Skokomish Indian Tribe
Environmental Programs
Department of Natural Resources

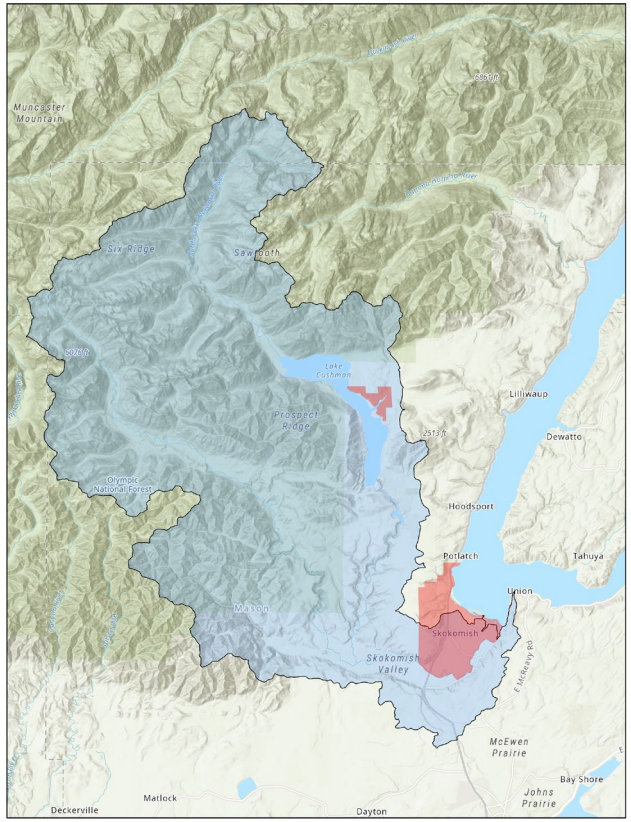
Alena Reynolds
♦
Seth Book

ELI National Training Workshop on Water Quality Assessment and Plans

June 4th, 2024

Tribal Water Quality Assessment: Methods and Tools

Using Water Quality Assessment for Protection of Skokomish Reservation Waters



Reservation:

South Hood Canal-Salish Sea

6085 acres

27 miles of stream length

Skokomish Watershed:

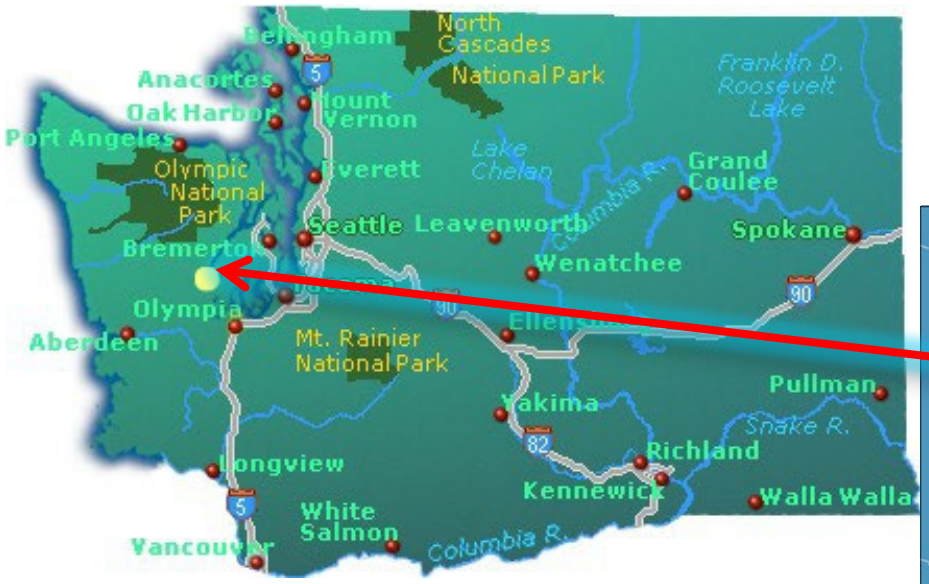
247 square miles

Agriculture (lower river valley)

Flows into Shellfish Beds

The Skokomish River, with Hood Canal and Olympic Mountains

Skokomish Reservation location



Skokomish Environmental Programs FUNDING- EPA Performance Partnership Grant GAP, CWA 319 - Nonpoint, CWA 106 - Tribal Water Quality Monitoring and Assessment

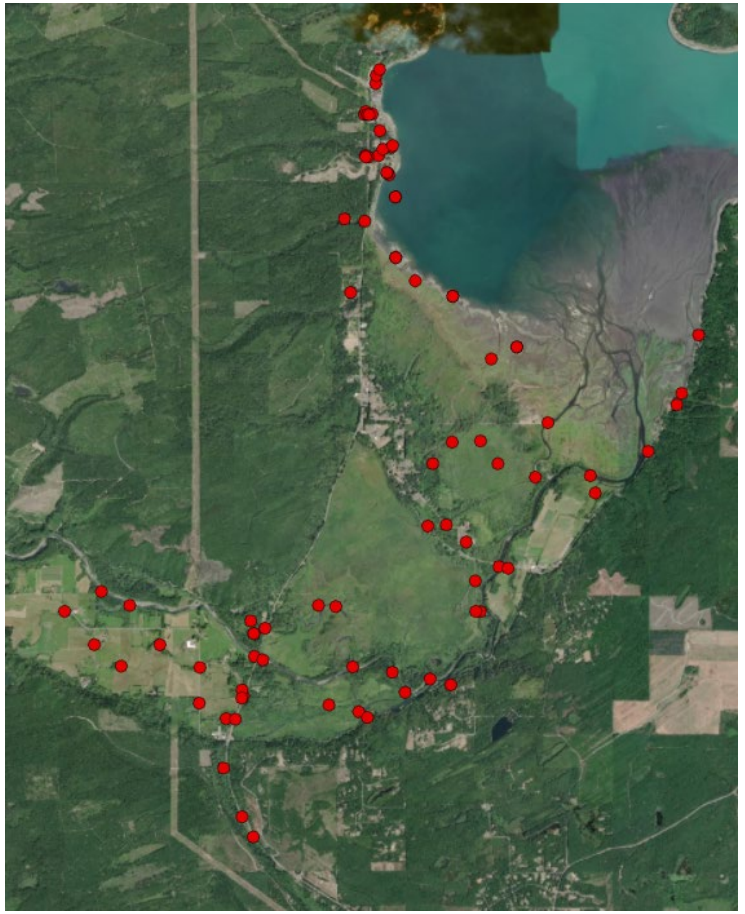
Upper South Fork Skokomish Restoration, Skokomish Drone Program 2022

Using CWA 106 to assess Water Quality

Skokomish Water Quality Monitoring (SWQM) Program

Monitor TMDL sites, Reservation surface waters for **Tribal Assessment Report (TAR)**.

Work with WA Dept of Ecology and local jurisdictions.

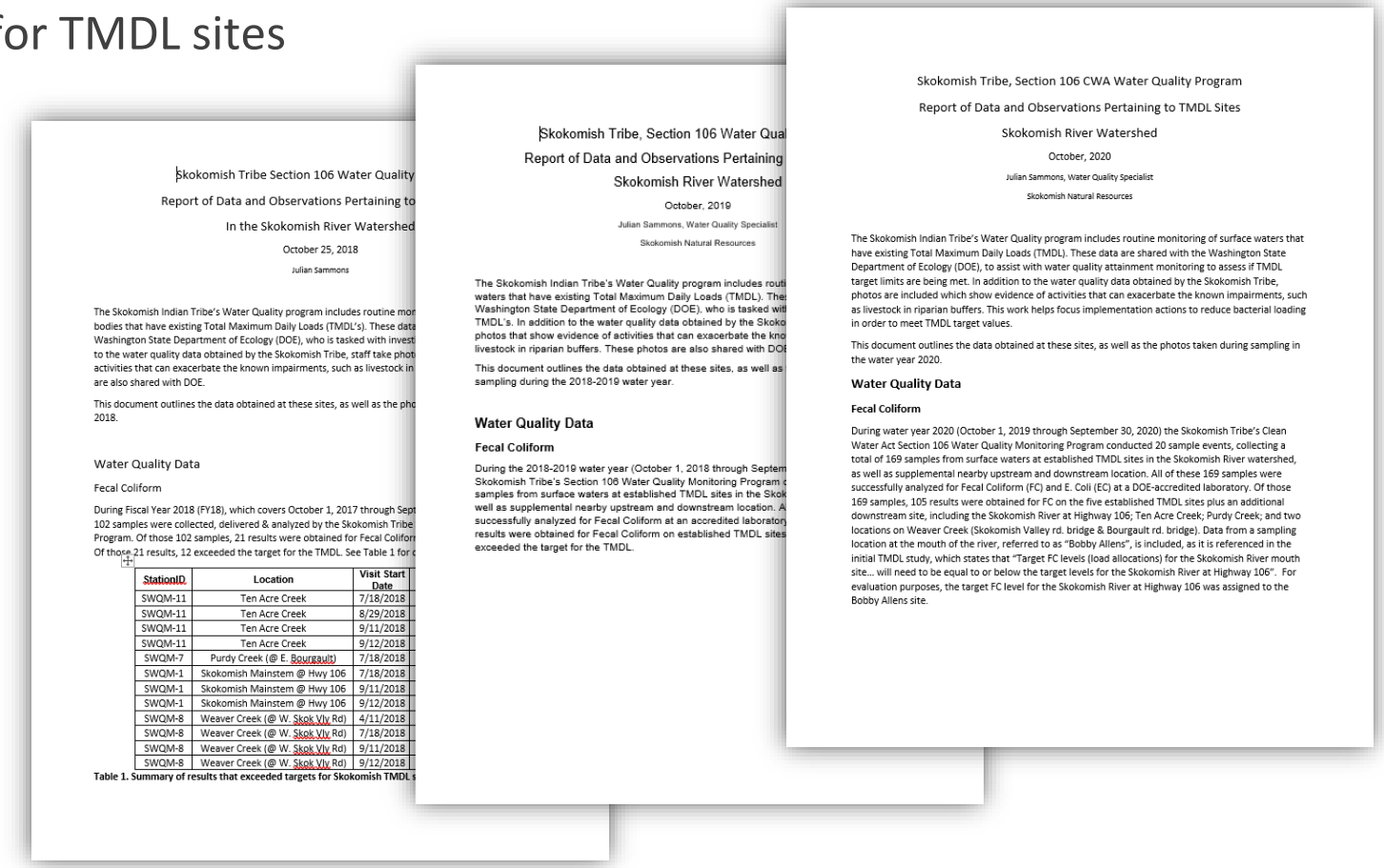


Reporting Data to WA Dept of Ecology

Submit annual summary of data for TMDL sites

Include photo observations

Report WQ violations



Skokomish Tribe Section 106 Water Quality

Report of Data and Observations Pertaining to

In the Skokomish River Watershed

October 25, 2018

Julian Sammons

The Skokomish Indian Tribe's Water Quality program includes routine mon
bodies that have existing Total Maximum Daily Loads (TMDL's). These data
Washington State Department of Ecology (DOE), who is tasked with invest
to the water quality data obtained by the Skokomish Tribe, staff take phot
activities that can exacerbate the known impairments, such as livestock in
are also shared with DOE.

This document outlines the data obtained at these sites, as well as the pho
2018.

Water Quality Data

Fecal Coliform

During Fiscal Year 2018 (FY18), which covers October 1, 2017 through Sept
102 samples were collected, delivered & analyzed by the Skokomish Tribe
Program. Of those 102 samples, 21 results were obtained for Fecal Colifor
Of those 21 results, 12 exceeded the target for the TMDL. See Table 1 for

StationID	Location	Visit Start Date
SWQM-11	Ten Acre Creek	7/18/2018
SWQM-11	Ten Acre Creek	8/29/2018
SWQM-11	Ten Acre Creek	9/11/2018
SWQM-11	Ten Acre Creek	9/12/2018
SWQM-7	Purdy Creek (@ E. Bourgault)	7/18/2018
SWQM-1	Skokomish Mainstem @ Hwy 106	7/18/2018
SWQM-1	Skokomish Mainstem @ Hwy 106	9/11/2018
SWQM-1	Skokomish Mainstem @ Hwy 106	9/12/2018
SWQM-8	Weaver Creek (@ W. Skok Vly Rd)	4/11/2018
SWQM-8	Weaver Creek (@ W. Skok Vly Rd)	7/18/2018
SWQM-8	Weaver Creek (@ W. Skok Vly Rd)	9/11/2018
SWQM-8	Weaver Creek (@ W. Skok Vly Rd)	9/12/2018

Table 1. Summary of results that exceeded targets for Skokomish TMDL

Skokomish Tribe, Section 106 Water Qual

Report of Data and Observations Pertaining

Skokomish River Watershed

October, 2019

Julian Sammons, Water Quality Specialist

Skokomish Natural Resources

The Skokomish Indian Tribe's Water Quality program includes routi
waters that have existing Total Maximum Daily Loads (TMDL). The
Washington State Department of Ecology (DOE), who is tasked wit
TMDL's. In addition to the water quality data obtained by the Skoko
photos that show evidence of activities that can exacerbate the kno
livestock in riparian buffers. These photos are also shared with DO

This document outlines the data obtained at these sites, as well as
sampling during the 2018-2019 water year.

Water Quality Data

Fecal Coliform

During the 2018-2019 water year (October 1, 2018 through Septem
Skokomish Tribe's Section 106 Water Quality Monitoring Program
samples from surface waters at established TMDL sites in the Skok
well as supplemental nearby upstream and downstream location. A
successfully analyzed for Fecal Coliform at an accredited laboratory
results were obtained for Fecal Coliform on established TMDL sites
exceeded the target for the TMDL.

Skokomish Tribe, Section 106 CWA Water Quality Program

Report of Data and Observations Pertaining to TMDL Sites

Skokomish River Watershed

October, 2020

Julian Sammons, Water Quality Specialist

Skokomish Natural Resources

The Skokomish Indian Tribe's Water Quality program includes routine monitoring of surface waters that have existing Total Maximum Daily Loads (TMDL). These data are shared with the Washington State Department of Ecology (DOE), to assist with water quality attainment monitoring to assess if TMDL target limits are being met. In addition to the water quality data obtained by the Skokomish Tribe, photos are included which show evidence of activities that can exacerbate the known impairments, such as livestock in riparian buffers. This work helps focus implementation actions to reduce bacterial loading in order to meet TMDL target values.

This document outlines the data obtained at these sites, as well as the photos taken during sampling in the water year 2020.

Water Quality Data

Fecal Coliform

During water year 2020 (October 1, 2019 through September 30, 2020) the Skokomish Tribe's Clean Water Act Section 106 Water Quality Monitoring Program conducted 20 sample events, collecting a total of 169 samples from surface waters at established TMDL sites in the Skokomish River watershed, as well as supplemental nearby upstream and downstream location. All of these 169 samples were successfully analyzed for Fecal Coliform (FC) and E. Coli (EC) at a DOE-accredited laboratory. Of those 169 samples, 105 results were obtained for FC on the five established TMDL sites plus an additional downstream site, including the Skokomish River at Highway 106; Ten Acre Creek; Purdy Creek; and two locations on Weaver Creek (Skokomish Valley rd. bridge & Bourgault rd. bridge). Data from a sampling location at the mouth of the river, referred to as "Bobby Allens", is included, as it is referenced in the initial TMDL study, which states that "Target FC levels (load allocations) for the Skokomish River mouth site… will need to be equal to or below the target levels for the Skokomish River at Highway 106". For evaluation purposes, the target FC level for the Skokomish River at Highway 106 was assigned to the Bobby Allens site.

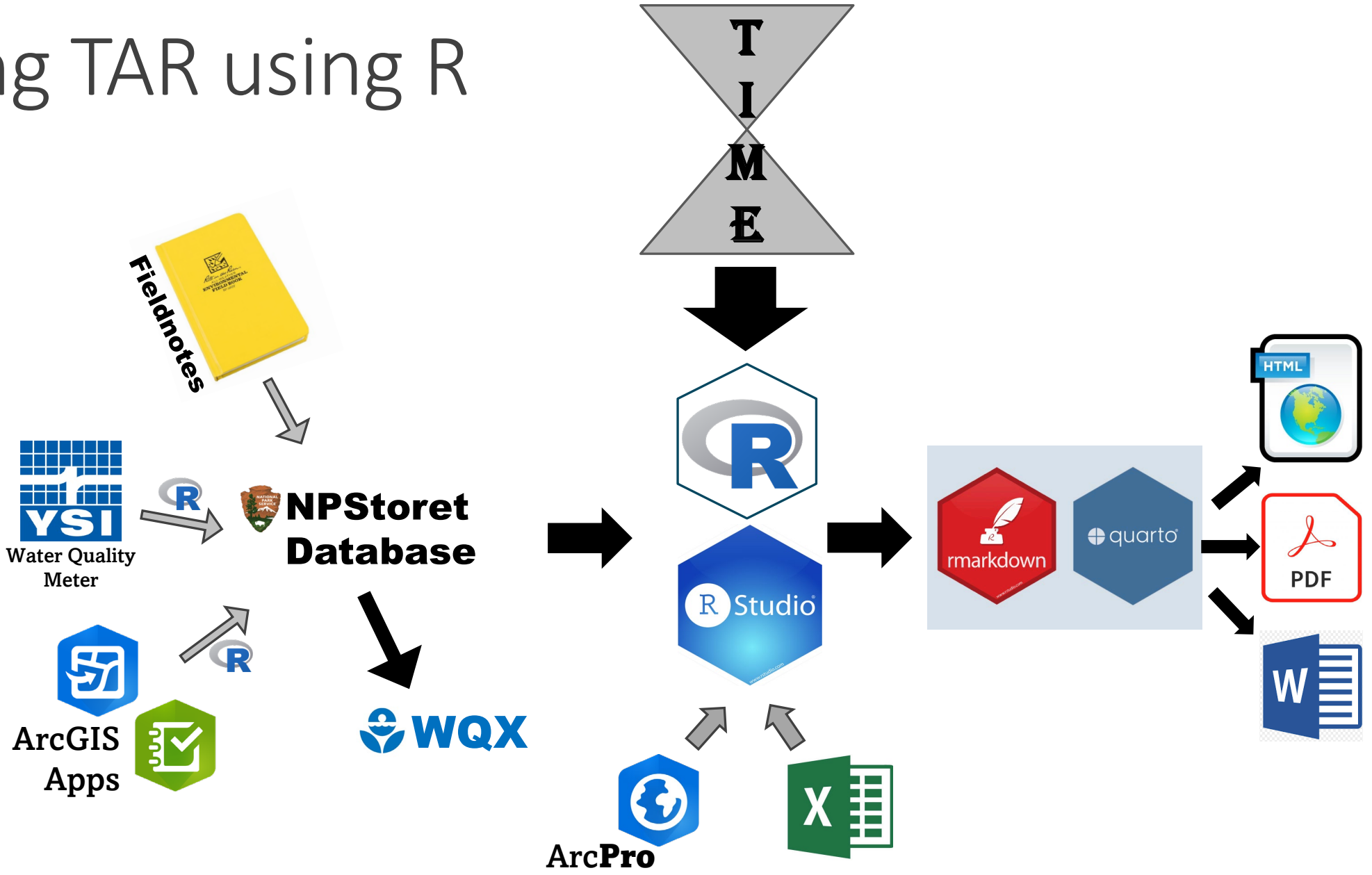
Developing TAR using R

Efficient

Reproduceable

Comparable

Sharable



Building the rmarkdown file

```
```{r set_up_geomeans, message=FALSE, warning=FALSE}

bact_data <- alldata_SWQM %>%
  filter(DISPLAY_NAME== 'Escherichia coli' | DISPLAY_NAME== 'Fecal Coliform') #%>%
  # mutate(WYear=water_year(dateTime, origin = "October"),
  #        Month=month(START_DATE)) %>%
  #WYQ1=10,11,12  WYQ2=1,2,3   WYQ3=4,5,6   WYQ4=7,8,9
  # mutate(WYQuarter=if_else(Month>=10&Month<=12,"Oct-Dec",NA)) %>%
  # mutate(WYQuarter=if_else(Month>=7&Month<=9,"July-Sept",WYQuarter)) %>%
  # mutate(WYQuarter=if_else(Month>=4&Month<=6,"April-June",WYQuarter)) %>%
  # mutate(WYQuarter=if_else(Month>=1&Month<=3,"Jan-March",WYQuarter))

greyscale_quartercolors <- c("gray80","gray60","gray40","gray20")

geomean_quartercolors <- c("#F0CC00","#CC79A7","#D55E00","#009E73")

ninetieth_quartercolors <- c

GeoMeanSWQMquarter <- bact_d
  # filter(StationID=="SWQM-
  mutate(Year=year(START_DATE
  group_by(StationID,DISPLAY
  mutate(ns=n()) %>%
  filter(ns>2) %>%
  summarise(ns=n(),geomean=g
            stdln=sd(ln_resu
            arthmeanofln=mea
            geomean2=exp(art
            ninthln=quantile
            zstdln=arthmeano
            geonintieth=exp(
            geonintieth2=exp

#add benchmarks and unit lab
GeoMeanSWQMquarter_wbm <- Ge
  merge(SWQM_benchmarkcriter
  mutate(pars_units=paste0(i
```

Source Visual

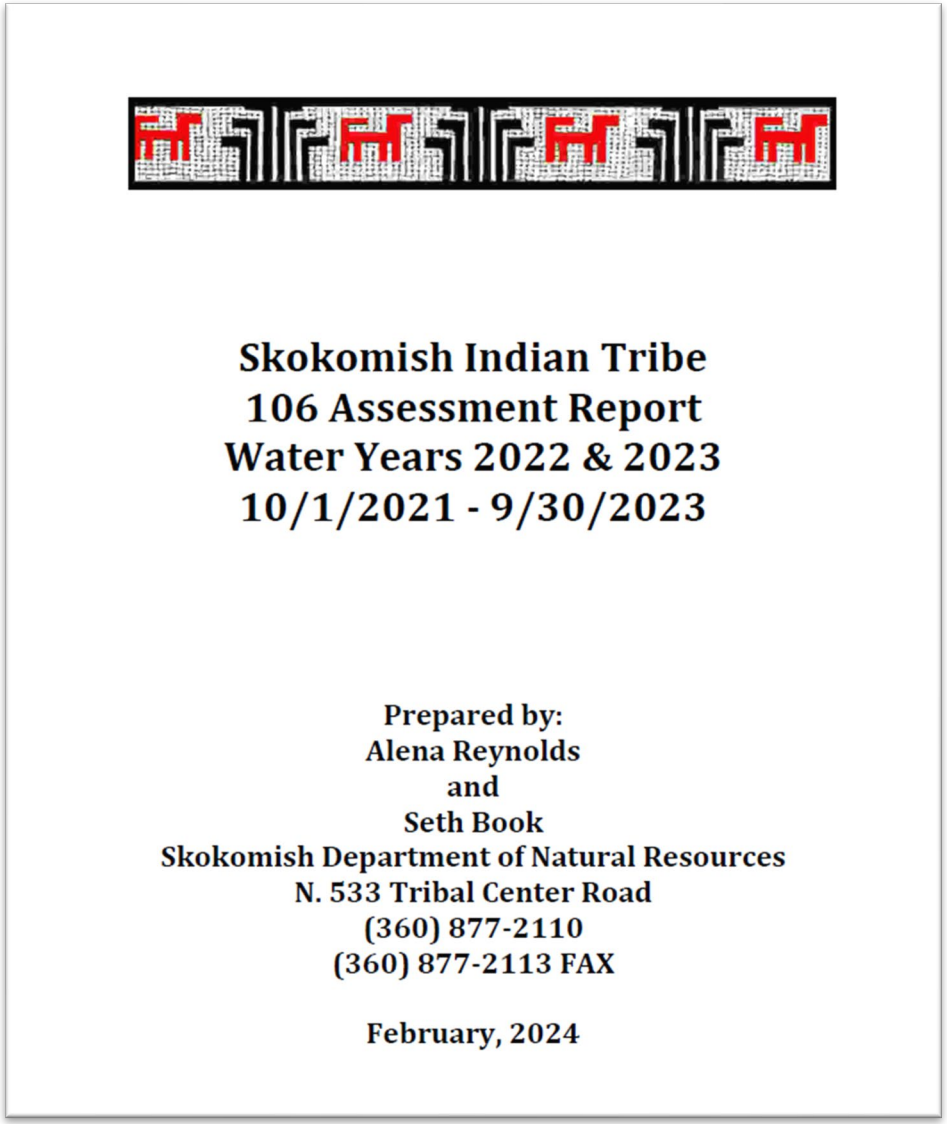
```
---
#title: "Skokomish Water Quality Assessment Report"
#author: 'Prepared by: Alena Reynolds, Environmental Program Biologist'
#date: "February, 2024"
output:
  officedown::rdocx_document:
    reference_docx: C:/Users/areynolds/OneDrive -
skokomish.org/Documents/R/RMarkdown/SWQM_TAR/FY22-FY23_TAR/MSWordStyletemplateFY22-23_TAR_DRAFT.docx
    toc: true
    table:
      caption:
        align: left
    reference_num: true
bibliography: citationsFY22FY23.bib
csl: apa-with-abstract.csl
always_allow_html: true
---

--------------------------------------------------------------------------------

```{r setup, message=FALSE, warning=FALSE, include=FALSE}
knitr::opts_chunk$set(echo = FALSE, warning=FALSE, fig.topcaption=FALSE,
tab.cap.pre="Table",tab.cap.sep=":", tab.cap.style='Table Caption')

```

```{r library, warning=FALSE, include=FALSE}
options(knitr.kable.NA="")
library(RODBC)
library(EnvStats)
library(tidyverse)
library(kableExtra)
library(readxl)
library(webshot)
# library(DT)
library(cowplot)
# library(leaflet)
library(readxl)
```



Skokomish Indian Tribe
106 Assessment Report
Water Years 2022 & 2023
10/1/2021 - 9/30/2023

Prepared by:
Alena Reynolds
and
Seth Book
Skokomish Department of Natural Resources
N. 533 Tribal Center Road
(360) 877-2110
(360) 877-2113 FAX

February, 2024

Example of a Table in rmarkdown

```
<!---BLOCK_LANDSCAPE_START--->

Table \@ref(tab:tab8) below shows the number of sites sampled and exceedances of
benchmark/criteria per parameter during the assessment period of 2022-2023. Detailed
exceedances of samples collected per site during the assessment period per site can be found
in Table \@ref(tab:tab11) in Section IV B.

```{r tbl8-compare-tble, message=FALSE, warning=FALSE, tab.cap ="Exceedances of results
collected during water years 2022 and 2023 per parameter.", tab.id='tab8', label='tab8'}
#get all counts %>%
SWQMcounts
  group_by
  rename(P
  mutate(a

SWQMstats_
  filter(\
  group_by
  rename(P
  mutate(a
#Will move
SWQMquals_
  filter(!
  group_by
  rename(P
  mutate(a

SWQMreject
  filter(\
  group_by
  rename(P
  mutate(a
```

```
#join stats together
SWQMstatstbl_B <- left_join(SWQMcounts_B,SWQMquals_B,
                            by=c('StationID','Parameter'))
SWQMstatstbl1_B <- left_join(SWQMstatstbl_B,SWQMreject_B,
                             by=c('StationID','Parameter'))

SWQMstatstbl2_B <- left_join(SWQMstatstbl1_B,SWQMstats_B,
                             by=c('StationID','Parameter'))



#get YSI excedances
SWQMexceedsYSI <- alldata_SWQM_withbenchmarks %>%
  filter(DISPLAY_NAME!= 'Es
  group_by(StationID,DISPLA
  rename(Parameter=DISPLAY_
  mutate(DU=case_when((RESU
Use',
                      (betw
~'Salmonid Rearing and Migra
                      (betw
'Core Summer Sa
'Char Spawning a
Rearing and Migr
~'Char Spawning
Spawning and Rea
saturation") ~'(
  ),
```

```
Criter
~'17.5°C
~ '16°C'
~ '12°C'
~'6.5mg/
(DO)") ~
~'95% sa
saturati
  ))
```

```
myexcsumft <- flextable(AReedtest_B) %>%
  theme_vanilla() %>%
  # autofit() %>%
  fontsize(size=10.5) %>%
  # align(align = "left", part = "header") %>%
  set_header_labels(Parameter = "Parameter",
                    DU = "DU",
                    Criteria_Value = "Criteria Value",
                    cntofsits = "# of sites",
                    Count = "Count",
                    Flagged = "Flagged",
                    Rejected = "Rejected",
                    Inc._Obs. = "Inc. Obs.",
                    Exceedances = "Exceedances",
                    Prop.Exc.="Prop. Exc.",
                    size=10.5 ) %>%
  set_table_properties(layout = "autofit")%>%
  set_caption(fp_p = tblalignment,
              align_with_table = FALSE)
#you can set the widths of individual cells:
#width(j=1, 0.88) %>%
# width(j=2, 1) %>%
# width(j=3, 1.06) %>%
# width(j=4, 0.69)
# width(j=5, 0.65) %>%
# width(j=6, 0.84) %>%
# width(j=7, 0.6) %>%
# width(j=8, 0.81) %>%
# width(j=9, 0.75) %>%
# width(j=10, 0.81)

myexcsumft

```
```

Table **8** below shows the number of sites sampled and exceedances of benchmark/criteria per parameter during the assessment period of 2022-2023. Detailed exceedances of samples collected per site during the assessment period per site can be found in Table **11** in Section IV B.

Table 8: Exceedances of results collected during water years 2022 and 2023 per parameter.

Parameter	DU	Criteria Value	# of sites	Count	Flagged	Rejected	Inc. Obs.	Exceedances
Dissolved oxygen (DO)	Char Spawning and Rearing	10mg/L	14	97	43	14	83	40
Dissolved oxygen (DO)	Salmon Rearing and Migration	6.5mg/L	2	10	2	1	9	7
Dissolved oxygen saturation	Char Spawning and Rearing	90% sat	10	4	3	0	4	1
Dissolved oxygen saturation	Core Summer Salmonid Habitat	90% sat	10	86	36	11	75	16
Escherichia coli	Primary Contact	100 MPN/100mL	1	9	1	1	8	8
Fecal Coliform	Shellfish Consumption	14 CFU/100mL	3	16	1	0	16	16
Fecal Coliform	Shellfish Consumption	43 CFU/100mL	11	113	6	0	113	85
Temperature, water	Char Spawning and Rearing	12°C	5	30	0	0	30	7
pH	All Low	6.5	1	9	0	1	8	1

Example of a Plot in rmarkdown

```
<!---BLOCK_LANDSCAPE_START--->

```{r temp-boxplots, fig.cap= "Box plot showing temperature values (YSI ProDSS).", fig.width=9.5, fig.height=6}

allparameters <- unique(alldata_SWQM$parameters_ns)
boxpars_tempdata <- alldata_SWQM_withbenchmarks %>%
  group_by(DISPLAY_NAME, StationID) %>%
  mutate(Mean=mean(RESULT_NUMBER,na.rm = TRUE)) %>%
  filter(DISPLAY_NAME=="Temperature, water")

test_legend_labels <- c(expression(bold("Aquatic Life Use")), "Aquatic Life Temp",
                        "Char Spawning and Rearing","Core Summer Salmonid",
                        "Salmonid Rearing and Migration")
test_legend_colors <- c(NA,
                        "#009E73",
                        "#D55E00",
                        "azure4",
                        "#0072B2")

boxpars_tempdata <- data.frame(boxpars_tempdata,stringsAsFactors = TRUE)

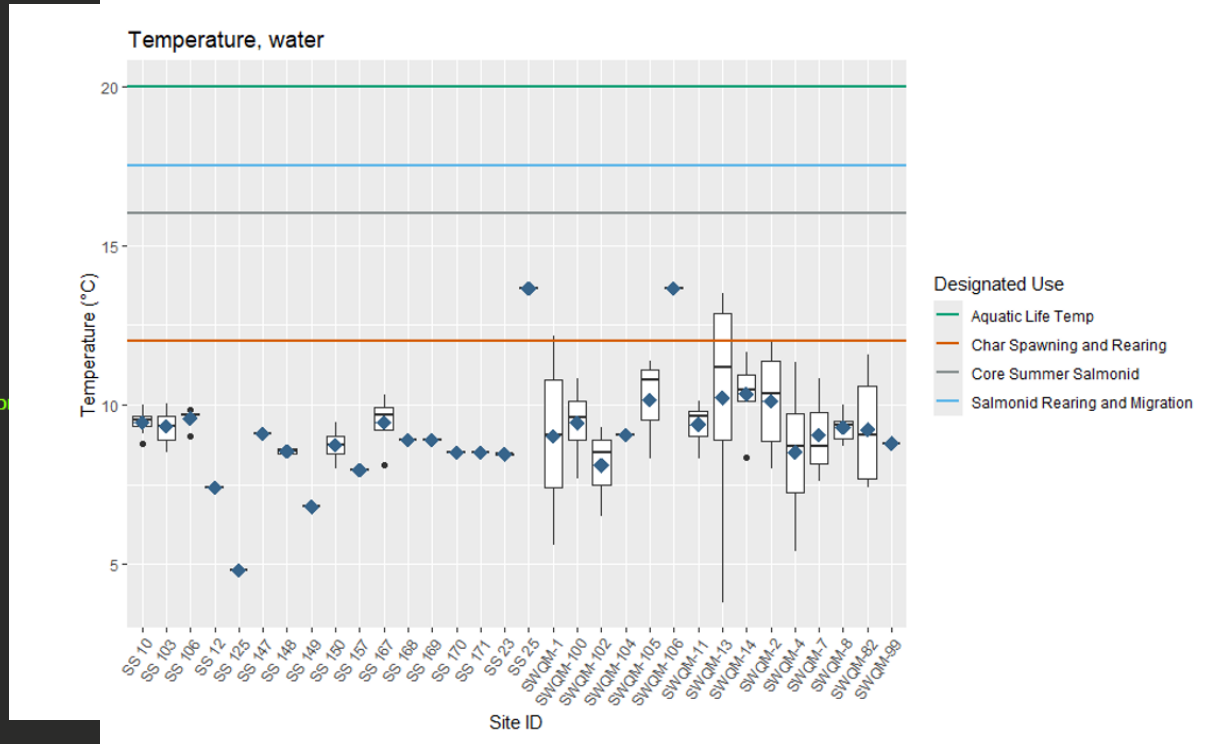

Temperature_water_boxplot <- ggplot(data=boxpars_tempdata, aes(x=StationID, y=RESULT_NUMBER))+
  geom_boxplot()+
  geom_point(data=boxpars_tempdata, inherit.aes = FALSE,aes(x=StationID,
                                                            y=Mean,color="steelblue4"),
             shape=18, size=4)+
  labs(title=boxpars_tempdata$DISPLAY_NAME, x="Site ID", y=boxpars_tempdata$pars_units, fill="Statio
  theme(axis.text.x = element_text(angle = 55, hjust=1))+
  scale_color_manual(name="Legend",values="steelblue4",labels="Mean", guide = "none")+
  geom_hline(size=0.75,aes(yintercept=aquatic_life,linetype="Aquatic Life Temp"),
             color="#009E73")+
  geom_hline(size=0.75,aes(yintercept=spawn_rear,linetype="Char Spawning and Rearing"),
             color="#D55E00")+
  geom_hline(size=0.75,aes(yintercept=core_summer,linetype="Core Summer Salmonid"),
             color="azure4")+
  geom_hline(size=0.75,aes(yintercept=rear_migrate,linetype="Salmonid Rearing and Migration"),
             color="#56B4E9")+
  scale_linetype_manual(name = "Designated Use",
                        values = c(1,1,1,1),
                        guide = guide_legend(override.aes = list(color = c(
                                                                   "#009E73",
                                                                   "#D55E00",
                                                                   "azure4",
                                                                   "#56B4E9"))))

  #assign(paste0(p, "_boxplot"),parboxplot)

#}#end of parameter for loop

#for testing changes to plots
`Temperature_water_boxplot`
```

<!---BLOCK_LANDSCAPE_STOP--->
```



7: Box plot showing temperature values (YSI ProDSS).

Future work: Prepare to adapt early

Federal Water Quality Standards Regulation to Protect Tribal Reserved Rights –Coordinate with EPA to understand, convey to leadership

Watching: Baseline Water Quality Standard for Reservations without Water Quality Standards: what are the implications for Skokomish?

Continue work on fish killing emerging contaminant- 6PPDq

- Proposed WA State Numeric Criteria for 6PPDq
- ITRC tire wear guidance (Sept, 2024)
- WA 6PPDq Chemical Action Plan
- Stormwater Retrofits

Incorporate new tools and software to continue to build capacity

- Share R code for TAR with other tribal technical professionals
- Tribal Exchange Network Group (TXG) member- EPA Exchange Network grant
- Northwest Indian Fisheries Commission R coding group

Skokomish Indian Tribe
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Department of Natural Resources

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Questions?