

SOP 2.5: Annual Reporting

This document provides an overview of the types of figures and tables that will be used in the annual reporting of water quality data as well as example R code used to create these products. Annual reports will be produced for each park and will include summaries of all water quality data collected (both discrete and continuous) for the appropriate water year (e.g., Water Year 2016; October 2015 – September 2016). Reporting will be completed after all QA/QC procedures have been executed and the data have been finalized.

Previous SOP Version #	Revision Date	Author	Changes Made	Reason for Change	New SOP Version #

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I. Annual Reporting for Discrete Water Quality Data

A. Introduction

- (1) Concise narrative regarding general conditions, noteworthy events, and overview of the sampling events generalized at the park level

B. Methods

- (1) Brief description of methods used to capture observations

C. Results

Results are presented through a series of figures and tables with a brief description.

- (1) Figures: For each core parameter at each site
 - a. Box Plots
 - i. Produce box plots for reporting period (Water Year) by month using historic data and overlay current year observations using developed R code (see appendix A) for example figure and R code)
 - b. Cumulative distribution functions (CDF's)
 - i. Produce CDF's for reporting period (Water Year) using developed R code (see appendix A)
- (2) Tables: For each site a table with all finalized observations for each core parameter will be presented
 - a. Produce tables for the reporting period and place tables for individual sites along with figures in the report

II. Annual Reporting for Continuous Water Quality Data

Continuous monitoring reporting occurs only in years where monitors are deployed in a park (see protocol narrative for guidance). These data will be presented in a separate section within the same report for discrete data when appropriate.

A. Introduction

- (1) Concise narrative regarding general conditions, noteworthy events, and overview of the deployment period.

B. Methods

- (1) Brief description of methods used to capture observations

C. Results

Results are presented through a series of figures and tables with a brief description. Reporting follows the general guidance of Wagner et al. (2006). Results are presented as daily minimum, maximum, and central tendency statistic (mean or median as appropriate).

- (1) Figures: for each core parameter:
 - a. Line Charts
 - i. Produce line charts for the reporting period (Water Year) based on daily values and include: maximum, mean/median (as appropriate), and minimum values using developed R code (see appendix A)
- (2) Tables: for each core parameter:
 - a. Produce tables for the reporting period by day and month based on daily values and include:
 - i. maximum, mean/median (as appropriate), and minimum values

- ii. all reported data will include data quality ratings (see SOP 2.3)

Appendix A: Example Figures with annotated R code

I. Figures and R code

A. Box Plots for Discrete Data

```
library(plyr)
library(ggplot2)
library(reshape2)

data<-read.csv("discrete_WQ_data.csv")
curyr<-"2014"
site<-"BOWA_01"
parm<-"DO"

data$date<-as.Date(data$date, format= "%m/%d/%Y") #convert from factor to
date format so that we can pull out month
data$month2<-as.factor(format(data$date, "%h")) #add column as to month ab
breviated date format for axes tick labels (e.g., Sep)
data$month<-as.factor(format(data$date, "%m")) #add column for factor for
month with numeric date format (e.g., 09)
data$month<-as.integer(data$month) #convert factor to numeric to change ye
ar column to Water Year
data$year<-ifelse(data$month > 9, (data$year + 1), data$year) #assign all
months to appropriate water year in year column (e.g., November 2014 year
column changes to 2015)
data<-rename(data, c("year"="water_year")) #change col label to reflect ch
ange from calendar year to water year

discrete.melt<-melt(data, id.vars=c("StationID", "date", "water_year", "m
onth2" ), measure.vars=c("temp", "DO", "SpC", "pH" )) # create molten data fr
ame (all values are represented for each site*time combination)

discrete.month<-dcast(discrete.melt, StationID +date+ water_year+ month2 ~
variable, add.missing=T , fill=NA ) # Add in missing monthly observations
for final analysis file

discrete.month$month2<-ordered(discrete.month$month2, levels= c("Oct", "No
v", "Dec", "Jan", "Feb", "Mar", "Apr", "May", "Jun", "Jul", "Aug", "Sep")) #orde
r month factor to set x-axis for plot to match water year

data<-discrete.month[discrete.month$StationID %in% site,] #create datafram
e for boxplot of historic data
data<-droplevels(data) #drop unused factors for dataframe

data2<-data[,c("StationID", "water_year", "month2", parm)] #create dataframe
```

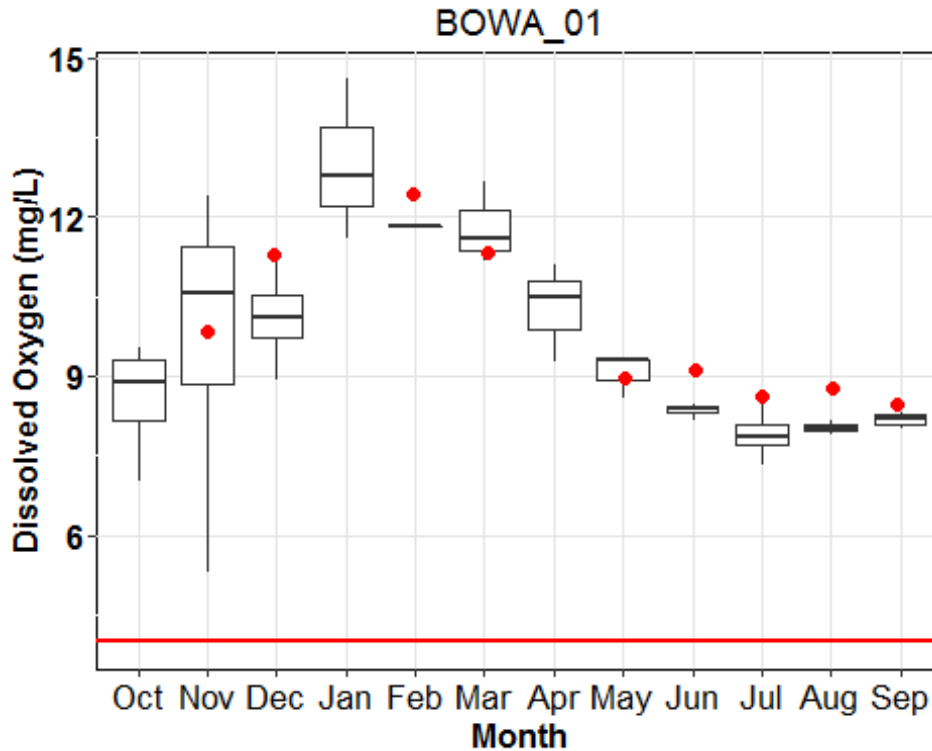
```

for current reporting period (current water year)
data2<-droplevels(data2) #drop unused factors for dataframe

p <- ggplot(data[!data$water_year %in% curyr,], aes(as.factor(month2), DO)
)+ labs(y = "Dissolved Oxygen (mg/L)", x= "Month") + geom_boxplot(outlier.
size=.5) #create plot with boxplots of historic data

p<- (p+ geom_jitter(data= data2[data2$water_year %in% curyr,], width= 0.1,
color="red", size=2)+
geom_hline(yintercept = 4, color ="red", size=1) +
theme(axis.text.y = element_text(color="black", vjust= 0.5,size = 1
6 * 0.8,face="bold"))+
theme(axis.text.x = element_text(angle = 0, color = "black", vjust=
0,size = 16 * 0.8)) +
theme(strip.text.x= element_text(size=12, face=c("bold.italic")))) +
theme(axis.title.x =element_text(size = 12, face ="bold", vjust= 1,
debug=F))+
theme(axis.title.y =element_text(size = 12, face ="bold", vjust= 1,
debug=F))+
theme(legend.key = element_rect(fill = "white", color = "black")) +
theme(panel.background = element_rect(fill="white", colour="black"
)) +
theme(panel.grid.major = element_line(colour = "grey90"))+ggtitle(d
ata$StationID[1])) #add current water year observations and set themes for
plot
print(p)

```



B. Cumulative Distribution Functions for Discrete Data

```
library(plyr)
library(ggplot2)
library(reshape2)

data<-read.csv("discrete_WQ_data.csv")
curyr<-"2013"
site<-"FRSP_03"
parm<-"DO"

data$date<-as.Date(data$date, format= "%m/%d/%Y") #convert from factor to
date format so that we can pull out month
data$month2<-as.factor(format(data$date, "%h")) #add column as to month ab
breivated date format for axes tick labels (e.g., Sep)
data$month<-as.factor(format(data$date, "%m")) #add column for factor for
month with numeric date format (e.g., 09)
data$month<-as.integer(data$month) #convert factor to numeric to change ye
ar column to Water Year
data$year<-ifelse(data$month > 9, (data$year + 1), data$year) #assign all
months to appropriate water year in year column (e.g., November 2014 year
column changes to 2015)
data<-rename(data, c("year"="water_year")) #change col label to reflect ch
ange from calendar year to water year

discrete.melt<-melt(data, id.vars=c("StationID" ,"date", "water_year" , "m
onth2" ), measure.vars=c("temp","DO","SpC","pH" )) # create molten data fr
```

ame (all values are represented for each site*time combination)

```
discrete.month<-dcast(discrete.melt,StationID +date+ water_year+ month2 ~  
variable, add.missing=T , fill=NA ) # Add in missing monthly observations  
for final analysis file
```

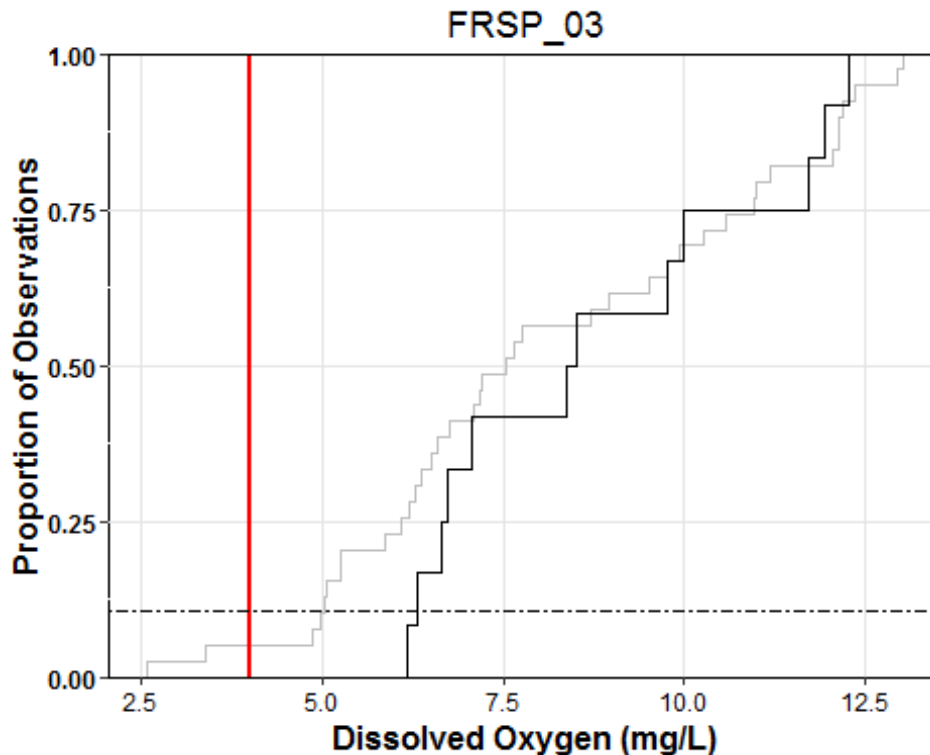
```
discrete.month$month2<-ordered(discrete.month$month2, levels= c("Oct", "Nov",  
"Dec", "Jan", "Feb", "Mar", "Apr", "May", "Jun", "Jul", "Aug", "Sep")) #order  
month factor to set x-axis for plot to match water year
```

```
data<-discrete.month[discrete.month$StationID %in% site,] #create dataframe  
for boxplot of historic data  
data<-droplevels(data) #drop unused factors for dataframe
```

```
data2<-data[,c("StationID","water_year","month2", parm)] #create dataframe  
for current reporting period (current water year)  
data2<-droplevels(data2) #drop unused factors for dataframe
```

```
p <- ggplot(data[!data$water_year %in% curyr,], aes(DO))+ labs(y="Proportion  
of Observations", x="Dissolved Oxygen (mg/L)")+  
  stat_ecdf(geom = "step", color = "grey", size =.5)#create plot with  
boxplots of historic data
```

```
p<- (p+ stat_ecdf(data= data2[data2$water_year %in% curyr,], geom = "step")  
) +  
  scale_y_continuous(expand = c(0,0))+  
  geom_vline(xintercept = 4, color = "red", size=1, show.legend = TRUE)  
) +  
  geom_hline(yintercept = .105, color = "black", lty=6, size=.5) +  
  geom_hline(yintercept = 0)+  
  geom_hline(yintercept = 1)+  
  theme(axis.text.y = element_text(color="black",face="bold"))+  
  theme(axis.text.x = element_text(angle = 0, color = "black")) +  
  theme(strip.text.x= element_text(size=12, face=c("bold.italic")))+  
  theme(axis.title.x =element_text(size = 12, face = "bold", vjust= 1,  
debug=F))+  
  theme(axis.title.y =element_text(size = 12, face = "bold", vjust= 1,  
debug=F))+  
  theme(legend.key = element_rect(fill = "white", color = "black")) +  
  theme(panel.background = element_rect(fill="white", colour="black")  
) +  
  theme(panel.grid.major = element_line(colour = "grey90"))+ggtitle(data$StationID[1])#add current water year observations and set themes for  
plot  
print(p)
```



C. Daily Statistics Plot for Continuous Data

D. `library(ggplot2)`

```
data<-read.csv("WY2016_VAFO_DO_Daily_Stats.csv")# Load data

data$date<-as.Date(data$date, format= "%m/%d/%Y") #convert from factor to
date format

r<-ggplot(data,aes(x=date, ymax=DO_Max, ymin=DO_Min))+ #create plot space
  labs(y="Dissolved Oxygen (mg/L)", x="Date")+ #Label axis
  geom_ribbon(fill="grey75") #plot max and min daily values as background

t<-(r+ geom_line(aes(date,DO_Mean), size=1)+ #add daily mean on top of max
/min ribbon
  scale_x_date(date_breaks = "1 month", date_labels = "%h %y", minor_b
reaks = NULL,
              limits = c(as.Date("2015-10-01"), as.Date("2016-09-30")
),expand = c(0.001,0))+ #set parameters for x-axis
  geom_hline(yintercept = 5, color = "red", size=1, show.legend = TRUE)
+ #plot state wq standard
  theme(axis.text.y = element_text(color="black",face="bold"))+
  theme(axis.text.x = element_text(angle = 0, color = "black")) +
  theme(strip.text.x= element_text(size=12, face=c("bold.italic")))+
  theme(axis.title.x =element_text(size = 12, face ="bold", vjust= 1,
debug=F))+
```

```

    theme(axis.title.y = element_text(size = 12, face = "bold", vjust= 1,
debug=F))+
    theme(legend.key = element_rect(fill = "white", color = "black")) +
    theme(panel.background = element_rect(fill="white", colour="black")
) +
    theme(panel.grid.major = element_line(colour = "grey90"))+ggtitle(da
ta$StationID[1])) #set themes for plot display and title
print(t)

```

