low (0 to 2]
Moderate (2 to 8]
High (8 to Inf]
Upper
Middle
Lower
Count
200
150
100
50
0
BD
Low
Moderate
High

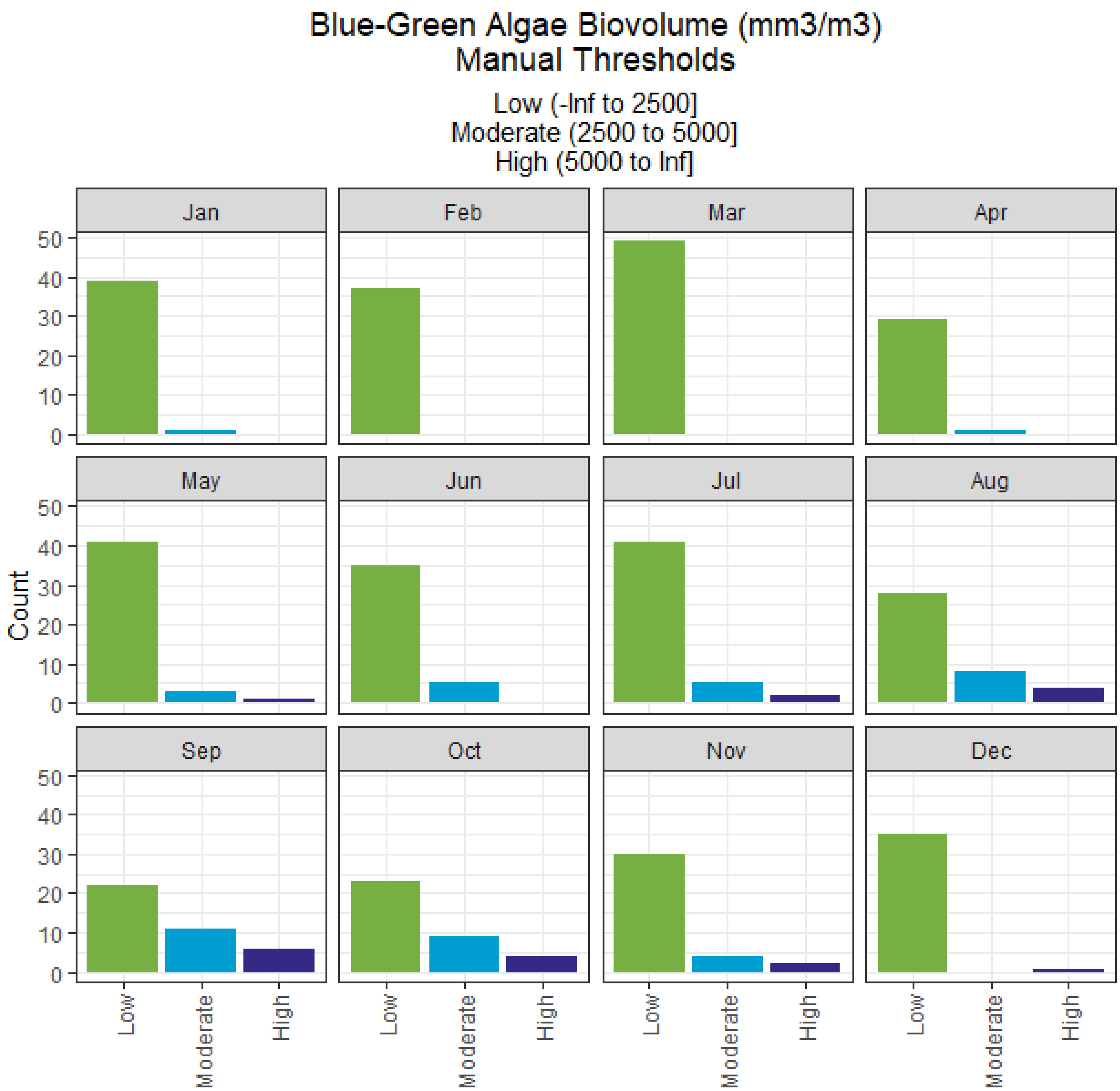


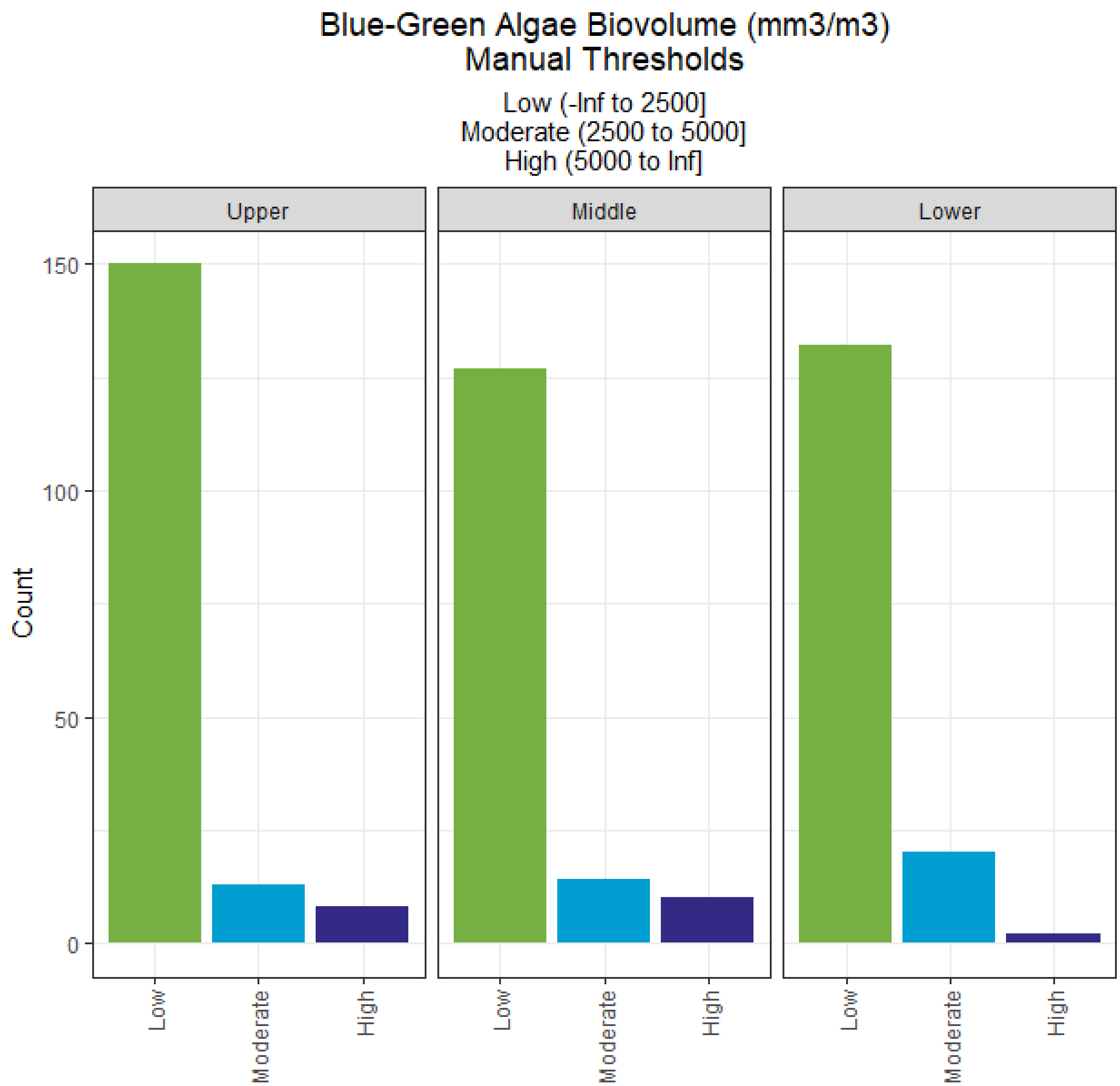
5.2.1.6 Blue-Green (Cyanobacteria) Biovolume

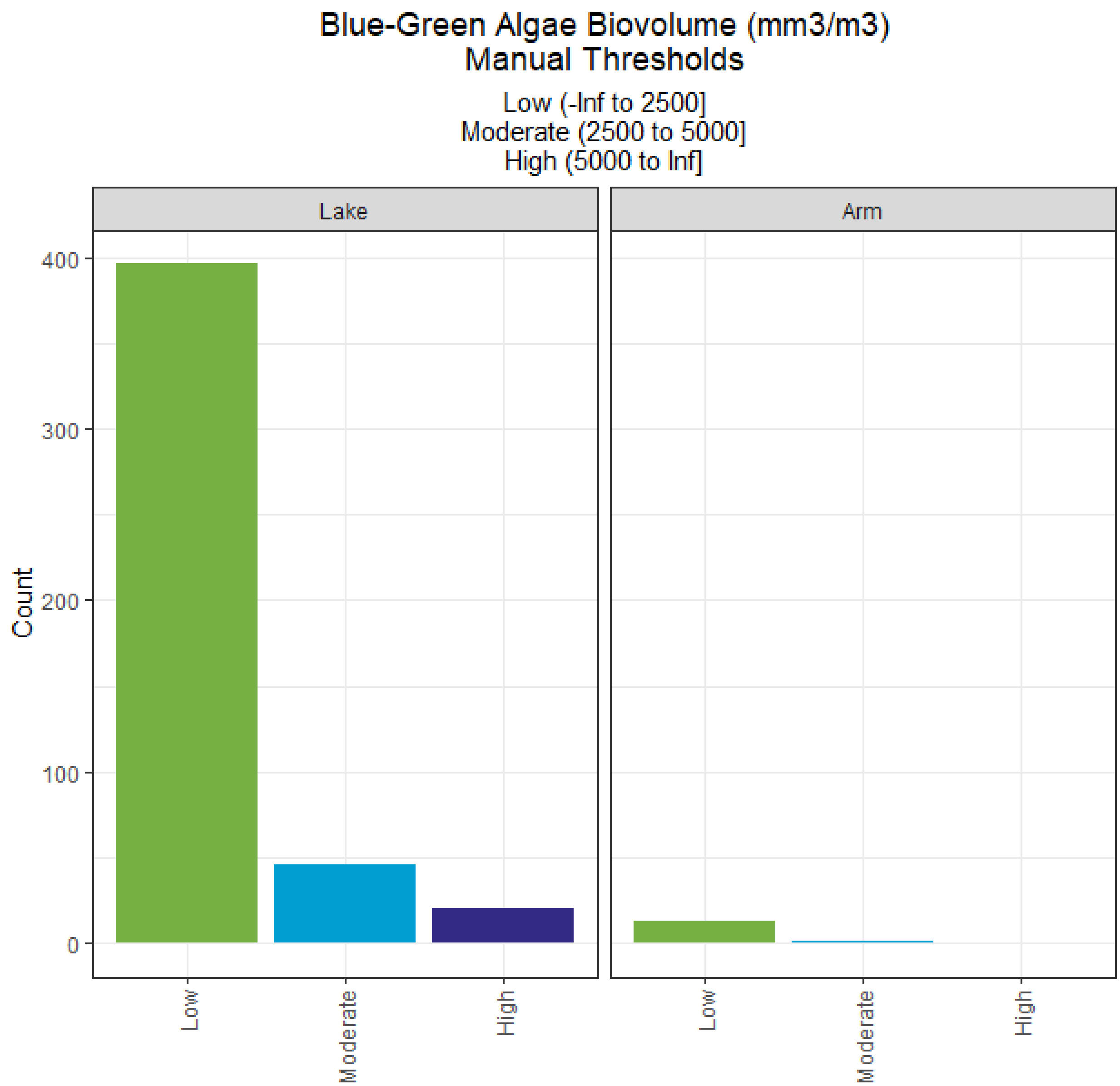
The observed biovolume for blue-green algae range from 0 to 1.8089^{4}.

BIN	N	MIN	MAX	LABELS
Low	409	0	2465	Low (-Inf to 2500]
Moderate	47	2531	4516	Moderate (2500 to 5000]
High	20	5034	18089	High (5000 to Inf]


Blue-Green Algae Biovolume (mm3/m3)
Manual Thresholds
Low (-Inf to 2500]
Moderate (2500 to 5000]
High (5000 to Inf]
2001
2005
2006
2007
2008
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Count
0
10
20
30
Low
Moderate
High

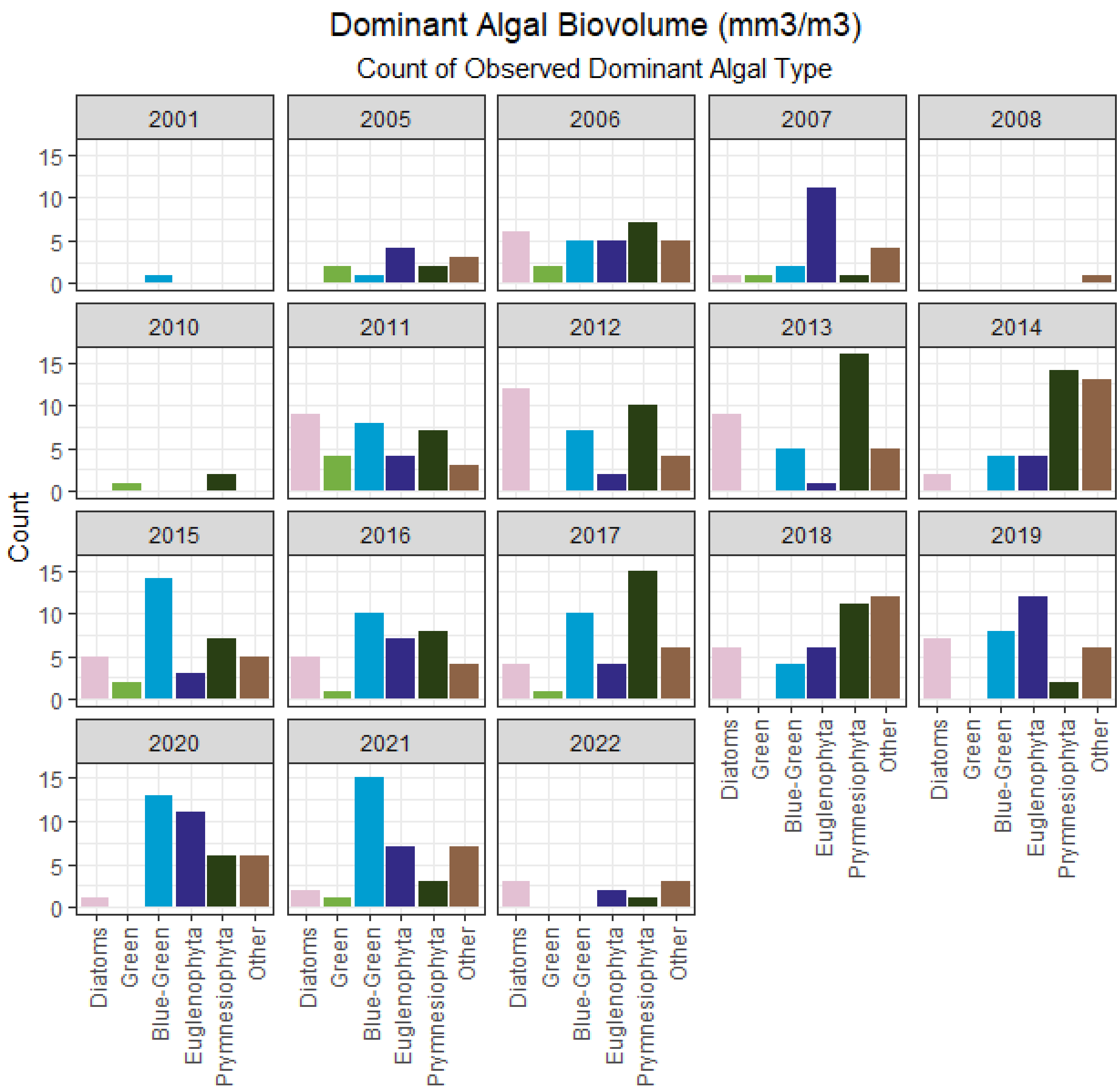

Blue-Green Algae Biovolume (mm3/m3)
Manual Thresholds
Low (-Inf to 2500]
Moderate (2500 to 5000]
High (5000 to Inf]
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Count
0
10
20
30
40
50
Low
Moderate
High

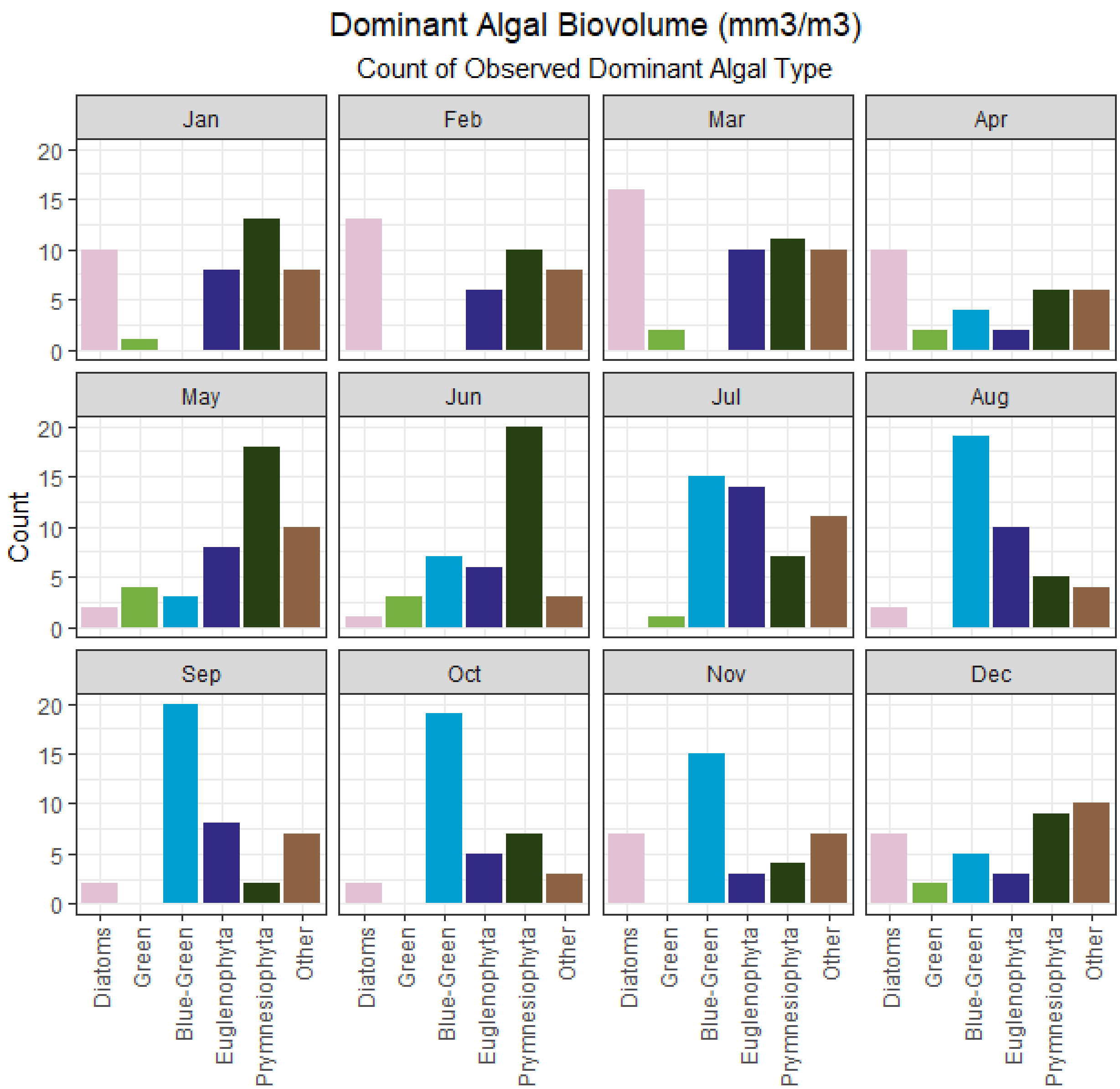

Blue-Green Algae Biovolume (mm3/m3)
Manual Thresholds
Low (-Inf to 2500]
Moderate (2500 to 5000]
High (5000 to Inf]
Upper
Middle
Lower
Count
150
100
50
0
Low
Moderate
High



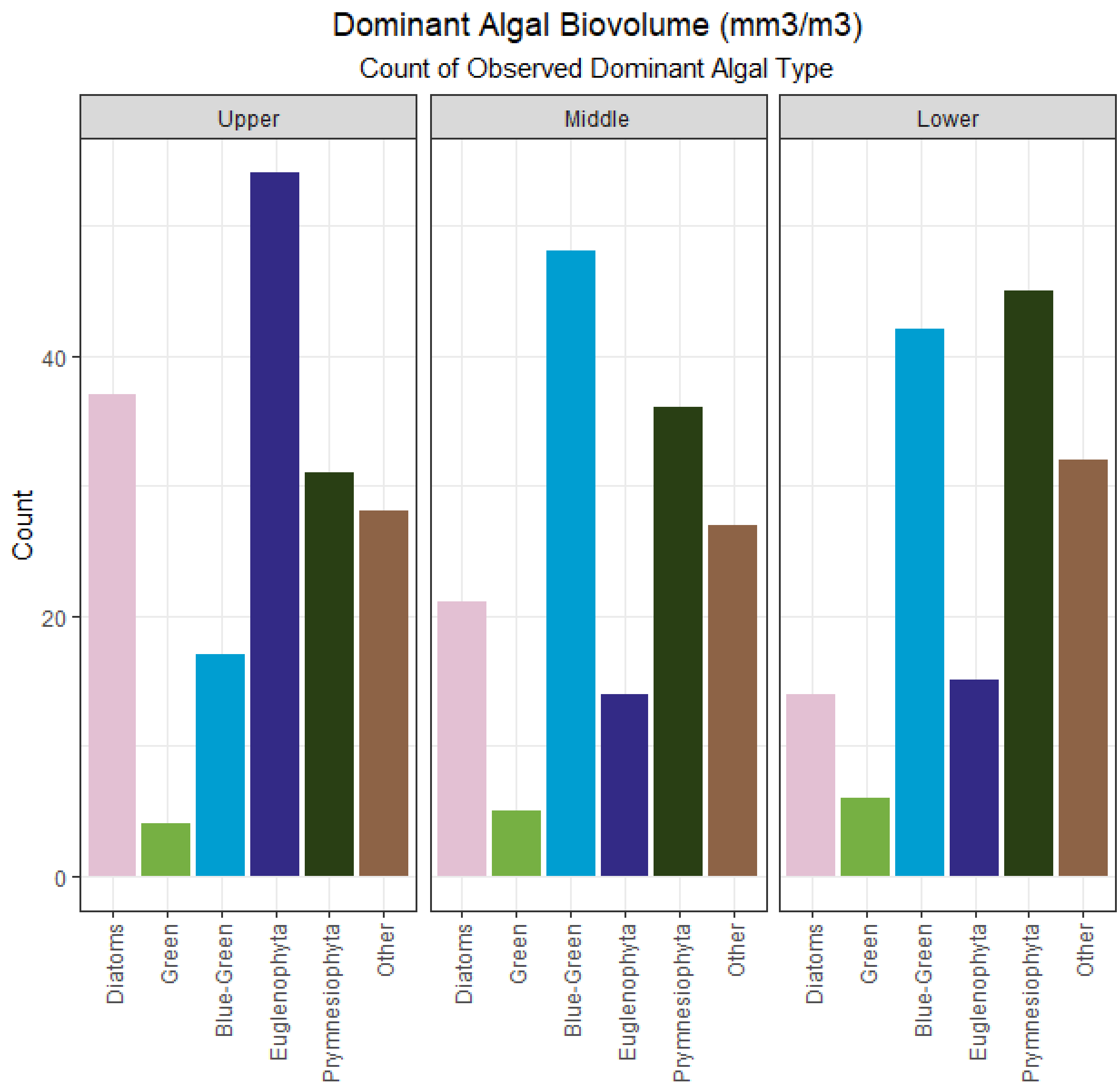
5.2.1.7 Dominant Algal Type

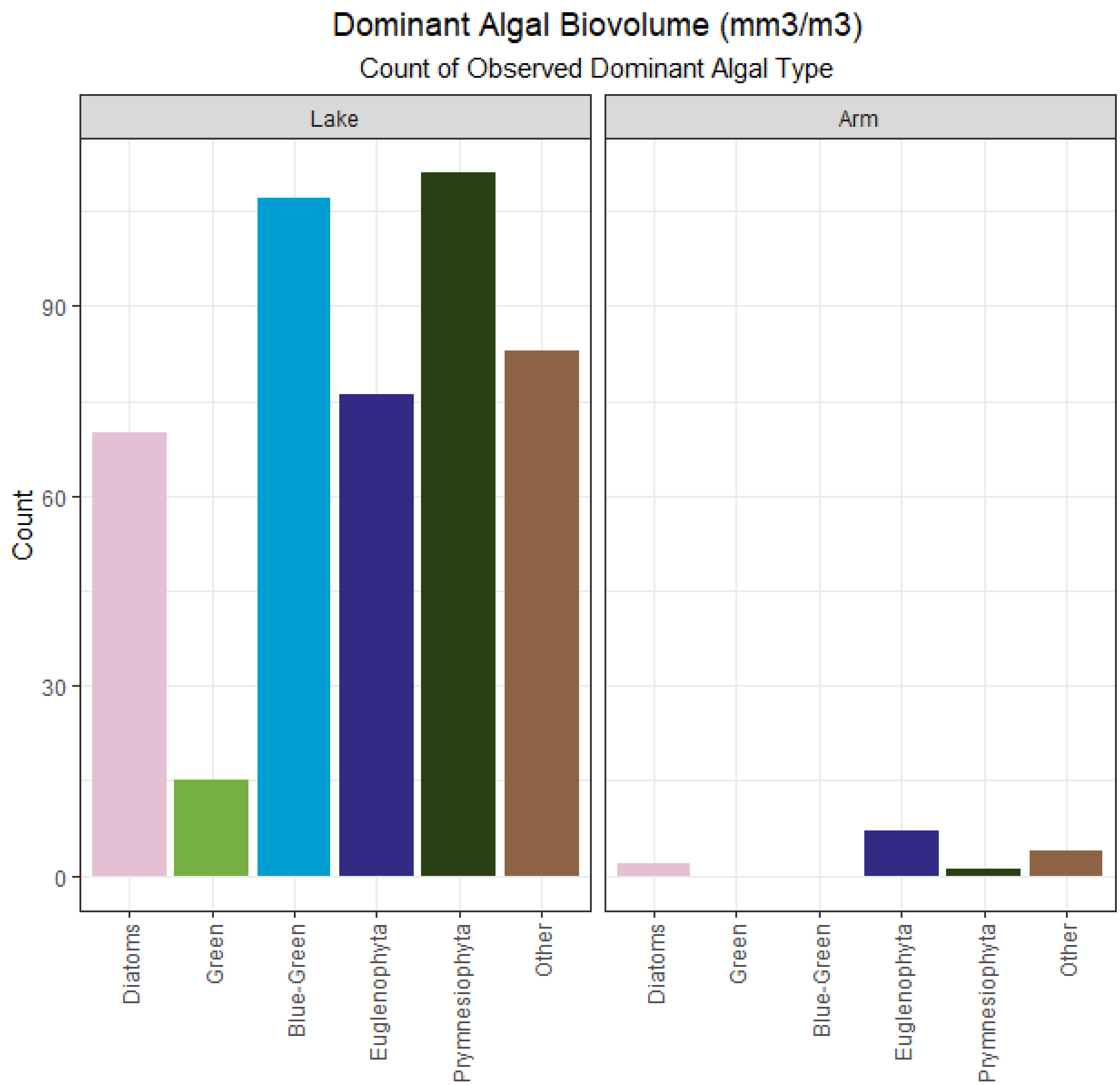
As this is a discrete variable rather than a binned continuous variable, it's preparation must be handled differently than previous nodes.


Dominant Algal Biovolume (mm3/m3)
Count of Observed Dominant Algal Type
2001
2005
2006
2007
2008
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Count
0
5
10
15
Diatoms
Green
Blue-Green
Euglenophyta
Prymnesiophyta
Other



Dominant Algal Biovolume (mm3/m3)
Count of Observed Dominant Algal Type
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Count
0
5
10
15
20
Diatoms
Green
Blue-Green
Euglenophyta
Prymnesiophyta
Other


Dominant Algal Biovolume (mm3/m3)
Count of Observed Dominant Algal Type
Upper
Middle
Lower
Count
0
20
40
Diatoms
Green
Blue-Green
Euglenophyta
Prymnesiophyta
Other



5.2.2 Lakewide Level Data

There are no lake wide algal variables to report.

5.3 Other – By Lake Unit and Lake Wide

5.3.1 Lake Unit Level Data

5.3.1.1 DO Concentration

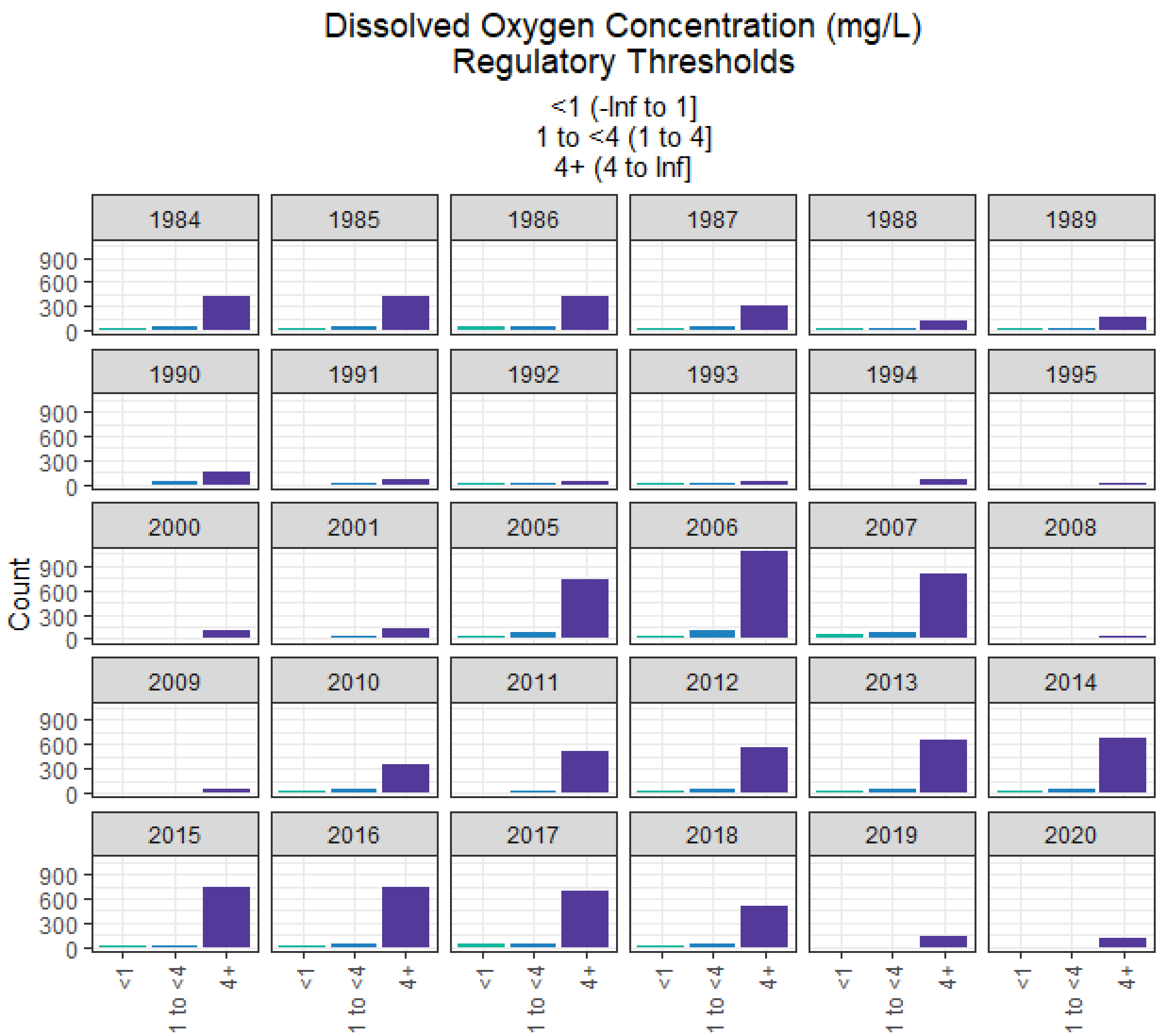
Dissolved oxygen concentration data are reported at the level of Site-Date. The observed data values range from 0 to 17.15.

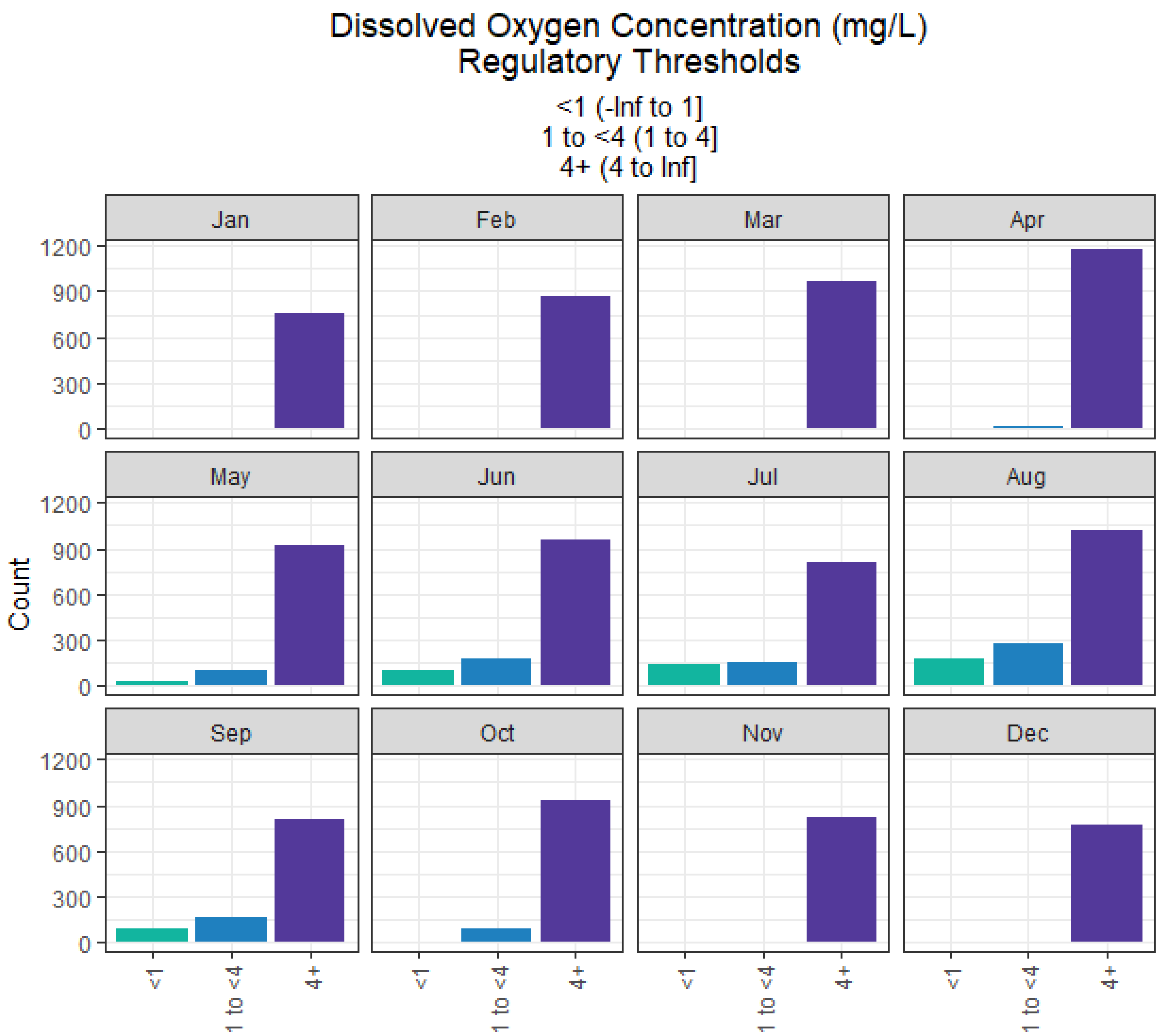
Dissolved oxygen concentration has a regulatory limit of 4 mg/L. The lake does stratify in summer, with lower DO waters at depth. Our model only considers DO as measured in the photic zone.

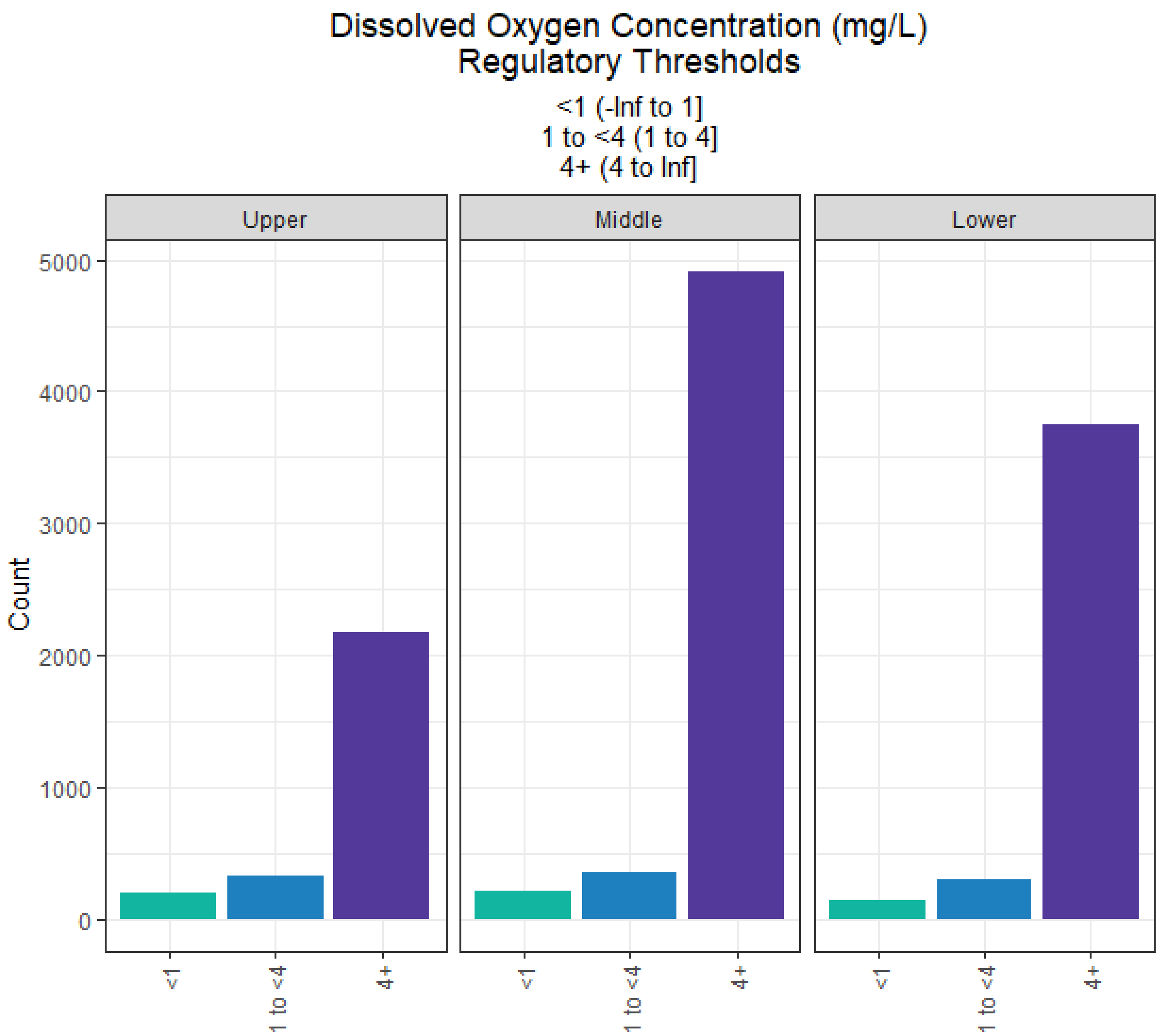
- Exceed: < 4 ug/L
- Not Exceed: >= 4 ug/L

We originally looked at these two levels, but per email from A Matos 2024-03-12, the breakpoints were changed to 0, 1, and 4 to have 3 bins.

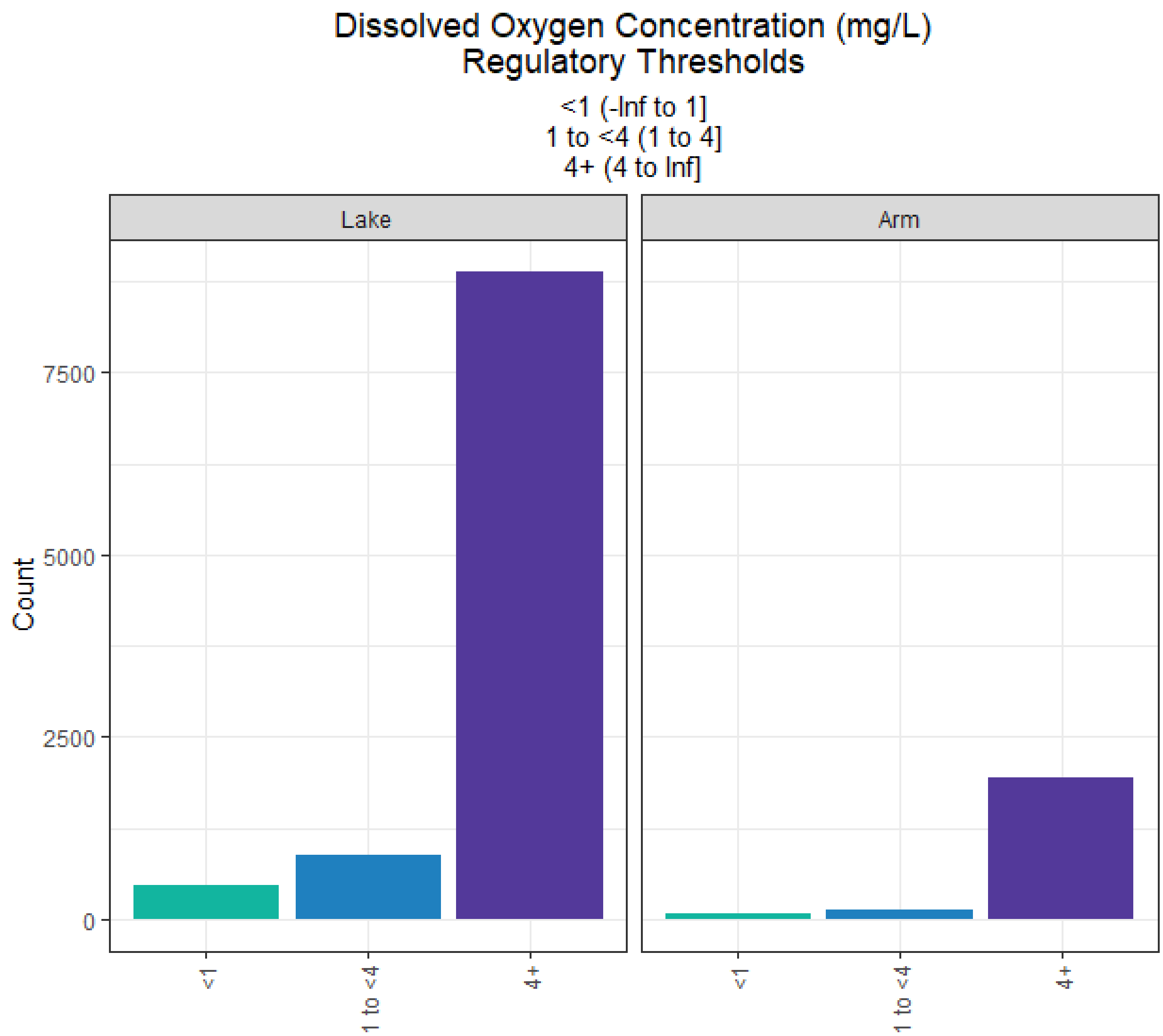
BIN	N	MIN	MAX	LABELS
<1	544	0	0.9	<1 (-Inf to 1]
1 to <4	982	1	4.0	1 to <4 (1 to 4]
4+	10827	4	17.1	4+ (4 to Inf]


Dissolved Oxygen Concentration (mg/L)
Regulatory Thresholds
<1 (-Inf to 1]
1 to <4 (1 to 4]
4+ (4 to Inf]
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
2000
2001
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Count
900
600
300
0
<1
1 to <4
4+


Dissolved Oxygen Concentration (mg/L)
Regulatory Thresholds
<1 (-Inf to 1]
1 to <4 (1 to 4]
4+ (4 to Inf]
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Count
0
300
600
900
1200
<1
1 to <4
4+



Dissolved Oxygen Concentration (mg/L)
Regulatory Thresholds
<1 (-Inf to 1]
1 to <4 (1 to 4]
4+ (4 to Inf]
Upper
Middle
Lower
Count
5000
4000
3000
2000
1000
0
<1
1 to <4
4+

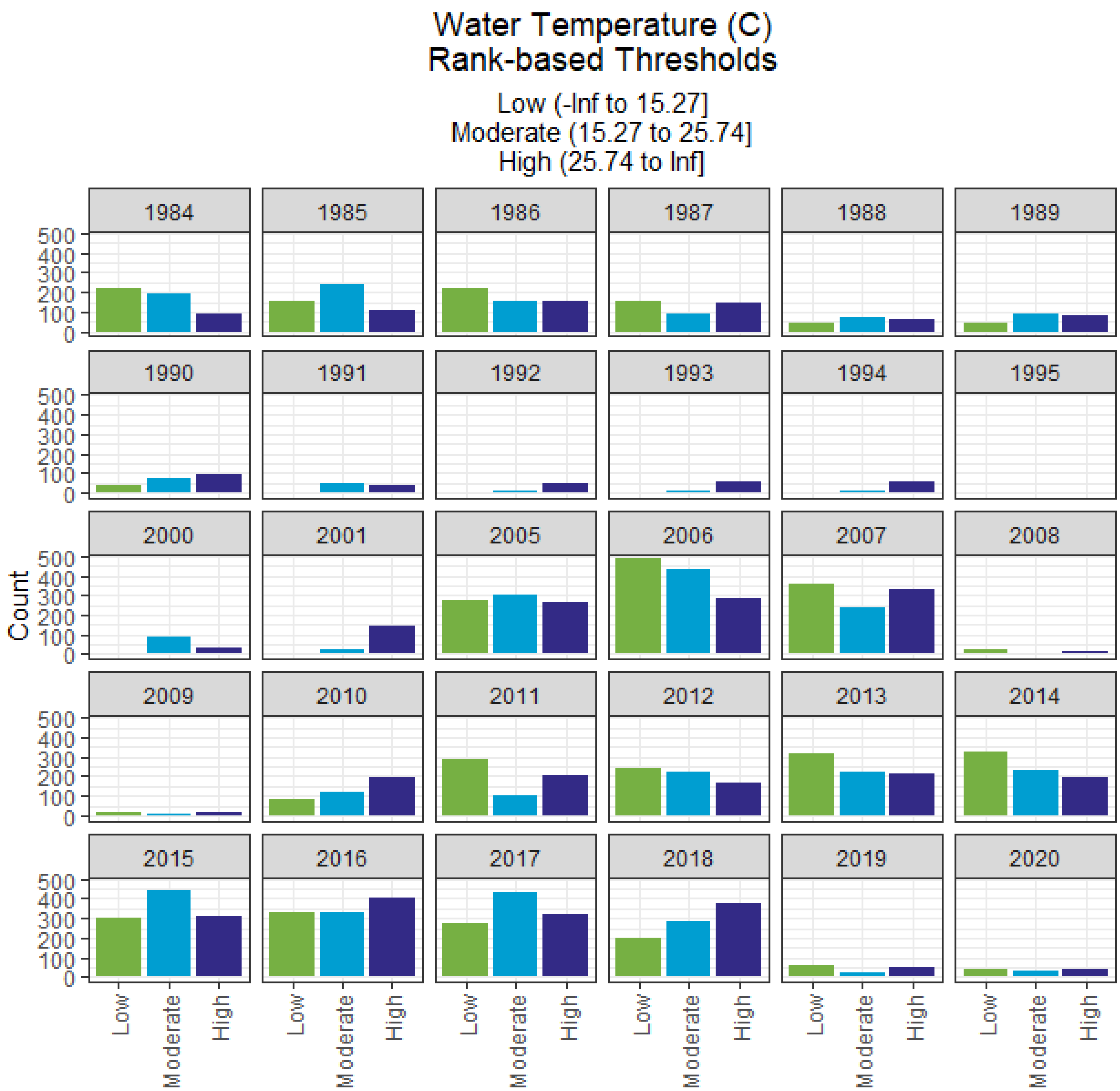


5.3.1.2 Water Temperature

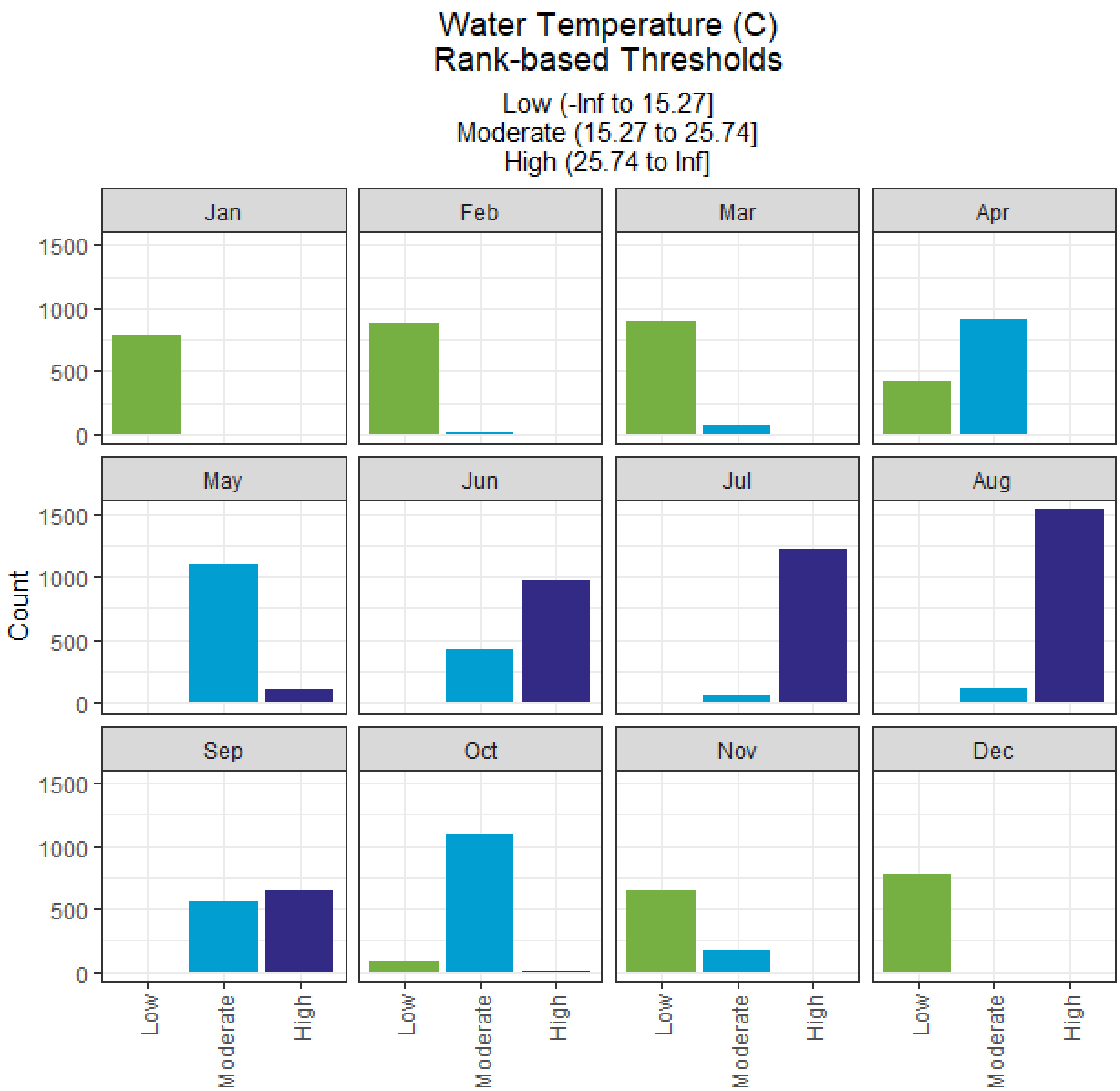
Water temperature data are reported at the level of Site-Date. We received multiple data resources that included some empirical surface water temperature data. The data are assembled in the **dataMerge_wtemp** file (rmd/docx).

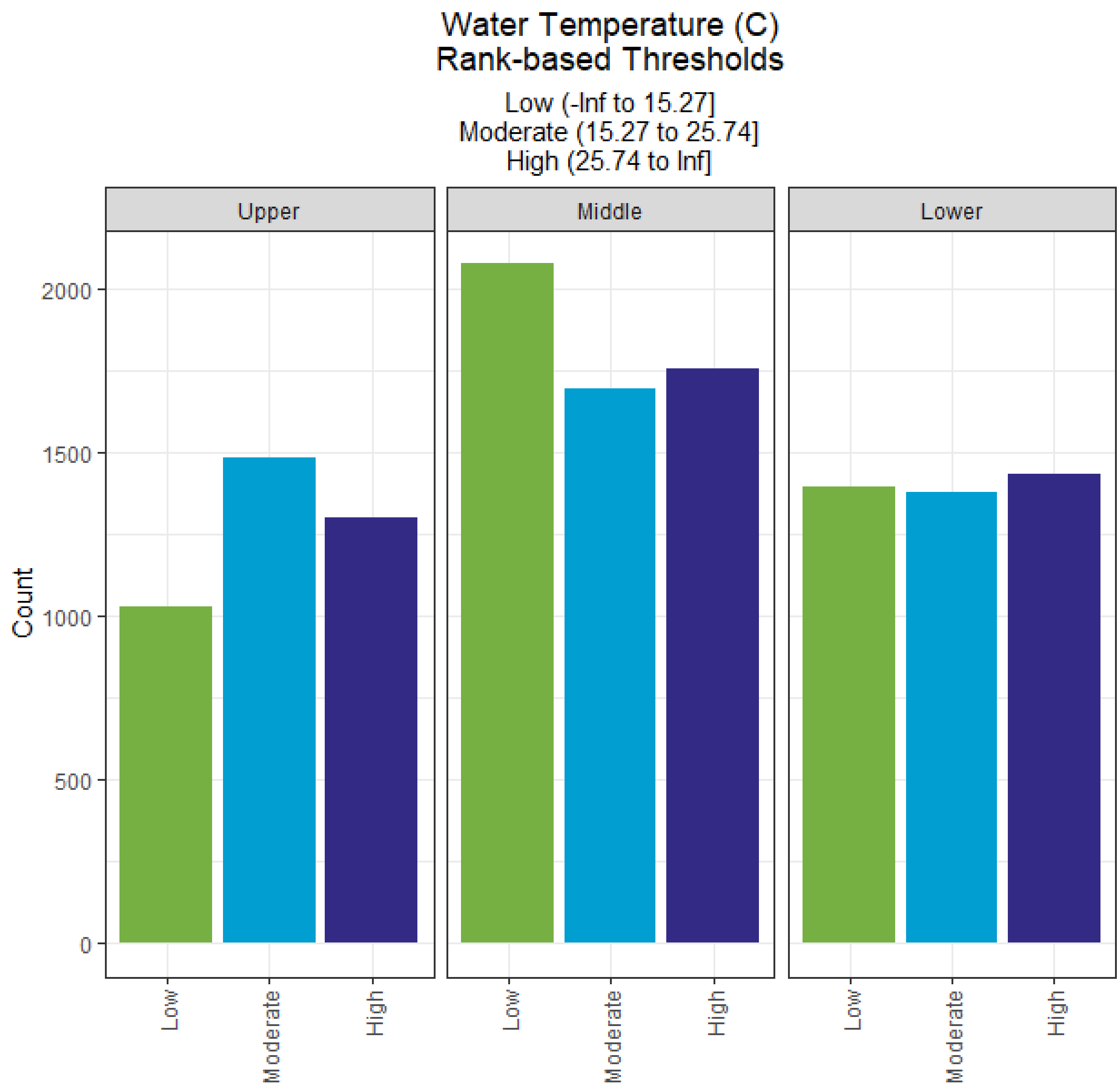
Temperature values are classified into three bins (Low, Moderate, High) using the “rank bin” method. There are no identified regulatory or critical values identified for this variable. The observed data values range from 1.6 to 33.4.

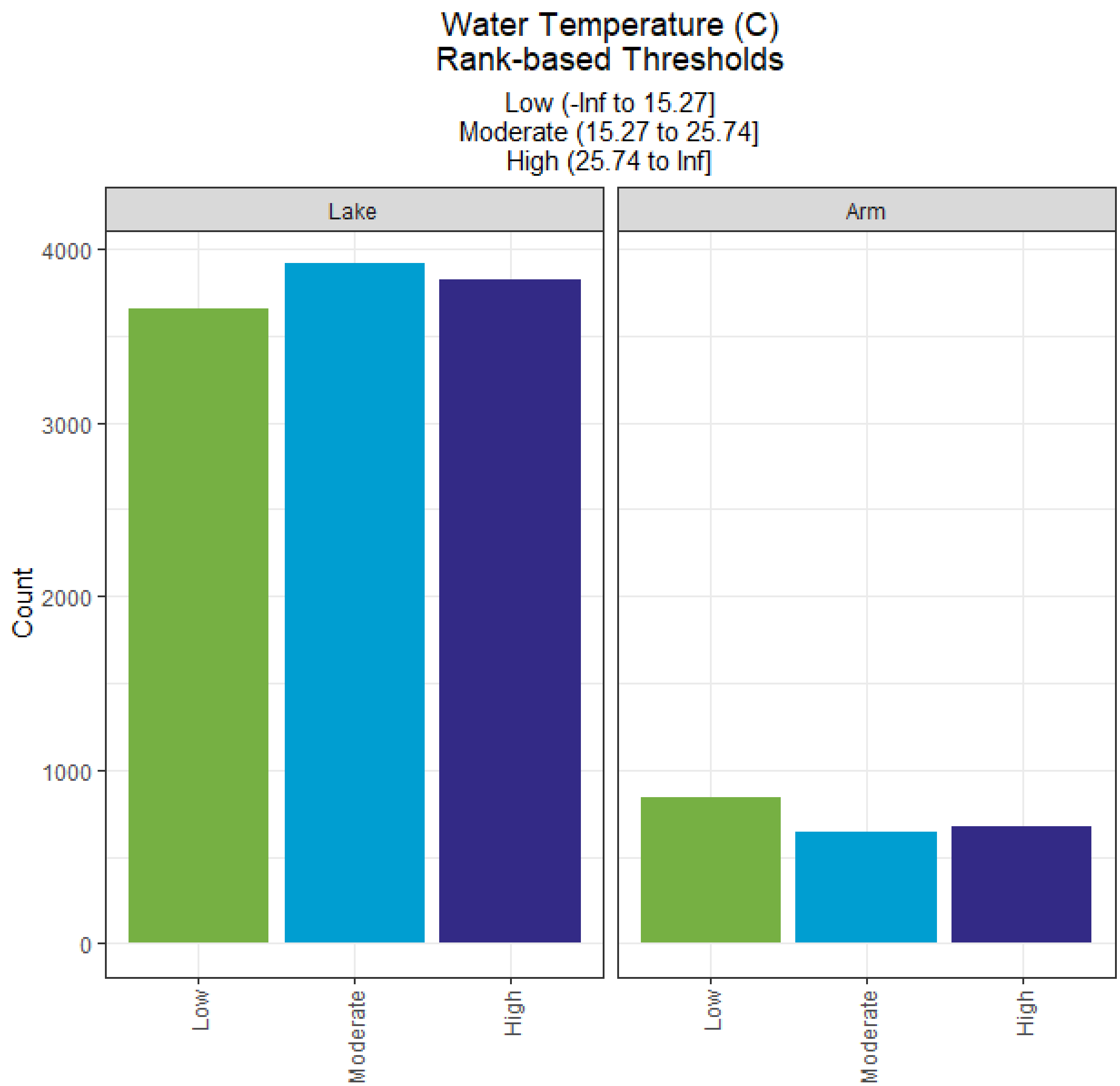
BIN	N	MIN	MAX	LABELS
Low	4499	1.6	15.2	Low (-Inf to 15.27]
Moderate	4555	15.3	25.7	Moderate (15.27 to 25.74]
High	4491	25.8	33.4	High (25.74 to Inf]



Water Temperature (C)
Rank-based Thresholds
Low (-Inf to 15.27]
Moderate (15.27 to 25.74]
High (25.74 to Inf]
Count
0
100
200
300
400
500
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
2000
2001
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Low
Moderate
High


Water Temperature (C)
Rank-based Thresholds
Low (-Inf to 15.27]
Moderate (15.27 to 25.74]
High (25.74 to Inf]
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Count
0
500
1000
1500
Low
Moderate
High


Water Temperature (C)
Rank-based Thresholds
Low (-Inf to 15.27]
Moderate (15.27 to 25.74]
High (25.74 to Inf]
Upper
Middle
Lower
Count
2000
1500
1000
500
0
Low
Moderate
High

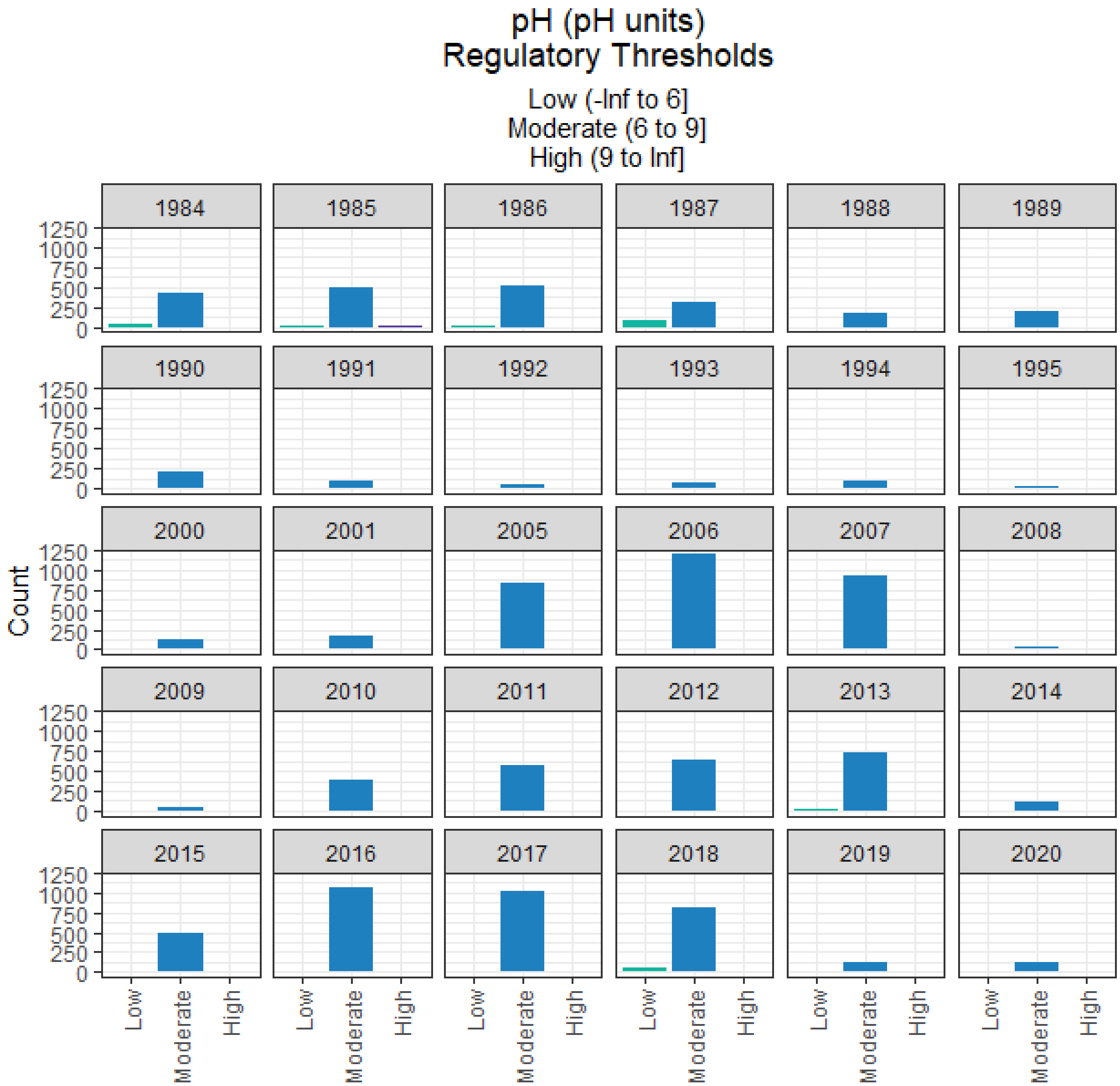


5.3.1.3 pH

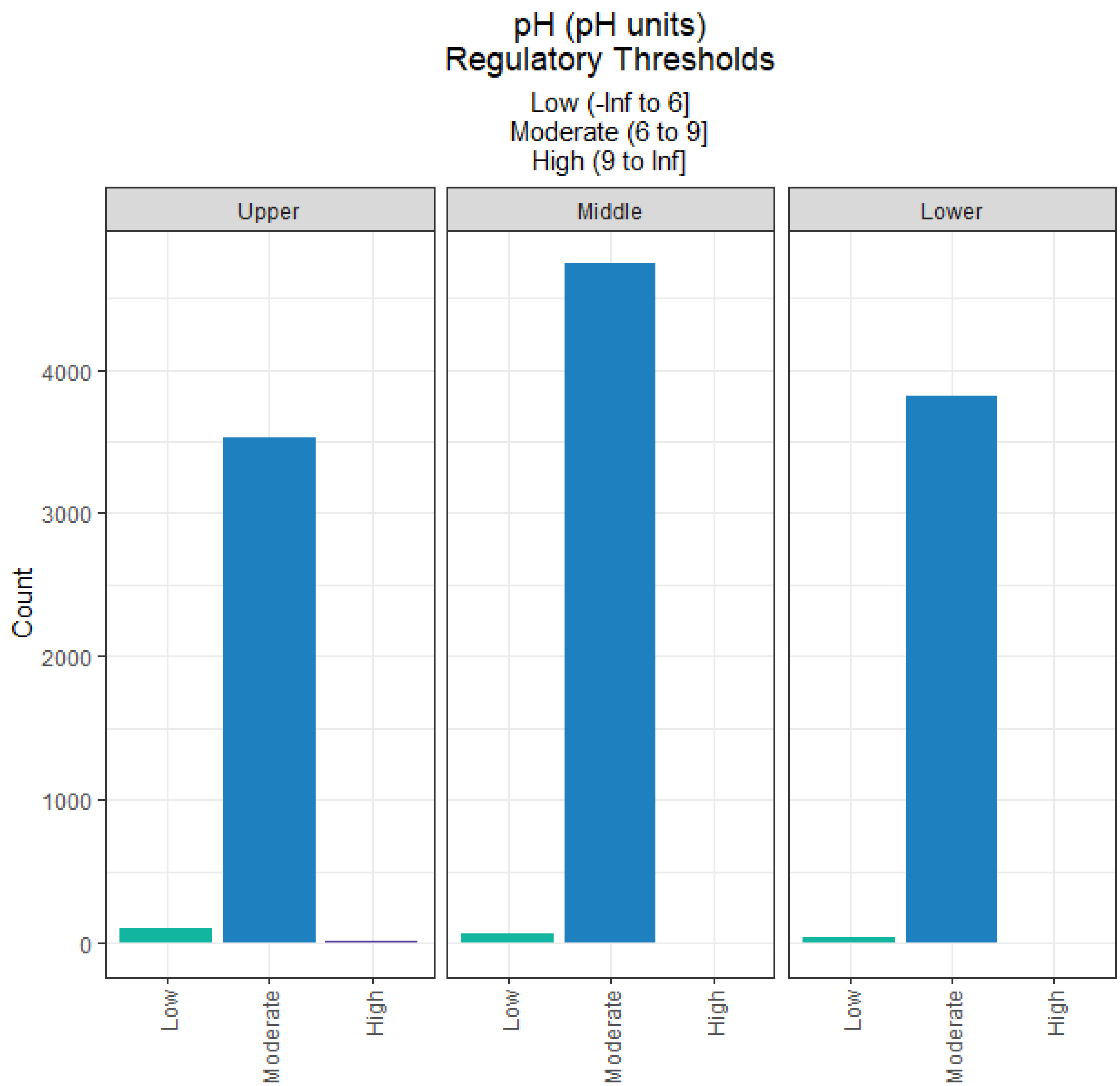
pH data are reported at the level of Site-Date. We received multiple data resources that included some empirical photic zone pH data. The data are assembled in the **dataMerge_ph** file (rmd/docx).

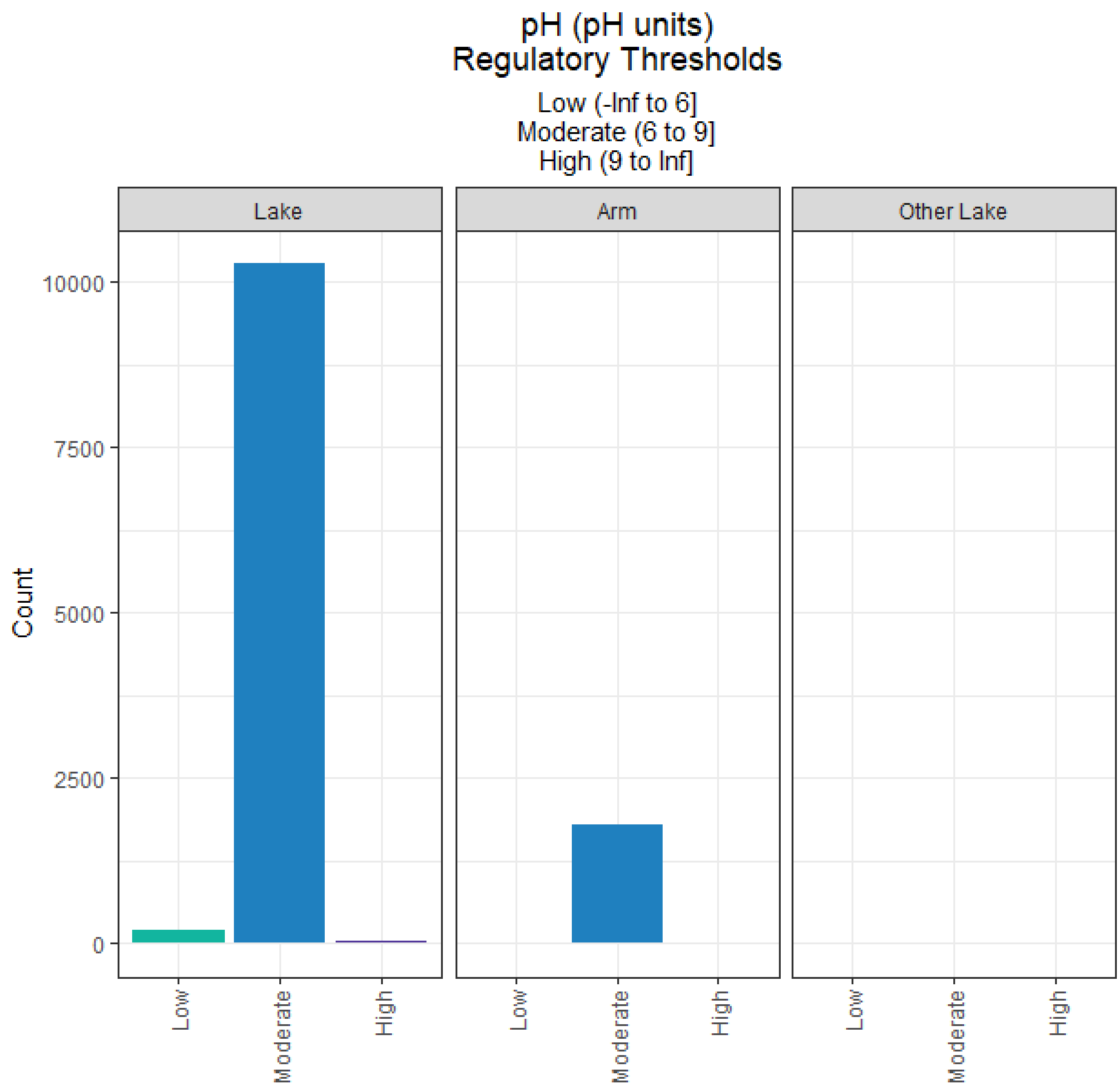
pH values are classified into three bins (Low, Moderate, High) based on regulatory values of 6-9 being the preferred range. The observed data values range from 5.1 to 10.

BIN	N	MIN	MAX	LABELS
Low	222	5.1	6	Low (-Inf to 6]
Moderate	12080	6.0	9	Moderate (6 to 9]
High	32	9.1	10	High (9 to Inf]


pH (pH units)
Regulatory Thresholds
Low (-Inf to 6]
Moderate (6 to 9]
High (9 to Inf]
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
2000
2001
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Count
1250
1000
750
500
250
0
Low
Moderate
High

pH (pH units)
Regulatory Thresholds
Low (-Inf to 6]
Moderate (6 to 9]
High (9 to Inf]
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Count
0
500
1000
1500
Low
Moderate
High

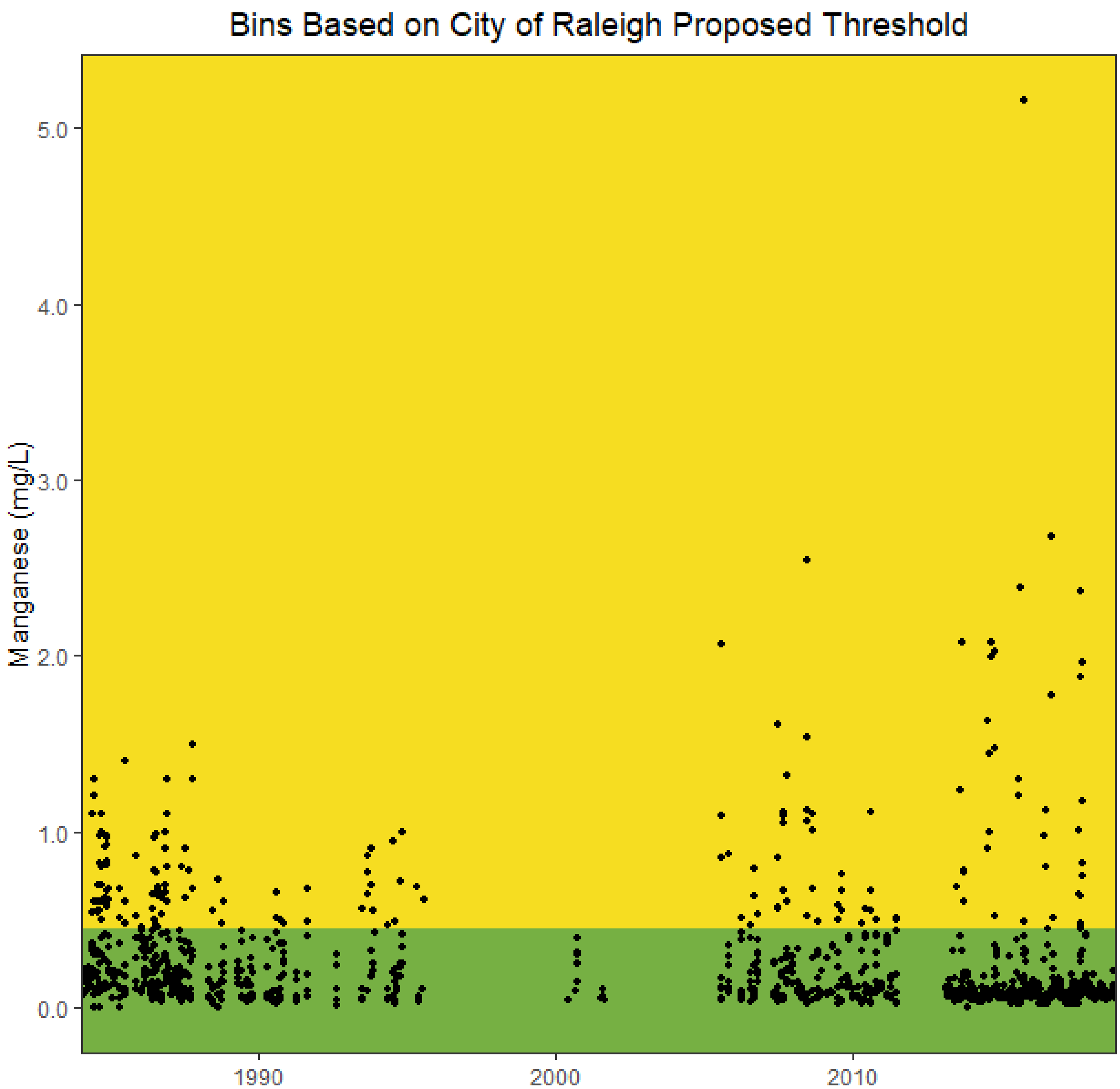

pH (pH units)
Regulatory Thresholds
Low (-Inf to 6]
Moderate (6 to 9]
High (9 to Inf]
Upper
Middle
Lower
Count
4000
3000
2000
1000
0
Low
Moderate
High



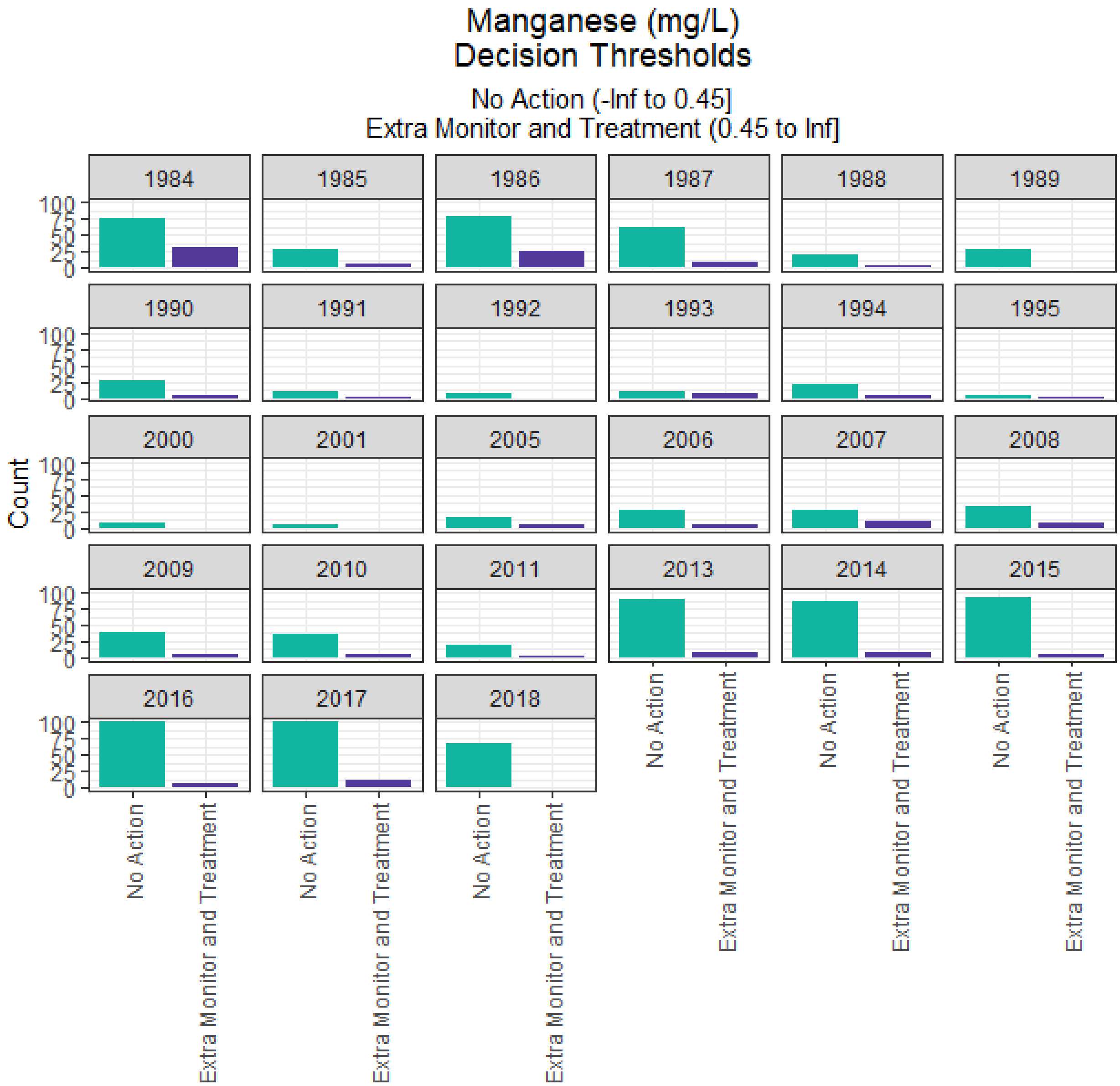
5.3.1.4 Manganese

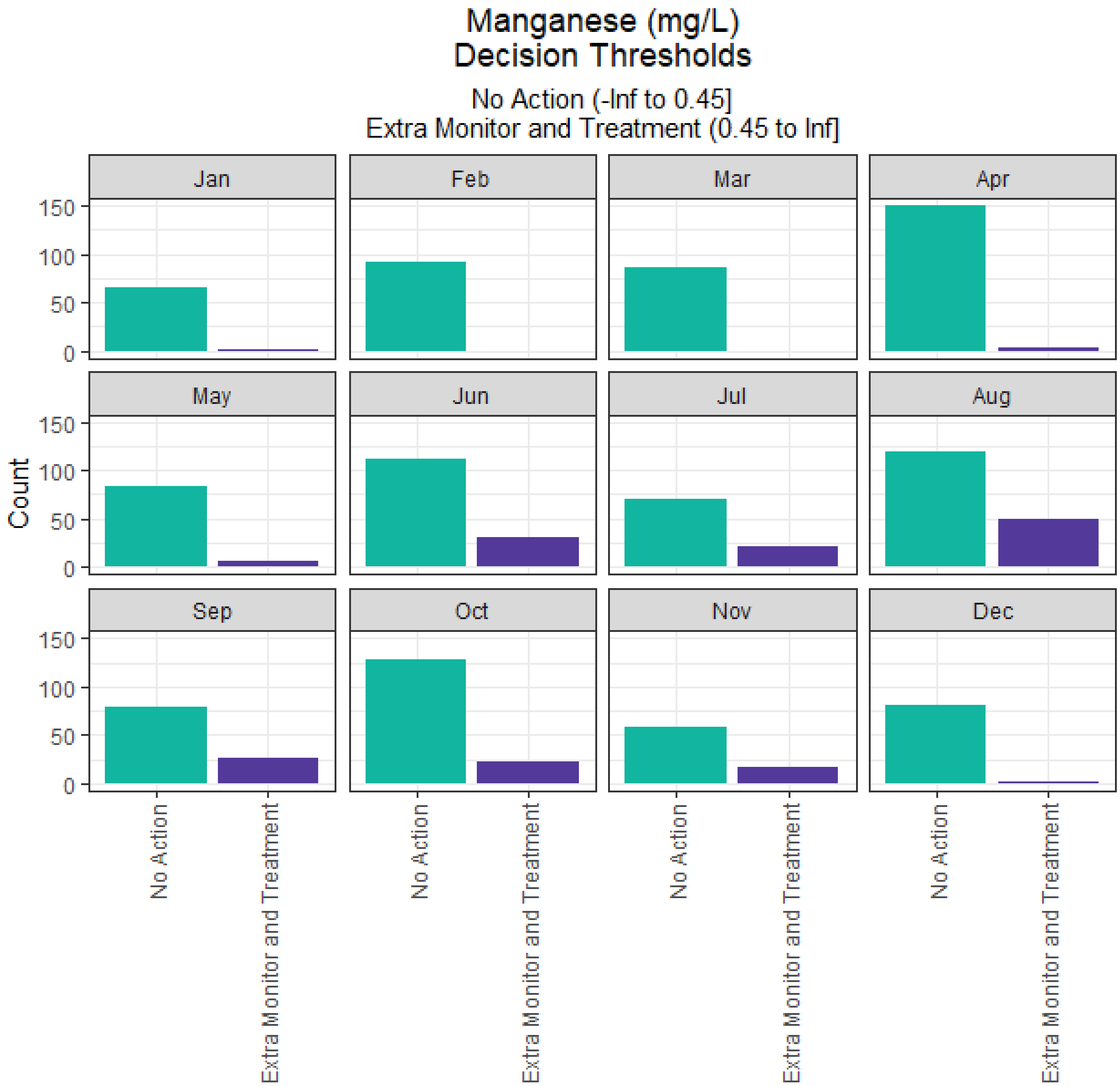
Manganese data are reported at the level of Site-Date. The observed data values range from 0 to 5.16.

Manganese has a regulatory limit of 0.5 mg/L. However, this is a secondary water limit, so Raleigh requested 0.45 mg/L as the model limit. This is the level at which they begin to monitor closely and it it continues to increase, then they add sodium permanganate (per Chris Phelps, 2024-03-12).

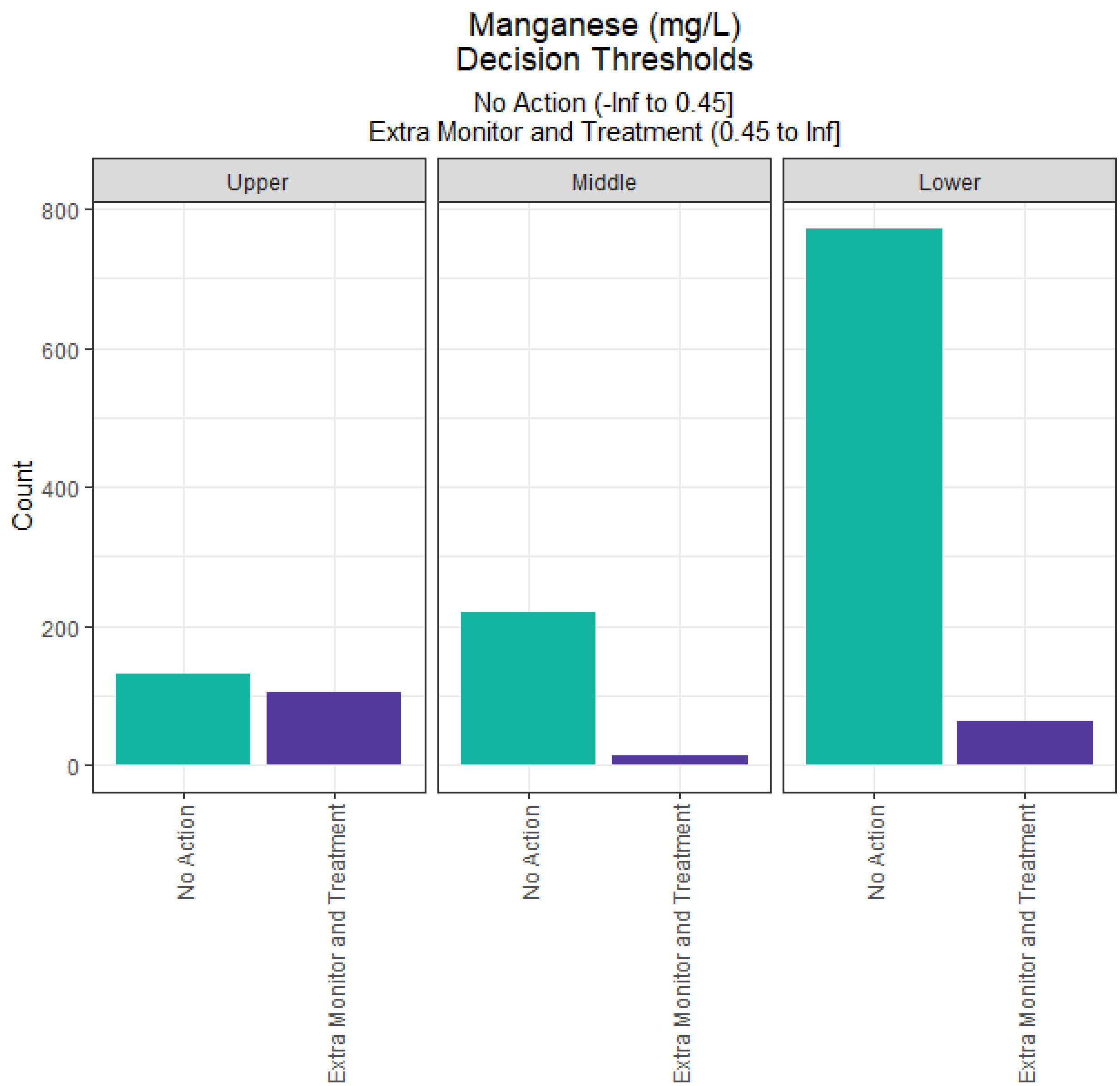


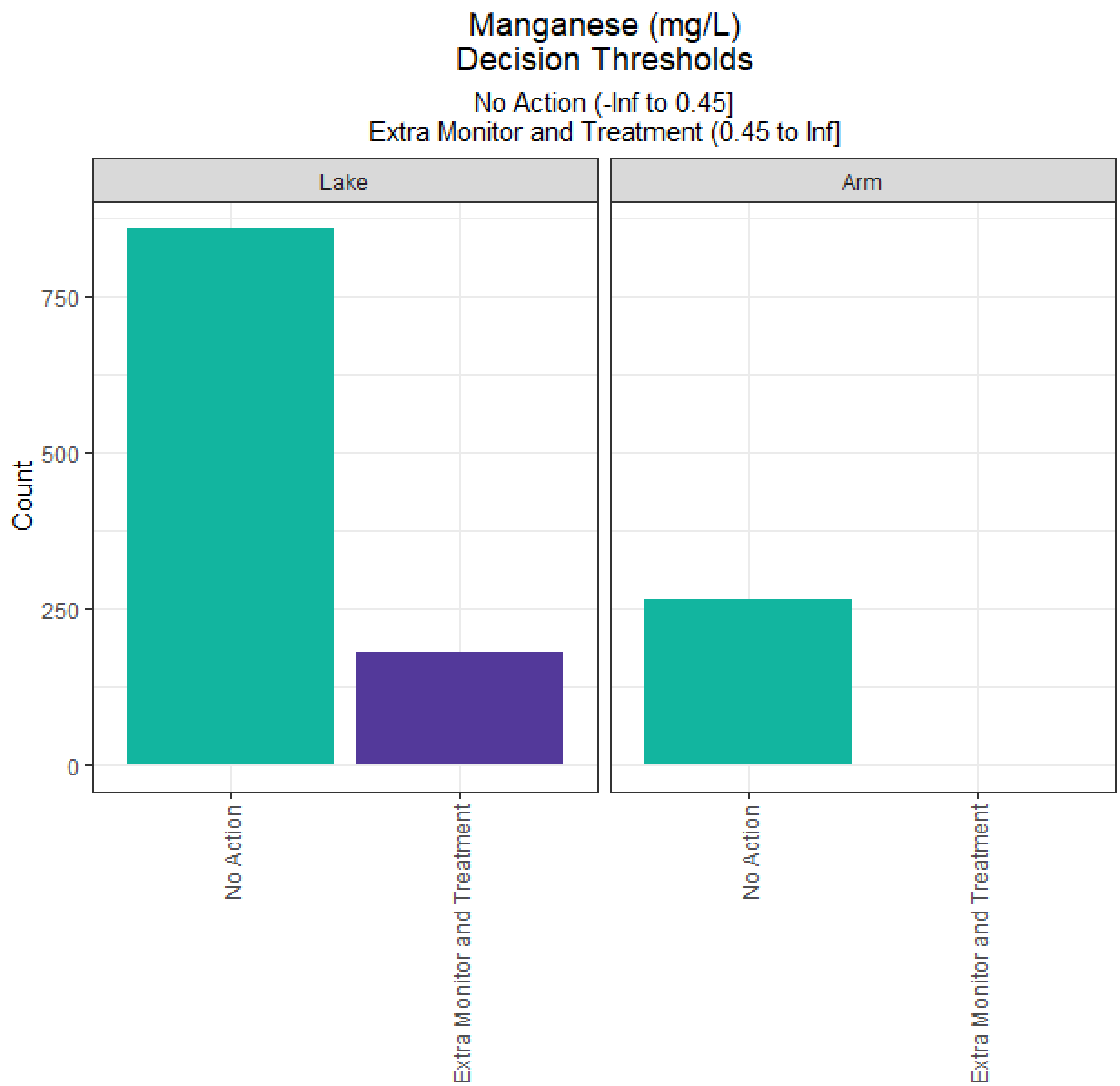
BIN	N	MIN	MAX	LABELS
No Action	1124	0.0	0.4	No Action (-Inf to 0.45]
Extra Monitor and Treatment	180	0.5	5.2	Extra Monitor and Treatment (0.45 to Inf]


Manganese (mg/L)
Decision Thresholds
No Action (-Inf to 0.45]
Extra Monitor and Treatment (0.45 to Inf]
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
2000
2001
2005
2006
2007
2008
2009
2010
2011
2013
2014
2015
2016
2017
2018
Count
100
75
50
25
0
No Action
Extra Monitor and Treatment



Manganese (mg/L)
Decision Thresholds
No Action (-Inf to 0.45]
Extra Monitor and Treatment (0.45 to Inf]
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Count
0
50
100
150
No Action
Extra Monitor and Treatment


Manganese (mg/L)
Decision Thresholds
No Action (-Inf to 0.45]
Extra Monitor and Treatment (0.45 to Inf]
Upper
Middle
Lower
Count
800
600
400
200
0
No Action
Extra Monitor and Treatment

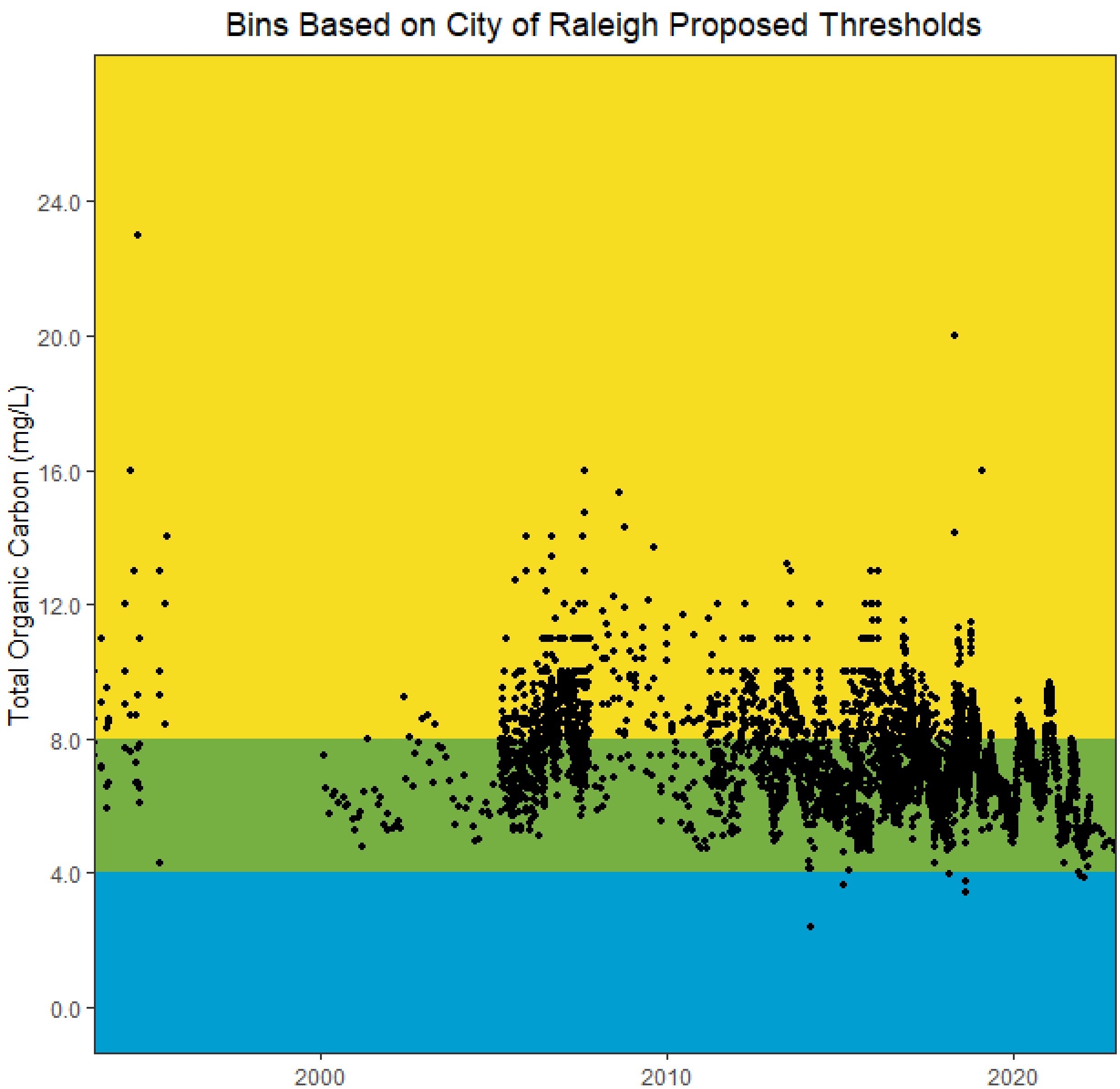


5.3.1.5 Total Organic Carbon

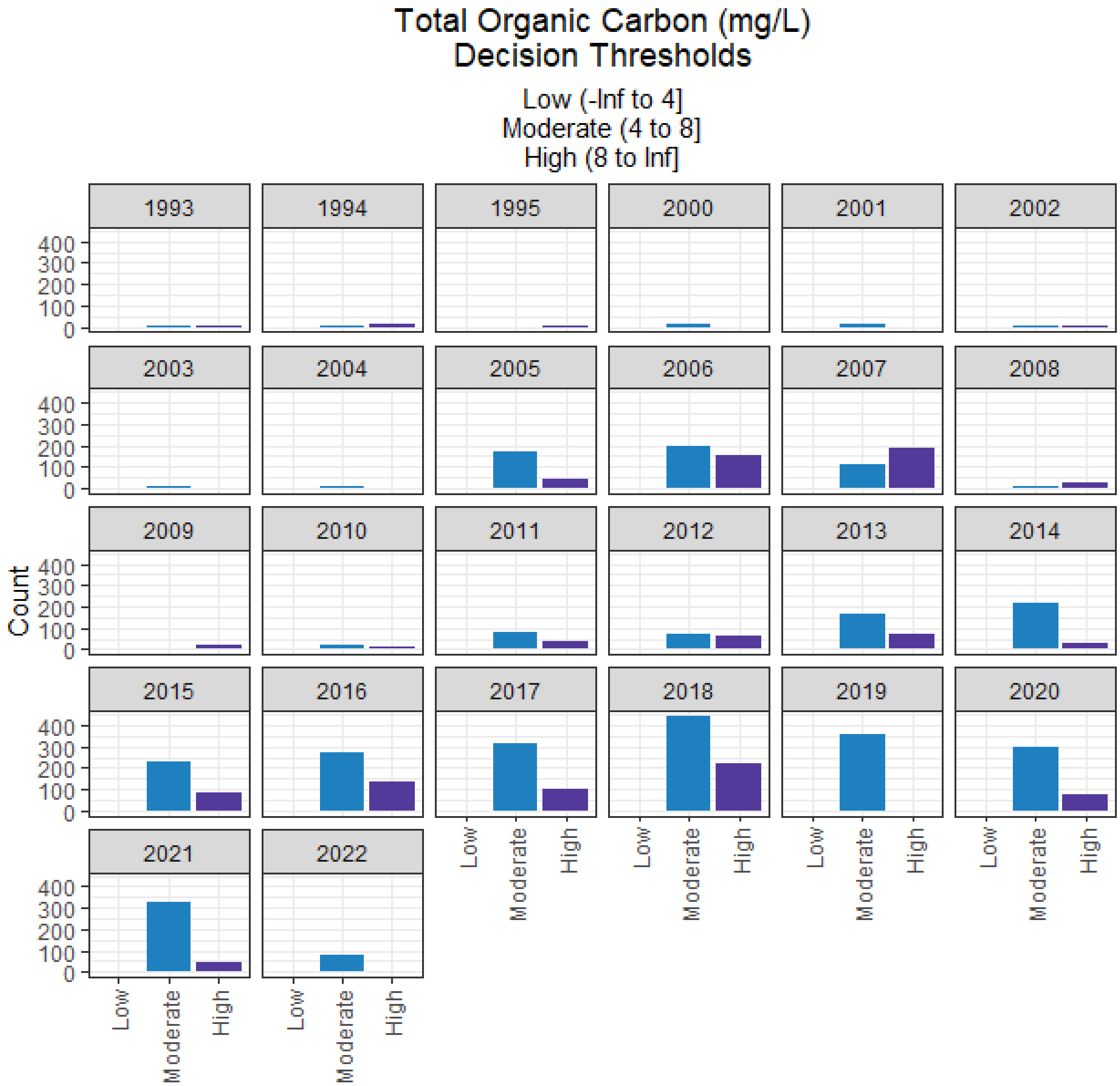
Total organic carbon data are reported at the level of Site-Date. The observed data values range from 2.4 to 23.

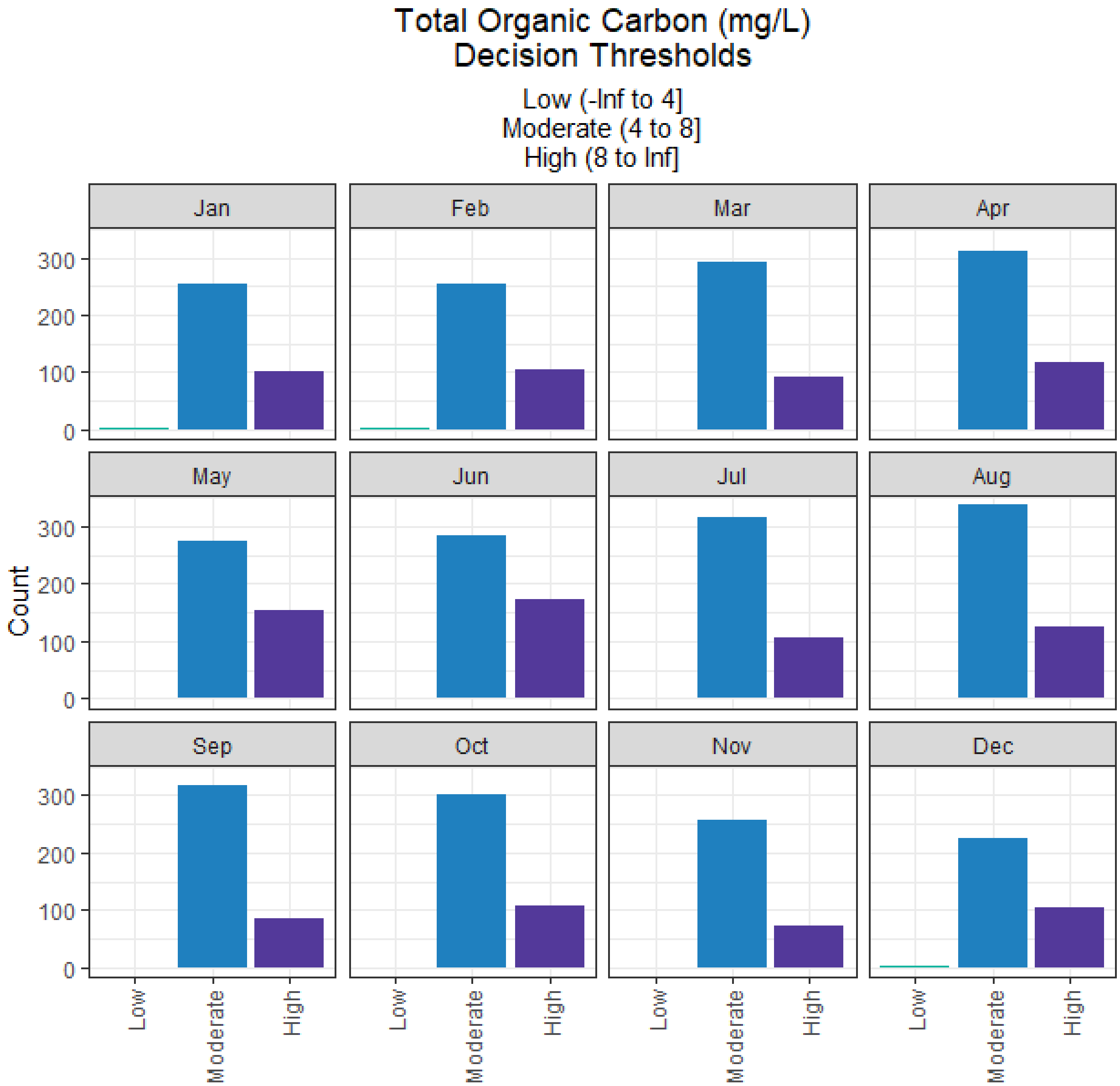
The U.S. Environmental Protection Agency's rule for disinfectants and disinfection by-products requires removal of total organic carbon (TOC) by surface water facilities using conventional or lime softening water treatment with levels of TOC above 2 mg/L in their source water. Our model only considers TOC as measured in the photic zone. TOC was always above 2 mg/L.

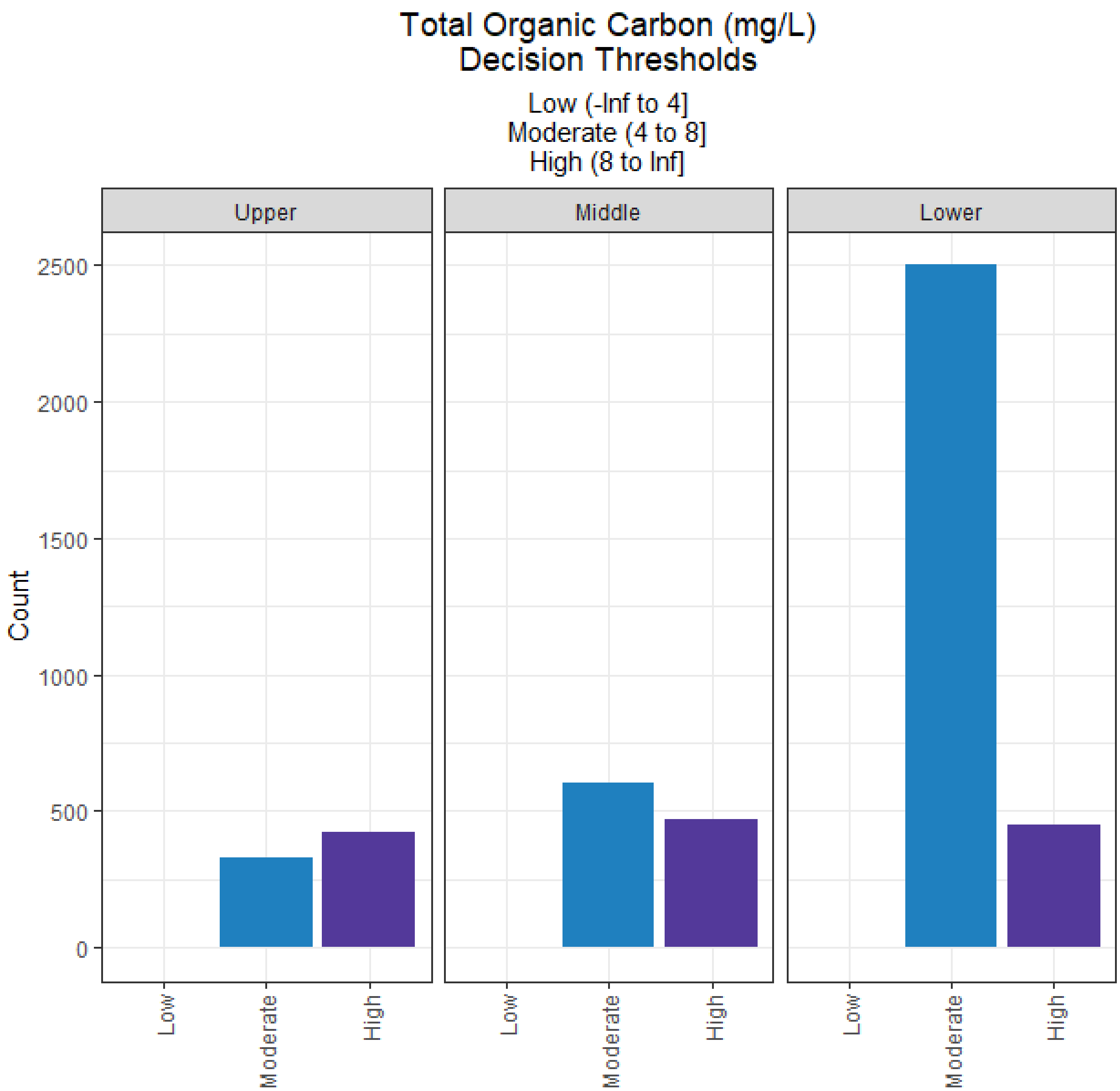
The City of Raleigh proposed 4 and 8 mg/L as threshold values that are meaningful to there monitoring and decision-making. We created a manual node for TOC with the data classified into three bins (Low, Moderate, High) based on these values.

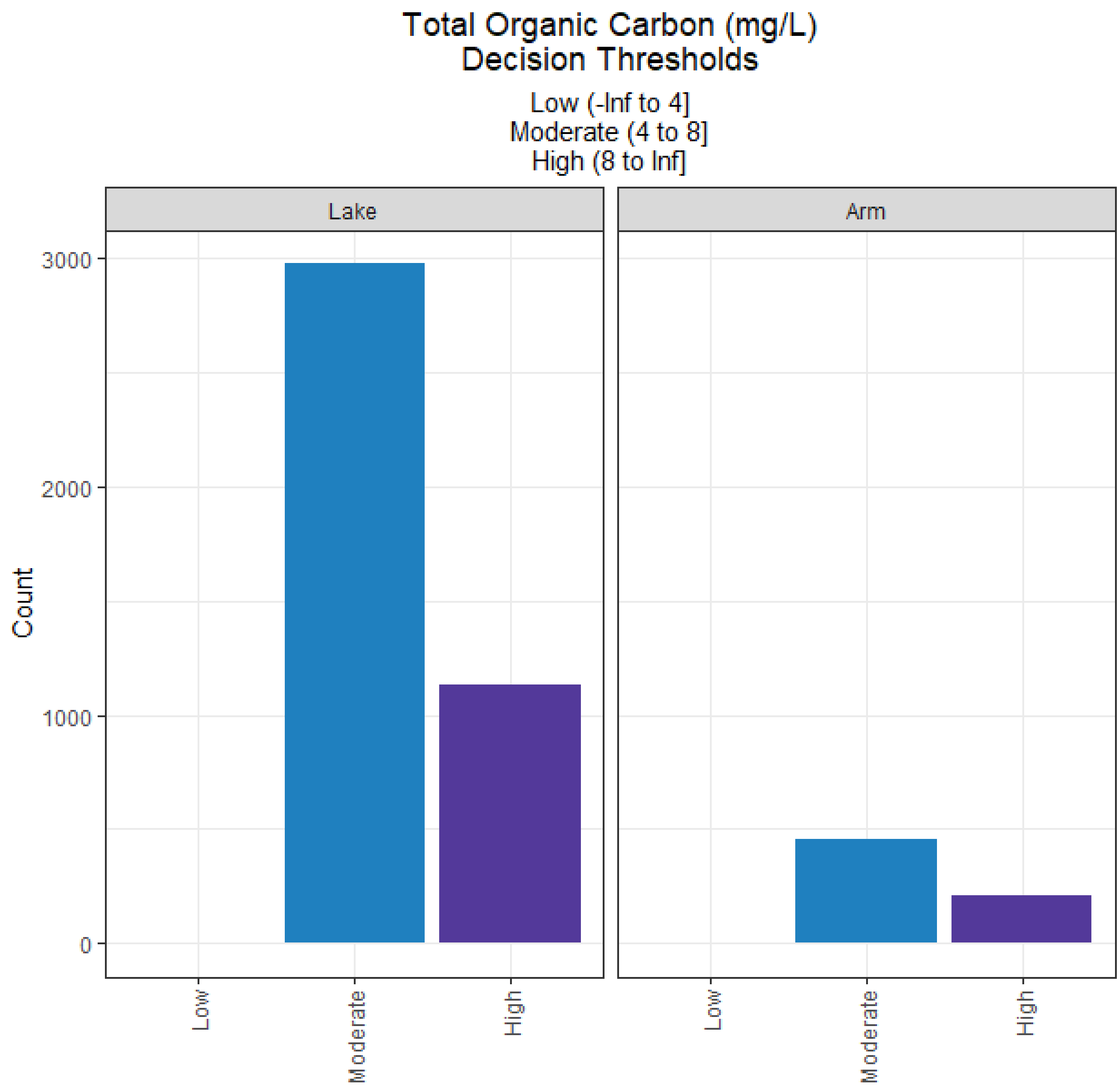


BIN	N	MIN	MAX	LABELS
Low	7	2.4	4	Low (-Inf to 4]
Moderate	3431	4.0	8	Moderate (4 to 8]
High	1344	8.0	23	High (8 to Inf]


Total Organic Carbon (mg/L)
Decision Thresholds
Low (-Inf to 4]
Moderate (4 to 8]
High (8 to Inf]
1993
1994
1995
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Count
0
100
200
300
400
Low
Moderate
High


Total Organic Carbon (mg/L)
Decision Thresholds
Low (-Inf to 4]
Moderate (4 to 8]
High (8 to Inf]
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Count
0
100
200
300
Low
Moderate
High


Total Organic Carbon (mg/L)
Decision Thresholds
Low (-Inf to 4]
Moderate (4 to 8]
High (8 to Inf]
Upper
Middle
Lower
Count
2500
2000
1500
1000
500
0
Low
Moderate
High



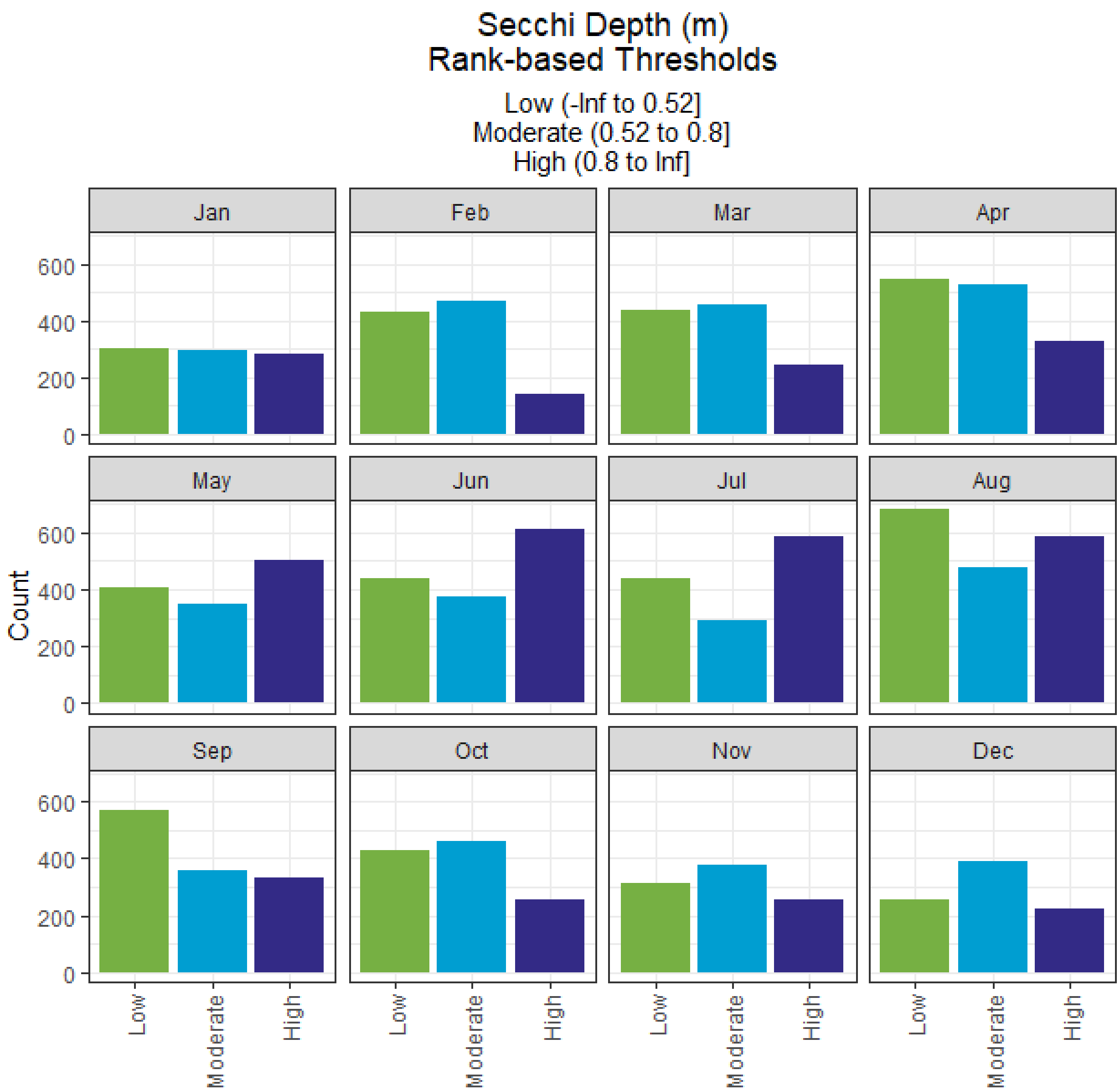
5.3.1.6 Secchi Depth (m)

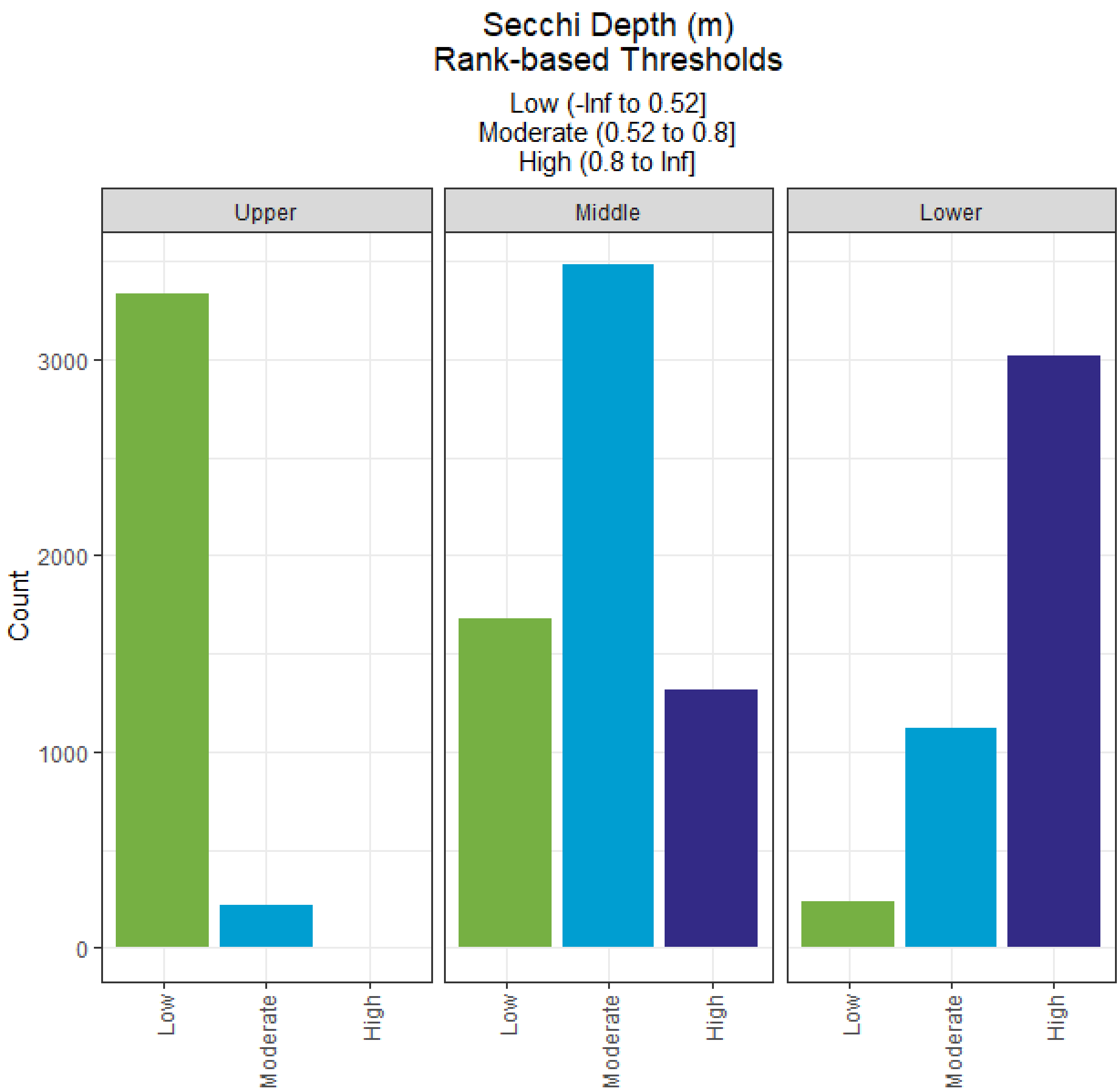
We created a rank-based node for secchi depth with the data classified into three bins (Low, Moderate, High) based on value ranks.

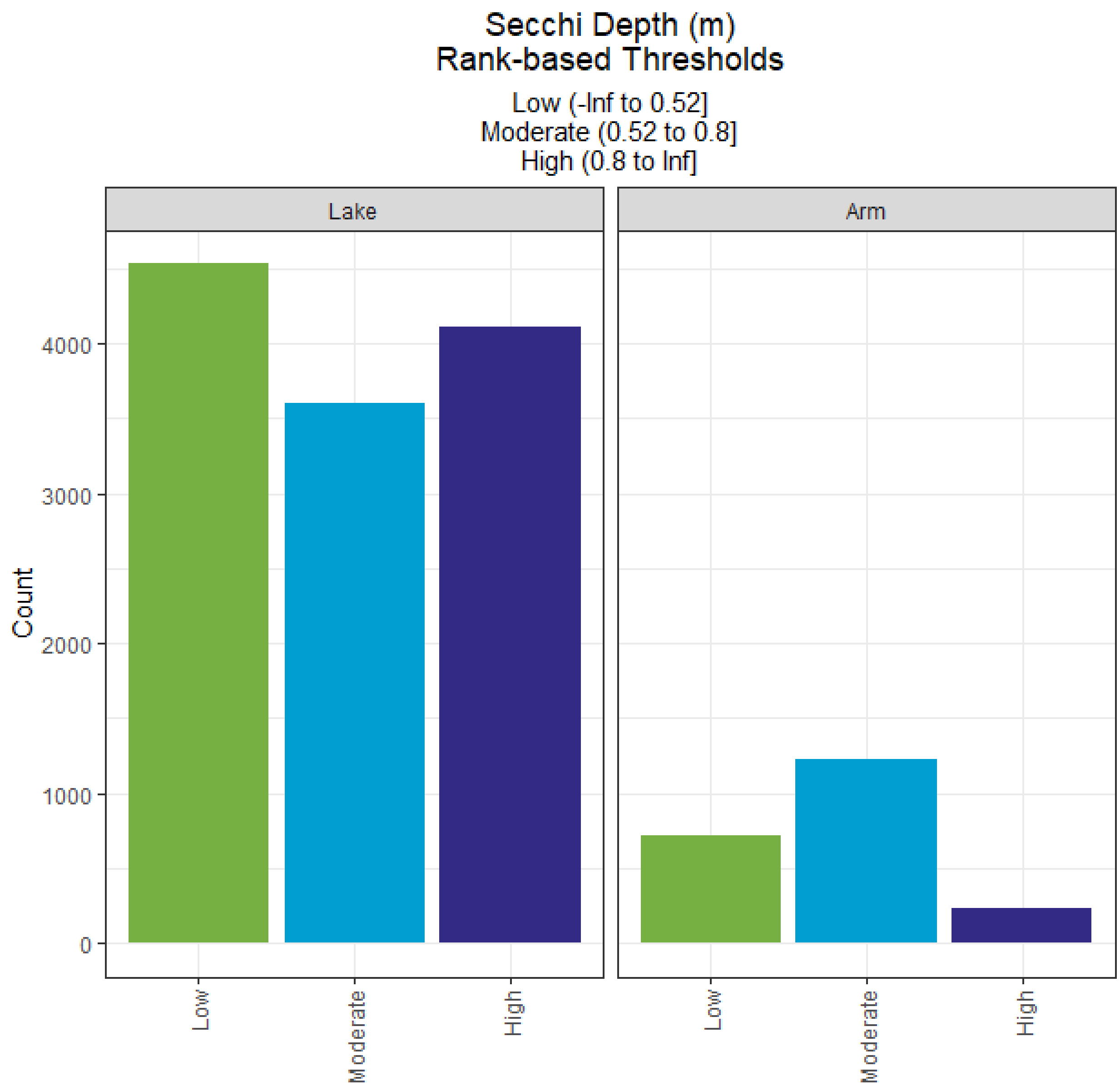
The observed data values range from 0 to 2.667.

BIN	N	MIN	MAX	LABELS
Low	5244	0.0	0.5	Low (-Inf to 0.52]
Moderate	4817	0.6	0.8	Moderate (0.52 to 0.8]
High	4338	0.8	2.7	High (0.8 to Inf]


Secchi Depth (m)
Rank-based Thresholds
Low (-Inf to 0.52]
Moderate (0.52 to 0.8]
High (0.8 to Inf]
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
2000
2001
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Count
0
200
400
600
Low
Moderate
High


Secchi Depth (m)
Rank-based Thresholds
Low (-Inf to 0.52]
Moderate (0.52 to 0.8]
High (0.8 to Inf]
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Count
0
200
400
600
Low
Moderate
High


Secchi Depth (m)
Rank-based Thresholds
Low (-Inf to 0.52]
Moderate (0.52 to 0.8]
High (0.8 to Inf]
Upper
Middle
Lower
Count
0
1000
2000
3000
Low
Moderate
High



5.3.2 Lakewide Level Data

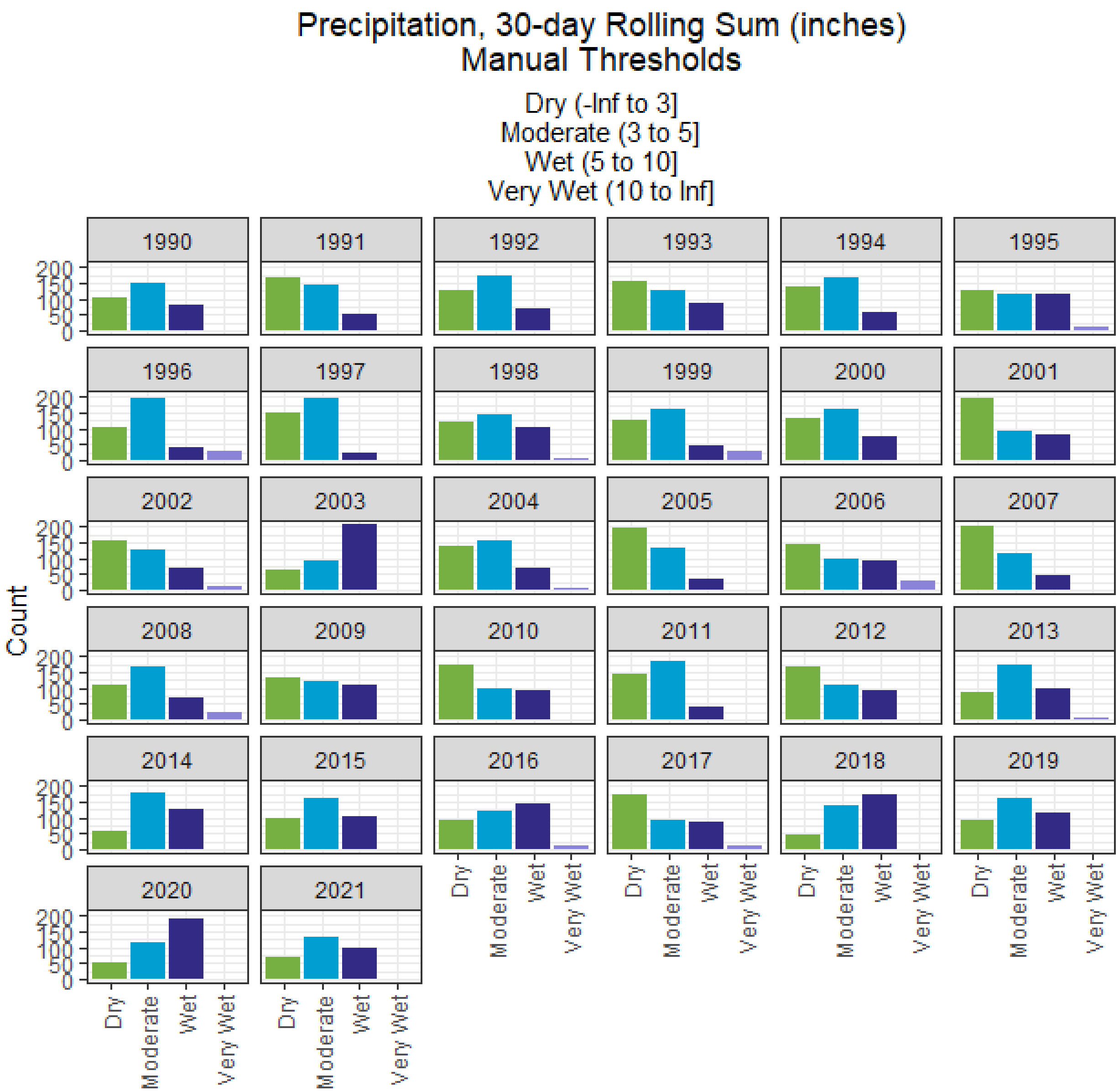
5.3.2.1 Precipitation - 30-day rolling sum

The precipitation data come from 30 years of daily NOAA data (1990 to 2020) and RDU airport. All data were prepared in the file **dataPrep_precip** (rmd/docx). For the model, we used the 30-day rolling sum data.

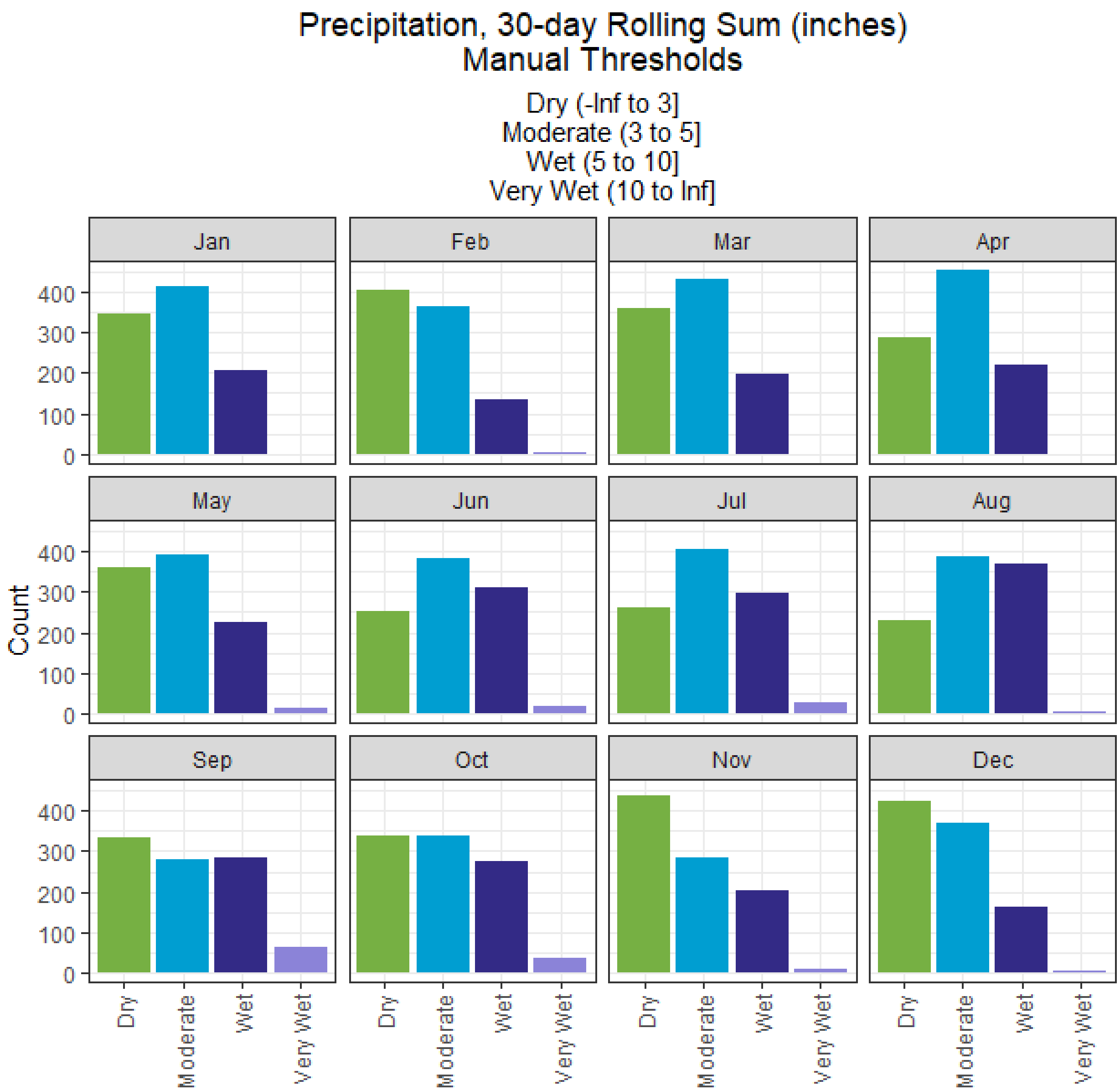
For the 30-day rolling sum data, we also used the manual bin method with the categories, Dry (<3), Moderate (3-5), Wet (5-10), and Very Wet (>10 inches).

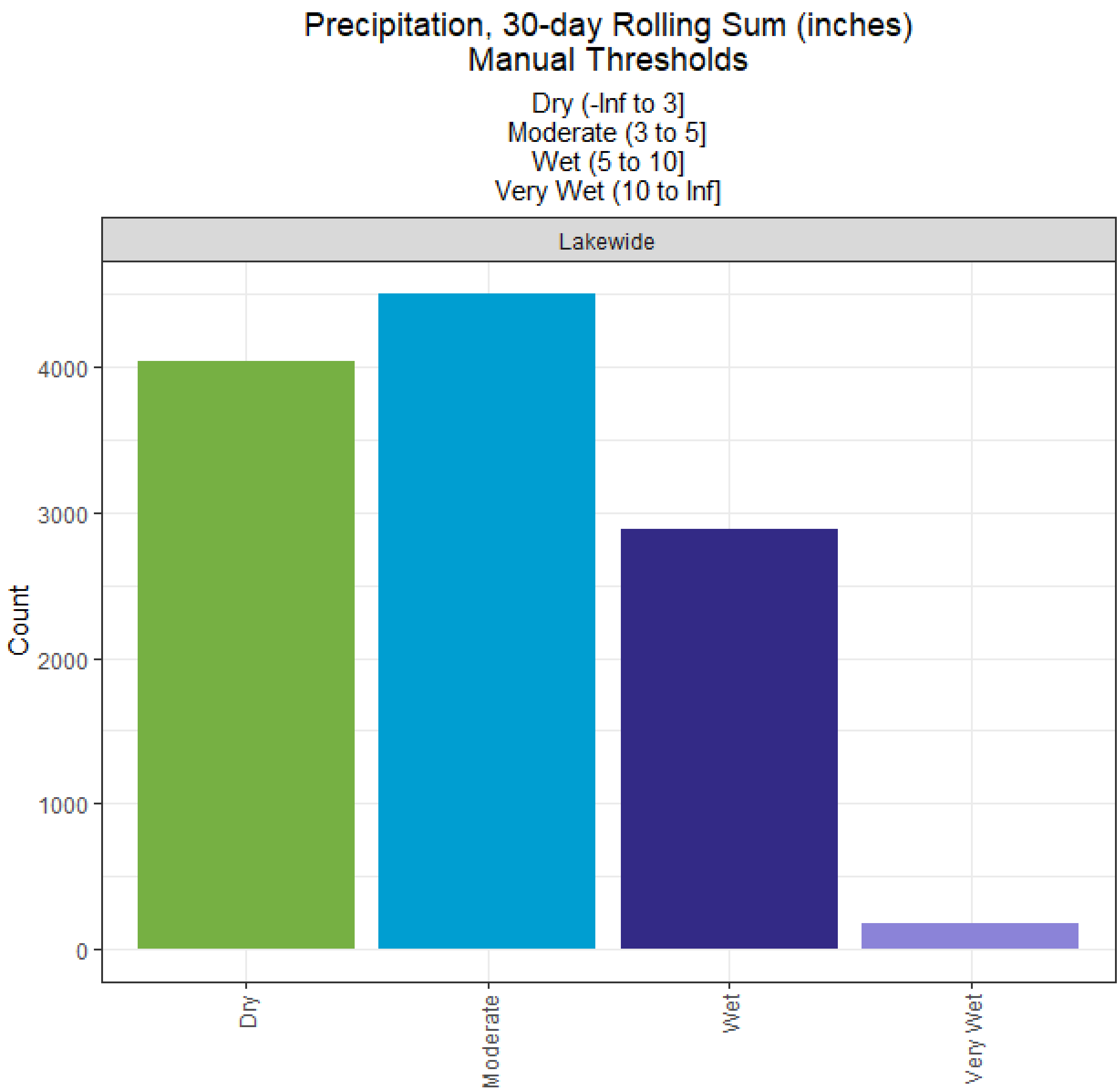
BIN	N	MIN	MAX	LABELS
Dry	4036	0	3	Dry (-Inf to 3]
Moderate	4508	3	5	Moderate (3 to 5]

BIN	N	MIN	MAX	LABELS
Wet	2881	5	10	Wet (5 to 10]
Very Wet	173	10	18	Very Wet (10 to Inf]



Precipitation, 30-day Rolling Sum (inches)
Manual Thresholds
Dry (-Inf to 3]
Moderate (3 to 5]
Wet (5 to 10]
Very Wet (10 to Inf]
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Count
0
50
100
150
200
Dry
Moderate
Wet
Very Wet


Precipitation, 30-day Rolling Sum (inches)
Manual Thresholds
Dry (-Inf to 3]
Moderate (3 to 5]
Wet (5 to 10]
Very Wet (10 to Inf]
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Count
0
100
200
300
400
Dry
Moderate
Wet
Very Wet



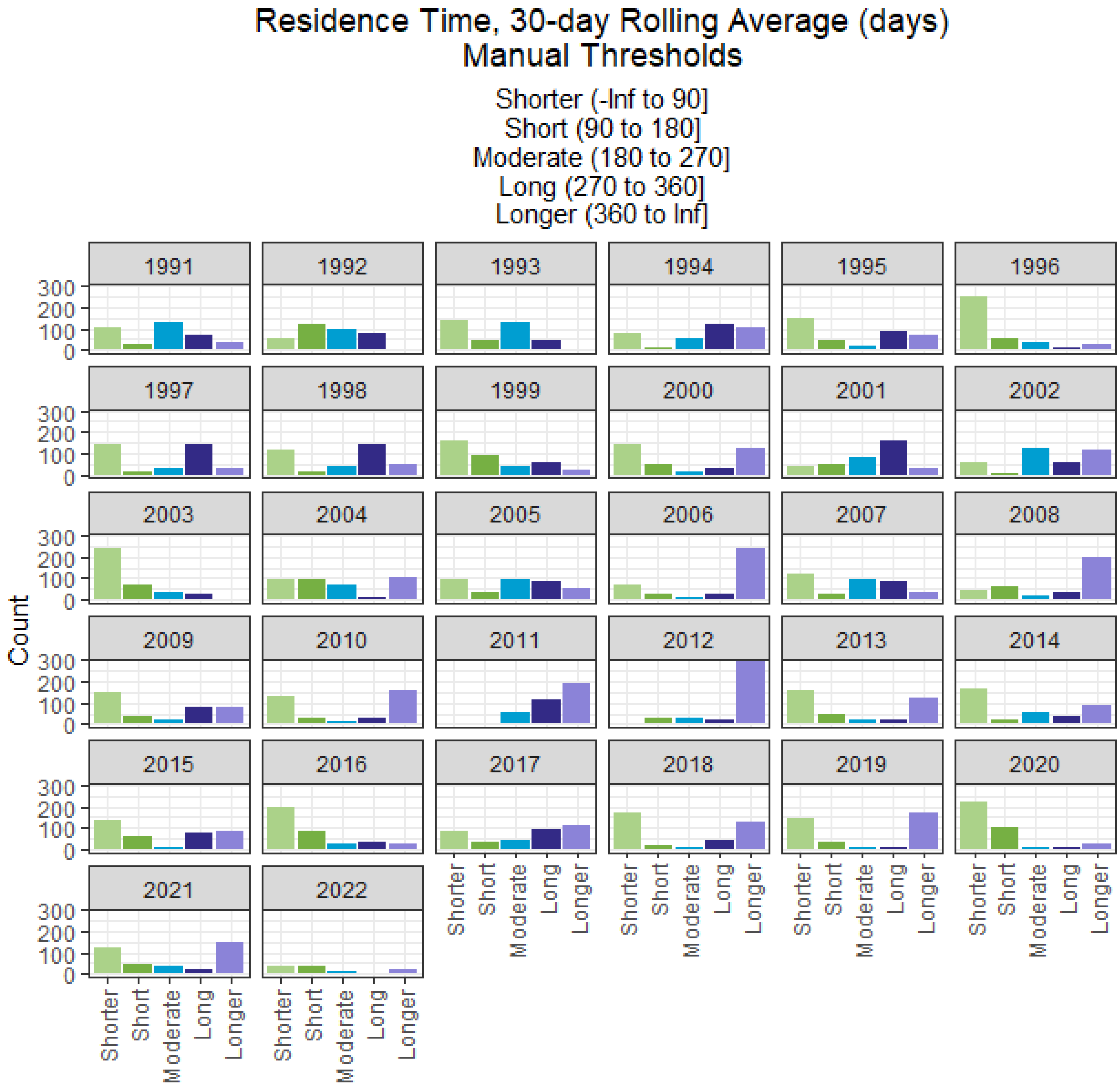
5.3.2.2 Residence Time - 30-day rolling average

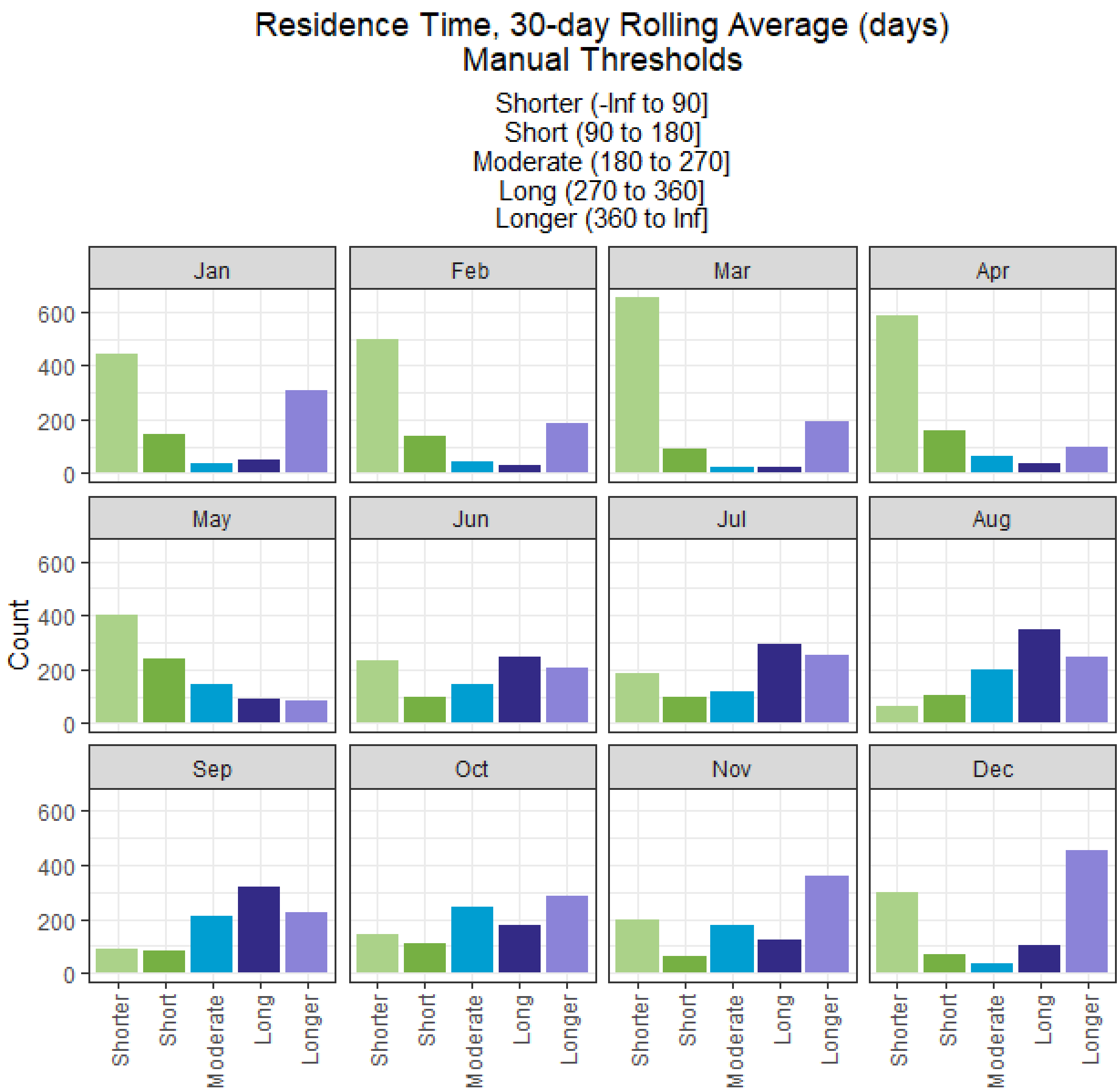
The residence time data were prepared in the file **dataPrep_residence** (rmd/docx). For the model, we used the 30-day rolling average data.

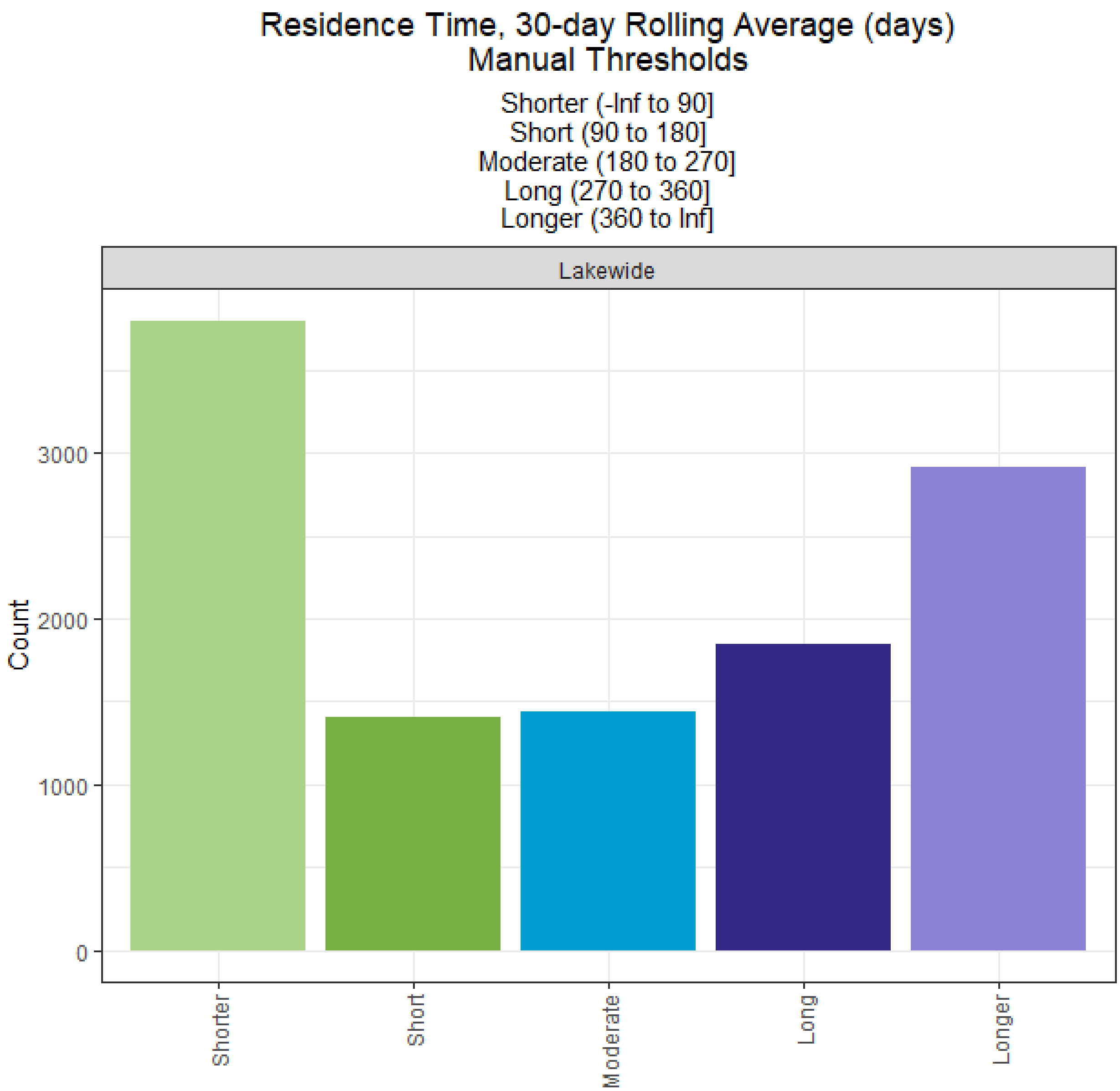
We defined bins as: "Very Short" (< 90), "Short" (90-180), "Moderate" (180-270), "Long" (270-360), and "Very Long" (> 360 days).

BIN	N	MIN	MAX	LABELS
Shorter	3796	16.6	90.0	Shorter (-Inf to 90]
Short	1401	90.0	179.8	Short (90 to 180]
Moderate	1441	180.1	269.9	Moderate (180 to 270]
Long	1841	270.1	360.0	Long (270 to 360]

BIN	N	MIN	MAX	LABELS
Longer	2912	360.0	1551.2	Longer (360 to Inf]


Residence Time, 30-day Rolling Average (days)
Manual Thresholds
Shorter (-Inf to 90]
Short (90 to 180]
Moderate (180 to 270]
Long (270 to 360]
Longer (360 to Inf]
Count
0
100
200
300
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Shorter
Short
Moderate
Long
Longer


Residence Time, 30-day Rolling Average (days)
Manual Thresholds
Shorter (-Inf to 90]
Short (90 to 180]
Moderate (180 to 270]
Long (270 to 360]
Longer (360 to Inf]
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Count
0
200
400
600
Shorter
Short
Moderate
Long
Longer


Residence Time, 30-day Rolling Average (days)
Manual Thresholds
Shorter (-Inf to 90]
Short (90 to 180]
Moderate (180 to 270]
Long (270 to 360]
Longer (360 to Inf]
Lakewide
Count
3000
2000
1000
0
Shorter
Short
Moderate
Long
Longer

Section 6: Conditional Probability Tables

Conditional probability tables are used to link the variables in the model such that knowing the category of one or more predictor variables informs the distribution of the outcome variable. This section is organized by the output variable (see the subsection headers).

Each subsection first lists the variables that the output variable is conditioned on (the variables that inform its distribution). This is followed by three conditional probability tables for the upper, middle, and lower lake segments. These tables show the distribution of observations for each combination of the variables that inform it. The categories for these distributions may include below detection (BD), low, medium, high, etc.

In certain cases, an extra step was applied to prepare the tables before adding them to the model network. Specifically, for events with limited data or small sample sizes, the original tables had probabilities of 0% or 100%. To account for the inherent uncertainty in most outcomes, these values were adjusted by setting the minimum probability to 0.1% and the maximum to 99.9%. This adjustment reflects the understanding that perfect certainty does not exist for most outcomes.

The tables also list the match method for each combination of input variables and the output variable. Ideally, the output variable and each of the input variables were collected on the same date in the same segment. Although Falls Lake is one of the most studied lakes in the USA with an abundance of sampling, all combinations of all variables values (e.g., high, moderate, low) have not been observed on any given date. In some cases, this is because a particular combination of observations would be unlikely (e.g., cool water temperatures in the warm season and vice versa). In others it is a knowledge gap because sampling has not occurred under all combinations of values across the history of the lake. When a date-segment match across potential categories was not observed in a segment, the following steps were used to populate the CPTs so that all combinations of inputs have values on which to base the probability of an outcome:

- Alternative 1: Expand time frame. First, within the segment, the time frame was expanded to half-month. Then, if no matches were found, the window was again expanded to the full month.
- Alternative 2: Expand spatial extent. If expanding the time window did not result in matches locally, data from the neighboring segment (middle for the upper or lower segment and lower for the middle segment) was evaluated for date, half-month, and then monthly matches. If no matches were found, the spatial extent was again expanded to include all lake units and the time-based search for matches repeated.

The chlorophyll-a ecological variable and total biovolume variable have very long conditional probability tables because they have so many input variables. For these variables, one lake segment per subsection is shown. The residence time conditional probability table applies lake wide and is not specified by lake segment.

6.1 Anatoxin A (anatotreg, ug/L) – Three Lake Segments

Conditioned on:

- Blue-Green Algae Biovolume Ecological (bgbioveco, mm3/m3)

Upper:

bgbioveco	BD	anatotreg: Low	anatotreg: Moderate	anatotreg: High	Match Method
Low	52.2	47.6	0.1	0.1	Date
Moderate	66.5	33.3	0.1	0.1	Date
High	0.1	99.7	0.1	0.1	Date

Middle:

bgbioveco	BD	anatotreg: Low	anatotreg: Moderate	anatotreg: High	Match Method
Low	64.7	35.3	0	0	Date
Moderate	25	75	0	0	Date
High	0	100	0	0	Date

Lower:

bgbioveco	BD	anatotreg: Low	anatotreg: Moderate	anatotreg: High	Match Method
Low	55.8	44	0.1	0.1	Date
Moderate	30	69.8	0.1	0.1	Date
High	99.7	0.1	0.1	0.1	Month

6.2 Blue-Green Algae Biovolume (mm3/m3, bgbioveco) – Three Lake Segments

Conditioned on:

- Water temperature (wtemp, C)
- Secchi Depth (secchi, ft)
- Total Algal Biovolume (totbiovman, mm3/m3)
- N:P Molar Ratio (npratio, mol)

Upper:

wtemp	secchi	totbiovman	npratio	bgbioveco: Low	bgbioveco: Moderate	bgbioveco: High	Match Method
Low	Low	Very Low	Low	100	0	0	Date
Low	Low	Very Low	Moderate	100	0	0	Date
Low	Low	Very Low	High	100	0	0	Date
Low	Low	Low	Low	99.9	0.1	0	Date
Low	Low	Low	Moderate	99.9	0.1	0	Date

wtemp	secchi	totbiovman	npratio	bgbioveco: Low	bgbioveco: Moderate	bgbioveco: High	Match Method
Low	Low	Low	High	99.9	0.1	0	Date
Low	Low	Bloom	Low	99.8	0.1	0.1	Date
Low	Low	Bloom	Moderate	99.8	0.1	0.1	Date
Low	Low	Bloom	High	99.8	0.1	0.1	Middle Date
Low	Low	Large Bloom	Low	99.8	0.1	0.1	Date
Low	Low	Large Bloom	Moderate	99.8	0.1	0.1	Month
Low	Low	Large Bloom	High	48.5	27.7	23.8	Middle Date
Low	Moderate	Very Low	Low	100	0	0	Date
Low	Moderate	Very Low	Moderate	100	0	0	Date
Low	Moderate	Very Low	High	100	0	0	Date
Low	Moderate	Low	Low	99.9	0.1	0	Date
Low	Moderate	Low	Moderate	99.9	0.1	0	Month
Low	Moderate	Low	High	99.9	0.1	0	Month
Low	Moderate	Bloom	Low	99.8	0.1	0.1	Date
Low	Moderate	Bloom	Moderate	99.8	0.1	0.1	Date
Low	Moderate	Bloom	High	99.8	0.1	0.1	Middle Date
Low	Moderate	Large Bloom	Low	99.8	0.1	0.1	Date
Low	Moderate	Large Bloom	Moderate	99.8	0.1	0.1	Month
Low	Moderate	Large Bloom	High	73.3	20.9	5.8	Middle Date
Low	High	Very Low	Low	100	0	0	Middle Date
Low	High	Very Low	Moderate	100	0	0	Middle Date
Low	High	Very Low	High	100	0	0	Middle Date
Low	High	Low	Low	99.9	0.1	0	Middle Date
Low	High	Low	Moderate	99.9	0.1	0	Middle Date
Low	High	Low	High	99.9	0.1	0	Middle Date
Low	High	Bloom	Low	99.8	0.1	0.1	Middle Date
Low	High	Bloom	Moderate	99.8	0.1	0.1	Middle Date
Low	High	Bloom	High	99.8	0.1	0.1	Middle Date
Low	High	Large Bloom	Low	99.8	0.1	0.1	Middle Date
Low	High	Large Bloom	Moderate	99.8	0.1	0.1	Middle Date
Low	High	Large Bloom	High	99.8	0.1	0.1	Middle Date
Moderate	Low	Very Low	Low	100	0	0	Date
Moderate	Low	Very Low	Moderate	100	0	0	Month
Moderate	Low	Very Low	High	100	0	0	Middle Date
Moderate	Low	Low	Low	99.9	0.1	0	Date
Moderate	Low	Low	Moderate	99.9	0.1	0	Date
Moderate	Low	Low	High	99.9	0.1	0	Date
Moderate	Low	Bloom	Low	95.1	4.8	0.1	Date

wtemp	secchi	totbiovman	npratio	bgbioveco: Low	bgbioveco: Moderate	bgbioveco: High	Match Method
Moderate	Low	Bloom	Moderate	99.8	0.1	0.1	Date
Moderate	Low	Bloom	High	70.8	29.1	0.1	Middle Date
Moderate	Low	Large Bloom	Low	95.2	3.9	0.9	Date
Moderate	Low	Large Bloom	Moderate	99.8	0.1	0.1	Date
Moderate	Low	Large Bloom	High	28.8	0.1	71.1	Middle Date
Moderate	Moderate	Very Low	Low	100	0	0	Half-Month
Moderate	Moderate	Very Low	Moderate	100	0	0	Middle Date
Moderate	Moderate	Very Low	High	100	0	0	Middle Date
Moderate	Moderate	Low	Low	99.9	0.1	0	Half-Month
Moderate	Moderate	Low	Moderate	99.9	0.1	0	Date
Moderate	Moderate	Low	High	99.9	0.1	0	Half-Month
Moderate	Moderate	Bloom	Low	44.8	27.6	27.6	Half-Month
Moderate	Moderate	Bloom	Moderate	99.8	0.1	0.1	Date
Moderate	Moderate	Bloom	High	59.9	40	0.1	Middle Date
Moderate	Moderate	Large Bloom	Low	79.9	20	0.1	Date
Moderate	Moderate	Large Bloom	Moderate	42	37.4	20.6	Half-Month
Moderate	Moderate	Large Bloom	High	42	17.4	40.6	Middle Date
Moderate	High	Very Low	Low	100	0	0	Middle Date
Moderate	High	Very Low	Moderate	100	0	0	Middle Date
Moderate	High	Very Low	High	100	0	0	Middle Date
Moderate	High	Low	Low	99.9	0.1	0	Middle Date
Moderate	High	Low	Moderate	99.9	0.1	0	Middle Date
Moderate	High	Low	High	99.9	0.1	0	Middle Date
Moderate	High	Bloom	Low	99.8	0.1	0.1	Half-Month
Moderate	High	Bloom	Moderate	99.8	0.1	0.1	Middle Date
Moderate	High	Bloom	High	99.8	0.1	0.1	Middle Date
Moderate	High	Large Bloom	Low	52.7	47.2	0.1	Middle Date
Moderate	High	Large Bloom	Moderate	84	15.9	0.1	Middle Date
Moderate	High	Large Bloom	High	92.3	7.6	0.1	Middle Date
High	Low	Very Low	Low	100	0	0	Month
High	Low	Very Low	Moderate	100	0	0	Month
High	Low	Very Low	High	100	0	0	Middle Date
High	Low	Low	Low	99.9	0.1	0	Date
High	Low	Low	Moderate	99.9	0.1	0	Date
High	Low	Low	High	99.9	0.1	0	Month
High	Low	Bloom	Low	71.2	28.7	0.1	Date
High	Low	Bloom	Moderate	99.8	0.1	0.1	Date
High	Low	Bloom	High	84.8	15.1	0.1	Middle Date

wtemp	secchi	totbiovman	npratio	bgbioveco: Low	bgbioveco: Moderate	bgbioveco: High	Match Method
High	Low	Large Bloom	Low	72.3	20.5	7.2	Date
High	Low	Large Bloom	Moderate	99.8	0.1	0.1	Date
High	Low	Large Bloom	High	5.9	0.1	94	Middle Date
High	Moderate	Very Low	Low	100	0	0	Middle Date
High	Moderate	Very Low	Moderate	100	0	0	Middle Date
High	Moderate	Very Low	High	100	0	0	Middle Date
High	Moderate	Low	Low	99.9	0.1	0	Half-Month
High	Moderate	Low	Moderate	99.9	0.1	0	Date
High	Moderate	Low	High	99.9	0.1	0	Month
High	Moderate	Bloom	Low	81.3	3.4	15.3	Half-Month
High	Moderate	Bloom	Moderate	48.9	2.2	48.9	Half-Month
High	Moderate	Bloom	High	92.4	7.5	0.1	Middle Date
High	Moderate	Large Bloom	Low	66.6	33.3	0.1	Date
High	Moderate	Large Bloom	Moderate	51.2	20	28.8	Half-Month
High	Moderate	Large Bloom	High	14.9	32.9	52.2	Middle Date
High	High	Very Low	Low	100	0	0	Middle Date
High	High	Very Low	Moderate	100	0	0	Middle Date
High	High	Very Low	High	100	0	0	Middle Date
High	High	Low	Low	99.9	0.1	0	Middle Date
High	High	Low	Moderate	99.9	0.1	0	Middle Date
High	High	Low	High	99.9	0.1	0	Middle Date
High	High	Bloom	Low	99.8	0.1	0.1	Month
High	High	Bloom	Moderate	85.6	14.3	0.1	Middle Date
High	High	Bloom	High	99.8	0.1	0.1	Middle Date
High	High	Large Bloom	Low	85.9	14	0.1	Middle Date
High	High	Large Bloom	Moderate	65.6	24	10.4	Middle Date
High	High	Large Bloom	High	14.7	39.8	45.5	Middle Date

Middle:

wtemp	secchi	totbiovman	npratio	bgbioveco: Low	bgbioveco: Moderate	bgbioveco: High	Match Method
Low	Low	Very Low	Low	100	0	0	Date
Low	Low	Very Low	Moderate	100	0	0	Date
Low	Low	Very Low	High	100	0	0	Date
Low	Low	Low	Low	99.9	0.1	0	Date
Low	Low	Low	Moderate	99.9	0.1	0	Date
Low	Low	Low	High	99.9	0.1	0	Date
Low	Low	Bloom	Low	99.8	0.1	0.1	Half-Month

wtemp	secchi	totbiovman	npratio	bgbioveco: Low	bgbioveco: Moderate	bgbioveco: High	Match Method
Low	Low	Bloom	Moderate	99.8	0.1	0.1	Date
Low	Low	Bloom	High	99.8	0.1	0.1	Date
Low	Low	Large Bloom	Low	99.8	0.1	0.1	Date
Low	Low	Large Bloom	Moderate	57.3	16.4	26.3	Date
Low	Low	Large Bloom	High	48.5	27.7	23.8	Date
Low	Moderate	Very Low	Low	100	0	0	Date
Low	Moderate	Very Low	Moderate	100	0	0	Date
Low	Moderate	Very Low	High	100	0	0	Date
Low	Moderate	Low	Low	99.9	0.1	0	Date
Low	Moderate	Low	Moderate	99.9	0.1	0	Date
Low	Moderate	Low	High	99.9	0.1	0	Date
Low	Moderate	Bloom	Low	99.8	0.1	0.1	Date
Low	Moderate	Bloom	Moderate	99.8	0.1	0.1	Date
Low	Moderate	Bloom	High	99.8	0.1	0.1	Date
Low	Moderate	Large Bloom	Low	99.8	0.1	0.1	Date
Low	Moderate	Large Bloom	Moderate	61.4	10.2	28.4	Date
Low	Moderate	Large Bloom	High	73.3	20.9	5.8	Date
Low	High	Very Low	Low	100	0	0	Date
Low	High	Very Low	Moderate	100	0	0	Date
Low	High	Very Low	High	100	0	0	Date
Low	High	Low	Low	99.9	0.1	0	Date
Low	High	Low	Moderate	99.9	0.1	0	Date
Low	High	Low	High	99.9	0.1	0	Date
Low	High	Bloom	Low	99.8	0.1	0.1	Date
Low	High	Bloom	Moderate	99.8	0.1	0.1	Date
Low	High	Bloom	High	99.8	0.1	0.1	Date
Low	High	Large Bloom	Low	99.8	0.1	0.1	Date
Low	High	Large Bloom	Moderate	99.8	0.1	0.1	Date
Low	High	Large Bloom	High	99.8	0.1	0.1	Date
Moderate	Low	Very Low	Low	100	0	0	Date
Moderate	Low	Very Low	Moderate	100	0	0	Date
Moderate	Low	Very Low	High	100	0	0	Date
Moderate	Low	Low	Low	30.9	69.1	0	Date
Moderate	Low	Low	Moderate	71.6	28.4	0	Date
Moderate	Low	Low	High	69.3	30.7	0	Date
Moderate	Low	Bloom	Low	95.8	0.1	4.1	Date
Moderate	Low	Bloom	Moderate	72.1	27.8	0.1	Date
Moderate	Low	Bloom	High	70.8	29.1	0.1	Date

wtemp	secchi	totbiovman	npratio	bgbioveco: Low	bgbioveco: Moderate	bgbioveco: High	Match Method
Moderate	Low	Large Bloom	Low	61.9	0.1	38	Date
Moderate	Low	Large Bloom	Moderate	61.5	0.1	38.4	Date
Moderate	Low	Large Bloom	High	28.8	0.1	71.1	Date
Moderate	Moderate	Very Low	Low	100	0	0	Date
Moderate	Moderate	Very Low	Moderate	100	0	0	Date
Moderate	Moderate	Very Low	High	100	0	0	Date
Moderate	Moderate	Low	Low	74.8	25.2	0	Date
Moderate	Moderate	Low	Moderate	96.9	3.1	0	Date
Moderate	Moderate	Low	High	99.2	0.8	0	Date
Moderate	Moderate	Bloom	Low	92.7	0.1	7.2	Date
Moderate	Moderate	Bloom	Moderate	69.2	30.7	0.1	Date
Moderate	Moderate	Bloom	High	59.9	40	0.1	Date
Moderate	Moderate	Large Bloom	Low	72.9	17.3	9.8	Date
Moderate	Moderate	Large Bloom	Moderate	50.7	16.9	32.4	Date
Moderate	Moderate	Large Bloom	High	42	17.4	40.6	Date
Moderate	High	Very Low	Low	100	0	0	Date
Moderate	High	Very Low	Moderate	100	0	0	Date
Moderate	High	Very Low	High	100	0	0	Date
Moderate	High	Low	Low	99.9	0.1	0	Date
Moderate	High	Low	Moderate	99.9	0.1	0	Date
Moderate	High	Low	High	99.9	0.1	0	Date
Moderate	High	Bloom	Low	99.8	0.1	0.1	Date
Moderate	High	Bloom	Moderate	99.8	0.1	0.1	Date
Moderate	High	Bloom	High	99.8	0.1	0.1	Date
Moderate	High	Large Bloom	Low	52.7	47.2	0.1	Date
Moderate	High	Large Bloom	Moderate	84	15.9	0.1	Date
Moderate	High	Large Bloom	High	92.3	7.6	0.1	Date
High	Low	Very Low	Low	100	0	0	Month
High	Low	Very Low	Moderate	100	0	0	Date
High	Low	Very Low	High	100	0	0	Date
High	Low	Low	Low	99.9	0.1	0	Date
High	Low	Low	Moderate	83.3	16.7	0	Date
High	Low	Low	High	35.8	64.2	0	Date
High	Low	Bloom	Low	68.5	31.4	0.1	Date
High	Low	Bloom	Moderate	40.1	59.8	0.1	Date
High	Low	Bloom	High	84.8	15.1	0.1	Date
High	Low	Large Bloom	Low	47	0.1	52.9	Date
High	Low	Large Bloom	Moderate	47.8	0.1	52.1	Date

wtemp	secchi	totbiovman	npratio	bgbioveco: Low	bgbioveco: Moderate	bgbioveco: High	Match Method
High	Low	Large Bloom	High	5.9	0.1	94	Date
High	Moderate	Very Low	Low	100	0	0	Date
High	Moderate	Very Low	Moderate	100	0	0	Date
High	Moderate	Very Low	High	100	0	0	Date
High	Moderate	Low	Low	99.9	0.1	0	Date
High	Moderate	Low	Moderate	90	10	0	Date
High	Moderate	Low	High	71.3	28.7	0	Date
High	Moderate	Bloom	Low	75.9	24	0.1	Date
High	Moderate	Bloom	Moderate	48	51.9	0.1	Date
High	Moderate	Bloom	High	92.4	7.5	0.1	Date
High	Moderate	Large Bloom	Low	41.6	41.6	16.8	Date
High	Moderate	Large Bloom	Moderate	50.6	34.2	15.2	Date
High	Moderate	Large Bloom	High	14.9	32.9	52.2	Date
High	High	Very Low	Low	100	0	0	Date
High	High	Very Low	Moderate	100	0	0	Date
High	High	Very Low	High	100	0	0	Date
High	High	Low	Low	99.9	0.1	0	Date
High	High	Low	Moderate	99.9	0.1	0	Date
High	High	Low	High	99.9	0.1	0	Date
High	High	Bloom	Low	99.8	0.1	0.1	Half-Month
High	High	Bloom	Moderate	85.6	14.3	0.1	Date
High	High	Bloom	High	99.8	0.1	0.1	Date
High	High	Large Bloom	Low	85.9	14	0.1	Date
High	High	Large Bloom	Moderate	65.6	24	10.4	Date
High	High	Large Bloom	High	14.7	39.8	45.5	Date

Lower:

wtemp	secchi	totbiovman	npratio	bgbioveco: Low	bgbioveco: Moderate	bgbioveco: High	Match Method
Low	Low	Very Low	Low	100	0	0	Middle Date
Low	Low	Very Low	Moderate	100	0	0	Date
Low	Low	Very Low	High	100	0	0	Date
Low	Low	Low	Low	99.9	0.1	0	Middle Date
Low	Low	Low	Moderate	99.9	0.1	0	Date
Low	Low	Low	High	99.9	0.1	0	Date
Low	Low	Bloom	Low	99.8	0.1	0.1	Middle Half-Month
Low	Low	Bloom	Moderate	99.8	0.1	0.1	Middle Date
Low	Low	Bloom	High	99.8	0.1	0.1	Middle Date

wtemp	secchi	totbiovman	npratio	bgbioveco: Low	bgbioveco: Moderate	bgbioveco: High	Match Method
Low	Low	Large Bloom	Low	99.8	0.1	0.1	Middle Date
Low	Low	Large Bloom	Moderate	57.3	16.4	26.3	Middle Date
Low	Low	Large Bloom	High	48.5	27.7	23.8	Middle Date
Low	Moderate	Very Low	Low	100	0	0	Middle Date
Low	Moderate	Very Low	Moderate	100	0	0	Date
Low	Moderate	Very Low	High	100	0	0	Half-Month
Low	Moderate	Low	Low	99.9	0.1	0	Date
Low	Moderate	Low	Moderate	99.9	0.1	0	Date
Low	Moderate	Low	High	99.9	0.1	0	Date
Low	Moderate	Bloom	Low	99.8	0.1	0.1	Middle Date
Low	Moderate	Bloom	Moderate	99.8	0.1	0.1	Date
Low	Moderate	Bloom	High	98.7	1.2	0.1	Date
Low	Moderate	Large Bloom	Low	99.8	0.1	0.1	Date
Low	Moderate	Large Bloom	Moderate	79.9	20	0.1	Date
Low	Moderate	Large Bloom	High	83.2	16.7	0.1	Date
Low	High	Very Low	Low	100	0	0	Middle Date
Low	High	Very Low	Moderate	100	0	0	Date
Low	High	Very Low	High	100	0	0	Date
Low	High	Low	Low	99.9	0.1	0	Date
Low	High	Low	Moderate	99.9	0.1	0	Date
Low	High	Low	High	99.9	0.1	0	Date
Low	High	Bloom	Low	99.8	0.1	0.1	Date
Low	High	Bloom	Moderate	99.8	0.1	0.1	Date
Low	High	Bloom	High	98.6	1.3	0.1	Date
Low	High	Large Bloom	Low	99.8	0.1	0.1	Date
Low	High	Large Bloom	Moderate	79.9	20	0.1	Date
Low	High	Large Bloom	High	95.4	4.5	0.1	Date
Moderate	Low	Very Low	Low	100	0	0	Middle Date
Moderate	Low	Very Low	Moderate	100	0	0	Month
Moderate	Low	Very Low	High	100	0	0	Month
Moderate	Low	Low	Low	99.9	0.1	0	Date
Moderate	Low	Low	Moderate	99.9	0.1	0	Date
Moderate	Low	Low	High	99.9	0.1	0	Month
Moderate	Low	Bloom	Low	99.8	0.1	0.1	Date
Moderate	Low	Bloom	Moderate	99.8	0.1	0.1	Date
Moderate	Low	Bloom	High	99.8	0.1	0.1	Date
Moderate	Low	Large Bloom	Low	99.8	0.1	0.1	Month
Moderate	Low	Large Bloom	Moderate	99.8	0.1	0.1	Date

wtemp	secchi	totbiovman	npratio	bgbioveco: Low	bgbioveco: Moderate	bgbioveco: High	Match Method
Moderate	Low	Large Bloom	High	99.8	0.1	0.1	Date
Moderate	Moderate	Very Low	Low	100	0	0	Middle Date
Moderate	Moderate	Very Low	Moderate	100	0	0	Half-Month
Moderate	Moderate	Very Low	High	100	0	0	Date
Moderate	Moderate	Low	Low	99.9	0.1	0	Date
Moderate	Moderate	Low	Moderate	99.9	0.1	0	Date
Moderate	Moderate	Low	High	99.9	0.1	0	Date
Moderate	Moderate	Bloom	Low	99.8	0.1	0.1	Date
Moderate	Moderate	Bloom	Moderate	99.8	0.1	0.1	Date
Moderate	Moderate	Bloom	High	18.9	24.5	56.6	Date
Moderate	Moderate	Large Bloom	Low	99.8	0.1	0.1	Month
Moderate	Moderate	Large Bloom	Moderate	99.8	0.1	0.1	Date
Moderate	Moderate	Large Bloom	High	69	30.9	0.1	Date
Moderate	High	Very Low	Low	100	0	0	Month
Moderate	High	Very Low	Moderate	100	0	0	Date
Moderate	High	Very Low	High	100	0	0	Date
Moderate	High	Low	Low	99.9	0.1	0	Date
Moderate	High	Low	Moderate	11.8	88.2	0	Date
Moderate	High	Low	High	76.8	23.2	0	Date
Moderate	High	Bloom	Low	99.8	0.1	0.1	Date
Moderate	High	Bloom	Moderate	16.7	83.2	0.1	Date
Moderate	High	Bloom	High	33.8	60.3	5.9	Date
Moderate	High	Large Bloom	Low	99.8	0.1	0.1	Month
Moderate	High	Large Bloom	Moderate	99.8	0.1	0.1	Date
Moderate	High	Large Bloom	High	73.6	26.3	0.1	Date
High	Low	Very Low	Low	100	0	0	Middle Month
High	Low	Very Low	Moderate	100	0	0	Middle Date
High	Low	Very Low	High	100	0	0	Middle Date
High	Low	Low	Low	99.9	0.1	0	Middle Date
High	Low	Low	Moderate	99.9	0.1	0	Month
High	Low	Low	High	99.9	0.1	0	Month
High	Low	Bloom	Low	68.5	31.4	0.1	Middle Date
High	Low	Bloom	Moderate	40.1	59.8	0.1	Middle Date
High	Low	Bloom	High	84.8	15.1	0.1	Middle Date
High	Low	Large Bloom	Low	47	0.1	52.9	Middle Date
High	Low	Large Bloom	Moderate	47.8	0.1	52.1	Middle Date
High	Low	Large Bloom	High	99.8	0.1	0.1	Date
High	Moderate	Very Low	Low	100	0	0	Middle Date

wtemp	secchi	totbiovman	npratio	bgbioveco: Low	bgbioveco: Moderate	bgbioveco: High	Match Method
High	Moderate	Very Low	Moderate	100	0	0	Middle Date
High	Moderate	Very Low	High	100	0	0	Date
High	Moderate	Low	Low	99.9	0.1	0	Middle Date
High	Moderate	Low	Moderate	99.9	0.1	0	Date
High	Moderate	Low	High	99.9	0.1	0	Date
High	Moderate	Bloom	Low	0.1	99.8	0.1	Month
High	Moderate	Bloom	Moderate	99.8	0.1	0.1	Month
High	Moderate	Bloom	High	0.1	99.8	0.1	Date
High	Moderate	Large Bloom	Low	41.6	41.6	16.8	Middle Date
High	Moderate	Large Bloom	Moderate	50.6	34.2	15.2	Middle Date
High	Moderate	Large Bloom	High	75.8	24.1	0.1	Date
High	High	Very Low	Low	100	0	0	Date
High	High	Very Low	Moderate	100	0	0	Date
High	High	Very Low	High	100	0	0	Date
High	High	Low	Low	99.9	0.1	0	Middle Date
High	High	Low	Moderate	99.9	0.1	0	Date
High	High	Low	High	99.9	0.1	0	Date
High	High	Bloom	Low	99.8	0.1	0.1	Half-Month
High	High	Bloom	Moderate	62.1	37.8	0.1	Month
High	High	Bloom	High	69.6	30.3	0.1	Date
High	High	Large Bloom	Low	99.8	0.1	0.1	Date
High	High	Large Bloom	Moderate	65.6	24	10.4	Middle Date
High	High	Large Bloom	High	61.3	9.2	29.5	Date

6.3 Chlorophyll-A Ecological (ug/L, chlaeco) – Upper Lake Segment

Conditioned on:

- Secchi Depth (secchi, ft)
- Total Nitrogen Concentration (totaln, mg/L)
- Water Temperature (wtemp, C)
- Total Phosphorus Concentration (totalp, mg/L)
- Residence Time (resid30, days)

Upper:

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	Very Low	Low	Very Low	Shorter	99.8	0.1	0.1	Lower Month
Low	Very Low	Low	Very Low	Short	99.8	0.1	0.1	Lower Month
Low	Very Low	Low	Very Low	Moderate	75.5	24.4	0.1	Interpolate

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	Very Low	Low	Very Low	Long	81.1	18.8	0.1	Interpolate
Low	Very Low	Low	Very Low	Longer	82.9	17	0.1	Interpolate
Low	Very Low	Low	Low	Shorter	0.1	99.8	0.1	Middle Half-Month
Low	Very Low	Low	Low	Short	0.1	99.8	0.1	Middle Half-Month
Low	Very Low	Low	Low	Moderate	99.8	0.1	0.1	Middle Half-Month
Low	Very Low	Low	Low	Long	99.8	0.1	0.1	Middle Half-Month
Low	Very Low	Low	Low	Longer	78.4	21.5	0.1	Middle Date
Low	Very Low	Low	Moderate	Shorter	62.4	37.5	0.1	Middle Date
Low	Very Low	Low	Moderate	Short	99.8	0.1	0.1	Middle Date
Low	Very Low	Low	Moderate	Moderate	99.8	0.1	0.1	Middle Half-Month
Low	Very Low	Low	Moderate	Long	99.8	0.1	0.1	Middle Half-Month
Low	Very Low	Low	Moderate	Longer	70.3	29.6	0.1	Middle Date
Low	Very Low	Low	High	Shorter	99.8	0.1	0.1	Half-Month
Low	Very Low	Low	High	Short	99.8	0.1	0.1	Date
Low	Very Low	Low	High	Moderate	99.8	0.1	0.1	Half-Month
Low	Very Low	Low	High	Long	99.8	0.1	0.1	Middle Half-Month
Low	Very Low	Low	High	Longer	29.3	35.4	35.3	Date
Low	Very Low	Low	Very High	Shorter	0.1	99.8	0.1	Date
Low	Very Low	Low	Very High	Short	99.8	0.1	0.1	Date
Low	Very Low	Low	Very High	Moderate	99.8	0.1	0.1	Half-Month
Low	Very Low	Low	Very High	Long	53.1	28.1	18.8	Interpolate
Low	Very Low	Low	Very High	Longer	32	34	34	Date
Low	Very Low	Moderate	Very Low	Shorter	87	12.9	0.1	Date
Low	Very Low	Moderate	Very Low	Short	46.6	53.3	0.1	Half-Month
Low	Very Low	Moderate	Very Low	Moderate	40	59.9	0.1	Lower Half-Month
Low	Very Low	Moderate	Very Low	Long	21.4	63.6	15	Interpolate
Low	Very Low	Moderate	Very Low	Longer	59.5	40.4	0.1	Interpolate
Low	Very Low	Moderate	Low	Shorter	74.9	25	0.1	Half-Month
Low	Very Low	Moderate	Low	Short	77.7	22.2	0.1	Date
Low	Very Low	Moderate	Low	Moderate	42.9	57	0.1	Half-Month
Low	Very Low	Moderate	Low	Long	0.1	40	59.9	Middle Date
Low	Very Low	Moderate	Low	Longer	48.5	51.4	0.1	Middle Date
Low	Very Low	Moderate	Moderate	Shorter	0.1	0.1	99.8	Date
Low	Very Low	Moderate	Moderate	Short	99.8	0.1	0.1	Date
Low	Very Low	Moderate	Moderate	Moderate	49.95	49.95	0.1	Date
Low	Very Low	Moderate	Moderate	Long	0.1	40	59.9	Middle Date
Low	Very Low	Moderate	Moderate	Longer	16.7	83.2	0.1	Middle Date
Low	Very Low	Moderate	High	Shorter	0.1	0.1	99.8	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	Very Low	Moderate	High	Short	99.8	0.1	0.1	Date
Low	Very Low	Moderate	High	Moderate	40	59.9	0.1	Lower Half-Month
Low	Very Low	Moderate	High	Long	0.1	40	59.9	Middle Date
Low	Very Low	Moderate	High	Longer	0.1	40	59.9	Middle Half-Month
Low	Very Low	Moderate	Very High	Shorter	2.3	21.4	76.3	Date
Low	Very Low	Moderate	Very High	Short	58.5	41.4	0.1	Date
Low	Very Low	Moderate	Very High	Moderate	49.95	49.95	0.1	Date
Low	Very Low	Moderate	Very High	Long	0.1	40	59.9	Middle Date
Low	Very Low	Moderate	Very High	Longer	11.4	62.3	26.3	Date
Low	Very Low	High	Very Low	Shorter	15.4	46.1	38.5	Half-Month
Low	Very Low	High	Very Low	Short	42.4	45.5	12.1	Interpolate
Low	Very Low	High	Very Low	Moderate	0.1	77.7	22.2	Half-Month
Low	Very Low	High	Very Low	Long	0.1	99.8	0.1	Date
Low	Very Low	High	Very Low	Longer	42.9	57	0.1	Middle Date
Low	Very Low	High	Low	Shorter	69.9	30	0.1	Middle Date
Low	Very Low	High	Low	Short	49.95	49.95	0.1	Date
Low	Very Low	High	Low	Moderate	42.9	57	0.1	Half-Month
Low	Very Low	High	Low	Long	0.1	40	59.9	Middle Date
Low	Very Low	High	Low	Longer	33.3	66.6	0.1	Middle Date
Low	Very Low	High	Moderate	Shorter	9.1	27.3	63.6	Half-Month
Low	Very Low	High	Moderate	Short	42.9	57	0.1	Half-Month
Low	Very Low	High	Moderate	Moderate	49.95	49.95	0.1	Date
Low	Very Low	High	Moderate	Long	0.1	40	59.9	Middle Date
Low	Very Low	High	Moderate	Longer	39.4	60.5	0.1	Middle Date
Low	Very Low	High	High	Shorter	10.7	32.2	57.1	Half-Month
Low	Very Low	High	High	Short	38.9	46.2	14.9	Interpolate
Low	Very Low	High	High	Moderate	0.1	77.7	22.2	Half-Month
Low	Very Low	High	High	Long	0.1	77.7	22.2	Half-Month
Low	Very Low	High	High	Longer	36.8	63.1	0.1	Middle Date
Low	Very Low	High	Very High	Shorter	0.1	20	79.9	Date
Low	Very Low	High	Very High	Short	49.95	49.95	0.1	Date
Low	Very Low	High	Very High	Moderate	49.95	49.95	0.1	Date
Low	Very Low	High	Very High	Long	0.1	77.7	22.2	Half-Month
Low	Very Low	High	Very High	Longer	0.1	40	59.9	Middle Half-Month
Low	Low	Low	Very Low	Shorter	99.8	0.1	0.1	Lower Month
Low	Low	Low	Very Low	Short	99.8	0.1	0.1	Lower Month
Low	Low	Low	Very Low	Moderate	57.9	37.7	4.4	Interpolate
Low	Low	Low	Very Low	Long	58.4	41.5	0.1	Interpolate

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	Low	Low	Very Low	Longer	56.2	18.8	25	Interpolate
Low	Low	Low	Low	Shorter	89.9	10	0.1	Middle Date
Low	Low	Low	Low	Short	0.1	99.8	0.1	Middle Date
Low	Low	Low	Low	Moderate	30	69.9	0.1	Middle Half-Month
Low	Low	Low	Low	Long	26.1	73.8	0.1	Middle Half-Month
Low	Low	Low	Low	Longer	25	25	50	Date
Low	Low	Low	Moderate	Shorter	76.5	23.4	0.1	Middle Date
Low	Low	Low	Moderate	Short	63	36.9	0.1	Middle Date
Low	Low	Low	Moderate	Moderate	33.3	66.6	0.1	Middle Date
Low	Low	Low	Moderate	Long	69.9	30	0.1	Middle Half-Month
Low	Low	Low	Moderate	Longer	53.2	46.7	0.1	Middle Date
Low	Low	Low	High	Shorter	66.7	33.2	0.1	Middle Date
Low	Low	Low	High	Short	60.7	39.2	0.1	Middle Date
Low	Low	Low	High	Moderate	45.5	54.4	0.1	Middle Date
Low	Low	Low	High	Long	33.3	66.6	0.1	Middle Date
Low	Low	Low	High	Longer	36.7	19.1	44.2	Date
Low	Low	Low	Very High	Shorter	0.1	99.8	0.1	Date
Low	Low	Low	Very High	Short	0.1	99.8	0.1	Half-Month
Low	Low	Low	Very High	Moderate	99.8	0.1	0.1	Middle Half-Month
Low	Low	Low	Very High	Long	33.3	66.6	0.1	Middle Date
Low	Low	Low	Very High	Longer	32.2	21.4	46.4	Date
Low	Low	Moderate	Very Low	Shorter	7.4	70.4	22.2	Half-Month
Low	Low	Moderate	Very Low	Short	66.6	33.3	0.1	Half-Month
Low	Low	Moderate	Very Low	Moderate	40	59.9	0.1	Lower Half-Month
Low	Low	Moderate	Very Low	Long	34.8	63.1	2.1	Interpolate
Low	Low	Moderate	Very Low	Longer	49	38.5	12.5	Interpolate
Low	Low	Moderate	Low	Shorter	74.6	25.3	0.1	Half-Month
Low	Low	Moderate	Low	Short	99.8	0.1	0.1	Date
Low	Low	Moderate	Low	Moderate	42.9	57	0.1	Half-Month
Low	Low	Moderate	Low	Long	0.1	99.8	0.1	Middle Date
Low	Low	Moderate	Low	Longer	65.4	34.5	0.1	Middle Date
Low	Low	Moderate	Moderate	Shorter	0.1	0.1	99.8	Date
Low	Low	Moderate	Moderate	Short	78.8	21.1	0.1	Date
Low	Low	Moderate	Moderate	Moderate	49.95	49.95	0.1	Date
Low	Low	Moderate	Moderate	Long	0.1	99.8	0.1	Middle Date
Low	Low	Moderate	Moderate	Longer	99.8	0.1	0.1	Date
Low	Low	Moderate	High	Shorter	14.3	38.1	47.6	Date
Low	Low	Moderate	High	Short	99.8	0.1	0.1	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	Low	Moderate	High	Moderate	99.8	0.1	0.1	Date
Low	Low	Moderate	High	Long	59.9	40	0.1	Half-Month
Low	Low	Moderate	High	Longer	99.8	0.1	0.1	Date
Low	Low	Moderate	Very High	Shorter	15.8	84.1	0.1	Date
Low	Low	Moderate	Very High	Short	99.8	0.1	0.1	Date
Low	Low	Moderate	Very High	Moderate	87.9	12	0.1	Date
Low	Low	Moderate	Very High	Long	0.1	99.8	0.1	Date
Low	Low	Moderate	Very High	Longer	0.1	50.3	49.6	Date
Low	Low	High	Very Low	Shorter	0.1	99.8	0.1	Date
Low	Low	High	Very Low	Short	52.3	47.6	0.1	Interpolate
Low	Low	High	Very Low	Moderate	46.6	49	4.4	Interpolate
Low	Low	High	Very Low	Long	31	67.3	1.7	Interpolate
Low	Low	High	Very Low	Longer	42.9	57	0.1	Middle Date
Low	Low	High	Low	Shorter	59.3	40.6	0.1	Middle Date
Low	Low	High	Low	Short	42.9	57	0.1	Half-Month
Low	Low	High	Low	Moderate	42.9	57	0.1	Half-Month
Low	Low	High	Low	Long	16.7	83	0.3	Middle Date
Low	Low	High	Low	Longer	24.8	74.3	0.9	Middle Date
Low	Low	High	Moderate	Shorter	0.1	99.8	0.1	Date
Low	Low	High	Moderate	Short	99.8	0.1	0.1	Date
Low	Low	High	Moderate	Moderate	49.95	49.95	0.1	Date
Low	Low	High	Moderate	Long	17.3	82.4	0.3	Middle Date
Low	Low	High	Moderate	Longer	31	68	1	Middle Date
Low	Low	High	High	Shorter	0.1	99.8	0.1	Date
Low	Low	High	High	Short	30.9	69	0.1	Date
Low	Low	High	High	Moderate	18.6	81.3	0.1	Middle Half-Month
Low	Low	High	High	Long	17.2	82	0.8	Middle Date
Low	Low	High	High	Longer	14.9	80.8	4.3	Middle Date
Low	Low	High	Very High	Shorter	0.1	35.5	64.4	Date
Low	Low	High	Very High	Short	2.7	97.2	0.1	Date
Low	Low	High	Very High	Moderate	49.95	49.95	0.1	Date
Low	Low	High	Very High	Long	0.1	99.8	0.1	Date
Low	Low	High	Very High	Longer	38.8	54.1	7.1	Middle Date
Low	Moderate	Low	Very Low	Shorter	55.7	37.3	7	Interpolate
Low	Moderate	Low	Very Low	Short	64.4	30.3	5.3	Interpolate
Low	Moderate	Low	Very Low	Moderate	45.3	46	8.7	Interpolate
Low	Moderate	Low	Very Low	Long	50	47.9	2.1	Interpolate
Low	Moderate	Low	Very Low	Longer	41.6	37.5	20.9	Interpolate

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	Moderate	Low	Low	Shorter	99.8	0.1	0.1	Date
Low	Moderate	Low	Low	Short	0.1	99.8	0.1	Middle Date
Low	Moderate	Low	Low	Moderate	30	69.9	0.1	Middle Half-Month
Low	Moderate	Low	Low	Long	26.1	73.8	0.1	Middle Half-Month
Low	Moderate	Low	Low	Longer	49.5	16.8	33.7	Date
Low	Moderate	Low	Moderate	Shorter	99.8	0.1	0.1	Date
Low	Moderate	Low	Moderate	Short	20	79.9	0.1	Half-Month
Low	Moderate	Low	Moderate	Moderate	0.1	99.8	0.1	Date
Low	Moderate	Low	Moderate	Long	69.9	30	0.1	Middle Half-Month
Low	Moderate	Low	Moderate	Longer	43.7	56.2	0.1	Middle Date
Low	Moderate	Low	High	Shorter	77.4	22.5	0.1	Date
Low	Moderate	Low	High	Short	44.4	30.6	25	Date
Low	Moderate	Low	High	Moderate	0.1	99.8	0.1	Date
Low	Moderate	Low	High	Long	29.4	64.5	6.1	Half-Month
Low	Moderate	Low	High	Longer	40.7	28.4	30.9	Date
Low	Moderate	Low	Very High	Shorter	57.3	29.3	13.4	Date
Low	Moderate	Low	Very High	Short	59	7.7	33.3	Date
Low	Moderate	Low	Very High	Moderate	27.6	68.6	3.8	Half-Month
Low	Moderate	Low	Very High	Long	20	79.9	0.1	Date
Low	Moderate	Low	Very High	Longer	27.7	35	37.3	Date
Low	Moderate	Moderate	Very Low	Shorter	16.4	48.8	34.8	Half-Month
Low	Moderate	Moderate	Very Low	Short	66.4	33.5	0.1	Date
Low	Moderate	Moderate	Very Low	Moderate	49.95	49.95	0.1	Date
Low	Moderate	Moderate	Very Low	Long	50	41.7	8.3	Half-Month
Low	Moderate	Moderate	Very Low	Longer	0.1	49.95	49.95	Date
Low	Moderate	Moderate	Low	Shorter	99.8	0.1	0.1	Date
Low	Moderate	Moderate	Low	Short	77.7	22.2	0.1	Date
Low	Moderate	Moderate	Low	Moderate	42.9	57	0.1	Half-Month
Low	Moderate	Moderate	Low	Long	11.9	87.4	0.7	Middle Date
Low	Moderate	Moderate	Low	Longer	99.8	0.1	0.1	Date
Low	Moderate	Moderate	Moderate	Shorter	14.9	83.4	1.7	Date
Low	Moderate	Moderate	Moderate	Short	98.6	1.3	0.1	Date
Low	Moderate	Moderate	Moderate	Moderate	37.7	61.2	1.1	Half-Month
Low	Moderate	Moderate	Moderate	Long	50	41.7	8.3	Half-Month
Low	Moderate	Moderate	Moderate	Longer	66.6	33.3	0.1	Date
Low	Moderate	Moderate	High	Shorter	10.6	89.1	0.3	Date
Low	Moderate	Moderate	High	Short	31.6	68.3	0.1	Date
Low	Moderate	Moderate	High	Moderate	99.8	0.1	0.1	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	Moderate	Moderate	High	Long	4.3	95.6	0.1	Date
Low	Moderate	Moderate	High	Longer	60.3	39.6	0.1	Date
Low	Moderate	Moderate	Very High	Shorter	4.5	94.1	1.4	Date
Low	Moderate	Moderate	Very High	Short	49.95	49.95	0.1	Date
Low	Moderate	Moderate	Very High	Moderate	95.6	4.3	0.1	Date
Low	Moderate	Moderate	Very High	Long	14.5	85.4	0.1	Date
Low	Moderate	Moderate	Very High	Longer	21.3	57.5	21.2	Date
Low	Moderate	High	Very Low	Shorter	0.1	99.8	0.1	Date
Low	Moderate	High	Very Low	Short	41.6	58.3	0.1	Interpolate
Low	Moderate	High	Very Low	Moderate	49.95	49.95	0.1	Date
Low	Moderate	High	Very Low	Long	50	41.7	8.3	Half-Month
Low	Moderate	High	Very Low	Longer	50	41.7	8.3	Half-Month
Low	Moderate	High	Low	Shorter	99.8	0.1	0.1	Half-Month
Low	Moderate	High	Low	Short	49.95	49.95	0.1	Date
Low	Moderate	High	Low	Moderate	42.9	57	0.1	Half-Month
Low	Moderate	High	Low	Long	49.95	0.1	49.95	Date
Low	Moderate	High	Low	Longer	12.5	25	62.5	Half-Month
Low	Moderate	High	Moderate	Shorter	0.8	72.5	26.7	Date
Low	Moderate	High	Moderate	Short	77	22.9	0.1	Date
Low	Moderate	High	Moderate	Moderate	49.9	41.9	8.2	Half-Month
Low	Moderate	High	Moderate	Long	50	41.7	8.3	Half-Month
Low	Moderate	High	Moderate	Longer	59.5	40.4	0.1	Date
Low	Moderate	High	High	Shorter	51.7	42.3	6	Date
Low	Moderate	High	High	Short	29.1	70.8	0.1	Date
Low	Moderate	High	High	Moderate	32.2	62.4	5.4	Half-Month
Low	Moderate	High	High	Long	0.1	99.8	0.1	Date
Low	Moderate	High	High	Longer	51.3	48.6	0.1	Date
Low	Moderate	High	Very High	Shorter	7	40.6	52.4	Date
Low	Moderate	High	Very High	Short	29.9	70	0.1	Date
Low	Moderate	High	Very High	Moderate	49.95	49.95	0.1	Date
Low	Moderate	High	Very High	Long	2.5	95	2.5	Date
Low	Moderate	High	Very High	Longer	27.8	72.1	0.1	Date
Low	High	Low	Very Low	Shorter	45.5	54.4	0.1	Half-Month
Low	High	Low	Very Low	Short	99.8	0.1	0.1	Date
Low	High	Low	Very Low	Moderate	59.4	31.9	8.7	Interpolate
Low	High	Low	Very Low	Long	33.3	66.6	0.1	Half-Month
Low	High	Low	Very Low	Longer	33.3	66.6	0.1	Half-Month
Low	High	Low	Low	Shorter	99.8	0.1	0.1	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	High	Low	Low	Short	89.9	10	0.1	Middle Half-Month
Low	High	Low	Low	Moderate	32.6	67.3	0.1	Interpolate
Low	High	Low	Low	Long	35	64.9	0.1	Interpolate
Low	High	Low	Low	Longer	50.7	49.2	0.1	Middle Date
Low	High	Low	Moderate	Shorter	99.8	0.1	0.1	Date
Low	High	Low	Moderate	Short	38.8	61.1	0.1	Half-Month
Low	High	Low	Moderate	Moderate	0.1	99.8	0.1	Date
Low	High	Low	Moderate	Long	33.3	66.6	0.1	Half-Month
Low	High	Low	Moderate	Longer	33.3	66.6	0.1	Half-Month
Low	High	Low	High	Shorter	72.2	27.7	0.1	Date
Low	High	Low	High	Short	69.8	22.9	7.3	Date
Low	High	Low	High	Moderate	0.1	99.8	0.1	Date
Low	High	Low	High	Long	99.8	0.1	0.1	Date
Low	High	Low	High	Longer	38.8	61.1	0.1	Date
Low	High	Low	Very High	Shorter	46.9	29.1	24	Date
Low	High	Low	Very High	Short	82.8	8.6	8.6	Date
Low	High	Low	Very High	Moderate	21.2	71.7	7.1	Half-Month
Low	High	Low	Very High	Long	20.7	79.2	0.1	Date
Low	High	Low	Very High	Longer	16.1	62.8	21.1	Date
Low	High	Moderate	Very Low	Shorter	45.5	54.4	0.1	Date
Low	High	Moderate	Very Low	Short	47.7	52.2	0.1	Half-Month
Low	High	Moderate	Very Low	Moderate	50	41.7	8.3	Half-Month
Low	High	Moderate	Very Low	Long	12.8	87.1	0.1	Date
Low	High	Moderate	Very Low	Longer	0.1	49.95	49.95	Date
Low	High	Moderate	Low	Shorter	99.8	0.1	0.1	Date
Low	High	Moderate	Low	Short	49.95	49.95	0.1	Date
Low	High	Moderate	Low	Moderate	42.9	57	0.1	Half-Month
Low	High	Moderate	Low	Long	0.1	99.8	0.1	Date
Low	High	Moderate	Low	Longer	17.5	82.4	0.1	Middle Date
Low	High	Moderate	Moderate	Shorter	45.5	51.5	3	Date
Low	High	Moderate	Moderate	Short	61.7	38.2	0.1	Date
Low	High	Moderate	Moderate	Moderate	49.3	43.1	7.6	Half-Month
Low	High	Moderate	Moderate	Long	39.9	56.8	3.3	Half-Month
Low	High	Moderate	Moderate	Longer	99.8	0.1	0.1	Date
Low	High	Moderate	High	Shorter	12.1	87.7	0.2	Date
Low	High	Moderate	High	Short	43.8	56.1	0.1	Date
Low	High	Moderate	High	Moderate	38.8	54	7.2	Half-Month
Low	High	Moderate	High	Long	6.1	79.5	14.4	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	High	Moderate	High	Longer	56.7	43.2	0.1	Date
Low	High	Moderate	Very High	Shorter	14.5	58.8	26.7	Date
Low	High	Moderate	Very High	Short	38.9	61	0.1	Date
Low	High	Moderate	Very High	Moderate	0.1	67.9	32	Date
Low	High	Moderate	Very High	Long	13.5	68.2	18.3	Date
Low	High	Moderate	Very High	Longer	22.9	52.6	24.5	Date
Low	High	High	Very Low	Shorter	0.1	99.8	0.1	Date
Low	High	High	Very Low	Short	31.8	66.5	1.7	Interpolate
Low	High	High	Very Low	Moderate	50	41.7	8.3	Half-Month
Low	High	High	Very Low	Long	33.3	66.6	0.1	Date
Low	High	High	Very Low	Longer	39.9	55	5.1	Half-Month
Low	High	High	Low	Shorter	45.9	47.3	6.8	Half-Month
Low	High	High	Low	Short	49.95	49.95	0.1	Date
Low	High	High	Low	Moderate	49.95	49.95	0.1	Date
Low	High	High	Low	Long	39.6	41.6	18.8	Date
Low	High	High	Low	Longer	12.5	25	62.5	Half-Month
Low	High	High	Moderate	Shorter	45.4	36.4	18.2	Date
Low	High	High	Moderate	Short	69.3	30.6	0.1	Date
Low	High	High	Moderate	Moderate	41.6	51.6	6.8	Half-Month
Low	High	High	Moderate	Long	27.9	64.5	7.6	Half-Month
Low	High	High	Moderate	Longer	99.8	0.1	0.1	Date
Low	High	High	High	Shorter	40.6	55.2	4.2	Date
Low	High	High	High	Short	26.4	73.5	0.1	Date
Low	High	High	High	Moderate	49.95	49.95	0.1	Date
Low	High	High	High	Long	6.9	72.7	20.4	Date
Low	High	High	High	Longer	30.8	69.1	0.1	Date
Low	High	High	Very High	Shorter	3	34.5	62.5	Date
Low	High	High	Very High	Short	2.5	83.6	13.9	Date
Low	High	High	Very High	Moderate	18.1	56.4	25.5	Date
Low	High	High	Very High	Long	9.6	66.9	23.5	Date
Low	High	High	Very High	Longer	1.6	98.3	0.1	Date
Low	Very High	Low	Very Low	Shorter	45.5	54.4	0.1	Half-Month
Low	Very High	Low	Very Low	Short	99.8	0.1	0.1	Date
Low	Very High	Low	Very Low	Moderate	61	38.9	0.1	Interpolate
Low	Very High	Low	Very Low	Long	33.3	66.6	0.1	Half-Month
Low	Very High	Low	Very Low	Longer	66.6	33.3	0.1	Date
Low	Very High	Low	Low	Shorter	99.8	0.1	0.1	Date
Low	Very High	Low	Low	Short	78	21.9	0.1	Interpolate

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	Very High	Low	Low	Moderate	33.3	46.7	20	Interpolate
Low	Very High	Low	Low	Long	34.8	61.9	3.3	Interpolate
Low	Very High	Low	Low	Longer	41	58.9	0.1	Middle Date
Low	Very High	Low	Moderate	Shorter	99.8	0.1	0.1	Date
Low	Very High	Low	Moderate	Short	45.5	54.4	0.1	Half-Month
Low	Very High	Low	Moderate	Moderate	0.1	99.8	0.1	Middle Half-Month
Low	Very High	Low	Moderate	Long	33.3	66.6	0.1	Half-Month
Low	Very High	Low	Moderate	Longer	33.3	66.6	0.1	Half-Month
Low	Very High	Low	High	Shorter	58.6	41.3	0.1	Date
Low	Very High	Low	High	Short	47.8	6	46.2	Date
Low	Very High	Low	High	Moderate	28.5	62.6	8.9	Half-Month
Low	Very High	Low	High	Long	99.8	0.1	0.1	Date
Low	Very High	Low	High	Longer	73.4	17.8	8.8	Date
Low	Very High	Low	Very High	Shorter	44.9	31.5	23.6	Date
Low	Very High	Low	Very High	Short	42.6	16.7	40.7	Date
Low	Very High	Low	Very High	Moderate	18.3	66.7	15	Date
Low	Very High	Low	Very High	Long	75.5	24.4	0.1	Date
Low	Very High	Low	Very High	Longer	42.3	46.6	11.1	Date
Low	Very High	Moderate	Very Low	Shorter	43.5	56.4	0.1	Date
Low	Very High	Moderate	Very Low	Short	49.1	50.8	0.1	Date
Low	Very High	Moderate	Very Low	Moderate	49.95	49.95	0.1	Date
Low	Very High	Moderate	Very Low	Long	16.7	83.2	0.1	Date
Low	Very High	Moderate	Very Low	Longer	74.9	25	0.1	Date
Low	Very High	Moderate	Low	Shorter	44.1	55	0.9	Half-Month
Low	Very High	Moderate	Low	Short	99.8	0.1	0.1	Date
Low	Very High	Moderate	Low	Moderate	0.1	40	59.9	Middle Date
Low	Very High	Moderate	Low	Long	33.3	50	16.7	Half-Month
Low	Very High	Moderate	Low	Longer	22.2	77.7	0.1	Middle Date
Low	Very High	Moderate	Moderate	Shorter	49.95	49.95	0.1	Date
Low	Very High	Moderate	Moderate	Short	33.3	66.6	0.1	Date
Low	Very High	Moderate	Moderate	Moderate	40.7	56.4	2.9	Half-Month
Low	Very High	Moderate	Moderate	Long	0.1	99.8	0.1	Date
Low	Very High	Moderate	Moderate	Longer	66.6	33.3	0.1	Date
Low	Very High	Moderate	High	Shorter	1.5	70.5	28	Date
Low	Very High	Moderate	High	Short	52.4	47.5	0.1	Date
Low	Very High	Moderate	High	Moderate	25	71.9	3.1	Half-Month
Low	Very High	Moderate	High	Long	1.7	86.5	11.8	Date
Low	Very High	Moderate	High	Longer	50.4	49.5	0.1	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	Very High	Moderate	Very High	Shorter	11.9	55.4	32.7	Date
Low	Very High	Moderate	Very High	Short	14.1	85.8	0.1	Date
Low	Very High	Moderate	Very High	Moderate	4.2	57	38.8	Date
Low	Very High	Moderate	Very High	Long	2.8	49.4	47.8	Date
Low	Very High	Moderate	Very High	Longer	2.5	51	46.5	Date
Low	Very High	High	Very Low	Shorter	0.1	85.8	14.1	Date
Low	Very High	High	Very Low	Short	11.1	88.8	0.1	Half-Month
Low	Very High	High	Very Low	Moderate	49.95	49.95	0.1	Date
Low	Very High	High	Very Low	Long	40.7	59.2	0.1	Date
Low	Very High	High	Very Low	Longer	99.8	0.1	0.1	Date
Low	Very High	High	Low	Shorter	76.3	20.7	3	Half-Month
Low	Very High	High	Low	Short	99.8	0.1	0.1	Date
Low	Very High	High	Low	Moderate	49.95	49.95	0.1	Date
Low	Very High	High	Low	Long	39.6	41.6	18.8	Date
Low	Very High	High	Low	Longer	12.5	25	62.5	Half-Month
Low	Very High	High	Moderate	Shorter	25.3	25.3	49.4	Date
Low	Very High	High	Moderate	Short	57.3	42.6	0.1	Date
Low	Very High	High	Moderate	Moderate	32	63.1	4.9	Half-Month
Low	Very High	High	Moderate	Long	0.1	52.5	47.4	Date
Low	Very High	High	Moderate	Longer	68.3	31.6	0.1	Date
Low	Very High	High	High	Shorter	21.7	57.9	20.4	Date
Low	Very High	High	High	Short	35.9	53.6	10.5	Half-Month
Low	Very High	High	High	Moderate	12.6	84.9	2.5	Half-Month
Low	Very High	High	High	Long	7.5	81	11.5	Date
Low	Very High	High	High	Longer	40.9	59	0.1	Date
Low	Very High	High	Very High	Shorter	2.3	68	29.7	Date
Low	Very High	High	Very High	Short	1.7	56.4	41.9	Date
Low	Very High	High	Very High	Moderate	11.1	39.6	49.3	Date
Low	Very High	High	Very High	Long	0.6	39	60.4	Date
Low	Very High	High	Very High	Longer	8.6	72.3	19.1	Date
Moderate	Very Low	Low	Very Low	Shorter	99.8	0.1	0.1	Lower Month
Moderate	Very Low	Low	Very Low	Short	99.8	0.1	0.1	Lower Month
Moderate	Very Low	Low	Very Low	Moderate	62.4	37.5	0.1	Lower Month
Moderate	Very Low	Low	Very Low	Long	62.4	37.5	0.1	Lower Month
Moderate	Very Low	Low	Very Low	Longer	87.4	12.5	0.1	Middle Date
Moderate	Very Low	Low	Low	Shorter	79.9	20	0.1	Middle Date
Moderate	Very Low	Low	Low	Short	0.1	99.8	0.1	Middle Half-Month
Moderate	Very Low	Low	Low	Moderate	99.8	0.1	0.1	Middle Half-Month

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Moderate	Very Low	Low	Low	Long	99.8	0.1	0.1	Middle Half-Month
Moderate	Very Low	Low	Low	Longer	79.4	20.5	0.1	Middle Date
Moderate	Very Low	Low	Moderate	Shorter	62.3	37.6	0.1	Middle Date
Moderate	Very Low	Low	Moderate	Short	0.1	99.8	0.1	Middle Half-Month
Moderate	Very Low	Low	Moderate	Moderate	99.8	0.1	0.1	Middle Half-Month
Moderate	Very Low	Low	Moderate	Long	99.8	0.1	0.1	Middle Half-Month
Moderate	Very Low	Low	Moderate	Longer	28.8	71.1	0.1	Middle Date
Moderate	Very Low	Low	High	Shorter	50.2	49.7	0.1	Middle Date
Moderate	Very Low	Low	High	Short	0.1	99.8	0.1	Middle Half-Month
Moderate	Very Low	Low	High	Moderate	99.8	0.1	0.1	Middle Half-Month
Moderate	Very Low	Low	High	Long	99.8	0.1	0.1	Middle Half-Month
Moderate	Very Low	Low	High	Longer	20	40	40	Date
Moderate	Very Low	Low	Very High	Shorter	40.7	59.2	0.1	Middle Date
Moderate	Very Low	Low	Very High	Short	62.5	37.4	0.1	Interpolate
Moderate	Very Low	Low	Very High	Moderate	85.6	14.3	0.1	Interpolate
Moderate	Very Low	Low	Very High	Long	38.3	36.7	25	Interpolate
Moderate	Very Low	Low	Very High	Longer	20	40	40	Date
Moderate	Very Low	Moderate	Very Low	Shorter	99.8	0.1	0.1	Date
Moderate	Very Low	Moderate	Very Low	Short	64.6	35.3	0.1	Half-Month
Moderate	Very Low	Moderate	Very Low	Moderate	33.5	66.4	0.1	Lower Date
Moderate	Very Low	Moderate	Very Low	Long	45.5	54.4	0.1	Lower Date
Moderate	Very Low	Moderate	Very Low	Longer	87.4	12.5	0.1	Middle Date
Moderate	Very Low	Moderate	Low	Shorter	74.9	25	0.1	Half-Month
Moderate	Very Low	Moderate	Low	Short	49.95	49.95	0.1	Date
Moderate	Very Low	Moderate	Low	Moderate	42.9	57	0.1	Half-Month
Moderate	Very Low	Moderate	Low	Long	11.7	49.3	39	Middle Date
Moderate	Very Low	Moderate	Low	Longer	75.7	24.2	0.1	Middle Date
Moderate	Very Low	Moderate	Moderate	Shorter	0.1	0.1	99.8	Date
Moderate	Very Low	Moderate	Moderate	Short	99.8	0.1	0.1	Date
Moderate	Very Low	Moderate	Moderate	Moderate	42.9	57	0.1	Half-Month
Moderate	Very Low	Moderate	Moderate	Long	0.1	40	59.9	Middle Date
Moderate	Very Low	Moderate	Moderate	Longer	52.6	47.3	0.1	Middle Date
Moderate	Very Low	Moderate	High	Shorter	0.1	0.1	99.8	Date
Moderate	Very Low	Moderate	High	Short	51.2	48.7	0.1	Half-Month
Moderate	Very Low	Moderate	High	Moderate	33.3	66.6	0.1	Middle Half-Month
Moderate	Very Low	Moderate	High	Long	7.1	45.7	47.2	Middle Date
Moderate	Very Low	Moderate	High	Longer	55.1	44.8	0.1	Middle Date
Moderate	Very Low	Moderate	Very High	Shorter	49.95	49.95	0.1	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Moderate	Very Low	Moderate	Very High	Short	64.6	35.3	0.1	Date
Moderate	Very Low	Moderate	Very High	Moderate	42.9	57	0.1	Half-Month
Moderate	Very Low	Moderate	Very High	Long	0.1	40	59.9	Middle Date
Moderate	Very Low	Moderate	Very High	Longer	0.1	40	59.9	Middle Half-Month
Moderate	Very Low	High	Very Low	Shorter	15.4	46.1	38.5	Half-Month
Moderate	Very Low	High	Very Low	Short	99.8	0.1	0.1	Lower Date
Moderate	Very Low	High	Very Low	Moderate	99.8	0.1	0.1	Middle Date
Moderate	Very Low	High	Very Low	Long	45.5	54.4	0.1	Lower Date
Moderate	Very Low	High	Very Low	Longer	42.9	57	0.1	Middle Date
Moderate	Very Low	High	Low	Shorter	64.7	34.9	0.4	Middle Date
Moderate	Very Low	High	Low	Short	49.95	49.95	0.1	Date
Moderate	Very Low	High	Low	Moderate	42.9	57	0.1	Half-Month
Moderate	Very Low	High	Low	Long	97.4	1.8	0.8	Middle Date
Moderate	Very Low	High	Low	Longer	76	23.9	0.1	Middle Date
Moderate	Very Low	High	Moderate	Shorter	9.1	27.3	63.6	Half-Month
Moderate	Very Low	High	Moderate	Short	42.9	57	0.1	Half-Month
Moderate	Very Low	High	Moderate	Moderate	42.9	57	0.1	Half-Month
Moderate	Very Low	High	Moderate	Long	93.5	2.6	3.9	Middle Date
Moderate	Very Low	High	Moderate	Longer	41.7	58.2	0.1	Middle Date
Moderate	Very Low	High	High	Shorter	10	30	60	Half-Month
Moderate	Very Low	High	High	Short	37.5	37.5	25	Middle Date
Moderate	Very Low	High	High	Moderate	22.4	77.5	0.1	Middle Date
Moderate	Very Low	High	High	Long	14	51.1	34.9	Middle Date
Moderate	Very Low	High	High	Longer	36.9	63	0.1	Middle Date
Moderate	Very Low	High	Very High	Shorter	13.6	40.8	45.6	Half-Month
Moderate	Very Low	High	Very High	Short	49.95	49.95	0.1	Date
Moderate	Very Low	High	Very High	Moderate	42.9	57	0.1	Half-Month
Moderate	Very Low	High	Very High	Long	0.1	40	59.9	Middle Date
Moderate	Very Low	High	Very High	Longer	0.1	40	59.9	Middle Half-Month
Moderate	Low	Low	Very Low	Shorter	99.8	0.1	0.1	Lower Half-Month
Moderate	Low	Low	Very Low	Short	32.3	31.8	35.9	Lower Half-Month
Moderate	Low	Low	Very Low	Moderate	61.6	20.8	17.6	Lower Half-Month
Moderate	Low	Low	Very Low	Long	90.8	9.1	0.1	Lower Half-Month
Moderate	Low	Low	Very Low	Longer	87.4	12.5	0.1	Middle Date
Moderate	Low	Low	Low	Shorter	83.2	16.7	0.1	Middle Date
Moderate	Low	Low	Low	Short	0.1	44.8	55.1	Middle Date
Moderate	Low	Low	Low	Moderate	55.5	44.4	0.1	Middle Date
Moderate	Low	Low	Low	Long	87.4	12.5	0.1	Middle Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Moderate	Low	Low	Low	Longer	25	25	50	Date
Moderate	Low	Low	Moderate	Shorter	71.6	28.3	0.1	Middle Date
Moderate	Low	Low	Moderate	Short	56.2	38.6	5.2	Middle Date
Moderate	Low	Low	Moderate	Moderate	60.8	39.1	0.1	Middle Date
Moderate	Low	Low	Moderate	Long	87.4	12.5	0.1	Middle Date
Moderate	Low	Low	Moderate	Longer	44.2	55.7	0.1	Middle Date
Moderate	Low	Low	High	Shorter	63.5	36.4	0.1	Middle Date
Moderate	Low	Low	High	Short	49.95	49.95	0.1	Middle Date
Moderate	Low	Low	High	Moderate	98.8	1.1	0.1	Middle Date
Moderate	Low	Low	High	Long	33.3	66.6	0.1	Middle Date
Moderate	Low	Low	High	Longer	45.4	16.1	38.5	Date
Moderate	Low	Low	Very High	Shorter	77.9	22	0.1	Middle Date
Moderate	Low	Low	Very High	Short	70	29.9	0.1	Middle Half-Month
Moderate	Low	Low	Very High	Moderate	63.5	36.4	0.1	Interpolate
Moderate	Low	Low	Very High	Long	33.3	66.6	0.1	Middle Date
Moderate	Low	Low	Very High	Longer	42	17.6	40.4	Date
Moderate	Low	Moderate	Very Low	Shorter	9.9	68.8	21.3	Half-Month
Moderate	Low	Moderate	Very Low	Short	66.6	33.3	0.1	Half-Month
Moderate	Low	Moderate	Very Low	Moderate	38.1	58.6	3.3	Lower Half-Month
Moderate	Low	Moderate	Very Low	Long	49	50.9	0.1	Lower Date
Moderate	Low	Moderate	Very Low	Longer	87.4	12.5	0.1	Middle Date
Moderate	Low	Moderate	Low	Shorter	74.1	25.8	0.1	Half-Month
Moderate	Low	Moderate	Low	Short	68.9	31	0.1	Half-Month
Moderate	Low	Moderate	Low	Moderate	42.9	57	0.1	Half-Month
Moderate	Low	Moderate	Low	Long	75.3	24.6	0.1	Middle Date
Moderate	Low	Moderate	Low	Longer	68.1	31.8	0.1	Middle Date
Moderate	Low	Moderate	Moderate	Shorter	0.1	0.1	99.8	Date
Moderate	Low	Moderate	Moderate	Short	99.8	0.1	0.1	Date
Moderate	Low	Moderate	Moderate	Moderate	42.9	57	0.1	Half-Month
Moderate	Low	Moderate	Moderate	Long	38.8	61.1	0.1	Middle Date
Moderate	Low	Moderate	Moderate	Longer	42.6	57.3	0.1	Middle Date
Moderate	Low	Moderate	High	Shorter	0.1	0.1	99.8	Date
Moderate	Low	Moderate	High	Short	99.8	0.1	0.1	Date
Moderate	Low	Moderate	High	Moderate	59.9	40	0.1	Half-Month
Moderate	Low	Moderate	High	Long	59.9	40	0.1	Half-Month
Moderate	Low	Moderate	High	Longer	31	68.9	0.1	Middle Date
Moderate	Low	Moderate	Very High	Shorter	26.7	49.5	23.8	Half-Month
Moderate	Low	Moderate	Very High	Short	53.7	45.8	0.5	Half-Month

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Moderate	Low	Moderate	Very High	Moderate	42.9	57	0.1	Half-Month
Moderate	Low	Moderate	Very High	Long	66.6	0.1	33.3	Half-Month
Moderate	Low	Moderate	Very High	Longer	32.7	37.4	29.9	Interpolate
Moderate	Low	High	Very Low	Shorter	0.1	99.8	0.1	Date
Moderate	Low	High	Very Low	Short	99.8	0.1	0.1	Lower Date
Moderate	Low	High	Very Low	Moderate	99.8	0.1	0.1	Middle Date
Moderate	Low	High	Very Low	Long	45.5	54.4	0.1	Lower Date
Moderate	Low	High	Very Low	Longer	42.9	57	0.1	Middle Date
Moderate	Low	High	Low	Shorter	54.4	45.2	0.4	Middle Date
Moderate	Low	High	Low	Short	42.9	57	0.1	Half-Month
Moderate	Low	High	Low	Moderate	42.9	57	0.1	Half-Month
Moderate	Low	High	Low	Long	51.6	48.3	0.1	Middle Date
Moderate	Low	High	Low	Longer	62	37.6	0.4	Middle Date
Moderate	Low	High	Moderate	Shorter	0.1	99.8	0.1	Date
Moderate	Low	High	Moderate	Short	99.8	0.1	0.1	Date
Moderate	Low	High	Moderate	Moderate	42.9	57	0.1	Half-Month
Moderate	Low	High	Moderate	Long	29.8	70	0.2	Middle Date
Moderate	Low	High	Moderate	Longer	38.3	61.1	0.6	Middle Date
Moderate	Low	High	High	Shorter	10.2	78	11.8	Half-Month
Moderate	Low	High	High	Short	34.2	65.7	0.1	Date
Moderate	Low	High	High	Moderate	44.9	50	5.1	Middle Date
Moderate	Low	High	High	Long	21.3	78.2	0.5	Middle Date
Moderate	Low	High	High	Longer	27.3	69.4	3.3	Middle Date
Moderate	Low	High	Very High	Shorter	12.4	72.6	15	Half-Month
Moderate	Low	High	Very High	Short	28.6	71.3	0.1	Date
Moderate	Low	High	Very High	Moderate	42.9	57	0.1	Half-Month
Moderate	Low	High	Very High	Long	66.6	0.1	33.3	Half-Month
Moderate	Low	High	Very High	Longer	41.7	52.2	6.1	Middle Date
Moderate	Moderate	Low	Very Low	Shorter	16.7	83.2	0.1	Middle Date
Moderate	Moderate	Low	Very Low	Short	55.3	18	26.7	Lower Half-Month
Moderate	Moderate	Low	Very Low	Moderate	56	17.8	26.2	Lower Half-Month
Moderate	Moderate	Low	Very Low	Long	90.8	9.1	0.1	Lower Half-Month
Moderate	Moderate	Low	Very Low	Longer	83.2	16.7	0.1	Lower Date
Moderate	Moderate	Low	Low	Shorter	87.1	12.8	0.1	Middle Date
Moderate	Moderate	Low	Low	Short	0.1	38	61.9	Middle Date
Moderate	Moderate	Low	Low	Moderate	0.1	99.8	0.1	Middle Date
Moderate	Moderate	Low	Low	Long	87.4	12.5	0.1	Middle Date
Moderate	Moderate	Low	Low	Longer	25	25	50	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Moderate	Moderate	Low	Moderate	Shorter	69.5	29.1	1.4	Middle Date
Moderate	Moderate	Low	Moderate	Short	54.6	29.9	15.5	Middle Date
Moderate	Moderate	Low	Moderate	Moderate	0.1	99.8	0.1	Middle Date
Moderate	Moderate	Low	Moderate	Long	87.4	12.5	0.1	Middle Date
Moderate	Moderate	Low	Moderate	Longer	44.1	55.8	0.1	Middle Date
Moderate	Moderate	Low	High	Shorter	33.3	66.6	0.1	Date
Moderate	Moderate	Low	High	Short	33.4	33.3	33.3	Date
Moderate	Moderate	Low	High	Moderate	70.7	29.2	0.1	Middle Half-Month
Moderate	Moderate	Low	High	Long	73.2	26.7	0.1	Middle Half-Month
Moderate	Moderate	Low	High	Longer	48.1	17.3	34.6	Date
Moderate	Moderate	Low	Very High	Shorter	33.3	66.6	0.1	Date
Moderate	Moderate	Low	Very High	Short	33.4	33.3	33.3	Date
Moderate	Moderate	Low	Very High	Moderate	0.1	99.8	0.1	Middle Half-Month
Moderate	Moderate	Low	Very High	Long	59.8	25.4	14.8	Lower Month
Moderate	Moderate	Low	Very High	Longer	25	25	50	Date
Moderate	Moderate	Moderate	Very Low	Shorter	19.3	51.7	29	Half-Month
Moderate	Moderate	Moderate	Very Low	Short	25	74.9	0.1	Date
Moderate	Moderate	Moderate	Very Low	Moderate	49.95	49.95	0.1	Date
Moderate	Moderate	Moderate	Very Low	Long	50	41.7	8.3	Half-Month
Moderate	Moderate	Moderate	Very Low	Longer	0.1	49.95	49.95	Date
Moderate	Moderate	Moderate	Low	Shorter	78.6	21.3	0.1	Half-Month
Moderate	Moderate	Moderate	Low	Short	49.95	49.95	0.1	Date
Moderate	Moderate	Moderate	Low	Moderate	42.9	57	0.1	Half-Month
Moderate	Moderate	Moderate	Low	Long	40	59.4	0.6	Middle Date
Moderate	Moderate	Moderate	Low	Longer	38.6	61.3	0.1	Middle Date
Moderate	Moderate	Moderate	Moderate	Shorter	6.9	93	0.1	Date
Moderate	Moderate	Moderate	Moderate	Short	99.8	0.1	0.1	Date
Moderate	Moderate	Moderate	Moderate	Moderate	36.5	63	0.5	Half-Month
Moderate	Moderate	Moderate	Moderate	Long	50	41.7	8.3	Half-Month
Moderate	Moderate	Moderate	Moderate	Longer	50	41.7	8.3	Half-Month
Moderate	Moderate	Moderate	High	Shorter	6.9	93	0.1	Date
Moderate	Moderate	Moderate	High	Short	42.3	57.6	0.1	Date
Moderate	Moderate	Moderate	High	Moderate	37.3	61.8	0.9	Half-Month
Moderate	Moderate	Moderate	High	Long	0.1	99.8	0.1	Date
Moderate	Moderate	Moderate	High	Longer	49.3	42.5	8.2	Half-Month
Moderate	Moderate	Moderate	Very High	Shorter	22.6	54.1	23.3	Half-Month
Moderate	Moderate	Moderate	Very High	Short	49.95	49.95	0.1	Date
Moderate	Moderate	Moderate	Very High	Moderate	49.95	49.95	0.1	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Moderate	Moderate	Moderate	Very High	Long	0.1	99.8	0.1	Date
Moderate	Moderate	Moderate	Very High	Longer	0.1	49.95	49.95	Date
Moderate	Moderate	High	Very Low	Shorter	0.1	99.8	0.1	Date
Moderate	Moderate	High	Very Low	Short	53.1	46.8	0.1	Interpolate
Moderate	Moderate	High	Very Low	Moderate	49.95	49.95	0.1	Date
Moderate	Moderate	High	Very Low	Long	50	41.7	8.3	Half-Month
Moderate	Moderate	High	Very Low	Longer	50	41.7	8.3	Half-Month
Moderate	Moderate	High	Low	Shorter	99.8	0.1	0.1	Half-Month
Moderate	Moderate	High	Low	Short	49.95	49.95	0.1	Date
Moderate	Moderate	High	Low	Moderate	42.9	57	0.1	Half-Month
Moderate	Moderate	High	Low	Long	37	62.9	0.1	Middle Date
Moderate	Moderate	High	Low	Longer	31.4	68.4	0.2	Middle Date
Moderate	Moderate	High	Moderate	Shorter	4.2	95.7	0.1	Date
Moderate	Moderate	High	Moderate	Short	88.9	11	0.1	Date
Moderate	Moderate	High	Moderate	Moderate	49.9	41.8	8.3	Half-Month
Moderate	Moderate	High	Moderate	Long	50	41.7	8.3	Half-Month
Moderate	Moderate	High	Moderate	Longer	50	41.7	8.3	Half-Month
Moderate	Moderate	High	High	Shorter	91.4	8.5	0.1	Date
Moderate	Moderate	High	High	Short	29.8	70.1	0.1	Date
Moderate	Moderate	High	High	Moderate	47	45.2	7.8	Half-Month
Moderate	Moderate	High	High	Long	0.1	99.8	0.1	Date
Moderate	Moderate	High	High	Longer	0.1	99.8	0.1	Date
Moderate	Moderate	High	Very High	Shorter	86.4	13.5	0.1	Date
Moderate	Moderate	High	Very High	Short	30	69.9	0.1	Date
Moderate	Moderate	High	Very High	Moderate	49.95	49.95	0.1	Date
Moderate	Moderate	High	Very High	Long	0.1	99.8	0.1	Date
Moderate	Moderate	High	Very High	Longer	0.1	99.8	0.1	Date
Moderate	High	Low	Very Low	Shorter	16.7	83.2	0.1	Middle Date
Moderate	High	Low	Very Low	Short	41.4	25.5	33.1	Lower Half-Month
Moderate	High	Low	Very Low	Moderate	54.4	19.2	26.4	Lower Half-Month
Moderate	High	Low	Very Low	Long	90.8	9.1	0.1	Lower Half-Month
Moderate	High	Low	Very Low	Longer	99.8	0.1	0.1	Lower Date
Moderate	High	Low	Low	Shorter	84.1	15.8	0.1	Middle Date
Moderate	High	Low	Low	Short	1	98.9	0.1	Middle Half-Month
Moderate	High	Low	Low	Moderate	0.1	99.8	0.1	Middle Date
Moderate	High	Low	Low	Long	66.6	33.3	0.1	Lower Date
Moderate	High	Low	Low	Longer	56	43.9	0.1	Middle Date
Moderate	High	Low	Moderate	Shorter	70.9	27.8	1.3	Middle Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Moderate	High	Low	Moderate	Short	73.1	26.8	0.1	Middle Date
Moderate	High	Low	Moderate	Moderate	0.1	99.8	0.1	Middle Date
Moderate	High	Low	Moderate	Long	69.9	30	0.1	Middle Half-Month
Moderate	High	Low	Moderate	Longer	33	66.9	0.1	Middle Date
Moderate	High	Low	High	Shorter	33.3	66.6	0.1	Date
Moderate	High	Low	High	Short	33.4	33.3	33.3	Date
Moderate	High	Low	High	Moderate	0.1	99.8	0.1	Date
Moderate	High	Low	High	Long	0.1	99.8	0.1	Half-Month
Moderate	High	Low	High	Longer	99.8	0.1	0.1	Date
Moderate	High	Low	Very High	Shorter	21.8	9.2	69	Date
Moderate	High	Low	Very High	Short	33.4	33.3	33.3	Date
Moderate	High	Low	Very High	Moderate	0.1	99.8	0.1	Date
Moderate	High	Low	Very High	Long	0.1	99.8	0.1	Half-Month
Moderate	High	Low	Very High	Longer	0.1	99.8	0.1	Half-Month
Moderate	High	Moderate	Very Low	Shorter	62.4	37.5	0.1	Date
Moderate	High	Moderate	Very Low	Short	46.6	53.3	0.1	Half-Month
Moderate	High	Moderate	Very Low	Moderate	50	41.7	8.3	Half-Month
Moderate	High	Moderate	Very Low	Long	50	41.7	8.3	Half-Month
Moderate	High	Moderate	Very Low	Longer	0.1	49.95	49.95	Date
Moderate	High	Moderate	Low	Shorter	99.8	0.1	0.1	Date
Moderate	High	Moderate	Low	Short	49.95	49.95	0.1	Date
Moderate	High	Moderate	Low	Moderate	42.9	57	0.1	Half-Month
Moderate	High	Moderate	Low	Long	21	57.5	21.5	Middle Date
Moderate	High	Moderate	Low	Longer	44.5	55.4	0.1	Middle Date
Moderate	High	Moderate	Moderate	Shorter	49.95	49.95	0.1	Date
Moderate	High	Moderate	Moderate	Short	99.8	0.1	0.1	Date
Moderate	High	Moderate	Moderate	Moderate	49.8	42.2	8	Half-Month
Moderate	High	Moderate	Moderate	Long	50	41.7	8.3	Half-Month
Moderate	High	Moderate	Moderate	Longer	99.8	0.1	0.1	Date
Moderate	High	Moderate	High	Shorter	49.95	49.95	0.1	Date
Moderate	High	Moderate	High	Short	99.8	0.1	0.1	Date
Moderate	High	Moderate	High	Moderate	48.3	43.5	8.2	Half-Month
Moderate	High	Moderate	High	Long	0.1	78.8	21.1	Date
Moderate	High	Moderate	High	Longer	99.8	0.1	0.1	Date
Moderate	High	Moderate	Very High	Shorter	22.7	77.2	0.1	Date
Moderate	High	Moderate	Very High	Short	88.9	11	0.1	Date
Moderate	High	Moderate	Very High	Moderate	45.8	46.8	7.4	Half-Month
Moderate	High	Moderate	Very High	Long	0.1	72	27.9	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Moderate	High	Moderate	Very High	Longer	0.1	49.95	49.95	Date
Moderate	High	High	Very Low	Shorter	0.1	99.8	0.1	Date
Moderate	High	High	Very Low	Short	36.6	61.3	2.1	Interpolate
Moderate	High	High	Very Low	Moderate	50	41.7	8.3	Half-Month
Moderate	High	High	Very Low	Long	50	41.7	8.3	Half-Month
Moderate	High	High	Very Low	Longer	47.8	44.6	7.6	Half-Month
Moderate	High	High	Low	Shorter	59.1	35.8	5.1	Half-Month
Moderate	High	High	Low	Short	49.95	49.95	0.1	Date
Moderate	High	High	Low	Moderate	42.9	57	0.1	Half-Month
Moderate	High	High	Low	Long	12.5	87.2	0.3	Middle Date
Moderate	High	High	Low	Longer	31.3	68.2	0.5	Middle Date
Moderate	High	High	Moderate	Shorter	17.3	66.7	16	Half-Month
Moderate	High	High	Moderate	Short	54.4	45.5	0.1	Date
Moderate	High	High	Moderate	Moderate	47.4	44.7	7.9	Half-Month
Moderate	High	High	Moderate	Long	38.7	54.9	6.4	Half-Month
Moderate	High	High	Moderate	Longer	99.8	0.1	0.1	Date
Moderate	High	High	High	Shorter	99.8	0.1	0.1	Date
Moderate	High	High	High	Short	31.5	68.4	0.1	Date
Moderate	High	High	High	Moderate	49.95	49.95	0.1	Date
Moderate	High	High	High	Long	6	67.1	26.9	Date
Moderate	High	High	High	Longer	99.8	0.1	0.1	Date
Moderate	High	High	Very High	Shorter	62.7	37.2	0.1	Date
Moderate	High	High	Very High	Short	28.9	71	0.1	Date
Moderate	High	High	Very High	Moderate	49.95	49.95	0.1	Date
Moderate	High	High	Very High	Long	3.9	65.1	31	Date
Moderate	High	High	Very High	Longer	41.1	51.2	7.7	Half-Month
Moderate	Very High	Low	Very Low	Shorter	99.8	0.1	0.1	Lower Half-Month
Moderate	Very High	Low	Very Low	Short	66.6	27.9	5.5	Interpolate
Moderate	Very High	Low	Very Low	Moderate	76.1	17.3	6.6	Interpolate
Moderate	Very High	Low	Very Low	Long	61.6	37	1.4	Interpolate
Moderate	Very High	Low	Very Low	Longer	62.4	37.5	0.1	Lower Date
Moderate	Very High	Low	Low	Shorter	0.1	99.8	0.1	Middle Date
Moderate	Very High	Low	Low	Short	33.3	66.6	0.1	Lower Half-Month
Moderate	Very High	Low	Low	Moderate	99.8	0.1	0.1	Lower Date
Moderate	Very High	Low	Low	Long	33.3	66.6	0.1	Lower Half-Month
Moderate	Very High	Low	Low	Longer	51.5	48.4	0.1	Middle Date
Moderate	Very High	Low	Moderate	Shorter	99.8	0.1	0.1	Date
Moderate	Very High	Low	Moderate	Short	0.1	99.8	0.1	Middle Half-Month

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Moderate	Very High	Low	Moderate	Moderate	0.1	99.8	0.1	Middle Half-Month
Moderate	Very High	Low	Moderate	Long	43.5	55.5	1	Interpolate
Moderate	Very High	Low	Moderate	Longer	28.5	71.4	0.1	Middle Date
Moderate	Very High	Low	High	Shorter	70	29.9	0.1	Date
Moderate	Very High	Low	High	Short	33.4	33.3	33.3	Date
Moderate	Very High	Low	High	Moderate	0.1	99.8	0.1	Middle Half-Month
Moderate	Very High	Low	High	Long	33.3	66.6	0.1	Middle Date
Moderate	Very High	Low	High	Longer	62.3	10.6	27.1	Date
Moderate	Very High	Low	Very High	Shorter	21.8	9.2	69	Date
Moderate	Very High	Low	Very High	Short	33.4	33.3	33.3	Date
Moderate	Very High	Low	Very High	Moderate	99.8	0.1	0.1	Date
Moderate	Very High	Low	Very High	Long	33.3	66.6	0.1	Middle Date
Moderate	Very High	Low	Very High	Longer	50.4	13.9	35.7	Date
Moderate	Very High	Moderate	Very Low	Shorter	0.1	99.8	0.1	Date
Moderate	Very High	Moderate	Very Low	Short	25	74.9	0.1	Date
Moderate	Very High	Moderate	Very Low	Moderate	49.95	49.95	0.1	Date
Moderate	Very High	Moderate	Very Low	Long	50	41.7	8.3	Half-Month
Moderate	Very High	Moderate	Very Low	Longer	50	41.7	8.3	Half-Month
Moderate	Very High	Moderate	Low	Shorter	99.8	0.1	0.1	Date
Moderate	Very High	Moderate	Low	Short	99.8	0.1	0.1	Date
Moderate	Very High	Moderate	Low	Moderate	41.4	43.4	15.2	Interpolate
Moderate	Very High	Moderate	Low	Long	0.1	40	59.9	Middle Date
Moderate	Very High	Moderate	Low	Longer	72.4	27.5	0.1	Middle Date
Moderate	Very High	Moderate	Moderate	Shorter	49.95	49.95	0.1	Date
Moderate	Very High	Moderate	Moderate	Short	37.7	62.2	0.1	Half-Month
Moderate	Very High	Moderate	Moderate	Moderate	38.1	60.5	1.4	Half-Month
Moderate	Very High	Moderate	Moderate	Long	50	41.7	8.3	Half-Month
Moderate	Very High	Moderate	Moderate	Longer	50	41.7	8.3	Half-Month
Moderate	Very High	Moderate	High	Shorter	86.9	13	0.1	Date
Moderate	Very High	Moderate	High	Short	25	74.9	0.1	Date
Moderate	Very High	Moderate	High	Moderate	38.3	59.2	2.5	Half-Month
Moderate	Very High	Moderate	High	Long	0.1	95	4.9	Date
Moderate	Very High	Moderate	High	Longer	46.4	45.8	7.8	Half-Month
Moderate	Very High	Moderate	Very High	Shorter	25.9	74	0.1	Date
Moderate	Very High	Moderate	Very High	Short	83.2	16.7	0.1	Date
Moderate	Very High	Moderate	Very High	Moderate	49.95	49.95	0.1	Date
Moderate	Very High	Moderate	Very High	Long	0.1	88.4	11.5	Date
Moderate	Very High	Moderate	Very High	Longer	0.1	99.8	0.1	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Moderate	Very High	High	Very Low	Shorter	0.1	99.8	0.1	Date
Moderate	Very High	High	Very Low	Short	47.7	52.2	0.1	Interpolate
Moderate	Very High	High	Very Low	Moderate	49.95	49.95	0.1	Date
Moderate	Very High	High	Very Low	Long	50	41.7	8.3	Half-Month
Moderate	Very High	High	Very Low	Longer	48.6	43.6	7.8	Half-Month
Moderate	Very High	High	Low	Shorter	99.8	0.1	0.1	Date
Moderate	Very High	High	Low	Short	99.8	0.1	0.1	Date
Moderate	Very High	High	Low	Moderate	0.1	99.8	0.1	Middle Date
Moderate	Very High	High	Low	Long	14.3	82.1	3.6	Middle Date
Moderate	Very High	High	Low	Longer	4.1	93.7	2.2	Middle Date
Moderate	Very High	High	Moderate	Shorter	49.95	49.95	0.1	Date
Moderate	Very High	High	Moderate	Short	23.7	76.2	0.1	Date
Moderate	Very High	High	Moderate	Moderate	45.9	46.4	7.7	Half-Month
Moderate	Very High	High	Moderate	Long	33.6	60.8	5.6	Half-Month
Moderate	Very High	High	Moderate	Longer	48.6	43.6	7.8	Half-Month
Moderate	Very High	High	High	Shorter	96.5	3.4	0.1	Date
Moderate	Very High	High	High	Short	33.4	54.1	12.5	Half-Month
Moderate	Very High	High	High	Moderate	36.9	56.9	6.2	Half-Month
Moderate	Very High	High	High	Long	7.6	84	8.4	Date
Moderate	Very High	High	High	Longer	0.1	99.8	0.1	Date
Moderate	Very High	High	Very High	Shorter	33.3	66.6	0.1	Date
Moderate	Very High	High	Very High	Short	60.7	39.2	0.1	Date
Moderate	Very High	High	Very High	Moderate	49.95	49.95	0.1	Date
Moderate	Very High	High	Very High	Long	11.3	76	12.7	Date
Moderate	Very High	High	Very High	Longer	0.1	99.8	0.1	Date
High	Very Low	Low	Very Low	Shorter	99.8	0.1	0.1	Lower Month
High	Very Low	Low	Very Low	Short	99.8	0.1	0.1	Lower Month
High	Very Low	Low	Very Low	Moderate	90.4	9.5	0.1	Lower Month
High	Very Low	Low	Very Low	Long	99.8	0.1	0.1	Lower Date
High	Very Low	Low	Very Low	Longer	87.4	12.5	0.1	Middle Date
High	Very Low	Low	Low	Shorter	79.9	20	0.1	Middle Date
High	Very Low	Low	Low	Short	99.8	0.1	0.1	Lower Date
High	Very Low	Low	Low	Moderate	80.3	19.6	0.1	Lower Half-Month
High	Very Low	Low	Low	Long	25	74.9	0.1	Lower Half-Month
High	Very Low	Low	Low	Longer	93.1	6.8	0.1	Middle Date
High	Very Low	Low	Moderate	Shorter	99.8	0.1	0.1	Middle Half-Month
High	Very Low	Low	Moderate	Short	99.8	0.1	0.1	Middle Date
High	Very Low	Low	Moderate	Moderate	99.8	0.1	0.1	Middle Half-Month

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
High	Very Low	Low	Moderate	Long	62.4	27.6	10	Interpolate
High	Very Low	Low	Moderate	Longer	61.6	38.3	0.1	Middle Date
High	Very Low	Low	High	Shorter	99.8	0.1	0.1	Middle Half-Month
High	Very Low	Low	High	Short	99.8	0.1	0.1	Middle Date
High	Very Low	Low	High	Moderate	99.8	0.1	0.1	Middle Half-Month
High	Very Low	Low	High	Long	69.7	20.9	9.4	Interpolate
High	Very Low	Low	High	Longer	42.2	57.7	0.1	Middle Date
High	Very Low	Low	Very High	Shorter	99.8	0.1	0.1	Middle Half-Month
High	Very Low	Low	Very High	Short	99.8	0.1	0.1	Middle Date
High	Very Low	Low	Very High	Moderate	99.8	0.1	0.1	Middle Half-Month
High	Very Low	Low	Very High	Long	66.7	13.3	20	Interpolate
High	Very Low	Low	Very High	Longer	19.4	55.6	25	Interpolate
High	Very Low	Moderate	Very Low	Shorter	37.5	62.4	0.1	Half-Month
High	Very Low	Moderate	Very Low	Short	37.5	62.4	0.1	Half-Month
High	Very Low	Moderate	Very Low	Moderate	93.6	6.3	0.1	Lower Date
High	Very Low	Moderate	Very Low	Long	79.9	20	0.1	Lower Date
High	Very Low	Moderate	Very Low	Longer	87.4	12.5	0.1	Middle Date
High	Very Low	Moderate	Low	Shorter	79.9	20	0.1	Middle Date
High	Very Low	Moderate	Low	Short	99.8	0.1	0.1	Middle Date
High	Very Low	Moderate	Low	Moderate	99.8	0.1	0.1	Middle Date
High	Very Low	Moderate	Low	Long	11.7	49.3	39	Middle Date
High	Very Low	Moderate	Low	Longer	67.3	32.6	0.1	Middle Date
High	Very Low	Moderate	Moderate	Shorter	37.5	62.4	0.1	Half-Month
High	Very Low	Moderate	Moderate	Short	37.5	62.4	0.1	Half-Month
High	Very Low	Moderate	Moderate	Moderate	99.8	0.1	0.1	Middle Date
High	Very Low	Moderate	Moderate	Long	0.1	40	59.9	Middle Date
High	Very Low	Moderate	Moderate	Longer	63.8	36.1	0.1	Middle Date
High	Very Low	Moderate	High	Shorter	37.5	62.4	0.1	Half-Month
High	Very Low	Moderate	High	Short	37.5	62.4	0.1	Half-Month
High	Very Low	Moderate	High	Moderate	33.3	66.6	0.1	Middle Half-Month
High	Very Low	Moderate	High	Long	7.1	45.7	47.2	Middle Date
High	Very Low	Moderate	High	Longer	70	29.9	0.1	Middle Date
High	Very Low	Moderate	Very High	Shorter	37.5	62.4	0.1	Half-Month
High	Very Low	Moderate	Very High	Short	37.5	62.4	0.1	Half-Month
High	Very Low	Moderate	Very High	Moderate	99.8	0.1	0.1	Lower Date
High	Very Low	Moderate	Very High	Long	0.1	40	59.9	Middle Date
High	Very Low	Moderate	Very High	Longer	0.1	40	59.9	Middle Half-Month
High	Very Low	High	Very Low	Shorter	99.8	0.1	0.1	Lower Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
High	Very Low	High	Very Low	Short	99.8	0.1	0.1	Lower Date
High	Very Low	High	Very Low	Moderate	99.8	0.1	0.1	Middle Date
High	Very Low	High	Very Low	Long	96.5	3.4	0.1	Lower Date
High	Very Low	High	Very Low	Longer	42.9	57	0.1	Middle Date
High	Very Low	High	Low	Shorter	36.3	57.4	6.3	Middle Date
High	Very Low	High	Low	Short	57.9	36.2	5.9	Middle Date
High	Very Low	High	Low	Moderate	97	2.9	0.1	Middle Date
High	Very Low	High	Low	Long	98.4	1.1	0.5	Middle Date
High	Very Low	High	Low	Longer	79.1	20.8	0.1	Middle Date
High	Very Low	High	Moderate	Shorter	41.9	53.8	4.3	Middle Date
High	Very Low	High	Moderate	Short	50.5	36	13.5	Middle Date
High	Very Low	High	Moderate	Moderate	83.2	16.7	0.1	Middle Date
High	Very Low	High	Moderate	Long	94	2.4	3.6	Middle Date
High	Very Low	High	Moderate	Longer	61.2	38.7	0.1	Middle Date
High	Very Low	High	High	Shorter	0.1	79.9	20	Middle Date
High	Very Low	High	High	Short	37.5	37.5	25	Middle Date
High	Very Low	High	High	Moderate	83.2	16.7	0.1	Middle Date
High	Very Low	High	High	Long	14	51.1	34.9	Middle Date
High	Very Low	High	High	Longer	31.1	68.8	0.1	Middle Date
High	Very Low	High	Very High	Shorter	85.6	14.3	0.1	Lower Half-Month
High	Very Low	High	Very High	Short	85.6	14.3	0.1	Lower Half-Month
High	Very Low	High	Very High	Moderate	99.8	0.1	0.1	Lower Date
High	Very Low	High	Very High	Long	0.1	40	59.9	Middle Date
High	Very Low	High	Very High	Longer	0.1	40	59.9	Middle Half-Month
High	Low	Low	Very Low	Shorter	99.8	0.1	0.1	Lower Half-Month
High	Low	Low	Very Low	Short	99.8	0.1	0.1	Lower Date
High	Low	Low	Very Low	Moderate	48.4	26	25.6	Lower Half-Month
High	Low	Low	Very Low	Long	99.8	0.1	0.1	Lower Date
High	Low	Low	Very Low	Longer	87.4	12.5	0.1	Middle Date
High	Low	Low	Low	Shorter	87.5	12.4	0.1	Middle Date
High	Low	Low	Low	Short	16	83.9	0.1	Middle Half-Month
High	Low	Low	Low	Moderate	56.8	43.1	0.1	Middle Date
High	Low	Low	Low	Long	87.4	12.5	0.1	Middle Date
High	Low	Low	Low	Longer	70.5	29.4	0.1	Middle Date
High	Low	Low	Moderate	Shorter	87.9	12	0.1	Middle Date
High	Low	Low	Moderate	Short	96.4	3.5	0.1	Middle Date
High	Low	Low	Moderate	Moderate	62.2	37.7	0.1	Middle Date
High	Low	Low	Moderate	Long	87.4	12.5	0.1	Middle Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
High	Low	Low	Moderate	Longer	27.5	72.4	0.1	Middle Date
High	Low	Low	High	Shorter	74.4	25.5	0.1	Middle Date
High	Low	Low	High	Short	98	1.9	0.1	Middle Date
High	Low	Low	High	Moderate	99.8	0.1	0.1	Middle Date
High	Low	Low	High	Long	99	0.9	0.1	Middle Half-Month
High	Low	Low	High	Longer	64.1	35.8	0.1	Middle Date
High	Low	Low	Very High	Shorter	81.7	18.2	0.1	Middle Date
High	Low	Low	Very High	Short	99.8	0.1	0.1	Middle Date
High	Low	Low	Very High	Moderate	99.8	0.1	0.1	Middle Half-Month
High	Low	Low	Very High	Long	99.8	0.1	0.1	Lower Month
High	Low	Low	Very High	Longer	15.4	84.5	0.1	Middle Date
High	Low	Moderate	Very Low	Shorter	99.8	0.1	0.1	Lower Date
High	Low	Moderate	Very Low	Short	99.8	0.1	0.1	Lower Date
High	Low	Moderate	Very Low	Moderate	99.8	0.1	0.1	Lower Date
High	Low	Moderate	Very Low	Long	65.5	34.4	0.1	Lower Date
High	Low	Moderate	Very Low	Longer	87.4	12.5	0.1	Middle Date
High	Low	Moderate	Low	Shorter	63.3	36.6	0.1	Middle Date
High	Low	Moderate	Low	Short	99.8	0.1	0.1	Middle Date
High	Low	Moderate	Low	Moderate	94.7	4	1.3	Middle Date
High	Low	Moderate	Low	Long	85.7	14.2	0.1	Middle Date
High	Low	Moderate	Low	Longer	44.2	55.7	0.1	Middle Date
High	Low	Moderate	Moderate	Shorter	41.4	58.5	0.1	Middle Date
High	Low	Moderate	Moderate	Short	99.8	0.1	0.1	Middle Date
High	Low	Moderate	Moderate	Moderate	88	9.1	2.9	Middle Date
High	Low	Moderate	Moderate	Long	70.1	29.8	0.1	Middle Date
High	Low	Moderate	Moderate	Longer	30.2	69.7	0.1	Middle Date
High	Low	Moderate	High	Shorter	38	61.9	0.1	Middle Date
High	Low	Moderate	High	Short	99.8	0.1	0.1	Middle Date
High	Low	Moderate	High	Moderate	27.5	57.7	14.8	Middle Date
High	Low	Moderate	High	Long	49.95	49.95	0.1	Middle Date
High	Low	Moderate	High	Longer	38.5	61.4	0.1	Middle Date
High	Low	Moderate	Very High	Shorter	50.8	49.1	0.1	Middle Date
High	Low	Moderate	Very High	Short	69.9	30	0.1	Middle Half-Month
High	Low	Moderate	Very High	Moderate	65.8	32.1	2.1	Interpolate
High	Low	Moderate	Very High	Long	79.9	20	0.1	Lower Half-Month
High	Low	Moderate	Very High	Longer	79.9	20	0.1	Lower Half-Month
High	Low	High	Very Low	Shorter	98	1.9	0.1	Lower Date
High	Low	High	Very Low	Short	99.8	0.1	0.1	Lower Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
High	Low	High	Very Low	Moderate	99.8	0.1	0.1	Middle Date
High	Low	High	Very Low	Long	69.8	30.1	0.1	Lower Date
High	Low	High	Very Low	Longer	42.9	57	0.1	Middle Date
High	Low	High	Low	Shorter	38.7	57.1	4.2	Middle Date
High	Low	High	Low	Short	61.8	35.4	2.8	Middle Date
High	Low	High	Low	Moderate	83.4	16.2	0.4	Middle Date
High	Low	High	Low	Long	84.9	15	0.1	Middle Date
High	Low	High	Low	Longer	59.4	40.1	0.5	Middle Date
High	Low	High	Moderate	Shorter	38.7	58.8	2.5	Middle Date
High	Low	High	Moderate	Short	57.7	36.1	6.2	Middle Date
High	Low	High	Moderate	Moderate	58.6	38.6	2.8	Middle Date
High	Low	High	Moderate	Long	57.9	42	0.1	Middle Date
High	Low	High	Moderate	Longer	43.1	55.5	1.4	Middle Date
High	Low	High	High	Shorter	11.6	78.2	10.2	Middle Date
High	Low	High	High	Short	41.2	48.2	10.6	Middle Date
High	Low	High	High	Moderate	61.4	37.5	1.1	Middle Date
High	Low	High	High	Long	39.1	60.8	0.1	Middle Date
High	Low	High	High	Longer	19.2	75.3	5.5	Middle Date
High	Low	High	Very High	Shorter	18.3	81.6	0.1	Middle Date
High	Low	High	Very High	Short	40	59.9	0.1	Middle Date
High	Low	High	Very High	Moderate	40	59.9	0.1	Middle Half-Month
High	Low	High	Very High	Long	23.9	68.3	7.8	Middle Half-Month
High	Low	High	Very High	Longer	26.3	62.5	11.2	Middle Date
High	Moderate	Low	Very Low	Shorter	16.7	83.2	0.1	Middle Date
High	Moderate	Low	Very Low	Short	70.3	12.1	17.6	Lower Half-Month
High	Moderate	Low	Very Low	Moderate	58.6	17.2	24.2	Lower Half-Month
High	Moderate	Low	Very Low	Long	90.8	9.1	0.1	Lower Half-Month
High	Moderate	Low	Very Low	Longer	47.3	52.6	0.1	Lower Date
High	Moderate	Low	Low	Shorter	63.9	36	0.1	Middle Date
High	Moderate	Low	Low	Short	18.9	81	0.1	Middle Half-Month
High	Moderate	Low	Low	Moderate	0.1	99.8	0.1	Middle Date
High	Moderate	Low	Low	Long	87.4	12.5	0.1	Middle Date
High	Moderate	Low	Low	Longer	71.2	28.7	0.1	Middle Date
High	Moderate	Low	Moderate	Shorter	77.4	22.5	0.1	Middle Date
High	Moderate	Low	Moderate	Short	82.8	17.1	0.1	Middle Date
High	Moderate	Low	Moderate	Moderate	0.1	99.8	0.1	Middle Date
High	Moderate	Low	Moderate	Long	87.4	12.5	0.1	Middle Date
High	Moderate	Low	Moderate	Longer	61.9	38	0.1	Middle Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
High	Moderate	Low	High	Shorter	61.3	38.6	0.1	Middle Date
High	Moderate	Low	High	Short	86	13.9	0.1	Middle Date
High	Moderate	Low	High	Moderate	66.9	33	0.1	Middle Half-Month
High	Moderate	Low	High	Long	69.9	30	0.1	Middle Half-Month
High	Moderate	Low	High	Longer	73.8	26.1	0.1	Middle Date
High	Moderate	Low	Very High	Shorter	55.1	44.8	0.1	Middle Date
High	Moderate	Low	Very High	Short	99.8	0.1	0.1	Middle Date
High	Moderate	Low	Very High	Moderate	63.2	36.7	0.1	Middle Half-Month
High	Moderate	Low	Very High	Long	61.7	20.7	17.6	Lower Month
High	Moderate	Low	Very High	Longer	15.4	84.5	0.1	Middle Date
High	Moderate	Moderate	Very Low	Shorter	37.5	62.4	0.1	Half-Month
High	Moderate	Moderate	Very Low	Short	25	74.9	0.1	Date
High	Moderate	Moderate	Very Low	Moderate	33.3	66.6	0.1	Lower Date
High	Moderate	Moderate	Very Low	Long	99.8	0.1	0.1	Lower Date
High	Moderate	Moderate	Very Low	Longer	99.8	0.1	0.1	Lower Date
High	Moderate	Moderate	Low	Shorter	42.9	57	0.1	Middle Date
High	Moderate	Moderate	Low	Short	47.1	39.6	13.3	Middle Half-Month
High	Moderate	Moderate	Low	Moderate	61.6	27.6	10.8	Middle Date
High	Moderate	Moderate	Low	Long	81.9	15.8	2.3	Middle Date
High	Moderate	Moderate	Low	Longer	38.2	61.7	0.1	Middle Date
High	Moderate	Moderate	Moderate	Shorter	37.5	62.4	0.1	Half-Month
High	Moderate	Moderate	Moderate	Short	37.5	62.4	0.1	Half-Month
High	Moderate	Moderate	Moderate	Moderate	49.1	36.6	14.3	Middle Date
High	Moderate	Moderate	Moderate	Long	70	18	12	Middle Date
High	Moderate	Moderate	Moderate	Longer	27.8	72.1	0.1	Middle Date
High	Moderate	Moderate	High	Shorter	37.5	62.4	0.1	Half-Month
High	Moderate	Moderate	High	Short	25	74.9	0.1	Date
High	Moderate	Moderate	High	Moderate	4.8	69	26.2	Middle Date
High	Moderate	Moderate	High	Long	11.7	49.3	39	Middle Date
High	Moderate	Moderate	High	Longer	16.1	83.8	0.1	Middle Date
High	Moderate	Moderate	Very High	Shorter	37.5	62.4	0.1	Half-Month
High	Moderate	Moderate	Very High	Short	37.5	62.4	0.1	Half-Month
High	Moderate	Moderate	Very High	Moderate	30.7	54.9	14.4	Interpolate
High	Moderate	Moderate	Very High	Long	0.1	40	59.9	Middle Date
High	Moderate	Moderate	Very High	Longer	0.1	40	59.9	Middle Half-Month
High	Moderate	High	Very Low	Shorter	99.8	0.1	0.1	Lower Half-Month
High	Moderate	High	Very Low	Short	94.3	5.6	0.1	Lower Month
High	Moderate	High	Very Low	Moderate	99.8	0.1	0.1	Middle Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
High	Moderate	High	Very Low	Long	73.7	24.9	1.4	Interpolate
High	Moderate	High	Very Low	Longer	63.6	34.3	2.1	Interpolate
High	Moderate	High	Low	Shorter	26	66.6	7.4	Middle Date
High	Moderate	High	Low	Short	57.2	33.3	9.5	Middle Date
High	Moderate	High	Low	Moderate	76.4	23.4	0.2	Middle Date
High	Moderate	High	Low	Long	69.4	30.4	0.2	Middle Date
High	Moderate	High	Low	Longer	72.1	25.6	2.3	Middle Date
High	Moderate	High	Moderate	Shorter	20.2	77.6	2.2	Middle Date
High	Moderate	High	Moderate	Short	67.1	26.9	6	Middle Date
High	Moderate	High	Moderate	Moderate	57.3	41	1.7	Middle Date
High	Moderate	High	Moderate	Long	54.4	45.1	0.5	Middle Date
High	Moderate	High	Moderate	Longer	36.4	56.3	7.3	Middle Date
High	Moderate	High	High	Shorter	11.9	83.1	5	Middle Date
High	Moderate	High	High	Short	48.7	42.5	8.8	Middle Date
High	Moderate	High	High	Moderate	54.2	45.2	0.6	Middle Date
High	Moderate	High	High	Long	26.5	72.9	0.6	Middle Date
High	Moderate	High	High	Longer	4.3	78.5	17.2	Middle Date
High	Moderate	High	Very High	Shorter	17.4	82.5	0.1	Middle Date
High	Moderate	High	Very High	Short	40	59.9	0.1	Middle Date
High	Moderate	High	Very High	Moderate	28.6	71.3	0.1	Middle Date
High	Moderate	High	Very High	Long	0.1	40	59.9	Middle Date
High	Moderate	High	Very High	Longer	6.9	75.4	17.7	Middle Date
High	High	Low	Very Low	Shorter	16.7	83.2	0.1	Middle Date
High	High	Low	Very Low	Short	25.3	34.1	40.6	Lower Half-Month
High	High	Low	Very Low	Moderate	47.8	23.5	28.7	Lower Half-Month
High	High	Low	Very Low	Long	90.8	9.1	0.1	Lower Half-Month
High	High	Low	Very Low	Longer	99.6	0.3	0.1	Lower Date
High	High	Low	Low	Shorter	44.6	55.3	0.1	Middle Date
High	High	Low	Low	Short	3	96.9	0.1	Middle Half-Month
High	High	Low	Low	Moderate	0.1	99.8	0.1	Middle Date
High	High	Low	Low	Long	99.8	0.1	0.1	Lower Date
High	High	Low	Low	Longer	75.4	24.5	0.1	Middle Date
High	High	Low	Moderate	Shorter	85.1	14.8	0.1	Middle Date
High	High	Low	Moderate	Short	88.2	11.7	0.1	Middle Date
High	High	Low	Moderate	Moderate	0.1	99.8	0.1	Middle Date
High	High	Low	Moderate	Long	69.9	30	0.1	Middle Half-Month
High	High	Low	Moderate	Longer	42.2	57.7	0.1	Middle Date
High	High	Low	High	Shorter	88	11.9	0.1	Middle Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
High	High	Low	High	Short	91.9	8	0.1	Middle Date
High	High	Low	High	Moderate	75	24.9	0.1	Middle Half-Month
High	High	Low	High	Long	69.9	30	0.1	Middle Half-Month
High	High	Low	High	Longer	57	42.9	0.1	Middle Date
High	High	Low	Very High	Shorter	42.8	57.1	0.1	Middle Date
High	High	Low	Very High	Short	99.8	0.1	0.1	Middle Date
High	High	Low	Very High	Moderate	77.5	22.4	0.1	Middle Half-Month
High	High	Low	Very High	Long	61.9	20.1	18	Lower Month
High	High	Low	Very High	Longer	15.4	84.5	0.1	Middle Date
High	High	Moderate	Very Low	Shorter	37.5	62.4	0.1	Half-Month
High	High	Moderate	Very Low	Short	37.5	62.4	0.1	Half-Month
High	High	Moderate	Very Low	Moderate	15.4	41.5	43.1	Lower Half-Month
High	High	Moderate	Very Low	Long	71.7	28.2	0.1	Lower Half-Month
High	High	Moderate	Very Low	Longer	99.8	0.1	0.1	Lower Date
High	High	Moderate	Low	Shorter	44.5	55.4	0.1	Middle Date
High	High	Moderate	Low	Short	2	70.6	27.4	Middle Half-Month
High	High	Moderate	Low	Moderate	76.9	16.5	6.6	Middle Date
High	High	Moderate	Low	Long	30.8	46.1	23.1	Middle Date
High	High	Moderate	Low	Longer	27.3	72.6	0.1	Middle Date
High	High	Moderate	Moderate	Shorter	37.5	62.4	0.1	Half-Month
High	High	Moderate	Moderate	Short	37.5	62.4	0.1	Half-Month
High	High	Moderate	Moderate	Moderate	71.4	20.4	8.2	Middle Date
High	High	Moderate	Moderate	Long	41.4	48.3	10.3	Middle Date
High	High	Moderate	Moderate	Longer	26.5	73.4	0.1	Middle Date
High	High	Moderate	High	Shorter	37.5	62.4	0.1	Half-Month
High	High	Moderate	High	Short	37.5	62.4	0.1	Half-Month
High	High	Moderate	High	Moderate	0.1	71.3	28.6	Middle Date
High	High	Moderate	High	Long	38.1	47.6	14.3	Middle Date
High	High	Moderate	High	Longer	30.9	69	0.1	Middle Date
High	High	Moderate	Very High	Shorter	37.5	62.4	0.1	Half-Month
High	High	Moderate	Very High	Short	37.5	62.4	0.1	Half-Month
High	High	Moderate	Very High	Moderate	31.6	52.4	16	Interpolate
High	High	Moderate	Very High	Long	0.1	40	59.9	Middle Date
High	High	Moderate	Very High	Longer	0.1	40	59.9	Middle Half-Month
High	High	High	Very Low	Shorter	99.8	0.1	0.1	Lower Date
High	High	High	Very Low	Short	83.4	16.5	0.1	Interpolate
High	High	High	Very Low	Moderate	49.4	40.3	10.3	Interpolate
High	High	High	Very Low	Long	52.8	47.1	0.1	Lower Month

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
High	High	High	Very Low	Longer	52.8	47.1	0.1	Lower Month
High	High	High	Low	Shorter	33	66.9	0.1	Middle Date
High	High	High	Low	Short	85.6	14.3	0.1	Middle Date
High	High	High	Low	Moderate	28.6	71.3	0.1	Middle Date
High	High	High	Low	Long	18.8	80.7	0.5	Middle Date
High	High	High	Low	Longer	30.9	66.2	2.9	Middle Date
High	High	High	Moderate	Shorter	8.1	91.8	0.1	Middle Date
High	High	High	Moderate	Short	66.7	33.2	0.1	Middle Date
High	High	High	Moderate	Moderate	28.6	71.3	0.1	Middle Date
High	High	High	Moderate	Long	28.8	70.3	0.9	Middle Date
High	High	High	Moderate	Longer	32.9	61.6	5.5	Middle Date
High	High	High	High	Shorter	8.7	91.2	0.1	Middle Date
High	High	High	High	Short	45.7	54.2	0.1	Middle Date
High	High	High	High	Moderate	28.6	71.3	0.1	Middle Date
High	High	High	High	Long	21.3	78.3	0.4	Middle Date
High	High	High	High	Longer	8.4	78.8	12.8	Middle Date
High	High	High	Very High	Shorter	17.5	82.4	0.1	Middle Half-Month
High	High	High	Very High	Short	40	59.9	0.1	Middle Date
High	High	High	Very High	Moderate	28.6	71.3	0.1	Middle Date
High	High	High	Very High	Long	0.1	40	59.9	Middle Date
High	High	High	Very High	Longer	9.8	73.5	16.7	Middle Date
High	Very High	Low	Very Low	Shorter	99.8	0.1	0.1	Lower Date
High	Very High	Low	Very Low	Short	99.8	0.1	0.1	Lower Month
High	Very High	Low	Very Low	Moderate	99.8	0.1	0.1	Lower Month
High	Very High	Low	Very Low	Long	99.8	0.1	0.1	Lower Month
High	Very High	Low	Very Low	Longer	71.9	28	0.1	Lower Date
High	Very High	Low	Low	Shorter	99.8	0.1	0.1	Lower Date
High	Very High	Low	Low	Short	33.3	66.6	0.1	Lower Half-Month
High	Very High	Low	Low	Moderate	33.3	66.6	0.1	Lower Half-Month
High	Very High	Low	Low	Long	99.8	0.1	0.1	Lower Date
High	Very High	Low	Low	Longer	29.5	70.4	0.1	Middle Date
High	Very High	Low	Moderate	Shorter	0.1	99.8	0.1	Middle Date
High	Very High	Low	Moderate	Short	0.1	99.8	0.1	Middle Half-Month
High	Very High	Low	Moderate	Moderate	0.1	99.8	0.1	Middle Half-Month
High	Very High	Low	Moderate	Long	99.8	0.1	0.1	Lower Month
High	Very High	Low	Moderate	Longer	20.2	79.7	0.1	Middle Date
High	Very High	Low	High	Shorter	0.1	99.8	0.1	Middle Date
High	Very High	Low	High	Short	0.1	99.8	0.1	Middle Half-Month

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
High	Very High	Low	High	Moderate	0.1	99.8	0.1	Middle Half-Month
High	Very High	Low	High	Long	36.5	53.5	10	Interpolate
High	Very High	Low	High	Longer	15.4	84.5	0.1	Middle Date
High	Very High	Low	Very High	Shorter	0.1	99.8	0.1	Middle Date
High	Very High	Low	Very High	Short	0.1	99.8	0.1	Middle Half-Month
High	Very High	Low	Very High	Moderate	0.1	99.8	0.1	Middle Half-Month
High	Very High	Low	Very High	Long	22.1	62.3	15.6	Interpolate
High	Very High	Low	Very High	Longer	15.4	84.5	0.1	Middle Date
High	Very High	Moderate	Very Low	Shorter	37.5	62.4	0.1	Half-Month
High	Very High	Moderate	Very Low	Short	25	74.9	0.1	Date
High	Very High	Moderate	Very Low	Moderate	47.6	41.6	10.8	Interpolate
High	Very High	Moderate	Very Low	Long	55.4	27.5	17.1	Interpolate
High	Very High	Moderate	Very Low	Longer	55.5	27.4	17.1	Interpolate
High	Very High	Moderate	Low	Shorter	99.8	0.1	0.1	Lower Half-Month
High	Very High	Moderate	Low	Short	99.8	0.1	0.1	Lower Half-Month
High	Very High	Moderate	Low	Moderate	52.6	30.8	16.6	Interpolate
High	Very High	Moderate	Low	Long	0.1	40	59.9	Middle Date
High	Very High	Moderate	Low	Longer	0.1	40	59.9	Middle Half-Month
High	Very High	Moderate	Moderate	Shorter	37.5	62.4	0.1	Half-Month
High	Very High	Moderate	Moderate	Short	37.5	62.4	0.1	Half-Month
High	Very High	Moderate	Moderate	Moderate	29.4	56.7	13.9	Interpolate
High	Very High	Moderate	Moderate	Long	0.1	40	59.9	Middle Date
High	Very High	Moderate	Moderate	Longer	0.1	40	59.9	Middle Half-Month
High	Very High	Moderate	High	Shorter	37.5	62.4	0.1	Half-Month
High	Very High	Moderate	High	Short	25	74.9	0.1	Date
High	Very High	Moderate	High	Moderate	12.7	69.1	18.2	Interpolate
High	Very High	Moderate	High	Long	0.1	40	59.9	Middle Date
High	Very High	Moderate	High	Longer	0.1	40	59.9	Middle Half-Month
High	Very High	Moderate	Very High	Shorter	37.5	62.4	0.1	Half-Month
High	Very High	Moderate	Very High	Short	37.5	62.4	0.1	Half-Month
High	Very High	Moderate	Very High	Moderate	21.9	63.1	15	Interpolate
High	Very High	Moderate	Very High	Long	0.1	40	59.9	Middle Date
High	Very High	Moderate	Very High	Longer	0.1	40	59.9	Middle Half-Month
High	Very High	High	Very Low	Shorter	99.8	0.1	0.1	Lower Month
High	Very High	High	Very Low	Short	99.8	0.1	0.1	Lower Month
High	Very High	High	Very Low	Moderate	74.9	25	0.1	Interpolate
High	Very High	High	Very Low	Long	39.4	57.4	3.2	Interpolate
High	Very High	High	Very Low	Longer	33.8	56.9	9.3	Interpolate

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
High	Very High	High	Low	Shorter	88.7	11.2	0.1	Interpolate
High	Very High	High	Low	Short	99.8	0.1	0.1	Middle Date
High	Very High	High	Low	Moderate	36	63.7	0.3	Interpolate
High	Very High	High	Low	Long	15.4	83.2	1.4	Middle Date
High	Very High	High	Low	Longer	0.1	79.9	20	Middle Date
High	Very High	High	Moderate	Shorter	99.8	0.1	0.1	Lower Month
High	Very High	High	Moderate	Short	99.8	0.1	0.1	Middle Date
High	Very High	High	Moderate	Moderate	47.4	49.8	2.8	Interpolate
High	Very High	High	Moderate	Long	15.2	81.4	3.4	Middle Date
High	Very High	High	Moderate	Longer	0.1	79.9	20	Middle Date
High	Very High	High	High	Shorter	99.8	0.1	0.1	Lower Month
High	Very High	High	High	Short	60.8	36.7	2.5	Interpolate
High	Very High	High	High	Moderate	27.3	70.2	2.5	Interpolate
High	Very High	High	High	Long	16.4	82.3	1.3	Middle Date
High	Very High	High	High	Longer	0.1	79.9	20	Middle Date
High	Very High	High	Very High	Shorter	47.1	52.8	0.1	Interpolate
High	Very High	High	Very High	Short	46.1	53.8	0.1	Interpolate
High	Very High	High	Very High	Moderate	26.2	53.8	20	Interpolate
High	Very High	High	Very High	Long	0.1	40	59.9	Middle Date
High	Very High	High	Very High	Longer	0.1	79.9	20	Middle Date

6.4 Chlorophyll-A Ecological (ug/L, chlaeco) – Middle Lake Segment

Conditioned on:

- Secchi Depth (secchi, ft)
- Total Nitrogen Concentration (totaln, mg/L)
- Water Temperature (wtemp, C)
- Total Phosphorus Concentration (totalp, mg/L)
- Residence Time (resid30, days)

Middle:

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	Very Low	Low	Very Low	Shorter	99.8	0.1	0.1	Lower Month
Low	Very Low	Low	Very Low	Short	99.8	0.1	0.1	Lower Month
Low	Very Low	Low	Very Low	Moderate	75.5	24.4	0.1	Interpolate

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	Very Low	Low	Very Low	Long	81.1	18.8	0.1	Interpolate
Low	Very Low	Low	Very Low	Longer	82.9	17	0.1	Interpolate
Low	Very Low	Low	Low	Shorter	0.1	99.8	0.1	Half-Month
Low	Very Low	Low	Low	Short	0.1	99.8	0.1	Half-Month
Low	Very Low	Low	Low	Moderate	99.8	0.1	0.1	Half-Month
Low	Very Low	Low	Low	Long	99.8	0.1	0.1	Half-Month
Low	Very Low	Low	Low	Longer	78.4	21.5	0.1	Date
Low	Very Low	Low	Moderate	Shorter	62.4	37.5	0.1	Date
Low	Very Low	Low	Moderate	Short	99.8	0.1	0.1	Date
Low	Very Low	Low	Moderate	Moderate	99.8	0.1	0.1	Half-Month
Low	Very Low	Low	Moderate	Long	99.8	0.1	0.1	Half-Month
Low	Very Low	Low	Moderate	Longer	70.3	29.6	0.1	Date
Low	Very Low	Low	High	Shorter	62.4	37.5	0.1	Date
Low	Very Low	Low	High	Short	99.8	0.1	0.1	Date
Low	Very Low	Low	High	Moderate	99.8	0.1	0.1	Half-Month
Low	Very Low	Low	High	Long	99.8	0.1	0.1	Half-Month
Low	Very Low	Low	High	Longer	82.1	17.8	0.1	Date
Low	Very Low	Low	Very High	Shorter	99.8	0.1	0.1	Half-Month
Low	Very Low	Low	Very High	Short	99.8	0.1	0.1	Date
Low	Very Low	Low	Very High	Moderate	99.8	0.1	0.1	Half-Month
Low	Very Low	Low	Very High	Long	53.1	28.1	18.8	Interpolate
Low	Very Low	Low	Very High	Longer	32	34	34	Upper Date
Low	Very Low	Moderate	Very Low	Shorter	87	12.9	0.1	Upper Date
Low	Very Low	Moderate	Very Low	Short	46.6	53.3	0.1	Upper Half-Month
Low	Very Low	Moderate	Very Low	Moderate	40	59.9	0.1	Lower Half-Month
Low	Very Low	Moderate	Very Low	Long	21.4	63.6	15	Interpolate
Low	Very Low	Moderate	Very Low	Longer	59.5	40.4	0.1	Interpolate
Low	Very Low	Moderate	Low	Shorter	91.5	8.4	0.1	Half-Month
Low	Very Low	Moderate	Low	Short	99.8	0.1	0.1	Date
Low	Very Low	Moderate	Low	Moderate	40	59.9	0.1	Lower Half-Month
Low	Very Low	Moderate	Low	Long	0.1	40	59.9	Date
Low	Very Low	Moderate	Low	Longer	48.5	51.4	0.1	Date
Low	Very Low	Moderate	Moderate	Shorter	62.4	37.5	0.1	Date
Low	Very Low	Moderate	Moderate	Short	92.2	7.7	0.1	Half-Month
Low	Very Low	Moderate	Moderate	Moderate	40	59.9	0.1	Lower Half-Month
Low	Very Low	Moderate	Moderate	Long	0.1	40	59.9	Date
Low	Very Low	Moderate	Moderate	Longer	16.7	83.2	0.1	Date
Low	Very Low	Moderate	High	Shorter	62.4	37.5	0.1	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	Very Low	Moderate	High	Short	0.1	99.8	0.1	Half-Month
Low	Very Low	Moderate	High	Moderate	40	59.9	0.1	Lower Half-Month
Low	Very Low	Moderate	High	Long	0.1	40	59.9	Date
Low	Very Low	Moderate	High	Longer	0.1	40	59.9	Half-Month
Low	Very Low	Moderate	Very High	Shorter	2.3	21.4	76.3	Upper Date
Low	Very Low	Moderate	Very High	Short	58.5	41.4	0.1	Upper Date
Low	Very Low	Moderate	Very High	Moderate	49.95	49.95	0.1	Upper Date
Low	Very Low	Moderate	Very High	Long	0.1	40	59.9	Date
Low	Very Low	Moderate	Very High	Longer	0.1	40	59.9	Half-Month
Low	Very Low	High	Very Low	Shorter	15.4	46.1	38.5	Upper Half-Month
Low	Very Low	High	Very Low	Short	46.8	41.1	12.1	Interpolate
Low	Very Low	High	Very Low	Moderate	0.1	77.7	22.2	Upper Half-Month
Low	Very Low	High	Very Low	Long	0.1	99.8	0.1	Upper Date
Low	Very Low	High	Very Low	Longer	42.9	57	0.1	Date
Low	Very Low	High	Low	Shorter	69.9	30	0.1	Date
Low	Very Low	High	Low	Short	71.6	28.3	0.1	Half-Month
Low	Very Low	High	Low	Moderate	0.1	99.8	0.1	Date
Low	Very Low	High	Low	Long	0.1	40	59.9	Date
Low	Very Low	High	Low	Longer	33.3	66.6	0.1	Date
Low	Very Low	High	Moderate	Shorter	69.9	30	0.1	Date
Low	Very Low	High	Moderate	Short	71.8	28.1	0.1	Half-Month
Low	Very Low	High	Moderate	Moderate	49.95	49.95	0.1	Upper Date
Low	Very Low	High	Moderate	Long	0.1	40	59.9	Date
Low	Very Low	High	Moderate	Longer	39.4	60.5	0.1	Date
Low	Very Low	High	High	Shorter	10.7	32.2	57.1	Upper Half-Month
Low	Very Low	High	High	Short	30.7	57.6	11.7	Interpolate
Low	Very Low	High	High	Moderate	0.1	99.8	0.1	Date
Low	Very Low	High	High	Long	0.1	40	59.9	Date
Low	Very Low	High	High	Longer	36.8	63.1	0.1	Date
Low	Very Low	High	Very High	Shorter	0.1	20	79.9	Upper Date
Low	Very Low	High	Very High	Short	49.95	49.95	0.1	Upper Date
Low	Very Low	High	Very High	Moderate	49.95	49.95	0.1	Upper Date
Low	Very Low	High	Very High	Long	0.1	40	59.9	Date
Low	Very Low	High	Very High	Longer	0.1	40	59.9	Half-Month
Low	Low	Low	Very Low	Shorter	99.8	0.1	0.1	Lower Month
Low	Low	Low	Very Low	Short	99.8	0.1	0.1	Lower Month
Low	Low	Low	Very Low	Moderate	57.9	37.7	4.4	Interpolate
Low	Low	Low	Very Low	Long	58.4	41.5	0.1	Interpolate

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	Low	Low	Very Low	Longer	83	16.9	0.1	Interpolate
Low	Low	Low	Low	Shorter	89.9	10	0.1	Date
Low	Low	Low	Low	Short	0.1	99.8	0.1	Date
Low	Low	Low	Low	Moderate	30	69.9	0.1	Half-Month
Low	Low	Low	Low	Long	26.1	73.8	0.1	Half-Month
Low	Low	Low	Low	Longer	78.6	21.3	0.1	Date
Low	Low	Low	Moderate	Shorter	76.5	23.4	0.1	Date
Low	Low	Low	Moderate	Short	63	36.9	0.1	Date
Low	Low	Low	Moderate	Moderate	33.3	66.6	0.1	Date
Low	Low	Low	Moderate	Long	69.9	30	0.1	Half-Month
Low	Low	Low	Moderate	Longer	53.2	46.7	0.1	Date
Low	Low	Low	High	Shorter	66.7	33.2	0.1	Date
Low	Low	Low	High	Short	60.7	39.2	0.1	Date
Low	Low	Low	High	Moderate	45.5	54.4	0.1	Date
Low	Low	Low	High	Long	33.3	66.6	0.1	Date
Low	Low	Low	High	Longer	55.7	44.2	0.1	Date
Low	Low	Low	Very High	Shorter	85	14.9	0.1	Date
Low	Low	Low	Very High	Short	99.8	0.1	0.1	Date
Low	Low	Low	Very High	Moderate	99.8	0.1	0.1	Half-Month
Low	Low	Low	Very High	Long	33.3	66.6	0.1	Date
Low	Low	Low	Very High	Longer	45.8	54.1	0.1	Date
Low	Low	Moderate	Very Low	Shorter	99.8	0.1	0.1	Lower Month
Low	Low	Moderate	Very Low	Short	99.8	0.1	0.1	Lower Month
Low	Low	Moderate	Very Low	Moderate	40	59.9	0.1	Lower Half-Month
Low	Low	Moderate	Very Low	Long	34.8	63.1	2.1	Interpolate
Low	Low	Moderate	Very Low	Longer	49	38.5	12.5	Interpolate
Low	Low	Moderate	Low	Shorter	34.5	65.4	0.1	Date
Low	Low	Moderate	Low	Short	99.2	0.7	0.1	Date
Low	Low	Moderate	Low	Moderate	33.3	66.6	0.1	Lower Date
Low	Low	Moderate	Low	Long	0.1	99.8	0.1	Date
Low	Low	Moderate	Low	Longer	65.4	34.5	0.1	Date
Low	Low	Moderate	Moderate	Shorter	47.7	52.2	0.1	Date
Low	Low	Moderate	Moderate	Short	69.1	30.8	0.1	Date
Low	Low	Moderate	Moderate	Moderate	33.3	66.6	0.1	Date
Low	Low	Moderate	Moderate	Long	0.1	99.8	0.1	Date
Low	Low	Moderate	Moderate	Longer	9.8	90.1	0.1	Date
Low	Low	Moderate	High	Shorter	39.1	60.8	0.1	Date
Low	Low	Moderate	High	Short	0.1	99.8	0.1	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	Low	Moderate	High	Moderate	33.3	66.6	0.1	Date
Low	Low	Moderate	High	Long	0.1	99.8	0.1	Date
Low	Low	Moderate	High	Longer	0.1	99.8	0.1	Date
Low	Low	Moderate	Very High	Shorter	23.1	76.8	0.1	Date
Low	Low	Moderate	Very High	Short	99.8	0.1	0.1	Upper Date
Low	Low	Moderate	Very High	Moderate	87.9	12	0.1	Upper Date
Low	Low	Moderate	Very High	Long	0.1	99.8	0.1	Upper Date
Low	Low	Moderate	Very High	Longer	0.1	50.3	49.6	Upper Date
Low	Low	High	Very Low	Shorter	74.9	25	0.1	Lower Date
Low	Low	High	Very Low	Short	90.1	9.8	0.1	Interpolate
Low	Low	High	Very Low	Moderate	42	53.6	4.4	Interpolate
Low	Low	High	Very Low	Long	31	67.3	1.7	Interpolate
Low	Low	High	Very Low	Longer	42.9	57	0.1	Date
Low	Low	High	Low	Shorter	59.3	40.6	0.1	Date
Low	Low	High	Low	Short	85.6	14.3	0.1	Date
Low	Low	High	Low	Moderate	20	79.9	0.1	Half-Month
Low	Low	High	Low	Long	16.7	83	0.3	Date
Low	Low	High	Low	Longer	24.8	74.3	0.9	Date
Low	Low	High	Moderate	Shorter	58.6	41.3	0.1	Date
Low	Low	High	Moderate	Short	64.1	35.8	0.1	Date
Low	Low	High	Moderate	Moderate	18.4	81.5	0.1	Half-Month
Low	Low	High	Moderate	Long	17.3	82.4	0.3	Date
Low	Low	High	Moderate	Longer	31	68	1	Date
Low	Low	High	High	Shorter	32.8	67.1	0.1	Date
Low	Low	High	High	Short	44.6	55.3	0.1	Date
Low	Low	High	High	Moderate	18.6	81.3	0.1	Half-Month
Low	Low	High	High	Long	17.2	82	0.8	Date
Low	Low	High	High	Longer	14.9	80.8	4.3	Date
Low	Low	High	Very High	Shorter	17.6	82.3	0.1	Date
Low	Low	High	Very High	Short	40	59.9	0.1	Date
Low	Low	High	Very High	Moderate	40	59.9	0.1	Half-Month
Low	Low	High	Very High	Long	14.3	71.4	14.3	Date
Low	Low	High	Very High	Longer	38.8	54.1	7.1	Date
Low	Moderate	Low	Very Low	Shorter	81.2	18.7	0.1	Interpolate
Low	Moderate	Low	Very Low	Short	71.1	23.6	5.3	Interpolate
Low	Moderate	Low	Very Low	Moderate	42	49.3	8.7	Interpolate
Low	Moderate	Low	Very Low	Long	50	47.9	2.1	Interpolate
Low	Moderate	Low	Very Low	Longer	47.7	39.8	12.5	Interpolate

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	Moderate	Low	Low	Shorter	89.9	10	0.1	Date
Low	Moderate	Low	Low	Short	0.1	99.8	0.1	Date
Low	Moderate	Low	Low	Moderate	30	69.9	0.1	Half-Month
Low	Moderate	Low	Low	Long	26.1	73.8	0.1	Half-Month
Low	Moderate	Low	Low	Longer	74	25.9	0.1	Date
Low	Moderate	Low	Moderate	Shorter	51.7	48.2	0.1	Date
Low	Moderate	Low	Moderate	Short	76.2	23.7	0.1	Date
Low	Moderate	Low	Moderate	Moderate	67.5	32.4	0.1	Half-Month
Low	Moderate	Low	Moderate	Long	69.9	30	0.1	Half-Month
Low	Moderate	Low	Moderate	Longer	43.7	56.2	0.1	Date
Low	Moderate	Low	High	Shorter	37.2	62.7	0.1	Date
Low	Moderate	Low	High	Short	75.6	24.3	0.1	Date
Low	Moderate	Low	High	Moderate	99.8	0.1	0.1	Date
Low	Moderate	Low	High	Long	72.5	27.4	0.1	Half-Month
Low	Moderate	Low	High	Longer	48.3	51.6	0.1	Date
Low	Moderate	Low	Very High	Shorter	36	63.9	0.1	Date
Low	Moderate	Low	Very High	Short	99.8	0.1	0.1	Date
Low	Moderate	Low	Very High	Moderate	20.8	79.1	0.1	Half-Month
Low	Moderate	Low	Very High	Long	20	79.9	0.1	Upper Date
Low	Moderate	Low	Very High	Longer	32.5	67.4	0.1	Date
Low	Moderate	Moderate	Very Low	Shorter	99.8	0.1	0.1	Lower Date
Low	Moderate	Moderate	Very Low	Short	99.8	0.1	0.1	Lower Month
Low	Moderate	Moderate	Very Low	Moderate	40	59.9	0.1	Lower Half-Month
Low	Moderate	Moderate	Very Low	Long	50	41.7	8.3	Upper Half-Month
Low	Moderate	Moderate	Very Low	Longer	0.1	49.95	49.95	Upper Date
Low	Moderate	Moderate	Low	Shorter	48.9	51	0.1	Date
Low	Moderate	Moderate	Low	Short	0.1	99.8	0.1	Date
Low	Moderate	Moderate	Low	Moderate	0.1	40	59.9	Date
Low	Moderate	Moderate	Low	Long	11.9	87.4	0.7	Date
Low	Moderate	Moderate	Low	Longer	8.4	91.5	0.1	Date
Low	Moderate	Moderate	Moderate	Shorter	60.5	38.8	0.7	Date
Low	Moderate	Moderate	Moderate	Short	84.8	15.1	0.1	Date
Low	Moderate	Moderate	Moderate	Moderate	66.6	33.3	0.1	Half-Month
Low	Moderate	Moderate	Moderate	Long	8.7	90.8	0.5	Date
Low	Moderate	Moderate	Moderate	Longer	15.3	84.6	0.1	Date
Low	Moderate	Moderate	High	Shorter	49.2	50.3	0.5	Date
Low	Moderate	Moderate	High	Short	0.1	99.8	0.1	Date
Low	Moderate	Moderate	High	Moderate	14.4	51.5	34.1	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	Moderate	Moderate	High	Long	21.5	78.2	0.3	Date
Low	Moderate	Moderate	High	Longer	10.8	89.1	0.1	Date
Low	Moderate	Moderate	Very High	Shorter	65	33.1	1.9	Date
Low	Moderate	Moderate	Very High	Short	85.6	14.3	0.1	Half-Month
Low	Moderate	Moderate	Very High	Moderate	2.4	41.9	55.7	Date
Low	Moderate	Moderate	Very High	Long	0.1	40	59.9	Date
Low	Moderate	Moderate	Very High	Longer	0.1	40	59.9	Half-Month
Low	Moderate	High	Very Low	Shorter	27.3	72.6	0.1	Lower Month
Low	Moderate	High	Very Low	Short	65.7	34.2	0.1	Interpolate
Low	Moderate	High	Very Low	Moderate	49.95	49.95	0.1	Upper Date
Low	Moderate	High	Very Low	Long	50	41.7	8.3	Upper Half-Month
Low	Moderate	High	Very Low	Longer	50	41.7	8.3	Upper Half-Month
Low	Moderate	High	Low	Shorter	54.5	45.4	0.1	Date
Low	Moderate	High	Low	Short	85.6	14.3	0.1	Date
Low	Moderate	High	Low	Moderate	0.1	99.8	0.1	Date
Low	Moderate	High	Low	Long	13.3	86.6	0.1	Date
Low	Moderate	High	Low	Longer	21.7	77.9	0.4	Date
Low	Moderate	High	Moderate	Shorter	42.5	56.8	0.7	Date
Low	Moderate	High	Moderate	Short	78.7	21.2	0.1	Date
Low	Moderate	High	Moderate	Moderate	0.1	79.9	20	Date
Low	Moderate	High	Moderate	Long	11.6	88.3	0.1	Date
Low	Moderate	High	Moderate	Longer	21.1	77.8	1.1	Date
Low	Moderate	High	High	Shorter	19.9	79.2	0.9	Date
Low	Moderate	High	High	Short	56.3	43.6	0.1	Date
Low	Moderate	High	High	Moderate	0.1	98.3	1.6	Date
Low	Moderate	High	High	Long	12.7	87.2	0.1	Date
Low	Moderate	High	High	Longer	10.7	86.7	2.6	Date
Low	Moderate	High	Very High	Shorter	11.5	84	4.5	Date
Low	Moderate	High	Very High	Short	40	59.9	0.1	Date
Low	Moderate	High	Very High	Moderate	0.1	79.9	20	Date
Low	Moderate	High	Very High	Long	10.8	81.2	8	Date
Low	Moderate	High	Very High	Longer	14	70.7	15.3	Date
Low	High	Low	Very Low	Shorter	99.8	0.1	0.1	Lower Date
Low	High	Low	Very Low	Short	99.8	0.1	0.1	Upper Date
Low	High	Low	Very Low	Moderate	56.9	36.5	6.6	Interpolate
Low	High	Low	Very Low	Long	33.3	66.6	0.1	Upper Half-Month
Low	High	Low	Very Low	Longer	33.3	66.6	0.1	Upper Half-Month
Low	High	Low	Low	Shorter	6.6	93.3	0.1	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	High	Low	Low	Short	89.9	10	0.1	Half-Month
Low	High	Low	Low	Moderate	37.1	50.9	12	Interpolate
Low	High	Low	Low	Long	44.7	53.8	1.5	Interpolate
Low	High	Low	Low	Longer	50.7	49.2	0.1	Date
Low	High	Low	Moderate	Shorter	20.8	79.1	0.1	Date
Low	High	Low	Moderate	Short	78.3	21.6	0.1	Date
Low	High	Low	Moderate	Moderate	65.4	34.5	0.1	Half-Month
Low	High	Low	Moderate	Long	69.9	30	0.1	Half-Month
Low	High	Low	Moderate	Longer	24.5	75.4	0.1	Date
Low	High	Low	High	Shorter	79.3	20.6	0.1	Date
Low	High	Low	High	Short	78.9	21	0.1	Date
Low	High	Low	High	Moderate	65.2	34.7	0.1	Half-Month
Low	High	Low	High	Long	33.3	66.6	0.1	Date
Low	High	Low	High	Longer	31.1	68.8	0.1	Date
Low	High	Low	Very High	Shorter	84	15.9	0.1	Date
Low	High	Low	Very High	Short	99.8	0.1	0.1	Date
Low	High	Low	Very High	Moderate	34.4	65.5	0.1	Half-Month
Low	High	Low	Very High	Long	33.3	66.6	0.1	Date
Low	High	Low	Very High	Longer	20.8	79.1	0.1	Date
Low	High	Moderate	Very Low	Shorter	99.8	0.1	0.1	Lower Date
Low	High	Moderate	Very Low	Short	99.8	0.1	0.1	Lower Month
Low	High	Moderate	Very Low	Moderate	40	59.9	0.1	Lower Half-Month
Low	High	Moderate	Very Low	Long	12.8	87.1	0.1	Upper Date
Low	High	Moderate	Very Low	Longer	0.1	49.95	49.95	Upper Date
Low	High	Moderate	Low	Shorter	55.4	44.5	0.1	Date
Low	High	Moderate	Low	Short	85.6	14.3	0.1	Half-Month
Low	High	Moderate	Low	Moderate	0.1	40	59.9	Date
Low	High	Moderate	Low	Long	21.2	69.6	9.2	Date
Low	High	Moderate	Low	Longer	17.5	82.4	0.1	Date
Low	High	Moderate	Moderate	Shorter	55.2	41.4	3.4	Date
Low	High	Moderate	Moderate	Short	85.6	14.3	0.1	Half-Month
Low	High	Moderate	Moderate	Moderate	25	74.9	0.1	Half-Month
Low	High	Moderate	Moderate	Long	21.2	69.6	9.2	Date
Low	High	Moderate	Moderate	Longer	30.5	69.4	0.1	Date
Low	High	Moderate	High	Shorter	50.1	47	2.9	Date
Low	High	Moderate	High	Short	85.6	14.3	0.1	Half-Month
Low	High	Moderate	High	Moderate	0.1	40	59.9	Date
Low	High	Moderate	High	Long	24.1	73.8	2.1	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	High	Moderate	High	Longer	33.6	66.3	0.1	Date
Low	High	Moderate	Very High	Shorter	45	48.2	6.8	Date
Low	High	Moderate	Very High	Short	85.6	14.3	0.1	Half-Month
Low	High	Moderate	Very High	Moderate	0.1	54.1	45.8	Date
Low	High	Moderate	Very High	Long	0.1	40	59.9	Date
Low	High	Moderate	Very High	Longer	0.1	40	59.9	Half-Month
Low	High	High	Very Low	Shorter	27.3	72.6	0.1	Lower Month
Low	High	High	Very Low	Short	54.8	43.5	1.7	Interpolate
Low	High	High	Very Low	Moderate	50	41.7	8.3	Upper Half-Month
Low	High	High	Very Low	Long	33.3	66.6	0.1	Upper Date
Low	High	High	Very Low	Longer	39.9	55	5.1	Upper Half-Month
Low	High	High	Low	Shorter	61.5	38.4	0.1	Date
Low	High	High	Low	Short	85.6	14.3	0.1	Date
Low	High	High	Low	Moderate	0.1	99.8	0.1	Date
Low	High	High	Low	Long	12.2	87.4	0.4	Date
Low	High	High	Low	Longer	12.6	86.8	0.6	Date
Low	High	High	Moderate	Shorter	45.5	50.3	4.2	Date
Low	High	High	Moderate	Short	68.6	31.3	0.1	Date
Low	High	High	Moderate	Moderate	0.1	79.9	20	Date
Low	High	High	Moderate	Long	12.3	87.4	0.3	Date
Low	High	High	Moderate	Longer	10.5	87.9	1.6	Date
Low	High	High	High	Shorter	19.4	71.9	8.7	Date
Low	High	High	High	Short	46.6	53.3	0.1	Date
Low	High	High	High	Moderate	0.1	97	2.9	Date
Low	High	High	High	Long	13	86.1	0.9	Date
Low	High	High	High	Longer	10.8	88	1.2	Date
Low	High	High	Very High	Shorter	0.1	85.6	14.3	Date
Low	High	High	Very High	Short	40	59.9	0.1	Date
Low	High	High	Very High	Moderate	0.1	79.9	20	Date
Low	High	High	Very High	Long	12.5	83.5	4	Date
Low	High	High	Very High	Longer	18.8	67.5	13.7	Date
Low	Very High	Low	Very Low	Shorter	99.8	0.1	0.1	Lower Date
Low	Very High	Low	Very Low	Short	99.8	0.1	0.1	Upper Date
Low	Very High	Low	Very Low	Moderate	61	38.9	0.1	Interpolate
Low	Very High	Low	Very Low	Long	33.3	66.6	0.1	Upper Half-Month
Low	Very High	Low	Very Low	Longer	66.6	33.3	0.1	Upper Date
Low	Very High	Low	Low	Shorter	0.1	99.8	0.1	Date
Low	Very High	Low	Low	Short	53.8	46.1	0.1	Interpolate

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	Very High	Low	Low	Moderate	33.3	46.7	20	Interpolate
Low	Very High	Low	Low	Long	28.2	59.8	12	Interpolate
Low	Very High	Low	Low	Longer	41	58.9	0.1	Date
Low	Very High	Low	Moderate	Shorter	6.6	93.3	0.1	Date
Low	Very High	Low	Moderate	Short	0.1	99.8	0.1	Half-Month
Low	Very High	Low	Moderate	Moderate	0.1	99.8	0.1	Half-Month
Low	Very High	Low	Moderate	Long	33.3	66.6	0.1	Upper Half-Month
Low	Very High	Low	Moderate	Longer	23.1	76.8	0.1	Date
Low	Very High	Low	High	Shorter	76.4	23.5	0.1	Date
Low	Very High	Low	High	Short	21.9	78	0.1	Half-Month
Low	Very High	Low	High	Moderate	0.1	99.8	0.1	Half-Month
Low	Very High	Low	High	Long	34.7	65.2	0.1	Date
Low	Very High	Low	High	Longer	54.8	45.1	0.1	Date
Low	Very High	Low	Very High	Shorter	66.3	33.6	0.1	Date
Low	Very High	Low	Very High	Short	10.8	89.1	0.1	Half-Month
Low	Very High	Low	Very High	Moderate	0.1	99.8	0.1	Half-Month
Low	Very High	Low	Very High	Long	33.3	66.6	0.1	Date
Low	Very High	Low	Very High	Longer	29.9	70	0.1	Date
Low	Very High	Moderate	Very Low	Shorter	99.8	0.1	0.1	Lower Month
Low	Very High	Moderate	Very Low	Short	49.1	50.8	0.1	Upper Date
Low	Very High	Moderate	Very Low	Moderate	49.95	49.95	0.1	Upper Date
Low	Very High	Moderate	Very Low	Long	16.7	83.2	0.1	Upper Date
Low	Very High	Moderate	Very Low	Longer	74.9	25	0.1	Upper Date
Low	Very High	Moderate	Low	Shorter	44.1	55	0.9	Upper Half-Month
Low	Very High	Moderate	Low	Short	99.8	0.1	0.1	Upper Date
Low	Very High	Moderate	Low	Moderate	0.1	40	59.9	Date
Low	Very High	Moderate	Low	Long	0.1	40	59.9	Date
Low	Very High	Moderate	Low	Longer	22.2	77.7	0.1	Date
Low	Very High	Moderate	Moderate	Shorter	99.8	0.1	0.1	Lower Month
Low	Very High	Moderate	Moderate	Short	33.3	66.6	0.1	Upper Date
Low	Very High	Moderate	Moderate	Moderate	25	74.9	0.1	Half-Month
Low	Very High	Moderate	Moderate	Long	0.1	40	59.9	Date
Low	Very High	Moderate	Moderate	Longer	46.6	53.3	0.1	Date
Low	Very High	Moderate	High	Shorter	66.6	33.3	0.1	Date
Low	Very High	Moderate	High	Short	52.4	47.5	0.1	Upper Date
Low	Very High	Moderate	High	Moderate	2.4	41.9	55.7	Date
Low	Very High	Moderate	High	Long	0.1	40	59.9	Date
Low	Very High	Moderate	High	Longer	33.4	66.5	0.1	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	Very High	Moderate	Very High	Shorter	66.6	33.3	0.1	Date
Low	Very High	Moderate	Very High	Short	14.1	85.8	0.1	Upper Date
Low	Very High	Moderate	Very High	Moderate	0.2	42	57.8	Date
Low	Very High	Moderate	Very High	Long	0.1	40	59.9	Date
Low	Very High	Moderate	Very High	Longer	0.1	40	59.9	Half-Month
Low	Very High	High	Very Low	Shorter	0.1	85.8	14.1	Upper Date
Low	Very High	High	Very Low	Short	11.1	88.8	0.1	Upper Half-Month
Low	Very High	High	Very Low	Moderate	49.95	49.95	0.1	Upper Date
Low	Very High	High	Very Low	Long	40.7	59.2	0.1	Upper Date
Low	Very High	High	Very Low	Longer	99.8	0.1	0.1	Upper Date
Low	Very High	High	Low	Shorter	76.3	20.7	3	Upper Half-Month
Low	Very High	High	Low	Short	99.8	0.1	0.1	Upper Date
Low	Very High	High	Low	Moderate	0.1	99.8	0.1	Date
Low	Very High	High	Low	Long	14.3	82.4	3.3	Date
Low	Very High	High	Low	Longer	2.8	96.6	0.6	Date
Low	Very High	High	Moderate	Shorter	25.3	25.3	49.4	Upper Date
Low	Very High	High	Moderate	Short	57.3	42.6	0.1	Upper Date
Low	Very High	High	Moderate	Moderate	0.1	79.9	20	Date
Low	Very High	High	Moderate	Long	13.1	84.5	2.4	Date
Low	Very High	High	Moderate	Longer	0.1	98.4	1.5	Date
Low	Very High	High	High	Shorter	21.7	57.9	20.4	Upper Date
Low	Very High	High	High	Short	35.9	53.6	10.5	Upper Half-Month
Low	Very High	High	High	Moderate	0.1	93.9	6	Date
Low	Very High	High	High	Long	14.7	80.5	4.8	Date
Low	Very High	High	High	Longer	7.4	91.3	1.3	Date
Low	Very High	High	Very High	Shorter	2.3	68	29.7	Upper Date
Low	Very High	High	Very High	Short	1.7	56.4	41.9	Upper Date
Low	Very High	High	Very High	Moderate	0.1	79.9	20	Date
Low	Very High	High	Very High	Long	12.8	75.7	11.5	Date
Low	Very High	High	Very High	Longer	0.1	79.9	20	Date
Moderate	Very Low	Low	Very Low	Shorter	99.8	0.1	0.1	Lower Month
Moderate	Very Low	Low	Very Low	Short	99.8	0.1	0.1	Lower Month
Moderate	Very Low	Low	Very Low	Moderate	62.4	37.5	0.1	Lower Month
Moderate	Very Low	Low	Very Low	Long	62.4	37.5	0.1	Lower Month
Moderate	Very Low	Low	Very Low	Longer	87.4	12.5	0.1	Date
Moderate	Very Low	Low	Low	Shorter	79.9	20	0.1	Date
Moderate	Very Low	Low	Low	Short	0.1	99.8	0.1	Half-Month
Moderate	Very Low	Low	Low	Moderate	99.8	0.1	0.1	Half-Month

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Moderate	Very Low	Low	Low	Long	99.8	0.1	0.1	Half-Month
Moderate	Very Low	Low	Low	Longer	79.4	20.5	0.1	Date
Moderate	Very Low	Low	Moderate	Shorter	62.3	37.6	0.1	Date
Moderate	Very Low	Low	Moderate	Short	0.1	99.8	0.1	Half-Month
Moderate	Very Low	Low	Moderate	Moderate	99.8	0.1	0.1	Half-Month
Moderate	Very Low	Low	Moderate	Long	99.8	0.1	0.1	Half-Month
Moderate	Very Low	Low	Moderate	Longer	28.8	71.1	0.1	Date
Moderate	Very Low	Low	High	Shorter	50.2	49.7	0.1	Date
Moderate	Very Low	Low	High	Short	0.1	99.8	0.1	Half-Month
Moderate	Very Low	Low	High	Moderate	99.8	0.1	0.1	Half-Month
Moderate	Very Low	Low	High	Long	99.8	0.1	0.1	Half-Month
Moderate	Very Low	Low	High	Longer	71	28.9	0.1	Date
Moderate	Very Low	Low	Very High	Shorter	40.7	59.2	0.1	Date
Moderate	Very Low	Low	Very High	Short	62.5	37.4	0.1	Interpolate
Moderate	Very Low	Low	Very High	Moderate	85.6	14.3	0.1	Interpolate
Moderate	Very Low	Low	Very High	Long	38.3	36.7	25	Interpolate
Moderate	Very Low	Low	Very High	Longer	20	40	40	Upper Date
Moderate	Very Low	Moderate	Very Low	Shorter	92	7.9	0.1	Lower Month
Moderate	Very Low	Moderate	Very Low	Short	91.8	8.1	0.1	Lower Month
Moderate	Very Low	Moderate	Very Low	Moderate	33.5	66.4	0.1	Lower Date
Moderate	Very Low	Moderate	Very Low	Long	45.5	54.4	0.1	Lower Date
Moderate	Very Low	Moderate	Very Low	Longer	87.4	12.5	0.1	Date
Moderate	Very Low	Moderate	Low	Shorter	79.9	20	0.1	Date
Moderate	Very Low	Moderate	Low	Short	99.8	0.1	0.1	Date
Moderate	Very Low	Moderate	Low	Moderate	99.8	0.1	0.1	Date
Moderate	Very Low	Moderate	Low	Long	11.7	49.3	39	Date
Moderate	Very Low	Moderate	Low	Longer	75.7	24.2	0.1	Date
Moderate	Very Low	Moderate	Moderate	Shorter	62.4	37.5	0.1	Date
Moderate	Very Low	Moderate	Moderate	Short	99.8	0.1	0.1	Date
Moderate	Very Low	Moderate	Moderate	Moderate	99.8	0.1	0.1	Date
Moderate	Very Low	Moderate	Moderate	Long	0.1	40	59.9	Date
Moderate	Very Low	Moderate	Moderate	Longer	52.6	47.3	0.1	Date
Moderate	Very Low	Moderate	High	Shorter	62.6	37.3	0.1	Date
Moderate	Very Low	Moderate	High	Short	0.1	99.8	0.1	Half-Month
Moderate	Very Low	Moderate	High	Moderate	33.3	66.6	0.1	Half-Month
Moderate	Very Low	Moderate	High	Long	7.1	45.7	47.2	Date
Moderate	Very Low	Moderate	High	Longer	55.1	44.8	0.1	Date
Moderate	Very Low	Moderate	Very High	Shorter	66.6	33.3	0.1	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Moderate	Very Low	Moderate	Very High	Short	64.6	35.3	0.1	Upper Date
Moderate	Very Low	Moderate	Very High	Moderate	42.9	57	0.1	Upper Half-Month
Moderate	Very Low	Moderate	Very High	Long	0.1	40	59.9	Date
Moderate	Very Low	Moderate	Very High	Longer	0.1	40	59.9	Half-Month
Moderate	Very Low	High	Very Low	Shorter	99.8	0.1	0.1	Lower Half-Month
Moderate	Very Low	High	Very Low	Short	99.8	0.1	0.1	Lower Date
Moderate	Very Low	High	Very Low	Moderate	99.8	0.1	0.1	Date
Moderate	Very Low	High	Very Low	Long	45.5	54.4	0.1	Lower Date
Moderate	Very Low	High	Very Low	Longer	42.9	57	0.1	Date
Moderate	Very Low	High	Low	Shorter	64.7	34.9	0.4	Date
Moderate	Very Low	High	Low	Short	53.9	37	9.1	Date
Moderate	Very Low	High	Low	Moderate	87.1	12.8	0.1	Date
Moderate	Very Low	High	Low	Long	97.4	1.8	0.8	Date
Moderate	Very Low	High	Low	Longer	76	23.9	0.1	Date
Moderate	Very Low	High	Moderate	Shorter	65.9	33.9	0.2	Date
Moderate	Very Low	High	Moderate	Short	45.6	37.1	17.3	Date
Moderate	Very Low	High	Moderate	Moderate	83.2	16.7	0.1	Date
Moderate	Very Low	High	Moderate	Long	93.5	2.6	3.9	Date
Moderate	Very Low	High	Moderate	Longer	41.7	58.2	0.1	Date
Moderate	Very Low	High	High	Shorter	0.1	79.9	20	Date
Moderate	Very Low	High	High	Short	37.5	37.5	25	Date
Moderate	Very Low	High	High	Moderate	22.4	77.5	0.1	Date
Moderate	Very Low	High	High	Long	14	51.1	34.9	Date
Moderate	Very Low	High	High	Longer	36.9	63	0.1	Date
Moderate	Very Low	High	Very High	Shorter	13.6	40.8	45.6	Upper Half-Month
Moderate	Very Low	High	Very High	Short	49.95	49.95	0.1	Upper Date
Moderate	Very Low	High	Very High	Moderate	42.9	57	0.1	Upper Half-Month
Moderate	Very Low	High	Very High	Long	0.1	40	59.9	Date
Moderate	Very Low	High	Very High	Longer	0.1	40	59.9	Half-Month
Moderate	Low	Low	Very Low	Shorter	99.8	0.1	0.1	Lower Half-Month
Moderate	Low	Low	Very Low	Short	32.3	31.8	35.9	Lower Half-Month
Moderate	Low	Low	Very Low	Moderate	61.6	20.8	17.6	Lower Half-Month
Moderate	Low	Low	Very Low	Long	90.8	9.1	0.1	Lower Half-Month
Moderate	Low	Low	Very Low	Longer	87.4	12.5	0.1	Date
Moderate	Low	Low	Low	Shorter	83.2	16.7	0.1	Date
Moderate	Low	Low	Low	Short	0.1	44.8	55.1	Date
Moderate	Low	Low	Low	Moderate	55.5	44.4	0.1	Date
Moderate	Low	Low	Low	Long	87.4	12.5	0.1	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Moderate	Low	Low	Low	Longer	57.9	42	0.1	Date
Moderate	Low	Low	Moderate	Shorter	71.6	28.3	0.1	Date
Moderate	Low	Low	Moderate	Short	56.2	38.6	5.2	Date
Moderate	Low	Low	Moderate	Moderate	60.8	39.1	0.1	Date
Moderate	Low	Low	Moderate	Long	87.4	12.5	0.1	Date
Moderate	Low	Low	Moderate	Longer	44.2	55.7	0.1	Date
Moderate	Low	Low	High	Shorter	63.5	36.4	0.1	Date
Moderate	Low	Low	High	Short	49.95	49.95	0.1	Date
Moderate	Low	Low	High	Moderate	98.8	1.1	0.1	Date
Moderate	Low	Low	High	Long	33.3	66.6	0.1	Date
Moderate	Low	Low	High	Longer	63.2	36.7	0.1	Date
Moderate	Low	Low	Very High	Shorter	77.9	22	0.1	Date
Moderate	Low	Low	Very High	Short	70	29.9	0.1	Half-Month
Moderate	Low	Low	Very High	Moderate	63.5	36.4	0.1	Interpolate
Moderate	Low	Low	Very High	Long	33.3	66.6	0.1	Date
Moderate	Low	Low	Very High	Longer	42.7	57.2	0.1	Date
Moderate	Low	Moderate	Very Low	Shorter	99.8	0.1	0.1	Lower Half-Month
Moderate	Low	Moderate	Very Low	Short	40	27.7	32.3	Lower Half-Month
Moderate	Low	Moderate	Very Low	Moderate	38.1	58.6	3.3	Lower Half-Month
Moderate	Low	Moderate	Very Low	Long	49	50.9	0.1	Lower Date
Moderate	Low	Moderate	Very Low	Longer	87.4	12.5	0.1	Date
Moderate	Low	Moderate	Low	Shorter	86.2	13.7	0.1	Date
Moderate	Low	Moderate	Low	Short	99.5	0.4	0.1	Date
Moderate	Low	Moderate	Low	Moderate	94.7	4.4	0.9	Date
Moderate	Low	Moderate	Low	Long	75.3	24.6	0.1	Date
Moderate	Low	Moderate	Low	Longer	68.1	31.8	0.1	Date
Moderate	Low	Moderate	Moderate	Shorter	62.4	37.5	0.1	Date
Moderate	Low	Moderate	Moderate	Short	99.7	0.2	0.1	Date
Moderate	Low	Moderate	Moderate	Moderate	82.4	15.3	2.3	Date
Moderate	Low	Moderate	Moderate	Long	38.8	61.1	0.1	Date
Moderate	Low	Moderate	Moderate	Longer	42.6	57.3	0.1	Date
Moderate	Low	Moderate	High	Shorter	56	43.9	0.1	Date
Moderate	Low	Moderate	High	Short	99	0.9	0.1	Date
Moderate	Low	Moderate	High	Moderate	47.8	47.8	4.4	Date
Moderate	Low	Moderate	High	Long	11.9	88	0.1	Date
Moderate	Low	Moderate	High	Longer	31	68.9	0.1	Date
Moderate	Low	Moderate	Very High	Shorter	56.2	43.7	0.1	Date
Moderate	Low	Moderate	Very High	Short	69.9	30	0.1	Half-Month

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Moderate	Low	Moderate	Very High	Moderate	42.9	57	0.1	Upper Half-Month
Moderate	Low	Moderate	Very High	Long	66.6	0.1	33.3	Upper Half-Month
Moderate	Low	Moderate	Very High	Longer	32.8	41.1	26.1	Interpolate
Moderate	Low	High	Very Low	Shorter	99.8	0.1	0.1	Lower Half-Month
Moderate	Low	High	Very Low	Short	99.8	0.1	0.1	Lower Date
Moderate	Low	High	Very Low	Moderate	99.8	0.1	0.1	Date
Moderate	Low	High	Very Low	Long	45.5	54.4	0.1	Lower Date
Moderate	Low	High	Very Low	Longer	42.9	57	0.1	Date
Moderate	Low	High	Low	Shorter	54.4	45.2	0.4	Date
Moderate	Low	High	Low	Short	64.2	32.9	2.9	Date
Moderate	Low	High	Low	Moderate	56.9	39.2	3.9	Date
Moderate	Low	High	Low	Long	51.6	48.3	0.1	Date
Moderate	Low	High	Low	Longer	62	37.6	0.4	Date
Moderate	Low	High	Moderate	Shorter	54.9	44.9	0.2	Date
Moderate	Low	High	Moderate	Short	59.7	33.4	6.9	Date
Moderate	Low	High	Moderate	Moderate	37	55.1	7.9	Date
Moderate	Low	High	Moderate	Long	29.8	70	0.2	Date
Moderate	Low	High	Moderate	Longer	38.3	61.1	0.6	Date
Moderate	Low	High	High	Shorter	23.2	74.8	2	Date
Moderate	Low	High	High	Short	40.7	43.2	16.1	Date
Moderate	Low	High	High	Moderate	44.9	50	5.1	Date
Moderate	Low	High	High	Long	21.3	78.2	0.5	Date
Moderate	Low	High	High	Longer	27.3	69.4	3.3	Date
Moderate	Low	High	Very High	Shorter	16.5	83.4	0.1	Date
Moderate	Low	High	Very High	Short	40	59.9	0.1	Date
Moderate	Low	High	Very High	Moderate	40	59.9	0.1	Half-Month
Moderate	Low	High	Very High	Long	14.3	71.4	14.3	Date
Moderate	Low	High	Very High	Longer	41.7	52.2	6.1	Date
Moderate	Moderate	Low	Very Low	Shorter	16.7	83.2	0.1	Date
Moderate	Moderate	Low	Very Low	Short	55.3	18	26.7	Lower Half-Month
Moderate	Moderate	Low	Very Low	Moderate	56	17.8	26.2	Lower Half-Month
Moderate	Moderate	Low	Very Low	Long	90.8	9.1	0.1	Lower Half-Month
Moderate	Moderate	Low	Very Low	Longer	83.2	16.7	0.1	Lower Date
Moderate	Moderate	Low	Low	Shorter	87.1	12.8	0.1	Date
Moderate	Moderate	Low	Low	Short	0.1	38	61.9	Date
Moderate	Moderate	Low	Low	Moderate	0.1	99.8	0.1	Date
Moderate	Moderate	Low	Low	Long	87.4	12.5	0.1	Date
Moderate	Moderate	Low	Low	Longer	55.2	44.7	0.1	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Moderate	Moderate	Low	Moderate	Shorter	69.5	29.1	1.4	Date
Moderate	Moderate	Low	Moderate	Short	54.6	29.9	15.5	Date
Moderate	Moderate	Low	Moderate	Moderate	0.1	99.8	0.1	Date
Moderate	Moderate	Low	Moderate	Long	87.4	12.5	0.1	Date
Moderate	Moderate	Low	Moderate	Longer	44.1	55.8	0.1	Date
Moderate	Moderate	Low	High	Shorter	51.2	46.9	1.9	Date
Moderate	Moderate	Low	High	Short	65.8	34.1	0.1	Date
Moderate	Moderate	Low	High	Moderate	70.7	29.2	0.1	Half-Month
Moderate	Moderate	Low	High	Long	73.2	26.7	0.1	Half-Month
Moderate	Moderate	Low	High	Longer	62.8	37.1	0.1	Date
Moderate	Moderate	Low	Very High	Shorter	50.6	44	5.4	Date
Moderate	Moderate	Low	Very High	Short	64	35.9	0.1	Half-Month
Moderate	Moderate	Low	Very High	Moderate	0.1	99.8	0.1	Half-Month
Moderate	Moderate	Low	Very High	Long	59.8	25.4	14.8	Lower Month
Moderate	Moderate	Low	Very High	Longer	31.2	68.7	0.1	Date
Moderate	Moderate	Moderate	Very Low	Shorter	99.8	0.1	0.1	Lower Date
Moderate	Moderate	Moderate	Very Low	Short	70.2	13.5	16.3	Lower Month
Moderate	Moderate	Moderate	Very Low	Moderate	33.3	66.6	0.1	Lower Date
Moderate	Moderate	Moderate	Very Low	Long	72.6	27.3	0.1	Lower Half-Month
Moderate	Moderate	Moderate	Very Low	Longer	99.8	0.1	0.1	Lower Date
Moderate	Moderate	Moderate	Low	Shorter	92.7	7.2	0.1	Date
Moderate	Moderate	Moderate	Low	Short	0.1	99.8	0.1	Date
Moderate	Moderate	Moderate	Low	Moderate	57.7	31.1	11.2	Date
Moderate	Moderate	Moderate	Low	Long	40	59.4	0.6	Date
Moderate	Moderate	Moderate	Low	Longer	38.6	61.3	0.1	Date
Moderate	Moderate	Moderate	Moderate	Shorter	16.3	5.8	77.9	Date
Moderate	Moderate	Moderate	Moderate	Short	99.7	0.2	0.1	Date
Moderate	Moderate	Moderate	Moderate	Moderate	35.2	48.2	16.6	Date
Moderate	Moderate	Moderate	Moderate	Long	6.9	92.5	0.6	Date
Moderate	Moderate	Moderate	Moderate	Longer	45.2	54.7	0.1	Date
Moderate	Moderate	Moderate	High	Shorter	14.4	20.6	65	Date
Moderate	Moderate	Moderate	High	Short	99.4	0.5	0.1	Date
Moderate	Moderate	Moderate	High	Moderate	20.6	61.6	17.8	Date
Moderate	Moderate	Moderate	High	Long	14.3	84.9	0.8	Date
Moderate	Moderate	Moderate	High	Longer	39	60.9	0.1	Date
Moderate	Moderate	Moderate	Very High	Shorter	22.8	36.2	41	Date
Moderate	Moderate	Moderate	Very High	Short	79.3	20.6	0.1	Half-Month
Moderate	Moderate	Moderate	Very High	Moderate	33.3	66.6	0.1	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Moderate	Moderate	Moderate	Very High	Long	0.1	40	59.9	Date
Moderate	Moderate	Moderate	Very High	Longer	0.1	40	59.9	Half-Month
Moderate	Moderate	High	Very Low	Shorter	27.3	72.6	0.1	Lower Month
Moderate	Moderate	High	Very Low	Short	74.8	20.8	4.4	Interpolate
Moderate	Moderate	High	Very Low	Moderate	99.8	0.1	0.1	Date
Moderate	Moderate	High	Very Low	Long	50	41.7	8.3	Upper Half-Month
Moderate	Moderate	High	Very Low	Longer	50	41.7	8.3	Upper Half-Month
Moderate	Moderate	High	Low	Shorter	48	51.4	0.6	Date
Moderate	Moderate	High	Low	Short	56.9	32.8	10.3	Date
Moderate	Moderate	High	Low	Moderate	51.3	46.7	2	Date
Moderate	Moderate	High	Low	Long	37	62.9	0.1	Date
Moderate	Moderate	High	Low	Longer	31.4	68.4	0.2	Date
Moderate	Moderate	High	Moderate	Shorter	40.4	59.1	0.5	Date
Moderate	Moderate	High	Moderate	Short	65.6	26.4	8	Date
Moderate	Moderate	High	Moderate	Moderate	36.5	56.6	6.9	Date
Moderate	Moderate	High	Moderate	Long	21.8	78.1	0.1	Date
Moderate	Moderate	High	Moderate	Longer	31.9	67.8	0.3	Date
Moderate	Moderate	High	High	Shorter	16.1	82.6	1.3	Date
Moderate	Moderate	High	High	Short	48.4	38.3	13.3	Date
Moderate	Moderate	High	High	Moderate	36.2	60.4	3.4	Date
Moderate	Moderate	High	High	Long	17.5	82.4	0.1	Date
Moderate	Moderate	High	High	Longer	25	73	2	Date
Moderate	Moderate	High	Very High	Shorter	14.2	84.3	1.5	Date
Moderate	Moderate	High	Very High	Short	40	59.9	0.1	Date
Moderate	Moderate	High	Very High	Moderate	26.6	72	1.4	Date
Moderate	Moderate	High	Very High	Long	10.7	80.4	8.9	Date
Moderate	Moderate	High	Very High	Longer	16.5	69	14.5	Date
Moderate	High	Low	Very Low	Shorter	16.7	83.2	0.1	Date
Moderate	High	Low	Very Low	Short	41.4	25.5	33.1	Lower Half-Month
Moderate	High	Low	Very Low	Moderate	54.4	19.2	26.4	Lower Half-Month
Moderate	High	Low	Very Low	Long	90.8	9.1	0.1	Lower Half-Month
Moderate	High	Low	Very Low	Longer	99.8	0.1	0.1	Lower Date
Moderate	High	Low	Low	Shorter	84.1	15.8	0.1	Date
Moderate	High	Low	Low	Short	1	98.9	0.1	Half-Month
Moderate	High	Low	Low	Moderate	0.1	99.8	0.1	Date
Moderate	High	Low	Low	Long	66.6	33.3	0.1	Lower Date
Moderate	High	Low	Low	Longer	56	43.9	0.1	Date
Moderate	High	Low	Moderate	Shorter	70.9	27.8	1.3	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Moderate	High	Low	Moderate	Short	73.1	26.8	0.1	Date
Moderate	High	Low	Moderate	Moderate	0.1	99.8	0.1	Date
Moderate	High	Low	Moderate	Long	69.9	30	0.1	Half-Month
Moderate	High	Low	Moderate	Longer	33	66.9	0.1	Date
Moderate	High	Low	High	Shorter	65.3	33.7	1	Date
Moderate	High	Low	High	Short	65.8	34.1	0.1	Date
Moderate	High	Low	High	Moderate	68.6	31.3	0.1	Half-Month
Moderate	High	Low	High	Long	33.3	66.6	0.1	Date
Moderate	High	Low	High	Longer	47.1	52.8	0.1	Date
Moderate	High	Low	Very High	Shorter	50.5	41.3	8.2	Date
Moderate	High	Low	Very High	Short	41.8	58.1	0.1	Half-Month
Moderate	High	Low	Very High	Moderate	0.1	99.8	0.1	Half-Month
Moderate	High	Low	Very High	Long	33.3	66.6	0.1	Date
Moderate	High	Low	Very High	Longer	20.3	79.6	0.1	Date
Moderate	High	Moderate	Very Low	Shorter	99.8	0.1	0.1	Lower Date
Moderate	High	Moderate	Very Low	Short	13.3	40	46.7	Lower Half-Month
Moderate	High	Moderate	Very Low	Moderate	36.4	57.4	6.2	Lower Half-Month
Moderate	High	Moderate	Very Low	Long	74.9	25	0.1	Lower Date
Moderate	High	Moderate	Very Low	Longer	99.8	0.1	0.1	Lower Date
Moderate	High	Moderate	Low	Shorter	55.8	44.1	0.1	Date
Moderate	High	Moderate	Low	Short	36.3	47.4	16.3	Half-Month
Moderate	High	Moderate	Low	Moderate	40	42.9	17.1	Date
Moderate	High	Moderate	Low	Long	21	57.5	21.5	Date
Moderate	High	Moderate	Low	Longer	44.5	55.4	0.1	Date
Moderate	High	Moderate	Moderate	Shorter	5	7.6	87.4	Date
Moderate	High	Moderate	Moderate	Short	58.4	33	8.6	Half-Month
Moderate	High	Moderate	Moderate	Moderate	33.3	47.7	19	Date
Moderate	High	Moderate	Moderate	Long	29.2	55.4	15.4	Date
Moderate	High	Moderate	Moderate	Longer	56.4	43.5	0.1	Date
Moderate	High	Moderate	High	Shorter	11	18	71	Date
Moderate	High	Moderate	High	Short	69	25.8	5.2	Half-Month
Moderate	High	Moderate	High	Moderate	0.1	71.3	28.6	Date
Moderate	High	Moderate	High	Long	25.3	67.5	7.2	Date
Moderate	High	Moderate	High	Longer	61	38.9	0.1	Date
Moderate	High	Moderate	Very High	Shorter	12.8	42.6	44.6	Date
Moderate	High	Moderate	Very High	Short	85.6	14.3	0.1	Half-Month
Moderate	High	Moderate	Very High	Moderate	25	74.9	0.1	Half-Month
Moderate	High	Moderate	Very High	Long	0.1	40	59.9	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Moderate	High	Moderate	Very High	Longer	0.1	40	59.9	Half-Month
Moderate	High	High	Very Low	Shorter	27.3	72.6	0.1	Lower Month
Moderate	High	High	Very Low	Short	44	42.2	13.8	Interpolate
Moderate	High	High	Very Low	Moderate	50	41.7	8.3	Upper Half-Month
Moderate	High	High	Very Low	Long	52.8	47.1	0.1	Lower Month
Moderate	High	High	Very Low	Longer	52.8	47.1	0.1	Lower Month
Moderate	High	High	Low	Shorter	63.4	36.5	0.1	Date
Moderate	High	High	Low	Short	85.6	14.3	0.1	Date
Moderate	High	High	Low	Moderate	26.5	73.4	0.1	Date
Moderate	High	High	Low	Long	12.5	87.2	0.3	Date
Moderate	High	High	Low	Longer	31.3	68.2	0.5	Date
Moderate	High	High	Moderate	Shorter	41.5	56.5	2	Date
Moderate	High	High	Moderate	Short	72.6	27.3	0.1	Date
Moderate	High	High	Moderate	Moderate	23.4	73	3.6	Date
Moderate	High	High	Moderate	Long	12.9	86.8	0.3	Date
Moderate	High	High	Moderate	Longer	35.1	64.3	0.6	Date
Moderate	High	High	High	Shorter	7.1	85.2	7.7	Date
Moderate	High	High	High	Short	49.2	50.7	0.1	Date
Moderate	High	High	High	Moderate	19.5	79.5	1	Date
Moderate	High	High	High	Long	14.1	85.2	0.7	Date
Moderate	High	High	High	Longer	19.5	78.7	1.8	Date
Moderate	High	High	Very High	Shorter	0.1	85.6	14.3	Date
Moderate	High	High	Very High	Short	40	59.9	0.1	Date
Moderate	High	High	Very High	Moderate	24.9	72.5	2.6	Date
Moderate	High	High	Very High	Long	12.4	83.9	3.7	Date
Moderate	High	High	Very High	Longer	21.8	65.5	12.7	Date
Moderate	Very High	Low	Very Low	Shorter	99.8	0.1	0.1	Lower Half-Month
Moderate	Very High	Low	Very Low	Short	66.6	27.9	5.5	Interpolate
Moderate	Very High	Low	Very Low	Moderate	76.1	17.3	6.6	Interpolate
Moderate	Very High	Low	Very Low	Long	61.6	37	1.4	Interpolate
Moderate	Very High	Low	Very Low	Longer	62.4	37.5	0.1	Lower Date
Moderate	Very High	Low	Low	Shorter	0.1	99.8	0.1	Date
Moderate	Very High	Low	Low	Short	33.3	66.6	0.1	Lower Half-Month
Moderate	Very High	Low	Low	Moderate	99.8	0.1	0.1	Lower Date
Moderate	Very High	Low	Low	Long	33.3	66.6	0.1	Lower Half-Month
Moderate	Very High	Low	Low	Longer	51.5	48.4	0.1	Date
Moderate	Very High	Low	Moderate	Shorter	19.8	74.7	5.5	Date
Moderate	Very High	Low	Moderate	Short	0.1	99.8	0.1	Half-Month

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Moderate	Very High	Low	Moderate	Moderate	0.1	99.8	0.1	Half-Month
Moderate	Very High	Low	Moderate	Long	37.3	55.2	7.5	Interpolate
Moderate	Very High	Low	Moderate	Longer	28.5	71.4	0.1	Date
Moderate	Very High	Low	High	Shorter	45.1	52.6	2.3	Date
Moderate	Very High	Low	High	Short	25.7	74.2	0.1	Half-Month
Moderate	Very High	Low	High	Moderate	0.1	99.8	0.1	Half-Month
Moderate	Very High	Low	High	Long	33.3	66.6	0.1	Date
Moderate	Very High	Low	High	Longer	64.3	35.6	0.1	Date
Moderate	Very High	Low	Very High	Shorter	40.3	44.7	15	Date
Moderate	Very High	Low	Very High	Short	15.3	84.6	0.1	Half-Month
Moderate	Very High	Low	Very High	Moderate	0.1	99.8	0.1	Half-Month
Moderate	Very High	Low	Very High	Long	33.3	66.6	0.1	Date
Moderate	Very High	Low	Very High	Longer	20.8	79.1	0.1	Date
Moderate	Very High	Moderate	Very Low	Shorter	99.8	0.1	0.1	Lower Month
Moderate	Very High	Moderate	Very Low	Short	25	74.9	0.1	Upper Date
Moderate	Very High	Moderate	Very Low	Moderate	49.95	49.95	0.1	Upper Date
Moderate	Very High	Moderate	Very Low	Long	50	41.7	8.3	Upper Half-Month
Moderate	Very High	Moderate	Very Low	Longer	50	41.7	8.3	Upper Half-Month
Moderate	Very High	Moderate	Low	Shorter	99.8	0.1	0.1	Upper Date
Moderate	Very High	Moderate	Low	Short	99.8	0.1	0.1	Upper Date
Moderate	Very High	Moderate	Low	Moderate	39.4	43.5	17.1	Interpolate
Moderate	Very High	Moderate	Low	Long	0.1	40	59.9	Date
Moderate	Very High	Moderate	Low	Longer	72.4	27.5	0.1	Date
Moderate	Very High	Moderate	Moderate	Shorter	0.1	28.6	71.3	Date
Moderate	Very High	Moderate	Moderate	Short	37.7	62.2	0.1	Upper Half-Month
Moderate	Very High	Moderate	Moderate	Moderate	25	74.9	0.1	Half-Month
Moderate	Very High	Moderate	Moderate	Long	0.1	40	59.9	Date
Moderate	Very High	Moderate	Moderate	Longer	89.5	10.4	0.1	Date
Moderate	Very High	Moderate	High	Shorter	51	32.2	16.8	Date
Moderate	Very High	Moderate	High	Short	25	74.9	0.1	Upper Date
Moderate	Very High	Moderate	High	Moderate	33.3	66.6	0.1	Date
Moderate	Very High	Moderate	High	Long	0.1	40	59.9	Date
Moderate	Very High	Moderate	High	Longer	79.8	20.1	0.1	Date
Moderate	Very High	Moderate	Very High	Shorter	62.6	33	4.4	Date
Moderate	Very High	Moderate	Very High	Short	83.2	16.7	0.1	Upper Date
Moderate	Very High	Moderate	Very High	Moderate	33.3	66.6	0.1	Date
Moderate	Very High	Moderate	Very High	Long	0.1	40	59.9	Date
Moderate	Very High	Moderate	Very High	Longer	0.1	40	59.9	Half-Month

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Moderate	Very High	High	Very Low	Shorter	0.1	99.8	0.1	Upper Date
Moderate	Very High	High	Very Low	Short	47.7	52.2	0.1	Interpolate
Moderate	Very High	High	Very Low	Moderate	49.95	49.95	0.1	Upper Date
Moderate	Very High	High	Very Low	Long	50	41.7	8.3	Upper Half-Month
Moderate	Very High	High	Very Low	Longer	48.6	43.6	7.8	Upper Half-Month
Moderate	Very High	High	Low	Shorter	99.8	0.1	0.1	Upper Date
Moderate	Very High	High	Low	Short	99.8	0.1	0.1	Date
Moderate	Very High	High	Low	Moderate	0.1	99.8	0.1	Date
Moderate	Very High	High	Low	Long	14.3	82.1	3.6	Date
Moderate	Very High	High	Low	Longer	4.1	93.7	2.2	Date
Moderate	Very High	High	Moderate	Shorter	49.95	49.95	0.1	Upper Date
Moderate	Very High	High	Moderate	Short	99.8	0.1	0.1	Date
Moderate	Very High	High	Moderate	Moderate	0.1	79.9	20	Date
Moderate	Very High	High	Moderate	Long	13	84.8	2.2	Date
Moderate	Very High	High	Moderate	Longer	0.1	94.5	5.4	Date
Moderate	Very High	High	High	Shorter	96.5	3.4	0.1	Upper Date
Moderate	Very High	High	High	Short	33.4	54.1	12.5	Upper Half-Month
Moderate	Very High	High	High	Moderate	0.1	93.4	6.5	Date
Moderate	Very High	High	High	Long	15	80	5	Date
Moderate	Very High	High	High	Longer	8.2	88.2	3.6	Date
Moderate	Very High	High	Very High	Shorter	33.3	66.6	0.1	Upper Date
Moderate	Very High	High	Very High	Short	60.7	39.2	0.1	Upper Date
Moderate	Very High	High	Very High	Moderate	0.1	79.9	20	Date
Moderate	Very High	High	Very High	Long	12.4	76.1	11.5	Date
Moderate	Very High	High	Very High	Longer	0.1	79.9	20	Date
High	Very Low	Low	Very Low	Shorter	99.8	0.1	0.1	Lower Month
High	Very Low	Low	Very Low	Short	99.8	0.1	0.1	Lower Month
High	Very Low	Low	Very Low	Moderate	90.4	9.5	0.1	Lower Month
High	Very Low	Low	Very Low	Long	99.8	0.1	0.1	Lower Date
High	Very Low	Low	Very Low	Longer	87.4	12.5	0.1	Date
High	Very Low	Low	Low	Shorter	79.9	20	0.1	Date
High	Very Low	Low	Low	Short	99.8	0.1	0.1	Lower Date
High	Very Low	Low	Low	Moderate	80.3	19.6	0.1	Lower Half-Month
High	Very Low	Low	Low	Long	25	74.9	0.1	Lower Half-Month
High	Very Low	Low	Low	Longer	93.1	6.8	0.1	Date
High	Very Low	Low	Moderate	Shorter	99.8	0.1	0.1	Half-Month
High	Very Low	Low	Moderate	Short	99.8	0.1	0.1	Date
High	Very Low	Low	Moderate	Moderate	99.8	0.1	0.1	Half-Month

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
High	Very Low	Low	Moderate	Long	62.4	27.6	10	Interpolate
High	Very Low	Low	Moderate	Longer	61.6	38.3	0.1	Date
High	Very Low	Low	High	Shorter	99.8	0.1	0.1	Half-Month
High	Very Low	Low	High	Short	99.8	0.1	0.1	Date
High	Very Low	Low	High	Moderate	99.8	0.1	0.1	Half-Month
High	Very Low	Low	High	Long	69.7	20.9	9.4	Interpolate
High	Very Low	Low	High	Longer	42.2	57.7	0.1	Date
High	Very Low	Low	Very High	Shorter	99.8	0.1	0.1	Half-Month
High	Very Low	Low	Very High	Short	99.8	0.1	0.1	Date
High	Very Low	Low	Very High	Moderate	99.8	0.1	0.1	Half-Month
High	Very Low	Low	Very High	Long	66.7	13.3	20	Interpolate
High	Very Low	Low	Very High	Longer	19.4	55.6	25	Interpolate
High	Very Low	Moderate	Very Low	Shorter	99.8	0.1	0.1	Lower Date
High	Very Low	Moderate	Very Low	Short	99.8	0.1	0.1	Lower Half-Month
High	Very Low	Moderate	Very Low	Moderate	93.6	6.3	0.1	Lower Date
High	Very Low	Moderate	Very Low	Long	79.9	20	0.1	Lower Date
High	Very Low	Moderate	Very Low	Longer	87.4	12.5	0.1	Date
High	Very Low	Moderate	Low	Shorter	79.9	20	0.1	Date
High	Very Low	Moderate	Low	Short	99.8	0.1	0.1	Date
High	Very Low	Moderate	Low	Moderate	99.8	0.1	0.1	Date
High	Very Low	Moderate	Low	Long	11.7	49.3	39	Date
High	Very Low	Moderate	Low	Longer	67.3	32.6	0.1	Date
High	Very Low	Moderate	Moderate	Shorter	99.8	0.1	0.1	Date
High	Very Low	Moderate	Moderate	Short	99.8	0.1	0.1	Date
High	Very Low	Moderate	Moderate	Moderate	99.8	0.1	0.1	Date
High	Very Low	Moderate	Moderate	Long	0.1	40	59.9	Date
High	Very Low	Moderate	Moderate	Longer	63.8	36.1	0.1	Date
High	Very Low	Moderate	High	Shorter	99.8	0.1	0.1	Lower Half-Month
High	Very Low	Moderate	High	Short	99.8	0.1	0.1	Lower Month
High	Very Low	Moderate	High	Moderate	33.3	66.6	0.1	Half-Month
High	Very Low	Moderate	High	Long	7.1	45.7	47.2	Date
High	Very Low	Moderate	High	Longer	70	29.9	0.1	Date
High	Very Low	Moderate	Very High	Shorter	99.8	0.1	0.1	Lower Month
High	Very Low	Moderate	Very High	Short	99.8	0.1	0.1	Lower Half-Month
High	Very Low	Moderate	Very High	Moderate	99.8	0.1	0.1	Lower Date
High	Very Low	Moderate	Very High	Long	0.1	40	59.9	Date
High	Very Low	Moderate	Very High	Longer	0.1	40	59.9	Half-Month
High	Very Low	High	Very Low	Shorter	99.8	0.1	0.1	Lower Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
High	Very Low	High	Very Low	Short	99.8	0.1	0.1	Lower Date
High	Very Low	High	Very Low	Moderate	99.8	0.1	0.1	Date
High	Very Low	High	Very Low	Long	96.5	3.4	0.1	Lower Date
High	Very Low	High	Very Low	Longer	42.9	57	0.1	Date
High	Very Low	High	Low	Shorter	36.3	57.4	6.3	Date
High	Very Low	High	Low	Short	57.9	36.2	5.9	Date
High	Very Low	High	Low	Moderate	97	2.9	0.1	Date
High	Very Low	High	Low	Long	98.4	1.1	0.5	Date
High	Very Low	High	Low	Longer	79.1	20.8	0.1	Date
High	Very Low	High	Moderate	Shorter	41.9	53.8	4.3	Date
High	Very Low	High	Moderate	Short	50.5	36	13.5	Date
High	Very Low	High	Moderate	Moderate	83.2	16.7	0.1	Date
High	Very Low	High	Moderate	Long	94	2.4	3.6	Date
High	Very Low	High	Moderate	Longer	61.2	38.7	0.1	Date
High	Very Low	High	High	Shorter	0.1	79.9	20	Date
High	Very Low	High	High	Short	37.5	37.5	25	Date
High	Very Low	High	High	Moderate	83.2	16.7	0.1	Date
High	Very Low	High	High	Long	14	51.1	34.9	Date
High	Very Low	High	High	Longer	31.1	68.8	0.1	Date
High	Very Low	High	Very High	Shorter	85.6	14.3	0.1	Lower Half-Month
High	Very Low	High	Very High	Short	85.6	14.3	0.1	Lower Half-Month
High	Very Low	High	Very High	Moderate	99.8	0.1	0.1	Lower Date
High	Very Low	High	Very High	Long	0.1	40	59.9	Date
High	Very Low	High	Very High	Longer	0.1	40	59.9	Half-Month
High	Low	Low	Very Low	Shorter	99.8	0.1	0.1	Lower Half-Month
High	Low	Low	Very Low	Short	99.8	0.1	0.1	Lower Date
High	Low	Low	Very Low	Moderate	48.4	26	25.6	Lower Half-Month
High	Low	Low	Very Low	Long	99.8	0.1	0.1	Lower Date
High	Low	Low	Very Low	Longer	87.4	12.5	0.1	Date
High	Low	Low	Low	Shorter	87.5	12.4	0.1	Date
High	Low	Low	Low	Short	16	83.9	0.1	Half-Month
High	Low	Low	Low	Moderate	56.8	43.1	0.1	Date
High	Low	Low	Low	Long	87.4	12.5	0.1	Date
High	Low	Low	Low	Longer	70.5	29.4	0.1	Date
High	Low	Low	Moderate	Shorter	87.9	12	0.1	Date
High	Low	Low	Moderate	Short	96.4	3.5	0.1	Date
High	Low	Low	Moderate	Moderate	62.2	37.7	0.1	Date
High	Low	Low	Moderate	Long	87.4	12.5	0.1	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
High	Low	Low	Moderate	Longer	27.5	72.4	0.1	Date
High	Low	Low	High	Shorter	74.4	25.5	0.1	Date
High	Low	Low	High	Short	98	1.9	0.1	Date
High	Low	Low	High	Moderate	99.8	0.1	0.1	Date
High	Low	Low	High	Long	99	0.9	0.1	Half-Month
High	Low	Low	High	Longer	64.1	35.8	0.1	Date
High	Low	Low	Very High	Shorter	81.7	18.2	0.1	Date
High	Low	Low	Very High	Short	99.8	0.1	0.1	Date
High	Low	Low	Very High	Moderate	99.8	0.1	0.1	Half-Month
High	Low	Low	Very High	Long	99.8	0.1	0.1	Lower Month
High	Low	Low	Very High	Longer	15.4	84.5	0.1	Date
High	Low	Moderate	Very Low	Shorter	99.8	0.1	0.1	Lower Date
High	Low	Moderate	Very Low	Short	99.8	0.1	0.1	Lower Date
High	Low	Moderate	Very Low	Moderate	99.8	0.1	0.1	Lower Date
High	Low	Moderate	Very Low	Long	65.5	34.4	0.1	Lower Date
High	Low	Moderate	Very Low	Longer	87.4	12.5	0.1	Date
High	Low	Moderate	Low	Shorter	63.3	36.6	0.1	Date
High	Low	Moderate	Low	Short	99.8	0.1	0.1	Date
High	Low	Moderate	Low	Moderate	94.7	4	1.3	Date
High	Low	Moderate	Low	Long	85.7	14.2	0.1	Date
High	Low	Moderate	Low	Longer	44.2	55.7	0.1	Date
High	Low	Moderate	Moderate	Shorter	41.4	58.5	0.1	Date
High	Low	Moderate	Moderate	Short	99.8	0.1	0.1	Date
High	Low	Moderate	Moderate	Moderate	88	9.1	2.9	Date
High	Low	Moderate	Moderate	Long	70.1	29.8	0.1	Date
High	Low	Moderate	Moderate	Longer	30.2	69.7	0.1	Date
High	Low	Moderate	High	Shorter	38	61.9	0.1	Date
High	Low	Moderate	High	Short	99.8	0.1	0.1	Date
High	Low	Moderate	High	Moderate	27.5	57.7	14.8	Date
High	Low	Moderate	High	Long	49.95	49.95	0.1	Date
High	Low	Moderate	High	Longer	38.5	61.4	0.1	Date
High	Low	Moderate	Very High	Shorter	50.8	49.1	0.1	Date
High	Low	Moderate	Very High	Short	69.9	30	0.1	Half-Month
High	Low	Moderate	Very High	Moderate	65.8	32.1	2.1	Interpolate
High	Low	Moderate	Very High	Long	79.9	20	0.1	Lower Half-Month
High	Low	Moderate	Very High	Longer	79.9	20	0.1	Lower Half-Month
High	Low	High	Very Low	Shorter	98	1.9	0.1	Lower Date
High	Low	High	Very Low	Short	99.8	0.1	0.1	Lower Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
High	Low	High	Very Low	Moderate	99.8	0.1	0.1	Date
High	Low	High	Very Low	Long	69.8	30.1	0.1	Lower Date
High	Low	High	Very Low	Longer	42.9	57	0.1	Date
High	Low	High	Low	Shorter	38.7	57.1	4.2	Date
High	Low	High	Low	Short	61.8	35.4	2.8	Date
High	Low	High	Low	Moderate	83.4	16.2	0.4	Date
High	Low	High	Low	Long	84.9	15	0.1	Date
High	Low	High	Low	Longer	59.4	40.1	0.5	Date
High	Low	High	Moderate	Shorter	38.7	58.8	2.5	Date
High	Low	High	Moderate	Short	57.7	36.1	6.2	Date
High	Low	High	Moderate	Moderate	58.6	38.6	2.8	Date
High	Low	High	Moderate	Long	57.9	42	0.1	Date
High	Low	High	Moderate	Longer	43.1	55.5	1.4	Date
High	Low	High	High	Shorter	11.6	78.2	10.2	Date
High	Low	High	High	Short	41.2	48.2	10.6	Date
High	Low	High	High	Moderate	61.4	37.5	1.1	Date
High	Low	High	High	Long	39.1	60.8	0.1	Date
High	Low	High	High	Longer	19.2	75.3	5.5	Date
High	Low	High	Very High	Shorter	18.3	81.6	0.1	Date
High	Low	High	Very High	Short	40	59.9	0.1	Date
High	Low	High	Very High	Moderate	40	59.9	0.1	Half-Month
High	Low	High	Very High	Long	23.9	68.3	7.8	Half-Month
High	Low	High	Very High	Longer	26.3	62.5	11.2	Date
High	Moderate	Low	Very Low	Shorter	16.7	83.2	0.1	Date
High	Moderate	Low	Very Low	Short	70.3	12.1	17.6	Lower Half-Month
High	Moderate	Low	Very Low	Moderate	58.6	17.2	24.2	Lower Half-Month
High	Moderate	Low	Very Low	Long	90.8	9.1	0.1	Lower Half-Month
High	Moderate	Low	Very Low	Longer	47.3	52.6	0.1	Lower Date
High	Moderate	Low	Low	Shorter	63.9	36	0.1	Date
High	Moderate	Low	Low	Short	18.9	81	0.1	Half-Month
High	Moderate	Low	Low	Moderate	0.1	99.8	0.1	Date
High	Moderate	Low	Low	Long	87.4	12.5	0.1	Date
High	Moderate	Low	Low	Longer	71.2	28.7	0.1	Date
High	Moderate	Low	Moderate	Shorter	77.4	22.5	0.1	Date
High	Moderate	Low	Moderate	Short	82.8	17.1	0.1	Date
High	Moderate	Low	Moderate	Moderate	0.1	99.8	0.1	Date
High	Moderate	Low	Moderate	Long	87.4	12.5	0.1	Date
High	Moderate	Low	Moderate	Longer	61.9	38	0.1	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
High	Moderate	Low	High	Shorter	61.3	38.6	0.1	Date
High	Moderate	Low	High	Short	86	13.9	0.1	Date
High	Moderate	Low	High	Moderate	66.9	33	0.1	Half-Month
High	Moderate	Low	High	Long	69.9	30	0.1	Half-Month
High	Moderate	Low	High	Longer	73.8	26.1	0.1	Date
High	Moderate	Low	Very High	Shorter	55.1	44.8	0.1	Date
High	Moderate	Low	Very High	Short	99.8	0.1	0.1	Date
High	Moderate	Low	Very High	Moderate	63.2	36.7	0.1	Half-Month
High	Moderate	Low	Very High	Long	61.7	20.7	17.6	Lower Month
High	Moderate	Low	Very High	Longer	15.4	84.5	0.1	Date
High	Moderate	Moderate	Very Low	Shorter	99.8	0.1	0.1	Lower Half-Month
High	Moderate	Moderate	Very Low	Short	99.8	0.1	0.1	Lower Half-Month
High	Moderate	Moderate	Very Low	Moderate	33.3	66.6	0.1	Lower Date
High	Moderate	Moderate	Very Low	Long	99.8	0.1	0.1	Lower Date
High	Moderate	Moderate	Very Low	Longer	99.8	0.1	0.1	Lower Date
High	Moderate	Moderate	Low	Shorter	42.9	57	0.1	Date
High	Moderate	Moderate	Low	Short	47.1	39.6	13.3	Half-Month
High	Moderate	Moderate	Low	Moderate	61.6	27.6	10.8	Date
High	Moderate	Moderate	Low	Long	81.9	15.8	2.3	Date
High	Moderate	Moderate	Low	Longer	38.2	61.7	0.1	Date
High	Moderate	Moderate	Moderate	Shorter	18.6	31.2	50.2	Date
High	Moderate	Moderate	Moderate	Short	99.8	0.1	0.1	Date
High	Moderate	Moderate	Moderate	Moderate	49.1	36.6	14.3	Date
High	Moderate	Moderate	Moderate	Long	70	18	12	Date
High	Moderate	Moderate	Moderate	Longer	27.8	72.1	0.1	Date
High	Moderate	Moderate	High	Shorter	26.8	52.7	20.5	Date
High	Moderate	Moderate	High	Short	99.8	0.1	0.1	Date
High	Moderate	Moderate	High	Moderate	4.8	69	26.2	Date
High	Moderate	Moderate	High	Long	11.7	49.3	39	Date
High	Moderate	Moderate	High	Longer	16.1	83.8	0.1	Date
High	Moderate	Moderate	Very High	Shorter	43.5	56.4	0.1	Date
High	Moderate	Moderate	Very High	Short	69.9	30	0.1	Half-Month
High	Moderate	Moderate	Very High	Moderate	33.3	52.3	14.4	Interpolate
High	Moderate	Moderate	Very High	Long	0.1	40	59.9	Date
High	Moderate	Moderate	Very High	Longer	0.1	40	59.9	Half-Month
High	Moderate	High	Very Low	Shorter	99.8	0.1	0.1	Lower Half-Month
High	Moderate	High	Very Low	Short	94.3	5.6	0.1	Lower Month
High	Moderate	High	Very Low	Moderate	99.8	0.1	0.1	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
High	Moderate	High	Very Low	Long	73.7	24.9	1.4	Interpolate
High	Moderate	High	Very Low	Longer	63.6	34.3	2.1	Interpolate
High	Moderate	High	Low	Shorter	26	66.6	7.4	Date
High	Moderate	High	Low	Short	57.2	33.3	9.5	Date
High	Moderate	High	Low	Moderate	76.4	23.4	0.2	Date
High	Moderate	High	Low	Long	69.4	30.4	0.2	Date
High	Moderate	High	Low	Longer	72.1	25.6	2.3	Date
High	Moderate	High	Moderate	Shorter	20.2	77.6	2.2	Date
High	Moderate	High	Moderate	Short	67.1	26.9	6	Date
High	Moderate	High	Moderate	Moderate	57.3	41	1.7	Date
High	Moderate	High	Moderate	Long	54.4	45.1	0.5	Date
High	Moderate	High	Moderate	Longer	36.4	56.3	7.3	Date
High	Moderate	High	High	Shorter	11.9	83.1	5	Date
High	Moderate	High	High	Short	48.7	42.5	8.8	Date
High	Moderate	High	High	Moderate	54.2	45.2	0.6	Date
High	Moderate	High	High	Long	26.5	72.9	0.6	Date
High	Moderate	High	High	Longer	4.3	78.5	17.2	Date
High	Moderate	High	Very High	Shorter	17.4	82.5	0.1	Date
High	Moderate	High	Very High	Short	40	59.9	0.1	Date
High	Moderate	High	Very High	Moderate	28.6	71.3	0.1	Date
High	Moderate	High	Very High	Long	0.1	40	59.9	Date
High	Moderate	High	Very High	Longer	6.9	75.4	17.7	Date
High	High	Low	Very Low	Shorter	16.7	83.2	0.1	Date
High	High	Low	Very Low	Short	25.3	34.1	40.6	Lower Half-Month
High	High	Low	Very Low	Moderate	47.8	23.5	28.7	Lower Half-Month
High	High	Low	Very Low	Long	90.8	9.1	0.1	Lower Half-Month
High	High	Low	Very Low	Longer	99.6	0.3	0.1	Lower Date
High	High	Low	Low	Shorter	44.6	55.3	0.1	Date
High	High	Low	Low	Short	3	96.9	0.1	Half-Month
High	High	Low	Low	Moderate	0.1	99.8	0.1	Date
High	High	Low	Low	Long	99.8	0.1	0.1	Lower Date
High	High	Low	Low	Longer	75.4	24.5	0.1	Date
High	High	Low	Moderate	Shorter	85.1	14.8	0.1	Date
High	High	Low	Moderate	Short	88.2	11.7	0.1	Date
High	High	Low	Moderate	Moderate	0.1	99.8	0.1	Date
High	High	Low	Moderate	Long	69.9	30	0.1	Half-Month
High	High	Low	Moderate	Longer	42.2	57.7	0.1	Date
High	High	Low	High	Shorter	88	11.9	0.1	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
High	High	Low	High	Short	91.9	8	0.1	Date
High	High	Low	High	Moderate	75	24.9	0.1	Half-Month
High	High	Low	High	Long	69.9	30	0.1	Half-Month
High	High	Low	High	Longer	57	42.9	0.1	Date
High	High	Low	Very High	Shorter	42.8	57.1	0.1	Date
High	High	Low	Very High	Short	99.8	0.1	0.1	Date
High	High	Low	Very High	Moderate	77.5	22.4	0.1	Half-Month
High	High	Low	Very High	Long	61.9	20.1	18	Lower Month
High	High	Low	Very High	Longer	15.4	84.5	0.1	Date
High	High	Moderate	Very Low	Shorter	0.1	49.95	49.95	Lower Half-Month
High	High	Moderate	Very Low	Short	13.3	40	46.7	Lower Half-Month
High	High	Moderate	Very Low	Moderate	15.4	41.5	43.1	Lower Half-Month
High	High	Moderate	Very Low	Long	71.7	28.2	0.1	Lower Half-Month
High	High	Moderate	Very Low	Longer	99.8	0.1	0.1	Lower Date
High	High	Moderate	Low	Shorter	44.5	55.4	0.1	Date
High	High	Moderate	Low	Short	2	70.6	27.4	Half-Month
High	High	Moderate	Low	Moderate	76.9	16.5	6.6	Date
High	High	Moderate	Low	Long	30.8	46.1	23.1	Date
High	High	Moderate	Low	Longer	27.3	72.6	0.1	Date
High	High	Moderate	Moderate	Shorter	8.7	34.8	56.5	Date
High	High	Moderate	Moderate	Short	8	68	24	Half-Month
High	High	Moderate	Moderate	Moderate	71.4	20.4	8.2	Date
High	High	Moderate	Moderate	Long	41.4	48.3	10.3	Date
High	High	Moderate	Moderate	Longer	26.5	73.4	0.1	Date
High	High	Moderate	High	Shorter	19.4	38.7	41.9	Date
High	High	Moderate	High	Short	10.1	67.1	22.8	Half-Month
High	High	Moderate	High	Moderate	0.1	71.3	28.6	Date
High	High	Moderate	High	Long	38.1	47.6	14.3	Date
High	High	Moderate	High	Longer	30.9	69	0.1	Date
High	High	Moderate	Very High	Shorter	16.7	83.2	0.1	Half-Month
High	High	Moderate	Very High	Short	37.5	62.4	0.1	Upper Half-Month
High	High	Moderate	Very High	Moderate	28.1	57.1	14.8	Interpolate
High	High	Moderate	Very High	Long	0.1	40	59.9	Date
High	High	Moderate	Very High	Longer	0.1	40	59.9	Half-Month
High	High	High	Very Low	Shorter	99.8	0.1	0.1	Lower Date
High	High	High	Very Low	Short	78.7	12	9.3	Interpolate
High	High	High	Very Low	Moderate	49.4	40.3	10.3	Interpolate
High	High	High	Very Low	Long	52.8	47.1	0.1	Lower Month

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
High	High	High	Very Low	Longer	52.8	47.1	0.1	Lower Month
High	High	High	Low	Shorter	33	66.9	0.1	Date
High	High	High	Low	Short	85.6	14.3	0.1	Date
High	High	High	Low	Moderate	28.6	71.3	0.1	Date
High	High	High	Low	Long	18.8	80.7	0.5	Date
High	High	High	Low	Longer	30.9	66.2	2.9	Date
High	High	High	Moderate	Shorter	8.1	91.8	0.1	Date
High	High	High	Moderate	Short	66.7	33.2	0.1	Date
High	High	High	Moderate	Moderate	28.6	71.3	0.1	Date
High	High	High	Moderate	Long	28.8	70.3	0.9	Date
High	High	High	Moderate	Longer	32.9	61.6	5.5	Date
High	High	High	High	Shorter	8.7	91.2	0.1	Date
High	High	High	High	Short	45.7	54.2	0.1	Date
High	High	High	High	Moderate	28.6	71.3	0.1	Date
High	High	High	High	Long	21.3	78.3	0.4	Date
High	High	High	High	Longer	8.4	78.8	12.8	Date
High	High	High	Very High	Shorter	17.5	82.4	0.1	Half-Month
High	High	High	Very High	Short	40	59.9	0.1	Date
High	High	High	Very High	Moderate	28.6	71.3	0.1	Date
High	High	High	Very High	Long	0.1	40	59.9	Date
High	High	High	Very High	Longer	9.8	73.5	16.7	Date
High	Very High	Low	Very Low	Shorter	99.8	0.1	0.1	Lower Date
High	Very High	Low	Very Low	Short	99.8	0.1	0.1	Lower Month
High	Very High	Low	Very Low	Moderate	99.8	0.1	0.1	Lower Month
High	Very High	Low	Very Low	Long	99.8	0.1	0.1	Lower Month
High	Very High	Low	Very Low	Longer	71.9	28	0.1	Lower Date
High	Very High	Low	Low	Shorter	99.8	0.1	0.1	Lower Date
High	Very High	Low	Low	Short	33.3	66.6	0.1	Lower Half-Month
High	Very High	Low	Low	Moderate	33.3	66.6	0.1	Lower Half-Month
High	Very High	Low	Low	Long	99.8	0.1	0.1	Lower Date
High	Very High	Low	Low	Longer	29.5	70.4	0.1	Date
High	Very High	Low	Moderate	Shorter	0.1	99.8	0.1	Date
High	Very High	Low	Moderate	Short	0.1	99.8	0.1	Half-Month
High	Very High	Low	Moderate	Moderate	0.1	99.8	0.1	Half-Month
High	Very High	Low	Moderate	Long	99.8	0.1	0.1	Lower Month
High	Very High	Low	Moderate	Longer	20.2	79.7	0.1	Date
High	Very High	Low	High	Shorter	0.1	99.8	0.1	Date
High	Very High	Low	High	Short	0.1	99.8	0.1	Half-Month

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
High	Very High	Low	High	Moderate	0.1	99.8	0.1	Half-Month
High	Very High	Low	High	Long	36.5	53.5	10	Interpolate
High	Very High	Low	High	Longer	15.4	84.5	0.1	Date
High	Very High	Low	Very High	Shorter	0.1	99.8	0.1	Date
High	Very High	Low	Very High	Short	0.1	99.8	0.1	Half-Month
High	Very High	Low	Very High	Moderate	0.1	99.8	0.1	Half-Month
High	Very High	Low	Very High	Long	22.1	62.3	15.6	Interpolate
High	Very High	Low	Very High	Longer	15.4	84.5	0.1	Date
High	Very High	Moderate	Very Low	Shorter	99.8	0.1	0.1	Lower Month
High	Very High	Moderate	Very Low	Short	99.8	0.1	0.1	Lower Month
High	Very High	Moderate	Very Low	Moderate	66.3	22.9	10.8	Interpolate
High	Very High	Moderate	Very Low	Long	55.4	27.5	17.1	Interpolate
High	Very High	Moderate	Very Low	Longer	55.5	27.4	17.1	Interpolate
High	Very High	Moderate	Low	Shorter	99.8	0.1	0.1	Lower Half-Month
High	Very High	Moderate	Low	Short	99.8	0.1	0.1	Lower Half-Month
High	Very High	Moderate	Low	Moderate	52.6	30.8	16.6	Interpolate
High	Very High	Moderate	Low	Long	0.1	40	59.9	Date
High	Very High	Moderate	Low	Longer	0.1	40	59.9	Half-Month
High	Very High	Moderate	Moderate	Shorter	99.8	0.1	0.1	Lower Month
High	Very High	Moderate	Moderate	Short	37.5	62.4	0.1	Upper Half-Month
High	Very High	Moderate	Moderate	Moderate	26.8	59.6	13.6	Interpolate
High	Very High	Moderate	Moderate	Long	0.1	40	59.9	Date
High	Very High	Moderate	Moderate	Longer	0.1	40	59.9	Half-Month
High	Very High	Moderate	High	Shorter	99.8	0.1	0.1	Lower Month
High	Very High	Moderate	High	Short	25	74.9	0.1	Upper Date
High	Very High	Moderate	High	Moderate	11.7	70.6	17.7	Interpolate
High	Very High	Moderate	High	Long	0.1	40	59.9	Date
High	Very High	Moderate	High	Longer	0.1	40	59.9	Half-Month
High	Very High	Moderate	Very High	Shorter	37.5	62.4	0.1	Upper Half-Month
High	Very High	Moderate	Very High	Short	37.5	62.4	0.1	Upper Half-Month
High	Very High	Moderate	Very High	Moderate	17.7	67.3	15	Interpolate
High	Very High	Moderate	Very High	Long	0.1	40	59.9	Date
High	Very High	Moderate	Very High	Longer	0.1	40	59.9	Half-Month
High	Very High	High	Very Low	Shorter	99.8	0.1	0.1	Lower Month
High	Very High	High	Very Low	Short	99.8	0.1	0.1	Lower Month
High	Very High	High	Very Low	Moderate	74.9	25	0.1	Interpolate
High	Very High	High	Very Low	Long	39.4	57.4	3.2	Interpolate
High	Very High	High	Very Low	Longer	33.8	56.9	9.3	Interpolate

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
High	Very High	High	Low	Shorter	88.7	11.2	0.1	Interpolate
High	Very High	High	Low	Short	99.8	0.1	0.1	Date
High	Very High	High	Low	Moderate	36	63.7	0.3	Interpolate
High	Very High	High	Low	Long	15.4	83.2	1.4	Date
High	Very High	High	Low	Longer	0.1	79.9	20	Date
High	Very High	High	Moderate	Shorter	99.8	0.1	0.1	Lower Month
High	Very High	High	Moderate	Short	99.8	0.1	0.1	Date
High	Very High	High	Moderate	Moderate	36	58.2	5.8	Interpolate
High	Very High	High	Moderate	Long	15.2	81.4	3.4	Date
High	Very High	High	Moderate	Longer	0.1	79.9	20	Date
High	Very High	High	High	Shorter	99.8	0.1	0.1	Lower Month
High	Very High	High	High	Short	60.8	36.7	2.5	Interpolate
High	Very High	High	High	Moderate	15	82.4	2.6	Interpolate
High	Very High	High	High	Long	16.4	82.3	1.3	Date
High	Very High	High	High	Longer	0.1	79.9	20	Date
High	Very High	High	Very High	Shorter	47.1	52.8	0.1	Interpolate
High	Very High	High	Very High	Short	46.1	53.8	0.1	Interpolate
High	Very High	High	Very High	Moderate	9.5	63.8	26.7	Interpolate
High	Very High	High	Very High	Long	0.1	40	59.9	Date
High	Very High	High	Very High	Longer	0.1	79.9	20	Date

6.5 Chlorophyll-A Ecological (ug/L, chlaeco) – Lower Lake Segment

Conditioned on:

- Secchi Depth (secchi, ft)
- Total Nitrogen Concentration (totaln, mg/L)
- Water Temperature (wtemp, C)
- Total Phosphorus Concentration (totalp, mg/L)
- Residence Time (resid30, days)

Lower:

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	Very Low	Low	Very Low	Shorter	99.8	0.1	0.1	Month
Low	Very Low	Low	Very Low	Short	99.8	0.1	0.1	Month
Low	Very Low	Low	Very Low	Moderate	75.5	24.4	0.1	Interpolate
Low	Very Low	Low	Very Low	Long	81.1	18.8	0.1	Interpolate
Low	Very Low	Low	Very Low	Longer	70.4	29.5	0.1	Interpolate

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	Very Low	Low	Low	Shorter	99.8	0.1	0.1	Date
Low	Very Low	Low	Low	Short	99.8	0.1	0.1	Half-Month
Low	Very Low	Low	Low	Moderate	99.8	0.1	0.1	Middle Half-Month
Low	Very Low	Low	Low	Long	99.8	0.1	0.1	Middle Half-Month
Low	Very Low	Low	Low	Longer	78.4	21.5	0.1	Middle Date
Low	Very Low	Low	Moderate	Shorter	99.8	0.1	0.1	Month
Low	Very Low	Low	Moderate	Short	99.8	0.1	0.1	Month
Low	Very Low	Low	Moderate	Moderate	99.8	0.1	0.1	Middle Half-Month
Low	Very Low	Low	Moderate	Long	99.8	0.1	0.1	Middle Half-Month
Low	Very Low	Low	Moderate	Longer	70.3	29.6	0.1	Middle Date
Low	Very Low	Low	High	Shorter	62.4	37.5	0.1	Middle Date
Low	Very Low	Low	High	Short	99.8	0.1	0.1	Middle Date
Low	Very Low	Low	High	Moderate	99.8	0.1	0.1	Middle Half-Month
Low	Very Low	Low	High	Long	99.8	0.1	0.1	Middle Half-Month
Low	Very Low	Low	High	Longer	82.1	17.8	0.1	Middle Date
Low	Very Low	Low	Very High	Shorter	99.8	0.1	0.1	Middle Half-Month
Low	Very Low	Low	Very High	Short	99.8	0.1	0.1	Middle Date
Low	Very Low	Low	Very High	Moderate	99.8	0.1	0.1	Middle Half-Month
Low	Very Low	Low	Very High	Long	53.1	28.1	18.8	Interpolate
Low	Very Low	Low	Very High	Longer	32	34	34	Upper Date
Low	Very Low	Moderate	Very Low	Shorter	87	12.9	0.1	Upper Date
Low	Very Low	Moderate	Very Low	Short	46.6	53.3	0.1	Upper Half-Month
Low	Very Low	Moderate	Very Low	Moderate	40	59.9	0.1	Half-Month
Low	Very Low	Moderate	Very Low	Long	21.4	63.6	15	Interpolate
Low	Very Low	Moderate	Very Low	Longer	63.7	36.2	0.1	Interpolate
Low	Very Low	Moderate	Low	Shorter	91.5	8.4	0.1	Middle Half-Month
Low	Very Low	Moderate	Low	Short	99.8	0.1	0.1	Middle Date
Low	Very Low	Moderate	Low	Moderate	40	59.9	0.1	Half-Month
Low	Very Low	Moderate	Low	Long	0.1	40	59.9	Middle Date
Low	Very Low	Moderate	Low	Longer	48.5	51.4	0.1	Middle Date
Low	Very Low	Moderate	Moderate	Shorter	62.4	37.5	0.1	Middle Date
Low	Very Low	Moderate	Moderate	Short	92.2	7.7	0.1	Middle Half-Month
Low	Very Low	Moderate	Moderate	Moderate	40	59.9	0.1	Half-Month
Low	Very Low	Moderate	Moderate	Long	0.1	40	59.9	Middle Date
Low	Very Low	Moderate	Moderate	Longer	16.7	83.2	0.1	Middle Date
Low	Very Low	Moderate	High	Shorter	62.4	37.5	0.1	Middle Date
Low	Very Low	Moderate	High	Short	0.1	99.8	0.1	Middle Half-Month
Low	Very Low	Moderate	High	Moderate	40	59.9	0.1	Half-Month

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	Very Low	Moderate	High	Long	0.1	40	59.9	Middle Date
Low	Very Low	Moderate	High	Longer	0.1	40	59.9	Middle Half-Month
Low	Very Low	Moderate	Very High	Shorter	2.3	21.4	76.3	Upper Date
Low	Very Low	Moderate	Very High	Short	58.5	41.4	0.1	Upper Date
Low	Very Low	Moderate	Very High	Moderate	49.95	49.95	0.1	Upper Date
Low	Very Low	Moderate	Very High	Long	0.1	40	59.9	Middle Date
Low	Very Low	Moderate	Very High	Longer	0.1	40	59.9	Middle Half-Month
Low	Very Low	High	Very Low	Shorter	15.4	46.1	38.5	Upper Half-Month
Low	Very Low	High	Very Low	Short	46.8	41.1	12.1	Interpolate
Low	Very Low	High	Very Low	Moderate	0.1	77.7	22.2	Upper Half-Month
Low	Very Low	High	Very Low	Long	0.1	99.8	0.1	Upper Date
Low	Very Low	High	Very Low	Longer	42.9	57	0.1	Middle Date
Low	Very Low	High	Low	Shorter	69.9	30	0.1	Middle Date
Low	Very Low	High	Low	Short	71.6	28.3	0.1	Middle Half-Month
Low	Very Low	High	Low	Moderate	0.1	99.8	0.1	Middle Date
Low	Very Low	High	Low	Long	0.1	40	59.9	Middle Date
Low	Very Low	High	Low	Longer	33.3	66.6	0.1	Middle Date
Low	Very Low	High	Moderate	Shorter	69.9	30	0.1	Middle Date
Low	Very Low	High	Moderate	Short	71.8	28.1	0.1	Middle Half-Month
Low	Very Low	High	Moderate	Moderate	49.95	49.95	0.1	Upper Date
Low	Very Low	High	Moderate	Long	0.1	40	59.9	Middle Date
Low	Very Low	High	Moderate	Longer	39.4	60.5	0.1	Middle Date
Low	Very Low	High	High	Shorter	10.7	32.2	57.1	Upper Half-Month
Low	Very Low	High	High	Short	30.7	57.6	11.7	Interpolate
Low	Very Low	High	High	Moderate	0.1	99.8	0.1	Middle Date
Low	Very Low	High	High	Long	0.1	40	59.9	Middle Date
Low	Very Low	High	High	Longer	36.8	63.1	0.1	Middle Date
Low	Very Low	High	Very High	Shorter	0.1	20	79.9	Upper Date
Low	Very Low	High	Very High	Short	49.95	49.95	0.1	Upper Date
Low	Very Low	High	Very High	Moderate	49.95	49.95	0.1	Upper Date
Low	Very Low	High	Very High	Long	0.1	40	59.9	Middle Date
Low	Very Low	High	Very High	Longer	0.1	40	59.9	Middle Half-Month
Low	Low	Low	Very Low	Shorter	99.8	0.1	0.1	Month
Low	Low	Low	Very Low	Short	99.8	0.1	0.1	Month
Low	Low	Low	Very Low	Moderate	57.9	37.7	4.4	Interpolate
Low	Low	Low	Very Low	Long	58.4	41.5	0.1	Interpolate
Low	Low	Low	Very Low	Longer	69.3	30.6	0.1	Interpolate
Low	Low	Low	Low	Shorter	99.8	0.1	0.1	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	Low	Low	Low	Short	99.8	0.1	0.1	Half-Month
Low	Low	Low	Low	Moderate	30	69.9	0.1	Middle Half-Month
Low	Low	Low	Low	Long	26.1	73.8	0.1	Middle Half-Month
Low	Low	Low	Low	Longer	78.6	21.3	0.1	Middle Date
Low	Low	Low	Moderate	Shorter	99.8	0.1	0.1	Month
Low	Low	Low	Moderate	Short	99.8	0.1	0.1	Month
Low	Low	Low	Moderate	Moderate	33.3	66.6	0.1	Middle Date
Low	Low	Low	Moderate	Long	69.9	30	0.1	Middle Half-Month
Low	Low	Low	Moderate	Longer	53.2	46.7	0.1	Middle Date
Low	Low	Low	High	Shorter	66.7	33.2	0.1	Middle Date
Low	Low	Low	High	Short	60.7	39.2	0.1	Middle Date
Low	Low	Low	High	Moderate	45.5	54.4	0.1	Middle Date
Low	Low	Low	High	Long	33.3	66.6	0.1	Middle Date
Low	Low	Low	High	Longer	55.7	44.2	0.1	Middle Date
Low	Low	Low	Very High	Shorter	85	14.9	0.1	Middle Date
Low	Low	Low	Very High	Short	99.8	0.1	0.1	Middle Date
Low	Low	Low	Very High	Moderate	99.8	0.1	0.1	Middle Half-Month
Low	Low	Low	Very High	Long	33.3	66.6	0.1	Middle Date
Low	Low	Low	Very High	Longer	45.8	54.1	0.1	Middle Date
Low	Low	Moderate	Very Low	Shorter	99.8	0.1	0.1	Month
Low	Low	Moderate	Very Low	Short	99.8	0.1	0.1	Month
Low	Low	Moderate	Very Low	Moderate	40	59.9	0.1	Half-Month
Low	Low	Moderate	Very Low	Long	34.8	63.1	2.1	Interpolate
Low	Low	Moderate	Very Low	Longer	41.3	46.2	12.5	Interpolate
Low	Low	Moderate	Low	Shorter	0.1	40	59.9	Date
Low	Low	Moderate	Low	Short	17.5	67	15.5	Month
Low	Low	Moderate	Low	Moderate	33.3	66.6	0.1	Date
Low	Low	Moderate	Low	Long	0.1	99.8	0.1	Middle Date
Low	Low	Moderate	Low	Longer	65.4	34.5	0.1	Middle Date
Low	Low	Moderate	Moderate	Shorter	11.1	72.2	16.7	Half-Month
Low	Low	Moderate	Moderate	Short	19	65.8	15.2	Month
Low	Low	Moderate	Moderate	Moderate	33.3	66.6	0.1	Date
Low	Low	Moderate	Moderate	Long	0.1	99.8	0.1	Middle Date
Low	Low	Moderate	Moderate	Longer	9.8	90.1	0.1	Middle Date
Low	Low	Moderate	High	Shorter	11.1	72.2	16.7	Half-Month
Low	Low	Moderate	High	Short	29.4	57.4	13.2	Month
Low	Low	Moderate	High	Moderate	33.3	66.6	0.1	Date
Low	Low	Moderate	High	Long	0.1	99.8	0.1	Middle Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	Low	Moderate	High	Longer	0.1	99.8	0.1	Middle Date
Low	Low	Moderate	Very High	Shorter	23.1	76.8	0.1	Middle Date
Low	Low	Moderate	Very High	Short	99.8	0.1	0.1	Upper Date
Low	Low	Moderate	Very High	Moderate	87.9	12	0.1	Upper Date
Low	Low	Moderate	Very High	Long	0.1	99.8	0.1	Upper Date
Low	Low	Moderate	Very High	Longer	0.1	50.3	49.6	Upper Date
Low	Low	High	Very Low	Shorter	74.9	25	0.1	Date
Low	Low	High	Very Low	Short	90.1	9.8	0.1	Interpolate
Low	Low	High	Very Low	Moderate	42	53.6	4.4	Interpolate
Low	Low	High	Very Low	Long	31	67.3	1.7	Interpolate
Low	Low	High	Very Low	Longer	42.9	57	0.1	Middle Date
Low	Low	High	Low	Shorter	74.9	25	0.1	Half-Month
Low	Low	High	Low	Short	85.6	14.3	0.1	Middle Date
Low	Low	High	Low	Moderate	20	79.9	0.1	Middle Half-Month
Low	Low	High	Low	Long	16.7	83	0.3	Middle Date
Low	Low	High	Low	Longer	24.8	74.3	0.9	Middle Date
Low	Low	High	Moderate	Shorter	74.9	25	0.1	Half-Month
Low	Low	High	Moderate	Short	64.1	35.8	0.1	Middle Date
Low	Low	High	Moderate	Moderate	18.4	81.5	0.1	Middle Half-Month
Low	Low	High	Moderate	Long	17.3	82.4	0.3	Middle Date
Low	Low	High	Moderate	Longer	31	68	1	Middle Date
Low	Low	High	High	Shorter	74.9	25	0.1	Half-Month
Low	Low	High	High	Short	44.6	55.3	0.1	Middle Date
Low	Low	High	High	Moderate	18.6	81.3	0.1	Middle Half-Month
Low	Low	High	High	Long	17.2	82	0.8	Middle Date
Low	Low	High	High	Longer	14.9	80.8	4.3	Middle Date
Low	Low	High	Very High	Shorter	74.9	25	0.1	Half-Month
Low	Low	High	Very High	Short	40	59.9	0.1	Middle Date
Low	Low	High	Very High	Moderate	40	59.9	0.1	Middle Half-Month
Low	Low	High	Very High	Long	14.3	71.4	14.3	Middle Date
Low	Low	High	Very High	Longer	38.8	54.1	7.1	Middle Date
Low	Moderate	Low	Very Low	Shorter	95.7	4.2	0.1	Interpolate
Low	Moderate	Low	Very Low	Short	71.1	23.6	5.3	Interpolate
Low	Moderate	Low	Very Low	Moderate	42	49.3	8.7	Interpolate
Low	Moderate	Low	Very Low	Long	50	47.9	2.1	Interpolate
Low	Moderate	Low	Very Low	Longer	47.7	39.8	12.5	Interpolate
Low	Moderate	Low	Low	Shorter	89.9	10	0.1	Middle Date
Low	Moderate	Low	Low	Short	0.1	99.8	0.1	Middle Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	Moderate	Low	Low	Moderate	30	69.9	0.1	Middle Half-Month
Low	Moderate	Low	Low	Long	26.1	73.8	0.1	Middle Half-Month
Low	Moderate	Low	Low	Longer	74	25.9	0.1	Middle Date
Low	Moderate	Low	Moderate	Shorter	99.8	0.1	0.1	Half-Month
Low	Moderate	Low	Moderate	Short	76.2	23.7	0.1	Middle Date
Low	Moderate	Low	Moderate	Moderate	67.5	32.4	0.1	Middle Half-Month
Low	Moderate	Low	Moderate	Long	69.9	30	0.1	Middle Half-Month
Low	Moderate	Low	Moderate	Longer	43.7	56.2	0.1	Middle Date
Low	Moderate	Low	High	Shorter	99.8	0.1	0.1	Half-Month
Low	Moderate	Low	High	Short	75.6	24.3	0.1	Middle Date
Low	Moderate	Low	High	Moderate	99.8	0.1	0.1	Middle Date
Low	Moderate	Low	High	Long	72.5	27.4	0.1	Middle Half-Month
Low	Moderate	Low	High	Longer	48.3	51.6	0.1	Middle Date
Low	Moderate	Low	Very High	Shorter	36	63.9	0.1	Middle Date
Low	Moderate	Low	Very High	Short	99.8	0.1	0.1	Middle Date
Low	Moderate	Low	Very High	Moderate	20.8	79.1	0.1	Middle Half-Month
Low	Moderate	Low	Very High	Long	20	79.9	0.1	Upper Date
Low	Moderate	Low	Very High	Longer	32.5	67.4	0.1	Middle Date
Low	Moderate	Moderate	Very Low	Shorter	99.8	0.1	0.1	Date
Low	Moderate	Moderate	Very Low	Short	99.8	0.1	0.1	Month
Low	Moderate	Moderate	Very Low	Moderate	40	59.9	0.1	Half-Month
Low	Moderate	Moderate	Very Low	Long	50	41.7	8.3	Upper Half-Month
Low	Moderate	Moderate	Very Low	Longer	0.1	49.95	49.95	Upper Date
Low	Moderate	Moderate	Low	Shorter	0.1	40	59.9	Date
Low	Moderate	Moderate	Low	Short	36	52	12	Month
Low	Moderate	Moderate	Low	Moderate	33.3	66.6	0.1	Date
Low	Moderate	Moderate	Low	Long	11.9	87.4	0.7	Middle Date
Low	Moderate	Moderate	Low	Longer	8.4	91.5	0.1	Middle Date
Low	Moderate	Moderate	Moderate	Shorter	99.8	0.1	0.1	Date
Low	Moderate	Moderate	Moderate	Short	40.2	48.6	11.2	Month
Low	Moderate	Moderate	Moderate	Moderate	33.3	66.6	0.1	Date
Low	Moderate	Moderate	Moderate	Long	8.7	90.8	0.5	Middle Date
Low	Moderate	Moderate	Moderate	Longer	15.3	84.6	0.1	Middle Date
Low	Moderate	Moderate	High	Shorter	99.8	0.1	0.1	Date
Low	Moderate	Moderate	High	Short	61.2	31.5	7.3	Month
Low	Moderate	Moderate	High	Moderate	33.3	66.6	0.1	Date
Low	Moderate	Moderate	High	Long	21.5	78.2	0.3	Middle Date
Low	Moderate	Moderate	High	Longer	10.8	89.1	0.1	Middle Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	Moderate	Moderate	Very High	Shorter	65	33.1	1.9	Middle Date
Low	Moderate	Moderate	Very High	Short	85.6	14.3	0.1	Middle Half-Month
Low	Moderate	Moderate	Very High	Moderate	2.4	41.9	55.7	Middle Date
Low	Moderate	Moderate	Very High	Long	0.1	40	59.9	Middle Date
Low	Moderate	Moderate	Very High	Longer	0.1	40	59.9	Middle Half-Month
Low	Moderate	High	Very Low	Shorter	27.3	72.6	0.1	Month
Low	Moderate	High	Very Low	Short	65.7	34.2	0.1	Interpolate
Low	Moderate	High	Very Low	Moderate	49.95	49.95	0.1	Upper Date
Low	Moderate	High	Very Low	Long	50	41.7	8.3	Upper Half-Month
Low	Moderate	High	Very Low	Longer	50	41.7	8.3	Upper Half-Month
Low	Moderate	High	Low	Shorter	16.7	83.2	0.1	Date
Low	Moderate	High	Low	Short	85.6	14.3	0.1	Middle Date
Low	Moderate	High	Low	Moderate	0.1	99.8	0.1	Middle Date
Low	Moderate	High	Low	Long	13.3	86.6	0.1	Middle Date
Low	Moderate	High	Low	Longer	21.7	77.9	0.4	Middle Date
Low	Moderate	High	Moderate	Shorter	27.3	72.6	0.1	Month
Low	Moderate	High	Moderate	Short	78.7	21.2	0.1	Middle Date
Low	Moderate	High	Moderate	Moderate	0.1	79.9	20	Middle Date
Low	Moderate	High	Moderate	Long	11.6	88.3	0.1	Middle Date
Low	Moderate	High	Moderate	Longer	21.1	77.8	1.1	Middle Date
Low	Moderate	High	High	Shorter	27.3	72.6	0.1	Month
Low	Moderate	High	High	Short	56.3	43.6	0.1	Middle Date
Low	Moderate	High	High	Moderate	0.1	98.3	1.6	Middle Date
Low	Moderate	High	High	Long	12.7	87.2	0.1	Middle Date
Low	Moderate	High	High	Longer	10.7	86.7	2.6	Middle Date
Low	Moderate	High	Very High	Shorter	11.5	84	4.5	Middle Date
Low	Moderate	High	Very High	Short	40	59.9	0.1	Middle Date
Low	Moderate	High	Very High	Moderate	0.1	79.9	20	Middle Date
Low	Moderate	High	Very High	Long	10.8	81.2	8	Middle Date
Low	Moderate	High	Very High	Longer	14	70.7	15.3	Middle Date
Low	High	Low	Very Low	Shorter	99.8	0.1	0.1	Date
Low	High	Low	Very Low	Short	99.8	0.1	0.1	Upper Date
Low	High	Low	Very Low	Moderate	56.9	36.5	6.6	Interpolate
Low	High	Low	Very Low	Long	33.3	66.6	0.1	Upper Half-Month
Low	High	Low	Very Low	Longer	33.3	66.6	0.1	Upper Half-Month
Low	High	Low	Low	Shorter	99.8	0.1	0.1	Date
Low	High	Low	Low	Short	89.9	10	0.1	Middle Half-Month
Low	High	Low	Low	Moderate	48.8	36.2	15	Interpolate

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	High	Low	Low	Long	44.7	53.8	1.5	Interpolate
Low	High	Low	Low	Longer	50.7	49.2	0.1	Middle Date
Low	High	Low	Moderate	Shorter	99.8	0.1	0.1	Date
Low	High	Low	Moderate	Short	78.3	21.6	0.1	Middle Date
Low	High	Low	Moderate	Moderate	65.4	34.5	0.1	Middle Half-Month
Low	High	Low	Moderate	Long	69.9	30	0.1	Middle Half-Month
Low	High	Low	Moderate	Longer	24.5	75.4	0.1	Middle Date
Low	High	Low	High	Shorter	99.8	0.1	0.1	Date
Low	High	Low	High	Short	78.9	21	0.1	Middle Date
Low	High	Low	High	Moderate	65.2	34.7	0.1	Middle Half-Month
Low	High	Low	High	Long	33.3	66.6	0.1	Middle Date
Low	High	Low	High	Longer	31.1	68.8	0.1	Middle Date
Low	High	Low	Very High	Shorter	84	15.9	0.1	Middle Date
Low	High	Low	Very High	Short	99.8	0.1	0.1	Middle Date
Low	High	Low	Very High	Moderate	34.4	65.5	0.1	Middle Half-Month
Low	High	Low	Very High	Long	33.3	66.6	0.1	Middle Date
Low	High	Low	Very High	Longer	20.8	79.1	0.1	Middle Date
Low	High	Moderate	Very Low	Shorter	99.8	0.1	0.1	Date
Low	High	Moderate	Very Low	Short	99.8	0.1	0.1	Month
Low	High	Moderate	Very Low	Moderate	40	59.9	0.1	Half-Month
Low	High	Moderate	Very Low	Long	12.8	87.1	0.1	Upper Date
Low	High	Moderate	Very Low	Longer	0.1	49.95	49.95	Upper Date
Low	High	Moderate	Low	Shorter	11.1	72.2	16.7	Half-Month
Low	High	Moderate	Low	Short	36	52	12	Month
Low	High	Moderate	Low	Moderate	33.3	66.6	0.1	Date
Low	High	Moderate	Low	Long	21.2	69.6	9.2	Middle Date
Low	High	Moderate	Low	Longer	17.5	82.4	0.1	Middle Date
Low	High	Moderate	Moderate	Shorter	41.2	29.4	29.4	Date
Low	High	Moderate	Moderate	Short	40.2	48.6	11.2	Month
Low	High	Moderate	Moderate	Moderate	33.3	66.6	0.1	Date
Low	High	Moderate	Moderate	Long	21.2	69.6	9.2	Middle Date
Low	High	Moderate	Moderate	Longer	30.5	69.4	0.1	Middle Date
Low	High	Moderate	High	Shorter	41.2	29.4	29.4	Date
Low	High	Moderate	High	Short	61.2	31.5	7.3	Month
Low	High	Moderate	High	Moderate	33.3	66.6	0.1	Date
Low	High	Moderate	High	Long	24.1	73.8	2.1	Middle Date
Low	High	Moderate	High	Longer	33.6	66.3	0.1	Middle Date
Low	High	Moderate	Very High	Shorter	0.1	49.95	49.95	Half-Month

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	High	Moderate	Very High	Short	85.6	14.3	0.1	Middle Half-Month
Low	High	Moderate	Very High	Moderate	0.1	54.1	45.8	Middle Date
Low	High	Moderate	Very High	Long	0.1	40	59.9	Middle Date
Low	High	Moderate	Very High	Longer	0.1	40	59.9	Middle Half-Month
Low	High	High	Very Low	Shorter	27.3	72.6	0.1	Month
Low	High	High	Very Low	Short	54.8	43.5	1.7	Interpolate
Low	High	High	Very Low	Moderate	50	41.7	8.3	Upper Half-Month
Low	High	High	Very Low	Long	33.3	66.6	0.1	Upper Date
Low	High	High	Very Low	Longer	39.9	55	5.1	Upper Half-Month
Low	High	High	Low	Shorter	27.3	72.6	0.1	Month
Low	High	High	Low	Short	85.6	14.3	0.1	Middle Date
Low	High	High	Low	Moderate	0.1	99.8	0.1	Middle Date
Low	High	High	Low	Long	12.2	87.4	0.4	Middle Date
Low	High	High	Low	Longer	12.6	86.8	0.6	Middle Date
Low	High	High	Moderate	Shorter	27.3	72.6	0.1	Month
Low	High	High	Moderate	Short	68.6	31.3	0.1	Middle Date
Low	High	High	Moderate	Moderate	0.1	79.9	20	Middle Date
Low	High	High	Moderate	Long	12.3	87.4	0.3	Middle Date
Low	High	High	Moderate	Longer	10.5	87.9	1.6	Middle Date
Low	High	High	High	Shorter	27.3	72.6	0.1	Month
Low	High	High	High	Short	46.6	53.3	0.1	Middle Date
Low	High	High	High	Moderate	0.1	97	2.9	Middle Date
Low	High	High	High	Long	13	86.1	0.9	Middle Date
Low	High	High	High	Longer	10.8	88	1.2	Middle Date
Low	High	High	Very High	Shorter	0.1	85.6	14.3	Middle Date
Low	High	High	Very High	Short	40	59.9	0.1	Middle Date
Low	High	High	Very High	Moderate	0.1	79.9	20	Middle Date
Low	High	High	Very High	Long	12.5	83.5	4	Middle Date
Low	High	High	Very High	Longer	18.8	67.5	13.7	Middle Date
Low	Very High	Low	Very Low	Shorter	99.8	0.1	0.1	Date
Low	Very High	Low	Very Low	Short	99.8	0.1	0.1	Upper Date
Low	Very High	Low	Very Low	Moderate	61	38.9	0.1	Interpolate
Low	Very High	Low	Very Low	Long	33.3	66.6	0.1	Upper Half-Month
Low	Very High	Low	Very Low	Longer	66.6	33.3	0.1	Upper Date
Low	Very High	Low	Low	Shorter	99.8	0.1	0.1	Date
Low	Very High	Low	Low	Short	70.5	29.4	0.1	Interpolate
Low	Very High	Low	Low	Moderate	33.3	46.7	20	Interpolate
Low	Very High	Low	Low	Long	28.2	59.8	12	Interpolate

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	Very High	Low	Low	Longer	41	58.9	0.1	Middle Date
Low	Very High	Low	Moderate	Shorter	99.8	0.1	0.1	Date
Low	Very High	Low	Moderate	Short	0.1	99.8	0.1	Middle Half-Month
Low	Very High	Low	Moderate	Moderate	0.1	99.8	0.1	Middle Half-Month
Low	Very High	Low	Moderate	Long	33.3	66.6	0.1	Upper Half-Month
Low	Very High	Low	Moderate	Longer	23.1	76.8	0.1	Middle Date
Low	Very High	Low	High	Shorter	99.8	0.1	0.1	Date
Low	Very High	Low	High	Short	21.9	78	0.1	Middle Half-Month
Low	Very High	Low	High	Moderate	0.1	99.8	0.1	Middle Half-Month
Low	Very High	Low	High	Long	34.7	65.2	0.1	Middle Date
Low	Very High	Low	High	Longer	54.8	45.1	0.1	Middle Date
Low	Very High	Low	Very High	Shorter	66.3	33.6	0.1	Middle Date
Low	Very High	Low	Very High	Short	10.8	89.1	0.1	Middle Half-Month
Low	Very High	Low	Very High	Moderate	0.1	99.8	0.1	Middle Half-Month
Low	Very High	Low	Very High	Long	33.3	66.6	0.1	Middle Date
Low	Very High	Low	Very High	Longer	29.9	70	0.1	Middle Date
Low	Very High	Moderate	Very Low	Shorter	99.8	0.1	0.1	Month
Low	Very High	Moderate	Very Low	Short	49.1	50.8	0.1	Upper Date
Low	Very High	Moderate	Very Low	Moderate	49.95	49.95	0.1	Upper Date
Low	Very High	Moderate	Very Low	Long	16.7	83.2	0.1	Upper Date
Low	Very High	Moderate	Very Low	Longer	74.9	25	0.1	Upper Date
Low	Very High	Moderate	Low	Shorter	44.1	55	0.9	Upper Half-Month
Low	Very High	Moderate	Low	Short	99.8	0.1	0.1	Upper Date
Low	Very High	Moderate	Low	Moderate	0.1	40	59.9	Middle Date
Low	Very High	Moderate	Low	Long	0.1	40	59.9	Middle Date
Low	Very High	Moderate	Low	Longer	22.2	77.7	0.1	Middle Date
Low	Very High	Moderate	Moderate	Shorter	99.8	0.1	0.1	Month
Low	Very High	Moderate	Moderate	Short	33.3	66.6	0.1	Upper Date
Low	Very High	Moderate	Moderate	Moderate	25	74.9	0.1	Middle Half-Month
Low	Very High	Moderate	Moderate	Long	0.1	40	59.9	Middle Date
Low	Very High	Moderate	Moderate	Longer	46.6	53.3	0.1	Middle Date
Low	Very High	Moderate	High	Shorter	99.8	0.1	0.1	Month
Low	Very High	Moderate	High	Short	52.4	47.5	0.1	Upper Date
Low	Very High	Moderate	High	Moderate	2.4	41.9	55.7	Middle Date
Low	Very High	Moderate	High	Long	0.1	40	59.9	Middle Date
Low	Very High	Moderate	High	Longer	33.4	66.5	0.1	Middle Date
Low	Very High	Moderate	Very High	Shorter	66.6	33.3	0.1	Middle Date
Low	Very High	Moderate	Very High	Short	14.1	85.8	0.1	Upper Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Low	Very High	Moderate	Very High	Moderate	0.2	42	57.8	Middle Date
Low	Very High	Moderate	Very High	Long	0.1	40	59.9	Middle Date
Low	Very High	Moderate	Very High	Longer	0.1	40	59.9	Middle Half-Month
Low	Very High	High	Very Low	Shorter	0.1	85.8	14.1	Upper Date
Low	Very High	High	Very Low	Short	11.1	88.8	0.1	Upper Half-Month
Low	Very High	High	Very Low	Moderate	49.95	49.95	0.1	Upper Date
Low	Very High	High	Very Low	Long	40.7	59.2	0.1	Upper Date
Low	Very High	High	Very Low	Longer	99.8	0.1	0.1	Upper Date
Low	Very High	High	Low	Shorter	76.3	20.7	3	Upper Half-Month
Low	Very High	High	Low	Short	99.8	0.1	0.1	Upper Date
Low	Very High	High	Low	Moderate	0.1	99.8	0.1	Middle Date
Low	Very High	High	Low	Long	14.3	82.4	3.3	Middle Date
Low	Very High	High	Low	Longer	2.8	96.6	0.6	Middle Date
Low	Very High	High	Moderate	Shorter	25.3	25.3	49.4	Upper Date
Low	Very High	High	Moderate	Short	57.3	42.6	0.1	Upper Date
Low	Very High	High	Moderate	Moderate	0.1	79.9	20	Middle Date
Low	Very High	High	Moderate	Long	13.1	84.5	2.4	Middle Date
Low	Very High	High	Moderate	Longer	0.1	98.4	1.5	Middle Date
Low	Very High	High	High	Shorter	21.7	57.9	20.4	Upper Date
Low	Very High	High	High	Short	35.9	53.6	10.5	Upper Half-Month
Low	Very High	High	High	Moderate	0.1	93.9	6	Middle Date
Low	Very High	High	High	Long	14.7	80.5	4.8	Middle Date
Low	Very High	High	High	Longer	7.4	91.3	1.3	Middle Date
Low	Very High	High	Very High	Shorter	2.3	68	29.7	Upper Date
Low	Very High	High	Very High	Short	1.7	56.4	41.9	Upper Date
Low	Very High	High	Very High	Moderate	0.1	79.9	20	Middle Date
Low	Very High	High	Very High	Long	12.8	75.7	11.5	Middle Date
Low	Very High	High	Very High	Longer	0.1	79.9	20	Middle Date
Moderate	Very Low	Low	Very Low	Shorter	99.8	0.1	0.1	Month
Moderate	Very Low	Low	Very Low	Short	99.8	0.1	0.1	Month
Moderate	Very Low	Low	Very Low	Moderate	62.4	37.5	0.1	Month
Moderate	Very Low	Low	Very Low	Long	62.4	37.5	0.1	Month
Moderate	Very Low	Low	Very Low	Longer	62.4	37.5	0.1	Month
Moderate	Very Low	Low	Low	Shorter	99.8	0.1	0.1	Date
Moderate	Very Low	Low	Low	Short	99.8	0.1	0.1	Half-Month
Moderate	Very Low	Low	Low	Moderate	62.4	37.5	0.1	Month
Moderate	Very Low	Low	Low	Long	62.4	37.5	0.1	Month
Moderate	Very Low	Low	Low	Longer	62.4	37.5	0.1	Month

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Moderate	Very Low	Low	Moderate	Shorter	83.7	16.2	0.1	Month
Moderate	Very Low	Low	Moderate	Short	90.3	9.6	0.1	Month
Moderate	Very Low	Low	Moderate	Moderate	99.8	0.1	0.1	Middle Half-Month
Moderate	Very Low	Low	Moderate	Long	99.8	0.1	0.1	Middle Half-Month
Moderate	Very Low	Low	Moderate	Longer	28.8	71.1	0.1	Middle Date
Moderate	Very Low	Low	High	Shorter	50.2	49.7	0.1	Middle Date
Moderate	Very Low	Low	High	Short	0.1	99.8	0.1	Middle Half-Month
Moderate	Very Low	Low	High	Moderate	99.8	0.1	0.1	Middle Half-Month
Moderate	Very Low	Low	High	Long	99.8	0.1	0.1	Middle Half-Month
Moderate	Very Low	Low	High	Longer	71	28.9	0.1	Middle Date
Moderate	Very Low	Low	Very High	Shorter	40.7	59.2	0.1	Middle Date
Moderate	Very Low	Low	Very High	Short	54.2	45.7	0.1	Interpolate
Moderate	Very Low	Low	Very High	Moderate	85.6	14.3	0.1	Interpolate
Moderate	Very Low	Low	Very High	Long	38.3	36.7	25	Interpolate
Moderate	Very Low	Low	Very High	Longer	20	40	40	Upper Date
Moderate	Very Low	Moderate	Very Low	Shorter	92	7.9	0.1	Month
Moderate	Very Low	Moderate	Very Low	Short	91.8	8.1	0.1	Month
Moderate	Very Low	Moderate	Very Low	Moderate	33.5	66.4	0.1	Date
Moderate	Very Low	Moderate	Very Low	Long	45.5	54.4	0.1	Date
Moderate	Very Low	Moderate	Very Low	Longer	99.8	0.1	0.1	Date
Moderate	Very Low	Moderate	Low	Shorter	89.4	10.5	0.1	Date
Moderate	Very Low	Moderate	Low	Short	89.2	10.7	0.1	Month
Moderate	Very Low	Moderate	Low	Moderate	33.5	66.4	0.1	Date
Moderate	Very Low	Moderate	Low	Long	45.5	54.4	0.1	Date
Moderate	Very Low	Moderate	Low	Longer	99.8	0.1	0.1	Date
Moderate	Very Low	Moderate	Moderate	Shorter	0.1	99.8	0.1	Date
Moderate	Very Low	Moderate	Moderate	Short	89.7	10.2	0.1	Month
Moderate	Very Low	Moderate	Moderate	Moderate	40	59.9	0.1	Half-Month
Moderate	Very Low	Moderate	Moderate	Long	0.1	40	59.9	Middle Date
Moderate	Very Low	Moderate	Moderate	Longer	52.6	47.3	0.1	Middle Date
Moderate	Very Low	Moderate	High	Shorter	62.6	37.3	0.1	Middle Date
Moderate	Very Low	Moderate	High	Short	0.1	99.8	0.1	Middle Half-Month
Moderate	Very Low	Moderate	High	Moderate	40	59.9	0.1	Half-Month
Moderate	Very Low	Moderate	High	Long	7.1	45.7	47.2	Middle Date
Moderate	Very Low	Moderate	High	Longer	55.1	44.8	0.1	Middle Date
Moderate	Very Low	Moderate	Very High	Shorter	66.6	33.3	0.1	Middle Date
Moderate	Very Low	Moderate	Very High	Short	64.6	35.3	0.1	Upper Date
Moderate	Very Low	Moderate	Very High	Moderate	42.9	57	0.1	Upper Half-Month

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Moderate	Very Low	Moderate	Very High	Long	0.1	40	59.9	Middle Date
Moderate	Very Low	Moderate	Very High	Longer	0.1	40	59.9	Middle Half-Month
Moderate	Very Low	High	Very Low	Shorter	99.8	0.1	0.1	Half-Month
Moderate	Very Low	High	Very Low	Short	99.8	0.1	0.1	Date
Moderate	Very Low	High	Very Low	Moderate	98.5	1.4	0.1	Half-Month
Moderate	Very Low	High	Very Low	Long	45.5	54.4	0.1	Date
Moderate	Very Low	High	Very Low	Longer	99.8	0.1	0.1	Date
Moderate	Very Low	High	Low	Shorter	68.5	31.4	0.1	Date
Moderate	Very Low	High	Low	Short	99.8	0.1	0.1	Date
Moderate	Very Low	High	Low	Moderate	79.9	20	0.1	Half-Month
Moderate	Very Low	High	Low	Long	45.5	54.4	0.1	Date
Moderate	Very Low	High	Low	Longer	99.8	0.1	0.1	Date
Moderate	Very Low	High	Moderate	Shorter	99.8	0.1	0.1	Month
Moderate	Very Low	High	Moderate	Short	99.8	0.1	0.1	Month
Moderate	Very Low	High	Moderate	Moderate	83.2	16.7	0.1	Middle Date
Moderate	Very Low	High	Moderate	Long	93.5	2.6	3.9	Middle Date
Moderate	Very Low	High	Moderate	Longer	41.7	58.2	0.1	Middle Date
Moderate	Very Low	High	High	Shorter	0.1	79.9	20	Middle Date
Moderate	Very Low	High	High	Short	37.5	37.5	25	Middle Date
Moderate	Very Low	High	High	Moderate	22.4	77.5	0.1	Middle Date
Moderate	Very Low	High	High	Long	14	51.1	34.9	Middle Date
Moderate	Very Low	High	High	Longer	36.9	63	0.1	Middle Date
Moderate	Very Low	High	Very High	Shorter	13.6	40.8	45.6	Upper Half-Month
Moderate	Very Low	High	Very High	Short	49.95	49.95	0.1	Upper Date
Moderate	Very Low	High	Very High	Moderate	42.9	57	0.1	Upper Half-Month
Moderate	Very Low	High	Very High	Long	0.1	40	59.9	Middle Date
Moderate	Very Low	High	Very High	Longer	0.1	40	59.9	Middle Half-Month
Moderate	Low	Low	Very Low	Shorter	99.8	0.1	0.1	Half-Month
Moderate	Low	Low	Very Low	Short	32.3	31.8	35.9	Half-Month
Moderate	Low	Low	Very Low	Moderate	61.6	20.8	17.6	Half-Month
Moderate	Low	Low	Very Low	Long	90.8	9.1	0.1	Half-Month
Moderate	Low	Low	Very Low	Longer	59.9	40	0.1	Date
Moderate	Low	Low	Low	Shorter	89.9	10	0.1	Date
Moderate	Low	Low	Low	Short	11.8	0.1	88.1	Date
Moderate	Low	Low	Low	Moderate	77.9	14.3	7.8	Half-Month
Moderate	Low	Low	Low	Long	90.8	9.1	0.1	Half-Month
Moderate	Low	Low	Low	Longer	46.8	53.1	0.1	Date
Moderate	Low	Low	Moderate	Shorter	74.9	25	0.1	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Moderate	Low	Low	Moderate	Short	13.3	40	46.7	Half-Month
Moderate	Low	Low	Moderate	Moderate	13.3	40	46.7	Half-Month
Moderate	Low	Low	Moderate	Long	87.4	12.5	0.1	Middle Date
Moderate	Low	Low	Moderate	Longer	0.1	99.8	0.1	Date
Moderate	Low	Low	High	Shorter	55.5	44.4	0.1	Date
Moderate	Low	Low	High	Short	23.1	76.8	0.1	Month
Moderate	Low	Low	High	Moderate	98.8	1.1	0.1	Middle Date
Moderate	Low	Low	High	Long	33.3	66.6	0.1	Middle Date
Moderate	Low	Low	High	Longer	0.1	99.8	0.1	Date
Moderate	Low	Low	Very High	Shorter	33.3	66.6	0.1	Date
Moderate	Low	Low	Very High	Short	20.3	79.6	0.1	Month
Moderate	Low	Low	Very High	Moderate	64.3	31.8	3.9	Interpolate
Moderate	Low	Low	Very High	Long	33.3	66.6	0.1	Middle Date
Moderate	Low	Low	Very High	Longer	42.7	57.2	0.1	Middle Date
Moderate	Low	Moderate	Very Low	Shorter	99.8	0.1	0.1	Half-Month
Moderate	Low	Moderate	Very Low	Short	40	27.7	32.3	Half-Month
Moderate	Low	Moderate	Very Low	Moderate	38.1	58.6	3.3	Half-Month
Moderate	Low	Moderate	Very Low	Long	49	50.9	0.1	Date
Moderate	Low	Moderate	Very Low	Longer	56.7	43.2	0.1	Half-Month
Moderate	Low	Moderate	Low	Shorter	43.6	26	30.4	Date
Moderate	Low	Moderate	Low	Short	99.8	0.1	0.1	Date
Moderate	Low	Moderate	Low	Moderate	19	80.9	0.1	Date
Moderate	Low	Moderate	Low	Long	59.8	40.1	0.1	Date
Moderate	Low	Moderate	Low	Longer	66.6	33.3	0.1	Date
Moderate	Low	Moderate	Moderate	Shorter	0.1	99.8	0.1	Date
Moderate	Low	Moderate	Moderate	Short	13.3	40	46.7	Half-Month
Moderate	Low	Moderate	Moderate	Moderate	27.5	72.4	0.1	Date
Moderate	Low	Moderate	Moderate	Long	16.7	83.2	0.1	Month
Moderate	Low	Moderate	Moderate	Longer	42.6	57.3	0.1	Middle Date
Moderate	Low	Moderate	High	Shorter	33.3	66.6	0.1	Date
Moderate	Low	Moderate	High	Short	27.9	58.6	13.5	Month
Moderate	Low	Moderate	High	Moderate	33.3	66.6	0.1	Date
Moderate	Low	Moderate	High	Long	90.8	9.1	0.1	Month
Moderate	Low	Moderate	High	Longer	90.8	9.1	0.1	Month
Moderate	Low	Moderate	Very High	Shorter	70.6	29.3	0.1	Month
Moderate	Low	Moderate	Very High	Short	83.2	16.7	0.1	Month
Moderate	Low	Moderate	Very High	Moderate	42.9	57	0.1	Upper Half-Month
Moderate	Low	Moderate	Very High	Long	66.6	0.1	33.3	Upper Half-Month

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Moderate	Low	Moderate	Very High	Longer	40.3	33.6	26.1	Interpolate
Moderate	Low	High	Very Low	Shorter	99.8	0.1	0.1	Half-Month
Moderate	Low	High	Very Low	Short	99.8	0.1	0.1	Date
Moderate	Low	High	Very Low	Moderate	99.8	0.1	0.1	Date
Moderate	Low	High	Very Low	Long	45.5	54.4	0.1	Date
Moderate	Low	High	Very Low	Longer	51.5	48.4	0.1	Half-Month
Moderate	Low	High	Low	Shorter	57.6	42.3	0.1	Date
Moderate	Low	High	Low	Short	99.8	0.1	0.1	Date
Moderate	Low	High	Low	Moderate	79.9	20	0.1	Half-Month
Moderate	Low	High	Low	Long	45.5	54.4	0.1	Date
Moderate	Low	High	Low	Longer	52	47.9	0.1	Half-Month
Moderate	Low	High	Moderate	Shorter	99.8	0.1	0.1	Month
Moderate	Low	High	Moderate	Short	99.8	0.1	0.1	Month
Moderate	Low	High	Moderate	Moderate	37	55.1	7.9	Middle Date
Moderate	Low	High	Moderate	Long	29.8	70	0.2	Middle Date
Moderate	Low	High	Moderate	Longer	38.3	61.1	0.6	Middle Date
Moderate	Low	High	High	Shorter	23.2	74.8	2	Middle Date
Moderate	Low	High	High	Short	40.7	43.2	16.1	Middle Date
Moderate	Low	High	High	Moderate	44.9	50	5.1	Middle Date
Moderate	Low	High	High	Long	21.3	78.2	0.5	Middle Date
Moderate	Low	High	High	Longer	27.3	69.4	3.3	Middle Date
Moderate	Low	High	Very High	Shorter	16.5	83.4	0.1	Middle Date
Moderate	Low	High	Very High	Short	40	59.9	0.1	Middle Date
Moderate	Low	High	Very High	Moderate	40	59.9	0.1	Middle Half-Month
Moderate	Low	High	Very High	Long	14.3	71.4	14.3	Middle Date
Moderate	Low	High	Very High	Longer	41.7	52.2	6.1	Middle Date
Moderate	Moderate	Low	Very Low	Shorter	88.8	11.1	0.1	Half-Month
Moderate	Moderate	Low	Very Low	Short	55.3	18	26.7	Half-Month
Moderate	Moderate	Low	Very Low	Moderate	56	17.8	26.2	Half-Month
Moderate	Moderate	Low	Very Low	Long	90.8	9.1	0.1	Half-Month
Moderate	Moderate	Low	Very Low	Longer	83.2	16.7	0.1	Date
Moderate	Moderate	Low	Low	Shorter	52.7	47.2	0.1	Date
Moderate	Moderate	Low	Low	Short	0.1	59.6	40.3	Date
Moderate	Moderate	Low	Low	Moderate	25	0.1	74.9	Date
Moderate	Moderate	Low	Low	Long	66.6	33.3	0.1	Date
Moderate	Moderate	Low	Low	Longer	53.2	46.7	0.1	Date
Moderate	Moderate	Low	Moderate	Shorter	67.6	32.3	0.1	Date
Moderate	Moderate	Low	Moderate	Short	99.8	0.1	0.1	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Moderate	Moderate	Low	Moderate	Moderate	99.8	0.1	0.1	Half-Month
Moderate	Moderate	Low	Moderate	Long	66.6	33.3	0.1	Date
Moderate	Moderate	Low	Moderate	Longer	67.5	32.4	0.1	Date
Moderate	Moderate	Low	High	Shorter	25	74.9	0.1	Date
Moderate	Moderate	Low	High	Short	77.7	22.2	0.1	Date
Moderate	Moderate	Low	High	Moderate	54.5	18.2	27.3	Half-Month
Moderate	Moderate	Low	High	Long	61.7	20.7	17.6	Month
Moderate	Moderate	Low	High	Longer	33.3	66.6	0.1	Date
Moderate	Moderate	Low	Very High	Shorter	33.3	66.6	0.1	Date
Moderate	Moderate	Low	Very High	Short	54.5	18.2	27.3	Half-Month
Moderate	Moderate	Low	Very High	Moderate	54.5	18.2	27.3	Half-Month
Moderate	Moderate	Low	Very High	Long	59.8	25.4	14.8	Month
Moderate	Moderate	Low	Very High	Longer	52.2	44.5	3.3	Month
Moderate	Moderate	Moderate	Very Low	Shorter	99.8	0.1	0.1	Date
Moderate	Moderate	Moderate	Very Low	Short	70.2	13.5	16.3	Month
Moderate	Moderate	Moderate	Very Low	Moderate	33.3	66.6	0.1	Date
Moderate	Moderate	Moderate	Very Low	Long	72.6	27.3	0.1	Half-Month
Moderate	Moderate	Moderate	Very Low	Longer	99.8	0.1	0.1	Date
Moderate	Moderate	Moderate	Low	Shorter	56.3	22.3	21.4	Date
Moderate	Moderate	Moderate	Low	Short	99.8	0.1	0.1	Half-Month
Moderate	Moderate	Moderate	Low	Moderate	12.3	87.6	0.1	Date
Moderate	Moderate	Moderate	Low	Long	72.6	27.3	0.1	Half-Month
Moderate	Moderate	Moderate	Low	Longer	76.8	23.1	0.1	Date
Moderate	Moderate	Moderate	Moderate	Shorter	99.8	0.1	0.1	Date
Moderate	Moderate	Moderate	Moderate	Short	52.7	31.4	15.9	Month
Moderate	Moderate	Moderate	Moderate	Moderate	19	80.9	0.1	Date
Moderate	Moderate	Moderate	Moderate	Long	16.7	83.2	0.1	Month
Moderate	Moderate	Moderate	Moderate	Longer	45.2	54.7	0.1	Middle Date
Moderate	Moderate	Moderate	High	Shorter	94.9	5	0.1	Date
Moderate	Moderate	Moderate	High	Short	59	33.3	7.7	Month
Moderate	Moderate	Moderate	High	Moderate	33.3	66.6	0.1	Date
Moderate	Moderate	Moderate	High	Long	90.8	9.1	0.1	Month
Moderate	Moderate	Moderate	High	Longer	90.8	9.1	0.1	Month
Moderate	Moderate	Moderate	Very High	Shorter	80.7	19.2	0.1	Month
Moderate	Moderate	Moderate	Very High	Short	83.2	16.7	0.1	Month
Moderate	Moderate	Moderate	Very High	Moderate	33.3	66.6	0.1	Middle Date
Moderate	Moderate	Moderate	Very High	Long	0.1	40	59.9	Middle Date
Moderate	Moderate	Moderate	Very High	Longer	0.1	40	59.9	Middle Half-Month

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Moderate	Moderate	High	Very Low	Shorter	27.3	72.6	0.1	Month
Moderate	Moderate	High	Very Low	Short	69.3	26.3	4.4	Interpolate
Moderate	Moderate	High	Very Low	Moderate	66.6	33.3	0.1	Month
Moderate	Moderate	High	Very Low	Long	50	41.7	8.3	Upper Half-Month
Moderate	Moderate	High	Very Low	Longer	50	41.7	8.3	Upper Half-Month
Moderate	Moderate	High	Low	Shorter	16.7	83.2	0.1	Date
Moderate	Moderate	High	Low	Short	56.9	32.8	10.3	Middle Date
Moderate	Moderate	High	Low	Moderate	66.6	33.3	0.1	Month
Moderate	Moderate	High	Low	Long	37	62.9	0.1	Middle Date
Moderate	Moderate	High	Low	Longer	31.4	68.4	0.2	Middle Date
Moderate	Moderate	High	Moderate	Shorter	27.3	72.6	0.1	Month
Moderate	Moderate	High	Moderate	Short	65.6	26.4	8	Middle Date
Moderate	Moderate	High	Moderate	Moderate	36.5	56.6	6.9	Middle Date
Moderate	Moderate	High	Moderate	Long	21.8	78.1	0.1	Middle Date
Moderate	Moderate	High	Moderate	Longer	31.9	67.8	0.3	Middle Date
Moderate	Moderate	High	High	Shorter	27.3	72.6	0.1	Month
Moderate	Moderate	High	High	Short	48.4	38.3	13.3	Middle Date
Moderate	Moderate	High	High	Moderate	36.2	60.4	3.4	Middle Date
Moderate	Moderate	High	High	Long	17.5	82.4	0.1	Middle Date
Moderate	Moderate	High	High	Longer	25	73	2	Middle Date
Moderate	Moderate	High	Very High	Shorter	14.2	84.3	1.5	Middle Date
Moderate	Moderate	High	Very High	Short	40	59.9	0.1	Middle Date
Moderate	Moderate	High	Very High	Moderate	26.6	72	1.4	Middle Date
Moderate	Moderate	High	Very High	Long	10.7	80.4	8.9	Middle Date
Moderate	Moderate	High	Very High	Longer	16.5	69	14.5	Middle Date
Moderate	High	Low	Very Low	Shorter	18.5	81.4	0.1	Half-Month
Moderate	High	Low	Very Low	Short	41.4	25.5	33.1	Half-Month
Moderate	High	Low	Very Low	Moderate	54.4	19.2	26.4	Half-Month
Moderate	High	Low	Very Low	Long	90.8	9.1	0.1	Half-Month
Moderate	High	Low	Very Low	Longer	99.8	0.1	0.1	Date
Moderate	High	Low	Low	Shorter	4.1	95.8	0.1	Date
Moderate	High	Low	Low	Short	0.1	99.8	0.1	Date
Moderate	High	Low	Low	Moderate	25	0.1	74.9	Date
Moderate	High	Low	Low	Long	66.6	33.3	0.1	Date
Moderate	High	Low	Low	Longer	68	31.9	0.1	Date
Moderate	High	Low	Moderate	Shorter	38	61.9	0.1	Date
Moderate	High	Low	Moderate	Short	99.8	0.1	0.1	Date
Moderate	High	Low	Moderate	Moderate	13.3	40	46.7	Half-Month

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Moderate	High	Low	Moderate	Long	66.6	33.3	0.1	Date
Moderate	High	Low	Moderate	Longer	77.7	22.2	0.1	Date
Moderate	High	Low	High	Shorter	48.1	51.8	0.1	Date
Moderate	High	Low	High	Short	59.9	40	0.1	Date
Moderate	High	Low	High	Moderate	54.5	18.2	27.3	Half-Month
Moderate	High	Low	High	Long	62	20.1	17.9	Month
Moderate	High	Low	High	Longer	33.3	66.6	0.1	Date
Moderate	High	Low	Very High	Shorter	0.1	99.8	0.1	Date
Moderate	High	Low	Very High	Short	35.1	47.3	17.6	Half-Month
Moderate	High	Low	Very High	Moderate	54.5	18.2	27.3	Half-Month
Moderate	High	Low	Very High	Long	60.6	23.5	15.9	Month
Moderate	High	Low	Very High	Longer	53	42.4	4.6	Month
Moderate	High	Moderate	Very Low	Shorter	99.8	0.1	0.1	Date
Moderate	High	Moderate	Very Low	Short	13.3	40	46.7	Half-Month
Moderate	High	Moderate	Very Low	Moderate	36.4	57.4	6.2	Half-Month
Moderate	High	Moderate	Very Low	Long	74.9	25	0.1	Date
Moderate	High	Moderate	Very Low	Longer	99.8	0.1	0.1	Date
Moderate	High	Moderate	Low	Shorter	99.8	0.1	0.1	Date
Moderate	High	Moderate	Low	Short	13.3	40	46.7	Half-Month
Moderate	High	Moderate	Low	Moderate	33.3	66.6	0.1	Date
Moderate	High	Moderate	Low	Long	74.9	25	0.1	Date
Moderate	High	Moderate	Low	Longer	82.9	17	0.1	Date
Moderate	High	Moderate	Moderate	Shorter	59	20.5	20.5	Date
Moderate	High	Moderate	Moderate	Short	13.3	40	46.7	Half-Month
Moderate	High	Moderate	Moderate	Moderate	33.3	66.6	0.1	Date
Moderate	High	Moderate	Moderate	Long	29.2	55.4	15.4	Middle Date
Moderate	High	Moderate	Moderate	Longer	56.4	43.5	0.1	Middle Date
Moderate	High	Moderate	High	Shorter	58.4	20.8	20.8	Date
Moderate	High	Moderate	High	Short	59	33.3	7.7	Month
Moderate	High	Moderate	High	Moderate	33.3	66.6	0.1	Date
Moderate	High	Moderate	High	Long	25.3	67.5	7.2	Middle Date
Moderate	High	Moderate	High	Longer	61	38.9	0.1	Middle Date
Moderate	High	Moderate	Very High	Shorter	0.1	49.95	49.95	Half-Month
Moderate	High	Moderate	Very High	Short	85.6	14.3	0.1	Middle Half-Month
Moderate	High	Moderate	Very High	Moderate	25	74.9	0.1	Middle Half-Month
Moderate	High	Moderate	Very High	Long	0.1	40	59.9	Middle Date
Moderate	High	Moderate	Very High	Longer	0.1	40	59.9	Middle Half-Month
Moderate	High	High	Very Low	Shorter	27.3	72.6	0.1	Month

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Moderate	High	High	Very Low	Short	44	42.2	13.8	Interpolate
Moderate	High	High	Very Low	Moderate	50	41.7	8.3	Upper Half-Month
Moderate	High	High	Very Low	Long	52.8	47.1	0.1	Month
Moderate	High	High	Very Low	Longer	52.8	47.1	0.1	Month
Moderate	High	High	Low	Shorter	27.3	72.6	0.1	Month
Moderate	High	High	Low	Short	85.6	14.3	0.1	Middle Date
Moderate	High	High	Low	Moderate	26.5	73.4	0.1	Middle Date
Moderate	High	High	Low	Long	52.8	47.1	0.1	Month
Moderate	High	High	Low	Longer	52.8	47.1	0.1	Month
Moderate	High	High	Moderate	Shorter	27.3	72.6	0.1	Month
Moderate	High	High	Moderate	Short	72.6	27.3	0.1	Middle Date
Moderate	High	High	Moderate	Moderate	23.4	73	3.6	Middle Date
Moderate	High	High	Moderate	Long	12.9	86.8	0.3	Middle Date
Moderate	High	High	Moderate	Longer	35.1	64.3	0.6	Middle Date
Moderate	High	High	High	Shorter	27.3	72.6	0.1	Month
Moderate	High	High	High	Short	49.2	50.7	0.1	Middle Date
Moderate	High	High	High	Moderate	19.5	79.5	1	Middle Date
Moderate	High	High	High	Long	14.1	85.2	0.7	Middle Date
Moderate	High	High	High	Longer	19.5	78.7	1.8	Middle Date
Moderate	High	High	Very High	Shorter	0.1	85.6	14.3	Middle Date
Moderate	High	High	Very High	Short	40	59.9	0.1	Middle Date
Moderate	High	High	Very High	Moderate	24.9	72.5	2.6	Middle Date
Moderate	High	High	Very High	Long	12.4	83.9	3.7	Middle Date
Moderate	High	High	Very High	Longer	21.8	65.5	12.7	Middle Date
Moderate	Very High	Low	Very Low	Shorter	99.8	0.1	0.1	Half-Month
Moderate	Very High	Low	Very Low	Short	66.6	27.9	5.5	Interpolate
Moderate	Very High	Low	Very Low	Moderate	76.1	17.3	6.6	Interpolate
Moderate	Very High	Low	Very Low	Long	61.6	37	1.4	Interpolate
Moderate	Very High	Low	Very Low	Longer	62.4	37.5	0.1	Date
Moderate	Very High	Low	Low	Shorter	99.8	0.1	0.1	Half-Month
Moderate	Very High	Low	Low	Short	33.3	66.6	0.1	Half-Month
Moderate	Very High	Low	Low	Moderate	99.8	0.1	0.1	Date
Moderate	Very High	Low	Low	Long	33.3	66.6	0.1	Half-Month
Moderate	Very High	Low	Low	Longer	45.6	54.3	0.1	Date
Moderate	Very High	Low	Moderate	Shorter	0.1	99.8	0.1	Date
Moderate	Very High	Low	Moderate	Short	0.1	99.8	0.1	Half-Month
Moderate	Very High	Low	Moderate	Moderate	0.1	99.8	0.1	Middle Half-Month
Moderate	Very High	Low	Moderate	Long	37.2	55.3	7.5	Interpolate

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Moderate	Very High	Low	Moderate	Longer	31.1	68.8	0.1	Date
Moderate	Very High	Low	High	Shorter	88.8	11.1	0.1	Date
Moderate	Very High	Low	High	Short	0.1	99.8	0.1	Half-Month
Moderate	Very High	Low	High	Moderate	0.1	99.8	0.1	Middle Half-Month
Moderate	Very High	Low	High	Long	33.3	66.6	0.1	Middle Date
Moderate	Very High	Low	High	Longer	64.3	35.6	0.1	Middle Date
Moderate	Very High	Low	Very High	Shorter	0.1	99.8	0.1	Date
Moderate	Very High	Low	Very High	Short	0.1	99.8	0.1	Half-Month
Moderate	Very High	Low	Very High	Moderate	0.1	99.8	0.1	Middle Half-Month
Moderate	Very High	Low	Very High	Long	33.3	66.6	0.1	Middle Date
Moderate	Very High	Low	Very High	Longer	20.8	79.1	0.1	Middle Date
Moderate	Very High	Moderate	Very Low	Shorter	99.8	0.1	0.1	Month
Moderate	Very High	Moderate	Very Low	Short	25	74.9	0.1	Upper Date
Moderate	Very High	Moderate	Very Low	Moderate	49.95	49.95	0.1	Upper Date
Moderate	Very High	Moderate	Very Low	Long	50	41.7	8.3	Upper Half-Month
Moderate	Very High	Moderate	Very Low	Longer	50	41.7	8.3	Upper Half-Month
Moderate	Very High	Moderate	Low	Shorter	99.8	0.1	0.1	Upper Date
Moderate	Very High	Moderate	Low	Short	99.8	0.1	0.1	Upper Date
Moderate	Very High	Moderate	Low	Moderate	38.5	46.5	15	Interpolate
Moderate	Very High	Moderate	Low	Long	0.1	40	59.9	Middle Date
Moderate	Very High	Moderate	Low	Longer	43.8	56.1	0.1	Month
Moderate	Very High	Moderate	Moderate	Shorter	99.8	0.1	0.1	Month
Moderate	Very High	Moderate	Moderate	Short	37.7	62.2	0.1	Upper Half-Month
Moderate	Very High	Moderate	Moderate	Moderate	25	74.9	0.1	Middle Half-Month
Moderate	Very High	Moderate	Moderate	Long	0.1	40	59.9	Middle Date
Moderate	Very High	Moderate	Moderate	Longer	89.5	10.4	0.1	Middle Date
Moderate	Very High	Moderate	High	Shorter	99.8	0.1	0.1	Month
Moderate	Very High	Moderate	High	Short	25	74.9	0.1	Upper Date
Moderate	Very High	Moderate	High	Moderate	33.3	66.6	0.1	Middle Date
Moderate	Very High	Moderate	High	Long	0.1	40	59.9	Middle Date
Moderate	Very High	Moderate	High	Longer	79.8	20.1	0.1	Middle Date
Moderate	Very High	Moderate	Very High	Shorter	62.6	33	4.4	Middle Date
Moderate	Very High	Moderate	Very High	Short	83.2	16.7	0.1	Upper Date
Moderate	Very High	Moderate	Very High	Moderate	33.3	66.6	0.1	Middle Date
Moderate	Very High	Moderate	Very High	Long	0.1	40	59.9	Middle Date
Moderate	Very High	Moderate	Very High	Longer	0.1	40	59.9	Middle Half-Month
Moderate	Very High	High	Very Low	Shorter	0.1	99.8	0.1	Upper Date
Moderate	Very High	High	Very Low	Short	47.7	52.2	0.1	Interpolate

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
Moderate	Very High	High	Very Low	Moderate	49.95	49.95	0.1	Upper Date
Moderate	Very High	High	Very Low	Long	50	41.7	8.3	Upper Half-Month
Moderate	Very High	High	Very Low	Longer	48.6	43.6	7.8	Upper Half-Month
Moderate	Very High	High	Low	Shorter	99.8	0.1	0.1	Upper Date
Moderate	Very High	High	Low	Short	99.8	0.1	0.1	Middle Date
Moderate	Very High	High	Low	Moderate	0.1	99.8	0.1	Middle Date
Moderate	Very High	High	Low	Long	14.3	82.1	3.6	Middle Date
Moderate	Very High	High	Low	Longer	4.1	93.7	2.2	Middle Date
Moderate	Very High	High	Moderate	Shorter	49.95	49.95	0.1	Upper Date
Moderate	Very High	High	Moderate	Short	99.8	0.1	0.1	Middle Date
Moderate	Very High	High	Moderate	Moderate	0.1	79.9	20	Middle Date
Moderate	Very High	High	Moderate	Long	13	84.8	2.2	Middle Date
Moderate	Very High	High	Moderate	Longer	0.1	94.5	5.4	Middle Date
Moderate	Very High	High	High	Shorter	96.5	3.4	0.1	Upper Date
Moderate	Very High	High	High	Short	33.4	54.1	12.5	Upper Half-Month
Moderate	Very High	High	High	Moderate	0.1	93.4	6.5	Middle Date
Moderate	Very High	High	High	Long	15	80	5	Middle Date
Moderate	Very High	High	High	Longer	8.2	88.2	3.6	Middle Date
Moderate	Very High	High	Very High	Shorter	33.3	66.6	0.1	Upper Date
Moderate	Very High	High	Very High	Short	60.7	39.2	0.1	Upper Date
Moderate	Very High	High	Very High	Moderate	0.1	79.9	20	Middle Date
Moderate	Very High	High	Very High	Long	12.4	76.1	11.5	Middle Date
Moderate	Very High	High	Very High	Longer	0.1	79.9	20	Middle Date
High	Very Low	Low	Very Low	Shorter	99.8	0.1	0.1	Month
High	Very Low	Low	Very Low	Short	99.8	0.1	0.1	Month
High	Very Low	Low	Very Low	Moderate	90.4	9.5	0.1	Month
High	Very Low	Low	Very Low	Long	99.8	0.1	0.1	Date
High	Very Low	Low	Very Low	Longer	99.8	0.1	0.1	Date
High	Very Low	Low	Low	Shorter	99.8	0.1	0.1	Date
High	Very Low	Low	Low	Short	99.8	0.1	0.1	Date
High	Very Low	Low	Low	Moderate	80.3	19.6	0.1	Half-Month
High	Very Low	Low	Low	Long	25	74.9	0.1	Half-Month
High	Very Low	Low	Low	Longer	83.1	16.8	0.1	Date
High	Very Low	Low	Moderate	Shorter	74.6	25.3	0.1	Month
High	Very Low	Low	Moderate	Short	83	16.9	0.1	Month
High	Very Low	Low	Moderate	Moderate	99.8	0.1	0.1	Middle Half-Month
High	Very Low	Low	Moderate	Long	81	18.9	0.1	Interpolate
High	Very Low	Low	Moderate	Longer	61.6	38.3	0.1	Middle Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
High	Very Low	Low	High	Shorter	99.8	0.1	0.1	Middle Half-Month
High	Very Low	Low	High	Short	99.8	0.1	0.1	Middle Date
High	Very Low	Low	High	Moderate	99.8	0.1	0.1	Middle Half-Month
High	Very Low	Low	High	Long	88.3	11.6	0.1	Interpolate
High	Very Low	Low	High	Longer	42.2	57.7	0.1	Middle Date
High	Very Low	Low	Very High	Shorter	99.8	0.1	0.1	Middle Half-Month
High	Very Low	Low	Very High	Short	99.8	0.1	0.1	Middle Date
High	Very Low	Low	Very High	Moderate	99.8	0.1	0.1	Middle Half-Month
High	Very Low	Low	Very High	Long	99.8	0.1	0.1	Interpolate
High	Very Low	Low	Very High	Longer	28	47	25	Interpolate
High	Very Low	Moderate	Very Low	Shorter	99.8	0.1	0.1	Date
High	Very Low	Moderate	Very Low	Short	99.8	0.1	0.1	Half-Month
High	Very Low	Moderate	Very Low	Moderate	93.6	6.3	0.1	Date
High	Very Low	Moderate	Very Low	Long	79.9	20	0.1	Date
High	Very Low	Moderate	Very Low	Longer	99.8	0.1	0.1	Date
High	Very Low	Moderate	Low	Shorter	96.3	3.6	0.1	Date
High	Very Low	Moderate	Low	Short	99.8	0.1	0.1	Date
High	Very Low	Moderate	Low	Moderate	98.3	1.6	0.1	Date
High	Very Low	Moderate	Low	Long	85.9	14	0.1	Date
High	Very Low	Moderate	Low	Longer	53	46.9	0.1	Date
High	Very Low	Moderate	Moderate	Shorter	0.1	99.8	0.1	Date
High	Very Low	Moderate	Moderate	Short	99.8	0.1	0.1	Half-Month
High	Very Low	Moderate	Moderate	Moderate	99.8	0.1	0.1	Date
High	Very Low	Moderate	Moderate	Long	99.8	0.1	0.1	Month
High	Very Low	Moderate	Moderate	Longer	99.8	0.1	0.1	Month
High	Very Low	Moderate	High	Shorter	99.8	0.1	0.1	Half-Month
High	Very Low	Moderate	High	Short	99.8	0.1	0.1	Month
High	Very Low	Moderate	High	Moderate	40	59.9	0.1	Half-Month
High	Very Low	Moderate	High	Long	99.8	0.1	0.1	Month
High	Very Low	Moderate	High	Longer	70	29.9	0.1	Middle Date
High	Very Low	Moderate	Very High	Shorter	99.8	0.1	0.1	Month
High	Very Low	Moderate	Very High	Short	99.8	0.1	0.1	Half-Month
High	Very Low	Moderate	Very High	Moderate	99.8	0.1	0.1	Date
High	Very Low	Moderate	Very High	Long	99.8	0.1	0.1	Month
High	Very Low	Moderate	Very High	Longer	0.1	40	59.9	Middle Half-Month
High	Very Low	High	Very Low	Shorter	99.8	0.1	0.1	Date
High	Very Low	High	Very Low	Short	99.8	0.1	0.1	Date
High	Very Low	High	Very Low	Moderate	99.8	0.1	0.1	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
High	Very Low	High	Very Low	Long	96.5	3.4	0.1	Date
High	Very Low	High	Very Low	Longer	99.8	0.1	0.1	Date
High	Very Low	High	Low	Shorter	97	2.9	0.1	Date
High	Very Low	High	Low	Short	99.8	0.1	0.1	Date
High	Very Low	High	Low	Moderate	99.8	0.1	0.1	Date
High	Very Low	High	Low	Long	95.9	4	0.1	Date
High	Very Low	High	Low	Longer	92.7	7.2	0.1	Date
High	Very Low	High	Moderate	Shorter	99.8	0.1	0.1	Date
High	Very Low	High	Moderate	Short	99.8	0.1	0.1	Date
High	Very Low	High	Moderate	Moderate	99.8	0.1	0.1	Date
High	Very Low	High	Moderate	Long	99.8	0.1	0.1	Half-Month
High	Very Low	High	Moderate	Longer	88	11.9	0.1	Month
High	Very Low	High	High	Shorter	99.8	0.1	0.1	Half-Month
High	Very Low	High	High	Short	99.8	0.1	0.1	Date
High	Very Low	High	High	Moderate	99.8	0.1	0.1	Half-Month
High	Very Low	High	High	Long	99.8	0.1	0.1	Date
High	Very Low	High	High	Longer	31.1	68.8	0.1	Middle Date
High	Very Low	High	Very High	Shorter	85.6	14.3	0.1	Half-Month
High	Very Low	High	Very High	Short	85.6	14.3	0.1	Half-Month
High	Very Low	High	Very High	Moderate	99.8	0.1	0.1	Date
High	Very Low	High	Very High	Long	98	1.9	0.1	Half-Month
High	Very Low	High	Very High	Longer	0.1	40	59.9	Middle Half-Month
High	Low	Low	Very Low	Shorter	99.8	0.1	0.1	Half-Month
High	Low	Low	Very Low	Short	99.8	0.1	0.1	Date
High	Low	Low	Very Low	Moderate	48.4	26	25.6	Half-Month
High	Low	Low	Very Low	Long	99.8	0.1	0.1	Date
High	Low	Low	Very Low	Longer	85.2	14.7	0.1	Date
High	Low	Low	Low	Shorter	99.8	0.1	0.1	Date
High	Low	Low	Low	Short	99.8	0.1	0.1	Date
High	Low	Low	Low	Moderate	99.6	0.1	0.3	Date
High	Low	Low	Low	Long	89.9	10	0.1	Half-Month
High	Low	Low	Low	Longer	56.8	43.1	0.1	Date
High	Low	Low	Moderate	Shorter	99.8	0.1	0.1	Half-Month
High	Low	Low	Moderate	Short	13.3	40	46.7	Half-Month
High	Low	Low	Moderate	Moderate	99.8	0.1	0.1	Date
High	Low	Low	Moderate	Long	99.8	0.1	0.1	Half-Month
High	Low	Low	Moderate	Longer	0.1	99.8	0.1	Date
High	Low	Low	High	Shorter	83.2	16.7	0.1	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
High	Low	Low	High	Short	68.1	31.8	0.1	Month
High	Low	Low	High	Moderate	99.8	0.1	0.1	Date
High	Low	Low	High	Long	99.8	0.1	0.1	Half-Month
High	Low	Low	High	Longer	0.1	99.8	0.1	Date
High	Low	Low	Very High	Shorter	83.2	16.7	0.1	Date
High	Low	Low	Very High	Short	99.8	0.1	0.1	Date
High	Low	Low	Very High	Moderate	99.8	0.1	0.1	Month
High	Low	Low	Very High	Long	99.8	0.1	0.1	Month
High	Low	Low	Very High	Longer	49.95	49.95	0.1	Date
High	Low	Moderate	Very Low	Shorter	99.8	0.1	0.1	Date
High	Low	Moderate	Very Low	Short	99.8	0.1	0.1	Date
High	Low	Moderate	Very Low	Moderate	99.8	0.1	0.1	Date
High	Low	Moderate	Very Low	Long	65.5	34.4	0.1	Date
High	Low	Moderate	Very Low	Longer	97.5	2.4	0.1	Date
High	Low	Moderate	Low	Shorter	83	9.3	7.7	Date
High	Low	Moderate	Low	Short	99.8	0.1	0.1	Date
High	Low	Moderate	Low	Moderate	98.4	0.1	1.5	Date
High	Low	Moderate	Low	Long	45.5	54.4	0.1	Date
High	Low	Moderate	Low	Longer	74.8	25.1	0.1	Date
High	Low	Moderate	Moderate	Shorter	0.1	99.8	0.1	Date
High	Low	Moderate	Moderate	Short	13.3	40	46.7	Half-Month
High	Low	Moderate	Moderate	Moderate	99.8	0.1	0.1	Date
High	Low	Moderate	Moderate	Long	99.8	0.1	0.1	Month
High	Low	Moderate	Moderate	Longer	99.8	0.1	0.1	Month
High	Low	Moderate	High	Shorter	33.3	66.6	0.1	Date
High	Low	Moderate	High	Short	46.2	43.7	10.1	Month
High	Low	Moderate	High	Moderate	63	36.9	0.1	Month
High	Low	Moderate	High	Long	83.3	16.6	0.1	Month
High	Low	Moderate	High	Longer	99.8	0.1	0.1	Date
High	Low	Moderate	Very High	Shorter	99.8	0.1	0.1	Half-Month
High	Low	Moderate	Very High	Short	99.8	0.1	0.1	Date
High	Low	Moderate	Very High	Moderate	75	24.9	0.1	Interpolate
High	Low	Moderate	Very High	Long	79.9	20	0.1	Half-Month
High	Low	Moderate	Very High	Longer	79.9	20	0.1	Half-Month
High	Low	High	Very Low	Shorter	98	1.9	0.1	Date
High	Low	High	Very Low	Short	99.8	0.1	0.1	Date
High	Low	High	Very Low	Moderate	99.8	0.1	0.1	Date
High	Low	High	Very Low	Long	69.8	30.1	0.1	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
High	Low	High	Very Low	Longer	99.8	0.1	0.1	Date
High	Low	High	Low	Shorter	97.8	2.1	0.1	Date
High	Low	High	Low	Short	99.8	0.1	0.1	Date
High	Low	High	Low	Moderate	99.8	0.1	0.1	Date
High	Low	High	Low	Long	68.4	31.5	0.1	Date
High	Low	High	Low	Longer	99.8	0.1	0.1	Date
High	Low	High	Moderate	Shorter	99.8	0.1	0.1	Date
High	Low	High	Moderate	Short	99.8	0.1	0.1	Date
High	Low	High	Moderate	Moderate	99.8	0.1	0.1	Date
High	Low	High	Moderate	Long	99.8	0.1	0.1	Half-Month
High	Low	High	Moderate	Longer	88	11.9	0.1	Month
High	Low	High	High	Shorter	96.9	3	0.1	Half-Month
High	Low	High	High	Short	99.8	0.1	0.1	Date
High	Low	High	High	Moderate	99.8	0.1	0.1	Half-Month
High	Low	High	High	Long	99.8	0.1	0.1	Month
High	Low	High	High	Longer	19.2	75.3	5.5	Middle Date
High	Low	High	Very High	Shorter	99.8	0.1	0.1	Date
High	Low	High	Very High	Short	40	59.9	0.1	Middle Date
High	Low	High	Very High	Moderate	40	59.9	0.1	Middle Half-Month
High	Low	High	Very High	Long	23.9	68.3	7.8	Middle Half-Month
High	Low	High	Very High	Longer	26.3	62.5	11.2	Middle Date
High	Moderate	Low	Very Low	Shorter	99.8	0.1	0.1	Half-Month
High	Moderate	Low	Very Low	Short	70.3	12.1	17.6	Half-Month
High	Moderate	Low	Very Low	Moderate	58.6	17.2	24.2	Half-Month
High	Moderate	Low	Very Low	Long	90.8	9.1	0.1	Half-Month
High	Moderate	Low	Very Low	Longer	47.3	52.6	0.1	Date
High	Moderate	Low	Low	Shorter	85.3	14.6	0.1	Date
High	Moderate	Low	Low	Short	0.1	99.8	0.1	Date
High	Moderate	Low	Low	Moderate	25	0.1	74.9	Date
High	Moderate	Low	Low	Long	56.2	43.7	0.1	Half-Month
High	Moderate	Low	Low	Longer	46.3	53.6	0.1	Date
High	Moderate	Low	Moderate	Shorter	51.8	48.1	0.1	Date
High	Moderate	Low	Moderate	Short	40.6	59.3	0.1	Half-Month
High	Moderate	Low	Moderate	Moderate	10.5	31.6	57.9	Month
High	Moderate	Low	Moderate	Long	49.95	49.95	0.1	Month
High	Moderate	Low	Moderate	Longer	46.8	53.1	0.1	Date
High	Moderate	Low	High	Shorter	42.6	57.3	0.1	Date
High	Moderate	Low	High	Short	33.3	66.6	0.1	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
High	Moderate	Low	High	Moderate	54.5	18.2	27.3	Half-Month
High	Moderate	Low	High	Long	62.3	19.3	18.4	Month
High	Moderate	Low	High	Longer	14.7	85.2	0.1	Date
High	Moderate	Low	Very High	Shorter	55.5	44.4	0.1	Date
High	Moderate	Low	Very High	Short	67.3	13.1	19.6	Half-Month
High	Moderate	Low	Very High	Moderate	54.5	18.2	27.3	Half-Month
High	Moderate	Low	Very High	Long	61.7	20.7	17.6	Month
High	Moderate	Low	Very High	Longer	49.95	49.95	0.1	Date
High	Moderate	Moderate	Very Low	Shorter	99.8	0.1	0.1	Half-Month
High	Moderate	Moderate	Very Low	Short	99.8	0.1	0.1	Half-Month
High	Moderate	Moderate	Very Low	Moderate	33.3	66.6	0.1	Date
High	Moderate	Moderate	Very Low	Long	99.8	0.1	0.1	Date
High	Moderate	Moderate	Very Low	Longer	99.8	0.1	0.1	Date
High	Moderate	Moderate	Low	Shorter	96.3	1.5	2.2	Date
High	Moderate	Moderate	Low	Short	99.8	0.1	0.1	Half-Month
High	Moderate	Moderate	Low	Moderate	89.9	10	0.1	Date
High	Moderate	Moderate	Low	Long	72.6	27.3	0.1	Half-Month
High	Moderate	Moderate	Low	Longer	74.4	25.5	0.1	Date
High	Moderate	Moderate	Moderate	Shorter	99.8	0.1	0.1	Date
High	Moderate	Moderate	Moderate	Short	55.4	27	17.6	Month
High	Moderate	Moderate	Moderate	Moderate	99.8	0.1	0.1	Date
High	Moderate	Moderate	Moderate	Long	70	18	12	Middle Date
High	Moderate	Moderate	Moderate	Longer	27.8	72.1	0.1	Middle Date
High	Moderate	Moderate	High	Shorter	33.3	66.6	0.1	Date
High	Moderate	Moderate	High	Short	78.3	17.6	4.1	Month
High	Moderate	Moderate	High	Moderate	40	59.9	0.1	Half-Month
High	Moderate	Moderate	High	Long	90.8	9.1	0.1	Month
High	Moderate	Moderate	High	Longer	99.8	0.1	0.1	Date
High	Moderate	Moderate	Very High	Shorter	99.8	0.1	0.1	Half-Month
High	Moderate	Moderate	Very High	Short	99.8	0.1	0.1	Half-Month
High	Moderate	Moderate	Very High	Moderate	42.7	42.7	14.6	Interpolate
High	Moderate	Moderate	Very High	Long	0.1	40	59.9	Middle Date
High	Moderate	Moderate	Very High	Longer	0.1	40	59.9	Middle Half-Month
High	Moderate	High	Very Low	Shorter	99.8	0.1	0.1	Half-Month
High	Moderate	High	Very Low	Short	94.3	5.6	0.1	Month
High	Moderate	High	Very Low	Moderate	66.6	33.3	0.1	Month
High	Moderate	High	Very Low	Long	68.2	30.4	1.4	Interpolate
High	Moderate	High	Very Low	Longer	75	22.9	2.1	Interpolate

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
High	Moderate	High	Low	Shorter	75.1	24.8	0.1	Half-Month
High	Moderate	High	Low	Short	94.3	5.6	0.1	Month
High	Moderate	High	Low	Moderate	66.6	33.3	0.1	Month
High	Moderate	High	Low	Long	69.4	30.4	0.2	Middle Date
High	Moderate	High	Low	Longer	72.1	25.6	2.3	Middle Date
High	Moderate	High	Moderate	Shorter	45.5	54.4	0.1	Half-Month
High	Moderate	High	Moderate	Short	67.1	26.9	6	Middle Date
High	Moderate	High	Moderate	Moderate	57.3	41	1.7	Middle Date
High	Moderate	High	Moderate	Long	54.4	45.1	0.5	Middle Date
High	Moderate	High	Moderate	Longer	36.4	56.3	7.3	Middle Date
High	Moderate	High	High	Shorter	99.8	0.1	0.1	Half-Month
High	Moderate	High	High	Short	48.7	42.5	8.8	Middle Date
High	Moderate	High	High	Moderate	54.2	45.2	0.6	Middle Date
High	Moderate	High	High	Long	26.5	72.9	0.6	Middle Date
High	Moderate	High	High	Longer	4.3	78.5	17.2	Middle Date
High	Moderate	High	Very High	Shorter	66.6	33.3	0.1	Month
High	Moderate	High	Very High	Short	40	59.9	0.1	Middle Date
High	Moderate	High	Very High	Moderate	28.6	71.3	0.1	Middle Date
High	Moderate	High	Very High	Long	0.1	40	59.9	Middle Date
High	Moderate	High	Very High	Longer	6.9	75.4	17.7	Middle Date
High	High	Low	Very Low	Shorter	99.8	0.1	0.1	Date
High	High	Low	Very Low	Short	25.3	34.1	40.6	Half-Month
High	High	Low	Very Low	Moderate	47.8	23.5	28.7	Half-Month
High	High	Low	Very Low	Long	90.8	9.1	0.1	Half-Month
High	High	Low	Very Low	Longer	99.6	0.3	0.1	Date
High	High	Low	Low	Shorter	72.3	27.6	0.1	Date
High	High	Low	Low	Short	0.1	99.8	0.1	Date
High	High	Low	Low	Moderate	25.9	0.1	74	Date
High	High	Low	Low	Long	99.8	0.1	0.1	Date
High	High	Low	Low	Longer	75.2	24.7	0.1	Date
High	High	Low	Moderate	Shorter	69.1	30.8	0.1	Date
High	High	Low	Moderate	Short	38.7	38.6	22.7	Half-Month
High	High	Low	Moderate	Moderate	15.2	45.5	39.3	Half-Month
High	High	Low	Moderate	Long	0.1	99.8	0.1	Half-Month
High	High	Low	Moderate	Longer	61	38.9	0.1	Date
High	High	Low	High	Shorter	49.8	50.1	0.1	Date
High	High	Low	High	Short	33.3	66.6	0.1	Date
High	High	Low	High	Moderate	52.5	22.2	25.3	Half-Month

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
High	High	Low	High	Long	62.4	19.1	18.5	Month
High	High	Low	High	Longer	16.1	83.8	0.1	Date
High	High	Low	Very High	Shorter	42.8	57.1	0.1	Middle Date
High	High	Low	Very High	Short	54.5	18.2	27.3	Half-Month
High	High	Low	Very High	Moderate	54.5	18.2	27.3	Half-Month
High	High	Low	Very High	Long	61.9	20.1	18	Month
High	High	Low	Very High	Longer	57.1	32.2	10.7	Month
High	High	Moderate	Very Low	Shorter	0.1	49.95	49.95	Half-Month
High	High	Moderate	Very Low	Short	13.3	40	46.7	Half-Month
High	High	Moderate	Very Low	Moderate	15.4	41.5	43.1	Half-Month
High	High	Moderate	Very Low	Long	71.7	28.2	0.1	Half-Month
High	High	Moderate	Very Low	Longer	99.8	0.1	0.1	Date
High	High	Moderate	Low	Shorter	99.8	0.1	0.1	Date
High	High	Moderate	Low	Short	13.3	40	46.7	Half-Month
High	High	Moderate	Low	Moderate	49.95	0.1	49.95	Date
High	High	Moderate	Low	Long	72.6	27.3	0.1	Half-Month
High	High	Moderate	Low	Longer	89.1	10.8	0.1	Date
High	High	Moderate	Moderate	Shorter	8.8	45.6	45.6	Date
High	High	Moderate	Moderate	Short	13.3	40	46.7	Half-Month
High	High	Moderate	Moderate	Moderate	18.7	44	37.3	Half-Month
High	High	Moderate	Moderate	Long	41.4	48.3	10.3	Middle Date
High	High	Moderate	Moderate	Longer	26.5	73.4	0.1	Middle Date
High	High	Moderate	High	Shorter	0.1	49.95	49.95	Date
High	High	Moderate	High	Short	78.3	17.6	4.1	Month
High	High	Moderate	High	Moderate	40	59.9	0.1	Half-Month
High	High	Moderate	High	Long	38.1	47.6	14.3	Middle Date
High	High	Moderate	High	Longer	30.9	69	0.1	Middle Date
High	High	Moderate	Very High	Shorter	0.1	49.95	49.95	Half-Month
High	High	Moderate	Very High	Short	37.5	62.4	0.1	Upper Half-Month
High	High	Moderate	Very High	Moderate	30.9	54.5	14.6	Interpolate
High	High	Moderate	Very High	Long	0.1	40	59.9	Middle Date
High	High	Moderate	Very High	Longer	0.1	40	59.9	Middle Half-Month
High	High	High	Very Low	Shorter	99.8	0.1	0.1	Date
High	High	High	Very Low	Short	78.7	12	9.3	Interpolate
High	High	High	Very Low	Moderate	42.7	47	10.3	Interpolate
High	High	High	Very Low	Long	52.8	47.1	0.1	Month
High	High	High	Very Low	Longer	52.8	47.1	0.1	Month
High	High	High	Low	Shorter	99.8	0.1	0.1	Date

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
High	High	High	Low	Short	85.6	14.3	0.1	Middle Date
High	High	High	Low	Moderate	28.6	71.3	0.1	Middle Date
High	High	High	Low	Long	52.8	47.1	0.1	Month
High	High	High	Low	Longer	52.8	47.1	0.1	Month
High	High	High	Moderate	Shorter	99.8	0.1	0.1	Date
High	High	High	Moderate	Short	66.7	33.2	0.1	Middle Date
High	High	High	Moderate	Moderate	28.6	71.3	0.1	Middle Date
High	High	High	Moderate	Long	28.8	70.3	0.9	Middle Date
High	High	High	Moderate	Longer	32.9	61.6	5.5	Middle Date
High	High	High	High	Shorter	8.7	91.2	0.1	Middle Date
High	High	High	High	Short	45.7	54.2	0.1	Middle Date
High	High	High	High	Moderate	28.6	71.3	0.1	Middle Date
High	High	High	High	Long	21.3	78.3	0.4	Middle Date
High	High	High	High	Longer	8.4	78.8	12.8	Middle Date
High	High	High	Very High	Shorter	17.5	82.4	0.1	Middle Half-Month
High	High	High	Very High	Short	40	59.9	0.1	Middle Date
High	High	High	Very High	Moderate	28.6	71.3	0.1	Middle Date
High	High	High	Very High	Long	0.1	40	59.9	Middle Date
High	High	High	Very High	Longer	9.8	73.5	16.7	Middle Date
High	Very High	Low	Very Low	Shorter	99.8	0.1	0.1	Date
High	Very High	Low	Very Low	Short	99.8	0.1	0.1	Month
High	Very High	Low	Very Low	Moderate	99.8	0.1	0.1	Month
High	Very High	Low	Very Low	Long	99.8	0.1	0.1	Month
High	Very High	Low	Very Low	Longer	71.9	28	0.1	Date
High	Very High	Low	Low	Shorter	99.8	0.1	0.1	Date
High	Very High	Low	Low	Short	33.3	66.6	0.1	Half-Month
High	Very High	Low	Low	Moderate	33.3	66.6	0.1	Half-Month
High	Very High	Low	Low	Long	99.8	0.1	0.1	Date
High	Very High	Low	Low	Longer	48.4	51.5	0.1	Date
High	Very High	Low	Moderate	Shorter	48.1	51.8	0.1	Date
High	Very High	Low	Moderate	Short	25	74.9	0.1	Half-Month
High	Very High	Low	Moderate	Moderate	25	74.9	0.1	Half-Month
High	Very High	Low	Moderate	Long	99.8	0.1	0.1	Month
High	Very High	Low	Moderate	Longer	28.5	71.4	0.1	Date
High	Very High	Low	High	Shorter	54.9	45	0.1	Date
High	Very High	Low	High	Short	25	74.9	0.1	Half-Month
High	Very High	Low	High	Moderate	25	74.9	0.1	Half-Month
High	Very High	Low	High	Long	39.4	47.5	13.1	Interpolate

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
High	Very High	Low	High	Longer	15.4	84.5	0.1	Middle Date
High	Very High	Low	Very High	Shorter	0.1	99.8	0.1	Middle Date
High	Very High	Low	Very High	Short	0.1	99.8	0.1	Middle Half-Month
High	Very High	Low	Very High	Moderate	0.1	99.8	0.1	Middle Half-Month
High	Very High	Low	Very High	Long	22.1	62.3	15.6	Interpolate
High	Very High	Low	Very High	Longer	15.4	84.5	0.1	Middle Date
High	Very High	Moderate	Very Low	Shorter	99.8	0.1	0.1	Month
High	Very High	Moderate	Very Low	Short	99.8	0.1	0.1	Month
High	Very High	Moderate	Very Low	Moderate	66.3	22.9	10.8	Interpolate
High	Very High	Moderate	Very Low	Long	55.4	27.5	17.1	Interpolate
High	Very High	Moderate	Very Low	Longer	66.4	31.5	2.1	Interpolate
High	Very High	Moderate	Low	Shorter	99.8	0.1	0.1	Half-Month
High	Very High	Moderate	Low	Short	99.8	0.1	0.1	Half-Month
High	Very High	Moderate	Low	Moderate	45.8	26.7	27.5	Interpolate
High	Very High	Moderate	Low	Long	0.1	40	59.9	Middle Date
High	Very High	Moderate	Low	Longer	43.8	56.1	0.1	Month
High	Very High	Moderate	Moderate	Shorter	99.8	0.1	0.1	Month
High	Very High	Moderate	Moderate	Short	37.5	62.4	0.1	Upper Half-Month
High	Very High	Moderate	Moderate	Moderate	21.2	59.3	19.5	Interpolate
High	Very High	Moderate	Moderate	Long	0.1	40	59.9	Middle Date
High	Very High	Moderate	Moderate	Longer	0.1	40	59.9	Middle Half-Month
High	Very High	Moderate	High	Shorter	99.8	0.1	0.1	Month
High	Very High	Moderate	High	Short	25	74.9	0.1	Upper Date
High	Very High	Moderate	High	Moderate	24.7	63.3	12	Interpolate
High	Very High	Moderate	High	Long	0.1	40	59.9	Middle Date
High	Very High	Moderate	High	Longer	0.1	40	59.9	Middle Half-Month
High	Very High	Moderate	Very High	Shorter	37.5	62.4	0.1	Upper Half-Month
High	Very High	Moderate	Very High	Short	37.5	62.4	0.1	Upper Half-Month
High	Very High	Moderate	Very High	Moderate	17.7	67.3	15	Interpolate
High	Very High	Moderate	Very High	Long	0.1	40	59.9	Middle Date
High	Very High	Moderate	Very High	Longer	0.1	40	59.9	Middle Half-Month
High	Very High	High	Very Low	Shorter	99.8	0.1	0.1	Month
High	Very High	High	Very Low	Short	99.8	0.1	0.1	Month
High	Very High	High	Very Low	Moderate	74.9	25	0.1	Interpolate
High	Very High	High	Very Low	Long	39.4	57.4	3.2	Interpolate
High	Very High	High	Very Low	Longer	33.8	56.9	9.3	Interpolate
High	Very High	High	Low	Shorter	99.8	0.1	0.1	Month
High	Very High	High	Low	Short	99.8	0.1	0.1	Month

secchi	totaln	wtemp	totalp	resid30	chlaeco: Low	chlaeco: Moderate	chlaeco: High	Match Method
High	Very High	High	Low	Moderate	36	63.7	0.3	Interpolate
High	Very High	High	Low	Long	15.4	83.2	1.4	Middle Date
High	Very High	High	Low	Longer	0.1	79.9	20	Middle Date
High	Very High	High	Moderate	Shorter	99.8	0.1	0.1	Month
High	Very High	High	Moderate	Short	99.8	0.1	0.1	Middle Date
High	Very High	High	Moderate	Moderate	36	58.2	5.8	Interpolate
High	Very High	High	Moderate	Long	15.2	81.4	3.4	Middle Date
High	Very High	High	Moderate	Longer	0.1	79.9	20	Middle Date
High	Very High	High	High	Shorter	99.8	0.1	0.1	Month
High	Very High	High	High	Short	60.8	36.7	2.5	Interpolate
High	Very High	High	High	Moderate	15	82.4	2.6	Interpolate
High	Very High	High	High	Long	16.4	82.3	1.3	Middle Date
High	Very High	High	High	Longer	0.1	79.9	20	Middle Date
High	Very High	High	Very High	Shorter	47.1	52.8	0.1	Interpolate
High	Very High	High	Very High	Short	46.1	53.8	0.1	Interpolate
High	Very High	High	Very High	Moderate	9.5	63.8	26.7	Interpolate
High	Very High	High	Very High	Long	0.1	40	59.9	Middle Date
High	Very High	High	Very High	Longer	0.1	79.9	20	Middle Date

6.6 Chlorophyl-A Regulatory (chlareg, ug/L) – All Segments

Conditioned on:

- Total Algal Biovolume (totbiovman, mm3/m3)

Upper:

totbiovman	chlareg: Not Exceed	chlareg: Exceed	Match Method
Very Low	81.8	18.2	Date
Low	62.7	37.3	Date
Bloom	61.4	38.6	Date
Large Bloom	30.3	69.7	Date

Middle:

totbiovman	chlareg: Not Exceed	chlareg: Exceed	Match Method
Very Low	92.1	7.9	Date
Low	86	14	Date
Bloom	71.5	28.5	Date

Large Bloom	76	24	Date

Lower:

totbiovman	chlareg: Not Exceed	chlareg: Exceed	Match Method
Very Low	97.7	2.3	Date
Low	92.7	7.3	Date
Bloom	88.6	11.4	Date
Large Bloom	84.1	15.9	Date

6.7 Cylindrospermopsin (cyltotreg, ug/L) – Three Lake Segments

Conditioned on:

- Blue-Green Algae Biovolume (bgbioveco, mm3/m3)

Upper:

bgbioveco	cyltotreg: BD	cyltotreg: Low	cyltotreg: Moderate	cyltotreg: High	Match Method
Low	99.7	0.1	0.1	0.1	Date
Moderate	99.7	0.1	0.1	0.1	Date
High	99.7	0.1	0.1	0.1	Interpolate

Middle:

bgbioveco	cyltotreg: BD	cyltotreg: Low	cyltotreg: Moderate	cyltotreg: High	Match Method
Low	97.8	2	0.1	0.1	Date
Moderate	49.9	49.9	0.1	0.1	Date
High	69.8	30	0.1	0.1	Date

Lower:

bgbioveco	cyltotreg: BD	cyltotreg: Low	cyltotreg: Moderate	cyltotreg: High	Match Method
Low	72.9	26.9	0.1	0.1	Date
Moderate	99.7	0.1	0.1	0.1	Date
High	99.7	0.1	0.1	0.1	Month

6.8 Dominant Algae Type by Biovolume (dombiov, mm3/m3) – Three Lake Segments

Conditioned on:

- Water Temperature (wtemp, C)
- Total Algal Biovolume (totbiovman, mm3/m3)
- Chlarophyll-A Ecological (chlaeco, ug/L)
- N:P Molar Ratio (npratio, mol)

Upper:

wtemp	totbiovman	chlaeco	npratio	dombiov: Diatoms	dombiov: Green	dombiov: Blue-Green	dombiov: Euglenophyta	dombiov: Prymnesiophyta	dombiov: Other	Match Method
Low	Very Low	Low	Low	28.4	0.1	0.1	50.4	12.1	8.9	Date
Low	Very Low	Low	Moderate	3.9	0.1	0.1	33.3	62.5	0.1	Date
Low	Very Low	Low	High	63.2	0.1	0.1	36.4	0.1	0.1	Date
Low	Very Low	Moderate	Low	5.8	2.2	0.1	69.1	7.6	15.2	Date
Low	Very Low	Moderate	Moderate	0.1	4.5	0.1	0.1	77.2	18	Date
Low	Very Low	Moderate	High	2.5	0.1	0.1	0.1	97.1	0.1	Middle Date
Low	Very Low	High	Low	41.9	0.1	0.1	57.7	0.1	0.1	Date
Low	Very Low	High	Moderate	0.1	99.5	0.1	0.1	0.1	0.1	Half-Month
Low	Very Low	High	High	0.8	33.3	0.1	0.1	65.6	0.1	Interpolate
Low	Low	Low	Low	13.7	0.1	0.1	28.8	0.1	57.2	Date
Low	Low	Low	Moderate	99.5	0.1	0.1	0.1	0.1	0.1	Date
Low	Low	Low	High	99.5	0.1	0.1	0.1	0.1	0.1	Date
Low	Low	Moderate	Low	21	0.1	0.1	3.7	2.9	72.2	Date
Low	Low	Moderate	Moderate	45.5	0.1	0.1	54.1	0.1	0.1	Date
Low	Low	Moderate	High	99.5	0.1	0.1	0.1	0.1	0.1	Half-Month
Low	Low	High	Low	99.5	0.1	0.1	0.1	0.1	0.1	Date
Low	Low	High	Moderate	90.1	0.1	5.4	0.1	0.1	4.2	Month
Low	Low	High	High	0.1	0.1	0.1	0.1	99.5	0.1	Middle Date
Low	Bloom	Low	Low	80.6	0.1	0.1	19	0.1	0.1	Date
Low	Bloom	Low	Moderate	91.4	0.1	0.1	8.2	0.1	0.1	Date

wtemp	totbiov man	chlaec o	nprati o	dombi ov: Diato ms	dombi ov: Green	dombio v: Blue-Green	dombiov: Euglenop hyta	dombiov: Prymnesiop hyta	dombi ov: Other	Match Method
Low	Bloom	Low	High	37.7	0.1	8.7	0.1	21.9	31.5	Middle Date
Low	Bloom	Moder ate	Low	48.9	0.1	0.1	23.7	13	14.2	Date
Low	Bloom	Moder ate	Moder ate	72.5	0.1	0.1	2.7	0.1	24.5	Date
Low	Bloom	Moder ate	High	56.9	0.1	1	0.1	0.1	41.8	Middle Date
Low	Bloom	High	Low	60.9	0.1	0.1	38.7	0.1	0.1	Date
Low	Bloom	High	Moder ate	99.5	0.1	0.1	0.1	0.1	0.1	Date
Low	Bloom	High	High	0.1	0.1	0.1	0.1	99.5	0.1	Lower Date
Low	Large Bloom	Low	Low	30	0.1	0.1	69.6	0.1	0.1	Date
Low	Large Bloom	Low	Moder ate	99.5	0.1	0.1	0.1	0.1	0.1	Month
Low	Large Bloom	Low	High	46	0.1	14	0.1	30.3	9.5	Middle Date
Low	Large Bloom	Moder ate	Low	99.5	0.1	0.1	0.1	0.1	0.1	Date
Low	Large Bloom	Moder ate	Moder ate	99.5	0.1	0.1	0.1	0.1	0.1	Month
Low	Large Bloom	Moder ate	High	15.5	0.1	3.1	0.1	11.6	69.6	Middle Date
Low	Large Bloom	High	Low	11.6	0.1	0.1	86.5	1.6	0.1	Date
Low	Large Bloom	High	Moder ate	99.5	0.1	0.1	0.1	0.1	0.1	Month
Low	Large Bloom	High	High	28.9	0.1	0.8	0.1	52.7	17.4	Interpolate
Moder ate	Very Low	Low	Low	42.9	0.1	0.1	56.7	0.1	0.1	Date
Moder ate	Very Low	Low	Moder ate	49.8	0.1	0.1	49.8	0.1	0.1	Month
Moder ate	Very Low	Low	High	0.1	0.1	51.9	0.1	39.5	8.3	Middle Date
Moder ate	Very Low	Moder ate	Low	0.1	45.1	0.1	45.3	0.1	9.3	Date
Moder ate	Very Low	Moder ate	Moder ate	0.1	32	6.2	4.3	39.8	17.6	Middle Date
Moder ate	Very Low	Moder ate	High	0.1	0.1	79.4	0.1	0.1	20.2	Middle Date

wtemp	totbiovman	chlaeco	npratio	dombiov: Diatoms	dombiov: Green	dombiov: Blue-Green	dombiov: Euglenophyta	dombiov: Prymnesiophyta	dombiov: Other	Match Method
Moderate	Very Low	High	Low	19	31	0.1	49.7	0.1	0.1	Date
Moderate	Very Low	High	Moderate	49.8	0.1	0.1	49.8	0.1	0.1	Month
Moderate	Very Low	High	High	16.7	0.1	26.6	16.7	0.1	39.8	Interpolate
Moderate	Low	Low	Low	52.2	0.1	6.6	14.8	0.1	26.2	Date
Moderate	Low	Low	Moderate	22.2	0.1	66.4	0.1	11.1	0.1	Date
Moderate	Low	Low	High	99.5	0.1	0.1	0.1	0.1	0.1	Date
Moderate	Low	Moderate	Low	7.6	12	4	76.2	0.1	0.1	Date
Moderate	Low	Moderate	Moderate	0.1	0.1	17.6	0.1	82	0.1	Date
Moderate	Low	Moderate	High	0.5	0.1	0.1	0.1	99.1	0.1	Half-Month
Moderate	Low	High	Low	0.1	13.6	0.1	86	0.1	0.1	Date
Moderate	Low	High	Moderate	0.1	0.1	0.1	0.1	99.5	0.1	Half-Month
Moderate	Low	High	High	0.1	0.1	0.1	0.1	0.1	99.5	Middle Date
Moderate	Bloom	Low	Low	0.1	0.1	0.1	0.1	99.5	0.1	Date
Moderate	Bloom	Low	Moderate	0.1	0.1	0.1	0.1	78.4	21.2	Half-Month
Moderate	Bloom	Low	High	18.9	0.1	0.1	0.1	80.7	0.1	Middle Date
Moderate	Bloom	Moderate	Low	33.2	0.1	1.4	43.4	21.8	0.1	Date
Moderate	Bloom	Moderate	Moderate	0.1	0.1	0.1	0.1	99.5	0.1	Date
Moderate	Bloom	Moderate	High	2.1	0.1	36.8	0.1	60.8	0.1	Middle Date
Moderate	Bloom	High	Low	0.1	0.1	0.1	95.7	3.9	0.1	Date
Moderate	Bloom	High	Moderate	0.1	0.1	0.1	0.1	33.3	66.3	Half-Month
Moderate	Bloom	High	High	0.1	0.1	99.5	0.1	0.1	0.1	Middle Date
Moderate	Large Bloom	Low	Low	49.8	0.1	0.1	49.8	0.1	0.1	Date

wtemp	totbiovman	chlaeco	npratio	dombiov: Diatoms	dombiov: Green	dombiov: Blue-Green	dombiov: Euglenophyta	dombiov: Prymnesiophyta	dombiov: Other	Match Method
Moderate	Large Bloom	Low	Moderate	0.1	0.1	0.1	0.1	35.2	64.4	Half-Month
Moderate	Large Bloom	Low	High	0.1	0.1	18	0.8	60.1	20.9	Middle Date
Moderate	Large Bloom	Moderate	Low	4.4	0.1	1.5	48	5.9	40.1	Date
Moderate	Large Bloom	Moderate	Moderate	74.6	0.1	0.1	0.1	25	0.1	Date
Moderate	Large Bloom	Moderate	High	0.1	0.1	50.4	13.3	11.1	25	Middle Date
Moderate	Large Bloom	High	Low	4	0.1	0.1	54.6	4.5	36.7	Date
Moderate	Large Bloom	High	Moderate	0.1	0.1	0.1	0.1	99.5	0.1	Date
Moderate	Large Bloom	High	High	0.1	0.1	0.1	0.1	99.5	0.1	Lower Date
High	Very Low	Low	Low	49.8	0.1	0.1	49.8	0.1	0.1	Month
High	Very Low	Low	Moderate	49.8	0.1	0.1	49.8	0.1	0.1	Month
High	Very Low	Low	High	0.1	0.1	87.6	1	0.1	11.1	Middle Date
High	Very Low	Moderate	Low	0.1	99.5	0.1	0.1	0.1	0.1	Middle Date
High	Very Low	Moderate	Moderate	0.1	12.4	40.9	42.5	0.1	4	Middle Date
High	Very Low	Moderate	High	0.1	0.1	84.7	11.4	0.1	3.6	Middle Date
High	Very Low	High	Low	49.8	0.1	0.1	49.8	0.1	0.1	Month
High	Very Low	High	Moderate	49.8	0.1	0.1	49.8	0.1	0.1	Month
High	Very Low	High	High	16.7	0.1	32.6	49.3	0.1	1.2	Interpolate
High	Low	Low	Low	0.1	0.1	0.1	99.5	0.1	0.1	Date
High	Low	Low	Moderate	0.1	0.1	0.1	0.1	99.5	0.1	Date
High	Low	Low	High	0.1	0.1	0.1	0.1	99.5	0.1	Month
High	Low	Moderate	Low	0.1	0.1	42.4	25.5	19.1	12.8	Date
High	Low	Moderate	Moderate	0.1	0.1	0.1	68.7	30.9	0.1	Half-Month

wtemp	totbiovman	chlaeco	npratio	dombiov: Diatoms	dombiov: Green	dombiov: Blue-Green	dombiov: Euglenophyta	dombiov: Prymnesiophyta	dombiov: Other	Match Method
High	Low	Moderate	High	0.1	0.1	0.1	0.1	99.5	0.1	Month
High	Low	High	Low	0.1	0.1	0.1	22.9	76.7	0.1	Date
High	Low	High	Moderate	0.1	0.1	0.1	52.4	47.2	0.1	Half-Month
High	Low	High	High	0.1	0.1	12.8	86.8	0.1	0.1	Middle Date
High	Bloom	Low	Low	0.1	0.1	0.1	0.1	99.5	0.1	Date
High	Bloom	Low	Moderate	0.1	0.1	0.1	46.7	2.2	50.8	Half-Month
High	Bloom	Low	High	0.1	56.6	12.1	3.3	16.6	11.3	Middle Date
High	Bloom	Moderate	Low	0.1	0.1	19.3	40.4	40	0.1	Date
High	Bloom	Moderate	Moderate	0.1	0.1	0.1	99.5	0.1	0.1	Date
High	Bloom	Moderate	High	0.1	0.1	5.2	11.3	28.6	54.7	Middle Date
High	Bloom	High	Low	0.1	0.1	6.3	91	2.4	0.1	Date
High	Bloom	High	Moderate	0.1	0.1	0.1	0.1	33.3	66.3	Half-Month
High	Bloom	High	High	0.1	0.1	0.1	99.5	0.1	0.1	Middle Date
High	Large Bloom	Low	Low	0.1	0.1	0.1	26.1	38.8	34.8	Date
High	Large Bloom	Low	Moderate	0.1	0.1	0.1	29.1	35.7	34.9	Half-Month
High	Large Bloom	Low	High	0.1	0.1	41.7	0.1	17.3	40.7	Middle Date
High	Large Bloom	Moderate	Low	5.6	0.1	16.8	41.5	11.7	24.3	Date
High	Large Bloom	Moderate	Moderate	0.1	0.1	0.1	0.1	99.5	0.1	Date
High	Large Bloom	Moderate	High	0.1	0.1	64.4	11.2	10.1	14.1	Middle Date
High	Large Bloom	High	Low	0.1	0.1	3.4	80.2	3.4	12.8	Date
High	Large Bloom	High	Moderate	0.1	0.1	0.1	0.1	99.5	0.1	Date
High	Large Bloom	High	High	0.1	0.1	99.5	0.1	0.1	0.1	Middle Date

Middle:

wtemp	totbiovman	chlaeco	npratio	dombiov: Diatoms	dombiov: Green	dombiov: Blue-Green	dombiov: Euglenophyta	dombiov: Prymnesiophyta	dombiov: Other	Match Method
Low	Very Low	Low	Low	59.2	1	0.1	8.6	30	1.1	Date
Low	Very Low	Low	Moderate	56.3	0.6	9.2	24.1	9.3	0.5	Date
Low	Very Low	Low	High	23.8	18.3	37	0.1	20.7	0.1	Date
Low	Very Low	Moderate	Low	41.7	1.3	0.1	0.1	49	7.8	Date
Low	Very Low	Moderate	Moderate	32.4	1.1	0.1	0.1	63	3.3	Date
Low	Very Low	Moderate	High	2.5	0.1	0.1	0.1	97.1	0.1	Date
Low	Very Low	High	Low	41.9	0.1	0.1	57.7	0.1	0.1	Upper Date
Low	Very Low	High	Moderate	0.1	99.5	0.1	0.1	0.1	0.1	Upper Half-Month
Low	Very Low	High	High	0.8	33.3	0.1	0.1	65.6	0.1	Interpolate
Low	Low	Low	Low	0.1	0.1	46	6.6	25.3	21.9	Date
Low	Low	Low	Moderate	3.5	0.1	33.8	4.1	40.8	17.7	Date
Low	Low	Low	High	18.8	0.1	66.4	3.9	8.5	2.3	Date
Low	Low	Moderate	Low	0.1	0.1	15.8	2	47.6	34.4	Date
Low	Low	Moderate	Moderate	0.4	0.1	13.5	4.7	55.7	25.6	Date
Low	Low	Moderate	High	1.5	0.1	28.3	36.4	25	8.7	Date
Low	Low	High	Low	99.5	0.1	0.1	0.1	0.1	0.1	Upper Date
Low	Low	High	Moderate	0.1	0.1	0.1	0.1	99.5	0.1	Date
Low	Low	High	High	0.1	0.1	0.1	0.1	99.5	0.1	Date
Low	Bloom	Low	Low	0.1	0.1	0.1	0.1	99.5	0.1	Date
Low	Bloom	Low	Moderate	24.2	0.1	11.9	0.1	33.5	30.2	Date
Low	Bloom	Low	High	37.7	0.1	8.7	0.1	21.9	31.5	Date
Low	Bloom	Moderate	Low	0.1	0.1	0.1	0.1	0.1	99.5	Half-Month
Low	Bloom	Moderate	Moderate	67.2	0.1	0.5	0.1	0.1	32	Date

wtemp	totbiovman	chlaeco	npratio	dombiov: Diatoms	dombiov: Green	dombiov: Blue-Green	dombiov: Euglenophyta	dombiov: Prymnesiophyta	dombiov: Other	Match Method
Low	Bloom	Moderate	High	56.9	0.1	1	0.1	0.1	41.8	Date
Low	Bloom	High	Low	60.9	0.1	0.1	38.7	0.1	0.1	Upper Date
Low	Bloom	High	Moderate	0.1	0.1	0.1	0.1	0.1	99.5	Lower Date
Low	Bloom	High	High	0.1	0.1	0.1	0.1	99.5	0.1	Lower Date
Low	Large Bloom	Low	Low	0.1	0.1	0.1	0.1	86.1	13.5	Date
Low	Large Bloom	Low	Moderate	40.3	0.1	37.4	0.1	9.8	12.3	Date
Low	Large Bloom	Low	High	46	0.1	14	0.1	30.3	9.5	Date
Low	Large Bloom	Moderate	Low	0.1	0.1	0.1	0.1	21.5	78.1	Date
Low	Large Bloom	Moderate	Moderate	21.3	0.1	13.7	0.1	2.6	62.2	Date
Low	Large Bloom	Moderate	High	15.5	0.1	3.1	0.1	11.6	69.6	Date
Low	Large Bloom	High	Low	0.1	0.1	0.1	0.1	0.1	99.5	Date
Low	Large Bloom	High	Moderate	0.1	0.1	0.1	0.1	0.1	99.5	Date
Low	Large Bloom	High	High	3.9	0.1	0.8	0.1	52.6	42.5	Interpolate
Moderate	Very Low	Low	Low	0.1	58.3	0.1	5.7	35.7	0.1	Date
Moderate	Very Low	Low	Moderate	0.1	20.7	18.7	2.4	49.9	8.2	Date
Moderate	Very Low	Low	High	0.1	0.1	51.9	0.1	39.5	8.3	Date
Moderate	Very Low	Moderate	Low	0.1	12.4	0.1	3.7	83.6	0.1	Date
Moderate	Very Low	Moderate	Moderate	0.1	32	6.2	4.3	39.8	17.6	Date
Moderate	Very Low	Moderate	High	0.1	0.1	79.4	0.1	0.1	20.2	Date
Moderate	Very Low	High	Low	19	31	0.1	49.7	0.1	0.1	Upper Date
Moderate	Very Low	High	Moderate	49.8	0.1	0.1	49.8	0.1	0.1	Upper Month
Moderate	Very Low	High	High	16.7	0.1	26.6	16.7	0.1	39.8	Interpolate

wtemp	totbiovman	chlaeco	npratio	dombiov: Diatoms	dombiov: Green	dombiov: Blue-Green	dombiov: Euglenophyta	dombiov: Prymnesiophyta	dombiov: Other	Match Method
Moderate	Low	Low	Low	0.1	0.1	85.7	0.1	13.9	0.1	Date
Moderate	Low	Low	Moderate	8	0.1	24.6	0.1	57.6	9.6	Date
Moderate	Low	Low	High	19.6	0.1	44	0.1	12.7	23.5	Date
Moderate	Low	Moderate	Low	0.1	0.1	92.4	0.1	7.2	0.1	Date
Moderate	Low	Moderate	Moderate	1	0.1	57.9	0.1	29.4	11.5	Date
Moderate	Low	Moderate	High	8.1	0.1	33.7	0.1	33.7	24.3	Date
Moderate	Low	High	Low	0.1	0.1	99.5	0.1	0.1	0.1	Month
Moderate	Low	High	Moderate	0.1	0.1	0.1	0.1	0.1	99.5	Date
Moderate	Low	High	High	0.1	0.1	0.1	0.1	0.1	99.5	Date
Moderate	Bloom	Low	Low	95.2	0.1	2.9	0.1	1.6	0.1	Date
Moderate	Bloom	Low	Moderate	59.2	0.1	0.1	0.1	40.4	0.1	Date
Moderate	Bloom	Low	High	18.9	0.1	0.1	0.1	80.7	0.1	Date
Moderate	Bloom	Moderate	Low	53.8	0.1	27.3	0.1	18.6	0.1	Date
Moderate	Bloom	Moderate	Moderate	7.3	0.1	40.6	0.1	51.8	0.1	Date
Moderate	Bloom	Moderate	High	2.1	0.1	36.8	0.1	60.8	0.1	Date
Moderate	Bloom	High	Low	0.1	0.1	94.6	0.1	5	0.1	Date
Moderate	Bloom	High	Moderate	0.1	0.1	72.8	0.1	26.8	0.1	Date
Moderate	Bloom	High	High	0.1	0.1	99.5	0.1	0.1	0.1	Date
Moderate	Large Bloom	Low	Low	0.1	0.1	0.1	1.3	98.3	0.1	Date
Moderate	Large Bloom	Low	Moderate	0.1	0.1	30.5	0.7	65.8	2.8	Date
Moderate	Large Bloom	Low	High	0.1	0.1	18	0.8	60.1	20.9	Date
Moderate	Large Bloom	Moderate	Low	0.1	0.1	30.7	9.5	39.5	20.1	Date

wtemp	totbiovman	chlaeco	npratio	dombiov: Diatoms	dombiov: Green	dombiov: Blue-Green	dombiov: Euglenophyta	dombiov: Prymnesiophyta	dombiov: Other	Match Method
Moderate	Large Bloom	Moderate	Moderate	0.1	0.1	46.4	12.1	31.9	9.4	Date
Moderate	Large Bloom	Moderate	High	0.1	0.1	50.4	13.3	11.1	25	Date
Moderate	Large Bloom	High	Low	0.1	0.1	0.1	0.1	0.1	99.5	Date
Moderate	Large Bloom	High	Moderate	0.1	0.1	0.1	0.1	93.5	6.1	Date
Moderate	Large Bloom	High	High	0.1	0.1	0.1	0.1	99.5	0.1	Lower Date
High	Very Low	Low	Low	0.1	99.5	0.1	0.1	0.1	0.1	Date
High	Very Low	Low	Moderate	0.1	9.2	64.1	6.3	0.1	20.2	Date
High	Very Low	Low	High	0.1	0.1	87.6	1	0.1	11.1	Date
High	Very Low	Moderate	Low	0.1	99.5	0.1	0.1	0.1	0.1	Date
High	Very Low	Moderate	Moderate	0.1	12.4	40.9	42.5	0.1	4	Date
High	Very Low	Moderate	High	0.1	0.1	84.7	11.4	0.1	3.6	Date
High	Very Low	High	Low	49.8	0.1	0.1	49.8	0.1	0.1	Upper Month
High	Very Low	High	Moderate	49.8	0.1	0.1	49.8	0.1	0.1	Upper Month
High	Very Low	High	High	16.7	0.1	32.6	49.3	0.1	1.2	Interpolate
High	Low	Low	Low	0.1	0.1	94.6	0.1	5	0.1	Date
High	Low	Low	Moderate	0.1	0.1	86.3	11	2.4	0.1	Date
High	Low	Low	High	0.1	0.1	86.1	10.6	3	0.1	Date
High	Low	Moderate	Low	0.1	0.1	80	0.1	19.6	0.1	Date
High	Low	Moderate	Moderate	0.1	0.1	81.7	7.2	10.8	0.1	Date
High	Low	Moderate	High	0.1	0.1	74.1	8.6	17	0.1	Date
High	Low	High	Low	0.1	0.1	99.5	0.1	0.1	0.1	Date
High	Low	High	Moderate	0.1	0.1	30.6	69	0.1	0.1	Date
High	Low	High	High	0.1	0.1	12.8	86.8	0.1	0.1	Date
High	Bloom	Low	Low	0.1	0.1	0.1	48.2	0.1	51.4	Date

wtemp	totbiovman	chlaeco	npratio	dombiov: Diatoms	dombiov: Green	dombiov: Blue-Green	dombiov: Euglenophyta	dombiov: Prymnesiophyta	dombiov: Other	Match Method
High	Bloom	Low	Moderate	0.1	0.1	55.4	10.2	28.4	5.8	Date
High	Bloom	Low	High	0.1	56.6	12.1	3.3	16.6	11.3	Date
High	Bloom	Moderate	Low	0.1	0.1	0.1	27.7	22.5	49.5	Date
High	Bloom	Moderate	Moderate	0.1	0.1	48.4	8.2	31.7	11.5	Date
High	Bloom	Moderate	High	0.1	0.1	5.2	11.3	28.6	54.7	Date
High	Bloom	High	Low	0.1	0.1	0.1	57.4	42.2	0.1	Date
High	Bloom	High	Moderate	0.1	0.1	0.1	40.6	59	0.1	Date
High	Bloom	High	High	0.1	0.1	0.1	99.5	0.1	0.1	Date
High	Large Bloom	Low	Low	0.1	0.1	9.7	0.1	56.3	33.7	Date
High	Large Bloom	Low	Moderate	0.1	0.1	12.2	0.1	23.6	63.9	Date
High	Large Bloom	Low	High	0.1	0.1	41.7	0.1	17.3	40.7	Date
High	Large Bloom	Moderate	Low	0.1	0.1	21.5	0.1	22.7	55.5	Date
High	Large Bloom	Moderate	Moderate	0.1	0.1	23.3	12.9	18.1	45.5	Date
High	Large Bloom	Moderate	High	0.1	0.1	64.4	11.2	10.1	14.1	Date
High	Large Bloom	High	Low	0.1	0.1	10.1	0.1	0.1	89.5	Month
High	Large Bloom	High	Moderate	0.1	0.1	99.5	0.1	0.1	0.1	Date
High	Large Bloom	High	High	0.1	0.1	99.5	0.1	0.1	0.1	Date

Lower:

wtemp	totbiovman	chlaeco	npratio	dombiov: Diatoms	dombiov: Green	dombiov: Blue-Green	dombiov: Euglenophyta	dombiov: Prymnesiophyta	dombiov: Other	Match Method
Low	Very Low	Low	Low	59.2	1	0.1	8.6	30	1.1	Middle Date
Low	Very Low	Low	Moderate	61.6	0.1	0.1	18.3	19.8	0.1	Date
Low	Very Low	Low	High	66.8	17.9	0.1	0.1	8.4	6.7	Date
Low	Very Low	Moderate	Low	41.7	1.3	0.1	0.1	49	7.8	Middle Date
Low	Very Low	Moderate	Moderate	0.1	0.1	0.1	0.1	99.5	0.1	Date
Low	Very Low	Moderate	High	0.1	0.1	0.1	0.1	99.5	0.1	Date
Low	Very Low	High	Low	41.9	0.1	0.1	57.7	0.1	0.1	Upper Date
Low	Very Low	High	Moderate	0.1	99.5	0.1	0.1	0.1	0.1	Upper Half-Month
Low	Very Low	High	High	0.1	33.3	0.1	0.1	66.3	0.1	Interpolate
Low	Low	Low	Low	0.1	0.1	0.1	0.1	0.1	99.5	Date
Low	Low	Low	Moderate	0.1	0.1	0.1	0.1	77.7	21.9	Date
Low	Low	Low	High	6.9	0.1	15.5	0.1	55.4	22	Date
Low	Low	Moderate	Low	0.1	0.1	0.1	0.1	99.5	0.1	Date
Low	Low	Moderate	Moderate	0.1	0.1	0.1	0.1	99.5	0.1	Date
Low	Low	Moderate	High	0.1	0.1	15.5	0.1	67	17.2	Date
Low	Low	High	Low	99.5	0.1	0.1	0.1	0.1	0.1	Upper Date
Low	Low	High	Moderate	0.1	0.1	0.1	0.1	99.5	0.1	Month
Low	Low	High	High	0.1	0.1	0.1	0.1	99.5	0.1	Date
Low	Bloom	Low	Low	0.1	0.1	99.5	0.1	0.1	0.1	Date
Low	Bloom	Low	Moderate	0.1	0.1	0.1	0.1	33.9	65.7	Date
Low	Bloom	Low	High	0.1	0.1	7.4	0.1	52	40.3	Date
Low	Bloom	Moderate	Low	0.1	0.1	99.5	0.1	0.1	0.1	Date
Low	Bloom	Moderate	Moderate	0.1	0.1	0.1	0.1	0.1	99.5	Date

wtemp	totbiovman	chlaeco	npratio	dombiov: Diatoms	dombiov: Green	dombiov: Blue-Green	dombiov: Euglenophyta	dombiov: Prymnesiophyta	dombiov: Other	Match Method
Low	Bloom	Moderate	High	24.3	0.1	4.9	0.1	18.2	52.4	Date
Low	Bloom	High	Low	60.9	0.1	0.1	38.7	0.1	0.1	Upper Date
Low	Bloom	High	Moderate	0.1	0.1	0.1	0.1	0.1	99.5	Date
Low	Bloom	High	High	0.1	0.1	0.1	0.1	99.5	0.1	Date
Low	Large Bloom	Low	Low	0.1	0.1	0.1	0.1	99.5	0.1	Month
Low	Large Bloom	Low	Moderate	0.1	0.1	0.1	0.1	0.1	99.5	Date
Low	Large Bloom	Low	High	20.8	0.1	0.1	0.1	17	61.9	Date
Low	Large Bloom	Moderate	Low	0.1	0.1	0.1	0.1	99.5	0.1	Date
Low	Large Bloom	Moderate	Moderate	49.8	0.1	0.1	0.1	49.8	0.1	Date
Low	Large Bloom	Moderate	High	18.3	0.1	0.1	0.1	63.1	18.3	Date
Low	Large Bloom	High	Low	0.1	0.1	0.1	0.1	0.1	99.5	Middle Date
Low	Large Bloom	High	Moderate	0.1	0.1	0.1	0.1	0.1	99.5	Middle Date
Low	Large Bloom	High	High	4.6	0.1	0.1	0.1	65.5	29.6	Interpolate
Moderate	Very Low	Low	Low	99.5	0.1	0.1	0.1	0.1	0.1	Date
Moderate	Very Low	Low	Moderate	4.7	0.1	0.1	0.1	0.1	94.9	Date
Moderate	Very Low	Low	High	0.1	27.4	17.9	0.1	24.1	30.4	Date
Moderate	Very Low	Moderate	Low	99.5	0.1	0.1	0.1	0.1	0.1	Date
Moderate	Very Low	Moderate	Moderate	99.5	0.1	0.1	0.1	0.1	0.1	Date
Moderate	Very Low	Moderate	High	0.1	0.1	0.1	0.1	0.1	99.5	Date
Moderate	Very Low	High	Low	19	31	0.1	49.7	0.1	0.1	Upper Date
Moderate	Very Low	High	Moderate	49.8	0.1	0.1	49.8	0.1	0.1	Upper Month
Moderate	Very Low	High	High	16.7	0.1	9.9	16.7	23.4	33.2	Interpolate

wtemp	totbiovman	chlaeco	npratio	dombiov: Diatoms	dombiov: Green	dombiov: Blue-Green	dombiov: Euglenophyta	dombiov: Prymnesiophyta	dombiov: Other	Match Method
Moderate	Low	Low	Low	77.4	0.1	0.1	0.1	22.2	0.1	Date
Moderate	Low	Low	Moderate	47.8	0.1	9.3	0.1	42.6	0.1	Date
Moderate	Low	Low	High	0.1	0.1	34.3	0.5	43.8	21.2	Date
Moderate	Low	Moderate	Low	0.1	0.1	0.1	33.3	66.3	0.1	Month
Moderate	Low	Moderate	Moderate	0.1	0.1	0.1	0.1	99.5	0.1	Date
Moderate	Low	Moderate	High	0.1	0.1	25.9	0.1	73.7	0.1	Date
Moderate	Low	High	Low	0.1	0.1	99.5	0.1	0.1	0.1	Middle Month
Moderate	Low	High	Moderate	0.1	0.1	0.1	0.1	99.5	0.1	Month
Moderate	Low	High	High	0.1	0.1	29.8	0.1	69.8	0.1	Month
Moderate	Bloom	Low	Low	0.1	0.1	0.1	99.5	0.1	0.1	Half-Month
Moderate	Bloom	Low	Moderate	0.1	0.1	99.5	0.1	0.1	0.1	Date
Moderate	Bloom	Low	High	0.1	19.3	63	10.7	6.8	0.1	Date
Moderate	Bloom	Moderate	Low	0.1	0.1	0.1	0.1	0.1	99.5	Date
Moderate	Bloom	Moderate	Moderate	0.1	0.1	42.9	0.1	0.1	56.7	Date
Moderate	Bloom	Moderate	High	0.1	0.1	74.6	0.1	0.1	25	Date
Moderate	Bloom	High	Low	0.1	0.1	0.1	0.1	0.1	99.5	Date
Moderate	Bloom	High	Moderate	0.1	0.1	0.1	0.1	0.1	99.5	Date
Moderate	Bloom	High	High	0.1	0.1	0.1	0.1	0.1	99.5	Date
Moderate	Large Bloom	Low	Low	0.1	0.1	0.1	0.1	99.5	0.1	Date
Moderate	Large Bloom	Low	Moderate	0.1	0.1	0.1	0.1	18.9	80.7	Date
Moderate	Large Bloom	Low	High	0.1	0.1	9.1	0.1	20	70.6	Date
Moderate	Large Bloom	Moderate	Low	0.1	0.1	0.1	8.9	17.8	73	Month

wtemp	totbiovman	chlaeco	npratio	dombiov: Diatoms	dombiov: Green	dombiov: Blue-Green	dombiov: Euglenophyta	dombiov: Prymnesiophyta	dombiov: Other	Match Method
Moderate	Large Bloom	Moderate	Moderate	0.1	0.1	0.1	0.1	99.5	0.1	Date
Moderate	Large Bloom	Moderate	High	0.1	0.1	5.7	0.1	46.2	47.8	Date
Moderate	Large Bloom	High	Low	0.1	0.1	0.1	0.1	0.1	99.5	Middle Date
Moderate	Large Bloom	High	Moderate	0.1	0.1	0.1	0.1	99.5	0.1	Date
Moderate	Large Bloom	High	High	0.1	0.1	0.1	0.1	99.5	0.1	Date
High	Very Low	Low	Low	0.1	0.1	0.1	0.1	0.1	99.5	Date
High	Very Low	Low	Moderate	0.1	0.1	0.1	0.1	0.1	99.5	Date
High	Very Low	Low	High	0.1	40.9	34.9	0.1	9.8	14.2	Date
High	Very Low	Moderate	Low	0.1	99.5	0.1	0.1	0.1	0.1	Middle Date
High	Very Low	Moderate	Moderate	0.1	12.4	40.9	42.5	0.1	4	Middle Date
High	Very Low	Moderate	High	0.1	0.1	84.7	11.4	0.1	3.6	Middle Date
High	Very Low	High	Low	49.8	0.1	0.1	49.8	0.1	0.1	Upper Month
High	Very Low	High	Moderate	49.8	0.1	0.1	49.8	0.1	0.1	Upper Month
High	Very Low	High	High	16.7	0.1	32.6	49.3	0.1	1.2	Interpolate
High	Low	Low	Low	0.1	0.1	0.1	33.3	66.3	0.1	Month
High	Low	Low	Moderate	0.1	0.1	51.1	4.3	44.3	0.1	Date
High	Low	Low	High	0.1	0.1	38.6	28.6	22.4	10.2	Date
High	Low	Moderate	Low	0.1	0.1	0.1	33.3	66.3	0.1	Month
High	Low	Moderate	Moderate	0.1	0.1	0.1	49.8	49.8	0.1	Date
High	Low	Moderate	High	0.1	0.1	0.1	49.8	49.8	0.1	Date
High	Low	High	Low	0.1	0.1	99.5	0.1	0.1	0.1	Middle Date
High	Low	High	Moderate	0.1	0.1	30.6	69	0.1	0.1	Middle Date
High	Low	High	High	0.1	0.1	12.8	86.8	0.1	0.1	Middle Date
High	Bloom	Low	Low	0.1	0.1	0.1	99.5	0.1	0.1	Half-Month

wtemp	totbiovman	chlaeco	npratio	dombiov: Diatoms	dombiov: Green	dombiov: Blue-Green	dombiov: Euglenophyta	dombiov: Prymnesiophyta	dombiov: Other	Match Method
High	Bloom	Low	Moderate	0.1	0.1	0.1	49.8	49.8	0.1	Date
High	Bloom	Low	High	0.1	0.1	73.4	23.6	1.2	1.6	Date
High	Bloom	Moderate	Low	0.1	0.1	0.1	33.3	66.3	0.1	Month
High	Bloom	Moderate	Moderate	0.1	0.1	0.1	49.8	49.8	0.1	Date
High	Bloom	Moderate	High	0.1	0.1	0.1	49.8	49.8	0.1	Date
High	Bloom	High	Low	0.1	0.1	0.1	57.4	42.2	0.1	Middle Date
High	Bloom	High	Moderate	0.1	0.1	0.1	40.6	59	0.1	Middle Date
High	Bloom	High	High	0.1	0.1	0.1	99.5	0.1	0.1	Middle Date
High	Large Bloom	Low	Low	0.1	0.1	0.1	0.1	99.5	0.1	Date
High	Large Bloom	Low	Moderate	0.1	0.1	0.1	33.3	66.3	0.1	Month
High	Large Bloom	Low	High	0.1	0.1	30.4	24.3	30.9	14.2	Date
High	Large Bloom	Moderate	Low	0.1	0.1	0.1	33.3	66.3	0.1	Month
High	Large Bloom	Moderate	Moderate	0.1	0.1	0.1	33.3	66.3	0.1	Month
High	Large Bloom	Moderate	High	0.1	0.1	0.1	0.1	39.1	60.5	Date
High	Large Bloom	High	Low	0.1	0.1	10.1	0.1	0.1	89.5	Middle Month
High	Large Bloom	High	Moderate	0.1	0.1	99.5	0.1	0.1	0.1	Middle Date
High	Large Bloom	High	High	0.1	0.1	99.5	0.1	0.1	0.1	Middle Date

6.9 Dissolved Oxygen (doreg, mg/L) – Three Lake Segments

Conditioned on:

- Water Temperature (wtemp, C)
- Residence Time (resid30, days)
- Total Algal Biovolume (totbiovman, mm3/m3)

Upper:

wtemp	resid30	totbiovman	doreg: <1	doreg: 1 to <4	doreg: 4+	Match Method
Low	Shorter	Very Low	0	0	100	Date
Low	Shorter	Low	0	0	100	Date
Low	Shorter	Bloom	0	0	100	Date
Low	Shorter	Large Bloom	0	0	100	Date
Low	Short	Very Low	0	0	100	Date
Low	Short	Low	0	0	100	Date
Low	Short	Bloom	0	0	100	Date
Low	Short	Large Bloom	0	0	100	Middle Date
Low	Moderate	Very Low	0	0	100	Month
Low	Moderate	Low	0	0	100	Date
Low	Moderate	Bloom	0	0	100	Middle Date
Low	Moderate	Large Bloom	0	0	100	Middle Month
Low	Long	Very Low	0	0	100	Half-Month
Low	Long	Low	0	0	100	Date
Low	Long	Bloom	0	0	100	Month
Low	Long	Large Bloom	0	0	100	Lower Month
Low	Longer	Very Low	0	0	100	Date
Low	Longer	Low	0	0	100	Date
Low	Longer	Bloom	0	0	100	Date
Low	Longer	Large Bloom	0	0	100	Date
Moderate	Shorter	Very Low	0.1	0.1	99.8	Date
Moderate	Shorter	Low	0.1	0.1	99.8	Date
Moderate	Shorter	Bloom	2.6	16.1	81.3	Date
Moderate	Shorter	Large Bloom	7.8	22.3	69.9	Date
Moderate	Short	Very Low	0.1	0.1	99.8	Date
Moderate	Short	Low	0.1	0.1	99.8	Date
Moderate	Short	Bloom	0.1	5	94.9	Date
Moderate	Short	Large Bloom	28.9	13	58.1	Half-Month
Moderate	Moderate	Very Low	0.1	0.1	99.8	Date
Moderate	Moderate	Low	0.1	0.1	99.8	Date
Moderate	Moderate	Bloom	9.2	16.9	73.9	Date
Moderate	Moderate	Large Bloom	14.3	9.5	76.2	Date
Moderate	Long	Very Low	8.7	13	78.3	Middle Date
Moderate	Long	Low	2.2	2.9	94.9	Half-Month
Moderate	Long	Bloom	10.7	3.6	85.7	Date
Moderate	Long	Large Bloom	19	7.9	73.1	Date
Moderate	Longer	Very Low	7.7	7.7	84.6	Date

wtemp	resid30	totbiovman	doreg: <1	doreg: 1 to <4	doreg: 4+	Match Method
Moderate	Longer	Low	2.5	16.6	80.9	Date
Moderate	Longer	Bloom	0.1	0.1	99.8	Date
Moderate	Longer	Large Bloom	2.9	28.2	68.9	Date
High	Shorter	Very Low	9.9	8.6	81.5	Middle Date
High	Shorter	Low	0.1	35.8	64.1	Date
High	Shorter	Bloom	5.9	38.8	55.3	Date
High	Shorter	Large Bloom	13.2	27.7	59.1	Date
High	Short	Very Low	0.1	0.1	99.8	Middle Date
High	Short	Low	0.1	0.1	99.8	Date
High	Short	Bloom	11	11	78	Date
High	Short	Large Bloom	31.8	10.6	57.6	Date
High	Moderate	Very Low	22.2	16.7	61.1	Month
High	Moderate	Low	22.2	0.1	77.7	Date
High	Moderate	Bloom	22.3	18.5	59.2	Date
High	Moderate	Large Bloom	24	20.2	55.8	Date
High	Long	Very Low	6.8	15.4	77.8	Middle Date
High	Long	Low	22.2	18.6	59.2	Half-Month
High	Long	Bloom	27.8	11.1	61.1	Date
High	Long	Large Bloom	21.3	11.1	67.6	Date
High	Longer	Very Low	14.7	11.8	73.5	Middle Date
High	Longer	Low	22.2	21.5	56.3	Date
High	Longer	Bloom	0.1	21.4	78.5	Date
High	Longer	Large Bloom	37	13	50	Date

Middle:

wtemp	resid30	totbiovman	doreg: <1	doreg: 1 to <4	doreg: 4+	Match Method
Low	Shorter	Very Low	0	0	100	Date
Low	Shorter	Low	0	0	100	Date
Low	Shorter	Bloom	0	0	100	Date
Low	Shorter	Large Bloom	0	0	100	Date
Low	Short	Very Low	0	0	100	Half-Month
Low	Short	Low	0	0	100	Date
Low	Short	Bloom	0	0	100	Month
Low	Short	Large Bloom	0	0	100	Date

wtemp	resid30	totbiovman	doreg: <1	doreg: 1 to <4	doreg: 4+	Match Method
Low	Moderate	Very Low	0	0	100	Date
Low	Moderate	Low	0	0	100	Half-Month
Low	Moderate	Bloom	0	0	100	Date
Low	Moderate	Large Bloom	0	0	100	Month
Low	Long	Very Low	0	0	100	Half-Month
Low	Long	Low	0	0	100	Date
Low	Long	Bloom	0	0	100	Half-Month
Low	Long	Large Bloom	0	0	100	Lower Month
Low	Longer	Very Low	0	0	100	Date
Low	Longer	Low	0	0	100	Date
Low	Longer	Bloom	0	0	100	Date
Low	Longer	Large Bloom	0	0	100	Date
Moderate	Shorter	Very Low	0.1	8	91.9	Date
Moderate	Shorter	Low	3.6	1.2	95.2	Date
Moderate	Shorter	Bloom	1.2	7.8	91	Date
Moderate	Shorter	Large Bloom	2.4	7.7	89.9	Date
Moderate	Short	Very Low	1.4	1.4	97.2	Date
Moderate	Short	Low	0.1	2.8	97.1	Date
Moderate	Short	Bloom	0.1	0.1	99.8	Date
Moderate	Short	Large Bloom	0.8	7.2	92	Half-Month
Moderate	Moderate	Very Low	0.1	8.3	91.6	Date
Moderate	Moderate	Low	1.7	15	83.3	Date
Moderate	Moderate	Bloom	0.1	0.1	99.8	Date
Moderate	Moderate	Large Bloom	3.4	20.7	75.9	Date
Moderate	Long	Very Low	8.7	13	78.3	Date
Moderate	Long	Low	0.1	2.7	97.2	Date
Moderate	Long	Bloom	0.1	11.7	88.2	Lower Date
Moderate	Long	Large Bloom	0.1	0.1	99.8	Date
Moderate	Longer	Very Low	2	1.6	96.4	Date
Moderate	Longer	Low	4.7	3	92.3	Date
Moderate	Longer	Bloom	0.1	1.5	98.4	Date
Moderate	Longer	Large Bloom	0.5	7.7	91.8	Date
High	Shorter	Very Low	9.9	8.6	81.5	Date
High	Shorter	Low	25.7	8.6	65.7	Date
High	Shorter	Bloom	10.9	19.9	69.2	Date
High	Shorter	Large Bloom	5.3	25.3	69.4	Date
High	Short	Very Low	0.1	0.1	99.8	Date
High	Short	Low	10.7	15.4	73.9	Date

wtemp	resid30	totbiovman	doreg: <1	doreg: 1 to <4	doreg: 4+	Match Method
High	Short	Bloom	0.1	0.1	99.8	Date
High	Short	Large Bloom	0.1	0.1	99.8	Date
High	Moderate	Very Low	12.2	12.3	75.5	Half-Month
High	Moderate	Low	33.3	13.3	53.4	Date
High	Moderate	Bloom	12	8	80	Date
High	Moderate	Large Bloom	15.8	17.5	66.7	Date
High	Long	Very Low	6.8	15.4	77.8	Date
High	Long	Low	5.7	10.1	84.2	Date
High	Long	Bloom	2.2	9.9	87.9	Date
High	Long	Large Bloom	11.4	8.6	80	Date
High	Longer	Very Low	14.7	11.8	73.5	Date
High	Longer	Low	9.3	12.6	78.1	Date
High	Longer	Bloom	0.1	0.1	99.8	Date
High	Longer	Large Bloom	9.4	19.3	71.3	Date

Lower:

wtemp	resid30	totbiovman	doreg: <1	doreg: 1 to <4	doreg: 4+	Match Method
Low	Shorter	Very Low	0	0	100	Date
Low	Shorter	Low	0	0	100	Date
Low	Shorter	Bloom	0	0	100	Date
Low	Shorter	Large Bloom	0	0	100	Date
Low	Short	Very Low	0	0	100	Half-Month
Low	Short	Low	0	0	100	Date
Low	Short	Bloom	0	0	100	Date
Low	Short	Large Bloom	0	0	100	Half-Month
Low	Moderate	Very Low	0	0	100	Half-Month
Low	Moderate	Low	0	0	100	Date
Low	Moderate	Bloom	0	0	100	Date
Low	Moderate	Large Bloom	0	0	100	Month
Low	Long	Very Low	0	0	100	Date
Low	Long	Low	0	0	100	Half-Month
Low	Long	Bloom	0	0	100	Month
Low	Long	Large Bloom	0	0	100	Month
Low	Longer	Very Low	0	0	100	Date

wtemp	resid30	totbiovman	doreg: <1	doreg: 1 to <4	doreg: 4+	Match Method
Low	Longer	Low	0	0	100	Date
Low	Longer	Bloom	0	0	100	Date
Low	Longer	Large Bloom	0	0	100	Date
Moderate	Shorter	Very Low	0.1	6.4	93.5	Date
Moderate	Shorter	Low	0.1	0.3	99.6	Date
Moderate	Shorter	Bloom	0.1	0.1	99.8	Date
Moderate	Shorter	Large Bloom	2.7	16.7	80.6	Date
Moderate	Short	Very Low	0.1	0.1	99.8	Date
Moderate	Short	Low	0.1	0.1	99.8	Date
Moderate	Short	Bloom	0.1	0.1	99.8	Date
Moderate	Short	Large Bloom	2.7	12	85.3	Month
Moderate	Moderate	Very Low	6.7	13.3	80	Half-Month
Moderate	Moderate	Low	1.2	0.6	98.2	Date
Moderate	Moderate	Bloom	0.1	13.3	86.6	Date
Moderate	Moderate	Large Bloom	0.1	0.1	99.8	Date
Moderate	Long	Very Low	3.5	7.1	89.4	Date
Moderate	Long	Low	0.1	26.7	73.2	Date
Moderate	Long	Bloom	0.1	11.7	88.2	Date
Moderate	Long	Large Bloom	8.3	4.2	87.5	Date
Moderate	Longer	Very Low	0.1	0.1	99.8	Date
Moderate	Longer	Low	0.7	8.7	90.6	Date
Moderate	Longer	Bloom	0.1	24.5	75.4	Date
Moderate	Longer	Large Bloom	0.1	4.8	95.1	Date
High	Shorter	Very Low	0.1	16.4	83.5	Date
High	Shorter	Low	6.8	18.5	74.7	Date
High	Shorter	Bloom	0.1	0.1	99.8	Date
High	Shorter	Large Bloom	5.6	25.9	68.5	Date
High	Short	Very Low	0.1	12.8	87.1	Date
High	Short	Low	0.1	7.7	92.2	Date
High	Short	Bloom	0.1	5.7	94.2	Date
High	Short	Large Bloom	13.3	13.3	73.4	Date
High	Moderate	Very Low	11.1	8.9	80	Date
High	Moderate	Low	17	14.1	68.9	Date
High	Moderate	Bloom	10.8	16.1	73.1	Half-Month
High	Moderate	Large Bloom	20	6.7	73.3	Date
High	Long	Very Low	4.8	9.6	85.6	Date
High	Long	Low	9.1	33.1	57.8	Half-Month
High	Long	Bloom	3.6	19.4	77	Date

wtemp	resid30	totbiovman	doreg: <1	doreg: 1 to <4	doreg: 4+	Match Method
High	Long	Large Bloom	8.3	4.2	87.5	Date
High	Longer	Very Low	10	13.3	76.7	Date
High	Longer	Low	8.3	15.4	76.3	Date
High	Longer	Bloom	0.1	24.7	75.2	Date
High	Longer	Large Bloom	14.7	5.5	79.8	Half-Month

6.10 Manganese (manreg, mg/L) – Three Lake Segments

Conditioned on:

- Residence Time (resid30, days)
- Precipitation (precip30, inches)
- Water Temperature (wtemp, C)

Upper:

resid30	precip30	wtemp	manreg: No Action	manreg: Extra Monitor and Treatment	Match Method
Shorter	Dry	Low	99.9	0.1	Half-Month
Shorter	Dry	Moderate	90.5	9.5	Half-Month
Shorter	Dry	High	38.1	61.9	Month
Shorter	Moderate	Low	99.9	0.1	Date
Shorter	Moderate	Moderate	89.5	10.5	Date
Shorter	Moderate	High	0.1	99.9	Half-Month
Shorter	Wet	Low	99.9	0.1	Date
Shorter	Wet	Moderate	99.9	0.1	Date
Shorter	Wet	High	47.4	52.6	Date
Shorter	Very Wet	Low	99.9	0.1	Half-Month
Shorter	Very Wet	Moderate	50	50	Date
Shorter	Very Wet	High	50	50	Date
Short	Dry	Low	99.9	0.1	Date
Short	Dry	Moderate	0.1	99.9	Date
Short	Dry	High	99.9	0.1	Half-Month
Short	Moderate	Low	0.1	99.9	Half-Month
Short	Moderate	Moderate	0.1	99.9	Date
Short	Moderate	High	99.9	0.1	Half-Month
Short	Wet	Low	99.7	0.3	Month
Short	Wet	Moderate	99.9	0.1	Half-Month
Short	Wet	High	59.4	40.6	Half-Month
Short	Very Wet	Low	99.9	0.1	Interpolate

resid30	precip30	wtemp	manreg: No Action	manreg: Extra Monitor and Treatment	Match Method
Short	Very Wet	Moderate	99.9	0.1	Lower Half-Month
Short	Very Wet	High	69.8	30.2	Interpolate
Moderate	Dry	Low	99.9	0.1	Half-Month
Moderate	Dry	Moderate	66.7	33.3	Date
Moderate	Dry	High	0.1	99.9	Date
Moderate	Moderate	Low	0.1	99.9	Date
Moderate	Moderate	Moderate	38.9	61.1	Date
Moderate	Moderate	High	0.1	99.9	Date
Moderate	Wet	Low	99.9	0.1	Half-Month
Moderate	Wet	Moderate	37.5	62.5	Half-Month
Moderate	Wet	High	26.5	73.5	Half-Month
Moderate	Very Wet	Low	99.9	0.1	Interpolate
Moderate	Very Wet	Moderate	99.9	0.1	Lower Half-Month
Moderate	Very Wet	High	63.2	36.8	Interpolate
Long	Dry	Low	99.9	0.1	Middle Date
Long	Dry	Moderate	92.3	7.7	Date
Long	Dry	High	20	80	Date
Long	Moderate	Low	99.9	0.1	Half-Month
Long	Moderate	Moderate	99.9	0.1	Date
Long	Moderate	High	0.1	99.9	Date
Long	Wet	Low	99.9	0.1	Half-Month
Long	Wet	Moderate	0.1	99.9	Date
Long	Wet	High	99.9	0.1	Date
Long	Very Wet	Low	99.9	0.1	Interpolate
Long	Very Wet	Moderate	50	50	Interpolate
Long	Very Wet	High	99.9	0.1	Interpolate
Longer	Dry	Low	99.9	0.1	Date
Longer	Dry	Moderate	78.9	21.1	Date
Longer	Dry	High	0.1	99.9	Half-Month
Longer	Moderate	Low	99.9	0.1	Date
Longer	Moderate	Moderate	99.9	0.1	Date
Longer	Moderate	High	0.1	99.9	Half-Month
Longer	Wet	Low	99.9	0.1	Half-Month
Longer	Wet	Moderate	66.7	33.3	Date
Longer	Wet	High	0.1	99.9	Date
Longer	Very Wet	Low	99.9	0.1	Interpolate

resid30	precip30	wtemp	manreg: No Action	manreg: Extra Monitor and Treatment	Match Method
Longer	Very Wet	Moderate	66.7	33.3	Interpolate
Longer	Very Wet	High	0.1	99.9	Interpolate

Middle:

resid30	precip30	wtemp	manreg: No Action	manreg: Extra Monitor and Treatment	Match Method
Shorter	Dry	Low	99.9	0.1	Half-Month
Shorter	Dry	Moderate	99.9	0.1	Date
Shorter	Dry	High	99.9	0.1	Month
Shorter	Moderate	Low	99.9	0.1	Date
Shorter	Moderate	Moderate	99.9	0.1	Date
Shorter	Moderate	High	99.9	0.1	Month
Shorter	Wet	Low	99.9	0.1	Date
Shorter	Wet	Moderate	99.9	0.1	Date
Shorter	Wet	High	99.9	0.1	Date
Shorter	Very Wet	Low	99.9	0.1	Half-Month
Shorter	Very Wet	Moderate	99.9	0.1	Lower Half-Month
Shorter	Very Wet	High	99.9	0.1	Date
Short	Dry	Low	99.9	0.1	Date
Short	Dry	Moderate	99.9	0.1	Date
Short	Dry	High	99.9	0.1	Half-Month
Short	Moderate	Low	99.9	0.1	Half-Month
Short	Moderate	Moderate	99.9	0.1	Half-Month
Short	Moderate	High	99.9	0.1	Half-Month
Short	Wet	Low	99.9	0.1	Month
Short	Wet	Moderate	99.9	0.1	Month
Short	Wet	High	99.9	0.1	Half-Month
Short	Very Wet	Low	99.9	0.1	Interpolate
Short	Very Wet	Moderate	99.9	0.1	Lower Half-Month
Short	Very Wet	High	99.9	0.1	Interpolate
Moderate	Dry	Low	99.9	0.1	Half-Month
Moderate	Dry	Moderate	99.9	0.1	Date
Moderate	Dry	High	0.1	99.9	Date
Moderate	Moderate	Low	99.9	0.1	Date
Moderate	Moderate	Moderate	99.9	0.1	Date

resid30	precip30	wtemp	manreg: No Action	manreg: Extra Monitor and Treatment	Match Method
Moderate	Moderate	High	99.9	0.1	Date
Moderate	Wet	Low	99.9	0.1	Half-Month
Moderate	Wet	Moderate	99.9	0.1	Month
Moderate	Wet	High	99.9	0.1	Half-Month
Moderate	Very Wet	Low	99.9	0.1	Interpolate
Moderate	Very Wet	Moderate	99.9	0.1	Lower Half-Month
Moderate	Very Wet	High	99.9	0.1	Interpolate
Long	Dry	Low	99.9	0.1	Date
Long	Dry	Moderate	66.7	33.3	Date
Long	Dry	High	98.3	1.7	Date
Long	Moderate	Low	99.9	0.1	Half-Month
Long	Moderate	Moderate	97	3	Date
Long	Moderate	High	90.5	9.5	Date
Long	Wet	Low	99.9	0.1	Half-Month
Long	Wet	Moderate	99.9	0.1	Half-Month
Long	Wet	High	99.9	0.1	Date
Long	Very Wet	Low	99.9	0.1	Interpolate
Long	Very Wet	Moderate	99.9	0.1	Interpolate
Long	Very Wet	High	99.9	0.1	Interpolate
Longer	Dry	Low	99.9	0.1	Date
Longer	Dry	Moderate	99.9	0.1	Date
Longer	Dry	High	98.4	1.6	Half-Month
Longer	Moderate	Low	99.9	0.1	Date
Longer	Moderate	Moderate	99.9	0.1	Date
Longer	Moderate	High	98.4	1.6	Half-Month
Longer	Wet	Low	99.9	0.1	Half-Month
Longer	Wet	Moderate	99.9	0.1	Date
Longer	Wet	High	99.9	0.1	Date
Longer	Very Wet	Low	99.9	0.1	Interpolate
Longer	Very Wet	Moderate	99.9	0.1	Interpolate
Longer	Very Wet	High	99.9	0.1	Interpolate

Lower:

resid30	precip30	wtemp	manreg: No Action	manreg: Extra Monitor and Treatment	Match Method
Shorter	Dry	Low	100	0	Half-Month
Shorter	Dry	Moderate	100	0	Date
Shorter	Dry	High	82.2	17.8	Half-Month
Shorter	Moderate	Low	100	0	Date
Shorter	Moderate	Moderate	100	0	Date
Shorter	Moderate	High	100	0	Date
Shorter	Wet	Low	100	0	Date
Shorter	Wet	Moderate	99.1	0.9	Date
Shorter	Wet	High	94.3	5.7	Date
Shorter	Very Wet	Low	100	0	Month
Shorter	Very Wet	Moderate	100	0	Half-Month
Shorter	Very Wet	High	100	0	Date
Short	Dry	Low	100	0	Date
Short	Dry	Moderate	84.6	15.4	Date
Short	Dry	High	77.8	22.2	Date
Short	Moderate	Low	100	0	Date
Short	Moderate	Moderate	99.2	0.8	Date
Short	Moderate	High	81.6	18.4	Date
Short	Wet	Low	100	0	Half-Month
Short	Wet	Moderate	97.9	2.1	Half-Month
Short	Wet	High	86.9	13.1	Half-Month
Short	Very Wet	Low	100	0	Interpolate
Short	Very Wet	Moderate	100	0	Half-Month
Short	Very Wet	High	95.6	4.4	Interpolate
Moderate	Dry	Low	100	0	Half-Month
Moderate	Dry	Moderate	93.4	6.6	Date
Moderate	Dry	High	92.9	7.1	Date
Moderate	Moderate	Low	100	0	Date
Moderate	Moderate	Moderate	87.5	12.5	Date
Moderate	Moderate	High	81.4	18.6	Date
Moderate	Wet	Low	100	0	Half-Month
Moderate	Wet	Moderate	92.6	7.4	Date
Moderate	Wet	High	76.5	23.5	Date
Moderate	Very Wet	Low	100	0	Interpolate
Moderate	Very Wet	Moderate	100	0	Half-Month

resid30	precip30	wtemp	manreg: No Action	manreg: Extra Monitor and Treatment	Match Method
Moderate	Very Wet	High	88.2	11.8	Interpolate
Long	Dry	Low	100	0	Date
Long	Dry	Moderate	93.9	6.1	Date
Long	Dry	High	88.7	11.3	Date
Long	Moderate	Low	100	0	Half-Month
Long	Moderate	Moderate	100	0	Date
Long	Moderate	High	83.6	16.4	Date
Long	Wet	Low	100	0	Half-Month
Long	Wet	Moderate	79.1	20.9	Date
Long	Wet	High	94.3	5.7	Date
Long	Very Wet	Low	100	0	Interpolate
Long	Very Wet	Moderate	89.6	10.4	Interpolate
Long	Very Wet	High	94.3	5.7	Interpolate
Longer	Dry	Low	100	0	Date
Longer	Dry	Moderate	78.8	21.2	Date
Longer	Dry	High	91.9	8.1	Half-Month
Longer	Moderate	Low	100	0	Date
Longer	Moderate	Moderate	93.6	6.4	Date
Longer	Moderate	High	74.9	25.1	Date
Longer	Wet	Low	100	0	Date
Longer	Wet	Moderate	100	0	Date
Longer	Wet	High	88.2	11.8	Date
Longer	Very Wet	Low	100	0	Interpolate
Longer	Very Wet	Moderate	100	0	Interpolate
Longer	Very Wet	High	88.2	11.8	Interpolate

6.11 Microcystin (mictotreg, ug/L) – Three Lake Segments

Conditioned on:

- Blue-Green Algae Biovolume (bgbioveco, mm3/m3)

Upper:

bgbioveco	mictotreg: BD	mictotreg: Low	mictotreg: Moderate	mictotreg: High	Match Method
Low	77.8	22	0.1	0.1	Date
Moderate	66.5	33.3	0.1	0.1	Date
High	0.1	99.7	0.1	0.1	Date

Middle:

bgbioveco	mictotreg: BD	mictotreg: Low	mictotreg: Moderate	mictotreg: High	Match Method
Low	49.2	50.6	0.1	0.1	Date
Moderate	16.7	83.1	0.1	0.1	Date
High	16.7	83.1	0.1	0.1	Date

Lower:

bgbioveco	mictotreg: BD	mictotreg: Low	mictotreg: Moderate	mictotreg: High	Match Method
Low	54.1	45.7	0.1	0.1	Date
Moderate	14.8	85	0.1	0.1	Date
High	0.1	99.7	0.1	0.1	Month

6.12 N:P Molar Ratio (npratio, mol) – Three Lake Segments

Conditioned on:

- Total Phosphorus (totalp, mg/L)
- Total Nitrogen (totaln, mg/L)

Upper:

totaln	totalp	npratio: Low	npratio: Moderate	npratio: High	Match Method
Very Low	Very Low	81.8	18.2	0	Half-Month
Very Low	Low	82.3	5.9	11.8	Month
Very Low	Moderate	100	0	0	Half-Month
Very Low	High	87.5	0	12.5	Date
Very Low	Very High	100	0	0	Date
Low	Very Low	78.9	21.1	0	Half-Month
Low	Low	87.5	12.5	0	Half-Month
Low	Moderate	67.5	28.9	3.6	Half-Month
Low	High	88.8	11.2	0	Date
Low	Very High	96.3	3.7	0	Date
Moderate	Very Low	68.3	31.7	0	Half-Month
Moderate	Low	94.5	3.3	2.2	Half-Month
Moderate	Moderate	19.3	80.7	0	Date
Moderate	High	65.6	34	0.4	Date
Moderate	Very High	89.6	10.4	0	Date
High	Very Low	82.6	17.4	0	Half-Month

totaln	totalp	npratio: Low	npratio: Moderate	npratio: High	Match Method
High	Low	100	0	0	Half-Month
High	Moderate	37.5	58.3	4.2	Date
High	High	68.8	30.9	0.3	Date
High	Very High	92.1	7.7	0.2	Date
Very High	Very Low	84.8	15.2	0	Half-Month
Very High	Low	96.4	0	3.6	Half-Month
Very High	Moderate	2.9	85.7	11.4	Date
Very High	High	51.8	44.7	3.5	Date
Very High	Very High	92.8	6.9	0.3	Date

Middle:

totaln	totalp	npratio: Low	npratio: Moderate	npratio: High	Match Method
Very Low	Very Low	18.4	13.8	67.8	Date
Very Low	Low	9.7	45.1	45.2	Date
Very Low	Moderate	26.9	55.5	17.6	Date
Very Low	High	40.6	45.9	13.5	Date
Very Low	Very High	71.7	25.3	3	Date
Low	Very Low	25.8	19.4	54.8	Date
Low	Low	8.3	45.8	45.9	Date
Low	Moderate	20.1	60.8	19.1	Date
Low	High	45.8	45.5	8.7	Date
Low	Very High	44.7	37.7	17.6	Date
Moderate	Very Low	0	0	100	Date
Moderate	Low	8.3	39.8	51.9	Date
Moderate	Moderate	18.4	57.3	24.3	Date
Moderate	High	36.7	50.3	13	Date
Moderate	Very High	45.1	41.9	13	Date
High	Very Low	0	0	100	Date
High	Low	6.9	38.8	54.3	Date
High	Moderate	11.9	58.6	29.5	Date
High	High	21.7	63.8	14.5	Date
High	Very High	43.2	45.8	11	Date
Very High	Very Low	0	15.6	84.4	Lower Date
Very High	Low	12.8	39.8	47.4	Date
Very High	Moderate	22.1	44.8	33.1	Date
Very High	High	21.2	62.1	16.7	Date
Very High	Very High	62.7	26	11.3	Date

Lower:

totaln	totalp	npratio: Low	npratio: Moderate	npratio: High	Match Method
Very Low	Very Low	2.7	4.9	92.4	Date
Very Low	Low	5.9	27.4	66.7	Date
Very Low	Moderate	65.5	23.8	10.7	Date
Very Low	High	47.3	5.3	47.4	Date
Very Low	Very High	77.8	0	22.2	Date
Low	Very Low	0	0.8	99.2	Date
Low	Low	3.4	18.1	78.5	Date
Low	Moderate	19.9	60.9	19.2	Date
Low	High	61	19.5	19.5	Date
Low	Very High	29.3	0	70.7	Date
Moderate	Very Low	4.6	10	85.4	Date
Moderate	Low	0.5	9	90.5	Date
Moderate	Moderate	0.8	73.6	25.6	Date
Moderate	High	29.7	55.9	14.4	Date
Moderate	Very High	88.9	0	11.1	Date
High	Very Low	3	18.7	78.3	Date
High	Low	0.1	18.1	81.8	Date
High	Moderate	2.2	42.1	55.7	Date
High	High	8.6	68.6	22.8	Date
High	Very High	15	55	30	Date
Very High	Very Low	0	15.6	84.4	Date
Very High	Low	0	8.7	91.3	Date
Very High	Moderate	1	9.7	89.3	Date
Very High	High	3	87.9	9.1	Date
Very High	Very High	8.3	75	16.7	Date

6.13 pH (phreg) – Three Lake Segments

Conditioned on:

- Total Algal Biovolume (totbiovman, mm3/m3)
- Precipitation (precip30, inches)

Upper:

totbiovman	precip30	phreg: Low	phreg: Moderate	phreg: High	Match Method
Very Low	Dry	0.1	96.7	3.2	Date
Very Low	Moderate	0.1	98.5	1.4	Date

Very Low	Wet	0.1	99.8	0.1	Date
Very Low	Very Wet	0.1	99.8	0.1	Interpolate
Low	Dry	0.1	79.1	20.8	Date
Low	Moderate	0.1	99.8	0.1	Date
Low	Wet	0.1	99.8	0.1	Date
Low	Very Wet	0.1	99.8	0.1	Half-Month
Bloom	Dry	0.1	97.8	2.1	Date
Bloom	Moderate	9.7	90.2	0.1	Date
Bloom	Wet	0.1	99.8	0.1	Date
Bloom	Very Wet	0.1	99.8	0.1	Date
Large Bloom	Dry	0.1	97.3	2.6	Date
Large Bloom	Moderate	0.1	99.8	0.1	Date
Large Bloom	Wet	4.5	94.9	0.6	Date
Large Bloom	Very Wet	0.1	99.8	0.1	Date

Middle:

totbiovman	precip30	phreg: Low	phreg: Moderate	phreg: High	Match Method
Very Low	Dry	0.1	99.8	0.1	Date
Very Low	Moderate	1	98.9	0.1	Date
Very Low	Wet	0.1	99.8	0.1	Date
Very Low	Very Wet	0.1	99.8	0.1	Interpolate
Low	Dry	0.1	99.8	0.1	Date
Low	Moderate	0.1	99.8	0.1	Date
Low	Wet	0.3	99.6	0.1	Date
Low	Very Wet	0.1	99.8	0.1	Half-Month
Bloom	Dry	0.1	99.8	0.1	Date
Bloom	Moderate	6.1	93.8	0.1	Date
Bloom	Wet	0.6	98.8	0.6	Date
Bloom	Very Wet	0.1	99.8	0.1	Month
Large Bloom	Dry	0.8	99.1	0.1	Date
Large Bloom	Moderate	0.1	99.8	0.1	Date
Large Bloom	Wet	0.1	99.8	0.1	Date
Large Bloom	Very Wet	0.1	99.8	0.1	Date

6.14 Residence Time (resid30, days) –Lakewide

Conditioned on:

- Precipitation (precip30, inches)
- Season (season, 6mo)

Lakewide:

precip30	season	resid30: Shorter	resid30: Short	resid30: Moderate	resid30: Long	resid30: Longer	Match Method
Dry	Cool	26.5	13.1	8.1	9.6	42.7	Date
Dry	Warm	6.1	9.9	27.5	33.5	23	Date
Moderate	Cool	54.5	11.2	6.5	5.7	22.1	Date
Moderate	Warm	14.1	14.3	17.1	29.3	25.2	Date
Wet	Cool	76.8	8.3	3.7	2.8	8.4	Date
Wet	Warm	35.7	13.9	12.7	16	21.7	Date
Very Wet	Cool	73	26.7	0.1	0.1	0.1	Date
Very Wet	Warm	68.3	14.6	8.2	3.8	5.1	Date

6.15 Total Organic Carbon (toc, mg/L) – Three Lake Segments

Conditioned on:

- Total Algal Biovolume (totbiovman, mm3/m3)
- Precipitation (precip30, inches)

Upper:

totbiovman	precip30	toc: Low	toc: Moderate	toc: High	Match Method
Very Low	Dry	0.1	59	40.9	Date
Very Low	Moderate	0.1	69.5	30.4	Date
Very Low	Wet	0.1	42.9	57	Date
Very Low	Very Wet	0.1	42.9	57	Interpolate
Low	Dry	0	63.6	36.4	Date
Low	Moderate	0	37.8	62.2	Date
Low	Wet	0	10	90	Date
Low	Very Wet	0	0	100	Middle Half-Month
Bloom	Dry	0	60.9	39.1	Date
Bloom	Moderate	0	50	50	Date
Bloom	Wet	0	33.3	66.7	Date
Bloom	Very Wet	0	100	0	Date
Large Bloom	Dry	0	43.8	56.2	Date
Large Bloom	Moderate	0	16.7	83.3	Date
Large Bloom	Wet	0	30	70	Date

Large Bloom	Very Wet	0	0	100	Date

Middle:

totbiovman	precip30	toc: Low	toc: Moderate	toc: High	Match Method
Very Low	Dry	0.1	82	17.9	Date
Very Low	Moderate	0.1	51	48.9	Date
Very Low	Wet	0.1	14.3	85.6	Date
Very Low	Very Wet	0.1	7.2	92.7	Interpolate
Low	Dry	0	79.3	20.7	Date
Low	Moderate	0	67.5	32.5	Date
Low	Wet	0	60.5	39.5	Date
Low	Very Wet	0	0	100	Half-Month
Bloom	Dry	0	75	25	Date
Bloom	Moderate	0	74.1	25.9	Date
Bloom	Wet	0	25	75	Date
Bloom	Very Wet	0	5.6	94.4	Month
Large Bloom	Dry	0	72.3	27.7	Date
Large Bloom	Moderate	0	26.5	73.5	Date
Large Bloom	Wet	0	62.7	37.3	Date
Large Bloom	Very Wet	0	0	100	Date

Lower:

totbiovman	precip30	toc: Low	toc: Moderate	toc: High	Match Method
Very Low	Dry	0.1	99.9	0	Date
Very Low	Moderate	0.1	68.5	31.4	Date
Very Low	Wet	0.1	83.2	16.7	Date
Very Low	Very Wet	0.1	49.95	49.95	Interpolate
Low	Dry	0	91.3	8.7	Date
Low	Moderate	0	84.5	15.5	Date
Low	Wet	0	79.5	20.5	Date
Low	Very Wet	0	16.7	83.3	Date
Bloom	Dry	0	77.8	22.2	Date
Bloom	Moderate	0	68.2	31.8	Date
Bloom	Wet	0	80.6	19.4	Date
Bloom	Very Wet	0	60	40	Half-Month
Large Bloom	Dry	0	87.2	12.8	Date
Large Bloom	Moderate	0	52.9	47.1	Date

Large Bloom	Wet	0	50	50	Date
Large Bloom	Very Wet	0	25	75	Date

6.16 Total Nitrogen (totaln, mg/L) – Three Lake Segments

Conditioned on:

- Total Nitrogen Load (tnloadman, lbs/mo)
- Residence Time (resid30, days)

Upper:

tnloadman	resid30	totaln: Very Low	totaln: Low	totaln: Moderate	totaln: High	totaln: Very High	Match Method
Very Low	Shorter	0.1	0.1	9.4	37.5	52.9	Month
Very Low	Short	0.1	0.1	31.8	33.3	34.7	Half-Month
Very Low	Moderate	0.1	17.2	24.1	13.8	44.8	Date
Very Low	Long	0.1	0.1	4.2	20.8	74.8	Date
Very Low	Longer	1.5	1.5	10.7	25.2	61.1	Date
Low	Shorter	0.1	0.1	6.9	16.1	76.8	Half-Month
Low	Short	0.1	0.1	17.5	31.6	50.7	Half-Month
Low	Moderate	0.2	2	20.3	45.4	32.1	Half-Month
Low	Long	0.1	0.1	12.5	15	72.3	Date
Low	Longer	1.8	1.8	5.3	22.8	68.3	Date
Moderate	Shorter	0.1	0.1	12.5	32.5	54.8	Date
Moderate	Short	3.1	6.2	32.8	37.6	20.3	Date
Moderate	Moderate	6.7	6.7	20	0.1	66.5	Date
Moderate	Long	5	0.1	0.1	25	69.8	Date
Moderate	Longer	0.1	3.2	16.1	19.4	61.2	Date
High	Shorter	5.4	4.3	21.7	28.3	40.3	Date
High	Short	4.8	9.5	19	26.2	40.5	Date
High	Moderate	1.3	0.1	21.7	26.2	50.7	Half-Month
High	Long	0.1	0.1	3	29.6	67.2	Half-Month
High	Longer	0.1	0.1	7.7	61.3	30.8	Date
Very High	Shorter	2.8	2.8	20.1	41	33.3	Date
Very High	Short	5.6	0.4	25.7	19.6	48.7	Half-Month
Very High	Moderate	0.1	0.1	46.7	12.3	40.8	Half-Month
Very High	Long	0.1	0.1	0.1	33.3	66.4	Half-Month
Very High	Longer	0.1	0.1	0.1	12.5	87.2	Month

Middle:

tnloadman	resid30	totaln: Very Low	totaln: Low	totaln: Moderate	totaln: High	totaln: Very High	Match Method
Very Low	Shorter	0.1	37.5	62.2	0.1	0.1	Half-Month
Very Low	Short	0.1	47.9	51.8	0.1	0.1	Half-Month
Very Low	Moderate	0.1	46.8	46.8	6.2	0.1	Half-Month
Very Low	Long	0.1	35	54.8	0.1	10	Date
Very Low	Longer	10.9	34.5	32.8	15.1	6.7	Date
Low	Shorter	6.5	35.1	58.2	0.1	0.1	Half-Month
Low	Short	8.8	25.2	57.8	7.1	1.1	Half-Month
Low	Moderate	6.2	3.1	25	21.9	43.8	Date
Low	Long	1.4	39.2	30.4	11.6	17.4	Date
Low	Longer	12.1	35.3	29.3	21.6	1.7	Date
Moderate	Shorter	13.9	49.9	22.2	13.9	0.1	Date
Moderate	Short	26.8	43.9	7.3	17.1	4.9	Date
Moderate	Moderate	12.5	49.9	25	12.5	0.1	Date
Moderate	Long	6.5	26.1	26.1	28.3	13	Date
Moderate	Longer	12.2	38.5	32.4	14.9	2	Date
High	Shorter	6.7	19.5	32.3	33	8.5	Date
High	Short	7.1	48.1	37.6	7.1	0.1	Date
High	Moderate	0.1	90.6	9.1	0.1	0.1	Date
High	Long	6	35.4	32.5	19.2	6.9	Half-Month
High	Longer	23.8	28.6	23.8	16.7	7.1	Date
Very High	Shorter	1.8	20	32.3	34.1	11.8	Date
Very High	Short	7.4	44.4	37	11.1	0.1	Date
Very High	Moderate	3	58.2	36.4	2.3	0.1	Half-Month
Very High	Long	2.7	56.6	34.1	6.5	0.1	Half-Month
Very High	Longer	7.7	55.7	36.4	0.1	0.1	Half-Month

Lower:

tnloadman	resid30	totaln: Very Low	totaln: Low	totaln: Moderate	totaln: High	totaln: Very High	Match Method
Very Low	Shorter	0.1	20	79.7	0.1	0.1	Half-Month
Very Low	Short	35.8	21.8	16.7	25.6	0.1	Half-Month
Very Low	Moderate	52.8	14.9	12.4	19.8	0.1	Half-Month
Very Low	Long	51.9	25.9	7.4	7.4	7.4	Date
Very Low	Longer	2.1	29.2	34.3	25	9.4	Date
Low	Shorter	13.2	17	67.8	0.1	1.9	Half-Month
Low	Short	76.9	6	4.1	10	3	Half-Month
Low	Moderate	79.9	8	4	8	0.1	Date

tnloadman	resid30	totaln: Very Low	totaln: Low	totaln: Moderate	totaln: High	totaln: Very High	Match Method
Low	Long	79.8	10	10	0.1	0.1	Date
Low	Longer	51.2	27	6.8	14.9	0.1	Date
Moderate	Shorter	33.3	16.7	49.8	0.1	0.1	Date
Moderate	Short	41.4	10.3	13.8	27.6	6.9	Date
Moderate	Moderate	52.1	26.1	8.7	13	0.1	Date
Moderate	Long	83	16.7	0.1	0.1	0.1	Date
Moderate	Longer	48.4	17.2	10.3	13.8	10.3	Date
High	Shorter	31	18	22	27	2	Date
High	Short	42.1	35.6	20	2.2	0.1	Date
High	Moderate	46	20.7	14.1	17.3	1.9	Half-Month
High	Long	48.3	39.6	2.5	8.3	1.3	Half-Month
High	Longer	45.9	38.5	0.1	15.4	0.1	Date
Very High	Shorter	13.3	25.8	25.8	27.6	7.5	Date
Very High	Short	49.8	34.9	4.4	8.2	2.7	Half-Month
Very High	Moderate	46.5	44.9	8.4	0.1	0.1	Half-Month
Very High	Long	2.4	97.3	0.1	0.1	0.1	Half-Month
Very High	Longer	33.3	66.4	0.1	0.1	0.1	Half-Month

6.17 Total Phosphorus (totalp, mg/L) – Three Lake Segments

Conditioned on:

- Total Phosphorus Load (tploadman, lbs/mo)
- Residence Time (resid30, days)

Upper:

tploadman	resid30	totalp: Very Low	totalp: Low	totalp: Moderate	totalp: High	totalp: Very High	Match Method
Very Low	Shorter	16.3	0.1	5.4	12.8	65.4	Half-Month
Very Low	Short	14.2	0.1	9.5	25.3	50.9	Half-Month
Very Low	Moderate	0.1	0.1	9.1	63.4	27.3	Date
Very Low	Long	11.4	2.3	2.3	29.5	54.5	Date
Very Low	Longer	3.4	1.1	4.5	20.5	70.5	Date
Low	Shorter	5	5	0.1	15	74.9	Date
Low	Short	9.5	0.1	23.8	38	28.6	Date
Low	Moderate	3.7	3.7	0.1	3.7	88.8	Date
Low	Long	0.1	2.4	2.4	16.7	78.4	Date
Low	Longer	4	0.1	6	18	71.9	Date

tploadman	resid30	totalp: Very Low	totalp: Low	totalp: Moderate	totalp: High	totalp: Very High	Match Method
Moderate	Shorter	4.3	6.5	6.5	41.4	41.3	Date
Moderate	Short	2.2	4.4	13.3	26.7	53.4	Date
Moderate	Moderate	0.9	5.1	6.1	2.4	85.5	Half-Month
Moderate	Long	8.7	4.3	0.1	8.7	78.2	Date
Moderate	Longer	0.1	0.1	0.1	5.6	94.1	Date
High	Shorter	19.2	0.1	5.8	13.5	61.4	Date
High	Short	0.1	0.1	7.1	21.4	71.3	Date
High	Moderate	4.5	0.1	11.7	13.8	69.9	Half-Month
High	Long	4.8	0.1	4.8	9.5	80.8	Date
High	Longer	0.1	0.1	0.1	10.5	89.2	Date
Very High	Shorter	2.3	0.8	10.6	26.5	59.8	Date
Very High	Short	4.8	4.8	9.5	14.3	66.6	Date
Very High	Moderate	0.1	0.1	26.1	19.8	53.9	Half-Month
Very High	Long	0.1	0.1	2	8.6	89.2	Half-Month
Very High	Longer	0.1	0.1	0.1	6.2	93.5	Date

Middle:

tploadman	resid30	totalp: Very Low	totalp: Low	totalp: Moderate	totalp: High	totalp: Very High	Match Method
Very Low	Shorter	0.1	26.2	31.2	34.5	8	Half-Month
Very Low	Short	0.1	47.6	34.8	16.2	1.3	Half-Month
Very Low	Moderate	0.1	49.8	35.7	14.3	0.1	Date
Very Low	Long	0.1	59.8	20	20	0.1	Date
Very Low	Longer	0.1	54.7	24.5	19.8	0.9	Date
Low	Shorter	0.1	11.9	35.7	45.2	7.1	Date
Low	Short	0.1	33.3	37.9	28.6	0.1	Date
Low	Moderate	2.9	55.8	29.4	11.8	0.1	Date
Low	Long	3.3	43.3	26.7	20	6.7	Date
Low	Longer	1	47	38	13	1	Date
Moderate	Shorter	0.1	14.7	14.7	47	23.5	Date
Moderate	Short	0.1	73	26.7	0.1	0.1	Date
Moderate	Moderate	0.1	27.9	30.2	20.9	20.9	Date
Moderate	Long	0.1	38	31.7	28.6	1.6	Date
Moderate	Longer	1.4	55	23.9	18.3	1.4	Date

tploadman	resid30	totalp: Very Low	totalp: Low	totalp: Moderate	totalp: High	totalp: Very High	Match Method
High	Shorter	1	28.2	33.9	29.1	7.8	Date
High	Short	1.3	36.6	27.8	34.2	0.1	Date
High	Moderate	0.1	43.7	21.5	21.3	13.4	Half-Month
High	Long	0.1	41.6	25	20.8	12.5	Date
High	Longer	0.1	31	42.1	25.4	1.4	Date
Very High	Shorter	0.1	19.2	28.8	45.7	6.2	Date
Very High	Short	0.1	7.7	30.8	49.9	11.5	Date
Very High	Moderate	0.1	37.9	35.7	21.9	4.4	Half-Month
Very High	Long	0.1	19.3	45.4	29.9	5.3	Half-Month
Very High	Longer	0.1	34.6	49.8	15.4	0.1	Date

Lower:

tploadman	resid30	totalp: Very Low	totalp: Low	totalp: Moderate	totalp: High	totalp: Very High	Match Method
Very Low	Shorter	25	35	20	12.5	7.5	Date
Very Low	Short	62.8	20	5.7	2.9	8.6	Date
Very Low	Moderate	20	59.9	6.7	6.7	6.7	Date
Very Low	Long	41.5	50.4	5.2	1.4	1.5	Half-Month
Very Low	Longer	30.1	56.9	9.7	1.1	2.2	Date
Low	Shorter	28.8	23.7	21.1	21.1	5.3	Date
Low	Short	34.9	30.4	4.3	21.7	8.7	Date
Low	Moderate	72.9	23.1	3.8	0.1	0.1	Date
Low	Long	84.7	15	0.1	0.1	0.1	Date
Low	Longer	59.2	37.3	1.7	1.7	0.1	Date
Moderate	Shorter	13	26.1	34.7	26.1	0.1	Date
Moderate	Short	12.5	41.7	12.5	8.3	25	Date
Moderate	Moderate	83.2	3.3	6.7	0.1	6.7	Date
Moderate	Long	90.8	8.9	0.1	0.1	0.1	Date
Moderate	Longer	79.2	20.5	0.1	0.1	0.1	Date
High	Shorter	40.3	30.2	15.8	7.2	6.5	Date
High	Short	39.5	47.2	7.9	5.3	0.1	Date
High	Moderate	53.5	34.8	8.9	1.2	1.6	Half-Month
High	Long	49.85	49.85	0.1	0.1	0.1	Date
High	Longer	12.5	87.2	0.1	0.1	0.1	Date

tploadman	resid30	totalp: Very Low	totalp: Low	totalp: Moderate	totalp: High	totalp: Very High	Match Method
Very High	Shorter	37.3	33	13.2	15.4	1.1	Date
Very High	Short	55.7	35.9	8.2	0.1	0.1	Half-Month
Very High	Moderate	11.8	83.7	4.3	0.1	0.1	Half-Month
Very High	Long	27.2	40.3	3.6	19.3	9.6	Half-Month
Very High	Longer	41.6	33.3	0.1	16.7	8.3	Date

6.18 Total Algal Biovolume (totbiovman, mm3/m3) – Upper Lake Segment

Conditioned on:

- Total Nitrogen (totaln, mg/L)
- Total Phosphorus (totalp, mg/L)
- Residence Time (resid30, days)
- Secchi Depth (secchi, ft)
- Water Temperature (wtemp, C)

Upper:

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	Very Low	Shorter	Low	Low	0.1	99.7	0.1	0.1	Lower Month
Very Low	Very Low	Shorter	Low	Moderate	0.1	0.1	35.9	63.9	Half-Month
Very Low	Very Low	Shorter	Low	High	0.1	0.1	33.3	66.5	Half-Month
Very Low	Very Low	Shorter	Moderate	Low	0.1	99.7	0.1	0.1	Lower Month
Very Low	Very Low	Shorter	Moderate	Moderate	0.1	0.1	41	58.8	Half-Month
Very Low	Very Low	Shorter	Moderate	High	0.1	0.1	33.3	66.5	Half-Month
Very Low	Very Low	Shorter	High	Low	0.1	99.7	0.1	0.1	Lower Month
Very Low	Very Low	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
Very Low	Very Low	Shorter	High	High	0.1	0.1	99.7	0.1	Month
Very Low	Very Low	Short	Low	Low	0.1	99.7	0.1	0.1	Lower Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	Very Low	Short	Low	Moderate	0.1	0.1	99.7	0.1	Half-Month
Very Low	Very Low	Short	Low	High	0.1	0.1	57.4	42.4	Month
Very Low	Very Low	Short	Moderate	Low	0.1	99.7	0.1	0.1	Lower Month
Very Low	Very Low	Short	Moderate	Moderate	0.1	0.1	99.7	0.1	Half-Month
Very Low	Very Low	Short	Moderate	High	0.1	0.1	61.2	38.6	Month
Very Low	Very Low	Short	High	Low	0.1	99.7	0.1	0.1	Lower Month
Very Low	Very Low	Short	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
Very Low	Very Low	Short	High	High	0.1	0.1	99.7	0.1	Month
Very Low	Very Low	Moderate	Low	Low	25	49.9	25	0.1	Interpolate
Very Low	Very Low	Moderate	Low	Moderate	0.1	0.2	99.6	0.1	Month
Very Low	Very Low	Moderate	Low	High	0.1	34.8	65	0.1	Month
Very Low	Very Low	Moderate	Moderate	Low	99.7	0.1	0.1	0.1	Lower Month
Very Low	Very Low	Moderate	Moderate	Moderate	0.1	0.1	99.7	0.1	Month
Very Low	Very Low	Moderate	Moderate	High	0.1	0.1	99.7	0.1	Month
Very Low	Very Low	Moderate	High	Low	99.7	0.1	0.1	0.1	Lower Month
Very Low	Very Low	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Month
Very Low	Very Low	Moderate	High	High	0.1	0.1	99.7	0.1	Month
Very Low	Very Low	Long	Low	Low	33.3	66.5	0.1	0.1	Interpolate
Very Low	Very Low	Long	Low	Moderate	0.1	99.7	0.1	0.1	Month
Very Low	Very Low	Long	Low	High	0.1	99.7	0.1	0.1	Month
Very Low	Very Low	Long	Moderate	Low	99.7	0.1	0.1	0.1	Lower Month
Very Low	Very Low	Long	Moderate	Moderate	0.1	0.1	0.1	99.7	Lower Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	Very Low	Long	Moderate	High	0.1	0.1	99.7	0.1	Middle Month
Very Low	Very Low	Long	High	Low	99.7	0.1	0.1	0.1	Lower Date
Very Low	Very Low	Long	High	Moderate	14.5	0.1	49.6	35.8	Lower Date
Very Low	Very Low	Long	High	High	0.1	0.1	99.7	0.1	Middle Month
Very Low	Very Low	Longer	Low	Low	0.1	77.7	11.1	11.1	Interpolate
Very Low	Very Low	Longer	Low	Moderate	0.1	99.7	0.1	0.1	Month
Very Low	Very Low	Longer	Low	High	0.1	99.7	0.1	0.1	Month
Very Low	Very Low	Longer	Moderate	Low	0.1	99.7	0.1	0.1	Middle Date
Very Low	Very Low	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Middle Date
Very Low	Very Low	Longer	Moderate	High	0.1	99.7	0.1	0.1	Middle Date
Very Low	Very Low	Longer	High	Low	0.1	99.7	0.1	0.1	Middle Date
Very Low	Very Low	Longer	High	Moderate	0.1	99.7	0.1	0.1	Middle Date
Very Low	Very Low	Longer	High	High	0.1	99.7	0.1	0.1	Middle Date
Very Low	Low	Shorter	Low	Low	86.1	13.7	0.1	0.1	Middle Month
Very Low	Low	Shorter	Low	Moderate	99.7	0.1	0.1	0.1	Half-Month
Very Low	Low	Shorter	Low	High	0.1	0.1	99.7	0.1	Month
Very Low	Low	Shorter	Moderate	Low	99.7	0.1	0.1	0.1	Middle Date
Very Low	Low	Shorter	Moderate	Moderate	99.7	0.1	0.1	0.1	Half-Month
Very Low	Low	Shorter	Moderate	High	0.1	0.1	99.7	0.1	Month
Very Low	Low	Shorter	High	Low	99.7	0.1	0.1	0.1	Middle Date
Very Low	Low	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Month
Very Low	Low	Shorter	High	High	0.1	0.1	99.7	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	Low	Short	Low	Low	20.8	79	0.1	0.1	Middle Month
Very Low	Low	Short	Low	Moderate	99.7	0.1	0.1	0.1	Half-Month
Very Low	Low	Short	Low	High	0.1	0.1	99.7	0.1	Month
Very Low	Low	Short	Moderate	Low	53.6	46.2	0.1	0.1	Middle Month
Very Low	Low	Short	Moderate	Moderate	99.7	0.1	0.1	0.1	Half-Month
Very Low	Low	Short	Moderate	High	0.1	0.1	99.7	0.1	Month
Very Low	Low	Short	High	Low	6.1	93.7	0.1	0.1	Middle Month
Very Low	Low	Short	High	Moderate	0.1	0.1	99.7	0.1	Month
Very Low	Low	Short	High	High	0.1	0.1	99.7	0.1	Month
Very Low	Low	Moderate	Low	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very Low	Low	Moderate	Low	Moderate	0.1	0.1	99.7	0.1	Month
Very Low	Low	Moderate	Low	High	0.1	0.1	99.7	0.1	Month
Very Low	Low	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very Low	Low	Moderate	Moderate	Moderate	0.1	0.1	99.7	0.1	Month
Very Low	Low	Moderate	Moderate	High	0.1	0.1	99.7	0.1	Month
Very Low	Low	Moderate	High	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	Low	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Month
Very Low	Low	Moderate	High	High	0.1	0.1	99.7	0.1	Month
Very Low	Low	Long	Low	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very Low	Low	Long	Low	Moderate	39.6	60.2	0.1	0.1	Middle Month
Very Low	Low	Long	Low	High	0.1	0.1	99.7	0.1	Middle Half-Month
Very Low	Low	Long	Moderate	Low	0.1	99.7	0.1	0.1	Middle Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	Low	Long	Moderate	Moderate	81.8	18	0.1	0.1	Middle Half-Month
Very Low	Low	Long	Moderate	High	73.8	26	0.1	0.1	Middle Date
Very Low	Low	Long	High	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	Low	Long	High	Moderate	99.5	0.3	0.1	0.1	Middle Half-Month
Very Low	Low	Long	High	High	43.8	56	0.1	0.1	Middle Date
Very Low	Low	Longer	Low	Low	0.1	33.3	33.3	33.3	Month
Very Low	Low	Longer	Low	Moderate	38	61.8	0.1	0.1	Middle Date
Very Low	Low	Longer	Low	High	0.1	99.7	0.1	0.1	Middle Date
Very Low	Low	Longer	Moderate	Low	0.1	33.3	33.3	33.3	Month
Very Low	Low	Longer	Moderate	Moderate	53.8	41.3	4.8	0.1	Middle Date
Very Low	Low	Longer	Moderate	High	70.8	29	0.1	0.1	Middle Date
Very Low	Low	Longer	High	Low	74.4	22.3	3.2	0.1	Middle Date
Very Low	Low	Longer	High	Moderate	44.5	19.7	35.7	0.1	Middle Date
Very Low	Low	Longer	High	High	91.2	8.6	0.1	0.1	Middle Date
Very Low	Moderate	Shorter	Low	Low	0.1	0.1	0.1	99.7	Month
Very Low	Moderate	Shorter	Low	Moderate	86.6	0.1	13.2	0.1	Half-Month
Very Low	Moderate	Shorter	Low	High	0.1	0.1	31.5	68.3	Month
Very Low	Moderate	Shorter	Moderate	Low	0.1	0.1	0.1	99.7	Month
Very Low	Moderate	Shorter	Moderate	Moderate	72.5	0.1	27.3	0.1	Half-Month
Very Low	Moderate	Shorter	Moderate	High	0.1	0.1	51.5	48.3	Month
Very Low	Moderate	Shorter	High	Low	47.6	52.2	0.1	0.1	Middle Month
Very Low	Moderate	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	Moderate	Shorter	High	High	0.1	0.1	99.7	0.1	Month
Very Low	Moderate	Short	Low	Low	30.4	69.4	0.1	0.1	Middle Month
Very Low	Moderate	Short	Low	Moderate	58.7	0.1	41.1	0.1	Half-Month
Very Low	Moderate	Short	Low	High	0.1	0.1	99.7	0.1	Month
Very Low	Moderate	Short	Moderate	Low	59.1	40.7	0.1	0.1	Middle Month
Very Low	Moderate	Short	Moderate	Moderate	36.8	0.1	63	0.1	Half-Month
Very Low	Moderate	Short	Moderate	High	0.1	0.1	99.7	0.1	Month
Very Low	Moderate	Short	High	Low	9.4	90.4	0.1	0.1	Middle Month
Very Low	Moderate	Short	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
Very Low	Moderate	Short	High	High	0.1	0.1	99.7	0.1	Month
Very Low	Moderate	Moderate	Low	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very Low	Moderate	Moderate	Low	Moderate	0.1	0.1	99.7	0.1	Month
Very Low	Moderate	Moderate	Low	High	0.1	0.1	99.7	0.1	Month
Very Low	Moderate	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very Low	Moderate	Moderate	Moderate	Moderate	0.1	0.1	99.7	0.1	Month
Very Low	Moderate	Moderate	Moderate	High	0.1	0.1	99.7	0.1	Month
Very Low	Moderate	Moderate	High	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	Moderate	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Month
Very Low	Moderate	Moderate	High	High	0.1	0.1	99.7	0.1	Month
Very Low	Moderate	Long	Low	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very Low	Moderate	Long	Low	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very Low	Moderate	Long	Low	High	0.1	0.1	99.7	0.1	Middle Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	Moderate	Long	Moderate	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very Low	Moderate	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Middle Half-Month
Very Low	Moderate	Long	Moderate	High	99.7	0.1	0.1	0.1	Middle Date
Very Low	Moderate	Long	High	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	Moderate	Long	High	Moderate	0.1	99.7	0.1	0.1	Middle Half-Month
Very Low	Moderate	Long	High	High	99.7	0.1	0.1	0.1	Middle Date
Very Low	Moderate	Longer	Low	Low	0.1	72.1	27.7	0.1	Middle Date
Very Low	Moderate	Longer	Low	Moderate	0.1	99.7	0.1	0.1	Middle Date
Very Low	Moderate	Longer	Low	High	0.1	99.7	0.1	0.1	Middle Date
Very Low	Moderate	Longer	Moderate	Low	0.1	78.5	21.3	0.1	Middle Date
Very Low	Moderate	Longer	Moderate	Moderate	0.1	82.3	17.5	0.1	Middle Date
Very Low	Moderate	Longer	Moderate	High	0.1	99.7	0.1	0.1	Middle Date
Very Low	Moderate	Longer	High	Low	0.1	69.9	29.9	0.1	Middle Date
Very Low	Moderate	Longer	High	Moderate	0.1	25.2	74.6	0.1	Middle Date
Very Low	Moderate	Longer	High	High	0.1	99.7	0.1	0.1	Middle Date
Very Low	High	Shorter	Low	Low	0.1	4.3	0.1	95.5	Month
Very Low	High	Shorter	Low	Moderate	20.2	0.1	28.7	51	Half-Month
Very Low	High	Shorter	Low	High	0.1	0.1	33.3	66.5	Half-Month
Very Low	High	Shorter	Moderate	Low	0.1	0.1	0.1	99.7	Month
Very Low	High	Shorter	Moderate	Moderate	23.4	0.1	31.4	45.1	Half-Month
Very Low	High	Shorter	Moderate	High	0.1	0.1	33.3	66.5	Half-Month
Very Low	High	Shorter	High	Low	10	89.8	0.1	0.1	Middle Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	High	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
Very Low	High	Shorter	High	High	0.1	0.1	99.7	0.1	Month
Very Low	High	Short	Low	Low	0.1	99.7	0.1	0.1	Month
Very Low	High	Short	Low	Moderate	58.7	0.1	41.1	0.1	Half-Month
Very Low	High	Short	Low	High	0.1	0.1	79.5	20.3	Month
Very Low	High	Short	Moderate	Low	23.7	76.1	0.1	0.1	Middle Month
Very Low	High	Short	Moderate	Moderate	36.8	0.1	63	0.1	Half-Month
Very Low	High	Short	Moderate	High	0.1	0.1	82.8	17	Month
Very Low	High	Short	High	Low	3.6	96.2	0.1	0.1	Middle Month
Very Low	High	Short	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
Very Low	High	Short	High	High	0.1	0.1	99.7	0.1	Month
Very Low	High	Moderate	Low	Low	0.1	99.7	0.1	0.1	Month
Very Low	High	Moderate	Low	Moderate	0.1	0.1	99.7	0.1	Month
Very Low	High	Moderate	Low	High	0.1	21.1	78.7	0.1	Month
Very Low	High	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very Low	High	Moderate	Moderate	Moderate	0.1	0.1	99.7	0.1	Month
Very Low	High	Moderate	Moderate	High	0.1	0.1	99.7	0.1	Month
Very Low	High	Moderate	High	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	High	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Month
Very Low	High	Moderate	High	High	0.1	0.1	99.7	0.1	Month
Very Low	High	Long	Low	Low	0.1	99.7	0.1	0.1	Month
Very Low	High	Long	Low	Moderate	0.1	99.7	0.1	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	High	Long	Low	High	0.1	99.7	0.1	0.1	Month
Very Low	High	Long	Moderate	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very Low	High	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Middle Half-Month
Very Low	High	Long	Moderate	High	0.1	46	50.6	3.3	Middle Half-Month
Very Low	High	Long	High	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	High	Long	High	Moderate	0.1	99.7	0.1	0.1	Middle Half-Month
Very Low	High	Long	High	High	0.1	12.8	65.7	21.4	Middle Half-Month
Very Low	High	Longer	Low	Low	0.1	49.9	0.1	49.9	Date
Very Low	High	Longer	Low	Moderate	0.1	99.7	0.1	0.1	Month
Very Low	High	Longer	Low	High	0.1	99.7	0.1	0.1	Month
Very Low	High	Longer	Moderate	Low	0.1	49.9	0.1	49.9	Date
Very Low	High	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Middle Date
Very Low	High	Longer	Moderate	High	0.1	99.7	0.1	0.1	Middle Date
Very Low	High	Longer	High	Low	0.1	43.9	55.9	0.1	Middle Date
Very Low	High	Longer	High	Moderate	0.1	99.7	0.1	0.1	Middle Date
Very Low	High	Longer	High	High	0.1	99.7	0.1	0.1	Middle Date
Very Low	Very High	Shorter	Low	Low	0.1	40.2	0.1	59.6	Month
Very Low	Very High	Shorter	Low	Moderate	0.1	0.1	0.1	99.7	Date
Very Low	Very High	Shorter	Low	High	0.1	0.1	0.1	99.7	Date
Very Low	Very High	Shorter	Moderate	Low	0.1	0.1	0.1	99.7	Month
Very Low	Very High	Shorter	Moderate	Moderate	5.1	0.1	35.5	59.3	Half-Month
Very Low	Very High	Shorter	Moderate	High	0.1	0.1	33.3	66.5	Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	Very High	Shorter	High	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
Very Low	Very High	Shorter	High	High	0.1	0.1	99.7	0.1	Month
Very Low	Very High	Short	Low	Low	0.1	99.7	0.1	0.1	Month
Very Low	Very High	Short	Low	Moderate	32.4	0.1	67.4	0.1	Half-Month
Very Low	Very High	Short	Low	High	0.1	0.1	75.2	24.6	Month
Very Low	Very High	Short	Moderate	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Short	Moderate	Moderate	16.3	0.1	83.5	0.1	Half-Month
Very Low	Very High	Short	Moderate	High	0.1	0.1	78.9	20.9	Month
Very Low	Very High	Short	High	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Short	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
Very Low	Very High	Short	High	High	0.1	0.1	99.7	0.1	Month
Very Low	Very High	Moderate	Low	Low	0.1	99.7	0.1	0.1	Month
Very Low	Very High	Moderate	Low	Moderate	0.1	0.1	99.7	0.1	Month
Very Low	Very High	Moderate	Low	High	0.1	23.7	76.1	0.1	Month
Very Low	Very High	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Moderate	Moderate	Moderate	0.1	0.1	99.7	0.1	Month
Very Low	Very High	Moderate	Moderate	High	0.1	0.1	99.7	0.1	Month
Very Low	Very High	Moderate	High	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Month
Very Low	Very High	Moderate	High	High	0.1	0.1	99.7	0.1	Month
Very Low	Very High	Long	Low	Low	0.1	99.7	0.1	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	Very High	Long	Low	Moderate	0.1	99.7	0.1	0.1	Month
Very Low	Very High	Long	Low	High	0.1	99.7	0.1	0.1	Month
Very Low	Very High	Long	Moderate	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Long	Moderate	High	0.1	0.1	99.7	0.1	Middle Date
Very Low	Very High	Long	High	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Long	High	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Long	High	High	0.1	0.1	99.7	0.1	Middle Half-Month
Very Low	Very High	Longer	Low	Low	0.1	49.9	0.1	49.9	Date
Very Low	Very High	Longer	Low	Moderate	49.9	49.9	0.1	0.1	Date
Very Low	Very High	Longer	Low	High	0.1	99.7	0.1	0.1	Month
Very Low	Very High	Longer	Moderate	Low	0.1	49.9	0.1	49.9	Date
Very Low	Very High	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Longer	Moderate	High	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Longer	High	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Longer	High	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Longer	High	High	0.1	99.7	0.1	0.1	Middle Month
Low	Very Low	Shorter	Low	Low	0.1	99.7	0.1	0.1	Month
Low	Very Low	Shorter	Low	Moderate	0.1	0.1	0.1	99.7	Half-Month
Low	Very Low	Shorter	Low	High	0.1	46.7	0.1	53.1	Half-Month
Low	Very Low	Shorter	Moderate	Low	0.1	99.7	0.1	0.1	Month
Low	Very Low	Shorter	Moderate	Moderate	0.1	0.1	0.1	99.7	Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Low	Very Low	Shorter	Moderate	High	0.1	63.4	0.1	36.4	Half-Month
Low	Very Low	Shorter	High	Low	11.3	0.1	88.5	0.1	Lower Half-Month
Low	Very Low	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Month
Low	Very Low	Shorter	High	High	0.1	0.1	99.7	0.1	Month
Low	Very Low	Short	Low	Low	0.1	99.7	0.1	0.1	Month
Low	Very Low	Short	Low	Moderate	74.1	8.4	17.4	0.1	Month
Low	Very Low	Short	Low	High	0.1	85.9	13.9	0.1	Month
Low	Very Low	Short	Moderate	Low	0.1	99.7	0.1	0.1	Month
Low	Very Low	Short	Moderate	Moderate	50.9	5.1	43.9	0.1	Month
Low	Very Low	Short	Moderate	High	0.1	86.9	12.9	0.1	Month
Low	Very Low	Short	High	Low	0.1	38.6	61.2	0.1	Lower Half-Month
Low	Very Low	Short	High	Moderate	0.1	0.1	99.7	0.1	Month
Low	Very Low	Short	High	High	0.1	0.1	99.7	0.1	Month
Low	Very Low	Moderate	Low	Low	18.1	56.8	25	0.1	Interpolate
Low	Very Low	Moderate	Low	Moderate	0.1	0.1	99.7	0.1	Month
Low	Very Low	Moderate	Low	High	0.1	85.9	13.9	0.1	Month
Low	Very Low	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Lower Half-Month
Low	Very Low	Moderate	Moderate	Moderate	0.1	0.1	99.7	0.1	Month
Low	Very Low	Moderate	Moderate	High	0.1	86.9	12.9	0.1	Month
Low	Very Low	Moderate	High	Low	0.1	99.7	0.1	0.1	Lower Half-Month
Low	Very Low	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Month
Low	Very Low	Moderate	High	High	0.1	0.1	99.7	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Low	Very Low	Long	Low	Low	39.9	59.9	0.1	0.1	Interpolate
Low	Very Low	Long	Low	Moderate	0.1	56.8	16.7	26.4	Interpolate
Low	Very Low	Long	Low	High	0.1	99.7	0.1	0.1	Month
Low	Very Low	Long	Moderate	Low	0.1	99.7	0.1	0.1	Lower Half-Month
Low	Very Low	Long	Moderate	Moderate	0.1	27.4	0.1	72.4	Lower Date
Low	Very Low	Long	Moderate	High	0.1	99.7	0.1	0.1	Month
Low	Very Low	Long	High	Low	99.7	0.1	0.1	0.1	Lower Date
Low	Very Low	Long	High	Moderate	16.8	0.1	0.1	83	Lower Date
Low	Very Low	Long	High	High	0.1	0.1	99.7	0.1	Middle Month
Low	Very Low	Longer	Low	Low	0.1	49.9	49.9	0.1	Interpolate
Low	Very Low	Longer	Low	Moderate	13.2	86.2	0.1	0.5	Interpolate
Low	Very Low	Longer	Low	High	0.1	99.7	0.1	0.1	Middle Date
Low	Very Low	Longer	Moderate	Low	0.1	99.7	0.1	0.1	Middle Date
Low	Very Low	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Middle Date
Low	Very Low	Longer	Moderate	High	0.1	99.7	0.1	0.1	Middle Date
Low	Very Low	Longer	High	Low	0.1	99.7	0.1	0.1	Middle Date
Low	Very Low	Longer	High	Moderate	0.1	99.7	0.1	0.1	Middle Date
Low	Very Low	Longer	High	High	0.1	99.7	0.1	0.1	Middle Date
Low	Low	Shorter	Low	Low	0.1	99.7	0.1	0.1	Month
Low	Low	Shorter	Low	Moderate	99.7	0.1	0.1	0.1	Half-Month
Low	Low	Shorter	Low	High	0.1	0.1	44	55.8	Month
Low	Low	Shorter	Moderate	Low	0.1	99.7	0.1	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Low	Low	Shorter	Moderate	Moderate	99.7	0.1	0.1	0.1	Half-Month
Low	Low	Shorter	Moderate	High	0.1	0.1	26.3	73.5	Month
Low	Low	Shorter	High	Low	57	0.1	0.1	42.8	Middle Date
Low	Low	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Month
Low	Low	Shorter	High	High	0.1	0.1	99.7	0.1	Month
Low	Low	Short	Low	Low	0.1	99.7	0.1	0.1	Month
Low	Low	Short	Low	Moderate	99.7	0.1	0.1	0.1	Half-Month
Low	Low	Short	Low	High	0.1	0.1	65.7	34.1	Month
Low	Low	Short	Moderate	Low	0.1	99.7	0.1	0.1	Month
Low	Low	Short	Moderate	Moderate	99.7	0.1	0.1	0.1	Half-Month
Low	Low	Short	Moderate	High	0.1	0.1	47	52.8	Month
Low	Low	Short	High	Low	88.9	0.1	0.1	10.9	Middle Half-Month
Low	Low	Short	High	Moderate	0.1	0.1	99.7	0.1	Month
Low	Low	Short	High	High	0.1	0.1	99.7	0.1	Month
Low	Low	Moderate	Low	Low	72.1	27.7	0.1	0.1	Middle Half-Month
Low	Low	Moderate	Low	Moderate	0.1	0.1	99.7	0.1	Month
Low	Low	Moderate	Low	High	0.1	0.1	99.7	0.1	Month
Low	Low	Moderate	Moderate	Low	44.4	0.1	55.4	0.1	Middle Date
Low	Low	Moderate	Moderate	Moderate	0.1	0.1	99.7	0.1	Month
Low	Low	Moderate	Moderate	High	0.1	0.1	99.7	0.1	Month
Low	Low	Moderate	High	Low	43.1	0.1	56.7	0.1	Middle Date
Low	Low	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Month
Low	Low	Moderate	High	High	0.1	0.1	99.7	0.1	Month
Low	Low	Long	Low	Low	79.5	20.3	0.1	0.1	Middle Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Low	Low	Long	Low	Moderate	0.1	14.1	0.1	85.7	Middle Date
Low	Low	Long	Low	High	5.8	4.1	53	37.1	Middle Date
Low	Low	Long	Moderate	Low	0.1	99.7	0.1	0.1	Middle Date
Low	Low	Long	Moderate	Moderate	1.5	86.1	0.1	12.3	Middle Date
Low	Low	Long	Moderate	High	49.6	2.3	26.8	21.3	Middle Date
Low	Low	Long	High	Low	0.1	99.7	0.1	0.1	Middle Date
Low	Low	Long	High	Moderate	6	93.8	0.1	0.1	Middle Date
Low	Low	Long	High	High	95.1	0.1	4.7	0.1	Middle Date
Low	Low	Longer	Low	Low	0.1	0.1	99.7	0.1	Date
Low	Low	Longer	Low	Moderate	66	31.5	0.1	2.4	Middle Date
Low	Low	Longer	Low	High	0.1	43.4	0.1	56.4	Middle Date
Low	Low	Longer	Moderate	Low	0.1	0.1	99.7	0.1	Date
Low	Low	Longer	Moderate	Moderate	62.4	10.3	4.1	23.2	Middle Date
Low	Low	Longer	Moderate	High	26.3	42.7	0.1	30.9	Middle Date
Low	Low	Longer	High	Low	52.8	33	12.4	1.8	Middle Date
Low	Low	Longer	High	Moderate	8.3	17	68.5	6.2	Middle Date
Low	Low	Longer	High	High	65.7	24.9	0.1	9.3	Middle Date
Low	Moderate	Shorter	Low	Low	0.1	58	0.1	41.8	Month
Low	Moderate	Shorter	Low	Moderate	86.3	10.1	1.6	2	Half-Month
Low	Moderate	Shorter	Low	High	0.1	55.2	30.6	14.1	Half-Month
Low	Moderate	Shorter	Moderate	Low	0.1	43.8	0.1	56	Month
Low	Moderate	Shorter	Moderate	Moderate	82.3	9.6	2.8	5.3	Half-Month
Low	Moderate	Shorter	Moderate	High	0.1	61.3	22.8	15.8	Half-Month
Low	Moderate	Shorter	High	Low	87	4.5	0.1	8.4	Middle Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Low	Moderate	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Month
Low	Moderate	Shorter	High	High	0.1	0.1	99.7	0.1	Month
Low	Moderate	Short	Low	Low	0.1	99.7	0.1	0.1	Month
Low	Moderate	Short	Low	Moderate	50.6	43.8	0.3	5.3	Half-Month
Low	Moderate	Short	Low	High	0.1	4.9	11.3	83.7	Half-Month
Low	Moderate	Short	Moderate	Low	0.1	99.7	0.1	0.1	Month
Low	Moderate	Short	Moderate	Moderate	46.1	39.8	0.5	13.6	Half-Month
Low	Moderate	Short	Moderate	High	0.1	0.1	8.3	91.5	Half-Month
Low	Moderate	Short	High	Low	0.1	99.7	0.1	0.1	Middle Date
Low	Moderate	Short	High	Moderate	0.1	0.1	99.7	0.1	Month
Low	Moderate	Short	High	High	0.1	0.1	99.7	0.1	Month
Low	Moderate	Moderate	Low	Low	3.6	96.2	0.1	0.1	Middle Half-Month
Low	Moderate	Moderate	Low	Moderate	0.1	0.1	99.7	0.1	Month
Low	Moderate	Moderate	Low	High	0.1	67.1	32.7	0.1	Month
Low	Moderate	Moderate	Moderate	Low	39	0.1	60.8	0.1	Middle Date
Low	Moderate	Moderate	Moderate	Moderate	0.1	0.1	99.7	0.1	Month
Low	Moderate	Moderate	Moderate	High	0.1	69	30.8	0.1	Month
Low	Moderate	Moderate	High	Low	37.7	0.1	62.1	0.1	Middle Date
Low	Moderate	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Month
Low	Moderate	Moderate	High	High	0.1	0.1	99.7	0.1	Month
Low	Moderate	Long	Low	Low	8.6	91.2	0.1	0.1	Middle Half-Month
Low	Moderate	Long	Low	Moderate	0.1	99.7	0.1	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Low	Moderate	Long	Low	High	0.1	99.7	0.1	0.1	Month
Low	Moderate	Long	Moderate	Low	0.1	99.7	0.1	0.1	Middle Date
Low	Moderate	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Month
Low	Moderate	Long	Moderate	High	0.1	99.7	0.1	0.1	Month
Low	Moderate	Long	High	Low	0.1	99.7	0.1	0.1	Middle Date
Low	Moderate	Long	High	Moderate	53.1	46.7	0.1	0.1	Middle Date
Low	Moderate	Long	High	High	88.3	0.1	11.5	0.1	Middle Date
Low	Moderate	Longer	Low	Low	0.1	26.7	7.1	66.1	Middle Date
Low	Moderate	Longer	Low	Moderate	0.1	99.7	0.1	0.1	Date
Low	Moderate	Longer	Low	High	0.1	75.2	0.1	24.6	Middle Date
Low	Moderate	Longer	Moderate	Low	0.1	54.4	15.9	29.6	Middle Date
Low	Moderate	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Month
Low	Moderate	Longer	Moderate	High	0.1	88.9	0.1	10.9	Middle Date
Low	Moderate	Longer	High	Low	0.1	62.4	33.5	4	Middle Date
Low	Moderate	Longer	High	Moderate	0.1	16	77.7	6.2	Middle Date
Low	Moderate	Longer	High	High	0.1	94	0.1	5.8	Middle Date
Low	High	Shorter	Low	Low	0.1	31.7	0.1	68.1	Month
Low	High	Shorter	Low	Moderate	59.1	11.4	3.2	26.3	Half-Month
Low	High	Shorter	Low	High	0.1	39	26.4	34.5	Half-Month
Low	High	Shorter	Moderate	Low	0.1	20.6	0.1	79.2	Month
Low	High	Shorter	Moderate	Moderate	42.5	8.2	4.4	44.9	Half-Month
Low	High	Shorter	Moderate	High	0.1	56.8	15.9	27.2	Half-Month
Low	High	Shorter	High	Low	54.5	45.3	0.1	0.1	Middle Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Low	High	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Month
Low	High	Shorter	High	High	0.1	0.1	99.7	0.1	Month
Low	High	Short	Low	Low	0.1	99.7	0.1	0.1	Month
Low	High	Short	Low	Moderate	0.1	0.1	99.7	0.1	Date
Low	High	Short	Low	High	0.1	0.1	11.9	87.9	Date
Low	High	Short	Moderate	Low	0.1	99.7	0.1	0.1	Month
Low	High	Short	Moderate	Moderate	29.8	42.9	0.9	26.4	Half-Month
Low	High	Short	Moderate	High	0.1	0.1	8.3	91.5	Half-Month
Low	High	Short	High	Low	0.1	99.7	0.1	0.1	Middle Date
Low	High	Short	High	Moderate	0.1	0.1	99.7	0.1	Month
Low	High	Short	High	High	0.1	0.1	99.7	0.1	Month
Low	High	Moderate	Low	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Low	High	Moderate	Low	Moderate	0.1	99.7	0.1	0.1	Date
Low	High	Moderate	Low	High	0.1	89	10.8	0.1	Month
Low	High	Moderate	Moderate	Low	0.1	0.1	99.7	0.1	Middle Date
Low	High	Moderate	Moderate	Moderate	0.1	93.9	5.9	0.1	Month
Low	High	Moderate	Moderate	High	0.1	89.8	10	0.1	Month
Low	High	Moderate	High	Low	0.1	0.1	99.7	0.1	Middle Date
Low	High	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Month
Low	High	Moderate	High	High	0.1	0.1	99.7	0.1	Month
Low	High	Long	Low	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Low	High	Long	Low	Moderate	0.1	99.7	0.1	0.1	Month
Low	High	Long	Low	High	0.1	99.7	0.1	0.1	Month
Low	High	Long	Moderate	Low	0.1	33.1	66.7	0.1	Middle Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Low	High	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Month
Low	High	Long	Moderate	High	0.1	99.7	0.1	0.1	Month
Low	High	Long	High	Low	0.1	3.4	96.4	0.1	Middle Half-Month
Low	High	Long	High	Moderate	99.7	0.1	0.1	0.1	Middle Date
Low	High	Long	High	High	85.8	0.1	14	0.1	Middle Date
Low	High	Longer	Low	Low	33.7	6.5	53.3	6.5	Date
Low	High	Longer	Low	Moderate	0.1	99.7	0.1	0.1	Date
Low	High	Longer	Low	High	0.1	43.4	0.1	56.4	Middle Date
Low	High	Longer	Moderate	Low	51.8	16.6	15	16.6	Date
Low	High	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Month
Low	High	Longer	Moderate	High	0.1	79.6	0.1	20.2	Middle Date
Low	High	Longer	High	Low	0.1	39.5	37.8	22.6	Middle Date
Low	High	Longer	High	Moderate	0.1	77.1	11	11.8	Middle Date
Low	High	Longer	High	High	0.1	89	0.1	10.8	Middle Date
Low	Very High	Shorter	Low	Low	0.1	82.8	0.1	17	Month
Low	Very High	Shorter	Low	Moderate	46.4	3.6	5.1	44.9	Half-Month
Low	Very High	Shorter	Low	High	0.1	34.7	30.6	34.6	Half-Month
Low	Very High	Shorter	Moderate	Low	0.1	73	0.1	26.8	Month
Low	Very High	Shorter	Moderate	Moderate	28.5	2.2	5.9	63.4	Half-Month
Low	Very High	Shorter	Moderate	High	0.1	36	26.7	37.2	Half-Month
Low	Very High	Shorter	High	Low	45.7	11.5	0.1	42.7	Middle Date
Low	Very High	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Month
Low	Very High	Shorter	High	High	0.1	0.1	99.7	0.1	Month
Low	Very High	Short	Low	Low	0.1	99.7	0.1	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Low	Very High	Short	Low	Moderate	76.5	0.1	23.3	0.1	Date
Low	Very High	Short	Low	High	0.1	13.8	38.6	47.5	Half-Month
Low	Very High	Short	Moderate	Low	0.1	99.7	0.1	0.1	Month
Low	Very High	Short	Moderate	Moderate	51.8	29.8	3.1	15.3	Half-Month
Low	Very High	Short	Moderate	High	0.1	0.1	35.1	64.7	Half-Month
Low	Very High	Short	High	Low	31.8	23.8	0.1	44.3	Middle Half-Month
Low	Very High	Short	High	Moderate	0.1	0.1	99.7	0.1	Month
Low	Very High	Short	High	High	0.1	0.1	99.7	0.1	Month
Low	Very High	Moderate	Low	Low	0.1	99.7	0.1	0.1	Middle Month
Low	Very High	Moderate	Low	Moderate	0.1	99.7	0.1	0.1	Date
Low	Very High	Moderate	Low	High	0.1	75.4	24.4	0.1	Month
Low	Very High	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Middle Month
Low	Very High	Moderate	Moderate	Moderate	0.1	57	42.8	0.1	Month
Low	Very High	Moderate	Moderate	High	0.1	76.9	22.9	0.1	Month
Low	Very High	Moderate	High	Low	0.1	99.7	0.1	0.1	Middle Month
Low	Very High	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Month
Low	Very High	Moderate	High	High	0.1	0.1	99.7	0.1	Month
Low	Very High	Long	Low	Low	0.1	99.7	0.1	0.1	Middle Month
Low	Very High	Long	Low	Moderate	0.1	99.7	0.1	0.1	Month
Low	Very High	Long	Low	High	0.1	99.7	0.1	0.1	Month
Low	Very High	Long	Moderate	Low	0.1	99.7	0.1	0.1	Middle Month
Low	Very High	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Low	Very High	Long	Moderate	High	0.1	99.7	0.1	0.1	Month
Low	Very High	Long	High	Low	0.1	99.7	0.1	0.1	Middle Month
Low	Very High	Long	High	Moderate	0.1	99.7	0.1	0.1	Middle Month
Low	Very High	Long	High	High	0.1	0.1	99.7	0.1	Middle Half-Month
Low	Very High	Longer	Low	Low	21.9	4.2	69.7	4.2	Date
Low	Very High	Longer	Low	Moderate	49.9	49.9	0.1	0.1	Date
Low	Very High	Longer	Low	High	0.1	99.7	0.1	0.1	Middle Month
Low	Very High	Longer	Moderate	Low	45	14.5	26	14.5	Date
Low	Very High	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Middle Month
Low	Very High	Longer	Moderate	High	0.1	99.7	0.1	0.1	Middle Month
Low	Very High	Longer	High	Low	0.1	0.1	0.1	99.7	Middle Date
Low	Very High	Longer	High	Moderate	0.1	99.7	0.1	0.1	Middle Month
Low	Very High	Longer	High	High	0.1	99.7	0.1	0.1	Middle Month
Moderate	Very Low	Shorter	Low	Low	0.1	99.7	0.1	0.1	Month
Moderate	Very Low	Shorter	Low	Moderate	0.1	0.1	32.3	67.5	Half-Month
Moderate	Very Low	Shorter	Low	High	0.1	68.5	3.9	27.5	Half-Month
Moderate	Very Low	Shorter	Moderate	Low	0.1	99.7	0.1	0.1	Month
Moderate	Very Low	Shorter	Moderate	Moderate	0.1	0.1	30.9	68.9	Half-Month
Moderate	Very Low	Shorter	Moderate	High	0.1	85.3	0.8	13.8	Half-Month
Moderate	Very Low	Shorter	High	Low	0.1	99.7	0.1	0.1	Middle Date
Moderate	Very Low	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
Moderate	Very Low	Shorter	High	High	0.1	0.1	99.7	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Moderate	Very Low	Short	Low	Low	0.1	99.7	0.1	0.1	Month
Moderate	Very Low	Short	Low	Moderate	0.1	0.1	99.7	0.1	Half-Month
Moderate	Very Low	Short	Low	High	0.1	86.7	9.1	4.1	Month
Moderate	Very Low	Short	Moderate	Low	0.1	99.7	0.1	0.1	Month
Moderate	Very Low	Short	Moderate	Moderate	0.1	0.1	99.7	0.1	Half-Month
Moderate	Very Low	Short	Moderate	High	0.1	88.8	8.1	3	Month
Moderate	Very Low	Short	High	Low	0.1	6	93.8	0.1	Lower Half-Month
Moderate	Very Low	Short	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
Moderate	Very Low	Short	High	High	0.1	0.1	99.7	0.1	Month
Moderate	Very Low	Moderate	Low	Low	18.1	57.8	24	0.1	Interpolate
Moderate	Very Low	Moderate	Low	Moderate	0.1	99.7	0.1	0.1	Half-Month
Moderate	Very Low	Moderate	Low	High	0.1	99.7	0.1	0.1	Half-Month
Moderate	Very Low	Moderate	Moderate	Low	0.1	4.1	95.7	0.1	Lower Half-Month
Moderate	Very Low	Moderate	Moderate	Moderate	0.1	99.7	0.1	0.1	Half-Month
Moderate	Very Low	Moderate	Moderate	High	0.1	99.7	0.1	0.1	Half-Month
Moderate	Very Low	Moderate	High	Low	0.1	11.3	88.5	0.1	Lower Half-Month
Moderate	Very Low	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Month
Moderate	Very Low	Moderate	High	High	0.1	0.1	99.7	0.1	Month
Moderate	Very Low	Long	Low	Low	19.9	79.9	0.1	0.1	Interpolate
Moderate	Very Low	Long	Low	Moderate	0.1	99.7	0.1	0.1	Half-Month
Moderate	Very Low	Long	Low	High	0.1	99.7	0.1	0.1	Half-Month
Moderate	Very Low	Long	Moderate	Low	0.1	99.7	0.1	0.1	Lower Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Moderate	Very Low	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Half-Month
Moderate	Very Low	Long	Moderate	High	0.1	99.7	0.1	0.1	Half-Month
Moderate	Very Low	Long	High	Low	0.1	99.7	0.1	0.1	Lower Half-Month
Moderate	Very Low	Long	High	Moderate	0.1	99.7	0.1	0.1	Lower Half-Month
Moderate	Very Low	Long	High	High	0.1	0.1	99.7	0.1	Middle Month
Moderate	Very Low	Longer	Low	Low	0.1	74.7	19	6.2	Interpolate
Moderate	Very Low	Longer	Low	Moderate	0.1	99.7	0.1	0.1	Half-Month
Moderate	Very Low	Longer	Low	High	0.1	99.7	0.1	0.1	Half-Month
Moderate	Very Low	Longer	Moderate	Low	0.1	49.9	25	25	Lower Date
Moderate	Very Low	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Half-Month
Moderate	Very Low	Longer	Moderate	High	0.1	99.7	0.1	0.1	Half-Month
Moderate	Very Low	Longer	High	Low	0.1	26.4	12.1	61.4	Lower Date
Moderate	Very Low	Longer	High	Moderate	15	78.9	0.1	6	Lower Date
Moderate	Very Low	Longer	High	High	15.4	47	16.7	20.9	Interpolate
Moderate	Low	Shorter	Low	Low	0.1	99.7	0.1	0.1	Half-Month
Moderate	Low	Shorter	Low	Moderate	17.1	82.7	0.1	0.1	Half-Month
Moderate	Low	Shorter	Low	High	0.1	31	14.2	54.7	Month
Moderate	Low	Shorter	Moderate	Low	0.1	99.7	0.1	0.1	Month
Moderate	Low	Shorter	Moderate	Moderate	99.7	0.1	0.1	0.1	Half-Month
Moderate	Low	Shorter	Moderate	High	0.1	5.8	9.9	84.2	Month
Moderate	Low	Shorter	High	Low	40.8	46.3	0.1	12.8	Middle Date
Moderate	Low	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Moderate	Low	Shorter	High	High	0.1	0.1	99.7	0.1	Month
Moderate	Low	Short	Low	Low	0.1	99.7	0.1	0.1	Month
Moderate	Low	Short	Low	Moderate	99.7	0.1	0.1	0.1	Half-Month
Moderate	Low	Short	Low	High	0.1	52.4	18.2	29.3	Month
Moderate	Low	Short	Moderate	Low	0.1	99.7	0.1	0.1	Month
Moderate	Low	Short	Moderate	Moderate	99.7	0.1	0.1	0.1	Half-Month
Moderate	Low	Short	Moderate	High	0.1	14.5	18.9	66.5	Month
Moderate	Low	Short	High	Low	82.7	0.1	0.1	17.1	Middle Half-Month
Moderate	Low	Short	High	Moderate	0.1	0.1	99.7	0.1	Month
Moderate	Low	Short	High	High	0.1	0.1	99.7	0.1	Month
Moderate	Low	Moderate	Low	Low	72.1	27.7	0.1	0.1	Middle Half-Month
Moderate	Low	Moderate	Low	Moderate	0.1	0.1	90.4	9.4	Month
Moderate	Low	Moderate	Low	High	0.1	96.4	1.2	2.3	Month
Moderate	Low	Moderate	Moderate	Low	99.7	0.1	0.1	0.1	Middle Date
Moderate	Low	Moderate	Moderate	Moderate	0.1	0.1	96.9	2.9	Month
Moderate	Low	Moderate	Moderate	High	0.1	92.1	5.1	2.7	Month
Moderate	Low	Moderate	High	Low	99.7	0.1	0.1	0.1	Middle Date
Moderate	Low	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Month
Moderate	Low	Moderate	High	High	0.1	0.1	99.7	0.1	Month
Moderate	Low	Long	Low	Low	79.5	20.3	0.1	0.1	Middle Half-Month
Moderate	Low	Long	Low	Moderate	0.1	0.1	0.1	99.7	Month
Moderate	Low	Long	Low	High	0.1	0.1	0.1	99.7	Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Moderate	Low	Long	Moderate	Low	0.1	99.7	0.1	0.1	Middle Date
Moderate	Low	Long	Moderate	Moderate	0.1	0.1	0.1	99.7	Month
Moderate	Low	Long	Moderate	High	0.1	49.8	0.1	50	Month
Moderate	Low	Long	High	Low	0.1	99.7	0.1	0.1	Middle Date
Moderate	Low	Long	High	Moderate	0.1	99.7	0.1	0.1	Middle Date
Moderate	Low	Long	High	High	72.9	0.1	4	23	Middle Date
Moderate	Low	Longer	Low	Low	0.1	49.2	50.6	0.1	Date
Moderate	Low	Longer	Low	Moderate	0.1	99.7	0.1	0.1	Date
Moderate	Low	Longer	Low	High	0.1	0.1	0.1	99.7	Half-Month
Moderate	Low	Longer	Moderate	Low	0.1	0.1	99.7	0.1	Date
Moderate	Low	Longer	Moderate	Moderate	0.1	58.6	0.1	41.2	Month
Moderate	Low	Longer	Moderate	High	0.1	0.1	0.1	99.7	Month
Moderate	Low	Longer	High	Low	43.2	41.2	11.1	4.5	Middle Date
Moderate	Low	Longer	High	Moderate	28.9	60.9	10.1	0.1	Middle Date
Moderate	Low	Longer	High	High	77.4	3.1	0.1	19.4	Middle Date
Moderate	Moderate	Shorter	Low	Low	0.1	99.7	0.1	0.1	Half-Month
Moderate	Moderate	Shorter	Low	Moderate	0.1	0.1	99.7	0.1	Date
Moderate	Moderate	Shorter	Low	High	0.1	74.8	9.6	15.5	Half-Month
Moderate	Moderate	Shorter	Moderate	Low	0.1	99.7	0.1	0.1	Month
Moderate	Moderate	Shorter	Moderate	Moderate	0.1	0.1	99.7	0.1	Date
Moderate	Moderate	Shorter	Moderate	High	0.1	69	9	21.9	Half-Month
Moderate	Moderate	Shorter	High	Low	81.9	12	0.1	6	Middle Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Moderate	Moderate	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
Moderate	Moderate	Shorter	High	High	0.1	0.1	99.7	0.1	Month
Moderate	Moderate	Short	Low	Low	0.1	99.7	0.1	0.1	Half-Month
Moderate	Moderate	Short	Low	Moderate	17.4	45	18.5	19.1	Half-Month
Moderate	Moderate	Short	Low	High	0.1	55.3	1.7	42.9	Half-Month
Moderate	Moderate	Short	Moderate	Low	0.1	99.7	0.1	0.1	Month
Moderate	Moderate	Short	Moderate	Moderate	4.2	10.9	71.8	13.1	Half-Month
Moderate	Moderate	Short	Moderate	High	0.1	25.3	1.9	72.7	Half-Month
Moderate	Moderate	Short	High	Low	0.1	99.7	0.1	0.1	Middle Date
Moderate	Moderate	Short	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
Moderate	Moderate	Short	High	High	0.1	0.1	99.7	0.1	Month
Moderate	Moderate	Moderate	Low	Low	0.1	99.7	0.1	0.1	Half-Month
Moderate	Moderate	Moderate	Low	Moderate	0.1	15.3	84.5	0.1	Half-Month
Moderate	Moderate	Moderate	Low	High	0.1	99.7	0.1	0.1	Half-Month
Moderate	Moderate	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Month
Moderate	Moderate	Moderate	Moderate	Moderate	0.1	6.3	93.5	0.1	Half-Month
Moderate	Moderate	Moderate	Moderate	High	0.1	99.7	0.1	0.1	Half-Month
Moderate	Moderate	Moderate	High	Low	99.7	0.1	0.1	0.1	Middle Date
Moderate	Moderate	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Month
Moderate	Moderate	Moderate	High	High	0.1	0.1	99.7	0.1	Month
Moderate	Moderate	Long	Low	Low	0.1	99.7	0.1	0.1	Month
Moderate	Moderate	Long	Low	Moderate	0.1	99.7	0.1	0.1	Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Moderate	Moderate	Long	Low	High	0.1	99.7	0.1	0.1	Half-Month
Moderate	Moderate	Long	Moderate	Low	0.1	99.7	0.1	0.1	Month
Moderate	Moderate	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Half-Month
Moderate	Moderate	Long	Moderate	High	0.1	99.7	0.1	0.1	Half-Month
Moderate	Moderate	Long	High	Low	0.1	99.7	0.1	0.1	Middle Date
Moderate	Moderate	Long	High	Moderate	0.1	99.7	0.1	0.1	Middle Date
Moderate	Moderate	Long	High	High	53.7	0.1	20.3	25.9	Middle Date
Moderate	Moderate	Longer	Low	Low	0.1	99.7	0.1	0.1	Month
Moderate	Moderate	Longer	Low	Moderate	0.1	99.7	0.1	0.1	Half-Month
Moderate	Moderate	Longer	Low	High	0.1	58.1	41.7	0.1	Half-Month
Moderate	Moderate	Longer	Moderate	Low	0.1	99.7	0.1	0.1	Month
Moderate	Moderate	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Half-Month
Moderate	Moderate	Longer	Moderate	High	0.1	99.7	0.1	0.1	Half-Month
Moderate	Moderate	Longer	High	Low	0.1	45.6	30.3	24	Middle Date
Moderate	Moderate	Longer	High	Moderate	0.1	80.8	19	0.1	Middle Date
Moderate	Moderate	Longer	High	High	0.1	35.1	0.1	64.7	Middle Date
Moderate	High	Shorter	Low	Low	84.8	15	0.1	0.1	Date
Moderate	High	Shorter	Low	Moderate	24.5	0.1	75.3	0.1	Date
Moderate	High	Shorter	Low	High	0.1	72.2	27.6	0.1	Date
Moderate	High	Shorter	Moderate	Low	0.1	32.1	0.1	67.7	Month
Moderate	High	Shorter	Moderate	Moderate	0.1	0.1	99.7	0.1	Date
Moderate	High	Shorter	Moderate	High	0.1	65	8.9	26	Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Moderate	High	Shorter	High	Low	59.5	40.3	0.1	0.1	Middle Date
Moderate	High	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
Moderate	High	Shorter	High	High	0.1	0.1	99.7	0.1	Month
Moderate	High	Short	Low	Low	99.7	0.1	0.1	0.1	Date
Moderate	High	Short	Low	Moderate	0.1	64.9	34.9	0.1	Date
Moderate	High	Short	Low	High	0.1	12.1	3.3	84.5	Half-Month
Moderate	High	Short	Moderate	Low	0.1	99.7	0.1	0.1	Month
Moderate	High	Short	Moderate	Moderate	3.8	16.4	44.4	35.4	Half-Month
Moderate	High	Short	Moderate	High	0.1	3.6	2.4	93.9	Half-Month
Moderate	High	Short	High	Low	0.1	99.7	0.1	0.1	Middle Date
Moderate	High	Short	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
Moderate	High	Short	High	High	0.1	0.1	99.7	0.1	Month
Moderate	High	Moderate	Low	Low	0.1	99.7	0.1	0.1	Date
Moderate	High	Moderate	Low	Moderate	0.1	99.7	0.1	0.1	Date
Moderate	High	Moderate	Low	High	0.1	64.1	0.1	35.7	Half-Month
Moderate	High	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Month
Moderate	High	Moderate	Moderate	Moderate	0.1	13.1	86.4	0.4	Half-Month
Moderate	High	Moderate	Moderate	High	0.1	93.8	0.1	6	Half-Month
Moderate	High	Moderate	High	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Moderate	High	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Month
Moderate	High	Moderate	High	High	0.1	0.1	99.7	0.1	Month
Moderate	High	Long	Low	Low	45.2	54.6	0.1	0.1	Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Moderate	High	Long	Low	Moderate	0.1	0.1	99.7	0.1	Date
Moderate	High	Long	Low	High	0.1	26.5	0.1	73.3	Half-Month
Moderate	High	Long	Moderate	Low	0.1	99.7	0.1	0.1	Month
Moderate	High	Long	Moderate	Moderate	0.1	86.7	0.1	13.1	Half-Month
Moderate	High	Long	Moderate	High	0.1	75.5	0.1	24.3	Half-Month
Moderate	High	Long	High	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Moderate	High	Long	High	Moderate	0.1	99.7	0.1	0.1	Middle Half-Month
Moderate	High	Long	High	High	26.6	0.1	15.2	58.1	Middle Date
Moderate	High	Longer	Low	Low	0.1	41.2	42.5	16.2	Date
Moderate	High	Longer	Low	Moderate	0.1	99.7	0.1	0.1	Date
Moderate	High	Longer	Low	High	0.1	56.9	27.2	15.8	Half-Month
Moderate	High	Longer	Moderate	Low	63.8	0.1	36	0.1	Date
Moderate	High	Longer	Moderate	Moderate	0.1	98.3	0.1	1.5	Half-Month
Moderate	High	Longer	Moderate	High	0.1	96.7	0.1	3.1	Half-Month
Moderate	High	Longer	High	Low	0.1	51.4	21.3	27.2	Middle Date
Moderate	High	Longer	High	Moderate	0.1	88.3	11.5	0.1	Middle Date
Moderate	High	Longer	High	High	0.1	99.7	0.1	0.1	Middle Date
Moderate	Very High	Shorter	Low	Low	66	14.3	19.6	0.1	Date
Moderate	Very High	Shorter	Low	Moderate	35.7	21.4	42.8	0.1	Date
Moderate	Very High	Shorter	Low	High	0.1	72.2	27.6	0.1	Date
Moderate	Very High	Shorter	Moderate	Low	0.1	21.1	0.4	78.4	Month
Moderate	Very High	Shorter	Moderate	Moderate	4.2	1	29.4	65.4	Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Moderate	Very High	Shorter	Moderate	High	0.1	61.8	18.2	19.9	Half-Month
Moderate	Very High	Shorter	High	Low	50.6	24.7	0.1	24.6	Middle Date
Moderate	Very High	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
Moderate	Very High	Shorter	High	High	0.1	0.1	99.7	0.1	Month
Moderate	Very High	Short	Low	Low	69.7	12.5	17.7	0.1	Half-Month
Moderate	Very High	Short	Low	Moderate	0.1	0.1	99.7	0.1	Date
Moderate	Very High	Short	Low	High	0.1	70.8	5.5	23.6	Half-Month
Moderate	Very High	Short	Moderate	Low	0.1	99.6	0.2	0.1	Month
Moderate	Very High	Short	Moderate	Moderate	11.7	20.1	32	36.2	Half-Month
Moderate	Very High	Short	Moderate	High	0.1	41.3	7.9	50.7	Half-Month
Moderate	Very High	Short	High	Low	12.8	47.6	0.1	39.5	Middle Half-Month
Moderate	Very High	Short	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
Moderate	Very High	Short	High	High	0.1	0.1	99.7	0.1	Month
Moderate	Very High	Moderate	Low	Low	15.6	84.2	0.1	0.1	Half-Month
Moderate	Very High	Moderate	Low	Moderate	0.1	99.7	0.1	0.1	Date
Moderate	Very High	Moderate	Low	High	0.1	44.5	0.1	55.3	Half-Month
Moderate	Very High	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Month
Moderate	Very High	Moderate	Moderate	Moderate	0.1	93.4	0.1	6.4	Half-Month
Moderate	Very High	Moderate	Moderate	High	0.1	87.2	0.1	12.6	Half-Month
Moderate	Very High	Moderate	High	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Moderate	Very High	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Month
Moderate	Very High	Moderate	High	High	0.1	0.1	99.7	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Moderate	Very High	Long	Low	Low	0.1	99.7	0.1	0.1	Date
Moderate	Very High	Long	Low	Moderate	0.1	0.1	99.7	0.1	Date
Moderate	Very High	Long	Low	High	0.1	11.7	0.1	88.1	Half-Month
Moderate	Very High	Long	Moderate	Low	0.1	99.7	0.1	0.1	Month
Moderate	Very High	Long	Moderate	Moderate	0.1	74.4	0.1	25.4	Half-Month
Moderate	Very High	Long	Moderate	High	0.1	57.8	0.1	42	Half-Month
Moderate	Very High	Long	High	Low	0.1	99.7	0.1	0.1	Middle Month
Moderate	Very High	Long	High	Moderate	0.1	99.7	0.1	0.1	Middle Month
Moderate	Very High	Long	High	High	0.1	0.1	29.9	69.9	Middle Half-Month
Moderate	Very High	Longer	Low	Low	0.1	0.1	72.2	27.6	Date
Moderate	Very High	Longer	Low	Moderate	48.4	51.4	0.1	0.1	Date
Moderate	Very High	Longer	Low	High	0.1	18.2	65.1	16.6	Half-Month
Moderate	Very High	Longer	Moderate	Low	0.1	0.1	99.7	0.1	Date
Moderate	Very High	Longer	Moderate	Moderate	0.1	96.5	0.1	3.3	Half-Month
Moderate	Very High	Longer	Moderate	High	0.1	93.1	0.1	6.7	Half-Month
Moderate	Very High	Longer	High	Low	0.1	0.1	0.1	99.7	Middle Date
Moderate	Very High	Longer	High	Moderate	0.1	99.7	0.1	0.1	Middle Month
Moderate	Very High	Longer	High	High	0.1	71.3	0.1	28.5	Middle Month
High	Very Low	Shorter	Low	Low	0.1	39.1	60.7	0.1	Month
High	Very Low	Shorter	Low	Moderate	0.1	0.1	0.1	99.7	Date
High	Very Low	Shorter	Low	High	0.1	0.1	0.1	99.7	Date
High	Very Low	Shorter	Moderate	Low	0.1	99.7	0.1	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
High	Very Low	Shorter	Moderate	Moderate	0.1	0.1	0.1	99.7	Date
High	Very Low	Shorter	Moderate	High	0.1	0.1	0.1	99.7	Date
High	Very Low	Shorter	High	Low	0.1	99.7	0.1	0.1	Middle Date
High	Very Low	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
High	Very Low	Shorter	High	High	0.1	0.1	99.7	0.1	Month
High	Very Low	Short	Low	Low	0.1	42.8	57	0.1	Month
High	Very Low	Short	Low	Moderate	0.1	0.1	99.7	0.1	Half-Month
High	Very Low	Short	Low	High	0.1	65.4	22.1	12.4	Month
High	Very Low	Short	Moderate	Low	0.1	99.7	0.1	0.1	Month
High	Very Low	Short	Moderate	Moderate	0.1	0.1	99.7	0.1	Half-Month
High	Very Low	Short	Moderate	High	0.1	70	20.4	9.5	Month
High	Very Low	Short	High	Low	0.1	14.5	85.3	0.1	Lower Half-Month
High	Very Low	Short	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
High	Very Low	Short	High	High	0.1	0.1	99.7	0.1	Month
High	Very Low	Moderate	Low	Low	0.1	66.3	33.5	0.1	Interpolate
High	Very Low	Moderate	Low	Moderate	0.1	99.7	0.1	0.1	Half-Month
High	Very Low	Moderate	Low	High	0.1	99.7	0.1	0.1	Half-Month
High	Very Low	Moderate	Moderate	Low	0.1	10.1	89.7	0.1	Lower Half-Month
High	Very Low	Moderate	Moderate	Moderate	0.1	99.7	0.1	0.1	Half-Month
High	Very Low	Moderate	Moderate	High	0.1	99.7	0.1	0.1	Half-Month
High	Very Low	Moderate	High	Low	0.1	25.3	74.5	0.1	Lower Half-Month
High	Very Low	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
High	Very Low	Moderate	High	High	0.1	0.1	99.7	0.1	Month
High	Very Low	Long	Low	Low	0.1	99.7	0.1	0.1	Half-Month
High	Very Low	Long	Low	Moderate	0.1	99.7	0.1	0.1	Date
High	Very Low	Long	Low	High	0.1	62.7	0.1	37.1	Half-Month
High	Very Low	Long	Moderate	Low	0.1	99.7	0.1	0.1	Lower Half-Month
High	Very Low	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Half-Month
High	Very Low	Long	Moderate	High	0.1	99.7	0.1	0.1	Half-Month
High	Very Low	Long	High	Low	0.1	99.7	0.1	0.1	Lower Half-Month
High	Very Low	Long	High	Moderate	0.1	99.7	0.1	0.1	Lower Half-Month
High	Very Low	Long	High	High	0.1	0.1	0.1	99.7	Lower Month
High	Very Low	Longer	Low	Low	0.1	99.7	0.1	0.1	Half-Month
High	Very Low	Longer	Low	Moderate	0.1	53.3	0.1	46.5	Half-Month
High	Very Low	Longer	Low	High	0.1	30.4	30.3	39.2	Half-Month
High	Very Low	Longer	Moderate	Low	0.1	99.7	0.1	0.1	Lower Date
High	Very Low	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Half-Month
High	Very Low	Longer	Moderate	High	0.1	77.7	11.1	11.1	Half-Month
High	Very Low	Longer	High	Low	0.1	74.8	0.1	25	Lower Date
High	Very Low	Longer	High	Moderate	12.7	0.1	71.9	15.3	Lower Date
High	Very Low	Longer	High	High	0.1	0.1	0.1	99.7	Lower Month
High	Low	Shorter	Low	Low	0.1	99.7	0.1	0.1	Half-Month
High	Low	Shorter	Low	Moderate	20.5	79.3	0.1	0.1	Half-Month
High	Low	Shorter	Low	High	0.1	38.8	19.8	41.3	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
High	Low	Shorter	Moderate	Low	0.1	99.7	0.1	0.1	Month
High	Low	Shorter	Moderate	Moderate	99.7	0.1	0.1	0.1	Half-Month
High	Low	Shorter	Moderate	High	0.1	9	17.1	73.8	Month
High	Low	Shorter	High	Low	27.4	72.4	0.1	0.1	Middle Date
High	Low	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Month
High	Low	Shorter	High	High	0.1	0.1	99.7	0.1	Month
High	Low	Short	Low	Low	0.1	99.7	0.1	0.1	Month
High	Low	Short	Low	Moderate	99.7	0.1	0.1	0.1	Half-Month
High	Low	Short	Low	High	0.1	61.3	23.4	15.2	Month
High	Low	Short	Moderate	Low	0.1	99.7	0.1	0.1	Month
High	Low	Short	Moderate	Moderate	99.7	0.1	0.1	0.1	Half-Month
High	Low	Short	Moderate	High	0.1	22.4	32.1	45.4	Month
High	Low	Short	High	Low	99.7	0.1	0.1	0.1	Middle Half-Month
High	Low	Short	High	Moderate	0.1	0.1	99.7	0.1	Month
High	Low	Short	High	High	0.1	0.1	99.7	0.1	Month
High	Low	Moderate	Low	Low	0.1	79.4	20.4	0.1	Middle Month
High	Low	Moderate	Low	Moderate	0.1	0.1	80.3	19.5	Month
High	Low	Moderate	Low	High	0.1	93.5	1.2	5.2	Month
High	Low	Moderate	Moderate	Low	99.7	0.1	0.1	0.1	Middle Date
High	Low	Moderate	Moderate	Moderate	0.1	0.1	93.3	6.5	Month
High	Low	Moderate	Moderate	High	0.1	88.8	4.9	6.2	Month
High	Low	Moderate	High	Low	99.7	0.1	0.1	0.1	Middle Date
High	Low	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Month
High	Low	Moderate	High	High	0.1	0.1	99.7	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
High	Low	Long	Low	Low	0.1	58.8	41	0.1	Middle Month
High	Low	Long	Low	Moderate	0.1	0.1	0.1	99.7	Month
High	Low	Long	Low	High	0.1	0.1	0.1	99.7	Half-Month
High	Low	Long	Moderate	Low	93.5	2	4.4	0.1	Middle Month
High	Low	Long	Moderate	Moderate	0.1	0.1	0.1	99.7	Month
High	Low	Long	Moderate	High	0.1	23.2	0.1	76.6	Month
High	Low	Long	High	Low	78.4	5.5	16	0.1	Middle Month
High	Low	Long	High	Moderate	99.7	0.1	0.1	0.1	Middle Date
High	Low	Long	High	High	37.1	0.1	0.1	62.7	Middle Date
High	Low	Longer	Low	Low	0.1	15.6	16.2	68.1	Middle Date
High	Low	Longer	Low	Moderate	0.1	0.1	0.1	99.7	Month
High	Low	Longer	Low	High	0.1	0.1	0.1	99.7	Half-Month
High	Low	Longer	Moderate	Low	0.1	44.1	19.2	36.6	Middle Date
High	Low	Longer	Moderate	Moderate	0.1	0.1	0.1	99.7	Month
High	Low	Longer	Moderate	High	0.1	0.1	0.1	99.7	Month
High	Low	Longer	High	Low	0.1	29.9	32.4	37.6	Middle Date
High	Low	Longer	High	Moderate	0.1	36.5	8.6	54.8	Middle Date
High	Low	Longer	High	High	0.1	5	0.1	94.8	Middle Date
High	Moderate	Shorter	Low	Low	0.1	90.2	0.1	9.6	Half-Month
High	Moderate	Shorter	Low	Moderate	16.2	66.4	8.5	8.9	Half-Month
High	Moderate	Shorter	Low	High	0.1	67.8	20.4	11.7	Half-Month
High	Moderate	Shorter	Moderate	Low	0.1	44	0.1	55.8	Month
High	Moderate	Shorter	Moderate	Moderate	15.9	50.1	18.5	15.5	Half-Month
High	Moderate	Shorter	Moderate	High	0.1	56.8	23.1	20	Half-Month
High	Moderate	Shorter	High	Low	92.2	7.6	0.1	0.1	Middle Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
High	Moderate	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
High	Moderate	Shorter	High	High	0.1	0.1	99.7	0.1	Month
High	Moderate	Short	Low	Low	0.1	99.7	0.1	0.1	Half-Month
High	Moderate	Short	Low	Moderate	3.7	85.3	5.3	5.7	Half-Month
High	Moderate	Short	Low	High	0.1	0.1	0.1	99.7	Date
High	Moderate	Short	Moderate	Low	0.1	99.7	0.1	0.1	Month
High	Moderate	Short	Moderate	Moderate	3.1	72.2	11	13.7	Half-Month
High	Moderate	Short	Moderate	High	0.1	0.1	0.1	99.7	Date
High	Moderate	Short	High	Low	0.1	99.7	0.1	0.1	Middle Date
High	Moderate	Short	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
High	Moderate	Short	High	High	0.1	0.1	99.7	0.1	Month
High	Moderate	Moderate	Low	Low	0.1	99.7	0.1	0.1	Half-Month
High	Moderate	Moderate	Low	Moderate	0.1	99.7	0.1	0.1	Half-Month
High	Moderate	Moderate	Low	High	0.1	76.6	0.1	23.2	Half-Month
High	Moderate	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Month
High	Moderate	Moderate	Moderate	Moderate	0.1	99.7	0.1	0.1	Half-Month
High	Moderate	Moderate	Moderate	High	0.1	92.4	0.1	7.4	Half-Month
High	Moderate	Moderate	High	Low	99.7	0.1	0.1	0.1	Middle Date
High	Moderate	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Month
High	Moderate	Moderate	High	High	0.1	0.1	99.7	0.1	Month
High	Moderate	Long	Low	Low	0.1	99.7	0.1	0.1	Half-Month
High	Moderate	Long	Low	Moderate	0.1	99.7	0.1	0.1	Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
High	Moderate	Long	Low	High	0.1	37.6	0.1	62.2	Half-Month
High	Moderate	Long	Moderate	Low	0.1	99.7	0.1	0.1	Month
High	Moderate	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Half-Month
High	Moderate	Long	Moderate	High	0.1	69.2	0.1	30.6	Half-Month
High	Moderate	Long	High	Low	0.1	99.7	0.1	0.1	Middle Half-Month
High	Moderate	Long	High	Moderate	99.7	0.1	0.1	0.1	Middle Date
High	Moderate	Long	High	High	69.1	0.1	0.1	30.7	Middle Date
High	Moderate	Longer	Low	Low	0.1	99.7	0.1	0.1	Half-Month
High	Moderate	Longer	Low	Moderate	0.1	99.7	0.1	0.1	Date
High	Moderate	Longer	Low	High	0.1	99.7	0.1	0.1	Date
High	Moderate	Longer	Moderate	Low	0.1	99.7	0.1	0.1	Month
High	Moderate	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Date
High	Moderate	Longer	Moderate	High	0.1	99.7	0.1	0.1	Date
High	Moderate	Longer	High	Low	0.1	8.4	20.1	71.4	Middle Date
High	Moderate	Longer	High	Moderate	0.1	40.5	11.3	48.1	Middle Date
High	Moderate	Longer	High	High	0.1	19.1	0.1	80.7	Middle Date
High	High	Shorter	Low	Low	76.6	0.1	23.2	0.1	Date
High	High	Shorter	Low	Moderate	24.1	0.1	57.7	18.1	Date
High	High	Shorter	Low	High	0.1	0.1	25.5	74.3	Date
High	High	Shorter	Moderate	Low	0.1	6.4	0.1	93.4	Month
High	High	Shorter	Moderate	Moderate	2.6	13.7	15.3	68.4	Half-Month
High	High	Shorter	Moderate	High	0.1	35.7	18.9	45.3	Half-Month
High	High	Shorter	High	Low	87.6	12.2	0.1	0.1	Middle Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
High	High	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
High	High	Shorter	High	High	0.1	0.1	99.7	0.1	Month
High	High	Short	Low	Low	99.7	0.1	0.1	0.1	Date
High	High	Short	Low	Moderate	0.1	99.7	0.1	0.1	Date
High	High	Short	Low	High	0.1	0.1	0.1	99.7	Date
High	High	Short	Moderate	Low	0.8	99	0.1	0.1	Month
High	High	Short	Moderate	Moderate	1.8	68.3	6.6	23.3	Half-Month
High	High	Short	Moderate	High	0.1	4.8	6.4	88.7	Half-Month
High	High	Short	High	Low	0.1	99.7	0.1	0.1	Middle Date
High	High	Short	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
High	High	Short	High	High	0.1	0.1	99.7	0.1	Month
High	High	Moderate	Low	Low	17.5	82.3	0.1	0.1	Half-Month
High	High	Moderate	Low	Moderate	0.1	79.1	0.1	20.7	Half-Month
High	High	Moderate	Low	High	0.1	0.1	0.1	99.7	Date
High	High	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Date
High	High	Moderate	Moderate	Moderate	0.1	96.9	0.1	2.9	Half-Month
High	High	Moderate	Moderate	High	0.1	0.1	0.1	99.7	Date
High	High	Moderate	High	Low	0.1	99.7	0.1	0.1	Middle Half-Month
High	High	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Month
High	High	Moderate	High	High	0.1	0.1	99.7	0.1	Month
High	High	Long	Low	Low	16.4	83.4	0.1	0.1	Half-Month
High	High	Long	Low	Moderate	0.1	14.3	85.5	0.1	Date
High	High	Long	Low	High	0.1	23	0.1	76.8	Half-Month
High	High	Long	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
High	High	Long	Moderate	Moderate	0.1	86.7	0.1	13.1	Half-Month
High	High	Long	Moderate	High	0.1	67.7	0.1	32.1	Half-Month
High	High	Long	High	Low	0.1	99.7	0.1	0.1	Middle Half-Month
High	High	Long	High	Moderate	99.7	0.1	0.1	0.1	Middle Date
High	High	Long	High	High	59.2	0.1	0.1	40.6	Middle Date
High	High	Longer	Low	Low	34.5	32.7	32.7	0.1	Date
High	High	Longer	Low	Moderate	0.1	62.9	0.1	36.9	Date
High	High	Longer	Low	High	0.1	30.8	69	0.1	Date
High	High	Longer	Moderate	Low	99.7	0.1	0.1	0.1	Date
High	High	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Date
High	High	Longer	Moderate	High	0.1	99.7	0.1	0.1	Date
High	High	Longer	High	Low	0.1	15.6	7.8	76.5	Middle Date
High	High	Longer	High	Moderate	0.1	5.7	30	64.2	Middle Date
High	High	Longer	High	High	0.1	40.9	0.1	58.9	Middle Date
High	Very High	Shorter	Low	Low	58.5	0.1	13.5	27.9	Date
High	Very High	Shorter	Low	Moderate	1.4	0.1	43.6	54.9	Date
High	Very High	Shorter	Low	High	0.1	0.1	17.2	82.6	Date
High	Very High	Shorter	Moderate	Low	0.1	0.1	0.1	99.7	Date
High	Very High	Shorter	Moderate	Moderate	0.1	0.1	0.1	99.7	Date
High	Very High	Shorter	Moderate	High	0.1	0.1	0.1	99.7	Date
High	Very High	Shorter	High	Low	73.1	26.7	0.1	0.1	Middle Date
High	Very High	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
High	Very High	Shorter	High	High	0.1	0.1	99.7	0.1	Month
High	Very High	Short	Low	Low	99.7	0.1	0.1	0.1	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
High	Very High	Short	Low	Moderate	0.1	0.1	99.7	0.1	Date
High	Very High	Short	Low	High	0.1	16.7	67.2	16	Date
High	Very High	Short	Moderate	Low	1	98.7	0.2	0.1	Month
High	Very High	Short	Moderate	Moderate	3.1	48.6	34.4	13.9	Half-Month
High	Very High	Short	Moderate	High	0.1	0.1	0.1	99.7	Date
High	Very High	Short	High	Low	35	64.8	0.1	0.1	Middle Half-Month
High	Very High	Short	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
High	Very High	Short	High	High	0.1	0.1	99.7	0.1	Month
High	Very High	Moderate	Low	Low	53.3	46.5	0.1	0.1	Half-Month
High	Very High	Moderate	Low	Moderate	0.1	0.1	61.7	38.1	Date
High	Very High	Moderate	Low	High	0.1	0.1	37.5	62.3	Date
High	Very High	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Date
High	Very High	Moderate	Moderate	Moderate	0.1	93.4	0.1	6.4	Half-Month
High	Very High	Moderate	Moderate	High	0.1	0.1	0.1	99.7	Date
High	Very High	Moderate	High	Low	0.1	99.7	0.1	0.1	Middle Half-Month
High	Very High	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Month
High	Very High	Moderate	High	High	0.1	0.1	99.7	0.1	Month
High	Very High	Long	Low	Low	0.1	99.7	0.1	0.1	Date
High	Very High	Long	Low	Moderate	0.1	0.1	73	26.8	Date
High	Very High	Long	Low	High	0.1	0.1	0.1	99.7	Date
High	Very High	Long	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
High	Very High	Long	Moderate	Moderate	0.1	74.4	0.1	25.4	Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
High	Very High	Long	Moderate	High	0.1	41.9	0.1	57.9	Half-Month
High	Very High	Long	High	Low	0.1	99.7	0.1	0.1	Middle Month
High	Very High	Long	High	Moderate	0.1	99.7	0.1	0.1	Middle Month
High	Very High	Long	High	High	0.1	0.1	67.9	31.9	Middle Half-Month
High	Very High	Longer	Low	Low	3	19.8	19.8	57.4	Date
High	Very High	Longer	Low	Moderate	0.1	20	0.1	79.8	Date
High	Very High	Longer	Low	High	0.1	56.4	43.4	0.1	Date
High	Very High	Longer	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
High	Very High	Longer	Moderate	Moderate	0.1	96.5	0.1	3.3	Half-Month
High	Very High	Longer	Moderate	High	0.1	56.3	16	27.6	Half-Month
High	Very High	Longer	High	Low	0.1	0.1	0.1	99.7	Middle Date
High	Very High	Longer	High	Moderate	0.1	99.7	0.1	0.1	Middle Month
High	Very High	Longer	High	High	0.1	29.5	0.1	70.3	Middle Month
Very High	Very Low	Shorter	Low	Low	99.7	0.1	0.1	0.1	Lower Date
Very High	Very Low	Shorter	Low	Moderate	0.1	0.1	0.1	99.7	Date
Very High	Very Low	Shorter	Low	High	0.1	0.1	0.1	99.7	Date
Very High	Very Low	Shorter	Moderate	Low	0.1	99.7	0.1	0.1	Month
Very High	Very Low	Shorter	Moderate	Moderate	0.1	0.1	0.1	99.7	Date
Very High	Very Low	Shorter	Moderate	High	0.1	0.1	0.1	99.7	Date
Very High	Very Low	Shorter	High	Low	99.7	0.1	0.1	0.1	Lower Date
Very High	Very Low	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
Very High	Very Low	Shorter	High	High	0.1	0.1	99.7	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very High	Very Low	Short	Low	Low	0.1	7.7	92.1	0.1	Month
Very High	Very Low	Short	Low	Moderate	0.1	0.1	99.7	0.1	Half-Month
Very High	Very Low	Short	Low	High	0.1	92.6	3.8	3.5	Month
Very High	Very Low	Short	Moderate	Low	0.1	99.7	0.1	0.1	Month
Very High	Very Low	Short	Moderate	Moderate	0.1	0.1	99.7	0.1	Half-Month
Very High	Very Low	Short	Moderate	High	0.1	94.2	3.1	2.6	Month
Very High	Very Low	Short	High	Low	0.1	0.1	0.1	99.7	Lower Month
Very High	Very Low	Short	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
Very High	Very Low	Short	High	High	0.1	0.1	99.7	0.1	Month
Very High	Very Low	Moderate	Low	Low	0.1	76.7	23.1	0.1	Interpolate
Very High	Very Low	Moderate	Low	Moderate	0.1	99.7	0.1	0.1	Half-Month
Very High	Very Low	Moderate	Low	High	0.1	99.7	0.1	0.1	Half-Month
Very High	Very Low	Moderate	Moderate	Low	0.1	61.9	18	20	Interpolate
Very High	Very Low	Moderate	Moderate	Moderate	0.1	99.7	0.1	0.1	Half-Month
Very High	Very Low	Moderate	Moderate	High	0.1	99.7	0.1	0.1	Half-Month
Very High	Very Low	Moderate	High	Low	0.1	0.1	0.1	99.7	Lower Month
Very High	Very Low	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Month
Very High	Very Low	Moderate	High	High	0.1	0.1	99.7	0.1	Month
Very High	Very Low	Long	Low	Low	0.1	99.7	0.1	0.1	Half-Month
Very High	Very Low	Long	Low	Moderate	0.1	20	0.1	79.8	Date
Very High	Very Low	Long	Low	High	0.1	0.1	0.1	99.7	Date
Very High	Very Low	Long	Moderate	Low	0.1	66.6	8.3	25	Interpolate

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very High	Very Low	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Half-Month
Very High	Very Low	Long	Moderate	High	0.1	99.7	0.1	0.1	Half-Month
Very High	Very Low	Long	High	Low	0.1	0.1	0.1	99.7	Lower Month
Very High	Very Low	Long	High	Moderate	0.1	59.9	20	20	Interpolate
Very High	Very Low	Long	High	High	7.2	25	25	42.8	Interpolate
Very High	Very Low	Longer	Low	Low	0.1	99.7	0.1	0.1	Half-Month
Very High	Very Low	Longer	Low	Moderate	0.1	35	0.1	64.8	Half-Month
Very High	Very Low	Longer	Low	High	0.1	31.7	21	47.2	Half-Month
Very High	Very Low	Longer	Moderate	Low	0.1	0.1	49.9	49.9	Lower Date
Very High	Very Low	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Half-Month
Very High	Very Low	Longer	Moderate	High	0.1	83.9	8	8	Half-Month
Very High	Very Low	Longer	High	Low	0.1	0.1	37.3	62.5	Lower Date
Very High	Very Low	Longer	High	Moderate	3.2	50	27.3	19.5	Interpolate
Very High	Very Low	Longer	High	High	22.1	39.2	2.7	36	Interpolate
Very High	Low	Shorter	Low	Low	0.1	99.7	0.1	0.1	Half-Month
Very High	Low	Shorter	Low	Moderate	0.1	99.7	0.1	0.1	Half-Month
Very High	Low	Shorter	Low	High	0.1	44	23.8	32.1	Month
Very High	Low	Shorter	Moderate	Low	0.1	99.7	0.1	0.1	Month
Very High	Low	Shorter	Moderate	Moderate	0.9	8.7	2.2	88.2	Month
Very High	Low	Shorter	Moderate	High	0.1	12.2	24.4	63.3	Month
Very High	Low	Shorter	High	Low	49.9	0.1	49.9	0.1	Middle Month
Very High	Low	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very High	Low	Shorter	High	High	0.1	0.1	99.7	0.1	Month
Very High	Low	Short	Low	Low	0.1	99.7	0.1	0.1	Month
Very High	Low	Short	Low	Moderate	24.2	49.5	22.7	3.6	Month
Very High	Low	Short	Low	High	0.1	66.6	26	7.3	Month
Very High	Low	Short	Moderate	Low	0.1	99.7	0.1	0.1	Month
Very High	Low	Short	Moderate	Moderate	14	25.1	46.3	14.6	Month
Very High	Low	Short	Moderate	High	0.1	29.7	43.3	26.9	Month
Very High	Low	Short	High	Low	49.9	0.1	49.9	0.1	Middle Month
Very High	Low	Short	High	Moderate	0.1	0.1	99.7	0.1	Month
Very High	Low	Short	High	High	0.1	0.1	99.7	0.1	Month
Very High	Low	Moderate	Low	Low	0.1	99.7	0.1	0.1	Middle Month
Very High	Low	Moderate	Low	Moderate	0.1	0.1	61.4	38.4	Month
Very High	Low	Moderate	Low	High	0.1	93.4	0.5	6	Month
Very High	Low	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Middle Month
Very High	Low	Moderate	Moderate	Moderate	0.1	0.1	84.7	15.1	Month
Very High	Low	Moderate	Moderate	High	0.1	90.5	2.2	7.2	Month
Very High	Low	Moderate	High	Low	0.1	99.7	0.1	0.1	Lower Half-Month
Very High	Low	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Month
Very High	Low	Moderate	High	High	0.1	0.1	99.7	0.1	Month
Very High	Low	Long	Low	Low	0.1	70.3	10.6	19	Interpolate
Very High	Low	Long	Low	Moderate	0.1	0.1	0.1	99.7	Month
Very High	Low	Long	Low	High	0.1	0.1	0.1	99.7	Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very High	Low	Long	Moderate	Low	0.1	99.7	0.1	0.1	Lower Half-Month
Very High	Low	Long	Moderate	Moderate	0.1	0.1	0.1	99.7	Month
Very High	Low	Long	Moderate	High	0.1	24.7	0.1	75.1	Month
Very High	Low	Long	High	Low	0.1	99.7	0.1	0.1	Lower Half-Month
Very High	Low	Long	High	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very High	Low	Long	High	High	28.9	0.1	0.1	70.9	Middle Date
Very High	Low	Longer	Low	Low	0.1	33.3	33.3	33.3	Month
Very High	Low	Longer	Low	Moderate	0.1	0.1	0.1	99.7	Month
Very High	Low	Longer	Low	High	0.1	0.1	0.1	99.7	Half-Month
Very High	Low	Longer	Moderate	Low	0.1	33.3	33.3	33.3	Month
Very High	Low	Longer	Moderate	Moderate	0.1	0.1	0.1	99.7	Month
Very High	Low	Longer	Moderate	High	0.1	0.1	0.1	99.7	Month
Very High	Low	Longer	High	Low	0.1	0.1	0.1	99.7	Middle Date
Very High	Low	Longer	High	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very High	Low	Longer	High	High	66	33.8	0.1	0.1	Middle Month
Very High	Moderate	Shorter	Low	Low	99.7	0.1	0.1	0.1	Date
Very High	Moderate	Shorter	Low	Moderate	0.1	11.6	5.9	82.4	Half-Month
Very High	Moderate	Shorter	Low	High	0.1	67.6	13.7	18.6	Half-Month
Very High	Moderate	Shorter	Moderate	Low	99.7	0.1	0.1	0.1	Date
Very High	Moderate	Shorter	Moderate	Moderate	0.1	1.7	49.2	49	Half-Month
Very High	Moderate	Shorter	Moderate	High	0.1	68.2	17.9	13.8	Half-Month
Very High	Moderate	Shorter	High	Low	0.1	99.7	0.1	0.1	Middle Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very High	Moderate	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
Very High	Moderate	Shorter	High	High	0.1	0.1	99.7	0.1	Month
Very High	Moderate	Short	Low	Low	0.1	54.9	44.9	0.1	Month
Very High	Moderate	Short	Low	Moderate	0.1	73.5	26.3	0.1	Half-Month
Very High	Moderate	Short	Low	High	0.1	0.1	0.1	99.7	Date
Very High	Moderate	Short	Moderate	Low	0.1	99.7	0.1	0.1	Month
Very High	Moderate	Short	Moderate	Moderate	0.1	28.9	70.9	0.1	Half-Month
Very High	Moderate	Short	Moderate	High	0.1	0.1	0.1	99.7	Date
Very High	Moderate	Short	High	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very High	Moderate	Short	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
Very High	Moderate	Short	High	High	0.1	0.1	99.7	0.1	Month
Very High	Moderate	Moderate	Low	Low	0.1	99.7	0.1	0.1	Month
Very High	Moderate	Moderate	Low	Moderate	0.1	38.7	61.1	0.1	Half-Month
Very High	Moderate	Moderate	Low	High	0.1	66.4	0.1	33.4	Half-Month
Very High	Moderate	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Month
Very High	Moderate	Moderate	Moderate	Moderate	0.1	19.1	80.7	0.1	Half-Month
Very High	Moderate	Moderate	Moderate	High	0.1	88	0.1	11.8	Half-Month
Very High	Moderate	Moderate	High	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very High	Moderate	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Month
Very High	Moderate	Moderate	High	High	0.1	0.1	99.7	0.1	Month
Very High	Moderate	Long	Low	Low	0.1	99.7	0.1	0.1	Half-Month
Very High	Moderate	Long	Low	Moderate	0.1	99.7	0.1	0.1	Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very High	Moderate	Long	Low	High	0.1	26.6	0.1	73.2	Half-Month
Very High	Moderate	Long	Moderate	Low	0.1	99.7	0.1	0.1	Month
Very High	Moderate	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Half-Month
Very High	Moderate	Long	Moderate	High	0.1	57.5	0.1	42.3	Half-Month
Very High	Moderate	Long	High	Low	0.1	0.1	0.1	99.7	Lower Month
Very High	Moderate	Long	High	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very High	Moderate	Long	High	High	37.8	0.1	0.1	62	Middle Date
Very High	Moderate	Longer	Low	Low	0.1	99.7	0.1	0.1	Half-Month
Very High	Moderate	Longer	Low	Moderate	0.1	99.7	0.1	0.1	Half-Month
Very High	Moderate	Longer	Low	High	0.1	22.4	62.7	14.8	Half-Month
Very High	Moderate	Longer	Moderate	Low	0.1	99.7	0.1	0.1	Month
Very High	Moderate	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Half-Month
Very High	Moderate	Longer	Moderate	High	0.1	83.9	8	8	Half-Month
Very High	Moderate	Longer	High	Low	0.1	0.1	0.1	99.7	Middle Date
Very High	Moderate	Longer	High	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very High	Moderate	Longer	High	High	68.6	31.2	0.1	0.1	Middle Month
Very High	High	Shorter	Low	Low	54.6	0.1	45.2	0.1	Date
Very High	High	Shorter	Low	Moderate	0.1	0.1	0.1	99.7	Date
Very High	High	Shorter	Low	High	0.1	35.6	0.1	64.2	Date
Very High	High	Shorter	Moderate	Low	99.7	0.1	0.1	0.1	Date
Very High	High	Shorter	Moderate	Moderate	0.1	2	34.3	63.6	Half-Month
Very High	High	Shorter	Moderate	High	0.1	59.4	16.4	24.1	Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very High	High	Shorter	High	Low	0.1	99.7	0.1	0.1	Middle Date
Very High	High	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
Very High	High	Shorter	High	High	0.1	0.1	99.7	0.1	Month
Very High	High	Short	Low	Low	99.7	0.1	0.1	0.1	Date
Very High	High	Short	Low	Moderate	0.1	82.2	17.6	0.1	Half-Month
Very High	High	Short	Low	High	0.1	62.8	34	3.1	Half-Month
Very High	High	Short	Moderate	Low	2.3	97.5	0.1	0.1	Month
Very High	High	Short	Moderate	Moderate	0.1	46.5	53.3	0.1	Half-Month
Very High	High	Short	Moderate	High	0.1	40.3	53.6	6	Half-Month
Very High	High	Short	High	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very High	High	Short	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
Very High	High	Short	High	High	0.1	0.1	99.7	0.1	Month
Very High	High	Moderate	Low	Low	99.7	0.1	0.1	0.1	Half-Month
Very High	High	Moderate	Low	Moderate	0.1	33.3	23.4	43.2	Half-Month
Very High	High	Moderate	Low	High	0.1	25.4	0.1	74.4	Half-Month
Very High	High	Moderate	Moderate	Low	2.8	97	0.1	0.1	Month
Very High	High	Moderate	Moderate	Moderate	0.1	32.9	62	5	Half-Month
Very High	High	Moderate	Moderate	High	0.1	73	0.1	26.8	Half-Month
Very High	High	Moderate	High	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very High	High	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Month
Very High	High	Moderate	High	High	0.1	0.1	99.7	0.1	Month
Very High	High	Long	Low	Low	1.2	98.6	0.1	0.1	Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very High	High	Long	Low	Moderate	0.1	99.7	0.1	0.1	Date
Very High	High	Long	Low	High	0.1	2.2	0.1	97.6	Half-Month
Very High	High	Long	Moderate	Low	0.5	99.3	0.1	0.1	Month
Very High	High	Long	Moderate	Moderate	0.1	56.8	0.1	43	Half-Month
Very High	High	Long	Moderate	High	0.1	14.5	0.1	85.3	Half-Month
Very High	High	Long	High	Low	0.1	66.5	0.1	33.3	Interpolate
Very High	High	Long	High	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very High	High	Long	High	High	47.7	0.1	0.1	52.1	Middle Date
Very High	High	Longer	Low	Low	76.2	3.1	7.7	13	Date
Very High	High	Longer	Low	Moderate	0.1	0.1	0.1	99.7	Date
Very High	High	Longer	Low	High	0.1	13.3	42.4	44.2	Half-Month
Very High	High	Longer	Moderate	Low	69.7	15.1	0.1	15.1	Date
Very High	High	Longer	Moderate	Moderate	0.1	92.8	0.1	7	Half-Month
Very High	High	Longer	Moderate	High	0.1	58.3	14.8	26.8	Half-Month
Very High	High	Longer	High	Low	0.1	0.1	0.1	99.7	Middle Date
Very High	High	Longer	High	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very High	High	Longer	High	High	49.4	50.4	0.1	0.1	Middle Month
Very High	Very High	Shorter	Low	Low	18.1	45.6	7.5	28.8	Date
Very High	Very High	Shorter	Low	Moderate	0.1	36.6	44.3	19	Date
Very High	Very High	Shorter	Low	High	0.1	71.2	11.2	17.5	Date
Very High	Very High	Shorter	Moderate	Low	0.1	0.1	0.1	99.7	Date
Very High	Very High	Shorter	Moderate	Moderate	0.1	0.1	0.1	99.7	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very High	Very High	Shorter	Moderate	High	0.1	0.1	0.1	99.7	Date
Very High	Very High	Shorter	High	Low	0.1	99.7	0.1	0.1	Middle Date
Very High	Very High	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
Very High	Very High	Shorter	High	High	0.1	0.1	99.7	0.1	Month
Very High	Very High	Short	Low	Low	52.4	47.4	0.1	0.1	Date
Very High	Very High	Short	Low	Moderate	0.1	0.1	99.7	0.1	Date
Very High	Very High	Short	Low	High	0.1	44.2	53.5	2.2	Date
Very High	Very High	Short	Moderate	Low	1.9	97.7	0.3	0.1	Month
Very High	Very High	Short	Moderate	Moderate	0.1	23.9	75.9	0.1	Half-Month
Very High	Very High	Short	Moderate	High	0.1	0.1	0.1	99.7	Date
Very High	Very High	Short	High	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very High	Very High	Short	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
Very High	Very High	Short	High	High	0.1	0.1	99.7	0.1	Month
Very High	Very High	Moderate	Low	Low	45.1	54.7	0.1	0.1	Half-Month
Very High	Very High	Moderate	Low	Moderate	21.1	0.1	37.2	41.6	Date
Very High	Very High	Moderate	Low	High	0.1	22.3	47.9	29.7	Date
Very High	Very High	Moderate	Moderate	Low	20.3	79.5	0.1	0.1	Month
Very High	Very High	Moderate	Moderate	Moderate	0.1	74.4	0.1	25.4	Half-Month
Very High	Very High	Moderate	Moderate	High	0.1	51.8	0.1	48	Half-Month
Very High	Very High	Moderate	High	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very High	Very High	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Month
Very High	Very High	Moderate	High	High	0.1	0.1	99.7	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very High	Very High	Long	Low	Low	0.1	99.7	0.1	0.1	Date
Very High	Very High	Long	Low	Moderate	0.1	0.1	38.4	61.4	Date
Very High	Very High	Long	Low	High	0.1	0.1	29.6	70.2	Date
Very High	Very High	Long	Moderate	Low	0.3	99.5	0.1	0.1	Month
Very High	Very High	Long	Moderate	Moderate	0.1	36.1	0.1	63.7	Half-Month
Very High	Very High	Long	Moderate	High	0.1	5.1	0.1	94.7	Half-Month
Very High	Very High	Long	High	Low	0.1	79.8	0.1	20	Interpolate
Very High	Very High	Long	High	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very High	Very High	Long	High	High	0.1	0.1	99.7	0.1	Middle Half-Month
Very High	Very High	Longer	Low	Low	22.3	15.2	43.7	18.8	Date
Very High	Very High	Longer	Low	Moderate	0.1	64.6	0.9	34.4	Date
Very High	Very High	Longer	Low	High	0.1	54.1	0.1	45.7	Date
Very High	Very High	Longer	Moderate	Low	60.9	19.5	0.1	19.5	Date
Very High	Very High	Longer	Moderate	Moderate	0.1	0.1	0.1	99.7	Date
Very High	Very High	Longer	Moderate	High	0.1	53.3	10.1	36.5	Half-Month
Very High	Very High	Longer	High	Low	0.1	0.1	0.1	99.7	Middle Date
Very High	Very High	Longer	High	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very High	Very High	Longer	High	High	0.1	99.7	0.1	0.1	Middle Month

6.19 Total Algal Biovolume (totbiovman, mm3/m3) – Middle Lake Segment

Conditioned on:

- Total Nitrogen (totaln, mg/L)
- Total Phosphorus (totalp, mg/L)
- Residence Time (resid30, days)
- Secchi Depth (secchi, ft)
- Water Temperature (wtemp, C)

Middle:

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	Very Low	Shorter	Low	Low	0.1	99.7	0.1	0.1	Lower Month
Very Low	Very Low	Shorter	Low	Moderate	0.1	0.1	35.9	63.9	Upper Half-Month
Very Low	Very Low	Shorter	Low	High	0.1	0.1	33.3	66.5	Upper Half-Month
Very Low	Very Low	Shorter	Moderate	Low	0.1	99.7	0.1	0.1	Lower Month
Very Low	Very Low	Shorter	Moderate	Moderate	84.7	2.4	3.2	9.7	Lower Month
Very Low	Very Low	Shorter	Moderate	High	0.1	99.7	0.1	0.1	Month
Very Low	Very Low	Shorter	High	Low	0.1	99.7	0.1	0.1	Lower Month
Very Low	Very Low	Shorter	High	Moderate	99.7	0.1	0.1	0.1	Lower Date
Very Low	Very Low	Shorter	High	High	0.1	99.7	0.1	0.1	Month
Very Low	Very Low	Short	Low	Low	0.1	99.7	0.1	0.1	Lower Month
Very Low	Very Low	Short	Low	Moderate	0.1	0.1	99.7	0.1	Upper Half-Month
Very Low	Very Low	Short	Low	High	0.1	0.1	57.4	42.4	Upper Month
Very Low	Very Low	Short	Moderate	Low	0.1	99.7	0.1	0.1	Lower Month
Very Low	Very Low	Short	Moderate	Moderate	72.2	0.1	20.5	7.2	Lower Month
Very Low	Very Low	Short	Moderate	High	0.1	99.7	0.1	0.1	Month
Very Low	Very Low	Short	High	Low	0.1	99.7	0.1	0.1	Lower Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	Very Low	Short	High	Moderate	0.1	99.7	0.1	0.1	Lower Half-Month
Very Low	Very Low	Short	High	High	0.1	99.7	0.1	0.1	Month
Very Low	Very Low	Moderate	Low	Low	25	49.9	0.1	25	Interpolate
Very Low	Very Low	Moderate	Low	Moderate	0.1	0.1	0.1	99.7	Lower Month
Very Low	Very Low	Moderate	Low	High	0.1	34.8	65	0.1	Upper Month
Very Low	Very Low	Moderate	Moderate	Low	99.7	0.1	0.1	0.1	Lower Month
Very Low	Very Low	Moderate	Moderate	Moderate	0.1	0.1	99.7	0.1	Lower Date
Very Low	Very Low	Moderate	Moderate	High	0.1	0.1	99.7	0.1	Date
Very Low	Very Low	Moderate	High	Low	99.7	0.1	0.1	0.1	Lower Month
Very Low	Very Low	Moderate	High	Moderate	0.1	60.9	38.9	0.1	Lower Date
Very Low	Very Low	Moderate	High	High	0.1	0.1	99.7	0.1	Date
Very Low	Very Low	Long	Low	Low	33.3	66.5	0.1	0.1	Interpolate
Very Low	Very Low	Long	Low	Moderate	0.1	99.7	0.1	0.1	Upper Month
Very Low	Very Low	Long	Low	High	0.1	99.7	0.1	0.1	Upper Month
Very Low	Very Low	Long	Moderate	Low	99.7	0.1	0.1	0.1	Lower Month
Very Low	Very Low	Long	Moderate	Moderate	0.1	0.1	0.1	99.7	Lower Date
Very Low	Very Low	Long	Moderate	High	0.1	0.1	99.7	0.1	Month
Very Low	Very Low	Long	High	Low	99.7	0.1	0.1	0.1	Lower Date
Very Low	Very Low	Long	High	Moderate	14.5	0.1	49.6	35.8	Lower Date
Very Low	Very Low	Long	High	High	0.1	0.1	99.7	0.1	Month
Very Low	Very Low	Longer	Low	Low	0.1	73.4	26.4	0.1	Interpolate
Very Low	Very Low	Longer	Low	Moderate	0.1	99.7	0.1	0.1	Upper Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	Very Low	Longer	Low	High	0.1	99.7	0.1	0.1	Date
Very Low	Very Low	Longer	Moderate	Low	0.1	99.7	0.1	0.1	Date
Very Low	Very Low	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Date
Very Low	Very Low	Longer	Moderate	High	0.1	99.7	0.1	0.1	Date
Very Low	Very Low	Longer	High	Low	0.1	99.7	0.1	0.1	Date
Very Low	Very Low	Longer	High	Moderate	0.1	99.7	0.1	0.1	Date
Very Low	Very Low	Longer	High	High	0.1	99.7	0.1	0.1	Date
Very Low	Low	Shorter	Low	Low	86.1	13.7	0.1	0.1	Month
Very Low	Low	Shorter	Low	Moderate	0.1	99.7	0.1	0.1	Half-Month
Very Low	Low	Shorter	Low	High	99.7	0.1	0.1	0.1	Date
Very Low	Low	Shorter	Moderate	Low	99.7	0.1	0.1	0.1	Date
Very Low	Low	Shorter	Moderate	Moderate	99.7	0.1	0.1	0.1	Date
Very Low	Low	Shorter	Moderate	High	99.7	0.1	0.1	0.1	Date
Very Low	Low	Shorter	High	Low	99.7	0.1	0.1	0.1	Date
Very Low	Low	Shorter	High	Moderate	99.7	0.1	0.1	0.1	Date
Very Low	Low	Shorter	High	High	99.7	0.1	0.1	0.1	Date
Very Low	Low	Short	Low	Low	20.8	79	0.1	0.1	Month
Very Low	Low	Short	Low	Moderate	0.1	99.7	0.1	0.1	Date
Very Low	Low	Short	Low	High	73.1	26.7	0.1	0.1	Half-Month
Very Low	Low	Short	Moderate	Low	53.6	46.2	0.1	0.1	Month
Very Low	Low	Short	Moderate	Moderate	76.4	23.4	0.1	0.1	Date
Very Low	Low	Short	Moderate	High	0.1	99.7	0.1	0.1	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	Low	Short	High	Low	6.1	93.7	0.1	0.1	Month
Very Low	Low	Short	High	Moderate	30.9	68.9	0.1	0.1	Date
Very Low	Low	Short	High	High	0.1	99.7	0.1	0.1	Date
Very Low	Low	Moderate	Low	Low	0.1	99.7	0.1	0.1	Half-Month
Very Low	Low	Moderate	Low	Moderate	0.1	99.7	0.1	0.1	Month
Very Low	Low	Moderate	Low	High	0.1	1.2	98.6	0.1	Month
Very Low	Low	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
Very Low	Low	Moderate	Moderate	Moderate	99.7	0.1	0.1	0.1	Half-Month
Very Low	Low	Moderate	Moderate	High	0.1	0.1	79.8	20	Date
Very Low	Low	Moderate	High	Low	0.1	99.7	0.1	0.1	Month
Very Low	Low	Moderate	High	Moderate	99.7	0.1	0.1	0.1	Half-Month
Very Low	Low	Moderate	High	High	0.1	0.1	82.6	17.2	Date
Very Low	Low	Long	Low	Low	0.1	99.7	0.1	0.1	Half-Month
Very Low	Low	Long	Low	Moderate	39.6	60.2	0.1	0.1	Month
Very Low	Low	Long	Low	High	0.1	0.1	99.7	0.1	Half-Month
Very Low	Low	Long	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
Very Low	Low	Long	Moderate	Moderate	81.8	18	0.1	0.1	Half-Month
Very Low	Low	Long	Moderate	High	73.8	26	0.1	0.1	Date
Very Low	Low	Long	High	Low	0.1	99.7	0.1	0.1	Month
Very Low	Low	Long	High	Moderate	99.5	0.3	0.1	0.1	Half-Month
Very Low	Low	Long	High	High	43.8	56	0.1	0.1	Date
Very Low	Low	Longer	Low	Low	0.1	20.7	79.1	0.1	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	Low	Longer	Low	Moderate	38	61.8	0.1	0.1	Date
Very Low	Low	Longer	Low	High	0.1	99.7	0.1	0.1	Date
Very Low	Low	Longer	Moderate	Low	4.9	84.6	10.4	0.1	Date
Very Low	Low	Longer	Moderate	Moderate	53.8	41.3	4.8	0.1	Date
Very Low	Low	Longer	Moderate	High	70.8	29	0.1	0.1	Date
Very Low	Low	Longer	High	Low	74.4	22.3	3.2	0.1	Date
Very Low	Low	Longer	High	Moderate	44.5	19.7	35.7	0.1	Date
Very Low	Low	Longer	High	High	91.2	8.6	0.1	0.1	Date
Very Low	Moderate	Shorter	Low	Low	99.7	0.1	0.1	0.1	Date
Very Low	Moderate	Shorter	Low	Moderate	99.7	0.1	0.1	0.1	Date
Very Low	Moderate	Shorter	Low	High	99.7	0.1	0.1	0.1	Date
Very Low	Moderate	Shorter	Moderate	Low	99.7	0.1	0.1	0.1	Date
Very Low	Moderate	Shorter	Moderate	Moderate	99.7	0.1	0.1	0.1	Date
Very Low	Moderate	Shorter	Moderate	High	99.7	0.1	0.1	0.1	Date
Very Low	Moderate	Shorter	High	Low	47.6	52.2	0.1	0.1	Month
Very Low	Moderate	Shorter	High	Moderate	53.3	46.5	0.1	0.1	Half-Month
Very Low	Moderate	Shorter	High	High	99.7	0.1	0.1	0.1	Date
Very Low	Moderate	Short	Low	Low	30.4	69.4	0.1	0.1	Month
Very Low	Moderate	Short	Low	Moderate	0.1	99.7	0.1	0.1	Half-Month
Very Low	Moderate	Short	Low	High	80.3	19.5	0.1	0.1	Half-Month
Very Low	Moderate	Short	Moderate	Low	59.1	40.7	0.1	0.1	Month
Very Low	Moderate	Short	Moderate	Moderate	99.7	0.1	0.1	0.1	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	Moderate	Short	Moderate	High	0.1	99.7	0.1	0.1	Date
Very Low	Moderate	Short	High	Low	9.4	90.4	0.1	0.1	Month
Very Low	Moderate	Short	High	Moderate	99.7	0.1	0.1	0.1	Date
Very Low	Moderate	Short	High	High	0.1	99.7	0.1	0.1	Date
Very Low	Moderate	Moderate	Low	Low	0.1	99.7	0.1	0.1	Half-Month
Very Low	Moderate	Moderate	Low	Moderate	0.1	99.7	0.1	0.1	Month
Very Low	Moderate	Moderate	Low	High	0.1	2.1	97.7	0.1	Month
Very Low	Moderate	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
Very Low	Moderate	Moderate	Moderate	Moderate	95.1	4.7	0.1	0.1	Month
Very Low	Moderate	Moderate	Moderate	High	0.1	0.1	0.1	99.7	Date
Very Low	Moderate	Moderate	High	Low	0.1	99.7	0.1	0.1	Month
Very Low	Moderate	Moderate	High	Moderate	98.9	0.9	0.1	0.1	Month
Very Low	Moderate	Moderate	High	High	0.1	0.1	0.1	99.7	Date
Very Low	Moderate	Long	Low	Low	0.1	99.7	0.1	0.1	Half-Month
Very Low	Moderate	Long	Low	Moderate	0.1	99.7	0.1	0.1	Month
Very Low	Moderate	Long	Low	High	0.1	0.1	99.7	0.1	Half-Month
Very Low	Moderate	Long	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
Very Low	Moderate	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Half-Month
Very Low	Moderate	Long	Moderate	High	99.7	0.1	0.1	0.1	Date
Very Low	Moderate	Long	High	Low	0.1	99.7	0.1	0.1	Month
Very Low	Moderate	Long	High	Moderate	0.1	99.7	0.1	0.1	Half-Month
Very Low	Moderate	Long	High	High	99.7	0.1	0.1	0.1	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	Moderate	Longer	Low	Low	0.1	72.1	27.7	0.1	Date
Very Low	Moderate	Longer	Low	Moderate	0.1	99.7	0.1	0.1	Date
Very Low	Moderate	Longer	Low	High	0.1	99.7	0.1	0.1	Date
Very Low	Moderate	Longer	Moderate	Low	0.1	78.5	21.3	0.1	Date
Very Low	Moderate	Longer	Moderate	Moderate	0.1	82.3	17.5	0.1	Date
Very Low	Moderate	Longer	Moderate	High	0.1	99.7	0.1	0.1	Date
Very Low	Moderate	Longer	High	Low	0.1	69.9	29.9	0.1	Date
Very Low	Moderate	Longer	High	Moderate	0.1	25.2	74.6	0.1	Date
Very Low	Moderate	Longer	High	High	0.1	99.7	0.1	0.1	Date
Very Low	High	Shorter	Low	Low	99.7	0.1	0.1	0.1	Date
Very Low	High	Shorter	Low	Moderate	99.7	0.1	0.1	0.1	Date
Very Low	High	Shorter	Low	High	0.1	0.1	0.1	99.7	Month
Very Low	High	Shorter	Moderate	Low	99.7	0.1	0.1	0.1	Date
Very Low	High	Shorter	Moderate	Moderate	99.7	0.1	0.1	0.1	Date
Very Low	High	Shorter	Moderate	High	0.1	99.7	0.1	0.1	Half-Month
Very Low	High	Shorter	High	Low	10	89.8	0.1	0.1	Month
Very Low	High	Shorter	High	Moderate	99.7	0.1	0.1	0.1	Month
Very Low	High	Shorter	High	High	0.1	99.7	0.1	0.1	Half-Month
Very Low	High	Short	Low	Low	14.9	84.9	0.1	0.1	Month
Very Low	High	Short	Low	Moderate	99.7	0.1	0.1	0.1	Month
Very Low	High	Short	Low	High	0.1	0.1	99.7	0.1	Month
Very Low	High	Short	Moderate	Low	23.7	76.1	0.1	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	High	Short	Moderate	Moderate	99.7	0.1	0.1	0.1	Month
Very Low	High	Short	Moderate	High	0.1	99.7	0.1	0.1	Date
Very Low	High	Short	High	Low	3.6	96.2	0.1	0.1	Month
Very Low	High	Short	High	Moderate	99.7	0.1	0.1	0.1	Month
Very Low	High	Short	High	High	0.1	99.7	0.1	0.1	Date
Very Low	High	Moderate	Low	Low	0.1	99.7	0.1	0.1	Half-Month
Very Low	High	Moderate	Low	Moderate	0.1	99.7	0.1	0.1	Month
Very Low	High	Moderate	Low	High	0.1	3.4	96.4	0.1	Month
Very Low	High	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
Very Low	High	Moderate	Moderate	Moderate	0.1	99.7	0.1	0.1	Month
Very Low	High	Moderate	Moderate	High	0.1	0.1	0.1	99.7	Date
Very Low	High	Moderate	High	Low	0.1	99.7	0.1	0.1	Month
Very Low	High	Moderate	High	Moderate	0.1	99.7	0.1	0.1	Month
Very Low	High	Moderate	High	High	0.1	0.1	0.1	99.7	Date
Very Low	High	Long	Low	Low	0.1	99.7	0.1	0.1	Half-Month
Very Low	High	Long	Low	Moderate	0.1	99.7	0.1	0.1	Month
Very Low	High	Long	Low	High	0.1	0.1	99.7	0.1	Half-Month
Very Low	High	Long	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
Very Low	High	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Half-Month
Very Low	High	Long	Moderate	High	0.1	46	50.6	3.3	Half-Month
Very Low	High	Long	High	Low	0.1	99.7	0.1	0.1	Month
Very Low	High	Long	High	Moderate	0.1	99.7	0.1	0.1	Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	High	Long	High	High	0.1	12.8	65.7	21.4	Half-Month
Very Low	High	Longer	Low	Low	0.1	83.7	16.1	0.1	Date
Very Low	High	Longer	Low	Moderate	0.1	99.7	0.1	0.1	Month
Very Low	High	Longer	Low	High	0.1	99.7	0.1	0.1	Date
Very Low	High	Longer	Moderate	Low	0.1	75.2	24.6	0.1	Date
Very Low	High	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Date
Very Low	High	Longer	Moderate	High	0.1	99.7	0.1	0.1	Date
Very Low	High	Longer	High	Low	0.1	43.9	55.9	0.1	Date
Very Low	High	Longer	High	Moderate	0.1	99.7	0.1	0.1	Date
Very Low	High	Longer	High	High	0.1	99.7	0.1	0.1	Date
Very Low	Very High	Shorter	Low	Low	0.1	99.7	0.1	0.1	Month
Very Low	Very High	Shorter	Low	Moderate	0.1	0.1	0.1	99.7	Upper Date
Very Low	Very High	Shorter	Low	High	0.1	0.1	0.1	99.7	Upper Date
Very Low	Very High	Shorter	Moderate	Low	0.1	99.7	0.1	0.1	Month
Very Low	Very High	Shorter	Moderate	Moderate	5.1	0.1	35.5	59.3	Upper Half-Month
Very Low	Very High	Shorter	Moderate	High	0.1	0.1	33.3	66.5	Upper Half-Month
Very Low	Very High	Shorter	High	Low	0.1	99.7	0.1	0.1	Month
Very Low	Very High	Shorter	High	Moderate	99.7	0.1	0.1	0.1	Lower Month
Very Low	Very High	Shorter	High	High	0.1	99.7	0.1	0.1	Lower Month
Very Low	Very High	Short	Low	Low	0.1	99.7	0.1	0.1	Month
Very Low	Very High	Short	Low	Moderate	32.4	0.1	67.4	0.1	Upper Half-Month
Very Low	Very High	Short	Low	High	0.1	0.1	99.7	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	Very High	Short	Moderate	Low	0.1	99.7	0.1	0.1	Month
Very Low	Very High	Short	Moderate	Moderate	16.3	0.1	83.5	0.1	Upper Half-Month
Very Low	Very High	Short	Moderate	High	0.1	0.1	99.7	0.1	Month
Very Low	Very High	Short	High	Low	0.1	99.7	0.1	0.1	Month
Very Low	Very High	Short	High	Moderate	0.1	99.7	0.1	0.1	Lower Half-Month
Very Low	Very High	Short	High	High	0.1	0.1	99.7	0.1	Month
Very Low	Very High	Moderate	Low	Low	0.1	99.7	0.1	0.1	Month
Very Low	Very High	Moderate	Low	Moderate	0.1	0.1	99.7	0.1	Upper Month
Very Low	Very High	Moderate	Low	High	0.1	0.1	99.7	0.1	Month
Very Low	Very High	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Month
Very Low	Very High	Moderate	Moderate	Moderate	0.1	0.1	99.7	0.1	Upper Month
Very Low	Very High	Moderate	Moderate	High	0.1	0.1	99.7	0.1	Month
Very Low	Very High	Moderate	High	Low	0.1	99.7	0.1	0.1	Month
Very Low	Very High	Moderate	High	Moderate	0.1	99.7	0.1	0.1	Lower Date
Very Low	Very High	Moderate	High	High	0.1	0.1	99.7	0.1	Month
Very Low	Very High	Long	Low	Low	0.1	99.7	0.1	0.1	Month
Very Low	Very High	Long	Low	Moderate	0.1	99.7	0.1	0.1	Month
Very Low	Very High	Long	Low	High	0.1	0.1	99.7	0.1	Half-Month
Very Low	Very High	Long	Moderate	Low	0.1	99.7	0.1	0.1	Month
Very Low	Very High	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Month
Very Low	Very High	Long	Moderate	High	0.1	0.1	99.7	0.1	Date
Very Low	Very High	Long	High	Low	0.1	99.7	0.1	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	Very High	Long	High	Moderate	0.1	99.7	0.1	0.1	Month
Very Low	Very High	Long	High	High	0.1	0.1	99.7	0.1	Half-Month
Very Low	Very High	Longer	Low	Low	0.1	99.7	0.1	0.1	Month
Very Low	Very High	Longer	Low	Moderate	0.1	99.7	0.1	0.1	Month
Very Low	Very High	Longer	Low	High	0.1	99.7	0.1	0.1	Month
Very Low	Very High	Longer	Moderate	Low	0.1	99.7	0.1	0.1	Month
Very Low	Very High	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Month
Very Low	Very High	Longer	Moderate	High	0.1	99.7	0.1	0.1	Month
Very Low	Very High	Longer	High	Low	0.1	99.7	0.1	0.1	Month
Very Low	Very High	Longer	High	Moderate	0.1	99.7	0.1	0.1	Month
Very Low	Very High	Longer	High	High	0.1	99.7	0.1	0.1	Month
Low	Very Low	Shorter	Low	Low	0.1	99.7	0.1	0.1	Lower Month
Low	Very Low	Shorter	Low	Moderate	0.1	99.7	0.1	0.1	Lower Month
Low	Very Low	Shorter	Low	High	0.1	0.1	0.1	99.7	Lower Date
Low	Very Low	Shorter	Moderate	Low	83.1	0.1	16.7	0.1	Lower Half-Month
Low	Very Low	Shorter	Moderate	Moderate	0.1	0.1	99.7	0.1	Lower Half-Month
Low	Very Low	Shorter	Moderate	High	0.1	99.7	0.1	0.1	Month
Low	Very Low	Shorter	High	Low	11.3	0.1	88.5	0.1	Lower Half-Month
Low	Very Low	Shorter	High	Moderate	99.7	0.1	0.1	0.1	Lower Date
Low	Very Low	Shorter	High	High	0.1	99.7	0.1	0.1	Month
Low	Very Low	Short	Low	Low	0.1	99.7	0.1	0.1	Lower Month
Low	Very Low	Short	Low	Moderate	0.1	99.7	0.1	0.1	Lower Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Low	Very Low	Short	Low	High	0.1	85.9	13.9	0.1	Upper Month
Low	Very Low	Short	Moderate	Low	0.1	31.2	68.6	0.1	Lower Half-Month
Low	Very Low	Short	Moderate	Moderate	0.1	0.1	99.7	0.1	Lower Half-Month
Low	Very Low	Short	Moderate	High	0.1	99.7	0.1	0.1	Month
Low	Very Low	Short	High	Low	0.1	38.6	61.2	0.1	Lower Half-Month
Low	Very Low	Short	High	Moderate	0.1	0.1	99.7	0.1	Lower Half-Month
Low	Very Low	Short	High	High	0.1	99.7	0.1	0.1	Month
Low	Very Low	Moderate	Low	Low	18.1	56.8	0.1	25	Interpolate
Low	Very Low	Moderate	Low	Moderate	0.1	0.1	0.1	99.7	Lower Month
Low	Very Low	Moderate	Low	High	0.1	85.9	13.9	0.1	Upper Month
Low	Very Low	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Lower Half-Month
Low	Very Low	Moderate	Moderate	Moderate	0.7	3.6	29	66.7	Lower Month
Low	Very Low	Moderate	Moderate	High	0.1	0.1	99.7	0.1	Date
Low	Very Low	Moderate	High	Low	0.1	99.7	0.1	0.1	Lower Half-Month
Low	Very Low	Moderate	High	Moderate	0.1	99.7	0.1	0.1	Lower Date
Low	Very Low	Moderate	High	High	0.1	0.1	99.7	0.1	Date
Low	Very Low	Long	Low	Low	39.9	59.9	0.1	0.1	Interpolate
Low	Very Low	Long	Low	Moderate	0.1	56.7	0.1	43.1	Interpolate
Low	Very Low	Long	Low	High	0.1	99.7	0.1	0.1	Upper Month
Low	Very Low	Long	Moderate	Low	0.1	99.7	0.1	0.1	Lower Half-Month
Low	Very Low	Long	Moderate	Moderate	0.1	27.4	0.1	72.4	Lower Date
Low	Very Low	Long	Moderate	High	0.1	0.1	99.7	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Low	Very Low	Long	High	Low	99.7	0.1	0.1	0.1	Lower Date
Low	Very Low	Long	High	Moderate	16.8	0.1	0.1	83	Lower Date
Low	Very Low	Long	High	High	0.1	0.1	99.7	0.1	Month
Low	Very Low	Longer	Low	Low	0.1	67.6	12.7	19.6	Interpolate
Low	Very Low	Longer	Low	Moderate	13.2	86.2	0.1	0.5	Interpolate
Low	Very Low	Longer	Low	High	0.1	99.7	0.1	0.1	Date
Low	Very Low	Longer	Moderate	Low	0.1	99.7	0.1	0.1	Date
Low	Very Low	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Date
Low	Very Low	Longer	Moderate	High	0.1	99.7	0.1	0.1	Date
Low	Very Low	Longer	High	Low	0.1	99.7	0.1	0.1	Date
Low	Very Low	Longer	High	Moderate	0.1	99.7	0.1	0.1	Date
Low	Very Low	Longer	High	High	0.1	99.7	0.1	0.1	Date
Low	Low	Shorter	Low	Low	99.7	0.1	0.1	0.1	Date
Low	Low	Shorter	Low	Moderate	0.1	6.8	90	3.1	Date
Low	Low	Shorter	Low	High	56.1	8.5	34.2	1.2	Date
Low	Low	Shorter	Moderate	Low	34.7	0.1	2.2	63	Date
Low	Low	Shorter	Moderate	Moderate	22.2	65.5	5	7.3	Date
Low	Low	Shorter	Moderate	High	83.7	10.7	4.5	1.1	Date
Low	Low	Shorter	High	Low	57	0.1	0.1	42.8	Date
Low	Low	Shorter	High	Moderate	57.5	7.5	20.8	14.2	Date
Low	Low	Shorter	High	High	88.7	5.6	4.7	1	Date
Low	Low	Short	Low	Low	99.7	0.1	0.1	0.1	Half-Month
Low	Low	Short	Low	Moderate	0.1	99.7	0.1	0.1	Date
Low	Low	Short	Low	High	31.2	67.9	0.8	0.1	Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Low	Low	Short	Moderate	Low	0.1	99.7	0.1	0.1	Date
Low	Low	Short	Moderate	Moderate	59.3	40.5	0.1	0.1	Date
Low	Low	Short	Moderate	High	0.1	99.7	0.1	0.1	Date
Low	Low	Short	High	Low	88.9	0.1	0.1	10.9	Half-Month
Low	Low	Short	High	Moderate	16.8	83	0.1	0.1	Date
Low	Low	Short	High	High	0.1	99.7	0.1	0.1	Date
Low	Low	Moderate	Low	Low	72.1	27.7	0.1	0.1	Half-Month
Low	Low	Moderate	Low	Moderate	97.1	2.6	0.1	0.2	Month
Low	Low	Moderate	Low	High	0.1	0.1	0.5	99.3	Half-Month
Low	Low	Moderate	Moderate	Low	44.4	0.1	55.4	0.1	Date
Low	Low	Moderate	Moderate	Moderate	85.2	8.3	0.1	6.4	Date
Low	Low	Moderate	Moderate	High	0.1	29.5	23.3	47.1	Date
Low	Low	Moderate	High	Low	43.1	0.1	56.7	0.1	Date
Low	Low	Moderate	High	Moderate	56.5	41.7	0.1	1.7	Date
Low	Low	Moderate	High	High	0.1	2.7	53.6	43.6	Date
Low	Low	Long	Low	Low	79.5	20.3	0.1	0.1	Half-Month
Low	Low	Long	Low	Moderate	0.1	14.1	0.1	85.7	Date
Low	Low	Long	Low	High	5.8	4.1	53	37.1	Date
Low	Low	Long	Moderate	Low	0.1	99.7	0.1	0.1	Date
Low	Low	Long	Moderate	Moderate	1.5	86.1	0.1	12.3	Date
Low	Low	Long	Moderate	High	49.6	2.3	26.8	21.3	Date
Low	Low	Long	High	Low	0.1	99.7	0.1	0.1	Date
Low	Low	Long	High	Moderate	6	93.8	0.1	0.1	Date
Low	Low	Long	High	High	95.1	0.1	4.7	0.1	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Low	Low	Longer	Low	Low	0.1	35.5	25.4	39	Date
Low	Low	Longer	Low	Moderate	66	31.5	0.1	2.4	Date
Low	Low	Longer	Low	High	0.1	43.4	0.1	56.4	Date
Low	Low	Longer	Moderate	Low	21.1	38.4	27.9	12.6	Date
Low	Low	Longer	Moderate	Moderate	62.4	10.3	4.1	23.2	Date
Low	Low	Longer	Moderate	High	26.3	42.7	0.1	30.9	Date
Low	Low	Longer	High	Low	52.8	33	12.4	1.8	Date
Low	Low	Longer	High	Moderate	8.3	17	68.5	6.2	Date
Low	Low	Longer	High	High	65.7	24.9	0.1	9.3	Date
Low	Moderate	Shorter	Low	Low	94.7	5.1	0.1	0.1	Date
Low	Moderate	Shorter	Low	Moderate	78.5	1.7	17.4	2.4	Date
Low	Moderate	Shorter	Low	High	62.3	6.3	19	12.4	Date
Low	Moderate	Shorter	Moderate	Low	87.2	4.5	1	7.3	Date
Low	Moderate	Shorter	Moderate	Moderate	81.8	13.5	1.5	3.2	Date
Low	Moderate	Shorter	Moderate	High	81.2	7.8	2.5	8.5	Date
Low	Moderate	Shorter	High	Low	87	4.5	0.1	8.4	Date
Low	Moderate	Shorter	High	Moderate	0.1	17.4	36.2	46.3	Date
Low	Moderate	Shorter	High	High	74.5	3.9	2.5	19.1	Date
Low	Moderate	Short	Low	Low	0.1	99.7	0.1	0.1	Date
Low	Moderate	Short	Low	Moderate	0.1	0.1	99.7	0.1	Date
Low	Moderate	Short	Low	High	37.2	54	8.7	0.1	Half-Month
Low	Moderate	Short	Moderate	Low	0.1	33.2	0.1	66.6	Date
Low	Moderate	Short	Moderate	Moderate	95.8	0.1	4	0.1	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Low	Moderate	Short	Moderate	High	0.1	99.7	0.1	0.1	Date
Low	Moderate	Short	High	Low	0.1	99.7	0.1	0.1	Date
Low	Moderate	Short	High	Moderate	99.7	0.1	0.1	0.1	Date
Low	Moderate	Short	High	High	0.1	99.7	0.1	0.1	Date
Low	Moderate	Moderate	Low	Low	3.6	96.2	0.1	0.1	Half-Month
Low	Moderate	Moderate	Low	Moderate	98.8	1	0.1	0.1	Month
Low	Moderate	Moderate	Low	High	0.1	0.1	5.1	94.7	Half-Month
Low	Moderate	Moderate	Moderate	Low	39	0.1	60.8	0.1	Date
Low	Moderate	Moderate	Moderate	Moderate	56.1	18.7	0.1	25.1	Date
Low	Moderate	Moderate	Moderate	High	0.1	71.2	0.1	28.6	Date
Low	Moderate	Moderate	High	Low	37.7	0.1	62.1	0.1	Date
Low	Moderate	Moderate	High	Moderate	28.7	66.1	0.1	5.1	Date
Low	Moderate	Moderate	High	High	0.1	19.8	0.1	80	Date
Low	Moderate	Long	Low	Low	8.6	91.2	0.1	0.1	Half-Month
Low	Moderate	Long	Low	Moderate	0.1	39.5	0.1	60.3	Date
Low	Moderate	Long	Low	High	2.5	14.1	67.4	16	Date
Low	Moderate	Long	Moderate	Low	0.1	99.7	0.1	0.1	Date
Low	Moderate	Long	Moderate	Moderate	12.3	54.7	0.1	32.9	Date
Low	Moderate	Long	Moderate	High	22.7	12.1	51.4	13.8	Date
Low	Moderate	Long	High	Low	0.1	99.7	0.1	0.1	Date
Low	Moderate	Long	High	Moderate	53.1	46.7	0.1	0.1	Date
Low	Moderate	Long	High	High	88.3	0.1	11.5	0.1	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Low	Moderate	Longer	Low	Low	0.1	26.7	7.1	66.1	Date
Low	Moderate	Longer	Low	Moderate	0.1	89.2	0.1	10.6	Date
Low	Moderate	Longer	Low	High	0.1	75.2	0.1	24.6	Date
Low	Moderate	Longer	Moderate	Low	0.1	54.4	15.9	29.6	Date
Low	Moderate	Longer	Moderate	Moderate	0.1	13	5.6	81.3	Date
Low	Moderate	Longer	Moderate	High	0.1	88.9	0.1	10.9	Date
Low	Moderate	Longer	High	Low	0.1	62.4	33.5	4	Date
Low	Moderate	Longer	High	Moderate	0.1	16	77.7	6.2	Date
Low	Moderate	Longer	High	High	0.1	94	0.1	5.8	Date
Low	High	Shorter	Low	Low	78.7	21.1	0.1	0.1	Date
Low	High	Shorter	Low	Moderate	80.2	2.7	13.4	3.7	Date
Low	High	Shorter	Low	High	0.1	24.3	36.9	38.7	Date
Low	High	Shorter	Moderate	Low	80.2	18.8	0.9	0.1	Date
Low	High	Shorter	Moderate	Moderate	93.8	2.4	1.3	2.5	Date
Low	High	Shorter	Moderate	High	0.1	48.6	7.6	43.7	Date
Low	High	Shorter	High	Low	54.5	45.3	0.1	0.1	Date
Low	High	Shorter	High	Moderate	0.1	27	28.1	44.8	Date
Low	High	Shorter	High	High	0.1	19.6	6.2	74.1	Date
Low	High	Short	Low	Low	0.1	99.7	0.1	0.1	Date
Low	High	Short	Low	Moderate	99.5	0.1	0.1	0.3	Month
Low	High	Short	Low	High	0.1	0.1	99.7	0.1	Half-Month
Low	High	Short	Moderate	Low	0.1	25.7	0.1	74.1	Date
Low	High	Short	Moderate	Moderate	99.7	0.1	0.1	0.1	Date
Low	High	Short	Moderate	High	0.1	99.7	0.1	0.1	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Low	High	Short	High	Low	0.1	99.7	0.1	0.1	Date
Low	High	Short	High	Moderate	99.7	0.1	0.1	0.1	Date
Low	High	Short	High	High	0.1	99.7	0.1	0.1	Date
Low	High	Moderate	Low	Low	0.1	99.7	0.1	0.1	Half-Month
Low	High	Moderate	Low	Moderate	99.6	0.1	0.1	0.2	Month
Low	High	Moderate	Low	High	0.1	0.1	1.3	98.5	Half-Month
Low	High	Moderate	Moderate	Low	0.1	0.1	99.7	0.1	Date
Low	High	Moderate	Moderate	Moderate	0.1	15.7	0.1	84.1	Date
Low	High	Moderate	Moderate	High	0.1	41.6	0.1	58.2	Date
Low	High	Moderate	High	Low	0.1	0.1	99.7	0.1	Date
Low	High	Moderate	High	Moderate	0.1	51.7	0.1	48.1	Date
Low	High	Moderate	High	High	0.1	7.6	0.1	92.2	Date
Low	High	Long	Low	Low	0.1	99.7	0.1	0.1	Half-Month
Low	High	Long	Low	Moderate	0.1	49.5	0.1	50.3	Date
Low	High	Long	Low	High	9.5	9	61.2	20.3	Date
Low	High	Long	Moderate	Low	0.1	33.1	66.7	0.1	Half-Month
Low	High	Long	Moderate	Moderate	29.5	30.9	0.1	39.5	Date
Low	High	Long	Moderate	High	11.2	9.6	57.3	21.9	Date
Low	High	Long	High	Low	0.1	3.4	96.4	0.1	Half-Month
Low	High	Long	High	Moderate	99.7	0.1	0.1	0.1	Date
Low	High	Long	High	High	85.8	0.1	14	0.1	Date
Low	High	Longer	Low	Low	0.1	52.1	7.4	40.4	Date
Low	High	Longer	Low	Moderate	0.1	93.2	0.1	6.6	Date
Low	High	Longer	Low	High	0.1	43.4	0.1	56.4	Date
Low	High	Longer	Moderate	Low	0.1	70.2	14.8	14.9	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Low	High	Longer	Moderate	Moderate	0.1	71.8	7.1	21	Date
Low	High	Longer	Moderate	High	0.1	79.6	0.1	20.2	Date
Low	High	Longer	High	Low	0.1	39.5	37.8	22.6	Date
Low	High	Longer	High	Moderate	0.1	77.1	11	11.8	Date
Low	High	Longer	High	High	0.1	89	0.1	10.8	Date
Low	Very High	Shorter	Low	Low	69.2	30.6	0.1	0.1	Date
Low	Very High	Shorter	Low	Moderate	0.1	41.9	0.1	57.9	Date
Low	Very High	Shorter	Low	High	0.1	69.7	0.1	30.1	Date
Low	Very High	Shorter	Moderate	Low	21.5	18.6	0.1	59.8	Date
Low	Very High	Shorter	Moderate	Moderate	0.1	22.1	0.1	77.7	Date
Low	Very High	Shorter	Moderate	High	0.1	75.5	0.1	24.3	Date
Low	Very High	Shorter	High	Low	45.7	11.5	0.1	42.7	Date
Low	Very High	Shorter	High	Moderate	0.1	21.4	0.1	78.4	Date
Low	Very High	Shorter	High	High	0.1	65.7	0.1	34.1	Date
Low	Very High	Short	Low	Low	99.7	0.1	0.1	0.1	Half-Month
Low	Very High	Short	Low	Moderate	0.1	0.1	0.1	99.7	Month
Low	Very High	Short	Low	High	0.1	0.1	91.1	8.7	Month
Low	Very High	Short	Moderate	Low	14.4	23.5	0.1	62	Half-Month
Low	Very High	Short	Moderate	Moderate	0.1	0.1	0.1	99.7	Half-Month
Low	Very High	Short	Moderate	High	0.1	0.1	71.5	28.3	Month
Low	Very High	Short	High	Low	31.8	23.8	0.1	44.3	Half-Month
Low	Very High	Short	High	Moderate	0.1	0.1	0.1	99.7	Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Low	Very High	Short	High	High	0.1	0.1	66.5	33.3	Month
Low	Very High	Moderate	Low	Low	0.1	99.7	0.1	0.1	Month
Low	Very High	Moderate	Low	Moderate	0.1	0.1	0.1	99.7	Month
Low	Very High	Moderate	Low	High	0.1	0.1	95.3	4.5	Month
Low	Very High	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Month
Low	Very High	Moderate	Moderate	Moderate	0.1	0.1	0.1	99.7	Month
Low	Very High	Moderate	Moderate	High	0.1	0.1	83.3	16.5	Month
Low	Very High	Moderate	High	Low	0.1	99.7	0.1	0.1	Month
Low	Very High	Moderate	High	Moderate	0.1	0.1	0.1	99.7	Month
Low	Very High	Moderate	High	High	0.1	0.1	79.8	20	Month
Low	Very High	Long	Low	Low	0.1	99.7	0.1	0.1	Month
Low	Very High	Long	Low	Moderate	0.1	99.7	0.1	0.1	Month
Low	Very High	Long	Low	High	0.1	0.1	99.7	0.1	Date
Low	Very High	Long	Moderate	Low	0.1	99.7	0.1	0.1	Month
Low	Very High	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Month
Low	Very High	Long	Moderate	High	0.1	0.1	99.7	0.1	Date
Low	Very High	Long	High	Low	0.1	99.7	0.1	0.1	Month
Low	Very High	Long	High	Moderate	0.1	99.7	0.1	0.1	Month
Low	Very High	Long	High	High	0.1	0.1	99.7	0.1	Half-Month
Low	Very High	Longer	Low	Low	0.1	48.6	0.1	51.2	Date
Low	Very High	Longer	Low	Moderate	0.1	99.7	0.1	0.1	Month
Low	Very High	Longer	Low	High	0.1	99.7	0.1	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Low	Very High	Longer	Moderate	Low	0.1	46.1	0.1	53.7	Date
Low	Very High	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Month
Low	Very High	Longer	Moderate	High	0.1	99.7	0.1	0.1	Month
Low	Very High	Longer	High	Low	0.1	0.1	0.1	99.7	Date
Low	Very High	Longer	High	Moderate	0.1	99.7	0.1	0.1	Month
Low	Very High	Longer	High	High	0.1	99.7	0.1	0.1	Month
Moderate	Very Low	Shorter	Low	Low	0.1	99.7	0.1	0.1	Upper Month
Moderate	Very Low	Shorter	Low	Moderate	0.1	99.7	0.1	0.1	Lower Date
Moderate	Very Low	Shorter	Low	High	0.1	99.7	0.1	0.1	Lower Month
Moderate	Very Low	Shorter	Moderate	Low	0.1	99.7	0.1	0.1	Date
Moderate	Very Low	Shorter	Moderate	Moderate	0.1	99.7	0.1	0.1	Lower Date
Moderate	Very Low	Shorter	Moderate	High	0.1	99.7	0.1	0.1	Month
Moderate	Very Low	Shorter	High	Low	0.1	99.7	0.1	0.1	Date
Moderate	Very Low	Shorter	High	Moderate	99.7	0.1	0.1	0.1	Lower Half-Month
Moderate	Very Low	Shorter	High	High	0.1	99.7	0.1	0.1	Month
Moderate	Very Low	Short	Low	Low	0.1	99.7	0.1	0.1	Upper Month
Moderate	Very Low	Short	Low	Moderate	0.1	99.7	0.1	0.1	Lower Month
Moderate	Very Low	Short	Low	High	0.1	86.7	9.1	4.1	Upper Month
Moderate	Very Low	Short	Moderate	Low	0.1	2.1	97.7	0.1	Lower Half-Month
Moderate	Very Low	Short	Moderate	Moderate	48.6	51.2	0.1	0.1	Lower Month
Moderate	Very Low	Short	Moderate	High	0.1	99.7	0.1	0.1	Month
Moderate	Very Low	Short	High	Low	0.1	6	93.8	0.1	Lower Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Moderate	Very Low	Short	High	Moderate	7.2	92.6	0.1	0.1	Lower Month
Moderate	Very Low	Short	High	High	0.1	99.7	0.1	0.1	Month
Moderate	Very Low	Moderate	Low	Low	18.1	32.9	24	25	Interpolate
Moderate	Very Low	Moderate	Low	Moderate	0.1	0.1	0.1	99.7	Lower Month
Moderate	Very Low	Moderate	Low	High	0.1	99.7	0.1	0.1	Upper Half-Month
Moderate	Very Low	Moderate	Moderate	Low	0.1	4.1	95.7	0.1	Lower Half-Month
Moderate	Very Low	Moderate	Moderate	Moderate	0.1	0.1	99.7	0.1	Lower Date
Moderate	Very Low	Moderate	Moderate	High	0.1	0.1	99.7	0.1	Date
Moderate	Very Low	Moderate	High	Low	0.1	11.3	88.5	0.1	Lower Half-Month
Moderate	Very Low	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Lower Date
Moderate	Very Low	Moderate	High	High	0.1	0.1	99.7	0.1	Date
Moderate	Very Low	Long	Low	Low	19.9	79.9	0.1	0.1	Interpolate
Moderate	Very Low	Long	Low	Moderate	0.1	99.7	0.1	0.1	Upper Half-Month
Moderate	Very Low	Long	Low	High	0.1	99.7	0.1	0.1	Upper Half-Month
Moderate	Very Low	Long	Moderate	Low	0.1	99.7	0.1	0.1	Lower Half-Month
Moderate	Very Low	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Lower Half-Month
Moderate	Very Low	Long	Moderate	High	0.1	0.1	99.7	0.1	Month
Moderate	Very Low	Long	High	Low	0.1	99.7	0.1	0.1	Lower Half-Month
Moderate	Very Low	Long	High	Moderate	0.1	99.7	0.1	0.1	Lower Half-Month
Moderate	Very Low	Long	High	High	0.1	0.1	99.7	0.1	Month
Moderate	Very Low	Longer	Low	Low	0.1	75.7	10.3	13.9	Interpolate
Moderate	Very Low	Longer	Low	Moderate	0.1	99.7	0.1	0.1	Upper Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Moderate	Very Low	Longer	Low	High	0.1	99.7	0.1	0.1	Upper Half-Month
Moderate	Very Low	Longer	Moderate	Low	0.1	49.9	25	25	Lower Date
Moderate	Very Low	Longer	Moderate	Moderate	99.7	0.1	0.1	0.1	Lower Date
Moderate	Very Low	Longer	Moderate	High	0.1	99.7	0.1	0.1	Upper Half-Month
Moderate	Very Low	Longer	High	Low	0.1	26.4	12.1	61.4	Lower Date
Moderate	Very Low	Longer	High	Moderate	15	78.9	0.1	6	Lower Date
Moderate	Very Low	Longer	High	High	15.4	47	16.7	20.9	Interpolate
Moderate	Low	Shorter	Low	Low	99.7	0.1	0.1	0.1	Date
Moderate	Low	Shorter	Low	Moderate	0.1	9.9	52.8	37.2	Date
Moderate	Low	Shorter	Low	High	49.3	18.6	30	2.1	Date
Moderate	Low	Shorter	Moderate	Low	55.6	4.8	0.1	39.5	Date
Moderate	Low	Shorter	Moderate	Moderate	0.1	90.8	2.4	6.7	Date
Moderate	Low	Shorter	Moderate	High	62.3	29.2	6	2.5	Date
Moderate	Low	Shorter	High	Low	40.8	46.3	0.1	12.8	Date
Moderate	Low	Shorter	High	Moderate	0.1	30.1	35.1	34.7	Date
Moderate	Low	Shorter	High	High	61.8	23.2	11.8	3.2	Date
Moderate	Low	Short	Low	Low	99.7	0.1	0.1	0.1	Half-Month
Moderate	Low	Short	Low	Moderate	0.1	0.1	0.1	99.7	Half-Month
Moderate	Low	Short	Low	High	44.3	48.2	7.4	0.1	Half-Month
Moderate	Low	Short	Moderate	Low	0.1	99.7	0.1	0.1	Date
Moderate	Low	Short	Moderate	Moderate	0.1	89.6	0.1	10.2	Half-Month
Moderate	Low	Short	Moderate	High	0.1	99.7	0.1	0.1	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Moderate	Low	Short	High	Low	82.7	0.1	0.1	17.1	Half-Month
Moderate	Low	Short	High	Moderate	0.1	92.9	0.1	6.9	Half-Month
Moderate	Low	Short	High	High	0.1	99.7	0.1	0.1	Date
Moderate	Low	Moderate	Low	Low	72.1	27.7	0.1	0.1	Half-Month
Moderate	Low	Moderate	Low	Moderate	0.1	0.1	99.7	0.1	Date
Moderate	Low	Moderate	Low	High	0.1	0.1	3.4	96.4	Half-Month
Moderate	Low	Moderate	Moderate	Low	99.7	0.1	0.1	0.1	Date
Moderate	Low	Moderate	Moderate	Moderate	41.6	50.8	0.1	7.5	Date
Moderate	Low	Moderate	Moderate	High	0.1	14.9	23.6	61.4	Date
Moderate	Low	Moderate	High	Low	99.7	0.1	0.1	0.1	Date
Moderate	Low	Moderate	High	Moderate	16.8	81.9	0.1	1.2	Date
Moderate	Low	Moderate	High	High	0.1	1.3	50.5	48.1	Date
Moderate	Low	Long	Low	Low	79.5	20.3	0.1	0.1	Half-Month
Moderate	Low	Long	Low	Moderate	0.1	60	0.1	39.8	Date
Moderate	Low	Long	Low	High	5	8.8	25.7	60.5	Date
Moderate	Low	Long	Moderate	Low	0.1	99.7	0.1	0.1	Date
Moderate	Low	Long	Moderate	Moderate	0.1	54.3	0.1	45.5	Date
Moderate	Low	Long	Moderate	High	28.4	7	18.5	46.1	Date
Moderate	Low	Long	High	Low	0.1	99.7	0.1	0.1	Date
Moderate	Low	Long	High	Moderate	0.1	99.7	0.1	0.1	Date
Moderate	Low	Long	High	High	72.9	0.1	4	23	Date
Moderate	Low	Longer	Low	Low	0.1	52.7	16.4	30.8	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Moderate	Low	Longer	Low	Moderate	4.8	46.7	45.1	3.4	Date
Moderate	Low	Longer	Low	High	0.1	79.4	0.1	20.4	Date
Moderate	Low	Longer	Moderate	Low	19.9	33.1	35.9	11.1	Date
Moderate	Low	Longer	Moderate	Moderate	13.5	29	22.4	35.1	Date
Moderate	Low	Longer	Moderate	High	4.8	85.6	0.1	9.5	Date
Moderate	Low	Longer	High	Low	43.2	41.2	11.1	4.5	Date
Moderate	Low	Longer	High	Moderate	28.9	60.9	10.1	0.1	Date
Moderate	Low	Longer	High	High	77.4	3.1	0.1	19.4	Date
Moderate	Moderate	Shorter	Low	Low	39.7	54.7	5.5	0.1	Date
Moderate	Moderate	Shorter	Low	Moderate	5	3.4	19.6	72	Date
Moderate	Moderate	Shorter	Low	High	36.5	9.2	17.1	37.2	Date
Moderate	Moderate	Shorter	Moderate	Low	70.4	16.8	0.8	12	Date
Moderate	Moderate	Shorter	Moderate	Moderate	2.3	13.2	1.2	83.3	Date
Moderate	Moderate	Shorter	Moderate	High	44.5	14.8	9.6	31.1	Date
Moderate	Moderate	Shorter	High	Low	81.9	12	0.1	6	Date
Moderate	Moderate	Shorter	High	Moderate	0.1	8.7	12	79.2	Date
Moderate	Moderate	Shorter	High	High	19.3	5.9	10.6	64.2	Date
Moderate	Moderate	Short	Low	Low	0.1	99.7	0.1	0.1	Date
Moderate	Moderate	Short	Low	Moderate	0.1	0.1	99.7	0.1	Date
Moderate	Moderate	Short	Low	High	30.4	22.1	47.4	0.1	Half-Month
Moderate	Moderate	Short	Moderate	Low	0.1	82.3	0.1	17.5	Date
Moderate	Moderate	Short	Moderate	Moderate	92.4	0.1	7.4	0.1	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Moderate	Moderate	Short	Moderate	High	0.1	99.7	0.1	0.1	Date
Moderate	Moderate	Short	High	Low	0.1	99.7	0.1	0.1	Date
Moderate	Moderate	Short	High	Moderate	99.7	0.1	0.1	0.1	Date
Moderate	Moderate	Short	High	High	0.1	99.7	0.1	0.1	Date
Moderate	Moderate	Moderate	Low	Low	0.5	99.3	0.1	0.1	Half-Month
Moderate	Moderate	Moderate	Low	Moderate	18.1	0.4	81.3	0.2	Month
Moderate	Moderate	Moderate	Low	High	0.1	0.1	26.3	73.5	Half-Month
Moderate	Moderate	Moderate	Moderate	Low	99.7	0.1	0.1	0.1	Date
Moderate	Moderate	Moderate	Moderate	Moderate	14.8	69.2	0.1	15.9	Date
Moderate	Moderate	Moderate	Moderate	High	0.1	57.4	0.1	42.4	Date
Moderate	Moderate	Moderate	High	Low	99.7	0.1	0.1	0.1	Date
Moderate	Moderate	Moderate	High	Moderate	5.4	92.2	0.1	2.3	Date
Moderate	Moderate	Moderate	High	High	0.1	11.6	0.1	88.2	Date
Moderate	Moderate	Long	Low	Low	1.6	98.2	0.1	0.1	Half-Month
Moderate	Moderate	Long	Low	Moderate	0.1	70.7	0.1	29.1	Date
Moderate	Moderate	Long	Low	High	2.2	30.7	42.5	24.6	Date
Moderate	Moderate	Long	Moderate	Low	0.1	99.7	0.1	0.1	Date
Moderate	Moderate	Long	Moderate	Moderate	0.1	56.6	0.1	43.2	Date
Moderate	Moderate	Long	Moderate	High	6.2	31	38.8	24	Date
Moderate	Moderate	Long	High	Low	0.1	99.7	0.1	0.1	Date
Moderate	Moderate	Long	High	Moderate	0.1	99.7	0.1	0.1	Date
Moderate	Moderate	Long	High	High	53.7	0.1	20.3	25.9	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Moderate	Moderate	Longer	Low	Low	0.1	23.4	3.7	72.8	Date
Moderate	Moderate	Longer	Low	Moderate	12.8	25.1	59.7	2.4	Date
Moderate	Moderate	Longer	Low	High	0.1	85.2	0.1	14.6	Date
Moderate	Moderate	Longer	Moderate	Low	0.1	40.5	15.8	43.6	Date
Moderate	Moderate	Longer	Moderate	Moderate	15.4	23.1	16.4	45.1	Date
Moderate	Moderate	Longer	Moderate	High	0.1	91.1	0.1	8.7	Date
Moderate	Moderate	Longer	High	Low	0.1	45.6	30.3	24	Date
Moderate	Moderate	Longer	High	Moderate	0.1	80.8	19	0.1	Date
Moderate	Moderate	Longer	High	High	0.1	35.1	0.1	64.7	Date
Moderate	High	Shorter	Low	Low	10.1	74.8	15	0.1	Date
Moderate	High	Shorter	Low	Moderate	6.2	6.2	18	69.6	Date
Moderate	High	Shorter	Low	High	0.1	19.7	18.4	61.8	Date
Moderate	High	Shorter	Moderate	Low	43.7	50.3	2.7	3.3	Date
Moderate	High	Shorter	Moderate	Moderate	7.2	5.6	2.6	84.6	Date
Moderate	High	Shorter	Moderate	High	0.1	35.1	7.2	57.6	Date
Moderate	High	Shorter	High	Low	59.5	40.3	0.1	0.1	Date
Moderate	High	Shorter	High	Moderate	0.1	24.8	12.5	62.6	Date
Moderate	High	Shorter	High	High	0.1	10.4	4	85.5	Date
Moderate	High	Short	Low	Low	0.1	99.7	0.1	0.1	Date
Moderate	High	Short	Low	Moderate	0.1	0.1	0.1	99.7	Half-Month
Moderate	High	Short	Low	High	0.1	0.1	99.7	0.1	Half-Month
Moderate	High	Short	Moderate	Low	0.1	75.5	0.1	24.3	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Moderate	High	Short	Moderate	Moderate	99.7	0.1	0.1	0.1	Date
Moderate	High	Short	Moderate	High	0.1	99.7	0.1	0.1	Date
Moderate	High	Short	High	Low	0.1	99.7	0.1	0.1	Date
Moderate	High	Short	High	Moderate	99.7	0.1	0.1	0.1	Date
Moderate	High	Short	High	High	0.1	99.7	0.1	0.1	Date
Moderate	High	Moderate	Low	Low	0.1	99.7	0.1	0.1	Half-Month
Moderate	High	Moderate	Low	Moderate	0.1	0.1	99.7	0.1	Date
Moderate	High	Moderate	Low	High	0.1	0.1	8.2	91.6	Half-Month
Moderate	High	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
Moderate	High	Moderate	Moderate	Moderate	0.1	58.6	9.8	31.5	Date
Moderate	High	Moderate	Moderate	High	0.1	28.2	0.1	71.6	Date
Moderate	High	Moderate	High	Low	0.1	99.7	0.1	0.1	Half-Month
Moderate	High	Moderate	High	Moderate	0.1	91.3	0.1	8.5	Date
Moderate	High	Moderate	High	High	0.1	4.3	0.1	95.5	Date
Moderate	High	Long	Low	Low	0.1	99.7	0.1	0.1	Half-Month
Moderate	High	Long	Low	Moderate	0.1	95	0.1	4.8	Date
Moderate	High	Long	Low	High	9	21.2	30.9	38.9	Date
Moderate	High	Long	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
Moderate	High	Long	Moderate	Moderate	0.1	82.4	0.1	17.4	Date
Moderate	High	Long	Moderate	High	0.1	24.8	32.5	42.6	Date
Moderate	High	Long	High	Low	0.1	99.7	0.1	0.1	Half-Month
Moderate	High	Long	High	Moderate	0.1	99.7	0.1	0.1	Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Moderate	High	Long	High	High	26.6	0.1	15.2	58.1	Date
Moderate	High	Longer	Low	Low	0.1	41.1	6.4	52.4	Date
Moderate	High	Longer	Low	Moderate	9.4	63	21.9	5.7	Date
Moderate	High	Longer	Low	High	0.1	0.1	0.1	99.7	Date
Moderate	High	Longer	Moderate	Low	0.1	61.7	12	26.2	Date
Moderate	High	Longer	Moderate	Moderate	23.5	50.5	15.1	10.9	Date
Moderate	High	Longer	Moderate	High	0.1	67.7	0.1	32.1	Date
Moderate	High	Longer	High	Low	0.1	51.4	21.3	27.2	Date
Moderate	High	Longer	High	Moderate	0.1	88.3	11.5	0.1	Date
Moderate	High	Longer	High	High	0.1	99.7	0.1	0.1	Date
Moderate	Very High	Shorter	Low	Low	17.6	82.2	0.1	0.1	Date
Moderate	Very High	Shorter	Low	Moderate	0.1	7.1	13	79.8	Date
Moderate	Very High	Shorter	Low	High	0.1	49.9	32.8	17.2	Date
Moderate	Very High	Shorter	Moderate	Low	38.8	23.8	0.1	37.3	Date
Moderate	Very High	Shorter	Moderate	Moderate	0.1	8.6	3.9	87.4	Date
Moderate	Very High	Shorter	Moderate	High	0.1	70.3	11.5	18.1	Date
Moderate	Very High	Shorter	High	Low	50.6	24.7	0.1	24.6	Date
Moderate	Very High	Shorter	High	Moderate	0.1	29.4	0.1	70.4	Date
Moderate	Very High	Shorter	High	High	0.1	70.5	0.1	29.3	Date
Moderate	Very High	Short	Low	Low	38.3	61.5	0.1	0.1	Half-Month
Moderate	Very High	Short	Low	Moderate	0.1	0.1	0.1	99.7	Half-Month
Moderate	Very High	Short	Low	High	0.1	0.1	56.7	43.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Moderate	Very High	Short	Moderate	Low	8.6	35.4	0.1	55.9	Half-Month
Moderate	Very High	Short	Moderate	Moderate	0.1	0.1	0.1	99.7	Half-Month
Moderate	Very High	Short	Moderate	High	0.1	0.1	24.1	75.7	Month
Moderate	Very High	Short	High	Low	12.8	47.6	0.1	39.5	Half-Month
Moderate	Very High	Short	High	Moderate	0.1	0.1	0.1	99.7	Half-Month
Moderate	Very High	Short	High	High	0.1	0.1	20	79.8	Month
Moderate	Very High	Moderate	Low	Low	0.1	99.7	0.1	0.1	Half-Month
Moderate	Very High	Moderate	Low	Moderate	0.1	0.1	99.7	0.1	Date
Moderate	Very High	Moderate	Low	High	0.1	0.1	99.7	0.1	Month
Moderate	Very High	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
Moderate	Very High	Moderate	Moderate	Moderate	0.1	0.1	99.7	0.1	Date
Moderate	Very High	Moderate	Moderate	High	0.1	0.1	0.1	99.7	Date
Moderate	Very High	Moderate	High	Low	0.1	99.7	0.1	0.1	Half-Month
Moderate	Very High	Moderate	High	Moderate	0.1	0.1	0.1	99.7	Month
Moderate	Very High	Moderate	High	High	0.1	0.1	0.1	99.7	Date
Moderate	Very High	Long	Low	Low	0.1	99.7	0.1	0.1	Month
Moderate	Very High	Long	Low	Moderate	0.1	99.7	0.1	0.1	Month
Moderate	Very High	Long	Low	High	0.1	0.1	99.7	0.1	Date
Moderate	Very High	Long	Moderate	Low	0.1	99.7	0.1	0.1	Month
Moderate	Very High	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Month
Moderate	Very High	Long	Moderate	High	0.1	0.1	99.7	0.1	Date
Moderate	Very High	Long	High	Low	0.1	99.7	0.1	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Moderate	Very High	Long	High	Moderate	0.1	99.7	0.1	0.1	Month
Moderate	Very High	Long	High	High	0.1	0.1	29.9	69.9	Half-Month
Moderate	Very High	Longer	Low	Low	0.1	32.1	0.1	67.7	Date
Moderate	Very High	Longer	Low	Moderate	0.1	99.7	0.1	0.1	Month
Moderate	Very High	Longer	Low	High	0.1	99.7	0.1	0.1	Month
Moderate	Very High	Longer	Moderate	Low	0.1	30	0.1	69.8	Date
Moderate	Very High	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Month
Moderate	Very High	Longer	Moderate	High	0.1	47.5	0.1	52.3	Month
Moderate	Very High	Longer	High	Low	0.1	0.1	0.1	99.7	Date
Moderate	Very High	Longer	High	Moderate	0.1	99.7	0.1	0.1	Month
Moderate	Very High	Longer	High	High	0.1	71.3	0.1	28.5	Month
High	Very Low	Shorter	Low	Low	99.7	0.1	0.1	0.1	Lower Date
High	Very Low	Shorter	Low	Moderate	0.1	99.7	0.1	0.1	Lower Date
High	Very Low	Shorter	Low	High	0.1	99.7	0.1	0.1	Lower Month
High	Very Low	Shorter	Moderate	Low	0.1	99.7	0.1	0.1	Date
High	Very Low	Shorter	Moderate	Moderate	0.1	99.7	0.1	0.1	Lower Date
High	Very Low	Shorter	Moderate	High	0.1	99.7	0.1	0.1	Lower Month
High	Very Low	Shorter	High	Low	0.1	99.7	0.1	0.1	Date
High	Very Low	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Lower Half-Month
High	Very Low	Shorter	High	High	0.1	99.7	0.1	0.1	Lower Date
High	Very Low	Short	Low	Low	0.1	42.8	57	0.1	Upper Month
High	Very Low	Short	Low	Moderate	0.1	99.7	0.1	0.1	Lower Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
High	Very Low	Short	Low	High	0.1	65.4	22.1	12.4	Upper Month
High	Very Low	Short	Moderate	Low	0.1	5.3	94.5	0.1	Lower Half-Month
High	Very Low	Short	Moderate	Moderate	0.1	99.7	0.1	0.1	Lower Month
High	Very Low	Short	Moderate	High	0.1	70	20.4	9.5	Upper Month
High	Very Low	Short	High	Low	0.1	14.5	85.3	0.1	Lower Half-Month
High	Very Low	Short	High	Moderate	0.1	99.7	0.1	0.1	Lower Month
High	Very Low	Short	High	High	0.1	0.1	99.7	0.1	Upper Month
High	Very Low	Moderate	Low	Low	0.1	46.4	33.5	20	Interpolate
High	Very Low	Moderate	Low	Moderate	0.1	0.1	0.1	99.7	Lower Month
High	Very Low	Moderate	Low	High	0.1	99.7	0.1	0.1	Upper Half-Month
High	Very Low	Moderate	Moderate	Low	0.1	10.1	89.7	0.1	Lower Half-Month
High	Very Low	Moderate	Moderate	Moderate	0.1	12.6	0.1	87.2	Lower Month
High	Very Low	Moderate	Moderate	High	0.1	99.7	0.1	0.1	Upper Half-Month
High	Very Low	Moderate	High	Low	0.1	25.3	74.5	0.1	Lower Half-Month
High	Very Low	Moderate	High	Moderate	0.1	5.9	0.1	93.9	Lower Month
High	Very Low	Moderate	High	High	0.1	0.1	99.7	0.1	Upper Month
High	Very Low	Long	Low	Low	0.1	99.7	0.1	0.1	Upper Half-Month
High	Very Low	Long	Low	Moderate	0.1	99.7	0.1	0.1	Upper Date
High	Very Low	Long	Low	High	0.1	62.7	0.1	37.1	Upper Half-Month
High	Very Low	Long	Moderate	Low	0.1	99.7	0.1	0.1	Lower Half-Month
High	Very Low	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Lower Date
High	Very Low	Long	Moderate	High	0.1	0.1	0.1	99.7	Lower Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
High	Very Low	Long	High	Low	0.1	99.7	0.1	0.1	Lower Half-Month
High	Very Low	Long	High	Moderate	0.1	99.7	0.1	0.1	Lower Half-Month
High	Very Low	Long	High	High	0.1	0.1	0.1	99.7	Lower Month
High	Very Low	Longer	Low	Low	0.1	99.7	0.1	0.1	Upper Half-Month
High	Very Low	Longer	Low	Moderate	0.1	53.3	0.1	46.5	Upper Half-Month
High	Very Low	Longer	Low	High	0.1	30.4	30.3	39.2	Upper Half-Month
High	Very Low	Longer	Moderate	Low	0.1	99.7	0.1	0.1	Lower Date
High	Very Low	Longer	Moderate	Moderate	99.7	0.1	0.1	0.1	Lower Date
High	Very Low	Longer	Moderate	High	0.1	0.1	0.1	99.7	Lower Month
High	Very Low	Longer	High	Low	0.1	74.8	0.1	25	Lower Date
High	Very Low	Longer	High	Moderate	12.7	0.1	71.9	15.3	Lower Date
High	Very Low	Longer	High	High	0.1	0.1	0.1	99.7	Lower Month
High	Low	Shorter	Low	Low	5.3	0.1	94.5	0.1	Date
High	Low	Shorter	Low	Moderate	0.1	0.1	70.1	29.7	Date
High	Low	Shorter	Low	High	52	0.1	47.8	0.1	Date
High	Low	Shorter	Moderate	Low	78.6	15.5	5.8	0.1	Date
High	Low	Shorter	Moderate	Moderate	0.1	0.1	68.6	31.2	Date
High	Low	Shorter	Moderate	High	78.3	0.1	21.5	0.1	Date
High	Low	Shorter	High	Low	27.4	72.4	0.1	0.1	Date
High	Low	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Date
High	Low	Shorter	High	High	16.8	0.1	83	0.1	Date
High	Low	Short	Low	Low	99.7	0.1	0.1	0.1	Half-Month
High	Low	Short	Low	Moderate	0.1	0.1	0.1	99.7	Half-Month
High	Low	Short	Low	High	96.6	0.1	3.2	0.1	Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
High	Low	Short	Moderate	Low	99.7	0.1	0.1	0.1	Half-Month
High	Low	Short	Moderate	Moderate	1.9	56.8	0.1	41.2	Half-Month
High	Low	Short	Moderate	High	96.3	0.1	3.5	0.1	Half-Month
High	Low	Short	High	Low	99.7	0.1	0.1	0.1	Half-Month
High	Low	Short	High	Moderate	4.7	95.1	0.1	0.1	Half-Month
High	Low	Short	High	High	79	0.1	20.8	0.1	Half-Month
High	Low	Moderate	Low	Low	0.1	79.4	20.4	0.1	Month
High	Low	Moderate	Low	Moderate	0.1	0.1	99.7	0.1	Date
High	Low	Moderate	Low	High	0.1	0.1	0.5	99.3	Half-Month
High	Low	Moderate	Moderate	Low	99.7	0.1	0.1	0.1	Date
High	Low	Moderate	Moderate	Moderate	0.1	99.7	0.1	0.1	Date
High	Low	Moderate	Moderate	High	0.1	0.1	0.1	99.7	Date
High	Low	Moderate	High	Low	99.7	0.1	0.1	0.1	Date
High	Low	Moderate	High	Moderate	0.1	99.7	0.1	0.1	Date
High	Low	Moderate	High	High	0.1	0.1	0.1	99.7	Date
High	Low	Long	Low	Low	0.1	58.8	41	0.1	Month
High	Low	Long	Low	Moderate	0.1	99.7	0.1	0.1	Date
High	Low	Long	Low	High	9.1	0.1	21.1	69.7	Date
High	Low	Long	Moderate	Low	93.5	2	4.4	0.1	Month
High	Low	Long	Moderate	Moderate	37.2	62.6	0.1	0.1	Date
High	Low	Long	Moderate	High	0.9	0.1	21.5	77.5	Date
High	Low	Long	High	Low	78.4	5.5	16	0.1	Month
High	Low	Long	High	Moderate	99.7	0.1	0.1	0.1	Date
High	Low	Long	High	High	37.1	0.1	0.1	62.7	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
High	Low	Longer	Low	Low	0.1	15.6	16.2	68.1	Date
High	Low	Longer	Low	Moderate	11.1	35.7	31	22.2	Date
High	Low	Longer	Low	High	0.1	21.8	0.1	78	Date
High	Low	Longer	Moderate	Low	0.1	44.1	19.2	36.6	Date
High	Low	Longer	Moderate	Moderate	11.7	12	8.7	67.6	Date
High	Low	Longer	Moderate	High	0.1	49.9	0.1	49.9	Date
High	Low	Longer	High	Low	0.1	29.9	32.4	37.6	Date
High	Low	Longer	High	Moderate	0.1	36.5	8.6	54.8	Date
High	Low	Longer	High	High	0.1	5	0.1	94.8	Date
High	Moderate	Shorter	Low	Low	9.3	31.8	58.8	0.1	Date
High	Moderate	Shorter	Low	Moderate	0.1	0.1	42.8	57	Date
High	Moderate	Shorter	Low	High	43.9	0.1	55.9	0.1	Date
High	Moderate	Shorter	Moderate	Low	63.1	19.8	13.7	3.4	Date
High	Moderate	Shorter	Moderate	Moderate	0.1	0.1	8.6	91.2	Date
High	Moderate	Shorter	Moderate	High	47.9	0.1	51.9	0.1	Date
High	Moderate	Shorter	High	Low	92.2	7.6	0.1	0.1	Date
High	Moderate	Shorter	High	Moderate	0.1	0.1	48.4	51.4	Date
High	Moderate	Shorter	High	High	5.2	0.1	94.6	0.1	Date
High	Moderate	Short	Low	Low	0.1	99.7	0.1	0.1	Date
High	Moderate	Short	Low	Moderate	0.1	0.1	0.1	99.7	Half-Month
High	Moderate	Short	Low	High	76	0.1	23.8	0.1	Half-Month
High	Moderate	Short	Moderate	Low	0.1	67.3	0.1	32.5	Date
High	Moderate	Short	Moderate	Moderate	4.6	30.1	0.1	65.2	Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
High	Moderate	Short	Moderate	High	75.9	0.1	23.9	0.1	Half-Month
High	Moderate	Short	High	Low	0.1	99.7	0.1	0.1	Date
High	Moderate	Short	High	Moderate	18.2	81.6	0.1	0.1	Half-Month
High	Moderate	Short	High	High	48.7	0.1	51.1	0.1	Half-Month
High	Moderate	Moderate	Low	Low	0.1	99.7	0.1	0.1	Half-Month
High	Moderate	Moderate	Low	Moderate	13.1	0.1	86.7	0.1	Month
High	Moderate	Moderate	Low	High	0.1	0.1	5.1	94.7	Half-Month
High	Moderate	Moderate	Moderate	Low	99.7	0.1	0.1	0.1	Date
High	Moderate	Moderate	Moderate	Moderate	0.1	99.7	0.1	0.1	Date
High	Moderate	Moderate	Moderate	High	0.1	0.1	0.1	99.7	Date
High	Moderate	Moderate	High	Low	99.7	0.1	0.1	0.1	Date
High	Moderate	Moderate	High	Moderate	0.1	99.7	0.1	0.1	Date
High	Moderate	Moderate	High	High	0.1	0.1	0.1	99.7	Date
High	Moderate	Long	Low	Low	0.1	99.7	0.1	0.1	Half-Month
High	Moderate	Long	Low	Moderate	0.1	99.7	0.1	0.1	Date
High	Moderate	Long	Low	High	4	0.1	67.2	28.7	Date
High	Moderate	Long	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
High	Moderate	Long	Moderate	Moderate	63.8	36	0.1	0.1	Date
High	Moderate	Long	Moderate	High	2.2	0.1	66.8	30.9	Date
High	Moderate	Long	High	Low	0.1	99.7	0.1	0.1	Half-Month
High	Moderate	Long	High	Moderate	99.7	0.1	0.1	0.1	Date
High	Moderate	Long	High	High	69.1	0.1	0.1	30.7	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
High	Moderate	Longer	Low	Low	0.1	6.5	1.7	91.7	Date
High	Moderate	Longer	Low	Moderate	26.4	21.3	37.2	15.1	Date
High	Moderate	Longer	Low	High	0.1	26.8	0.1	73	Date
High	Moderate	Longer	Moderate	Low	0.1	18.2	4	77.7	Date
High	Moderate	Longer	Moderate	Moderate	18	13.5	6.2	62.3	Date
High	Moderate	Longer	Moderate	High	0.1	71.9	0.1	27.9	Date
High	Moderate	Longer	High	Low	0.1	8.4	20.1	71.4	Date
High	Moderate	Longer	High	Moderate	0.1	40.5	11.3	48.1	Date
High	Moderate	Longer	High	High	0.1	19.1	0.1	80.7	Date
High	High	Shorter	Low	Low	76.6	6.3	17	0.1	Date
High	High	Shorter	Low	Moderate	0.1	0.1	42.8	57	Date
High	High	Shorter	Low	High	0.1	0.1	99.7	0.1	Date
High	High	Shorter	Moderate	Low	49.5	26	22.1	2.4	Date
High	High	Shorter	Moderate	Moderate	0.1	0.1	16	83.8	Date
High	High	Shorter	Moderate	High	0.1	0.1	99.7	0.1	Date
High	High	Shorter	High	Low	87.6	12.2	0.1	0.1	Date
High	High	Shorter	High	Moderate	0.1	0.1	61.8	38	Date
High	High	Shorter	High	High	0.1	0.1	99.7	0.1	Date
High	High	Short	Low	Low	0.1	99.7	0.1	0.1	Date
High	High	Short	Low	Moderate	0.1	0.1	0.1	99.7	Half-Month
High	High	Short	Low	High	0.1	0.1	99.7	0.1	Half-Month
High	High	Short	Moderate	Low	0.1	67.3	0.1	32.5	Date
High	High	Short	Moderate	Moderate	3.7	18	0.1	78.2	Half-Month
High	High	Short	Moderate	High	41.4	0.1	58.4	0.1	Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
High	High	Short	High	Low	0.1	99.7	0.1	0.1	Date
High	High	Short	High	Moderate	22.9	76.9	0.1	0.1	Half-Month
High	High	Short	High	High	62.5	0.1	37.3	0.1	Half-Month
High	High	Moderate	Low	Low	0.1	99.7	0.1	0.1	Half-Month
High	High	Moderate	Low	Moderate	0.1	0.1	99.7	0.1	Date
High	High	Moderate	Low	High	0.1	0.1	1.3	98.5	Half-Month
High	High	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
High	High	Moderate	Moderate	Moderate	0.1	99.7	0.1	0.1	Date
High	High	Moderate	Moderate	High	0.1	0.1	0.1	99.7	Date
High	High	Moderate	High	Low	0.1	99.7	0.1	0.1	Half-Month
High	High	Moderate	High	Moderate	0.1	99.7	0.1	0.1	Date
High	High	Moderate	High	High	0.1	0.1	0.1	99.7	Date
High	High	Long	Low	Low	0.1	99.7	0.1	0.1	Half-Month
High	High	Long	Low	Moderate	0.1	99.7	0.1	0.1	Date
High	High	Long	Low	High	18.5	0.1	31.7	49.7	Date
High	High	Long	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
High	High	Long	Moderate	Moderate	19.1	80.7	0.1	0.1	Date
High	High	Long	Moderate	High	2.6	0.1	35.7	61.6	Date
High	High	Long	High	Low	0.1	99.7	0.1	0.1	Half-Month
High	High	Long	High	Moderate	99.7	0.1	0.1	0.1	Date
High	High	Long	High	High	59.2	0.1	0.1	40.6	Date
High	High	Longer	Low	Low	0.1	25.2	0.1	74.6	Date
High	High	Longer	Low	Moderate	30.4	0.1	21.4	48.1	Date
High	High	Longer	Low	High	0.1	0.1	0.1	99.7	Date
High	High	Longer	Moderate	Low	0.1	33.9	2.8	63.2	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
High	High	Longer	Moderate	Moderate	19.7	6.9	4.5	68.9	Date
High	High	Longer	Moderate	High	0.1	33.4	0.1	66.4	Date
High	High	Longer	High	Low	0.1	15.6	7.8	76.5	Date
High	High	Longer	High	Moderate	0.1	5.7	30	64.2	Date
High	High	Longer	High	High	0.1	40.9	0.1	58.9	Date
High	Very High	Shorter	Low	Low	80.6	19.2	0.1	0.1	Date
High	Very High	Shorter	Low	Moderate	0.1	0.1	47.5	52.3	Date
High	Very High	Shorter	Low	High	0.1	0.1	99.7	0.1	Date
High	Very High	Shorter	Moderate	Low	54.5	30	0.1	15.4	Date
High	Very High	Shorter	Moderate	Moderate	0.1	0.1	28.2	71.6	Date
High	Very High	Shorter	Moderate	High	0.1	0.1	99.7	0.1	Date
High	Very High	Shorter	High	Low	73.1	26.7	0.1	0.1	Date
High	Very High	Shorter	High	Moderate	0.1	99.7	0.1	0.1	Half-Month
High	Very High	Shorter	High	High	0.1	99.7	0.1	0.1	Half-Month
High	Very High	Short	Low	Low	72.5	27.3	0.1	0.1	Half-Month
High	Very High	Short	Low	Moderate	0.1	0.1	0.1	99.7	Half-Month
High	Very High	Short	Low	High	0.1	0.1	99.7	0.1	Month
High	Very High	Short	Moderate	Low	84.4	15.4	0.1	0.1	Half-Month
High	Very High	Short	Moderate	Moderate	0.1	0.1	0.1	99.7	Half-Month
High	Very High	Short	Moderate	High	0.1	0.1	99.7	0.1	Month
High	Very High	Short	High	Low	35	64.8	0.1	0.1	Half-Month
High	Very High	Short	High	Moderate	0.1	0.1	0.1	99.7	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
High	Very High	Short	High	High	0.1	0.1	99.7	0.1	Month
High	Very High	Moderate	Low	Low	0.1	99.7	0.1	0.1	Half-Month
High	Very High	Moderate	Low	Moderate	0.1	0.1	99.7	0.1	Date
High	Very High	Moderate	Low	High	0.1	0.1	99.7	0.1	Month
High	Very High	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
High	Very High	Moderate	Moderate	Moderate	0.1	0.1	99.7	0.1	Month
High	Very High	Moderate	Moderate	High	0.1	0.1	0.1	99.7	Date
High	Very High	Moderate	High	Low	0.1	99.7	0.1	0.1	Half-Month
High	Very High	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Upper Month
High	Very High	Moderate	High	High	0.1	0.1	0.1	99.7	Date
High	Very High	Long	Low	Low	0.1	99.7	0.1	0.1	Month
High	Very High	Long	Low	Moderate	0.1	99.7	0.1	0.1	Month
High	Very High	Long	Low	High	0.1	0.1	99.7	0.1	Date
High	Very High	Long	Moderate	Low	0.1	99.7	0.1	0.1	Month
High	Very High	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Month
High	Very High	Long	Moderate	High	0.1	0.1	99.7	0.1	Date
High	Very High	Long	High	Low	0.1	99.7	0.1	0.1	Month
High	Very High	Long	High	Moderate	0.1	99.7	0.1	0.1	Month
High	Very High	Long	High	High	0.1	0.1	67.9	31.9	Half-Month
High	Very High	Longer	Low	Low	0.1	11.2	0.1	88.6	Date
High	Very High	Longer	Low	Moderate	0.1	99.7	0.1	0.1	Month
High	Very High	Longer	Low	High	0.1	99.7	0.1	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
High	Very High	Longer	Moderate	Low	0.1	10.2	0.1	89.6	Date
High	Very High	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Month
High	Very High	Longer	Moderate	High	0.1	13.1	0.1	86.7	Month
High	Very High	Longer	High	Low	0.1	0.1	0.1	99.7	Date
High	Very High	Longer	High	Moderate	0.1	99.7	0.1	0.1	Month
High	Very High	Longer	High	High	0.1	29.5	0.1	70.3	Month
Very High	Very Low	Shorter	Low	Low	99.7	0.1	0.1	0.1	Lower Date
Very High	Very Low	Shorter	Low	Moderate	99.7	0.1	0.1	0.1	Lower Month
Very High	Very Low	Shorter	Low	High	0.1	0.1	0.1	99.7	Upper Date
Very High	Very Low	Shorter	Moderate	Low	99.7	0.1	0.1	0.1	Lower Half-Month
Very High	Very Low	Shorter	Moderate	Moderate	99.7	0.1	0.1	0.1	Lower Month
Very High	Very Low	Shorter	Moderate	High	0.1	0.1	0.1	99.7	Upper Date
Very High	Very Low	Shorter	High	Low	99.7	0.1	0.1	0.1	Lower Date
Very High	Very Low	Shorter	High	Moderate	19.3	80.5	0.1	0.1	Lower Month
Very High	Very Low	Shorter	High	High	58.7	41.1	0.1	0.1	Lower Month
Very High	Very Low	Short	Low	Low	0.1	7.7	92.1	0.1	Upper Month
Very High	Very Low	Short	Low	Moderate	0.1	0.1	99.7	0.1	Upper Half-Month
Very High	Very Low	Short	Low	High	0.1	92.6	3.8	3.5	Upper Month
Very High	Very Low	Short	Moderate	Low	0.1	99.7	0.1	0.1	Upper Month
Very High	Very Low	Short	Moderate	Moderate	0.1	0.1	99.7	0.1	Upper Half-Month
Very High	Very Low	Short	Moderate	High	0.1	94.2	3.1	2.6	Upper Month
Very High	Very Low	Short	High	Low	0.1	0.1	0.1	99.7	Lower Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very High	Very Low	Short	High	Moderate	0.1	99.7	0.1	0.1	Lower Month
Very High	Very Low	Short	High	High	0.1	99.7	0.1	0.1	Lower Month
Very High	Very Low	Moderate	Low	Low	0.1	76.7	23.1	0.1	Interpolate
Very High	Very Low	Moderate	Low	Moderate	0.1	99.7	0.1	0.1	Upper Half-Month
Very High	Very Low	Moderate	Low	High	0.1	99.7	0.1	0.1	Upper Half-Month
Very High	Very Low	Moderate	Moderate	Low	0.1	61.9	18	20	Interpolate
Very High	Very Low	Moderate	Moderate	Moderate	0.1	99.7	0.1	0.1	Upper Half-Month
Very High	Very Low	Moderate	Moderate	High	0.1	99.7	0.1	0.1	Upper Half-Month
Very High	Very Low	Moderate	High	Low	0.1	0.1	0.1	99.7	Lower Month
Very High	Very Low	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Upper Month
Very High	Very Low	Moderate	High	High	0.1	0.1	99.7	0.1	Upper Month
Very High	Very Low	Long	Low	Low	0.1	99.7	0.1	0.1	Upper Half-Month
Very High	Very Low	Long	Low	Moderate	0.1	20	0.1	79.8	Upper Date
Very High	Very Low	Long	Low	High	0.1	0.1	0.1	99.7	Upper Date
Very High	Very Low	Long	Moderate	Low	0.1	66.6	8.3	25	Interpolate
Very High	Very Low	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Upper Half-Month
Very High	Very Low	Long	Moderate	High	0.1	99.7	0.1	0.1	Upper Half-Month
Very High	Very Low	Long	High	Low	0.1	0.1	0.1	99.7	Lower Month
Very High	Very Low	Long	High	Moderate	0.1	59.9	20	20	Interpolate
Very High	Very Low	Long	High	High	7.2	25	25	42.8	Interpolate
Very High	Very Low	Longer	Low	Low	0.1	99.7	0.1	0.1	Upper Half-Month
Very High	Very Low	Longer	Low	Moderate	0.1	35	0.1	64.8	Upper Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very High	Very Low	Longer	Low	High	0.1	31.7	21	47.2	Upper Half-Month
Very High	Very Low	Longer	Moderate	Low	0.1	0.1	49.9	49.9	Lower Date
Very High	Very Low	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Upper Half-Month
Very High	Very Low	Longer	Moderate	High	0.1	83.9	8	8	Upper Half-Month
Very High	Very Low	Longer	High	Low	0.1	0.1	37.3	62.5	Lower Date
Very High	Very Low	Longer	High	Moderate	3.2	50	27.3	19.5	Interpolate
Very High	Very Low	Longer	High	High	22.1	39.2	2.7	36	Interpolate
Very High	Low	Shorter	Low	Low	0.1	0.1	99.7	0.1	Date
Very High	Low	Shorter	Low	Moderate	0.1	99.7	0.1	0.1	Upper Half-Month
Very High	Low	Shorter	Low	High	0.1	44	23.8	32.1	Upper Month
Very High	Low	Shorter	Moderate	Low	0.1	0.1	99.7	0.1	Date
Very High	Low	Shorter	Moderate	Moderate	0.9	8.7	2.2	88.2	Upper Month
Very High	Low	Shorter	Moderate	High	0.1	12.2	24.4	63.3	Upper Month
Very High	Low	Shorter	High	Low	49.9	0.1	49.9	0.1	Month
Very High	Low	Shorter	High	Moderate	0.1	99.7	0.1	0.1	Lower Half-Month
Very High	Low	Shorter	High	High	59.9	39.9	0.1	0.1	Lower Month
Very High	Low	Short	Low	Low	0.1	99.7	0.1	0.1	Month
Very High	Low	Short	Low	Moderate	24.2	49.5	22.7	3.6	Upper Month
Very High	Low	Short	Low	High	0.1	0.1	99.7	0.1	Month
Very High	Low	Short	Moderate	Low	1.7	96.5	1.7	0.1	Month
Very High	Low	Short	Moderate	Moderate	14	25.1	46.3	14.6	Upper Month
Very High	Low	Short	Moderate	High	0.1	0.1	99.7	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very High	Low	Short	High	Low	49.9	0.1	49.9	0.1	Month
Very High	Low	Short	High	Moderate	0.1	99.7	0.1	0.1	Lower Half-Month
Very High	Low	Short	High	High	0.1	0.1	99.7	0.1	Month
Very High	Low	Moderate	Low	Low	0.1	99.7	0.1	0.1	Month
Very High	Low	Moderate	Low	Moderate	0.1	0.1	99.7	0.1	Date
Very High	Low	Moderate	Low	High	0.1	0.1	99.7	0.1	Month
Very High	Low	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Month
Very High	Low	Moderate	Moderate	Moderate	13.8	0.1	86	0.1	Month
Very High	Low	Moderate	Moderate	High	0.1	0.1	99.7	0.1	Month
Very High	Low	Moderate	High	Low	0.1	99.7	0.1	0.1	Lower Half-Month
Very High	Low	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Upper Month
Very High	Low	Moderate	High	High	0.1	0.1	99.7	0.1	Month
Very High	Low	Long	Low	Low	14.3	73.1	5.9	6.7	Interpolate
Very High	Low	Long	Low	Moderate	99.7	0.1	0.1	0.1	Half-Month
Very High	Low	Long	Low	High	26.6	0.1	39.8	33.5	Date
Very High	Low	Long	Moderate	Low	0.1	99.7	0.1	0.1	Lower Half-Month
Very High	Low	Long	Moderate	Moderate	99.7	0.1	0.1	0.1	Half-Month
Very High	Low	Long	Moderate	High	0.1	0.1	56.6	43.2	Date
Very High	Low	Long	High	Low	0.1	99.7	0.1	0.1	Lower Half-Month
Very High	Low	Long	High	Moderate	0.1	99.7	0.1	0.1	Month
Very High	Low	Long	High	High	28.9	0.1	0.1	70.9	Date
Very High	Low	Longer	Low	Low	0.1	52.7	0.1	47.1	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very High	Low	Longer	Low	Moderate	21.6	0.1	0.1	78.2	Date
Very High	Low	Longer	Low	High	0.1	0.1	0.1	99.7	Date
Very High	Low	Longer	Moderate	Low	0.1	67.6	0.1	32.2	Date
Very High	Low	Longer	Moderate	Moderate	71.9	0.1	0.1	27.9	Date
Very High	Low	Longer	Moderate	High	0.1	0.1	0.1	99.7	Date
Very High	Low	Longer	High	Low	0.1	0.1	0.1	99.7	Date
Very High	Low	Longer	High	Moderate	0.1	99.7	0.1	0.1	Month
Very High	Low	Longer	High	High	66	33.8	0.1	0.1	Month
Very High	Moderate	Shorter	Low	Low	0.1	60.4	39.4	0.1	Date
Very High	Moderate	Shorter	Low	Moderate	0.1	0.1	99.7	0.1	Month
Very High	Moderate	Shorter	Low	High	0.1	67.6	13.7	18.6	Upper Half-Month
Very High	Moderate	Shorter	Moderate	Low	0.1	52	41.1	6.8	Date
Very High	Moderate	Shorter	Moderate	Moderate	0.1	0.1	0.1	99.7	Date
Very High	Moderate	Shorter	Moderate	High	0.1	68.2	17.9	13.8	Upper Half-Month
Very High	Moderate	Shorter	High	Low	0.1	99.7	0.1	0.1	Date
Very High	Moderate	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Month
Very High	Moderate	Shorter	High	High	99.7	0.1	0.1	0.1	Lower Month
Very High	Moderate	Short	Low	Low	0.1	99.7	0.1	0.1	Half-Month
Very High	Moderate	Short	Low	Moderate	0.1	0.1	99.7	0.1	Month
Very High	Moderate	Short	Low	High	0.1	0.1	99.7	0.1	Month
Very High	Moderate	Short	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
Very High	Moderate	Short	Moderate	Moderate	0.1	0.1	99.7	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very High	Moderate	Short	Moderate	High	0.1	0.1	99.7	0.1	Month
Very High	Moderate	Short	High	Low	0.1	99.7	0.1	0.1	Half-Month
Very High	Moderate	Short	High	Moderate	0.1	0.1	99.7	0.1	Month
Very High	Moderate	Short	High	High	0.1	0.1	99.7	0.1	Month
Very High	Moderate	Moderate	Low	Low	0.1	99.7	0.1	0.1	Half-Month
Very High	Moderate	Moderate	Low	Moderate	0.4	0.1	99.4	0.1	Month
Very High	Moderate	Moderate	Low	High	0.1	0.1	99.7	0.1	Month
Very High	Moderate	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
Very High	Moderate	Moderate	Moderate	Moderate	12.6	0.1	87.2	0.1	Month
Very High	Moderate	Moderate	Moderate	High	0.1	0.1	99.7	0.1	Month
Very High	Moderate	Moderate	High	Low	0.1	99.7	0.1	0.1	Half-Month
Very High	Moderate	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Upper Month
Very High	Moderate	Moderate	High	High	0.1	0.1	99.7	0.1	Month
Very High	Moderate	Long	Low	Low	0.1	99.7	0.1	0.1	Upper Half-Month
Very High	Moderate	Long	Low	Moderate	99.7	0.1	0.1	0.1	Half-Month
Very High	Moderate	Long	Low	High	10.2	0.1	81.1	8.6	Date
Very High	Moderate	Long	Moderate	Low	0.1	99.7	0.1	0.1	Upper Month
Very High	Moderate	Long	Moderate	Moderate	99.7	0.1	0.1	0.1	Half-Month
Very High	Moderate	Long	Moderate	High	0.1	0.1	91.6	8.2	Date
Very High	Moderate	Long	High	Low	0.1	0.1	0.1	99.7	Lower Month
Very High	Moderate	Long	High	Moderate	0.1	99.7	0.1	0.1	Month
Very High	Moderate	Long	High	High	37.8	0.1	0.1	62	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very High	Moderate	Longer	Low	Low	0.1	18.3	0.1	81.5	Date
Very High	Moderate	Longer	Low	Moderate	46.6	0.1	0.1	53.2	Date
Very High	Moderate	Longer	Low	High	0.1	0.1	0.1	99.7	Date
Very High	Moderate	Longer	Moderate	Low	0.1	29.7	0.1	70.1	Date
Very High	Moderate	Longer	Moderate	Moderate	89.4	0.1	0.1	10.4	Date
Very High	Moderate	Longer	Moderate	High	0.1	0.1	0.1	99.7	Date
Very High	Moderate	Longer	High	Low	0.1	0.1	0.1	99.7	Date
Very High	Moderate	Longer	High	Moderate	0.1	99.7	0.1	0.1	Month
Very High	Moderate	Longer	High	High	68.6	31.2	0.1	0.1	Month
Very High	High	Shorter	Low	Low	73.9	9.1	16.9	0.1	Date
Very High	High	Shorter	Low	Moderate	0.1	0.1	99.7	0.1	Date
Very High	High	Shorter	Low	High	0.1	35.6	0.1	64.2	Upper Date
Very High	High	Shorter	Moderate	Low	24.1	36.2	36.3	3.4	Date
Very High	High	Shorter	Moderate	Moderate	0.1	0.1	71.4	28.4	Date
Very High	High	Shorter	Moderate	High	0.1	59.4	16.4	24.1	Upper Half-Month
Very High	High	Shorter	High	Low	0.1	99.7	0.1	0.1	Date
Very High	High	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Month
Very High	High	Shorter	High	High	99.7	0.1	0.1	0.1	Lower Month
Very High	High	Short	Low	Low	69	30.8	0.1	0.1	Half-Month
Very High	High	Short	Low	Moderate	0.1	0.1	99.7	0.1	Month
Very High	High	Short	Low	High	0.1	0.1	99.7	0.1	Month
Very High	High	Short	Moderate	Low	79.6	20.2	0.1	0.1	Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very High	High	Short	Moderate	Moderate	0.1	0.1	99.7	0.1	Month
Very High	High	Short	Moderate	High	0.1	0.1	99.7	0.1	Month
Very High	High	Short	High	Low	0.1	99.7	0.1	0.1	Half-Month
Very High	High	Short	High	Moderate	0.1	0.1	99.7	0.1	Month
Very High	High	Short	High	High	0.1	0.1	99.7	0.1	Month
Very High	High	Moderate	Low	Low	0.1	99.7	0.1	0.1	Half-Month
Very High	High	Moderate	Low	Moderate	0.1	0.1	99.7	0.1	Date
Very High	High	Moderate	Low	High	0.1	0.1	99.7	0.1	Month
Very High	High	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
Very High	High	Moderate	Moderate	Moderate	0.1	0.1	99.7	0.1	Date
Very High	High	Moderate	Moderate	High	0.1	0.1	99.7	0.1	Month
Very High	High	Moderate	High	Low	0.1	99.7	0.1	0.1	Half-Month
Very High	High	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Upper Month
Very High	High	Moderate	High	High	0.1	0.1	99.7	0.1	Month
Very High	High	Long	Low	Low	1.2	98.6	0.1	0.1	Upper Half-Month
Very High	High	Long	Low	Moderate	99.7	0.1	0.1	0.1	Half-Month
Very High	High	Long	Low	High	33.2	0.1	48.2	18.5	Date
Very High	High	Long	Moderate	Low	0.5	99.3	0.1	0.1	Upper Month
Very High	High	Long	Moderate	Moderate	99.7	0.1	0.1	0.1	Half-Month
Very High	High	Long	Moderate	High	0.1	0.1	73.1	26.7	Date
Very High	High	Long	High	Low	0.1	66.5	0.1	33.3	Interpolate
Very High	High	Long	High	Moderate	0.1	99.7	0.1	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very High	High	Long	High	High	47.7	0.1	0.1	52.1	Date
Very High	High	Longer	Low	Low	0.1	69	0.1	30.8	Date
Very High	High	Longer	Low	Moderate	31.2	0.1	0.1	68.6	Date
Very High	High	Longer	Low	High	0.1	0.1	0.1	99.7	Date
Very High	High	Longer	Moderate	Low	0.1	80.6	0.1	19.2	Date
Very High	High	Longer	Moderate	Moderate	78.6	0.1	0.1	21.2	Date
Very High	High	Longer	Moderate	High	0.1	0.1	0.1	99.7	Date
Very High	High	Longer	High	Low	0.1	0.1	0.1	99.7	Date
Very High	High	Longer	High	Moderate	0.1	99.7	0.1	0.1	Month
Very High	High	Longer	High	High	49.4	50.4	0.1	0.1	Month
Very High	Very High	Shorter	Low	Low	61.4	38.4	0.1	0.1	Date
Very High	Very High	Shorter	Low	Moderate	0.1	0.1	99.7	0.1	Date
Very High	Very High	Shorter	Low	High	0.1	71.2	11.2	17.5	Upper Date
Very High	Very High	Shorter	Moderate	Low	17.9	58.9	0.1	23.1	Date
Very High	Very High	Shorter	Moderate	Moderate	0.1	0.1	92	7.8	Date
Very High	Very High	Shorter	Moderate	High	0.1	0.1	0.1	99.7	Upper Date
Very High	Very High	Shorter	High	Low	0.1	99.7	0.1	0.1	Date
Very High	Very High	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Month
Very High	Very High	Shorter	High	High	0.1	0.1	99.7	0.1	Upper Month
Very High	Very High	Short	Low	Low	36	63.8	0.1	0.1	Half-Month
Very High	Very High	Short	Low	Moderate	0.1	0.1	99.7	0.1	Month
Very High	Very High	Short	Low	High	0.1	0.1	99.7	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very High	Very High	Short	Moderate	Low	49.6	50.2	0.1	0.1	Half-Month
Very High	Very High	Short	Moderate	Moderate	0.1	0.1	99.7	0.1	Month
Very High	Very High	Short	Moderate	High	0.1	0.1	99.7	0.1	Month
Very High	Very High	Short	High	Low	0.1	99.7	0.1	0.1	Half-Month
Very High	Very High	Short	High	Moderate	0.1	0.1	99.7	0.1	Month
Very High	Very High	Short	High	High	0.1	0.1	99.7	0.1	Month
Very High	Very High	Moderate	Low	Low	0.1	99.7	0.1	0.1	Half-Month
Very High	Very High	Moderate	Low	Moderate	0.1	0.1	99.7	0.1	Date
Very High	Very High	Moderate	Low	High	0.1	0.1	99.7	0.1	Month
Very High	Very High	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
Very High	Very High	Moderate	Moderate	Moderate	0.1	0.1	99.7	0.1	Date
Very High	Very High	Moderate	Moderate	High	0.1	0.1	99.7	0.1	Month
Very High	Very High	Moderate	High	Low	0.1	99.7	0.1	0.1	Half-Month
Very High	Very High	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Upper Month
Very High	Very High	Moderate	High	High	0.1	0.1	99.7	0.1	Month
Very High	Very High	Long	Low	Low	0.1	99.7	0.1	0.1	Upper Date
Very High	Very High	Long	Low	Moderate	0.1	99.7	0.1	0.1	Month
Very High	Very High	Long	Low	High	0.1	0.1	99.7	0.1	Date
Very High	Very High	Long	Moderate	Low	0.3	99.5	0.1	0.1	Upper Month
Very High	Very High	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Month
Very High	Very High	Long	Moderate	High	0.1	0.1	99.7	0.1	Date
Very High	Very High	Long	High	Low	0.1	79.8	0.1	20	Interpolate

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very High	Very High	Long	High	Moderate	0.1	99.7	0.1	0.1	Month
Very High	Very High	Long	High	High	0.1	0.1	99.7	0.1	Half-Month
Very High	Very High	Longer	Low	Low	0.1	0.1	0.1	99.7	Date
Very High	Very High	Longer	Low	Moderate	0.1	99.7	0.1	0.1	Month
Very High	Very High	Longer	Low	High	0.1	99.7	0.1	0.1	Month
Very High	Very High	Longer	Moderate	Low	0.1	0.1	0.1	99.7	Date
Very High	Very High	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Month
Very High	Very High	Longer	Moderate	High	0.1	99.7	0.1	0.1	Month
Very High	Very High	Longer	High	Low	0.1	0.1	0.1	99.7	Date
Very High	Very High	Longer	High	Moderate	0.1	99.7	0.1	0.1	Month
Very High	Very High	Longer	High	High	0.1	99.7	0.1	0.1	Month

6.20 Total Algal Biovolume (totbiovman, mm3/m3) – Lower Lake Segment

Conditioned on:

- Total Nitrogen (totaln, mg/L)
- Total Phosphorus (totalp, mg/L)
- Residence Time (resid30, days)
- Secchi Depth (secchi, ft)
- Water Temperature (wtemp, C)

Lower:

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	Very Low	Shorter	Low	Low	0.1	99.7	0.1	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	Very Low	Shorter	Low	Moderate	0.1	0.1	35.9	63.9	Upper Half-Month
Very Low	Very Low	Shorter	Low	High	0.1	0.1	33.3	66.5	Upper Half-Month
Very Low	Very Low	Shorter	Moderate	Low	0.1	99.7	0.1	0.1	Month
Very Low	Very Low	Shorter	Moderate	Moderate	84.7	2.4	3.2	9.7	Month
Very Low	Very Low	Shorter	Moderate	High	0.1	0.1	95.3	4.5	Half-Month
Very Low	Very Low	Shorter	High	Low	0.1	99.7	0.1	0.1	Month
Very Low	Very Low	Shorter	High	Moderate	99.7	0.1	0.1	0.1	Date
Very Low	Very Low	Shorter	High	High	2	97.8	0.1	0.1	Date
Very Low	Very Low	Short	Low	Low	0.1	99.7	0.1	0.1	Month
Very Low	Very Low	Short	Low	Moderate	0.1	0.1	99.7	0.1	Upper Half-Month
Very Low	Very Low	Short	Low	High	0.1	0.1	57.4	42.4	Upper Month
Very Low	Very Low	Short	Moderate	Low	0.1	99.7	0.1	0.1	Month
Very Low	Very Low	Short	Moderate	Moderate	72.2	0.1	20.5	7.2	Month
Very Low	Very Low	Short	Moderate	High	0.1	0.1	99.7	0.1	Date
Very Low	Very Low	Short	High	Low	0.1	99.7	0.1	0.1	Month
Very Low	Very Low	Short	High	Moderate	0.1	99.7	0.1	0.1	Half-Month
Very Low	Very Low	Short	High	High	28.2	39.8	22.1	9.9	Date
Very Low	Very Low	Moderate	Low	Low	25	49.9	0.1	25	Interpolate
Very Low	Very Low	Moderate	Low	Moderate	0.1	0.1	0.1	99.7	Month
Very Low	Very Low	Moderate	Low	High	0.1	34.8	65	0.1	Upper Month
Very Low	Very Low	Moderate	Moderate	Low	99.7	0.1	0.1	0.1	Month
Very Low	Very Low	Moderate	Moderate	Moderate	0.1	0.1	99.7	0.1	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	Very Low	Moderate	Moderate	High	0.1	0.1	99.7	0.1	Half-Month
Very Low	Very Low	Moderate	High	Low	99.7	0.1	0.1	0.1	Month
Very Low	Very Low	Moderate	High	Moderate	0.1	60.9	38.9	0.1	Date
Very Low	Very Low	Moderate	High	High	51.5	32.1	0.1	16.3	Date
Very Low	Very Low	Long	Low	Low	33.3	66.5	0.1	0.1	Interpolate
Very Low	Very Low	Long	Low	Moderate	0.1	99.7	0.1	0.1	Upper Month
Very Low	Very Low	Long	Low	High	0.1	99.7	0.1	0.1	Upper Month
Very Low	Very Low	Long	Moderate	Low	99.7	0.1	0.1	0.1	Month
Very Low	Very Low	Long	Moderate	Moderate	0.1	0.1	0.1	99.7	Date
Very Low	Very Low	Long	Moderate	High	0.1	0.1	0.1	99.7	Date
Very Low	Very Low	Long	High	Low	99.7	0.1	0.1	0.1	Date
Very Low	Very Low	Long	High	Moderate	14.5	0.1	49.6	35.8	Date
Very Low	Very Low	Long	High	High	33.2	8.8	54.8	3.2	Date
Very Low	Very Low	Longer	Low	Low	33.3	40.2	26.4	0.1	Interpolate
Very Low	Very Low	Longer	Low	Moderate	0.1	99.7	0.1	0.1	Upper Month
Very Low	Very Low	Longer	Low	High	0.1	99.7	0.1	0.1	Middle Date
Very Low	Very Low	Longer	Moderate	Low	99.7	0.1	0.1	0.1	Month
Very Low	Very Low	Longer	Moderate	Moderate	0.1	0.1	0.1	99.7	Half-Month
Very Low	Very Low	Longer	Moderate	High	0.1	0.1	28.7	71.1	Half-Month
Very Low	Very Low	Longer	High	Low	99.7	0.1	0.1	0.1	Date
Very Low	Very Low	Longer	High	Moderate	65.9	21.7	12.3	0.1	Date
Very Low	Very Low	Longer	High	High	17.9	70.3	11.7	0.1	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	Low	Shorter	Low	Low	0.1	99.7	0.1	0.1	Date
Very Low	Low	Shorter	Low	Moderate	0.1	99.7	0.1	0.1	Middle Half-Month
Very Low	Low	Shorter	Low	High	99.7	0.1	0.1	0.1	Middle Date
Very Low	Low	Shorter	Moderate	Low	0.1	99.7	0.1	0.1	Date
Very Low	Low	Shorter	Moderate	Moderate	79.4	2.9	0.1	17.6	Date
Very Low	Low	Shorter	Moderate	High	24.8	14.7	0.1	60.4	Date
Very Low	Low	Shorter	High	Low	0.1	99.7	0.1	0.1	Date
Very Low	Low	Shorter	High	Moderate	80.2	4.9	0.1	14.8	Date
Very Low	Low	Shorter	High	High	11.3	77.6	0.1	11	Date
Very Low	Low	Short	Low	Low	0.1	99.7	0.1	0.1	Half-Month
Very Low	Low	Short	Low	Moderate	0.1	99.7	0.1	0.1	Middle Date
Very Low	Low	Short	Low	High	73.1	26.7	0.1	0.1	Middle Half-Month
Very Low	Low	Short	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
Very Low	Low	Short	Moderate	Moderate	91	0.1	3.2	5.7	Month
Very Low	Low	Short	Moderate	High	0.1	0.1	99.7	0.1	Date
Very Low	Low	Short	High	Low	0.1	99.7	0.1	0.1	Half-Month
Very Low	Low	Short	High	Moderate	61.5	38.3	0.1	0.1	Date
Very Low	Low	Short	High	High	44.3	15.7	8.7	31.3	Date
Very Low	Low	Moderate	Low	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very Low	Low	Moderate	Low	Moderate	0.1	0.1	0.1	99.7	Month
Very Low	Low	Moderate	Low	High	0.1	1.2	98.6	0.1	Middle Month
Very Low	Low	Moderate	Moderate	Low	99.7	0.1	0.1	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	Low	Moderate	Moderate	Moderate	0.1	0.1	99.7	0.1	Date
Very Low	Low	Moderate	Moderate	High	0.1	0.1	99.7	0.1	Half-Month
Very Low	Low	Moderate	High	Low	0.1	99.7	0.1	0.1	Half-Month
Very Low	Low	Moderate	High	Moderate	0.1	31.9	53	15	Date
Very Low	Low	Moderate	High	High	0.1	0.1	0.1	99.7	Date
Very Low	Low	Long	Low	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very Low	Low	Long	Low	Moderate	39.6	60.2	0.1	0.1	Middle Month
Very Low	Low	Long	Low	High	0.1	0.1	99.7	0.1	Middle Half-Month
Very Low	Low	Long	Moderate	Low	99.7	0.1	0.1	0.1	Month
Very Low	Low	Long	Moderate	Moderate	0.1	0.1	0.1	99.7	Date
Very Low	Low	Long	Moderate	High	0.1	0.1	0.1	99.7	Date
Very Low	Low	Long	High	Low	0.1	99.7	0.1	0.1	Half-Month
Very Low	Low	Long	High	Moderate	27.5	0.1	60.9	11.5	Date
Very Low	Low	Long	High	High	69.7	0.1	25	5.2	Date
Very Low	Low	Longer	Low	Low	0.1	20.7	79.1	0.1	Middle Date
Very Low	Low	Longer	Low	Moderate	38	61.8	0.1	0.1	Middle Date
Very Low	Low	Longer	Low	High	0.1	99.7	0.1	0.1	Middle Date
Very Low	Low	Longer	Moderate	Low	99.7	0.1	0.1	0.1	Month
Very Low	Low	Longer	Moderate	Moderate	0.1	0.1	0.1	99.7	Half-Month
Very Low	Low	Longer	Moderate	High	0.1	0.1	34.9	64.9	Half-Month
Very Low	Low	Longer	High	Low	0.6	29.1	70.2	0.1	Date
Very Low	Low	Longer	High	Moderate	4.1	1.5	38.7	55.7	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	Low	Longer	High	High	21.4	78.4	0.1	0.1	Date
Very Low	Moderate	Shorter	Low	Low	0.1	99.7	0.1	0.1	Month
Very Low	Moderate	Shorter	Low	Moderate	99.7	0.1	0.1	0.1	Middle Date
Very Low	Moderate	Shorter	Low	High	99.7	0.1	0.1	0.1	Middle Date
Very Low	Moderate	Shorter	Moderate	Low	0.1	99.7	0.1	0.1	Month
Very Low	Moderate	Shorter	Moderate	Moderate	95	0.1	4.8	0.1	Month
Very Low	Moderate	Shorter	Moderate	High	0.1	0.1	99.7	0.1	Month
Very Low	Moderate	Shorter	High	Low	0.1	99.7	0.1	0.1	Month
Very Low	Moderate	Shorter	High	Moderate	77.2	0.1	22.6	0.1	Month
Very Low	Moderate	Shorter	High	High	0.1	99.7	0.1	0.1	Date
Very Low	Moderate	Short	Low	Low	0.1	99.7	0.1	0.1	Month
Very Low	Moderate	Short	Low	Moderate	0.1	99.7	0.1	0.1	Middle Half-Month
Very Low	Moderate	Short	Low	High	80.3	19.5	0.1	0.1	Middle Half-Month
Very Low	Moderate	Short	Moderate	Low	0.1	99.7	0.1	0.1	Month
Very Low	Moderate	Short	Moderate	Moderate	87.4	0.1	12.4	0.1	Month
Very Low	Moderate	Short	Moderate	High	0.1	0.1	99.7	0.1	Month
Very Low	Moderate	Short	High	Low	0.1	99.7	0.1	0.1	Month
Very Low	Moderate	Short	High	Moderate	8.9	0.1	90.9	0.1	Month
Very Low	Moderate	Short	High	High	0.1	43.4	56.4	0.1	Month
Very Low	Moderate	Moderate	Low	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very Low	Moderate	Moderate	Low	Moderate	0.1	0.1	0.1	99.7	Month
Very Low	Moderate	Moderate	Low	High	0.1	2.1	97.7	0.1	Middle Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	Moderate	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very Low	Moderate	Moderate	Moderate	Moderate	0.1	0.1	0.1	99.7	Month
Very Low	Moderate	Moderate	Moderate	High	0.1	0.1	0.1	99.7	Middle Date
Very Low	Moderate	Moderate	High	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	Moderate	Moderate	High	Moderate	0.1	0.1	0.1	99.7	Date
Very Low	Moderate	Moderate	High	High	63.4	36.4	0.1	0.1	Date
Very Low	Moderate	Long	Low	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very Low	Moderate	Long	Low	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very Low	Moderate	Long	Low	High	0.1	0.1	99.7	0.1	Middle Half-Month
Very Low	Moderate	Long	Moderate	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very Low	Moderate	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Middle Half-Month
Very Low	Moderate	Long	Moderate	High	99.7	0.1	0.1	0.1	Middle Date
Very Low	Moderate	Long	High	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	Moderate	Long	High	Moderate	81.2	18.6	0.1	0.1	Month
Very Low	Moderate	Long	High	High	37.9	61.9	0.1	0.1	Half-Month
Very Low	Moderate	Longer	Low	Low	0.1	72.1	27.7	0.1	Middle Date
Very Low	Moderate	Longer	Low	Moderate	0.1	99.7	0.1	0.1	Middle Date
Very Low	Moderate	Longer	Low	High	0.1	99.7	0.1	0.1	Middle Date
Very Low	Moderate	Longer	Moderate	Low	0.1	78.5	21.3	0.1	Middle Date
Very Low	Moderate	Longer	Moderate	Moderate	0.1	82.3	17.5	0.1	Middle Date
Very Low	Moderate	Longer	Moderate	High	0.1	99.7	0.1	0.1	Middle Date
Very Low	Moderate	Longer	High	Low	0.1	69.9	29.9	0.1	Middle Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	Moderate	Longer	High	Moderate	0.1	99.7	0.1	0.1	Month
Very Low	Moderate	Longer	High	High	0.1	99.7	0.1	0.1	Month
Very Low	High	Shorter	Low	Low	99.7	0.1	0.1	0.1	Middle Date
Very Low	High	Shorter	Low	Moderate	99.7	0.1	0.1	0.1	Middle Date
Very Low	High	Shorter	Low	High	0.1	0.1	0.1	99.7	Middle Month
Very Low	High	Shorter	Moderate	Low	99.7	0.1	0.1	0.1	Middle Date
Very Low	High	Shorter	Moderate	Moderate	99.7	0.1	0.1	0.1	Middle Date
Very Low	High	Shorter	Moderate	High	0.1	99.7	0.1	0.1	Middle Half-Month
Very Low	High	Shorter	High	Low	10	89.8	0.1	0.1	Middle Month
Very Low	High	Shorter	High	Moderate	99.7	0.1	0.1	0.1	Half-Month
Very Low	High	Shorter	High	High	25.3	0.1	0.1	74.5	Half-Month
Very Low	High	Short	Low	Low	14.9	84.9	0.1	0.1	Middle Month
Very Low	High	Short	Low	Moderate	99.7	0.1	0.1	0.1	Middle Month
Very Low	High	Short	Low	High	0.1	0.1	99.7	0.1	Middle Month
Very Low	High	Short	Moderate	Low	23.7	76.1	0.1	0.1	Middle Month
Very Low	High	Short	Moderate	Moderate	99.7	0.1	0.1	0.1	Middle Month
Very Low	High	Short	Moderate	High	0.1	99.7	0.1	0.1	Middle Date
Very Low	High	Short	High	Low	3.6	96.2	0.1	0.1	Middle Month
Very Low	High	Short	High	Moderate	0.1	0.1	0.1	99.7	Month
Very Low	High	Short	High	High	0.1	0.1	0.1	99.7	Date
Very Low	High	Moderate	Low	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very Low	High	Moderate	Low	Moderate	0.1	0.1	0.1	99.7	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	High	Moderate	Low	High	0.1	3.4	96.4	0.1	Middle Month
Very Low	High	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very Low	High	Moderate	Moderate	Moderate	0.1	0.1	0.1	99.7	Month
Very Low	High	Moderate	Moderate	High	0.1	0.1	0.1	99.7	Middle Date
Very Low	High	Moderate	High	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	High	Moderate	High	Moderate	0.1	0.1	0.1	99.7	Month
Very Low	High	Moderate	High	High	0.1	0.1	0.1	99.7	Half-Month
Very Low	High	Long	Low	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very Low	High	Long	Low	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very Low	High	Long	Low	High	0.1	0.1	99.7	0.1	Middle Half-Month
Very Low	High	Long	Moderate	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very Low	High	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Middle Half-Month
Very Low	High	Long	Moderate	High	0.1	46	50.6	3.3	Middle Half-Month
Very Low	High	Long	High	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	High	Long	High	Moderate	0.1	0.1	0.1	99.7	Month
Very Low	High	Long	High	High	0.1	0.1	0.1	99.7	Month
Very Low	High	Longer	Low	Low	0.1	83.7	16.1	0.1	Middle Date
Very Low	High	Longer	Low	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very Low	High	Longer	Low	High	0.1	99.7	0.1	0.1	Middle Date
Very Low	High	Longer	Moderate	Low	0.1	75.2	24.6	0.1	Middle Date
Very Low	High	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Middle Date
Very Low	High	Longer	Moderate	High	0.1	99.7	0.1	0.1	Middle Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	High	Longer	High	Low	0.1	43.9	55.9	0.1	Middle Date
Very Low	High	Longer	High	Moderate	0.1	99.7	0.1	0.1	Middle Date
Very Low	High	Longer	High	High	0.1	99.7	0.1	0.1	Middle Date
Very Low	Very High	Shorter	Low	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Shorter	Low	Moderate	0.1	0.1	0.1	99.7	Upper Date
Very Low	Very High	Shorter	Low	High	0.1	0.1	0.1	99.7	Upper Date
Very Low	Very High	Shorter	Moderate	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Shorter	Moderate	Moderate	5.1	0.1	35.5	59.3	Upper Half-Month
Very Low	Very High	Shorter	Moderate	High	0.1	0.1	33.3	66.5	Upper Half-Month
Very Low	Very High	Shorter	High	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Shorter	High	Moderate	99.7	0.1	0.1	0.1	Month
Very Low	Very High	Shorter	High	High	0.1	99.7	0.1	0.1	Month
Very Low	Very High	Short	Low	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Short	Low	Moderate	32.4	0.1	67.4	0.1	Upper Half-Month
Very Low	Very High	Short	Low	High	0.1	0.1	99.7	0.1	Middle Month
Very Low	Very High	Short	Moderate	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Short	Moderate	Moderate	16.3	0.1	83.5	0.1	Upper Half-Month
Very Low	Very High	Short	Moderate	High	0.1	0.1	99.7	0.1	Middle Month
Very Low	Very High	Short	High	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Short	High	Moderate	0.1	99.7	0.1	0.1	Half-Month
Very Low	Very High	Short	High	High	0.1	99.7	0.1	0.1	Month
Very Low	Very High	Moderate	Low	Low	0.1	99.7	0.1	0.1	Middle Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	Very High	Moderate	Low	Moderate	0.1	0.1	99.7	0.1	Upper Month
Very Low	Very High	Moderate	Low	High	0.1	0.1	99.7	0.1	Middle Month
Very Low	Very High	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Moderate	Moderate	Moderate	0.1	0.1	99.7	0.1	Upper Month
Very Low	Very High	Moderate	Moderate	High	0.1	0.1	99.7	0.1	Middle Month
Very Low	Very High	Moderate	High	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Moderate	High	Moderate	0.1	99.7	0.1	0.1	Date
Very Low	Very High	Moderate	High	High	99.7	0.1	0.1	0.1	Date
Very Low	Very High	Long	Low	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Long	Low	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Long	Low	High	0.1	0.1	99.7	0.1	Middle Half-Month
Very Low	Very High	Long	Moderate	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Long	Moderate	High	0.1	0.1	99.7	0.1	Middle Date
Very Low	Very High	Long	High	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Long	High	Moderate	99.7	0.1	0.1	0.1	Month
Very Low	Very High	Long	High	High	99.7	0.1	0.1	0.1	Half-Month
Very Low	Very High	Longer	Low	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Longer	Low	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Longer	Low	High	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Longer	Moderate	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Middle Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very Low	Very High	Longer	Moderate	High	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Longer	High	Low	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Longer	High	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very Low	Very High	Longer	High	High	0.1	99.7	0.1	0.1	Middle Month
Low	Very Low	Shorter	Low	Low	0.1	99.7	0.1	0.1	Month
Low	Very Low	Shorter	Low	Moderate	0.1	99.7	0.1	0.1	Month
Low	Very Low	Shorter	Low	High	0.1	0.1	0.1	99.7	Date
Low	Very Low	Shorter	Moderate	Low	83.1	0.1	16.7	0.1	Half-Month
Low	Very Low	Shorter	Moderate	Moderate	0.1	0.1	99.7	0.1	Half-Month
Low	Very Low	Shorter	Moderate	High	0.1	0.1	72.5	27.3	Half-Month
Low	Very Low	Shorter	High	Low	11.3	0.1	88.5	0.1	Half-Month
Low	Very Low	Shorter	High	Moderate	99.7	0.1	0.1	0.1	Date
Low	Very Low	Shorter	High	High	14.4	76	0.1	9.5	Date
Low	Very Low	Short	Low	Low	0.1	99.7	0.1	0.1	Month
Low	Very Low	Short	Low	Moderate	0.1	99.7	0.1	0.1	Month
Low	Very Low	Short	Low	High	0.1	85.9	13.9	0.1	Upper Month
Low	Very Low	Short	Moderate	Low	0.1	31.2	68.6	0.1	Half-Month
Low	Very Low	Short	Moderate	Moderate	0.1	0.1	99.7	0.1	Half-Month
Low	Very Low	Short	Moderate	High	0.1	0.1	99.7	0.1	Date
Low	Very Low	Short	High	Low	0.1	38.6	61.2	0.1	Half-Month
Low	Very Low	Short	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
Low	Very Low	Short	High	High	0.1	39.1	21.7	39.1	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Low	Very Low	Moderate	Low	Low	18.1	56.8	0.1	25	Interpolate
Low	Very Low	Moderate	Low	Moderate	0.1	0.1	0.1	99.7	Month
Low	Very Low	Moderate	Low	High	0.1	85.9	13.9	0.1	Upper Month
Low	Very Low	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
Low	Very Low	Moderate	Moderate	Moderate	0.7	3.6	29	66.7	Month
Low	Very Low	Moderate	Moderate	High	0.1	0.1	99.7	0.1	Half-Month
Low	Very Low	Moderate	High	Low	0.1	99.7	0.1	0.1	Half-Month
Low	Very Low	Moderate	High	Moderate	0.1	99.7	0.1	0.1	Date
Low	Very Low	Moderate	High	High	0.1	99.7	0.1	0.1	Date
Low	Very Low	Long	Low	Low	39.9	59.9	0.1	0.1	Interpolate
Low	Very Low	Long	Low	Moderate	0.1	56.7	0.1	43.1	Interpolate
Low	Very Low	Long	Low	High	0.1	99.7	0.1	0.1	Upper Month
Low	Very Low	Long	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
Low	Very Low	Long	Moderate	Moderate	0.1	27.4	0.1	72.4	Date
Low	Very Low	Long	Moderate	High	0.1	0.1	0.1	99.7	Date
Low	Very Low	Long	High	Low	99.7	0.1	0.1	0.1	Date
Low	Very Low	Long	High	Moderate	16.8	0.1	0.1	83	Date
Low	Very Low	Long	High	High	0.1	22.5	44.8	32.6	Date
Low	Very Low	Longer	Low	Low	0.1	17.8	12.7	69.4	Interpolate
Low	Very Low	Longer	Low	Moderate	13.2	72.6	0.1	14.1	Interpolate
Low	Very Low	Longer	Low	High	0.1	99.7	0.1	0.1	Middle Date
Low	Very Low	Longer	Moderate	Low	0.1	0.1	0.1	99.7	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Low	Very Low	Longer	Moderate	Moderate	0.1	32	0.1	67.8	Half-Month
Low	Very Low	Longer	Moderate	High	0.1	0.1	6.3	93.5	Half-Month
Low	Very Low	Longer	High	Low	5.9	23.7	0.1	70.3	Date
Low	Very Low	Longer	High	Moderate	11.9	85.1	0.1	2.9	Date
Low	Very Low	Longer	High	High	15.4	84.4	0.1	0.1	Date
Low	Low	Shorter	Low	Low	0.1	99.7	0.1	0.1	Date
Low	Low	Shorter	Low	Moderate	0.1	0.1	0.1	99.7	Date
Low	Low	Shorter	Low	High	0.1	0.1	0.1	99.7	Half-Month
Low	Low	Shorter	Moderate	Low	0.1	79.8	0.1	20	Date
Low	Low	Shorter	Moderate	Moderate	17	34.6	0.1	48.3	Date
Low	Low	Shorter	Moderate	High	0.1	19.5	0.1	80.3	Date
Low	Low	Shorter	High	Low	0.1	99.7	0.1	0.1	Date
Low	Low	Shorter	High	Moderate	28.5	56.3	0.1	15.1	Date
Low	Low	Shorter	High	High	13.4	81.6	0.1	4.9	Date
Low	Low	Short	Low	Low	0.1	99.7	0.1	0.1	Half-Month
Low	Low	Short	Low	Moderate	0.1	8	0.1	91.8	Month
Low	Low	Short	Low	High	31.2	67.9	0.8	0.1	Middle Half-Month
Low	Low	Short	Moderate	Low	0.1	88	11.8	0.1	Date
Low	Low	Short	Moderate	Moderate	0.1	0.1	99.7	0.1	Date
Low	Low	Short	Moderate	High	0.1	0.1	99.7	0.1	Date
Low	Low	Short	High	Low	0.1	0.1	99.7	0.1	Date
Low	Low	Short	High	Moderate	0.1	0.1	99.7	0.1	Date
Low	Low	Short	High	High	0.1	13.2	7.4	79.3	Date
Low	Low	Moderate	Low	Low	72.1	27.7	0.1	0.1	Middle Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Low	Low	Moderate	Low	Moderate	0.1	0.1	0.1	99.7	Month
Low	Low	Moderate	Low	High	0.1	0.1	0.5	99.3	Middle Half-Month
Low	Low	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
Low	Low	Moderate	Moderate	Moderate	0.1	99.7	0.1	0.1	Half-Month
Low	Low	Moderate	Moderate	High	0.1	0.1	99.7	0.1	Half-Month
Low	Low	Moderate	High	Low	0.1	99.7	0.1	0.1	Date
Low	Low	Moderate	High	Moderate	0.1	51.2	0.1	48.6	Date
Low	Low	Moderate	High	High	0.1	0.1	68.8	31	Half-Month
Low	Low	Long	Low	Low	79.5	20.3	0.1	0.1	Middle Half-Month
Low	Low	Long	Low	Moderate	0.1	14.1	0.1	85.7	Middle Date
Low	Low	Long	Low	High	5.8	4.1	53	37.1	Middle Date
Low	Low	Long	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
Low	Low	Long	Moderate	Moderate	0.1	72.4	0.1	27.4	Date
Low	Low	Long	Moderate	High	0.1	0.1	0.1	99.7	Date
Low	Low	Long	High	Low	0.1	99.7	0.1	0.1	Half-Month
Low	Low	Long	High	Moderate	0.1	0.1	0.1	99.7	Date
Low	Low	Long	High	High	0.1	0.1	61.4	38.4	Date
Low	Low	Longer	Low	Low	0.1	35.5	25.4	39	Middle Date
Low	Low	Longer	Low	Moderate	66	31.5	0.1	2.4	Middle Date
Low	Low	Longer	Low	High	0.1	43.4	0.1	56.4	Middle Date
Low	Low	Longer	Moderate	Low	0.1	3.6	24.1	72.2	Date
Low	Low	Longer	Moderate	Moderate	0.1	32	0.1	67.8	Half-Month
Low	Low	Longer	Moderate	High	0.1	0.1	8.2	91.6	Half-Month
Low	Low	Longer	High	Low	0.3	26.9	43.7	29.1	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Low	Low	Longer	High	Moderate	9.1	45.8	42.9	2.2	Date
Low	Low	Longer	High	High	49.9	49.9	0.1	0.1	Date
Low	Moderate	Shorter	Low	Low	0.1	99.7	0.1	0.1	Month
Low	Moderate	Shorter	Low	Moderate	0.1	0.1	0.1	99.7	Half-Month
Low	Moderate	Shorter	Low	High	0.1	0.1	0.1	99.7	Half-Month
Low	Moderate	Shorter	Moderate	Low	79.8	0.1	0.1	20	Date
Low	Moderate	Shorter	Moderate	Moderate	4.2	0.1	0.1	95.6	Half-Month
Low	Moderate	Shorter	Moderate	High	0.1	0.1	99.7	0.1	Month
Low	Moderate	Shorter	High	Low	99.7	0.1	0.1	0.1	Half-Month
Low	Moderate	Shorter	High	Moderate	0.1	8.6	0.1	91.2	Half-Month
Low	Moderate	Shorter	High	High	0.1	99.7	0.1	0.1	Date
Low	Moderate	Short	Low	Low	0.1	99.7	0.1	0.1	Month
Low	Moderate	Short	Low	Moderate	0.1	9.9	0.1	89.9	Month
Low	Moderate	Short	Low	High	37.2	54	8.7	0.1	Middle Half-Month
Low	Moderate	Short	Moderate	Low	4.5	95.3	0.1	0.1	Month
Low	Moderate	Short	Moderate	Moderate	15.7	21.2	0.3	62.8	Month
Low	Moderate	Short	Moderate	High	0.1	0.1	99.7	0.1	Month
Low	Moderate	Short	High	Low	1.4	98.4	0.1	0.1	Month
Low	Moderate	Short	High	Moderate	2.6	47.7	3.3	46.4	Month
Low	Moderate	Short	High	High	0.1	50.4	49.4	0.1	Month
Low	Moderate	Moderate	Low	Low	3.6	96.2	0.1	0.1	Middle Half-Month
Low	Moderate	Moderate	Low	Moderate	0.1	0.1	0.1	99.7	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Low	Moderate	Moderate	Low	High	0.1	0.1	5.1	94.7	Middle Half-Month
Low	Moderate	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Month
Low	Moderate	Moderate	Moderate	Moderate	0.1	0.9	0.1	98.9	Month
Low	Moderate	Moderate	Moderate	High	0.1	71.2	0.1	28.6	Middle Date
Low	Moderate	Moderate	High	Low	0.1	99.7	0.1	0.1	Date
Low	Moderate	Moderate	High	Moderate	0.1	0.1	0.1	99.7	Date
Low	Moderate	Moderate	High	High	0.1	99.7	0.1	0.1	Date
Low	Moderate	Long	Low	Low	8.6	91.2	0.1	0.1	Middle Half-Month
Low	Moderate	Long	Low	Moderate	0.1	39.5	0.1	60.3	Middle Date
Low	Moderate	Long	Low	High	2.5	14.1	67.4	16	Middle Date
Low	Moderate	Long	Moderate	Low	0.1	99.7	0.1	0.1	Middle Date
Low	Moderate	Long	Moderate	Moderate	12.3	54.7	0.1	32.9	Middle Date
Low	Moderate	Long	Moderate	High	22.7	12.1	51.4	13.8	Middle Date
Low	Moderate	Long	High	Low	0.1	99.7	0.1	0.1	Half-Month
Low	Moderate	Long	High	Moderate	0.1	99.7	0.1	0.1	Month
Low	Moderate	Long	High	High	0.1	99.7	0.1	0.1	Half-Month
Low	Moderate	Longer	Low	Low	0.1	26.7	7.1	66.1	Middle Date
Low	Moderate	Longer	Low	Moderate	0.1	89.2	0.1	10.6	Middle Date
Low	Moderate	Longer	Low	High	0.1	75.2	0.1	24.6	Middle Date
Low	Moderate	Longer	Moderate	Low	0.1	99.7	0.1	0.1	Date
Low	Moderate	Longer	Moderate	Moderate	0.1	13	5.6	81.3	Middle Date
Low	Moderate	Longer	Moderate	High	0.1	88.9	0.1	10.9	Middle Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Low	Moderate	Longer	High	Low	0.1	99.7	0.1	0.1	Date
Low	Moderate	Longer	High	Moderate	0.1	99.7	0.1	0.1	Month
Low	Moderate	Longer	High	High	0.1	99.7	0.1	0.1	Month
Low	High	Shorter	Low	Low	78.7	21.1	0.1	0.1	Middle Date
Low	High	Shorter	Low	Moderate	0.1	0.1	0.1	99.7	Half-Month
Low	High	Shorter	Low	High	0.1	0.1	0.1	99.7	Half-Month
Low	High	Shorter	Moderate	Low	66.5	0.1	0.1	33.3	Date
Low	High	Shorter	Moderate	Moderate	0.1	0.1	0.1	99.7	Half-Month
Low	High	Shorter	Moderate	High	0.1	48.6	7.6	43.7	Middle Date
Low	High	Shorter	High	Low	99.7	0.1	0.1	0.1	Half-Month
Low	High	Shorter	High	Moderate	18.9	0.1	0.1	80.9	Half-Month
Low	High	Shorter	High	High	32.8	0.1	0.1	67	Half-Month
Low	High	Short	Low	Low	0.1	99.7	0.1	0.1	Middle Date
Low	High	Short	Low	Moderate	0.1	22.6	0.1	77.2	Month
Low	High	Short	Low	High	0.1	0.1	99.7	0.1	Middle Half-Month
Low	High	Short	Moderate	Low	7.4	0.1	0.1	92.4	Month
Low	High	Short	Moderate	Moderate	0.1	20.8	0.1	79	Month
Low	High	Short	Moderate	High	0.1	99.7	0.1	0.1	Middle Date
Low	High	Short	High	Low	0.7	51.2	0.1	48	Month
Low	High	Short	High	Moderate	0.1	38.2	0.1	61.6	Month
Low	High	Short	High	High	0.1	0.1	0.1	99.7	Date
Low	High	Moderate	Low	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Low	High	Moderate	Low	Moderate	0.1	0.1	0.1	99.7	Month
Low	High	Moderate	Low	High	0.1	0.1	1.3	98.5	Middle Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Low	High	Moderate	Moderate	Low	0.1	0.1	99.7	0.1	Middle Date
Low	High	Moderate	Moderate	Moderate	0.1	0.1	0.1	99.7	Month
Low	High	Moderate	Moderate	High	0.1	41.6	0.1	58.2	Middle Date
Low	High	Moderate	High	Low	0.1	99.7	0.1	0.1	Date
Low	High	Moderate	High	Moderate	0.1	0.1	0.1	99.7	Month
Low	High	Moderate	High	High	0.1	0.1	0.1	99.7	Half-Month
Low	High	Long	Low	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Low	High	Long	Low	Moderate	0.1	49.5	0.1	50.3	Middle Date
Low	High	Long	Low	High	9.5	9	61.2	20.3	Middle Date
Low	High	Long	Moderate	Low	0.1	33.1	66.7	0.1	Middle Half-Month
Low	High	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Month
Low	High	Long	Moderate	High	11.2	9.6	57.3	21.9	Middle Date
Low	High	Long	High	Low	0.1	99.7	0.1	0.1	Half-Month
Low	High	Long	High	Moderate	0.1	99.7	0.1	0.1	Half-Month
Low	High	Long	High	High	0.1	0.1	0.1	99.7	Month
Low	High	Longer	Low	Low	0.1	52.1	7.4	40.4	Middle Date
Low	High	Longer	Low	Moderate	0.1	93.2	0.1	6.6	Middle Date
Low	High	Longer	Low	High	0.1	43.4	0.1	56.4	Middle Date
Low	High	Longer	Moderate	Low	0.1	99.7	0.1	0.1	Date
Low	High	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Month
Low	High	Longer	Moderate	High	0.1	79.6	0.1	20.2	Middle Date
Low	High	Longer	High	Low	0.1	99.7	0.1	0.1	Date
Low	High	Longer	High	Moderate	0.1	99.7	0.1	0.1	Date
Low	High	Longer	High	High	0.1	89	0.1	10.8	Middle Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Low	Very High	Shorter	Low	Low	69.2	30.6	0.1	0.1	Middle Date
Low	Very High	Shorter	Low	Moderate	0.1	41.9	0.1	57.9	Middle Date
Low	Very High	Shorter	Low	High	0.1	0.1	0.1	99.7	Half-Month
Low	Very High	Shorter	Moderate	Low	0.1	0.1	0.1	99.7	Half-Month
Low	Very High	Shorter	Moderate	Moderate	0.1	22.1	0.1	77.7	Middle Date
Low	Very High	Shorter	Moderate	High	0.1	75.5	0.1	24.3	Middle Date
Low	Very High	Shorter	High	Low	0.1	0.1	0.1	99.7	Month
Low	Very High	Shorter	High	Moderate	0.1	99.7	0.1	0.1	Month
Low	Very High	Shorter	High	High	0.1	0.1	0.1	99.7	Half-Month
Low	Very High	Short	Low	Low	99.7	0.1	0.1	0.1	Middle Half-Month
Low	Very High	Short	Low	Moderate	0.1	0.1	0.1	99.7	Middle Month
Low	Very High	Short	Low	High	0.1	0.1	91.1	8.7	Middle Month
Low	Very High	Short	Moderate	Low	0.1	0.1	0.1	99.7	Month
Low	Very High	Short	Moderate	Moderate	0.1	0.1	0.1	99.7	Middle Half-Month
Low	Very High	Short	Moderate	High	0.1	0.1	71.5	28.3	Middle Month
Low	Very High	Short	High	Low	0.1	84	0.1	15.8	Month
Low	Very High	Short	High	Moderate	0.1	0.1	0.1	99.7	Middle Half-Month
Low	Very High	Short	High	High	0.1	0.1	66.5	33.3	Middle Month
Low	Very High	Moderate	Low	Low	0.1	99.7	0.1	0.1	Middle Month
Low	Very High	Moderate	Low	Moderate	0.1	0.1	0.1	99.7	Middle Month
Low	Very High	Moderate	Low	High	0.1	0.1	95.3	4.5	Middle Month
Low	Very High	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Middle Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Low	Very High	Moderate	Moderate	Moderate	0.1	0.1	0.1	99.7	Middle Month
Low	Very High	Moderate	Moderate	High	0.1	0.1	83.3	16.5	Middle Month
Low	Very High	Moderate	High	Low	0.1	99.7	0.1	0.1	Month
Low	Very High	Moderate	High	Moderate	0.1	0.1	0.1	99.7	Middle Month
Low	Very High	Moderate	High	High	0.1	0.1	79.8	20	Middle Month
Low	Very High	Long	Low	Low	0.1	99.7	0.1	0.1	Middle Month
Low	Very High	Long	Low	Moderate	0.1	99.7	0.1	0.1	Middle Month
Low	Very High	Long	Low	High	0.1	0.1	99.7	0.1	Middle Date
Low	Very High	Long	Moderate	Low	0.1	99.7	0.1	0.1	Middle Month
Low	Very High	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Middle Month
Low	Very High	Long	Moderate	High	0.1	0.1	99.7	0.1	Middle Date
Low	Very High	Long	High	Low	0.1	99.7	0.1	0.1	Month
Low	Very High	Long	High	Moderate	0.1	99.7	0.1	0.1	Half-Month
Low	Very High	Long	High	High	0.1	0.1	99.7	0.1	Middle Half-Month
Low	Very High	Longer	Low	Low	0.1	48.6	0.1	51.2	Middle Date
Low	Very High	Longer	Low	Moderate	0.1	99.7	0.1	0.1	Middle Month
Low	Very High	Longer	Low	High	0.1	99.7	0.1	0.1	Middle Month
Low	Very High	Longer	Moderate	Low	0.1	46.1	0.1	53.7	Middle Date
Low	Very High	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Middle Month
Low	Very High	Longer	Moderate	High	0.1	99.7	0.1	0.1	Middle Month
Low	Very High	Longer	High	Low	0.1	0.1	99.7	0.1	Date
Low	Very High	Longer	High	Moderate	0.1	99.7	0.1	0.1	Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Low	Very High	Longer	High	High	0.1	99.7	0.1	0.1	Middle Month
Moderate	Very Low	Shorter	Low	Low	0.1	99.7	0.1	0.1	Upper Month
Moderate	Very Low	Shorter	Low	Moderate	0.1	99.7	0.1	0.1	Date
Moderate	Very Low	Shorter	Low	High	0.1	99.7	0.1	0.1	Month
Moderate	Very Low	Shorter	Moderate	Low	99.7	0.1	0.1	0.1	Half-Month
Moderate	Very Low	Shorter	Moderate	Moderate	0.1	99.7	0.1	0.1	Date
Moderate	Very Low	Shorter	Moderate	High	0.1	99.7	0.1	0.1	Month
Moderate	Very Low	Shorter	High	Low	99.7	0.1	0.1	0.1	Half-Month
Moderate	Very Low	Shorter	High	Moderate	99.7	0.1	0.1	0.1	Half-Month
Moderate	Very Low	Shorter	High	High	99.7	0.1	0.1	0.1	Half-Month
Moderate	Very Low	Short	Low	Low	0.1	99.7	0.1	0.1	Upper Month
Moderate	Very Low	Short	Low	Moderate	0.1	99.7	0.1	0.1	Month
Moderate	Very Low	Short	Low	High	0.1	86.7	9.1	4.1	Upper Month
Moderate	Very Low	Short	Moderate	Low	0.1	2.1	97.7	0.1	Half-Month
Moderate	Very Low	Short	Moderate	Moderate	48.6	51.2	0.1	0.1	Month
Moderate	Very Low	Short	Moderate	High	0.1	99.7	0.1	0.1	Middle Month
Moderate	Very Low	Short	High	Low	0.1	6	93.8	0.1	Half-Month
Moderate	Very Low	Short	High	Moderate	7.2	92.6	0.1	0.1	Month
Moderate	Very Low	Short	High	High	0.1	99.7	0.1	0.1	Month
Moderate	Very Low	Moderate	Low	Low	18.1	32.9	24	25	Interpolate
Moderate	Very Low	Moderate	Low	Moderate	0.1	0.1	0.1	99.7	Month
Moderate	Very Low	Moderate	Low	High	0.1	99.7	0.1	0.1	Upper Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Moderate	Very Low	Moderate	Moderate	Low	0.1	4.1	95.7	0.1	Half-Month
Moderate	Very Low	Moderate	Moderate	Moderate	0.1	0.1	99.7	0.1	Date
Moderate	Very Low	Moderate	Moderate	High	0.1	0.1	99.7	0.1	Month
Moderate	Very Low	Moderate	High	Low	0.1	11.3	88.5	0.1	Half-Month
Moderate	Very Low	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Date
Moderate	Very Low	Moderate	High	High	0.1	0.1	99.7	0.1	Month
Moderate	Very Low	Long	Low	Low	19.9	79.9	0.1	0.1	Interpolate
Moderate	Very Low	Long	Low	Moderate	0.1	99.7	0.1	0.1	Upper Half-Month
Moderate	Very Low	Long	Low	High	0.1	99.7	0.1	0.1	Upper Half-Month
Moderate	Very Low	Long	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
Moderate	Very Low	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Half-Month
Moderate	Very Low	Long	Moderate	High	0.1	0.1	99.7	0.1	Middle Month
Moderate	Very Low	Long	High	Low	0.1	99.7	0.1	0.1	Half-Month
Moderate	Very Low	Long	High	Moderate	0.1	99.7	0.1	0.1	Half-Month
Moderate	Very Low	Long	High	High	0.1	0.1	99.7	0.1	Middle Month
Moderate	Very Low	Longer	Low	Low	0.1	75.7	10.3	13.9	Interpolate
Moderate	Very Low	Longer	Low	Moderate	0.1	99.7	0.1	0.1	Upper Half-Month
Moderate	Very Low	Longer	Low	High	0.1	99.7	0.1	0.1	Upper Half-Month
Moderate	Very Low	Longer	Moderate	Low	0.1	49.9	25	25	Date
Moderate	Very Low	Longer	Moderate	Moderate	99.7	0.1	0.1	0.1	Date
Moderate	Very Low	Longer	Moderate	High	0.1	99.7	0.1	0.1	Upper Half-Month
Moderate	Very Low	Longer	High	Low	0.1	26.4	12.1	61.4	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Moderate	Very Low	Longer	High	Moderate	15	78.9	0.1	6	Date
Moderate	Very Low	Longer	High	High	18	44.4	16.7	20.9	Interpolate
Moderate	Low	Shorter	Low	Low	99.7	0.1	0.1	0.1	Middle Date
Moderate	Low	Shorter	Low	Moderate	0.1	0.1	0.1	99.7	Date
Moderate	Low	Shorter	Low	High	0.1	99.7	0.1	0.1	Month
Moderate	Low	Shorter	Moderate	Low	0.1	13.5	0.1	86.3	Date
Moderate	Low	Shorter	Moderate	Moderate	34.6	34.6	0.1	30.7	Date
Moderate	Low	Shorter	Moderate	High	0.1	99.7	0.1	0.1	Month
Moderate	Low	Shorter	High	Low	0.1	99.7	0.1	0.1	Date
Moderate	Low	Shorter	High	Moderate	0.1	85.7	0.1	14.1	Date
Moderate	Low	Shorter	High	High	54.3	45.5	0.1	0.1	Half-Month
Moderate	Low	Short	Low	Low	99.7	0.1	0.1	0.1	Middle Half-Month
Moderate	Low	Short	Low	Moderate	0.1	30.4	0.1	69.4	Month
Moderate	Low	Short	Low	High	44.3	48.2	7.4	0.1	Middle Half-Month
Moderate	Low	Short	Moderate	Low	0.1	99.7	0.1	0.1	Date
Moderate	Low	Short	Moderate	Moderate	0.1	99.7	0.1	0.1	Half-Month
Moderate	Low	Short	Moderate	High	0.1	99.7	0.1	0.1	Middle Date
Moderate	Low	Short	High	Low	0.1	99.7	0.1	0.1	Date
Moderate	Low	Short	High	Moderate	0.1	99.7	0.1	0.1	Half-Month
Moderate	Low	Short	High	High	0.1	99.7	0.1	0.1	Month
Moderate	Low	Moderate	Low	Low	72.1	27.7	0.1	0.1	Middle Half-Month
Moderate	Low	Moderate	Low	Moderate	0.1	0.1	0.1	99.7	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Moderate	Low	Moderate	Low	High	0.1	0.1	3.4	96.4	Middle Half-Month
Moderate	Low	Moderate	Moderate	Low	0.1	0.1	99.7	0.1	Date
Moderate	Low	Moderate	Moderate	Moderate	0.1	0.1	99.7	0.1	Date
Moderate	Low	Moderate	Moderate	High	0.1	0.1	99.7	0.1	Month
Moderate	Low	Moderate	High	Low	0.1	0.1	99.7	0.1	Date
Moderate	Low	Moderate	High	Moderate	0.1	0.1	15	84.8	Date
Moderate	Low	Moderate	High	High	0.1	0.1	99.7	0.1	Month
Moderate	Low	Long	Low	Low	79.5	20.3	0.1	0.1	Middle Half-Month
Moderate	Low	Long	Low	Moderate	0.1	60	0.1	39.8	Middle Date
Moderate	Low	Long	Low	High	5	8.8	25.7	60.5	Middle Date
Moderate	Low	Long	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
Moderate	Low	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Half-Month
Moderate	Low	Long	Moderate	High	28.4	7	18.5	46.1	Middle Date
Moderate	Low	Long	High	Low	0.1	99.7	0.1	0.1	Half-Month
Moderate	Low	Long	High	Moderate	0.1	99.7	0.1	0.1	Half-Month
Moderate	Low	Long	High	High	72.9	0.1	4	23	Middle Date
Moderate	Low	Longer	Low	Low	0.1	52.7	16.4	30.8	Middle Date
Moderate	Low	Longer	Low	Moderate	4.8	46.7	45.1	3.4	Middle Date
Moderate	Low	Longer	Low	High	0.1	79.4	0.1	20.4	Middle Date
Moderate	Low	Longer	Moderate	Low	0.1	24.2	46.7	29	Date
Moderate	Low	Longer	Moderate	Moderate	99.7	0.1	0.1	0.1	Date
Moderate	Low	Longer	Moderate	High	4.8	85.6	0.1	9.5	Middle Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Moderate	Low	Longer	High	Low	0.1	40.5	36	23.4	Date
Moderate	Low	Longer	High	Moderate	11.4	83.9	0.1	4.6	Date
Moderate	Low	Longer	High	High	77.4	3.1	0.1	19.4	Middle Date
Moderate	Moderate	Shorter	Low	Low	39.7	54.7	5.5	0.1	Middle Date
Moderate	Moderate	Shorter	Low	Moderate	0.1	99.7	0.1	0.1	Date
Moderate	Moderate	Shorter	Low	High	0.1	99.7	0.1	0.1	Month
Moderate	Moderate	Shorter	Moderate	Low	85.9	3.3	0.1	10.7	Date
Moderate	Moderate	Shorter	Moderate	Moderate	0.1	99.7	0.1	0.1	Date
Moderate	Moderate	Shorter	Moderate	High	0.1	99.7	0.1	0.1	Month
Moderate	Moderate	Shorter	High	Low	0.1	99.7	0.1	0.1	Date
Moderate	Moderate	Shorter	High	Moderate	0.1	99.7	0.1	0.1	Date
Moderate	Moderate	Shorter	High	High	0.1	99.7	0.1	0.1	Half-Month
Moderate	Moderate	Short	Low	Low	0.1	99.7	0.1	0.1	Middle Date
Moderate	Moderate	Short	Low	Moderate	0.1	35.4	0.1	64.4	Month
Moderate	Moderate	Short	Low	High	30.4	22.1	47.4	0.1	Middle Half-Month
Moderate	Moderate	Short	Moderate	Low	2.8	97	0.1	0.1	Month
Moderate	Moderate	Short	Moderate	Moderate	46	29.3	0.1	24.6	Month
Moderate	Moderate	Short	Moderate	High	0.1	99.7	0.1	0.1	Middle Date
Moderate	Moderate	Short	High	Low	0.1	99.7	0.1	0.1	Half-Month
Moderate	Moderate	Short	High	Moderate	5.7	80.4	0.1	13.8	Month
Moderate	Moderate	Short	High	High	0.1	99.7	0.1	0.1	Middle Date
Moderate	Moderate	Moderate	Low	Low	0.5	99.3	0.1	0.1	Middle Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Moderate	Moderate	Moderate	Low	Moderate	0.1	0.1	0.1	99.7	Month
Moderate	Moderate	Moderate	Low	High	0.1	0.1	26.3	73.5	Middle Half-Month
Moderate	Moderate	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Month
Moderate	Moderate	Moderate	Moderate	Moderate	0.1	0.9	0.1	98.9	Month
Moderate	Moderate	Moderate	Moderate	High	0.1	57.4	0.1	42.4	Middle Date
Moderate	Moderate	Moderate	High	Low	0.1	99.7	0.1	0.1	Month
Moderate	Moderate	Moderate	High	Moderate	0.1	0.1	0.1	99.7	Date
Moderate	Moderate	Moderate	High	High	0.1	11.6	0.1	88.2	Middle Date
Moderate	Moderate	Long	Low	Low	1.6	98.2	0.1	0.1	Middle Half-Month
Moderate	Moderate	Long	Low	Moderate	0.1	70.7	0.1	29.1	Middle Date
Moderate	Moderate	Long	Low	High	2.2	30.7	42.5	24.6	Middle Date
Moderate	Moderate	Long	Moderate	Low	0.1	0.1	99.7	0.1	Month
Moderate	Moderate	Long	Moderate	Moderate	0.1	56.6	0.1	43.2	Middle Date
Moderate	Moderate	Long	Moderate	High	6.2	31	38.8	24	Middle Date
Moderate	Moderate	Long	High	Low	0.1	0.1	99.7	0.1	Month
Moderate	Moderate	Long	High	Moderate	0.1	99.7	0.1	0.1	Middle Date
Moderate	Moderate	Long	High	High	53.7	0.1	20.3	25.9	Middle Date
Moderate	Moderate	Longer	Low	Low	0.1	23.4	3.7	72.8	Middle Date
Moderate	Moderate	Longer	Low	Moderate	12.8	25.1	59.7	2.4	Middle Date
Moderate	Moderate	Longer	Low	High	0.1	85.2	0.1	14.6	Middle Date
Moderate	Moderate	Longer	Moderate	Low	0.1	37.45	37.45	25	Date
Moderate	Moderate	Longer	Moderate	Moderate	15.4	23.1	16.4	45.1	Middle Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Moderate	Moderate	Longer	Moderate	High	0.1	91.1	0.1	8.7	Middle Date
Moderate	Moderate	Longer	High	Low	0.1	46.3	39	14.6	Date
Moderate	Moderate	Longer	High	Moderate	0.1	80.8	19	0.1	Middle Date
Moderate	Moderate	Longer	High	High	0.1	35.1	0.1	64.7	Middle Date
Moderate	High	Shorter	Low	Low	10.1	74.8	15	0.1	Middle Date
Moderate	High	Shorter	Low	Moderate	0.1	99.7	0.1	0.1	Date
Moderate	High	Shorter	Low	High	0.1	99.7	0.1	0.1	Month
Moderate	High	Shorter	Moderate	Low	28.6	0.1	0.1	71.2	Date
Moderate	High	Shorter	Moderate	Moderate	0.1	99.7	0.1	0.1	Date
Moderate	High	Shorter	Moderate	High	0.1	99.7	0.1	0.1	Month
Moderate	High	Shorter	High	Low	0.1	0.1	0.1	99.7	Date
Moderate	High	Shorter	High	Moderate	36.8	0.1	0.1	63	Half-Month
Moderate	High	Shorter	High	High	99.7	0.1	0.1	0.1	Half-Month
Moderate	High	Short	Low	Low	0.1	99.7	0.1	0.1	Middle Date
Moderate	High	Short	Low	Moderate	0.1	59.1	0.1	40.7	Month
Moderate	High	Short	Low	High	0.1	0.1	99.7	0.1	Middle Half-Month
Moderate	High	Short	Moderate	Low	0.1	0.1	46.7	53.1	Half-Month
Moderate	High	Short	Moderate	Moderate	0.1	56.6	0.1	43.2	Month
Moderate	High	Short	Moderate	High	0.1	99.7	0.1	0.1	Middle Date
Moderate	High	Short	High	Low	0.1	0.1	30.5	69.3	Half-Month
Moderate	High	Short	High	Moderate	0.1	77.6	0.1	22.2	Month
Moderate	High	Short	High	High	0.1	99.7	0.1	0.1	Middle Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Moderate	High	Moderate	Low	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Moderate	High	Moderate	Low	Moderate	0.1	0.1	0.1	99.7	Month
Moderate	High	Moderate	Low	High	0.1	0.1	8.2	91.6	Middle Half-Month
Moderate	High	Moderate	Moderate	Low	0.1	0.1	99.7	0.1	Half-Month
Moderate	High	Moderate	Moderate	Moderate	0.1	0.1	0.1	99.7	Month
Moderate	High	Moderate	Moderate	High	0.1	28.2	0.1	71.6	Middle Date
Moderate	High	Moderate	High	Low	0.1	0.1	99.7	0.1	Half-Month
Moderate	High	Moderate	High	Moderate	0.1	0.1	0.1	99.7	Month
Moderate	High	Moderate	High	High	0.1	4.3	0.1	95.5	Middle Date
Moderate	High	Long	Low	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Moderate	High	Long	Low	Moderate	0.1	95	0.1	4.8	Middle Date
Moderate	High	Long	Low	High	9	21.2	30.9	38.9	Middle Date
Moderate	High	Long	Moderate	Low	0.1	0.1	99.7	0.1	Month
Moderate	High	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Month
Moderate	High	Long	Moderate	High	0.1	24.8	32.5	42.6	Middle Date
Moderate	High	Long	High	Low	0.1	0.1	99.7	0.1	Month
Moderate	High	Long	High	Moderate	0.1	99.7	0.1	0.1	Month
Moderate	High	Long	High	High	26.6	0.1	15.2	58.1	Middle Date
Moderate	High	Longer	Low	Low	0.1	41.1	6.4	52.4	Middle Date
Moderate	High	Longer	Low	Moderate	9.4	63	21.9	5.7	Middle Date
Moderate	High	Longer	Low	High	0.1	0.1	0.1	99.7	Middle Date
Moderate	High	Longer	Moderate	Low	0.1	33.3	66.5	0.1	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Moderate	High	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Month
Moderate	High	Longer	Moderate	High	0.1	67.7	0.1	32.1	Middle Date
Moderate	High	Longer	High	Low	0.1	70.4	29.4	0.1	Date
Moderate	High	Longer	High	Moderate	0.1	99.7	0.1	0.1	Date
Moderate	High	Longer	High	High	0.1	99.7	0.1	0.1	Middle Date
Moderate	Very High	Shorter	Low	Low	17.6	82.2	0.1	0.1	Middle Date
Moderate	Very High	Shorter	Low	Moderate	0.1	7.1	13	79.8	Middle Date
Moderate	Very High	Shorter	Low	High	0.1	49.9	32.8	17.2	Middle Date
Moderate	Very High	Shorter	Moderate	Low	0.1	0.1	0.1	99.7	Half-Month
Moderate	Very High	Shorter	Moderate	Moderate	0.1	8.6	3.9	87.4	Middle Date
Moderate	Very High	Shorter	Moderate	High	0.1	70.3	11.5	18.1	Middle Date
Moderate	Very High	Shorter	High	Low	0.1	0.1	0.1	99.7	Month
Moderate	Very High	Shorter	High	Moderate	0.1	99.7	0.1	0.1	Month
Moderate	Very High	Shorter	High	High	0.1	99.7	0.1	0.1	Month
Moderate	Very High	Short	Low	Low	38.3	61.5	0.1	0.1	Middle Half-Month
Moderate	Very High	Short	Low	Moderate	0.1	0.1	0.1	99.7	Middle Half-Month
Moderate	Very High	Short	Low	High	0.1	0.1	56.7	43.1	Middle Month
Moderate	Very High	Short	Moderate	Low	0.1	0.1	99.7	0.1	Half-Month
Moderate	Very High	Short	Moderate	Moderate	0.1	0.1	0.1	99.7	Middle Half-Month
Moderate	Very High	Short	Moderate	High	0.1	0.1	24.1	75.7	Middle Month
Moderate	Very High	Short	High	Low	0.1	0.1	99.7	0.1	Half-Month
Moderate	Very High	Short	High	Moderate	0.1	0.1	0.1	99.7	Middle Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Moderate	Very High	Short	High	High	0.1	0.1	20	79.8	Middle Month
Moderate	Very High	Moderate	Low	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Moderate	Very High	Moderate	Low	Moderate	0.1	0.1	99.7	0.1	Middle Date
Moderate	Very High	Moderate	Low	High	0.1	0.1	99.7	0.1	Middle Month
Moderate	Very High	Moderate	Moderate	Low	0.1	0.1	99.7	0.1	Half-Month
Moderate	Very High	Moderate	Moderate	Moderate	0.1	0.1	99.7	0.1	Middle Date
Moderate	Very High	Moderate	Moderate	High	0.1	0.1	0.1	99.7	Middle Date
Moderate	Very High	Moderate	High	Low	0.1	0.1	99.7	0.1	Half-Month
Moderate	Very High	Moderate	High	Moderate	0.1	0.1	0.1	99.7	Middle Month
Moderate	Very High	Moderate	High	High	0.1	0.1	0.1	99.7	Middle Date
Moderate	Very High	Long	Low	Low	0.1	99.7	0.1	0.1	Middle Month
Moderate	Very High	Long	Low	Moderate	0.1	99.7	0.1	0.1	Middle Month
Moderate	Very High	Long	Low	High	0.1	0.1	99.7	0.1	Middle Date
Moderate	Very High	Long	Moderate	Low	0.1	0.1	99.7	0.1	Month
Moderate	Very High	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Middle Month
Moderate	Very High	Long	Moderate	High	0.1	0.1	99.7	0.1	Middle Date
Moderate	Very High	Long	High	Low	0.1	0.1	99.7	0.1	Month
Moderate	Very High	Long	High	Moderate	0.1	99.7	0.1	0.1	Middle Month
Moderate	Very High	Long	High	High	0.1	0.1	29.9	69.9	Middle Half-Month
Moderate	Very High	Longer	Low	Low	0.1	32.1	0.1	67.7	Middle Date
Moderate	Very High	Longer	Low	Moderate	0.1	99.7	0.1	0.1	Middle Month
Moderate	Very High	Longer	Low	High	0.1	99.7	0.1	0.1	Middle Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Moderate	Very High	Longer	Moderate	Low	0.1	0.1	99.7	0.1	Month
Moderate	Very High	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Middle Month
Moderate	Very High	Longer	Moderate	High	0.1	47.5	0.1	52.3	Middle Month
Moderate	Very High	Longer	High	Low	0.1	0.1	99.7	0.1	Date
Moderate	Very High	Longer	High	Moderate	0.1	99.7	0.1	0.1	Middle Month
Moderate	Very High	Longer	High	High	0.1	71.3	0.1	28.5	Middle Month
High	Very Low	Shorter	Low	Low	99.7	0.1	0.1	0.1	Date
High	Very Low	Shorter	Low	Moderate	0.1	99.7	0.1	0.1	Date
High	Very Low	Shorter	Low	High	0.1	99.7	0.1	0.1	Month
High	Very Low	Shorter	Moderate	Low	18.2	0.1	81.6	0.1	Half-Month
High	Very Low	Shorter	Moderate	Moderate	0.1	99.7	0.1	0.1	Date
High	Very Low	Shorter	Moderate	High	0.1	99.7	0.1	0.1	Month
High	Very Low	Shorter	High	Low	99.7	0.1	0.1	0.1	Date
High	Very Low	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
High	Very Low	Shorter	High	High	0.1	99.7	0.1	0.1	Date
High	Very Low	Short	Low	Low	0.1	42.8	57	0.1	Upper Month
High	Very Low	Short	Low	Moderate	0.1	99.7	0.1	0.1	Month
High	Very Low	Short	Low	High	0.1	65.4	22.1	12.4	Upper Month
High	Very Low	Short	Moderate	Low	0.1	5.3	94.5	0.1	Half-Month
High	Very Low	Short	Moderate	Moderate	0.1	99.7	0.1	0.1	Month
High	Very Low	Short	Moderate	High	0.1	70	20.4	9.5	Upper Month
High	Very Low	Short	High	Low	0.1	14.5	85.3	0.1	Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
High	Very Low	Short	High	Moderate	0.1	99.7	0.1	0.1	Month
High	Very Low	Short	High	High	0.1	0.1	99.7	0.1	Upper Month
High	Very Low	Moderate	Low	Low	0.1	46.4	33.5	20	Interpolate
High	Very Low	Moderate	Low	Moderate	0.1	0.1	0.1	99.7	Month
High	Very Low	Moderate	Low	High	0.1	99.7	0.1	0.1	Upper Half-Month
High	Very Low	Moderate	Moderate	Low	0.1	10.1	89.7	0.1	Half-Month
High	Very Low	Moderate	Moderate	Moderate	0.1	12.6	0.1	87.2	Month
High	Very Low	Moderate	Moderate	High	0.1	99.7	0.1	0.1	Upper Half-Month
High	Very Low	Moderate	High	Low	0.1	25.3	74.5	0.1	Half-Month
High	Very Low	Moderate	High	Moderate	0.1	5.9	0.1	93.9	Month
High	Very Low	Moderate	High	High	0.1	0.1	99.7	0.1	Upper Month
High	Very Low	Long	Low	Low	0.1	99.7	0.1	0.1	Upper Half-Month
High	Very Low	Long	Low	Moderate	0.1	99.7	0.1	0.1	Upper Date
High	Very Low	Long	Low	High	0.1	62.7	0.1	37.1	Upper Half-Month
High	Very Low	Long	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
High	Very Low	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Date
High	Very Low	Long	Moderate	High	0.1	0.1	0.1	99.7	Month
High	Very Low	Long	High	Low	0.1	99.7	0.1	0.1	Half-Month
High	Very Low	Long	High	Moderate	0.1	99.7	0.1	0.1	Half-Month
High	Very Low	Long	High	High	0.1	0.1	0.1	99.7	Month
High	Very Low	Longer	Low	Low	0.1	99.7	0.1	0.1	Upper Half-Month
High	Very Low	Longer	Low	Moderate	0.1	53.3	0.1	46.5	Upper Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
High	Very Low	Longer	Low	High	0.1	30.4	30.3	39.2	Upper Half-Month
High	Very Low	Longer	Moderate	Low	0.1	99.7	0.1	0.1	Date
High	Very Low	Longer	Moderate	Moderate	99.7	0.1	0.1	0.1	Date
High	Very Low	Longer	Moderate	High	0.1	0.1	0.1	99.7	Month
High	Very Low	Longer	High	Low	0.1	74.8	0.1	25	Date
High	Very Low	Longer	High	Moderate	12.7	0.1	71.9	15.3	Date
High	Very Low	Longer	High	High	0.1	0.1	0.1	99.7	Month
High	Low	Shorter	Low	Low	99.7	0.1	0.1	0.1	Date
High	Low	Shorter	Low	Moderate	0.1	0.1	0.1	99.7	Half-Month
High	Low	Shorter	Low	High	0.1	99.7	0.1	0.1	Month
High	Low	Shorter	Moderate	Low	0.1	5.4	85.9	8.6	Date
High	Low	Shorter	Moderate	Moderate	0.1	99.7	0.1	0.1	Date
High	Low	Shorter	Moderate	High	0.1	99.7	0.1	0.1	Month
High	Low	Shorter	High	Low	82.4	17.4	0.1	0.1	Date
High	Low	Shorter	High	Moderate	0.1	99.7	0.1	0.1	Date
High	Low	Shorter	High	High	0.1	99.7	0.1	0.1	Date
High	Low	Short	Low	Low	99.7	0.1	0.1	0.1	Middle Half-Month
High	Low	Short	Low	Moderate	0.1	30.4	0.1	69.4	Month
High	Low	Short	Low	High	96.6	0.1	3.2	0.1	Middle Half-Month
High	Low	Short	Moderate	Low	0.1	99.7	0.1	0.1	Date
High	Low	Short	Moderate	Moderate	0.1	88.8	0.1	11	Month
High	Low	Short	Moderate	High	96.3	0.1	3.5	0.1	Middle Half-Month
High	Low	Short	High	Low	0.1	99.7	0.1	0.1	Date
High	Low	Short	High	Moderate	0.1	96.1	0.1	3.7	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
High	Low	Short	High	High	79	0.1	20.8	0.1	Middle Half-Month
High	Low	Moderate	Low	Low	0.1	79.4	20.4	0.1	Middle Month
High	Low	Moderate	Low	Moderate	0.1	0.1	0.1	99.7	Month
High	Low	Moderate	Low	High	0.1	0.1	0.5	99.3	Middle Half-Month
High	Low	Moderate	Moderate	Low	0.1	0.1	99.7	0.1	Date
High	Low	Moderate	Moderate	Moderate	0.1	6.7	0.1	93.1	Month
High	Low	Moderate	Moderate	High	0.1	0.1	0.1	99.7	Middle Date
High	Low	Moderate	High	Low	0.1	0.1	99.7	0.1	Date
High	Low	Moderate	High	Moderate	0.1	3	0.1	96.8	Month
High	Low	Moderate	High	High	0.1	0.1	0.1	99.7	Middle Date
High	Low	Long	Low	Low	0.1	58.8	41	0.1	Middle Month
High	Low	Long	Low	Moderate	0.1	99.7	0.1	0.1	Middle Date
High	Low	Long	Low	High	9.1	0.1	21.1	69.7	Middle Date
High	Low	Long	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
High	Low	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Date
High	Low	Long	Moderate	High	0.1	0.1	0.1	99.7	Month
High	Low	Long	High	Low	0.1	99.7	0.1	0.1	Half-Month
High	Low	Long	High	Moderate	0.1	99.7	0.1	0.1	Half-Month
High	Low	Long	High	High	0.1	0.1	0.1	99.7	Month
High	Low	Longer	Low	Low	0.1	15.6	16.2	68.1	Middle Date
High	Low	Longer	Low	Moderate	11.1	35.7	31	22.2	Middle Date
High	Low	Longer	Low	High	0.1	21.8	0.1	78	Middle Date
High	Low	Longer	Moderate	Low	0.1	55	32.7	12.2	Date
High	Low	Longer	Moderate	Moderate	99.7	0.1	0.1	0.1	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
High	Low	Longer	Moderate	High	0.1	0.1	0.1	99.7	Month
High	Low	Longer	High	Low	0.1	63.1	28.6	8.2	Date
High	Low	Longer	High	Moderate	2.6	79.6	14.7	3.1	Date
High	Low	Longer	High	High	0.1	0.1	0.1	99.7	Month
High	Moderate	Shorter	Low	Low	99.7	0.1	0.1	0.1	Date
High	Moderate	Shorter	Low	Moderate	0.1	21.9	77.9	0.1	Date
High	Moderate	Shorter	Low	High	0.1	99.7	0.1	0.1	Month
High	Moderate	Shorter	Moderate	Low	22.7	32	37.7	7.6	Date
High	Moderate	Shorter	Moderate	Moderate	0.1	38	61.8	0.1	Date
High	Moderate	Shorter	Moderate	High	0.1	99.7	0.1	0.1	Month
High	Moderate	Shorter	High	Low	61.3	38.5	0.1	0.1	Date
High	Moderate	Shorter	High	Moderate	0.1	11.3	88.5	0.1	Date
High	Moderate	Shorter	High	High	0.1	99.7	0.1	0.1	Date
High	Moderate	Short	Low	Low	0.1	99.7	0.1	0.1	Middle Date
High	Moderate	Short	Low	Moderate	0.1	35.4	0.1	64.4	Month
High	Moderate	Short	Low	High	76	0.1	23.8	0.1	Middle Half-Month
High	Moderate	Short	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
High	Moderate	Short	Moderate	Moderate	0.1	68.2	0.1	31.6	Month
High	Moderate	Short	Moderate	High	75.9	0.1	23.9	0.1	Middle Half-Month
High	Moderate	Short	High	Low	99.7	0.1	0.1	0.1	Half-Month
High	Moderate	Short	High	Moderate	0.1	89.3	0.1	10.5	Month
High	Moderate	Short	High	High	48.7	0.1	51.1	0.1	Middle Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
High	Moderate	Moderate	Low	Low	0.1	99.7	0.1	0.1	Middle Half-Month
High	Moderate	Moderate	Low	Moderate	0.1	0.1	0.1	99.7	Month
High	Moderate	Moderate	Low	High	0.1	0.1	5.1	94.7	Middle Half-Month
High	Moderate	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Month
High	Moderate	Moderate	Moderate	Moderate	0.1	2.3	0.1	97.5	Month
High	Moderate	Moderate	Moderate	High	0.1	0.1	0.1	99.7	Middle Date
High	Moderate	Moderate	High	Low	99.7	0.1	0.1	0.1	Half-Month
High	Moderate	Moderate	High	Moderate	0.1	1	0.1	98.8	Month
High	Moderate	Moderate	High	High	0.1	0.1	0.1	99.7	Middle Date
High	Moderate	Long	Low	Low	0.1	99.7	0.1	0.1	Middle Half-Month
High	Moderate	Long	Low	Moderate	0.1	99.7	0.1	0.1	Middle Date
High	Moderate	Long	Low	High	4	0.1	67.2	28.7	Middle Date
High	Moderate	Long	Moderate	Low	0.1	0.1	99.7	0.1	Month
High	Moderate	Long	Moderate	Moderate	63.8	36	0.1	0.1	Middle Date
High	Moderate	Long	Moderate	High	2.2	0.1	66.8	30.9	Middle Date
High	Moderate	Long	High	Low	0.1	0.1	75.6	24.2	Month
High	Moderate	Long	High	Moderate	99.7	0.1	0.1	0.1	Middle Date
High	Moderate	Long	High	High	69.1	0.1	0.1	30.7	Middle Date
High	Moderate	Longer	Low	Low	0.1	6.5	1.7	91.7	Middle Date
High	Moderate	Longer	Low	Moderate	26.4	21.3	37.2	15.1	Middle Date
High	Moderate	Longer	Low	High	0.1	26.8	0.1	73	Middle Date
High	Moderate	Longer	Moderate	Low	0.1	62.4	25	12.5	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
High	Moderate	Longer	Moderate	Moderate	18	13.5	6.2	62.3	Middle Date
High	Moderate	Longer	Moderate	High	0.1	71.9	0.1	27.9	Middle Date
High	Moderate	Longer	High	Low	0.1	76.4	14.7	8.8	Date
High	Moderate	Longer	High	Moderate	0.1	40.5	11.3	48.1	Middle Date
High	Moderate	Longer	High	High	0.1	19.1	0.1	80.7	Middle Date
High	High	Shorter	Low	Low	99.7	0.1	0.1	0.1	Date
High	High	Shorter	Low	Moderate	0.1	21.9	77.9	0.1	Date
High	High	Shorter	Low	High	0.1	99.7	0.1	0.1	Month
High	High	Shorter	Moderate	Low	42.8	42.8	0.1	14.3	Date
High	High	Shorter	Moderate	Moderate	0.1	35.9	63.9	0.1	Date
High	High	Shorter	Moderate	High	0.1	99.7	0.1	0.1	Month
High	High	Shorter	High	Low	99.7	0.1	0.1	0.1	Date
High	High	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Date
High	High	Shorter	High	High	0.1	0.1	99.7	0.1	Middle Date
High	High	Short	Low	Low	0.1	99.7	0.1	0.1	Middle Date
High	High	Short	Low	Moderate	0.1	59.1	0.1	40.7	Month
High	High	Short	Low	High	0.1	0.1	99.7	0.1	Middle Half-Month
High	High	Short	Moderate	Low	0.1	50.2	49.6	0.1	Half-Month
High	High	Short	Moderate	Moderate	0.1	56.6	0.1	43.2	Month
High	High	Short	Moderate	High	41.4	0.1	58.4	0.1	Middle Half-Month
High	High	Short	High	Low	38.8	0.1	61	0.1	Half-Month
High	High	Short	High	Moderate	0.1	77.6	0.1	22.2	Month
High	High	Short	High	High	62.5	0.1	37.3	0.1	Middle Half-Month
High	High	Moderate	Low	Low	0.1	99.7	0.1	0.1	Middle Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
High	High	Moderate	Low	Moderate	0.1	0.1	0.1	99.7	Month
High	High	Moderate	Low	High	0.1	0.1	1.3	98.5	Middle Half-Month
High	High	Moderate	Moderate	Low	0.1	0.1	99.7	0.1	Half-Month
High	High	Moderate	Moderate	Moderate	0.1	0.1	0.1	99.7	Month
High	High	Moderate	Moderate	High	0.1	0.1	0.1	99.7	Middle Date
High	High	Moderate	High	Low	17.5	0.1	82.3	0.1	Half-Month
High	High	Moderate	High	Moderate	0.1	0.1	0.1	99.7	Month
High	High	Moderate	High	High	0.1	0.1	0.1	99.7	Middle Date
High	High	Long	Low	Low	0.1	99.7	0.1	0.1	Middle Half-Month
High	High	Long	Low	Moderate	0.1	99.7	0.1	0.1	Middle Date
High	High	Long	Low	High	18.5	0.1	31.7	49.7	Middle Date
High	High	Long	Moderate	Low	0.1	0.1	99.7	0.1	Month
High	High	Long	Moderate	Moderate	19.1	80.7	0.1	0.1	Middle Date
High	High	Long	Moderate	High	2.6	0.1	35.7	61.6	Middle Date
High	High	Long	High	Low	0.1	0.1	99.7	0.1	Month
High	High	Long	High	Moderate	99.7	0.1	0.1	0.1	Middle Date
High	High	Long	High	High	59.2	0.1	0.1	40.6	Middle Date
High	High	Longer	Low	Low	0.1	25.2	0.1	74.6	Middle Date
High	High	Longer	Low	Moderate	30.4	0.1	21.4	48.1	Middle Date
High	High	Longer	Low	High	0.1	0.1	0.1	99.7	Middle Date
High	High	Longer	Moderate	Low	0.1	33.3	66.5	0.1	Date
High	High	Longer	Moderate	Moderate	19.7	6.9	4.5	68.9	Middle Date
High	High	Longer	Moderate	High	0.1	33.4	0.1	66.4	Middle Date
High	High	Longer	High	Low	0.1	70.4	29.4	0.1	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
High	High	Longer	High	Moderate	0.1	5.7	30	64.2	Middle Date
High	High	Longer	High	High	0.1	40.9	0.1	58.9	Middle Date
High	Very High	Shorter	Low	Low	80.6	19.2	0.1	0.1	Middle Date
High	Very High	Shorter	Low	Moderate	0.1	0.1	99.7	0.1	Half-Month
High	Very High	Shorter	Low	High	0.1	0.1	99.7	0.1	Middle Date
High	Very High	Shorter	Moderate	Low	0.1	99.7	0.1	0.1	Date
High	Very High	Shorter	Moderate	Moderate	0.1	0.1	99.7	0.1	Half-Month
High	Very High	Shorter	Moderate	High	0.1	0.1	99.7	0.1	Middle Date
High	Very High	Shorter	High	Low	73.1	26.7	0.1	0.1	Middle Date
High	Very High	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Half-Month
High	Very High	Shorter	High	High	0.1	99.7	0.1	0.1	Middle Half-Month
High	Very High	Short	Low	Low	72.5	27.3	0.1	0.1	Middle Half-Month
High	Very High	Short	Low	Moderate	0.1	0.1	0.1	99.7	Middle Half-Month
High	Very High	Short	Low	High	0.1	0.1	99.7	0.1	Middle Month
High	Very High	Short	Moderate	Low	0.1	66.8	33	0.1	Half-Month
High	Very High	Short	Moderate	Moderate	0.1	0.1	0.1	99.7	Middle Half-Month
High	Very High	Short	Moderate	High	0.1	0.1	99.7	0.1	Middle Month
High	Very High	Short	High	Low	0.1	0.1	99.7	0.1	Half-Month
High	Very High	Short	High	Moderate	0.1	0.1	0.1	99.7	Middle Month
High	Very High	Short	High	High	0.1	0.1	99.7	0.1	Middle Month
High	Very High	Moderate	Low	Low	0.1	99.7	0.1	0.1	Middle Half-Month
High	Very High	Moderate	Low	Moderate	0.1	0.1	99.7	0.1	Middle Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
High	Very High	Moderate	Low	High	0.1	0.1	99.7	0.1	Middle Month
High	Very High	Moderate	Moderate	Low	0.1	0.1	99.7	0.1	Half-Month
High	Very High	Moderate	Moderate	Moderate	0.1	0.1	99.7	0.1	Middle Month
High	Very High	Moderate	Moderate	High	0.1	0.1	0.1	99.7	Middle Date
High	Very High	Moderate	High	Low	0.1	0.1	99.7	0.1	Half-Month
High	Very High	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Upper Month
High	Very High	Moderate	High	High	0.1	0.1	0.1	99.7	Middle Date
High	Very High	Long	Low	Low	0.1	99.7	0.1	0.1	Middle Month
High	Very High	Long	Low	Moderate	0.1	99.7	0.1	0.1	Middle Month
High	Very High	Long	Low	High	0.1	0.1	99.7	0.1	Middle Date
High	Very High	Long	Moderate	Low	0.1	0.1	99.7	0.1	Month
High	Very High	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Middle Month
High	Very High	Long	Moderate	High	0.1	0.1	99.7	0.1	Middle Date
High	Very High	Long	High	Low	0.1	0.1	99.7	0.1	Month
High	Very High	Long	High	Moderate	0.1	99.7	0.1	0.1	Middle Month
High	Very High	Long	High	High	0.1	0.1	67.9	31.9	Middle Half-Month
High	Very High	Longer	Low	Low	0.1	11.2	0.1	88.6	Middle Date
High	Very High	Longer	Low	Moderate	0.1	99.7	0.1	0.1	Middle Month
High	Very High	Longer	Low	High	0.1	99.7	0.1	0.1	Middle Month
High	Very High	Longer	Moderate	Low	0.1	0.1	99.7	0.1	Month
High	Very High	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Middle Month
High	Very High	Longer	Moderate	High	0.1	13.1	0.1	86.7	Middle Month

totaln	totalp	resid30	secchi	wtemp	totbiovm an: Very Low	totbiovm an: Low	totbiovm an: Bloom	totbiovm an: Large Bloom	Match Method
High	Very High	Longer	High	Low	0.1	0.1	99.7	0.1	Month
High	Very High	Longer	High	Modera te	0.1	99.7	0.1	0.1	Middle Month
High	Very High	Longer	High	High	0.1	29.5	0.1	70.3	Middle Month
Very High	Very Low	Shorter	Low	Low	99.7	0.1	0.1	0.1	Date
Very High	Very Low	Shorter	Low	Modera te	99.7	0.1	0.1	0.1	Month
Very High	Very Low	Shorter	Low	High	0.1	0.1	0.1	99.7	Upper Date
Very High	Very Low	Shorter	Modera te	Low	99.7	0.1	0.1	0.1	Half-Month
Very High	Very Low	Shorter	Modera te	Modera te	99.7	0.1	0.1	0.1	Month
Very High	Very Low	Shorter	Modera te	High	0.1	0.1	0.1	99.7	Upper Date
Very High	Very Low	Shorter	High	Low	99.7	0.1	0.1	0.1	Date
Very High	Very Low	Shorter	High	Modera te	19.3	80.5	0.1	0.1	Month
Very High	Very Low	Shorter	High	High	58.7	41.1	0.1	0.1	Month
Very High	Very Low	Short	Low	Low	0.1	7.7	92.1	0.1	Upper Month
Very High	Very Low	Short	Low	Modera te	0.1	0.1	99.7	0.1	Upper Half-Month
Very High	Very Low	Short	Low	High	0.1	92.6	3.8	3.5	Upper Month
Very High	Very Low	Short	Modera te	Low	0.1	99.7	0.1	0.1	Upper Month
Very High	Very Low	Short	Modera te	Modera te	0.1	0.1	99.7	0.1	Upper Half-Month
Very High	Very Low	Short	Modera te	High	0.1	94.2	3.1	2.6	Upper Month
Very High	Very Low	Short	High	Low	0.1	0.1	0.1	99.7	Month
Very High	Very Low	Short	High	Modera te	0.1	99.7	0.1	0.1	Month
Very High	Very Low	Short	High	High	0.1	99.7	0.1	0.1	Month
Very High	Very Low	Modera te	Low	Low	0.1	76.7	23.1	0.1	Interpolate

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very High	Very Low	Moderate	Low	Moderate	0.1	99.7	0.1	0.1	Upper Half-Month
Very High	Very Low	Moderate	Low	High	0.1	99.7	0.1	0.1	Upper Half-Month
Very High	Very Low	Moderate	Moderate	Low	0.1	61.9	18	20	Interpolate
Very High	Very Low	Moderate	Moderate	Moderate	0.1	99.7	0.1	0.1	Upper Half-Month
Very High	Very Low	Moderate	Moderate	High	0.1	99.7	0.1	0.1	Upper Half-Month
Very High	Very Low	Moderate	High	Low	0.1	0.1	0.1	99.7	Month
Very High	Very Low	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Upper Month
Very High	Very Low	Moderate	High	High	0.1	0.1	99.7	0.1	Upper Month
Very High	Very Low	Long	Low	Low	0.1	99.7	0.1	0.1	Upper Half-Month
Very High	Very Low	Long	Low	Moderate	0.1	20	0.1	79.8	Upper Date
Very High	Very Low	Long	Low	High	0.1	0.1	0.1	99.7	Upper Date
Very High	Very Low	Long	Moderate	Low	0.1	66.6	8.3	25	Interpolate
Very High	Very Low	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Upper Half-Month
Very High	Very Low	Long	Moderate	High	0.1	99.7	0.1	0.1	Upper Half-Month
Very High	Very Low	Long	High	Low	0.1	0.1	0.1	99.7	Month
Very High	Very Low	Long	High	Moderate	0.1	59.9	20	20	Interpolate
Very High	Very Low	Long	High	High	7.2	25	25	42.8	Interpolate
Very High	Very Low	Longer	Low	Low	0.1	99.7	0.1	0.1	Upper Half-Month
Very High	Very Low	Longer	Low	Moderate	0.1	35	0.1	64.8	Upper Half-Month
Very High	Very Low	Longer	Low	High	0.1	31.7	21	47.2	Upper Half-Month
Very High	Very Low	Longer	Moderate	Low	0.1	0.1	49.9	49.9	Date
Very High	Very Low	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Upper Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very High	Very Low	Longer	Moderate	High	0.1	83.9	8	8	Upper Half-Month
Very High	Very Low	Longer	High	Low	0.1	0.1	37.3	62.5	Date
Very High	Very Low	Longer	High	Moderate	3.2	25	52.3	19.5	Interpolate
Very High	Very Low	Longer	High	High	22.1	39.2	2.7	36	Interpolate
Very High	Low	Shorter	Low	Low	99.7	0.1	0.1	0.1	Date
Very High	Low	Shorter	Low	Moderate	0.1	99.7	0.1	0.1	Upper Half-Month
Very High	Low	Shorter	Low	High	0.1	44	23.8	32.1	Upper Month
Very High	Low	Shorter	Moderate	Low	99.7	0.1	0.1	0.1	Half-Month
Very High	Low	Shorter	Moderate	Moderate	0.9	8.7	2.2	88.2	Upper Month
Very High	Low	Shorter	Moderate	High	0.1	12.2	24.4	63.3	Upper Month
Very High	Low	Shorter	High	Low	99.7	0.1	0.1	0.1	Date
Very High	Low	Shorter	High	Moderate	0.1	99.7	0.1	0.1	Half-Month
Very High	Low	Shorter	High	High	59.9	39.9	0.1	0.1	Month
Very High	Low	Short	Low	Low	0.1	99.7	0.1	0.1	Middle Month
Very High	Low	Short	Low	Moderate	24.2	49.5	22.7	3.6	Upper Month
Very High	Low	Short	Low	High	0.1	0.1	99.7	0.1	Middle Month
Very High	Low	Short	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
Very High	Low	Short	Moderate	Moderate	14	25.1	46.3	14.6	Upper Month
Very High	Low	Short	Moderate	High	0.1	0.1	99.7	0.1	Middle Month
Very High	Low	Short	High	Low	0.1	99.7	0.1	0.1	Half-Month
Very High	Low	Short	High	Moderate	0.1	99.7	0.1	0.1	Half-Month
Very High	Low	Short	High	High	0.1	99.7	0.1	0.1	Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very High	Low	Moderate	Low	Low	0.1	99.7	0.1	0.1	Middle Month
Very High	Low	Moderate	Low	Moderate	0.1	0.1	99.7	0.1	Middle Date
Very High	Low	Moderate	Low	High	0.1	0.1	99.7	0.1	Middle Month
Very High	Low	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
Very High	Low	Moderate	Moderate	Moderate	13.8	0.1	86	0.1	Middle Month
Very High	Low	Moderate	Moderate	High	0.1	0.1	99.7	0.1	Middle Month
Very High	Low	Moderate	High	Low	0.1	99.7	0.1	0.1	Half-Month
Very High	Low	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Upper Month
Very High	Low	Moderate	High	High	0.1	0.1	99.7	0.1	Middle Month
Very High	Low	Long	Low	Low	14.3	73.1	5.9	6.7	Interpolate
Very High	Low	Long	Low	Moderate	99.7	0.1	0.1	0.1	Middle Half-Month
Very High	Low	Long	Low	High	26.6	0.1	39.8	33.5	Middle Date
Very High	Low	Long	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
Very High	Low	Long	Moderate	Moderate	99.7	0.1	0.1	0.1	Middle Half-Month
Very High	Low	Long	Moderate	High	0.1	0.1	56.6	43.2	Middle Date
Very High	Low	Long	High	Low	0.1	99.7	0.1	0.1	Half-Month
Very High	Low	Long	High	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very High	Low	Long	High	High	28.9	0.1	0.1	70.9	Middle Date
Very High	Low	Longer	Low	Low	0.1	52.7	0.1	47.1	Middle Date
Very High	Low	Longer	Low	Moderate	21.6	0.1	0.1	78.2	Middle Date
Very High	Low	Longer	Low	High	0.1	0.1	0.1	99.7	Middle Date
Very High	Low	Longer	Moderate	Low	0.1	0.1	79.1	20.7	Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very High	Low	Longer	Moderate	Moderate	0.1	0.1	99.7	0.1	Month
Very High	Low	Longer	Moderate	High	0.1	0.1	0.1	99.7	Middle Date
Very High	Low	Longer	High	Low	0.1	0.1	70.9	28.9	Date
Very High	Low	Longer	High	Moderate	0.1	0.1	99.7	0.1	Month
Very High	Low	Longer	High	High	66	33.8	0.1	0.1	Middle Month
Very High	Moderate	Shorter	Low	Low	99.7	0.1	0.1	0.1	Date
Very High	Moderate	Shorter	Low	Moderate	99.7	0.1	0.1	0.1	Month
Very High	Moderate	Shorter	Low	High	0.1	67.6	13.7	18.6	Upper Half-Month
Very High	Moderate	Shorter	Moderate	Low	0.1	99.7	0.1	0.1	Date
Very High	Moderate	Shorter	Moderate	Moderate	99.7	0.1	0.1	0.1	Month
Very High	Moderate	Shorter	Moderate	High	0.1	68.2	17.9	13.8	Upper Half-Month
Very High	Moderate	Shorter	High	Low	99.7	0.1	0.1	0.1	Date
Very High	Moderate	Shorter	High	Moderate	99.7	0.1	0.1	0.1	Month
Very High	Moderate	Shorter	High	High	99.7	0.1	0.1	0.1	Month
Very High	Moderate	Short	Low	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very High	Moderate	Short	Low	Moderate	0.1	0.1	99.7	0.1	Middle Month
Very High	Moderate	Short	Low	High	0.1	0.1	99.7	0.1	Middle Month
Very High	Moderate	Short	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
Very High	Moderate	Short	Moderate	Moderate	0.1	0.1	99.7	0.1	Middle Month
Very High	Moderate	Short	Moderate	High	0.1	0.1	99.7	0.1	Middle Month
Very High	Moderate	Short	High	Low	99.7	0.1	0.1	0.1	Half-Month
Very High	Moderate	Short	High	Moderate	0.1	0.1	99.7	0.1	Middle Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very High	Moderate	Short	High	High	0.1	0.1	99.7	0.1	Middle Month
Very High	Moderate	Moderate	Low	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very High	Moderate	Moderate	Low	Moderate	0.4	0.1	99.4	0.1	Middle Month
Very High	Moderate	Moderate	Low	High	0.1	0.1	99.7	0.1	Middle Month
Very High	Moderate	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very High	Moderate	Moderate	Moderate	Moderate	12.6	0.1	87.2	0.1	Middle Month
Very High	Moderate	Moderate	Moderate	High	0.1	0.1	99.7	0.1	Middle Month
Very High	Moderate	Moderate	High	Low	99.7	0.1	0.1	0.1	Half-Month
Very High	Moderate	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Upper Month
Very High	Moderate	Moderate	High	High	0.1	0.1	99.7	0.1	Middle Month
Very High	Moderate	Long	Low	Low	0.1	99.7	0.1	0.1	Upper Half-Month
Very High	Moderate	Long	Low	Moderate	99.7	0.1	0.1	0.1	Middle Half-Month
Very High	Moderate	Long	Low	High	10.2	0.1	81.1	8.6	Middle Date
Very High	Moderate	Long	Moderate	Low	0.1	99.7	0.1	0.1	Upper Month
Very High	Moderate	Long	Moderate	Moderate	99.7	0.1	0.1	0.1	Middle Half-Month
Very High	Moderate	Long	Moderate	High	0.1	0.1	91.6	8.2	Middle Date
Very High	Moderate	Long	High	Low	0.1	0.1	0.1	99.7	Month
Very High	Moderate	Long	High	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very High	Moderate	Long	High	High	37.8	0.1	0.1	62	Middle Date
Very High	Moderate	Longer	Low	Low	0.1	18.3	0.1	81.5	Middle Date
Very High	Moderate	Longer	Low	Moderate	46.6	0.1	0.1	53.2	Middle Date
Very High	Moderate	Longer	Low	High	0.1	0.1	0.1	99.7	Middle Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very High	Moderate	Longer	Moderate	Low	0.1	0.1	99.7	0.1	Date
Very High	Moderate	Longer	Moderate	Moderate	89.4	0.1	0.1	10.4	Middle Date
Very High	Moderate	Longer	Moderate	High	0.1	0.1	0.1	99.7	Middle Date
Very High	Moderate	Longer	High	Low	0.1	0.1	99.7	0.1	Date
Very High	Moderate	Longer	High	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very High	Moderate	Longer	High	High	68.6	31.2	0.1	0.1	Middle Month
Very High	High	Shorter	Low	Low	99.7	0.1	0.1	0.1	Date
Very High	High	Shorter	Low	Moderate	99.7	0.1	0.1	0.1	Month
Very High	High	Shorter	Low	High	0.1	35.6	0.1	64.2	Upper Date
Very High	High	Shorter	Moderate	Low	85.5	14.3	0.1	0.1	Date
Very High	High	Shorter	Moderate	Moderate	99.7	0.1	0.1	0.1	Month
Very High	High	Shorter	Moderate	High	0.1	59.4	16.4	24.1	Upper Half-Month
Very High	High	Shorter	High	Low	99.7	0.1	0.1	0.1	Date
Very High	High	Shorter	High	Moderate	99.7	0.1	0.1	0.1	Month
Very High	High	Shorter	High	High	99.7	0.1	0.1	0.1	Month
Very High	High	Short	Low	Low	69	30.8	0.1	0.1	Middle Half-Month
Very High	High	Short	Low	Moderate	0.1	0.1	99.7	0.1	Middle Month
Very High	High	Short	Low	High	0.1	0.1	99.7	0.1	Middle Month
Very High	High	Short	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
Very High	High	Short	Moderate	Moderate	0.1	0.1	99.7	0.1	Middle Month
Very High	High	Short	Moderate	High	0.1	0.1	99.7	0.1	Middle Month
Very High	High	Short	High	Low	99.7	0.1	0.1	0.1	Half-Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very High	High	Short	High	Moderate	0.1	0.1	99.7	0.1	Middle Month
Very High	High	Short	High	High	0.1	0.1	99.7	0.1	Middle Month
Very High	High	Moderate	Low	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very High	High	Moderate	Low	Moderate	0.1	0.1	99.7	0.1	Middle Date
Very High	High	Moderate	Low	High	0.1	0.1	99.7	0.1	Middle Month
Very High	High	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very High	High	Moderate	Moderate	Moderate	0.1	0.1	99.7	0.1	Middle Date
Very High	High	Moderate	Moderate	High	0.1	0.1	99.7	0.1	Middle Month
Very High	High	Moderate	High	Low	99.7	0.1	0.1	0.1	Half-Month
Very High	High	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Upper Month
Very High	High	Moderate	High	High	0.1	0.1	99.7	0.1	Middle Month
Very High	High	Long	Low	Low	1.2	98.6	0.1	0.1	Upper Half-Month
Very High	High	Long	Low	Moderate	99.7	0.1	0.1	0.1	Middle Half-Month
Very High	High	Long	Low	High	33.2	0.1	48.2	18.5	Middle Date
Very High	High	Long	Moderate	Low	0.5	99.3	0.1	0.1	Upper Month
Very High	High	Long	Moderate	Moderate	99.7	0.1	0.1	0.1	Middle Half-Month
Very High	High	Long	Moderate	High	0.1	0.1	73.1	26.7	Middle Date
Very High	High	Long	High	Low	16.8	33.2	16.7	33.3	Interpolate
Very High	High	Long	High	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very High	High	Long	High	High	47.7	0.1	0.1	52.1	Middle Date
Very High	High	Longer	Low	Low	0.1	69	0.1	30.8	Middle Date
Very High	High	Longer	Low	Moderate	31.2	0.1	0.1	68.6	Middle Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very High	High	Longer	Low	High	0.1	0.1	0.1	99.7	Middle Date
Very High	High	Longer	Moderate	Low	0.1	80.6	0.1	19.2	Middle Date
Very High	High	Longer	Moderate	Moderate	78.6	0.1	0.1	21.2	Middle Date
Very High	High	Longer	Moderate	High	0.1	0.1	0.1	99.7	Middle Date
Very High	High	Longer	High	Low	0.1	0.1	0.1	99.7	Middle Date
Very High	High	Longer	High	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very High	High	Longer	High	High	49.4	50.4	0.1	0.1	Middle Month
Very High	Very High	Shorter	Low	Low	61.4	38.4	0.1	0.1	Middle Date
Very High	Very High	Shorter	Low	Moderate	0.1	0.1	99.7	0.1	Middle Date
Very High	Very High	Shorter	Low	High	0.1	71.2	11.2	17.5	Upper Date
Very High	Very High	Shorter	Moderate	Low	0.1	99.7	0.1	0.1	Date
Very High	Very High	Shorter	Moderate	Moderate	0.1	0.1	92	7.8	Middle Date
Very High	Very High	Shorter	Moderate	High	0.1	0.1	0.1	99.7	Upper Date
Very High	Very High	Shorter	High	Low	0.1	99.7	0.1	0.1	Middle Date
Very High	Very High	Shorter	High	Moderate	0.1	0.1	99.7	0.1	Middle Month
Very High	Very High	Shorter	High	High	0.1	0.1	99.7	0.1	Upper Month
Very High	Very High	Short	Low	Low	36	63.8	0.1	0.1	Middle Half-Month
Very High	Very High	Short	Low	Moderate	0.1	0.1	99.7	0.1	Middle Month
Very High	Very High	Short	Low	High	0.1	0.1	99.7	0.1	Middle Month
Very High	Very High	Short	Moderate	Low	0.1	99.7	0.1	0.1	Half-Month
Very High	Very High	Short	Moderate	Moderate	0.1	0.1	99.7	0.1	Middle Month
Very High	Very High	Short	Moderate	High	0.1	0.1	99.7	0.1	Middle Month

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very High	Very High	Short	High	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very High	Very High	Short	High	Moderate	0.1	0.1	99.7	0.1	Middle Month
Very High	Very High	Short	High	High	0.1	0.1	99.7	0.1	Middle Month
Very High	Very High	Moderate	Low	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very High	Very High	Moderate	Low	Moderate	0.1	0.1	99.7	0.1	Middle Date
Very High	Very High	Moderate	Low	High	0.1	0.1	99.7	0.1	Middle Month
Very High	Very High	Moderate	Moderate	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very High	Very High	Moderate	Moderate	Moderate	0.1	0.1	99.7	0.1	Middle Date
Very High	Very High	Moderate	Moderate	High	0.1	0.1	99.7	0.1	Middle Month
Very High	Very High	Moderate	High	Low	0.1	99.7	0.1	0.1	Middle Half-Month
Very High	Very High	Moderate	High	Moderate	0.1	0.1	99.7	0.1	Upper Month
Very High	Very High	Moderate	High	High	0.1	0.1	99.7	0.1	Middle Month
Very High	Very High	Long	Low	Low	0.1	99.7	0.1	0.1	Upper Date
Very High	Very High	Long	Low	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very High	Very High	Long	Low	High	0.1	0.1	99.7	0.1	Middle Date
Very High	Very High	Long	Moderate	Low	0.3	99.5	0.1	0.1	Upper Month
Very High	Very High	Long	Moderate	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very High	Very High	Long	Moderate	High	0.1	0.1	99.7	0.1	Middle Date
Very High	Very High	Long	High	Low	0.1	59.9	20	20	Interpolate
Very High	Very High	Long	High	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very High	Very High	Long	High	High	0.1	0.1	99.7	0.1	Middle Half-Month
Very High	Very High	Longer	Low	Low	0.1	0.1	0.1	99.7	Middle Date

totaln	totalp	resid30	secchi	wtemp	totbiovman: Very Low	totbiovman: Low	totbiovman: Bloom	totbiovman: Large Bloom	Match Method
Very High	Very High	Longer	Low	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very High	Very High	Longer	Low	High	0.1	99.7	0.1	0.1	Middle Month
Very High	Very High	Longer	Moderate	Low	0.1	0.1	0.1	99.7	Middle Date
Very High	Very High	Longer	Moderate	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very High	Very High	Longer	Moderate	High	0.1	99.7	0.1	0.1	Middle Month
Very High	Very High	Longer	High	Low	0.1	0.1	0.1	99.7	Middle Date
Very High	Very High	Longer	High	Moderate	0.1	99.7	0.1	0.1	Middle Month
Very High	Very High	Longer	High	High	0.1	99.7	0.1	0.1	Middle Month

6.21 Water Temperature (wtemp, C) – Three Lake Segments

Conditioned on:

- Season (season, 6mo)

Upper:

season	wtemp: Low	wtemp: Moderate	wtemp: High	Match Method
Cool	77.9	22.1	0	Date
Warm	2.4	47.7	49.9	Date

Middle:

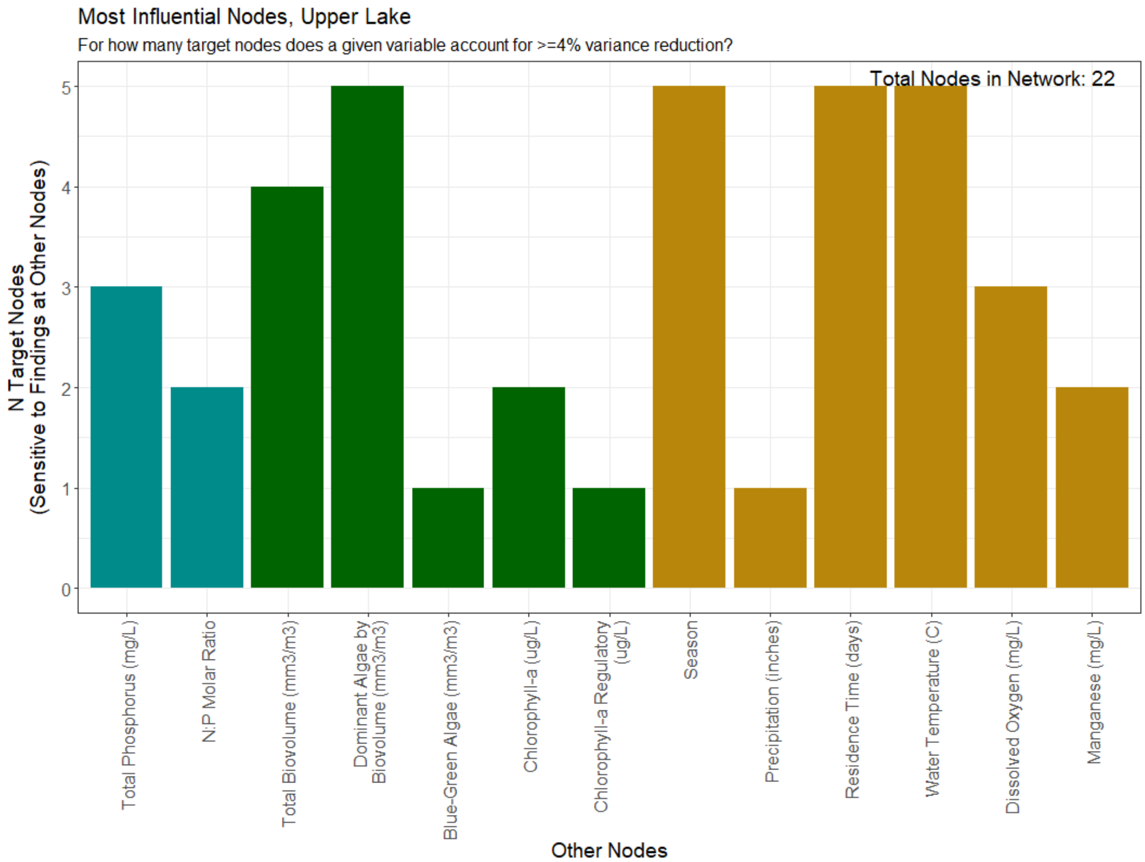
season	wtemp: Low	wtemp: Moderate	wtemp: High	Match Method
Cool	82.2	17.8	0	Date
Warm	0.8	42	57.2	Date

Lower:

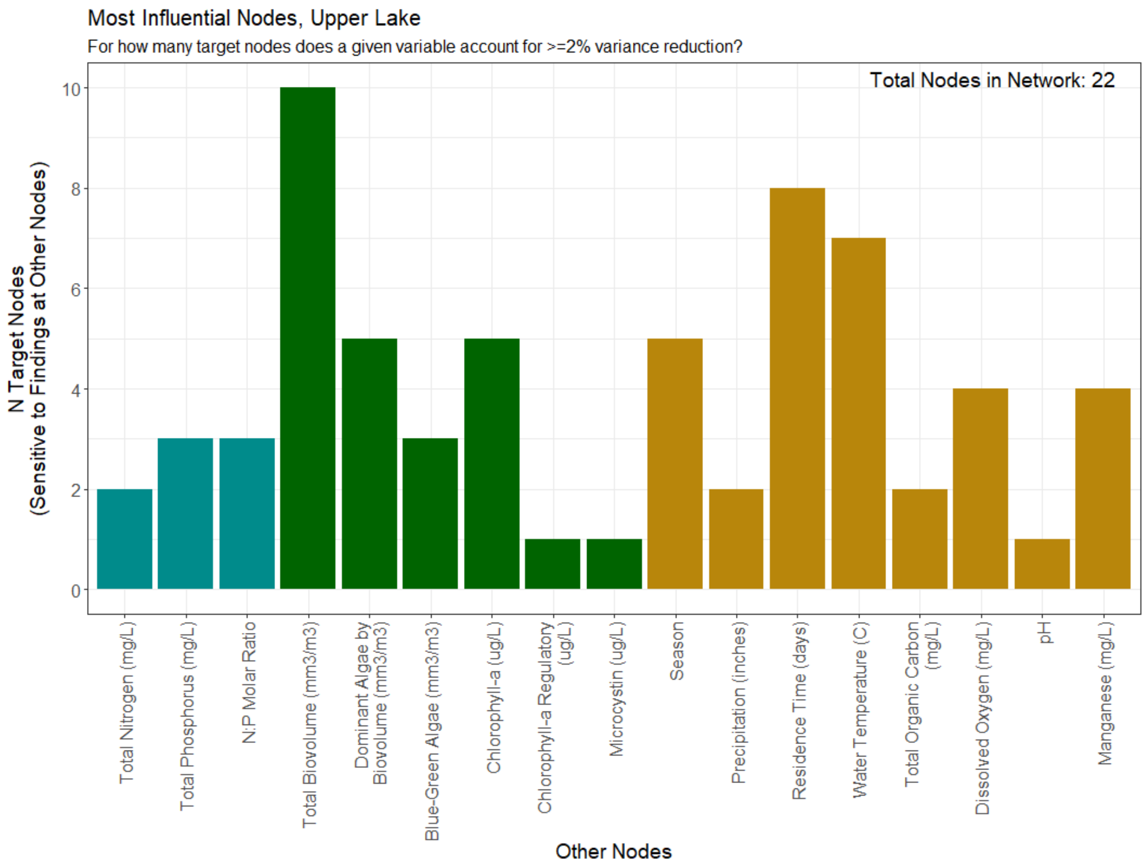
season	wtemp: Low	wtemp: Moderate	wtemp: High	Match Method
Cool	75.9	24.1	0	Date
Warm	0	40.2	59.8	Date

Section 7: Model Sensitivity Analyses

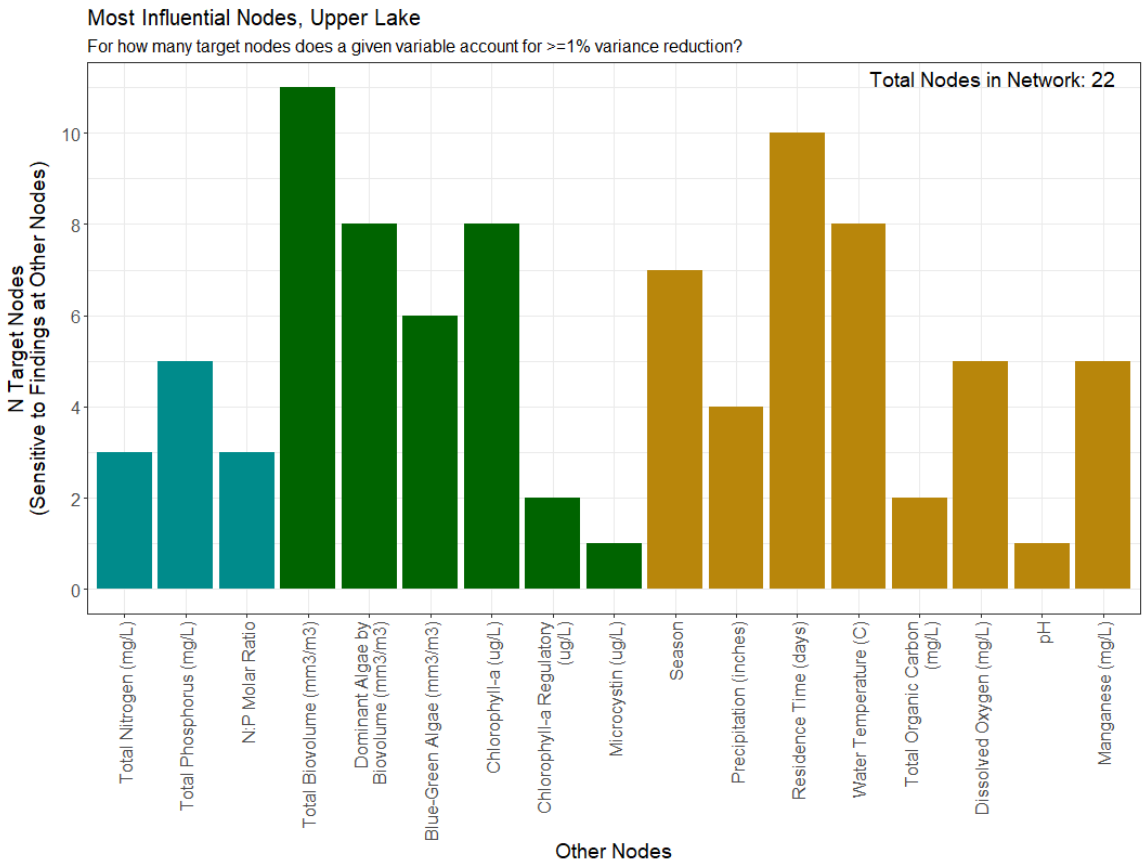
7.1 Upper Lake



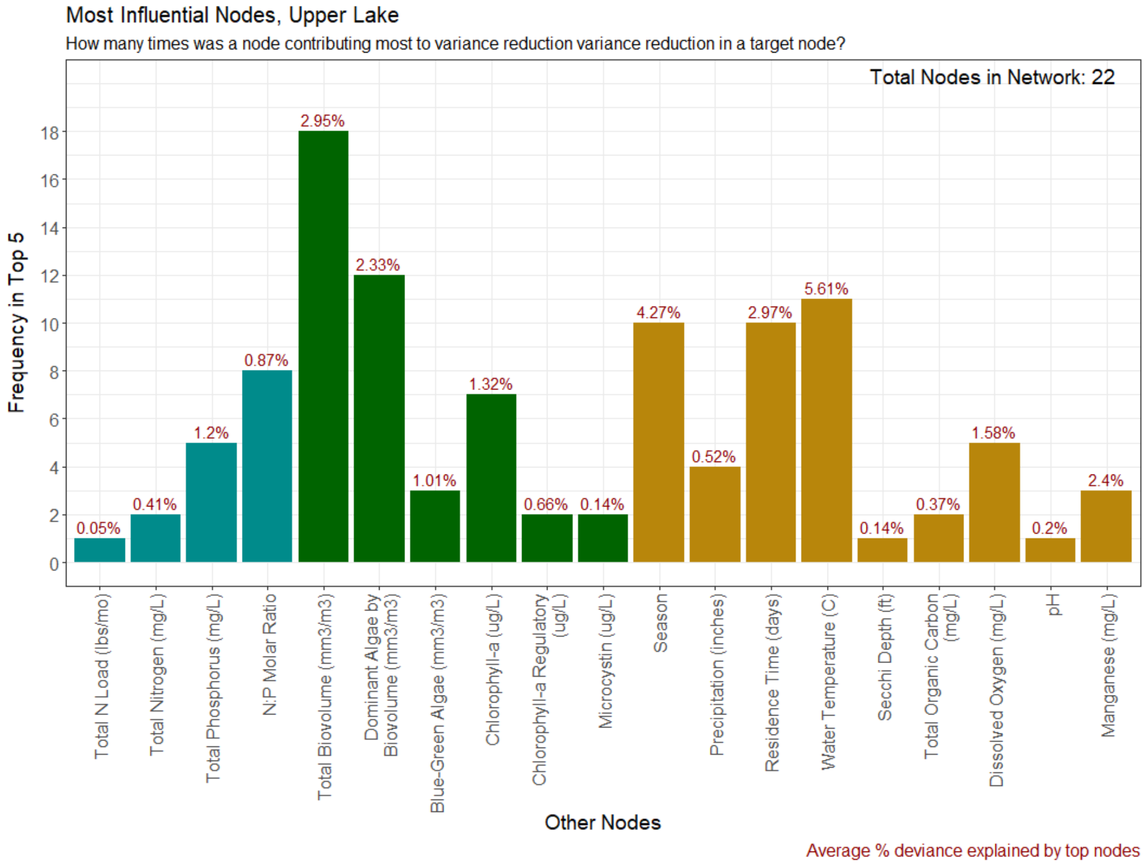
Most Influential Nodes in Upper Lake with More than Four Percent Variance Reduction



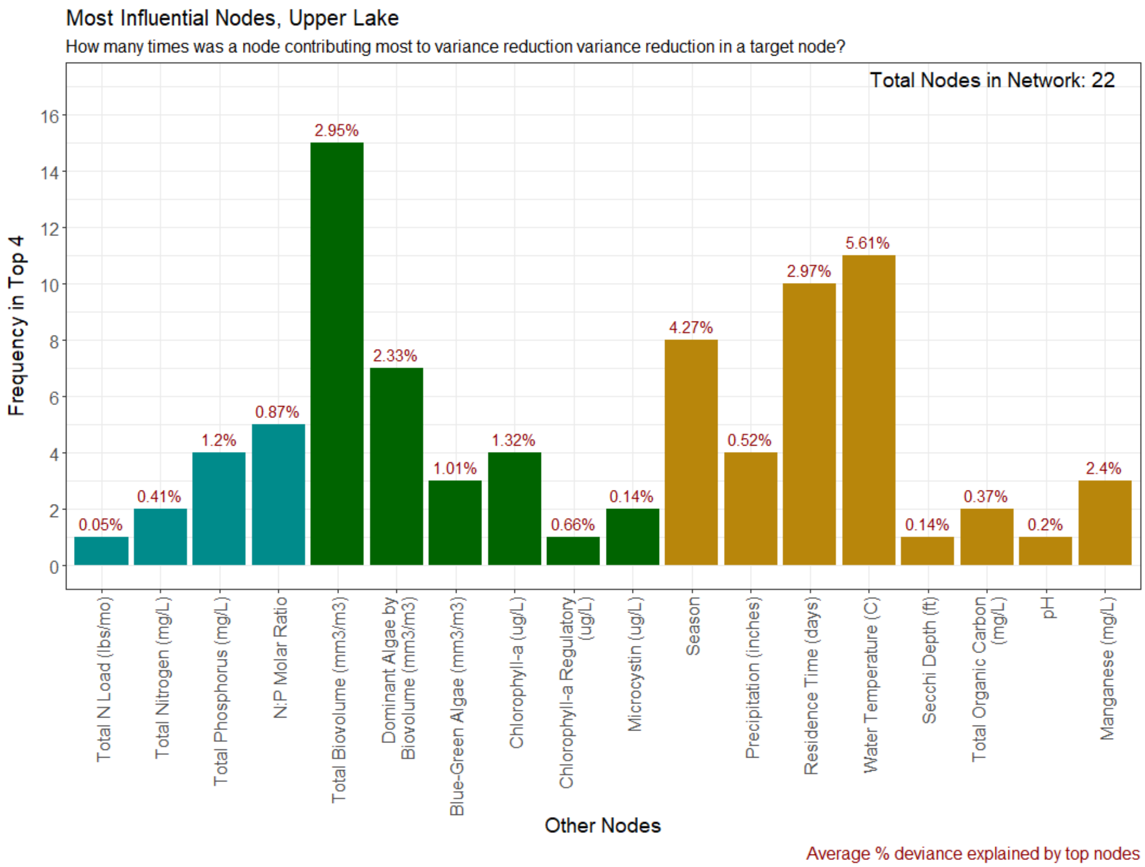
Most Influential Nodes in Upper Lake with More than Two Percent Variance Reduction



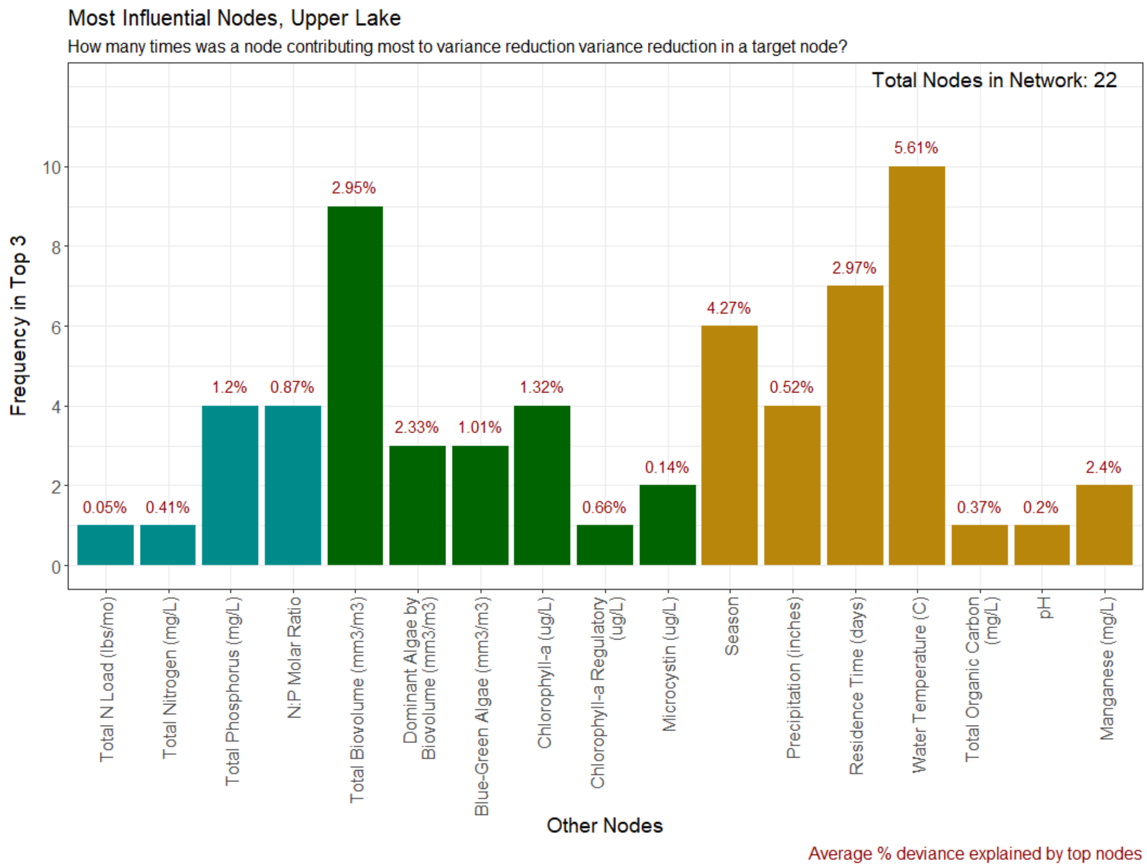
Most Influential Nodes in Upper Lake with More than One Percent Variance Reduction



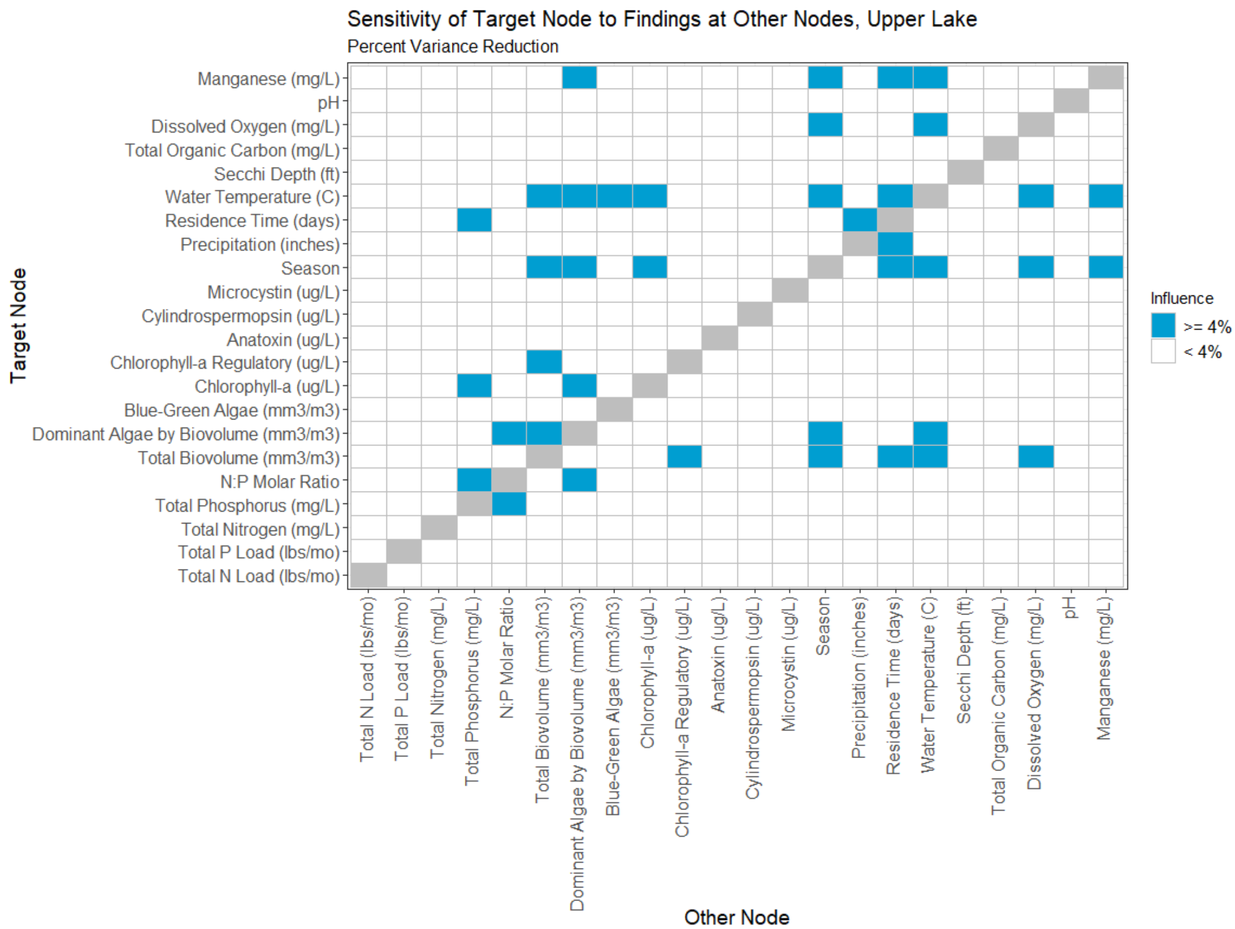
Frequency of Being One of the Top Five Most Influential Nodes in Upper Lake



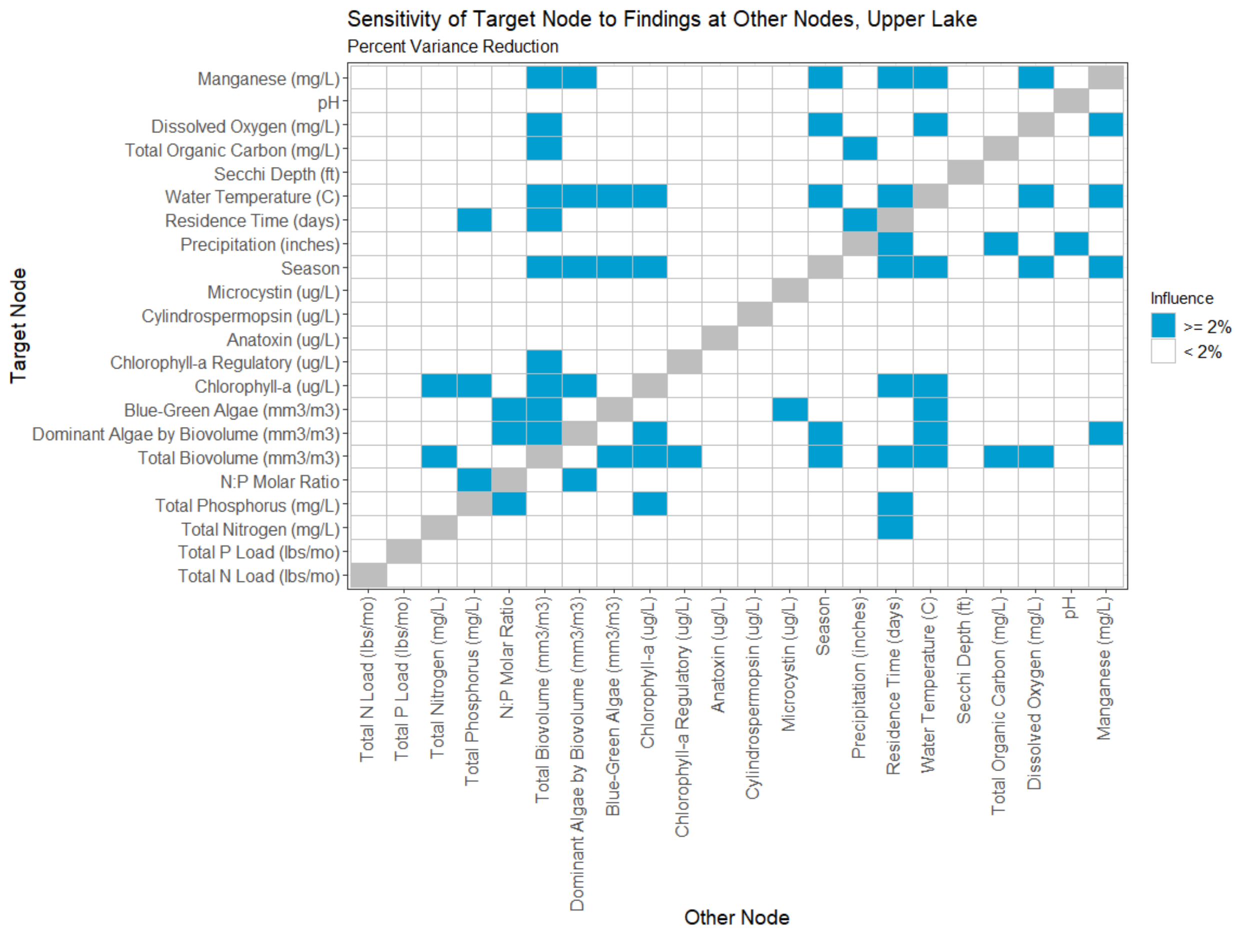
Frequency of Being One of the Top Four Most Influential Nodes in Upper Lake



Frequency of Being One of the Top Three Most Influential Nodes in Upper Lake

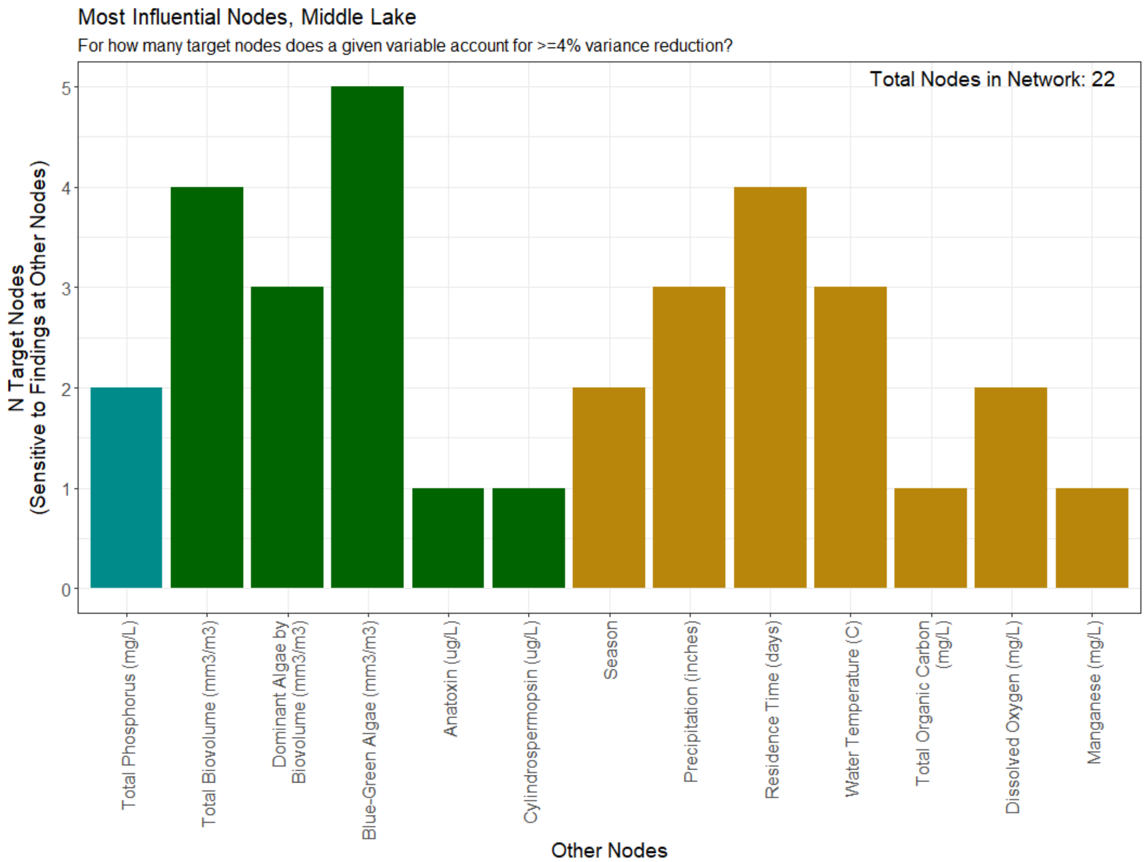


Other Nodes that Influence the Target Node by At Least Four Percent in the Upper Lake

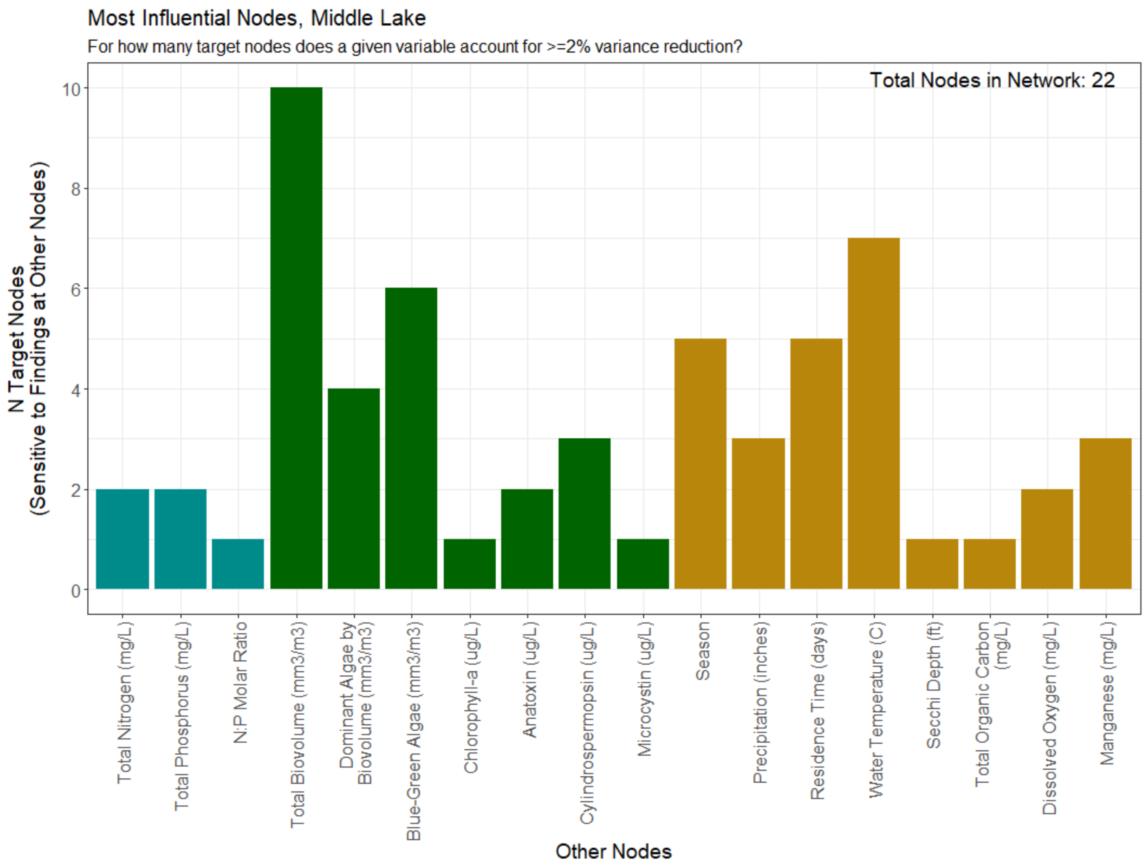


Other Nodes that Influence the Target Node by At Least Two Percent in the Upper Lake

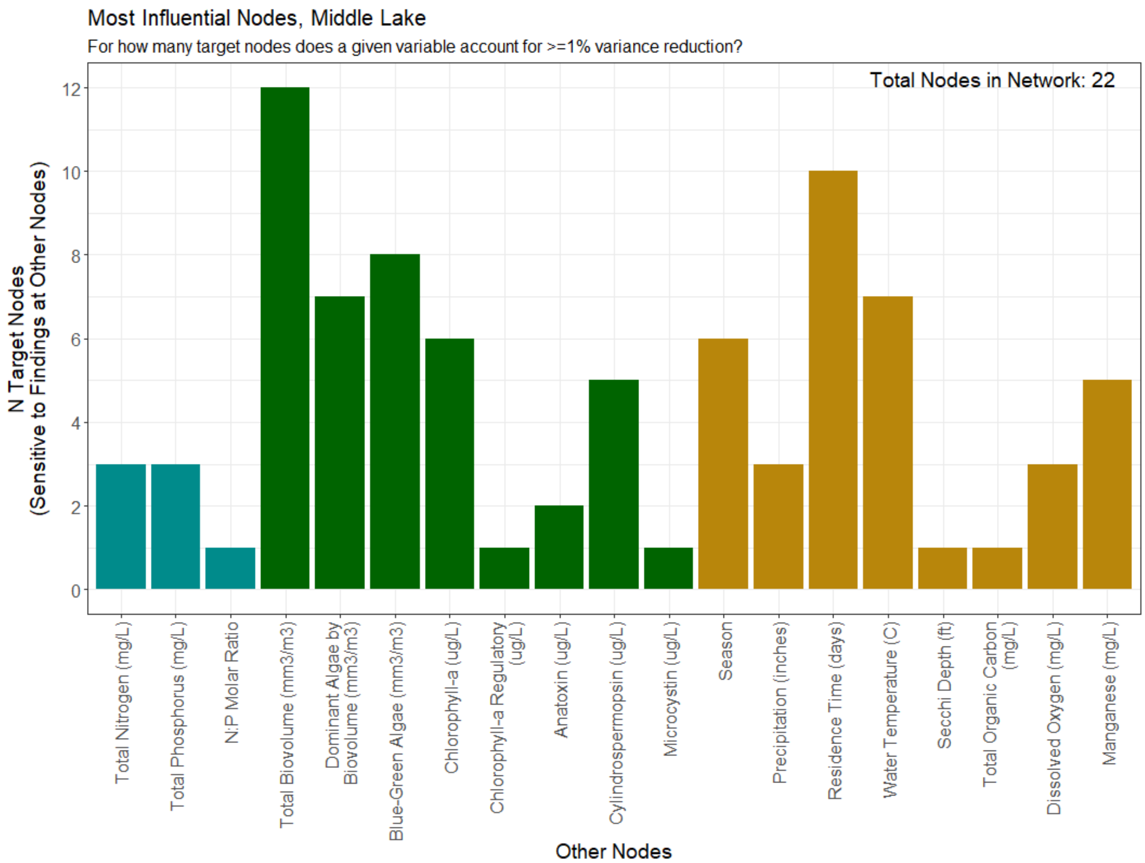
7.2 Middle Lake



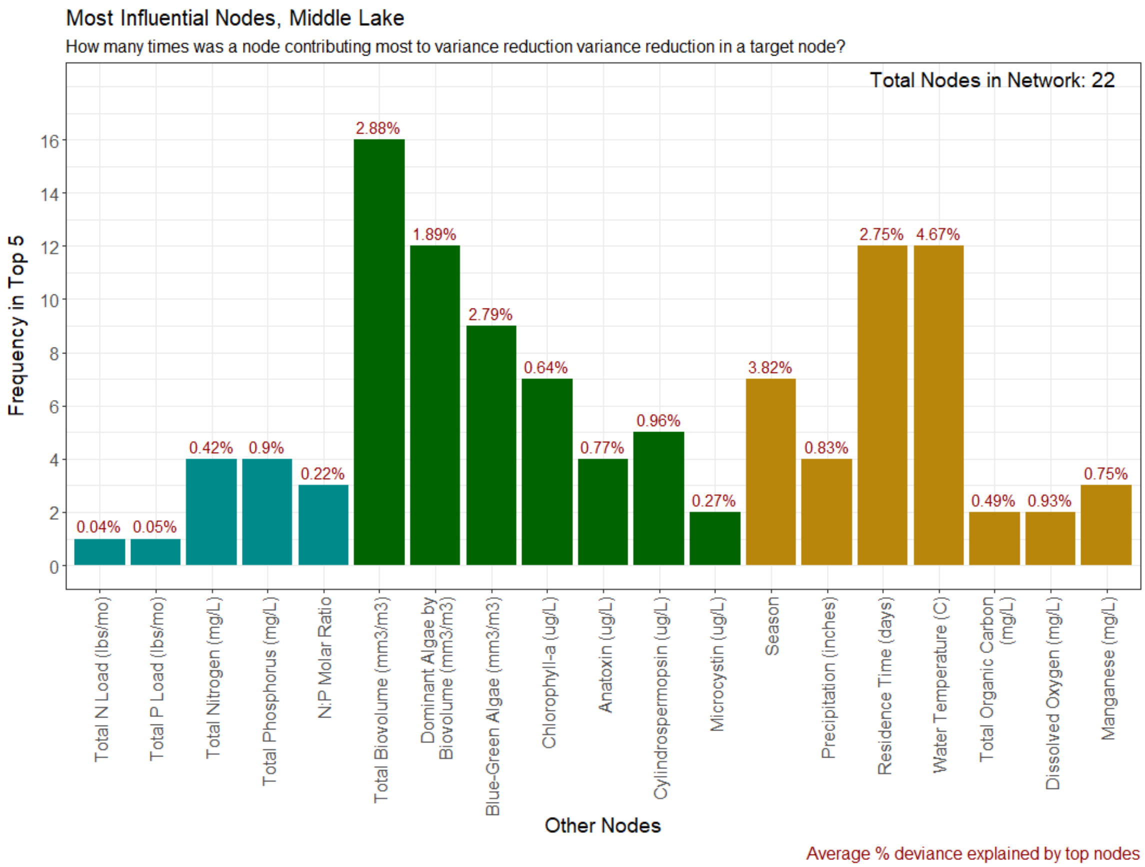
Most Influential Nodes in Middle Lake with More than Four Percent Variance Reduction



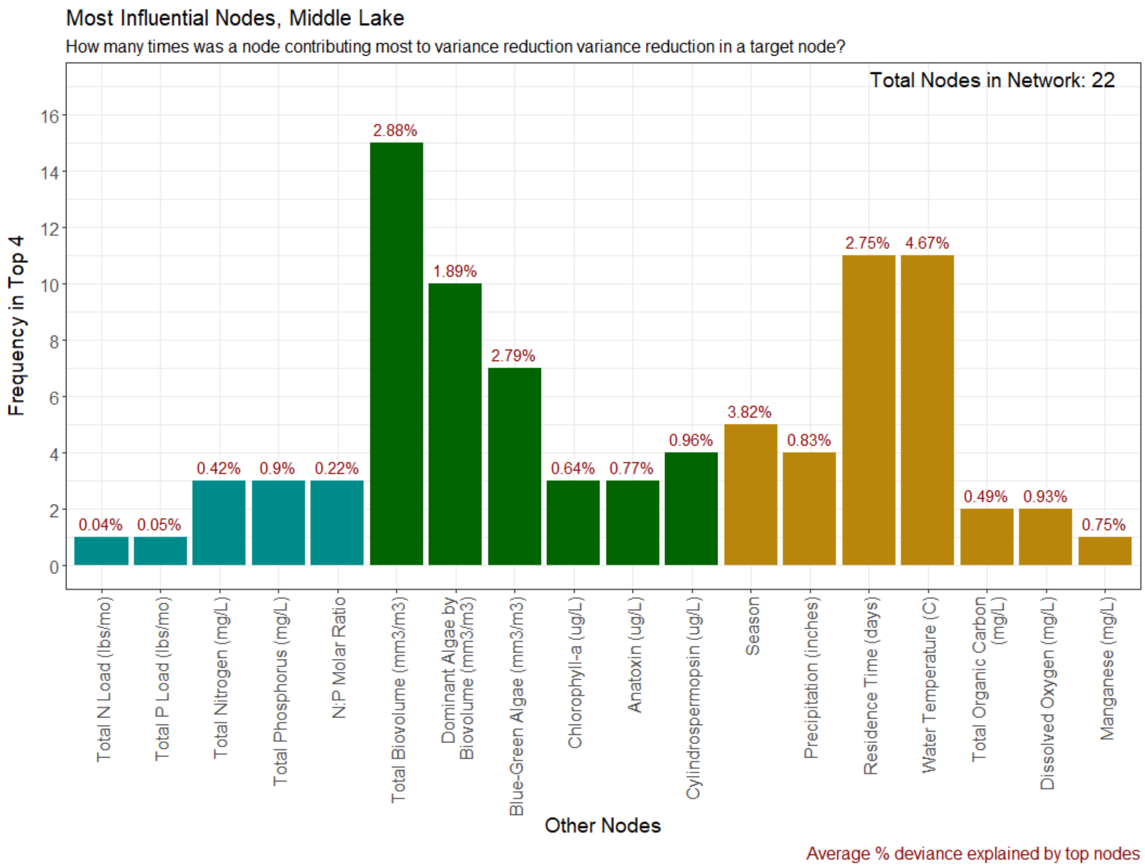
Most Influential Nodes in Middle Lake with More than Two Percent Variance Reduction



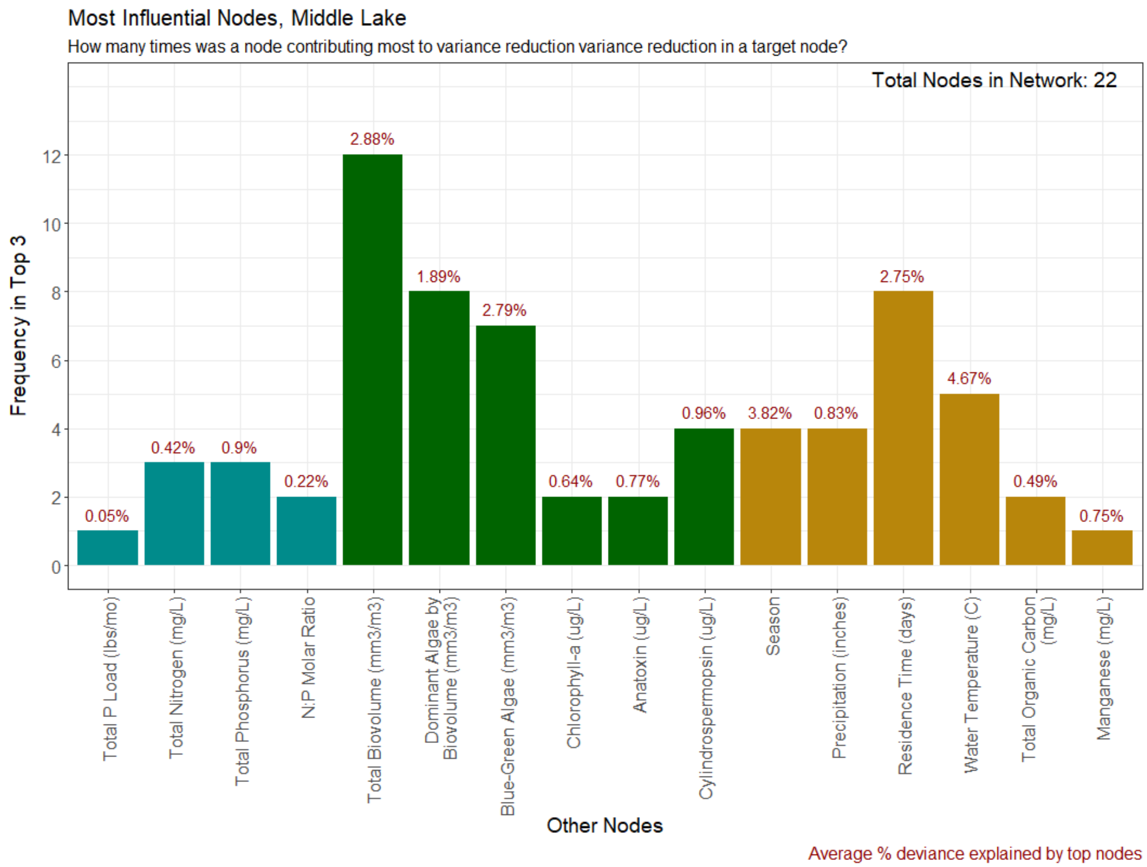
Most Influential Nodes in Middle Lake with More than One Percent Variance Reduction



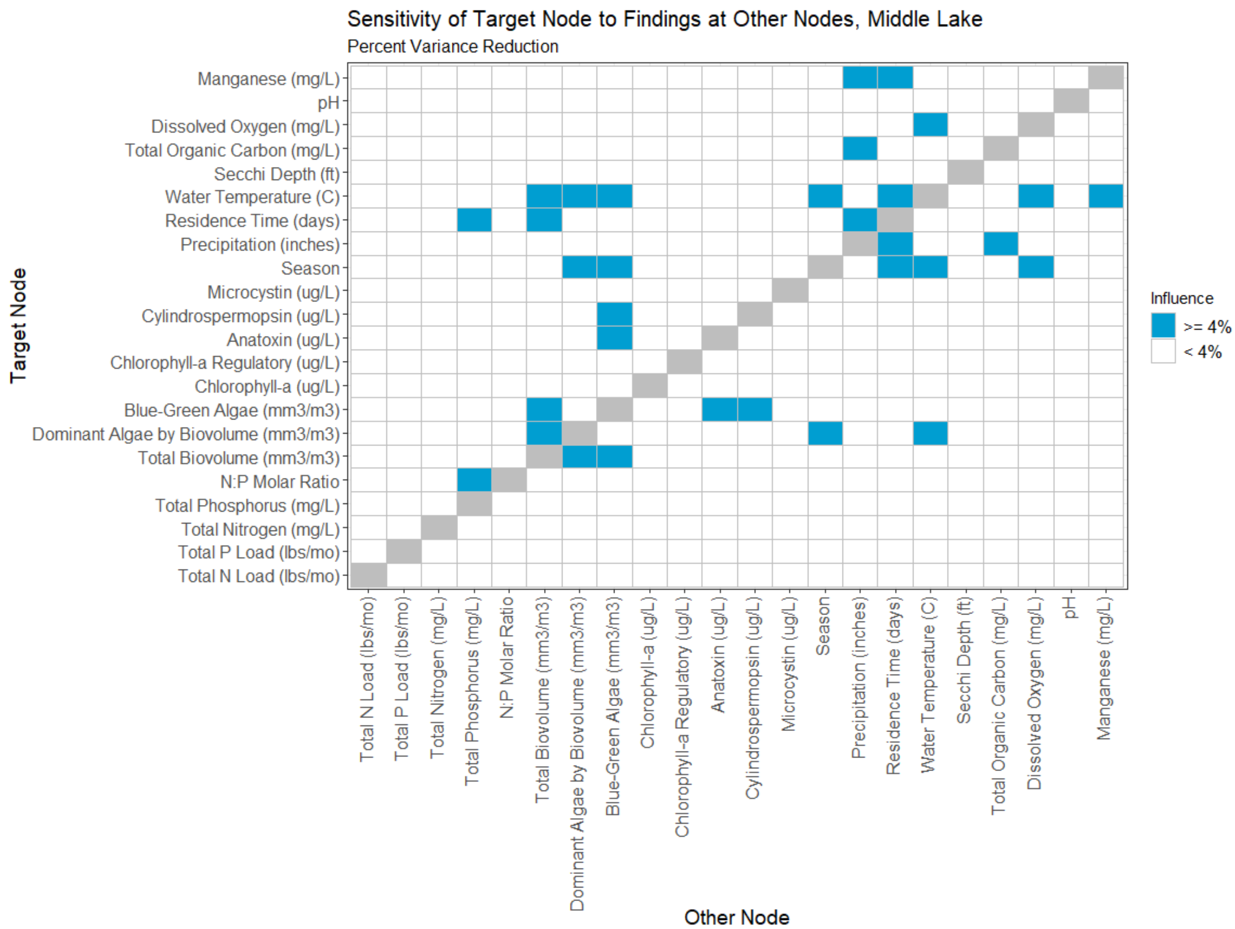
Frequency of Being One of the Top Five Most Influential Nodes in Middle Lake



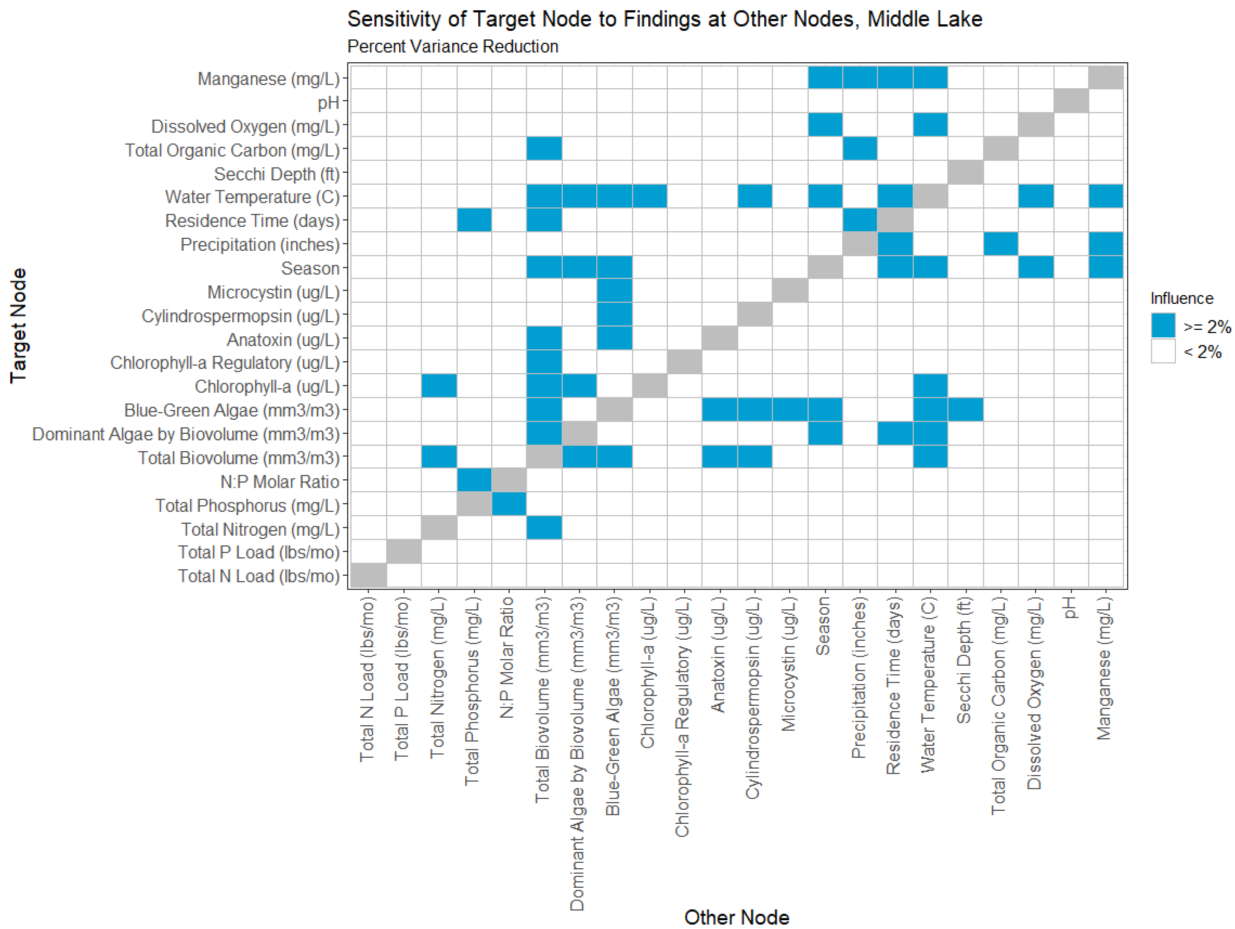
Frequency of Being One of the Top Four Most Influential Nodes in Middle Lake



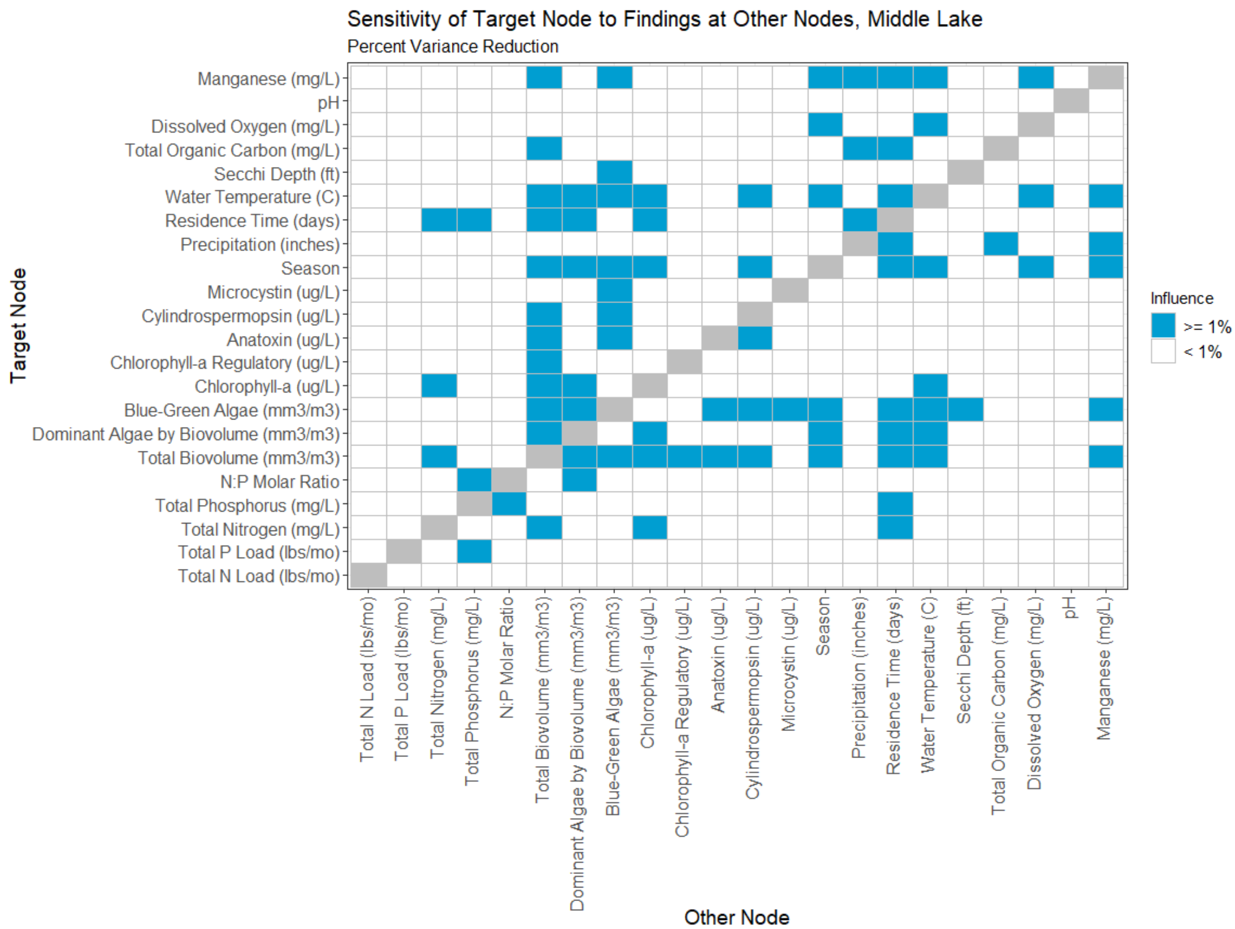
Frequency of Being One of the Top Three Most Influential Nodes in Middle Lake



Other Nodes that Influence the Target Node by At Least Four Percent in the Middle Lake

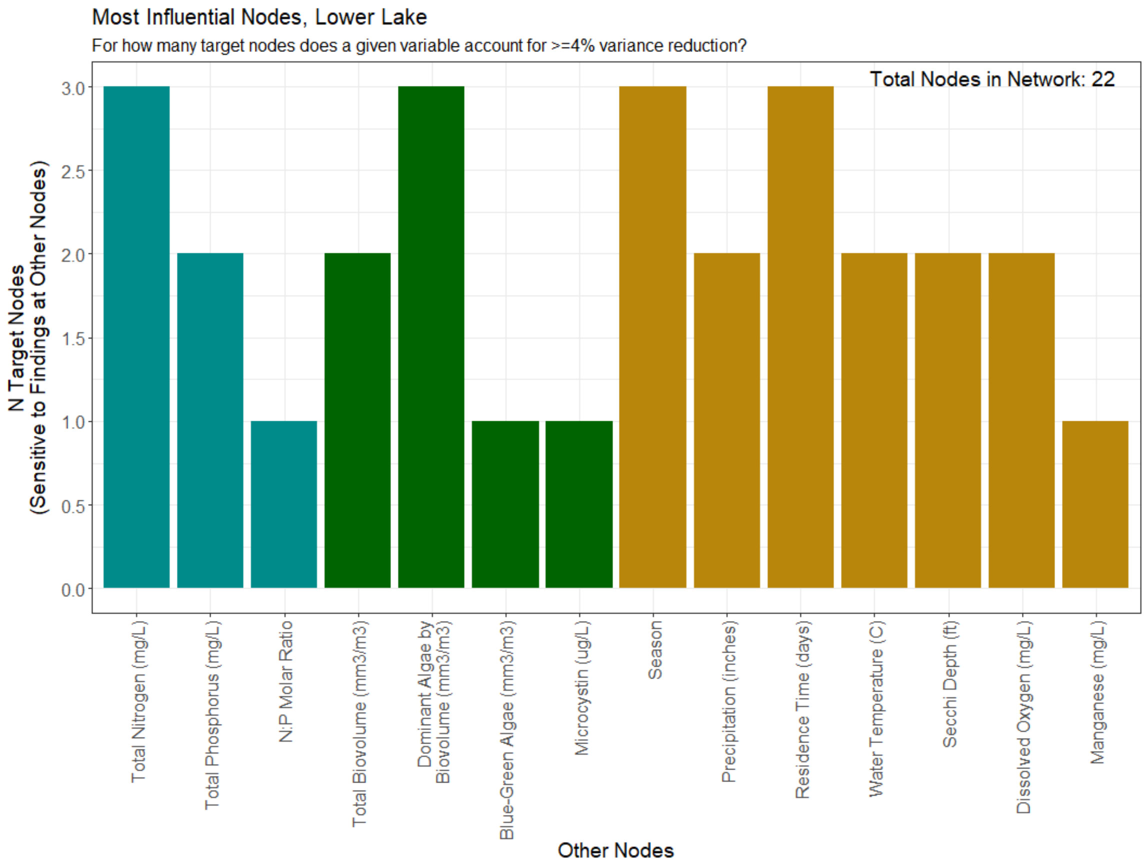


Other Nodes that Influence the Target Node by At Least Two Percent in the Middle Lake

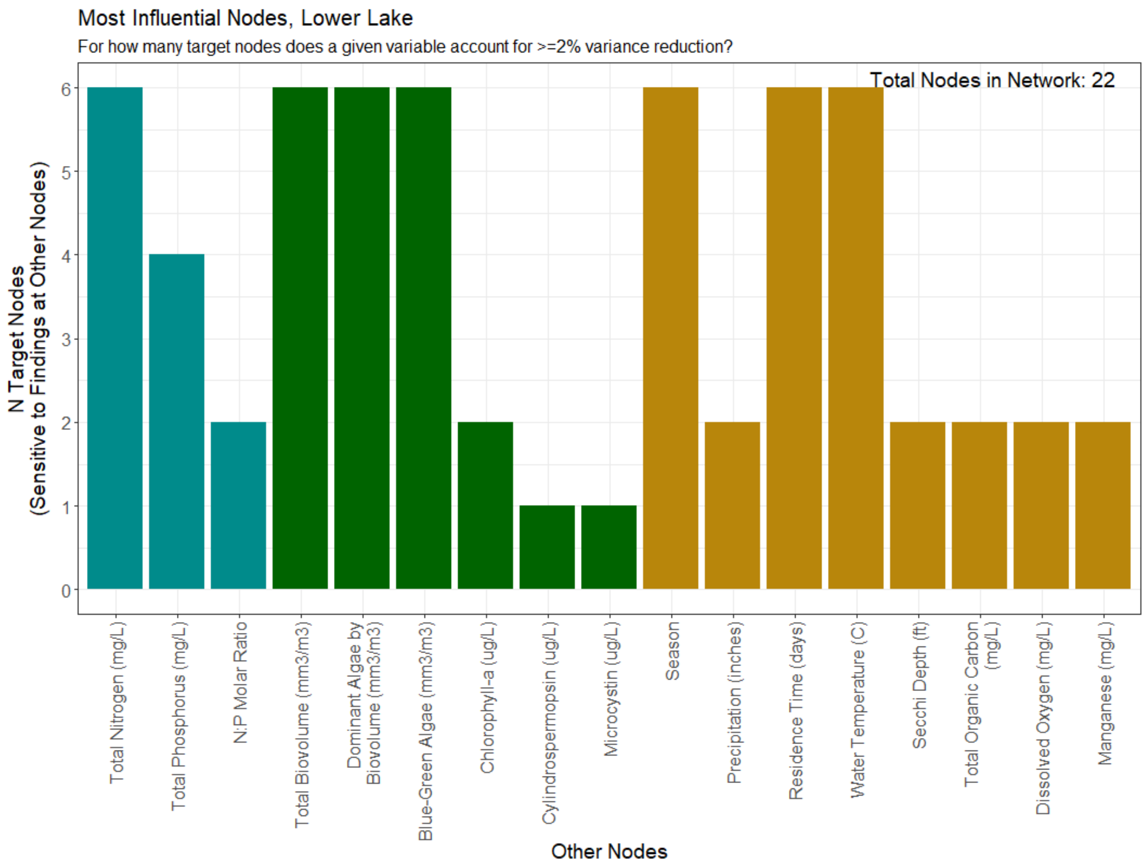


Other Nodes that Influence the Target Node by At Least One Percent in the Middle Lake

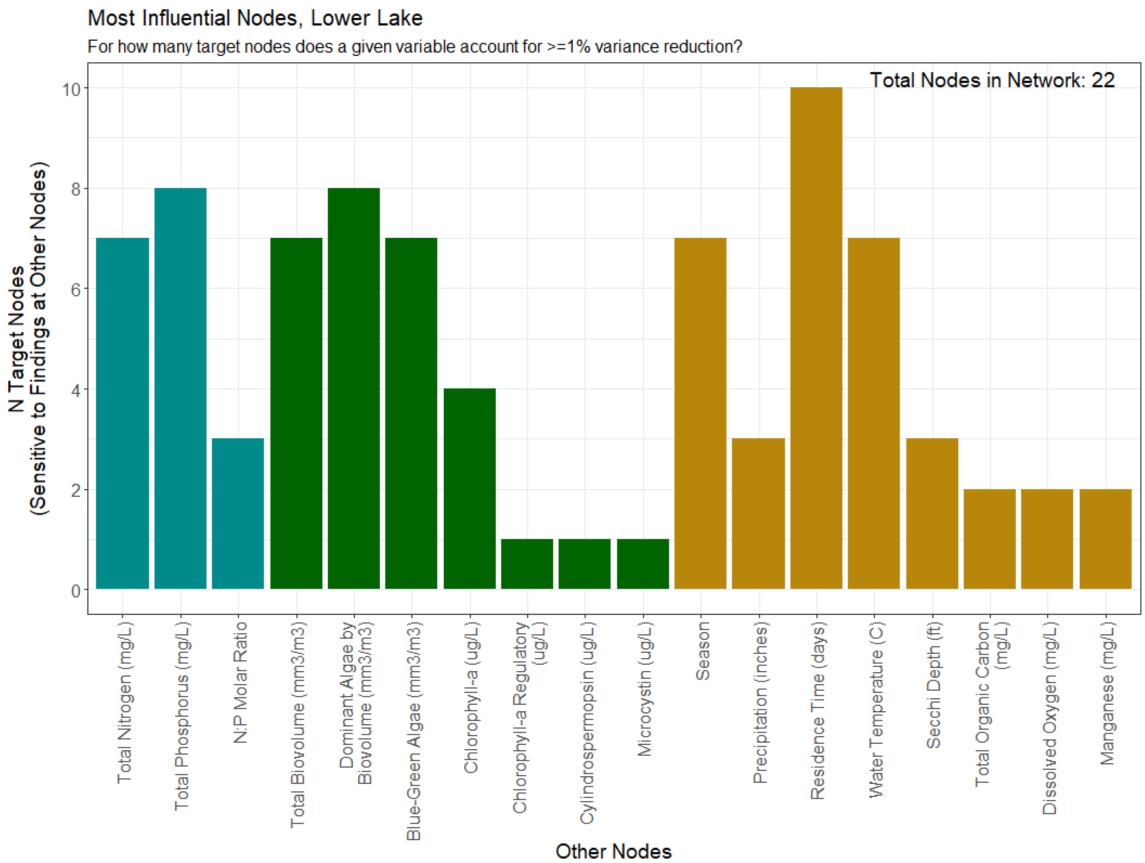
7.3 Lower lake



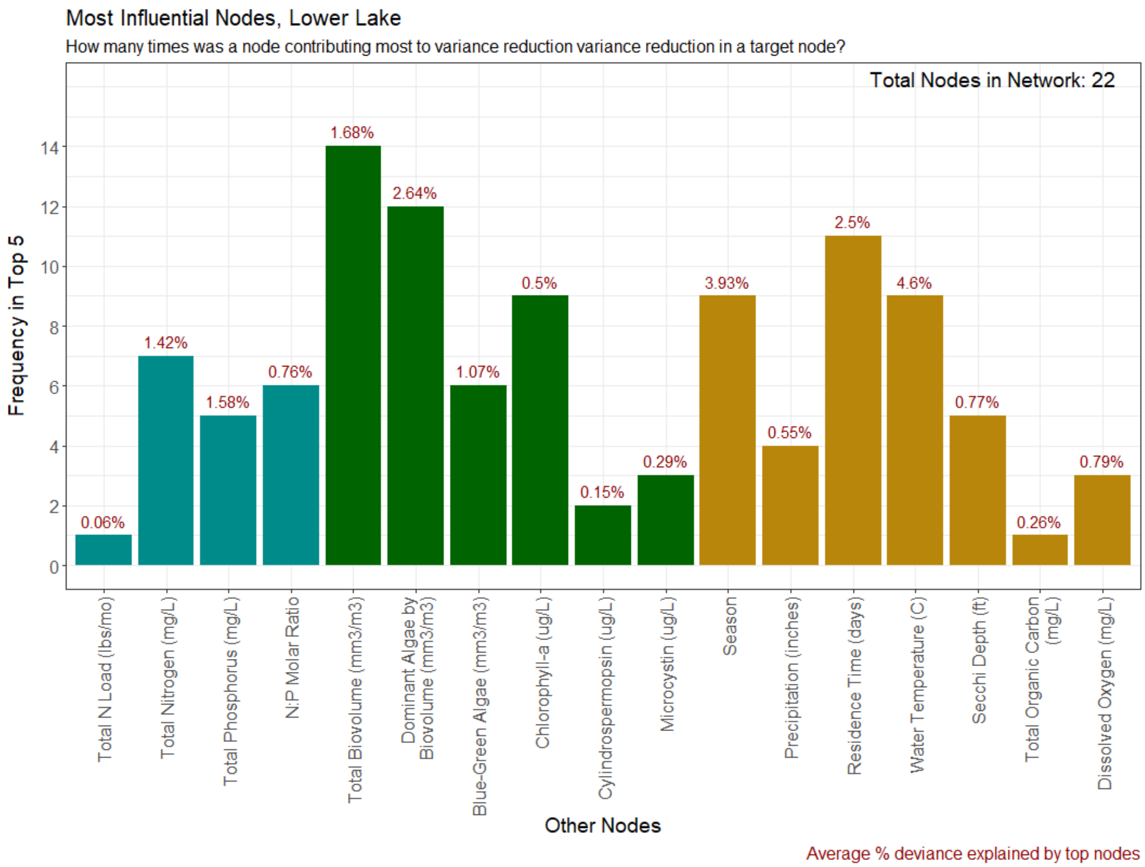
Most Influential Nodes in Lower Lake with More than Four Percent Variance Reduction



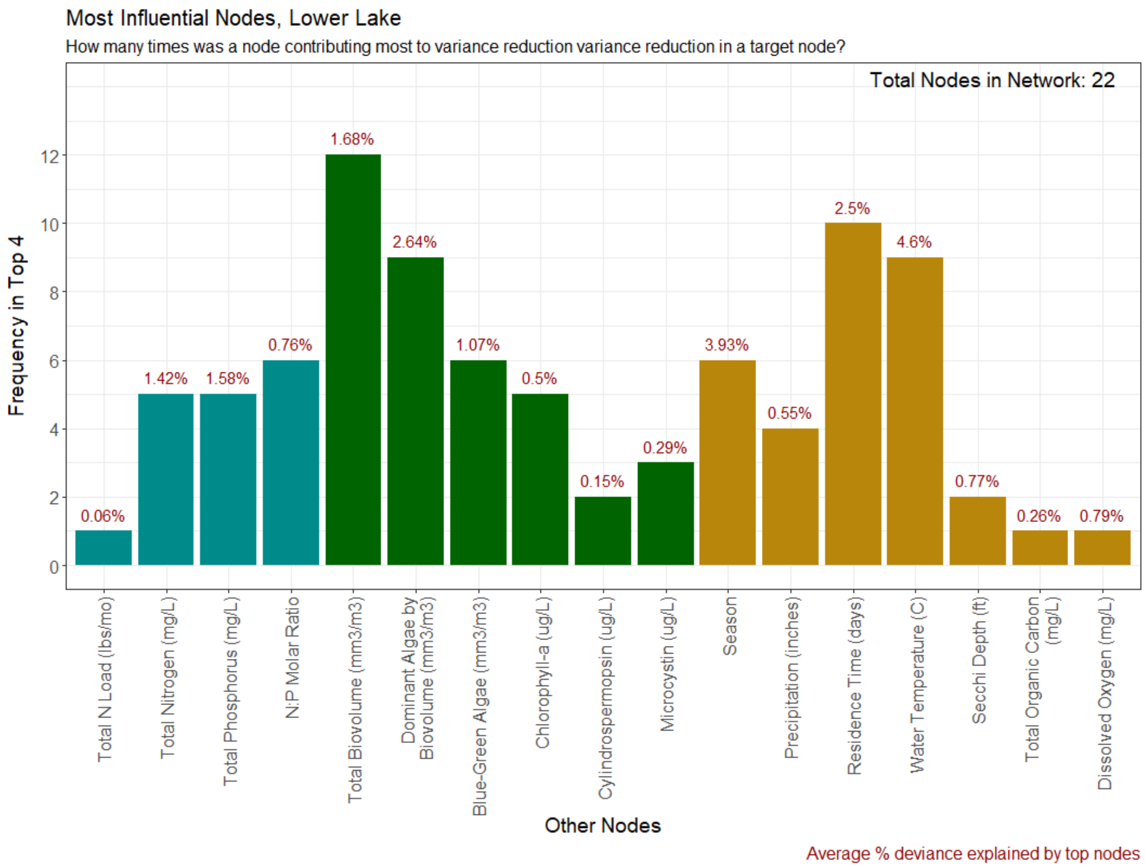
Most Influential Nodes in Lower Lake with More than Two Percent Variance Reduction



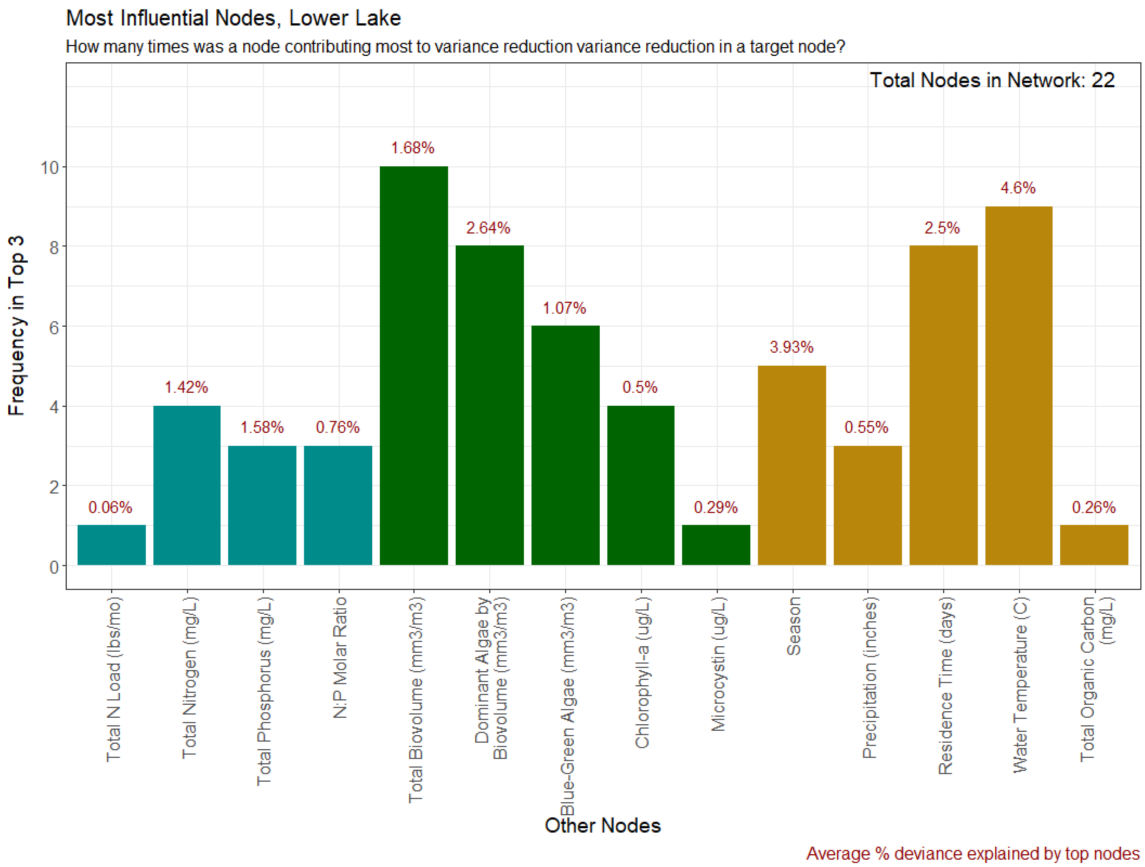
Most Influential Nodes in Lower Lake with More than One Percent Variance Reduction



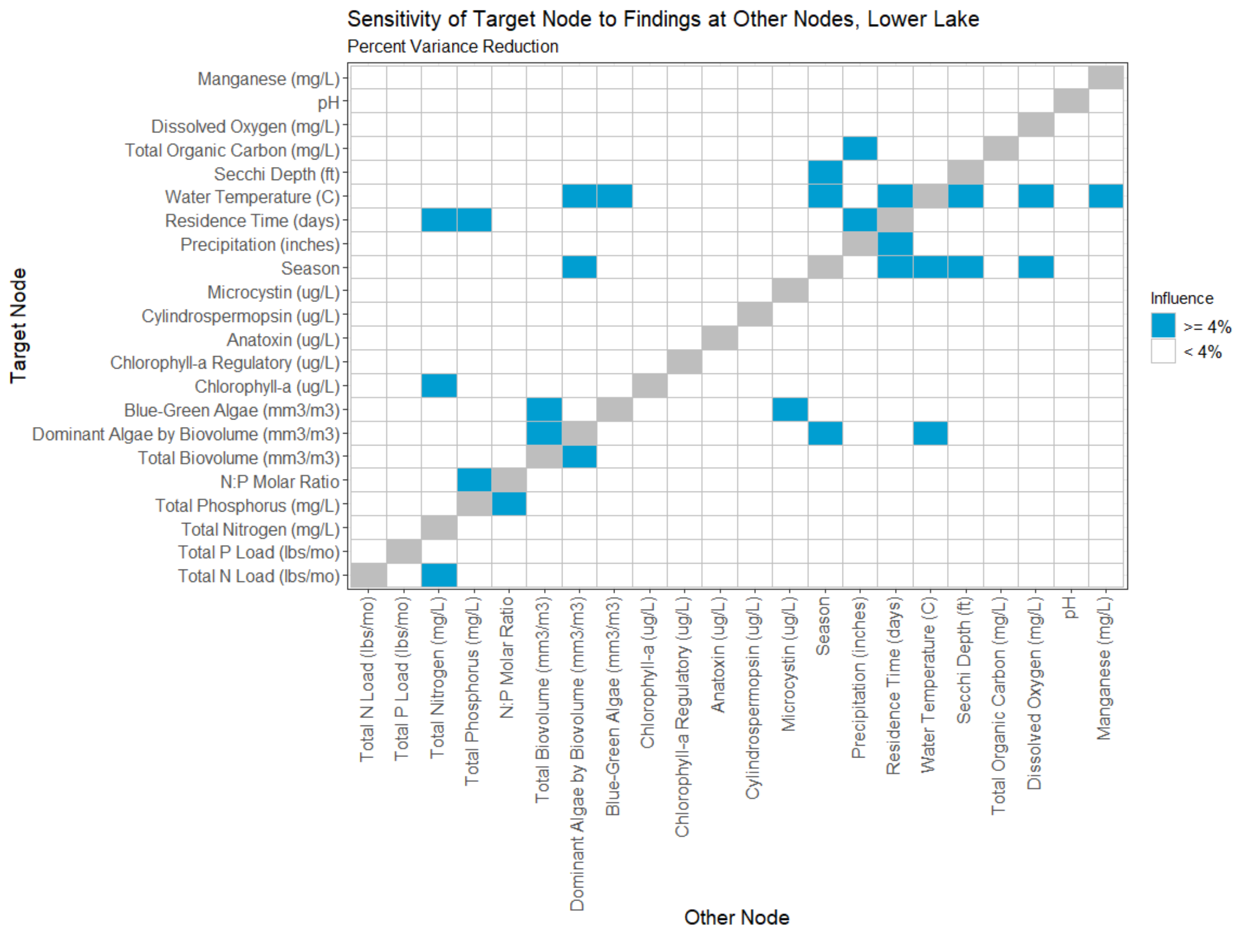
Frequency of Being One of the Top Five Most Influential Nodes in Lower Lake



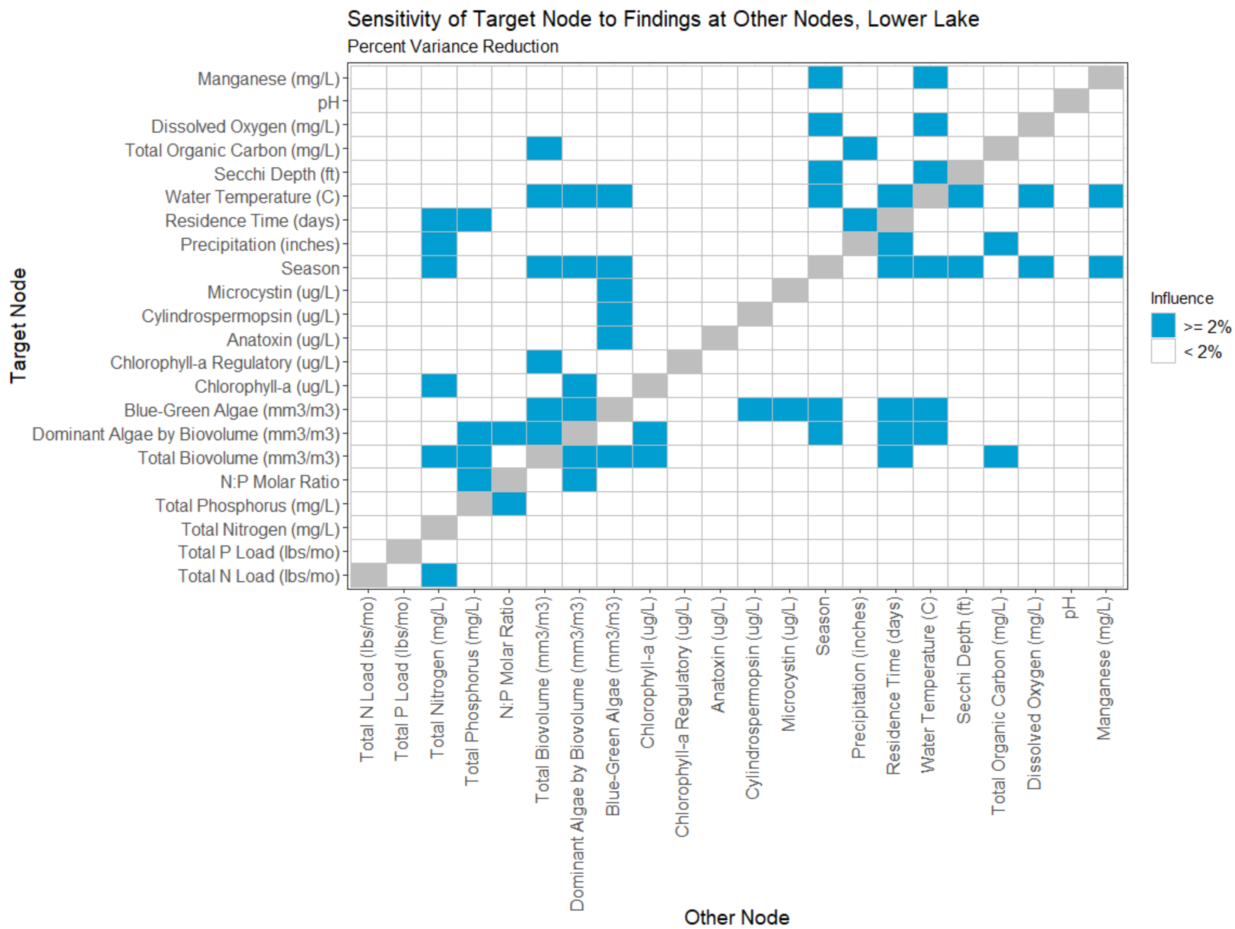
Frequency of Being One of the Top Four Most Influential Nodes in Lower Lake



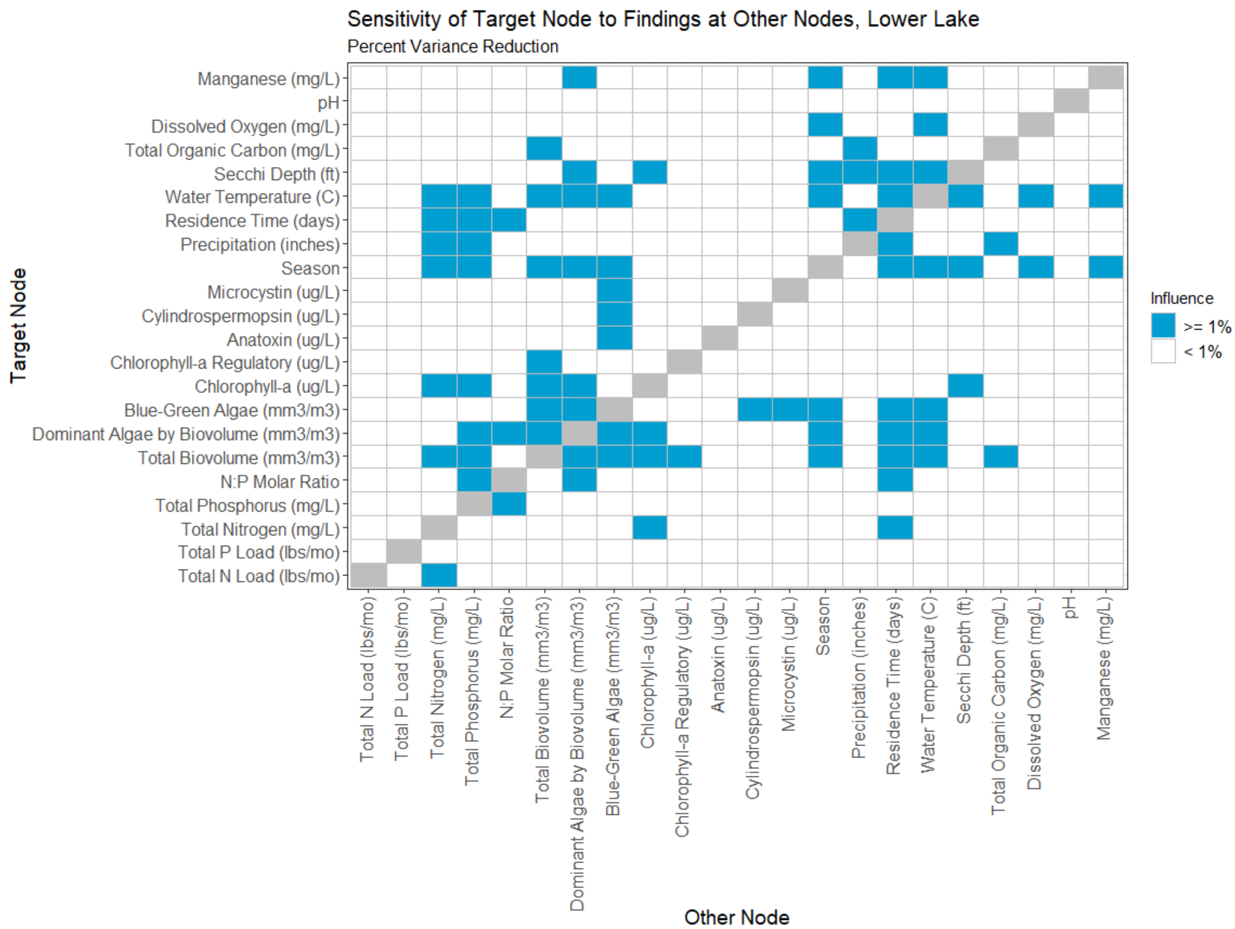
Frequency of Being One of the Top Three Most Influential Nodes in Lower Lake



Other Nodes that Influence the Target Node by At Least Four Percent in the Lower Lake



Other Nodes that Influence the Target Node by At Least Two Percent in the Lower Lake


Sensitivity of Target Node to Findings at Other Nodes, Lower Lake
Percent Variance Reduction
Target Node
Manganese (mg/L)
pH
Dissolved Oxygen (mg/L)
Total Organic Carbon (mg/L)
Secchi Depth (ft)
Water Temperature (C)
Residence Time (days)
Precipitation (inches)
Season
Microcystin (ug/L)
Cylindrospermopsin (ug/L)
Anatoxin (ug/L)
Chlorophyll-a Regulatory (ug/L)
Chlorophyll-a (ug/L)
Blue-Green Algae (mm3/m3)
Dominant Algae by Biovolume (mm3/m3)
Total Biovolume (mm3/m3)
N:P Molar Ratio
Total Phosphorus (mg/L)
Total Nitrogen (mg/L)
Total P Load (lbs/mo)
Total N Load (lbs/mo)
Other Node
Influence
>= 1%
< 1%