



2022

Whatcom Conservation District - Edge of Field Monitor Internship

John Porco
Western Washington University

Follow this and additional works at: https://cedar.wwu.edu/cenv_internship



Part of the [Environmental Sciences Commons](#)

Recommended Citation

Porco, John, "Whatcom Conservation District - Edge of Field Monitor Internship" (2022). *College of the Environment Internship Reports*. 57.

https://cedar.wwu.edu/cenv_internship/57

This Article is brought to you for free and open access by the College of the Environment at Western CEDAR. It has been accepted for inclusion in College of the Environment Internship Reports by an authorized administrator of Western CEDAR. For more information, please contact westerncedar@wwu.edu.



Internship Title: Edge of Field Monitoring at Whatcom Conservation District

Student Name: John Porco

Internship Dates: 12/9/2021 – 3/31/2022

Printed Advisor Name John McLaughlin

I grant to Western Washington University the non-exclusive royalty-free right to archive, reproduce, distribute, and display this Internship Report document in any and all forms, including electronic format, via any digital library mechanisms maintained by WWU.

I represent and warrant this is original work, and does not infringe or violate any rights of others. I warrant that I have obtained written permissions from the owner of any third party copyrighted material included in this document.

I acknowledge that I retain ownership rights to the copyright of this work, including but not limited to the right to use all or part of this work in future works, such as articles or books. Library users are granted permission for individual, research and non-commercial reproduction of this work for educational purposes only. Any further digital posting of this document requires specific permission from the author.

Any copying or publication of this document for commercial purposes, or for financial gain, is not allowed without my written permission.

STUDENT SIGNATURE

A handwritten signature in black ink that reads "John Porco". The signature is written in a cursive style with a long horizontal line extending from the end.

DATE: 1/21/2022

Table of Contents

Executive Summary 3

Introduction 3

Internship Activities 5

Internship Achievements..... 7

Discussion and Evaluation 8

Acknowledgements 9

Appendices 10

 Appendix A - Glossary 10

 Appendix B – EoF Datasheet 11

 Appendix C – Nitrate Challenge Rmarkdown..... 12

Executive Summary

This internship was with the Whatcom Conservation District. The district assists local landowners in improving their land use methods to benefit the natural environment of Whatcom County. One of the major resources the district is working to protect is water quality. There are many sources of water pollution in Whatcom County, but agriculture is the one that the district works with. Dairy production in particular is a major potential source of nutrient, fecal coliform, and sediment contamination. Pollutants that enter the Nooksack River pollute the bays the river drains into, which yields significant adverse effects such as those on shellfish harvest. The internship role included helping the district carry out multiple research projects, gather relevant information, and summarize data that will be later used to find significant results and advise decisions. The primary project that I worked on is Edge of Field monitoring. This project consisted of collecting surface runoff data from volunteering farms to investigate the effectiveness of different manure application practices. My work included collecting samples and maintaining equipment in the field. A smaller portion of office work was almost entirely data analysis with some additional housekeeping tasks. In working for this internship, I hoped to gain skills and knowledge that will help me in the future. I achieved almost all my goals and gained valuable skills such as water sample collection skills, field technician skills, and data analysis skills, in addition to gaining more knowledge about water quality, conservation work, and agriculture which will help me as I pursue a career in hydrology or agriculture. The Whatcom Conservation District is an environmental steward that successfully performs important conservation work for the region, and I am happy I have been able to work with them.

Introduction

The Whatcom Conservation District (WCD), a small government agency whose mission is to assist Whatcom County's landowners with their natural resource management and conservation choices, sponsored my internship that began in intersession in December 2021. The district's staff use their expertise and knowledge of water quality, local ecosystems, and best management practices to promote responsible stewardship and sustainable land management while maintaining economic viability. The district boasts a group of individuals with a broad and diverse range of backgrounds who are separated into four teams. The Farm Planning & Engineering team assists local farms in the development and installation of best management practices. The Outreach & Education team informs the public through mediums such as newsletters and workshops and provides opportunities for concerned parties to volunteer and get involved with the district. The Habitat & Restoration team strives to restore natural ecosystems using voluntary and incentive-based programs to encourage stewardship by landowners. Salmon habitat and native plant species are the primary areas of restoration. Finally, the Science & Research team, with which I have been hired to intern, aims to gather information to increase understanding of conservation practices and use that information to provide science-based solutions. These teams, while separate, often work collaboratively on district projects.

In protecting the county's valuable natural resources, the WCD focuses on four priority areas: water quality, habitat, water quantity, and conserving working lands. The two areas of focus relevant to this project are water quality and conserving working lands. The Nooksack watershed in Whatcom County hosts a wide array of land uses and provides a bounty of natural resources. However, with such a productive and heavily used region comes environmental costs such as degraded water quality.

The Nooksack River flows throughout the watershed and drains into the Portage and Bellingham bays. Many segments of the Nooksack River and tributaries are on the Department of Ecology (DOE) 303(d) list and suffer from low dissolved oxygen from nutrient input and fecal coliform contamination. Shellfish harvest is an important recreational, commercial, and tribal industry of Portage Bay, but the river's water quality impairments result in seasonal closures which drastically affects the communities involved. Fecal coliform, sediment, and nutrients can enter waterways from a variety of sources such as poorly managed human waste and industrial sources, but poor manure management practices in agriculture are a significant contributor to surface water quality issues in Whatcom County. Dairy production, Whatcom County's largest agricultural industry, is a potential major contributor to water quality pollutants including nutrients, sediment, and fecal coliform. Agricultural surface runoff enters watersheds that drain into the Nooksack River which then eventually drains out into Portage Bay. The industry has made great progress in reducing its environmental impact over the years, in part thanks to the district's assistance, but there is still work to be done. As an environmental steward of the region, particularly one that focuses on water quality and working lands, the WCD serves an important role in learning about and addressing this issue.

The purpose of the internship project, Edge of Field (EoF) monitoring, is to assess the effectiveness of agricultural land management practices that affect surface runoff. Specifically, the project uses a paired study design to compare two manure application setback distances: a static, annual 100-foot setback distance as the control treatment, and a dynamic setback distance that varies between 10, 40, and 80 feet depending on the time of the year. With all other variables equal, the project will determine if the experimental dynamic manure application setback will be as effective as the static 100-foot setback.

EoF monitoring stations have been installed at the experimental sites and are used to monitor surface runoff. The stations contain ISCO samplers that are capable of collecting runoff volume data and water samples, as well as equipment that collects rainfall and soil moisture data. The samples taken from the field monitoring sites are analyzed for orthophosphate, nitrate, ammonia, total nitrogen, suspended-sediment concentration (SSC), fecal coliform, and E. coli. There are four sites each with control and treatments fields across Whatcom County that have agreed to participate in the study. The results of this project will enhance our knowledge of manure application and agricultural land management practices. This will advise the future implementation of best management practices and result in a lower impact to surface quality without affecting the economic success of landowners in the industry. The project began in 2016, is led by conservation research specialist Scarlett Graham, M.S., and was originally developed by Nichole Embertson, Ph.D.

While EoF is the primary project of this internship, I assisted in other district research projects including the Conservation Innovation Grant (CIG), which is a controlled drainage research project, and the Nutrient Sensor Action Challenge, which seeks to expand the Nooksack Watershed's nitrate monitoring system that is currently limited using cost-effective sensor to collect more nutrient information.

Coming into this internship, I hoped to expand my understanding of hydrology and learn skills valuable to the field. In particular, I wanted to learn and practice the field techniques used in water sample collection, water quality lab analysis methods, and how to analyze the data and implement our findings into solutions. Additionally, I hoped to gain more knowledge about

fundamental concepts of hydrology and environmental science, as well as industry knowledge of conservation work and agriculture. The internship allows me to apply the skills and knowledge gained through my education, and gain experience that will aid me in starting a career in hydrology or agriculture.

Internship Activities

A majority of the time I spent working for this internship (about 70%) was doing field work for EoF. My duties in the field primarily included conducting water quality sampling and maintaining field and laboratory equipment. The monitoring stations contain modems and dataloggers that allowed me to remotely gather information on the status of each station using LoggerNet. Using this information, I could determine when it is necessary to travel out to the sites in order to collect samples or perform maintenance. To determine if time to collect a water sample from a particular station, I would check the flow graph produced by the ISCO sampler to visually identify if a runoff event has occurred and if the runoff event has finished. Then, I would look into the provided ISCO information to find the event start and end time, check if enough samples have been taken by the sampler, and take note of any errors the sampler may have run into. Similarly, I used a datalogger app to check if there is any surprising or errant data collected from the with the sampler that may warrant a maintenance trip. Examples of issues that could skew the data include a sampler not taking samples when it should be, a lost connection to a sampler, or a station losing power. A maintenance trip could also be warranted if I had noticed something awry the last time I was at a site and made a note to address it the next time I would visit.

If I determined that I would go out into the field, I would need to prepare for what I need to do for a given trip. If we were collecting samples, I needed to prepare the 1L sampling bottles that were used to collect a water sample and be sent to the lab for analysis of the relevant contaminants. Preparation includes writing the necessary lab info on the bottle and bringing a cooler containing ice packs to preserve the samples until they reach the lab. Furthermore, I need to prepare sampling checklists that were used to document what I did and what I noted at each site visit. Maintenance required a broad range of preparations or equipment depending on what needed to be repaired, cleaned, or replaced.

Once everything was prepared, I would drive out to the specified sites for that field day and perform the tasks that were previously deemed necessary. Site visits may include sample collection or maintenance or both depending on several variables including maintenance need, weather, time since the last runoff event, and my availability. To collect a sample, I would unlock and open the monitoring station (Figure 1.), remove the ISCO “brain,” and inspect the large composite sampling bottle. If the ISCO had successfully collected at least 10 samples over the duration of the runoff event, there was usually enough water in the bottle to send to the lab. I would shake the bottle up to homogenize the water sample then transfer it into the appropriate 1L bottle. I needed to handle the bottles carefully so as to not contaminate the sample. Sometimes I took a field duplicate of a sample for statistical analysis. Afterwards, I would properly replace the large bottle into the ISCO, making sure the tubing enters the top of the bottle securely.

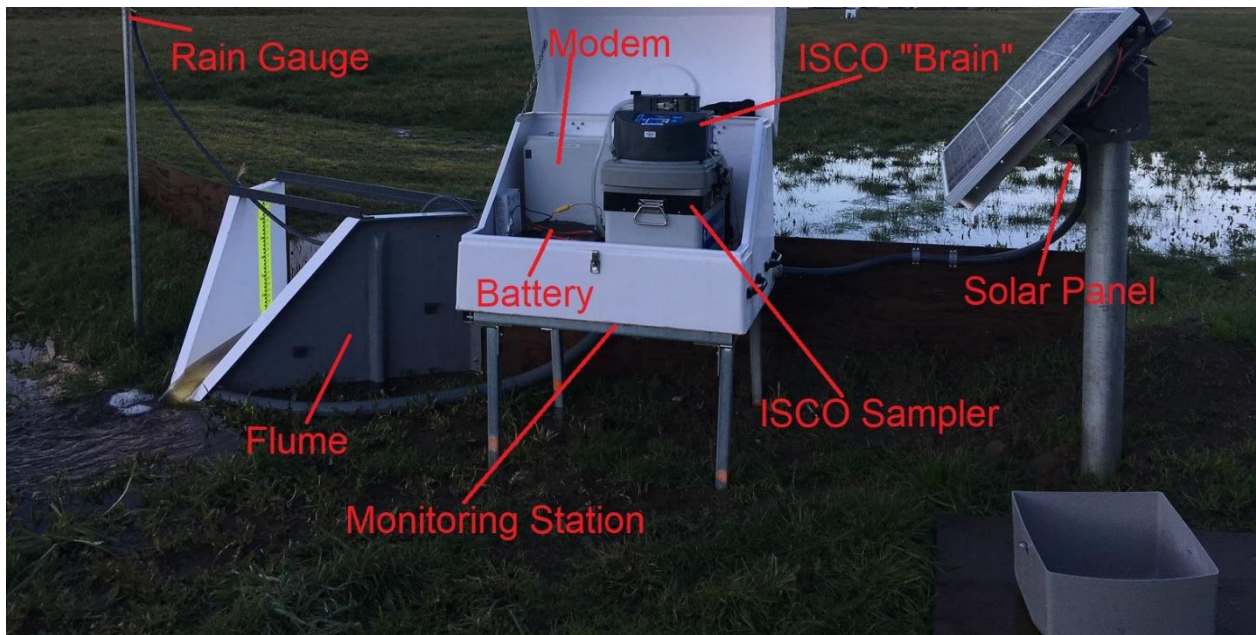


Figure 1. Photograph/diagram of a monitoring station. All relevant parts of the station are labeled. Note: The top of the photograph has been cropped to protect the identity of the participating landowner. Only the rain gauge is excluded from the image due to this edit.

With each sample collection I also had to take a water level reading in inches by simply placing a ruler into the pipe or flume the water is flowing out of and recording the water level. I would then convert my measured water level to feet and compare it to the ISCO water level reading. I would adjust the ISCO reading if the difference is greater than 0.01 inches. Two stations at a particular site have Agri drains that are used to gather data on groundwater. The ISCO gathers data just like it would with surface runoff, but in order to find a measured water level value, I would lower a tape measure deep into the drain and the length reading is subtracted from the drain height. After collection, I would store the filled 1L bottles in a cooler with ice packs and take them to the Exact Scientific Services lab for analysis. It was important that I maintain a field notebook with anything noteworthy that I observe.

Every site visit included at least some inspection of the monitoring station to determine if any maintenance was necessary. Things to check on during routine sample collection included checking if desiccant packets are saturated and need to be replaced, ensuring nothing is loose or leaking in the flume structure, ensuring the water flow pathway is clear, ensuring the station's battery is adequately charged, checking if anything is frozen, and making sure the ISCO sampler is working properly. About once a week, I replaced the sampling bottles during a sample collection trip and thoroughly clean the old ones in the lab to prevent future contamination. If the station was physically obstructed, I used tools such as a shovel or wiper to clear or clean off the flume or drain of the station. Insufficient batteries were replaced and recharged at the office lab.

A small portion of the field work I have done was for CIG. These trips were mostly cleanup and repair. After the recent floods, underground dataloggers were taken out of commission and equipment on the CIG site was carried away by water. Scarlett and I picked up debris, recollected the dataloggers to see which had survived, and at a later date returned to replace and repair everything that had been damaged at the site.

In the office, there was some housekeeping work that I did such as cleaning sample bottles but most of my time was spent doing data analysis for multiple projects. For EoF, I would receive lab results from Exact Scientific Services and enter the data into an Excel document while keeping an eye out for anything of note. A significant portion of the office time however was spent on the other projects I had been invited to work on: CIG and the Nitrate Challenge. For CIG, I downloaded precipitation and temperature data from WSU's AgWeatherNet (AWG) semimonthly and created a plot that showed minimum and maximum temperature values as well as the number of days there was precipitation for each month. These plots were included in the CIG field activities report. The data analysis I did for the Nitrate Challenge was much more involved. I worked on developing an R program that automatically pulled nitrate data from the United States Geological Survey (USGS) for specified sites, plotted them, and provided summary information. The idea behind creating this program was to make a way to visualize the data and identify patterns in a shareable and reproducible way.

Internship Achievements

My most significant achievement was gaining proficiency in performing environmental field research and collecting water quality samples as part of a larger monitoring program. At the start of the internship, Scarlett accompanied me on every site visit and showed me how to perform the various tasks associated with the sampling program. By March however, I was able to carry out the necessary activities of the research independently. This is a highly valuable skill that will carry over into a myriad of career paths that suit my interest. Furthermore, the technical and industry knowledge I have obtained is indispensable and will assist me in the future as well.

In both my field and office work I have accomplished numerous specific and tangible achievements for the district. Not all of what I have achieved is immediately reflected in the district's deliverables, but I have contributed significantly to large projects that will last much longer than my time interning for the WCD.

In the field, I have assisted in maintaining the consistent functionality and results of our field sites. For EoF, I have helped keep the field monitoring stations in operating order, ensuring that we do not have any gaps in our data, and I have collected months' worth of runoff data. The results of this are ample high-quality runoff data that may be analyzed and used to answer the district's questions about agricultural management practices. Additionally, for CIG, I have helped the reestablishment of soil moisture monitors, enabling data collection to continue for this project after the site has been disrupted by recent flooding.

In the office, I have helped to organize, analyze, and produce visual summaries of the results of each project. For EoF, I kept the large datasheet of all the water quality lab results up to date to eventually be used to produce results and findings of the project (See appendix B). For CIG, I have produced several plots displaying summary data to be used in a report for the project. The plots display monthly precipitation and weather data from October 2021 (Figure 2.) through January 2022. Finally, for the Nitrate Challenge, I have produced a functional R program that can be used by anyone to grab data from the USGS database for our sites of interest and summarize the data into a series of plots that can be used to identify patterns in the data. This data analysis task is still a work in progress, but I have included the current version of the Rmarkdown file for now (See appendix C).

Monthly Weather Summary - Sumas.E AgWeatherNet

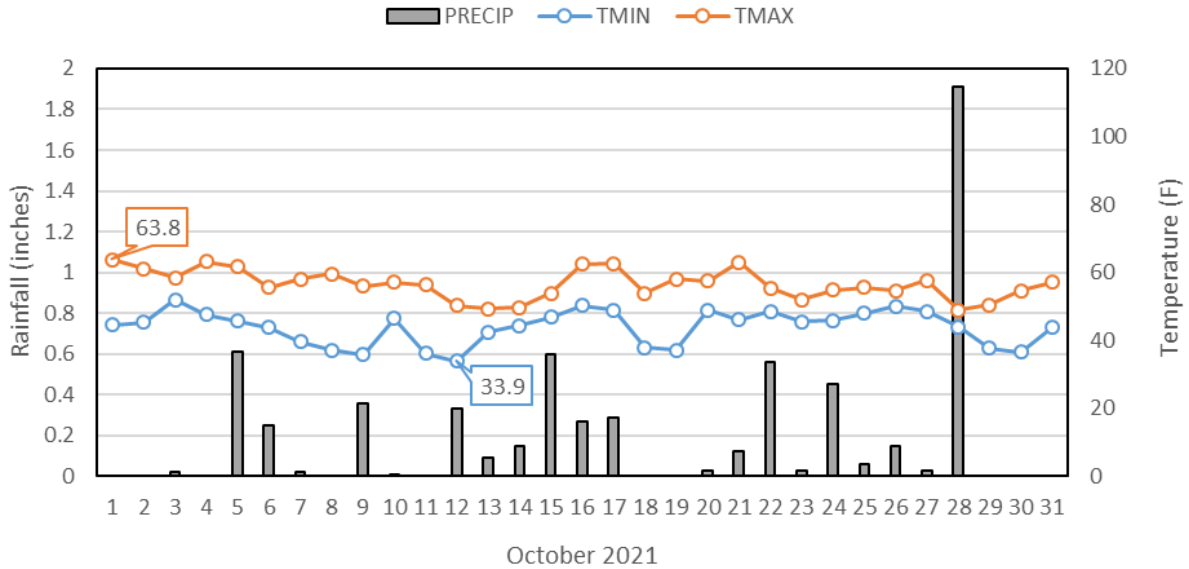


Figure 2. Monthly weather summary displaying temperature and precipitation information for October 2021 to be used in the CIG field activities report. Data were gathered from AWG and analyzed and plotted in Microsoft Excel.

Discussion and Evaluation

I found my internship work and the WCD to be highly effective in achieving the district’s mission as well as my own objectives. While the projects I worked will not be completed during my internship, I have read about past projects the WCD has completed and saw that they produce successful and significant results that protect the natural resources in Whatcom County. The research work that I have done will contribute producing high-quality data that will be used in the future to guide implementation of nutrient management practices. Furthermore, the WCD’s intern program is effective in teaching undergraduate students, giving them experience on a variety of local conservation related projects, and helping them move on to greater things. Scarlett has described to me herself how part of what she likes about the intern position is that it is great opportunity for students to cycle through. As mentioned in the achievements section, what I learned at this internship is greatly valuable and will serve me greatly as I continue my career.

In terms of areas that could use improvement, one aspect of the internship that I found to be somewhat disappointing is that I have not learned any water quality lab analysis methods. With all our samples analyzed by Exact Scientific Services, I have not had the opportunity to analyze the samples myself. Though I do not know how this could feasibly be accomplished. Another area that I think could be improved is the availability of work there is for interns to do. Whether or not there was work to be done relied heavily on external factors, particularly if there had been a rain or runoff event. I think it would better serve interns if there was work to be done more consistently. However, I understand that due to funding constraints and the nature of the internship, this is largely out of the district’s control.

The outcome of the internship overall aligned nicely with the goals I set out to accomplish when I started. I confidently feel as though I have gained a greater understanding of hydrology measurements and proficiency in skills relevant to the field. The internship certainly met my goal to gain knowledge relevant to my desired career. Interning for the WCD helped me not only review and expand my understanding of environmental science and hydrology concepts but gave me insight into how these fields function outside of academia. Additionally, the internship introduced me to conservation work, how government agencies function, and how to build and maintain relationships with landowners. The other significant goal I set out was to learn hands-on field skills. As mentioned before, I am now capable of independently performing the water sampling program and I have had a lot of practices in collecting and handling water samples. The field skills I gained will allow me to effectively perform field technician duties in future jobs. Data analysis was another skill I wanted to develop with this internship, and while I feel as though my data analysis skills learned through my education were already good, applying them at this internship helped these skills grow further.

Interning at the WCD went above and beyond my expectations. I feel as though this experience will prove invaluable as I continue in my career, and I feel truly fortunate to have been allowed this opportunity.

Acknowledgements

I would like to thank everyone at the Whatcom Conservation District for providing this opportunity and helping me take the first step in my career. I would also like to thank conservation research specialist, Scarlett Graham M.S., as she served as my supervisor and taught me just about everything that I learned during my internship.

Appendices

Appendix A - Glossary

AWG - AgWeatherNet, a weather data service provided by WSU.

CIG - Conservation Innovation Grant

DOE - Department of Ecology

EoF - Edge of Field

Exact Scientific Services - A local laboratory capable of performing water testing among other types of tests.

ISCO - A refrigerated water sampling device designed to withstand the harsh outdoor environments

LoggerNet – A program that assists in data retrieval from a data logger to a PC

R – A statistical programming language

SSC - Suspended Sediment Concentration

USGS - United State Geological Survey

WCD - Whatcom Conservation District

WSU - Washington State University

Appendix B – EoF Datasheet

Only a small portion of the data is displayed in this table rather than the entirety of the datasheet. Certain columns have been omitted from the table because they were either not particularly important for the sake of this report or contained private information.

Sample Description	Orthophosphate	Nitrate-N	Ammonia	Total Nitrogen	Total Phosphorus	SSC	Fecal Coliform
DF1L1-113021-0545	1.84	0.096	0.623	3.36	2.35	7	11
DF1L2-113021-0545	2.2	1.65	0.667	4.08	2.74	9	18
DF3L2-113021-0710	0.057	<0.05	<0.05	1.6	0.756	87.3	11
DF4P6-113021-0540	0.093	0.493	<0.05	3.84	0.374	35.3	46
DF4AG-113021-0550	0.059	0.345	<0.05	2.25	0.376	73	56
DF4L2-113021-0550	0.277	0.12	0.276	2.48	0.506	17	15
DF4L1-113021-0550	0.19	0.31	0.179	2.14	0.53	33.3	800
DF1L1-120421-0840	2.58	0.107		6.89	3.23		
DF1L2-120421-0840	5.25	0.089		7.77	5.82		
DF4AG-120421-0840	0.052	0.384	<0.05	2.29	0.192	16	23
DF4FD-120421-0840	<0.05	0.38	<0.05	2.91	0.206	16	3
DF4L1-120421-1110	0.145	0.142		2.51	0.462		
DF4P6-120421-0840	0.058	0.477	<0.05	1.88	0.24	19	26
DF4L2-120421-0845	0.31	0.179	0.319	3.66	0.548	25.5	3
DF1L1-120621-1340	2.35	<0.05	1.46	5.25	3.15	4	8
DF1L2-120621-1230	4.69	0.155		3.95	5.39	5	3
DF4AG-120621-0820	0.117	0.414	<0.05	1.11	0.248	31.3	8
DF4P6-120721-1210	0.136	0.519	<0.05	1.72	0.26	20.3	22
DF4L1-120621-1645	0.054	0.318	0.168	0.84	0.109	<3.3	<4
DF4L2-120621-1550	0.237	0.167	0.199	2.46	0.482	4	<4
DF1L1-121021-0435	1.85	<0.05	0.763	4.99	3.46	8	50
DF1L2-120921-0735	4.87	0.06	0.324	6.38	5.63	9	11
DF1FD-120921-0735	4.88	0.061	0.364	2.83	5.53	7	14
DF4AG-121021-1255	0.101	0.384	<0.05	1.7	0.256	24	19
DF4P6-120921-1040	0.128	0.516	<0.05	1.38	0.265	14.3	78
DF4L1-121021-2205	0.106	0.142	0.104	1.54	0.376	36	11
DF4L2-121021-0525	0.252	0.185	0.236	2.89	0.525	7.7	6
DF4AG-121321-1430	0.417	2.4	<0.05	1.46	0.113	<3.30	6
DF4L2-121321-0805	1.23	0.993	0.318	1.92	0.452	<10.0	<4

Appendix C – Nitrate Challenge Rmarkdown

This program is currently in a draft state; some chunks that are not quite functional are commented out. However, the most important aspects are in working order. This includes identifying and gathering instantaneous data for specific sites and parameters, then creating hydroplots for each site.

DRAFT: USGS dataretrieval trial

Scarlett, John

1/4/2022

Packages

```
library(dataRetrieval)
library(maps)
library(dplyr)

##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##   filter, lag

## The following objects are masked from 'package:base':
##
##   intersect, setdiff, setequal, union

#install.packages (c("dataRetrieval", "EGRET", "tidyverse", "hydroTSM"))
library(EGRET)
library(hydroTSM)

## Loading required package: zoo

##
## Attaching package: 'zoo'

## The following objects are masked from 'package:base':
##
##   as.Date, as.Date.numeric

## Loading required package: xts

##
## Attaching package: 'xts'

## The following objects are masked from 'package:dplyr':
##
##   first, last

#write('PATH="{RTOOLS40_HOME}\\usr\\bin;{PATH}"', file = "~/Renvirom", append = TRUE)
Sys.which("make")

##
##                               make
## "C:\\rtools40\\usr\\bin\\make.exe"
```

```
#install.packages("jsonlite", type = "source")
```

Find what data is available

```
data_WA_stream_N <- whatNWISdata(stateCd="WA", siteType="ST", parameterCd="99133")  
nrow(data_WA_stream_N)
```

```
## [1] 9
```

Creates a map of sites

```
map('state', regions='washington')  
title(main="Washington Stream Nitrate Sites")  
points(x=data_WA_stream_N$dec_long_va,  
       y=data_WA_stream_N$dec_lat_va)
```

Washington Stream Nitrate Sites



Finds what NWIS parameters are available for the 3 sites and uses parameter codes to find corresponding parameter names. Creates a table with the columns: Parameter Code, Name, Start, End, Count, and Units.

```
#get available instantaneous data
```

```
availData <- whatNWISdata(siteNumber = c("12211390", "12212050", "12213100"), service = "uv")  
names(availData)
```

```
## [1] "agency_cd"           "site_no"             "station_nm"  
## [4] "site_tp_cd"         "dec_lat_va"         "dec_long_va"  
## [7] "coord_acy_cd"      "dec_coord_datum_cd" "alt_va"  
## [10] "alt_acy_va"        "alt_datum_cd"      "huc_cd"  
## [13] "data_type_cd"     "parm_cd"           "stat_cd"  
## [16] "ts_id"            "loc_web_ds"        "medium_grp_cd"  
## [19] "parm_grp_cd"      "srs_id"            "access_cd"  
## [22] "begin_date"       "end_date"          "count_nu"
```

```
#gets parameter codes and puts them into a format usable by 'grep' function.  
parameters <- (availData$parm_cd)
```

```

gparameters <- paste(parameters, collapse = "|")

#get parameter info for sites in Whatcom
WhatcomParams <- parameterCdFile[grep(gparameters,
                                     parameterCdFile$parameter_cd,
                                     ignore.case=TRUE,),]

names(WhatcomParams)[1] <- 'parm_cd'
names(WhatcomParams)

## [1] "parm_cd"          "parameter_group_nm" "parameter_nm"
## [4] "casrn"            "srsname"           "parameter_units"

sName <- (WhatcomParams$srsname)

#merge the data with the parameter info
availData_m <- (merge( availData,WhatcomParams, by = "parm_cd"))

#pull out the data for the summary table

begindate <- (availData_m$begin_date)
print(begindate)

## [1] "2008-05-07" "2007-12-01" "1989-10-01" "1998-12-03" "2007-10-01"
## [6] "2007-10-01" "2011-10-29" "2019-10-07" "2019-01-20" "2019-03-28"
## [11] "2019-01-20"

enddate <- (availData_m$end_date)
print(enddate)

## [1] "2022-01-19" "2022-01-19" "2022-01-19" "2022-01-19" "2022-01-19"
## [6] "2022-01-19" "2022-01-19" "2022-01-19" "2019-04-04" "2022-01-19"
## [11] "2021-11-08"

C <- (availData_m$count_nu)
print(C)

## [1] 5005 5163 11798 8448 5224 5224 3735 835 74 1028 1023

pCode <- (availData_m$parm_cd)
print(gparameters)

## [1] "99133|00010|00060|00065|99133|99133|00010|00060|00065|63680|99133"

pName <- (availData_m$srsname)
print(pName)

## [1] "Temperature, water"
## [2] "Temperature, water"
## [3] "Stream flow, mean. daily"
## [4] "Stream flow, mean. daily"
## [5] "Height, gage"
## [6] "Height, gage"
## [7] "Turbidity"
## [8] "Inorganic nitrogen (nitrate and nitrite)"
## [9] "Inorganic nitrogen (nitrate and nitrite)"
## [10] "Inorganic nitrogen (nitrate and nitrite)"
## [11] "Inorganic nitrogen (nitrate and nitrite)"

U <- (availData_m$parameter_units)
print(U)

```

```

## [1] "deg C"      "deg C"      "ft3/s"      "ft3/s"      "ft"         "ft"
## [7] "FNU"        "mg/l as N"  "mg/l as N"  "mg/l as N"  "mg/l as N"

sCode <- (availData_m$site_no)
print(sCode)

## [1] "12212050" "12213100" "12213100" "12212050" "12212050" "12213100"
## [7] "12213100" "12211390" "12212050" "12213100" "12212050"

sName <- (availData_m$station_nm)
print(sName)

## [1] "FISHTRAP CREEK AT FRONT STREET AT LYNDEN, WA"
## [2] "NOOKSACK RIVER AT FERNDAL, WA"
## [3] "NOOKSACK RIVER AT FERNDAL, WA"
## [4] "FISHTRAP CREEK AT FRONT STREET AT LYNDEN, WA"
## [5] "FISHTRAP CREEK AT FRONT STREET AT LYNDEN, WA"
## [6] "NOOKSACK RIVER AT FERNDAL, WA"
## [7] "NOOKSACK RIVER AT FERNDAL, WA"
## [8] "KAMM CREEK AT KAMM ROAD NEAR LYNDEN, WA"
## [9] "FISHTRAP CREEK AT FRONT STREET AT LYNDEN, WA"
## [10] "NOOKSACK RIVER AT FERNDAL, WA"
## [11] "FISHTRAP CREEK AT FRONT STREET AT LYNDEN, WA"

#create the table
instantData <- availData_m["00003" == availData_m$stat_cd,]

tableData <- with(instantData,
  data.frame(
    Site_Code = sCode,
    Site_Name = sName,
    Parameter_Code = pCode,
    Parameter_Name = pName,
    Start=begindate,
    End=enddate,
    Count=C,
    Unit =U
  )
)
tableData

##      Site_Code      Site_Name Parameter_Code
## 1  12212050 FISHTRAP CREEK AT FRONT STREET AT LYNDEN, WA      00010
## 2  12213100      NOOKSACK RIVER AT FERNDAL, WA      00010
## 3  12213100      NOOKSACK RIVER AT FERNDAL, WA      00060
## 4  12212050 FISHTRAP CREEK AT FRONT STREET AT LYNDEN, WA      00060
## 5  12212050 FISHTRAP CREEK AT FRONT STREET AT LYNDEN, WA      00065
## 6  12213100      NOOKSACK RIVER AT FERNDAL, WA      00065
## 7  12213100      NOOKSACK RIVER AT FERNDAL, WA      63680
## 8  12211390      KAMM CREEK AT KAMM ROAD NEAR LYNDEN, WA      99133
## 9  12212050 FISHTRAP CREEK AT FRONT STREET AT LYNDEN, WA      99133
## 10 12213100      NOOKSACK RIVER AT FERNDAL, WA      99133
## 11 12212050 FISHTRAP CREEK AT FRONT STREET AT LYNDEN, WA      99133
##      Parameter_Name      Start      End Count
## 1      Temperature, water 2008-05-07 2022-01-19 5005
## 2      Temperature, water 2007-12-01 2022-01-19 5163
## 3      Stream flow, mean. daily 1989-10-01 2022-01-19 11798
## 4      Stream flow, mean. daily 1998-12-03 2022-01-19 8448
## 5      Height, gage 2007-10-01 2022-01-19 5224
## 6      Height, gage 2007-10-01 2022-01-19 5224
## 7      Turbidity 2011-10-29 2022-01-19 3735
## 8  Inorganic nitrogen (nitrate and nitrite) 2019-10-07 2022-01-19 835

```



```
## 9 Inorganic nitrogen (nitrate and nitrite) 2019-01-20 2019-04-04 74
## 10 Inorganic nitrogen (nitrate and nitrite) 2019-03-28 2022-01-19 1028
## 11 Inorganic nitrogen (nitrate and nitrite) 2019-01-20 2021-11-08 1023
## Unit
## 1 deg C
## 2 deg C
## 3 ft3/s
## 4 ft3/s
## 5 ft
## 6 ft
## 7 FNU
## 8 mg/l as N
## 9 mg/l as N
## 10 mg/l as N
## 11 mg/l as N
```

```
write.table(tableData, file="table.Data.tsv", sep="\t", row.names = FALSE, quote=FALSE)
getwd()
```

```
## [1] "C:/Users/jporco/whatcomcd/Company - Site Collection Documents/Programs and Projects/Research/SUNA and Nutrient Challenge/Data Analysis"
```

Downloads all 15-minute data from the 3 sites (12211390 (Kamm), 12212050 (Fishtrap), 12213100 (Nooksack)) 00010 - temperature, water 00060 - discharge 00065 - gage height 99133 - NO3+NO2, water, insitu 63680 - turbidity

```
#whatcom_N_uv <- readNWISuv(siteNumbers=c("12211390", "12212050", "12213100"),
#                               parameterCd=c("00010", "00060", "00065", "99133", "63680"),
#                               startDate="2019-01-01", endDate="2022-01-01")
#nrow(whatcom_N_uv)
#names(whatcom_N_uv)
```

```
#write.csv(whatcom_N_uv, "C:/Users/jporco/whatcomcd/Company - Site Collection Documents/Programs and Projects/Research/SUNA and Nutrient Challenge/Data Analysis/instantaneousdata", row.names = FALSE)
```

Data wrangling: 1. Made 3 separate dataframe for each station 2. Need to do extra work for FT data because the NO3 measurements aren't lined up with the flow and temp measurements.

```
whatcom_N_uvcsv <- read.csv("instantaneousdata")
names(whatcom_N_uvcsv)
## [1] "agency_cd"
## [2] "site_no"
## [3] "dateTime"
## [4] "X_00010_00000"
## [5] "X_00010_00000_cd"
## [6] "X_.Removed.on.April.4..2019._99133_00000"
## [7] "X_.Removed.on.April.4..2019._99133_00000_cd"
## [8] "X_00060_00000"
## [9] "X_00060_00000_cd"
## [10] "X_00065_00000"
## [11] "X_00065_00000_cd"
## [12] "X_63680_00000"
## [13] "X_63680_00000_cd"
## [14] "X_99133_00000"
## [15] "X_99133_00000_cd"
## [16] "tz_cd"
```

```

Kamm <- filter(whatcom_N_uvcsv, site_no == "12211390")
Nook <- filter(whatcom_N_uvcsv, site_no == "12213100")
FT <- filter(whatcom_N_uvcsv, site_no == "12212050")

#select NO3 data columns from FT dataset and create new dataframe
FT_NO3 <- select(FT, c(dateTime,X_99133_00000, X_99133_00000_cd))
# delete columns with NA from FT_NO3 dataframe
FT_NO3 <- filter(FT_NO3, X_99133_00000 != "NA")

#delete NO3 data columns from FT
FT <- select (FT,-c(X_99133_00000, X_99133_00000_cd))
#delete rows with NA values
FT <- filter(FT, X_00010_00000 != "NA")

#merge FT with FT_NO3
FT <- (merge(FT,FT_NO3, by = "dateTime"))

#set -99999 values to NA
FT <- FT %>%
  mutate(X_99133_00000 = replace(X_99133_00000, X_99133_00000 == -99999, " "))

```

Note: long gaps may be dealt with using the function (blankTime)

Get variable and site info tables for plotting

```

variableInfo <- attr(whatcom_N_uvcsv, "variableInfo")
siteInfo <- attr(whatcom_N_uvcsv, "siteInfo")

```

Plots currently not working after the inclusion of turbidity, not super familiar with these plot functions so I need Scarlett's help
Plot Kamm data

```

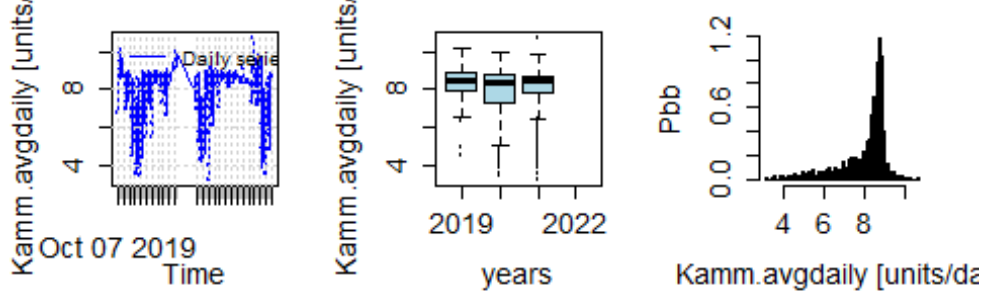
#par(mar=c(5,5,5,5)) #sets the size of the plot window

#plot(Kamm$dateTime, Kamm$X_99133_00000,
# ylab=variableInfo$variableName[4],
# col="blue",type="l",
# xlab="" )
#title(siteInfo$station_nm[3])

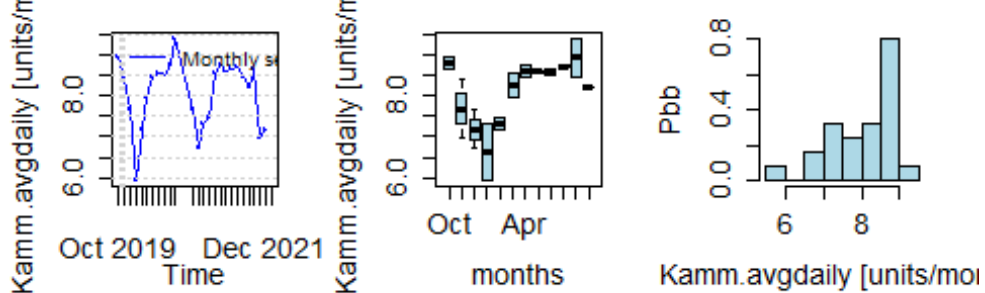
#read in data and creates hydroplots for Kamm Creek
Kamm.Date <- as.POSIXct(Kamm$dateTime, tz="America/Los_Angeles")
Kamm.xts <- xts(Kamm$X_99133_00000, order.by = Kamm.Date)
Kamm.avgdaily=subdaily2daily(Kamm.xts, FUN=mean, na.rm=F)
hydroplot(Kamm.avgdaily, FUN = "mean", main="Kamm Creek Nitrate", pfreq = "dm", from="2019-10-07")

```

Time series Kamm Creek Boxplot Kamm Creek Histogram Kamm Creek



Time series Kamm Creely Boxplot Kamm Creely Histogram Kamm Cre

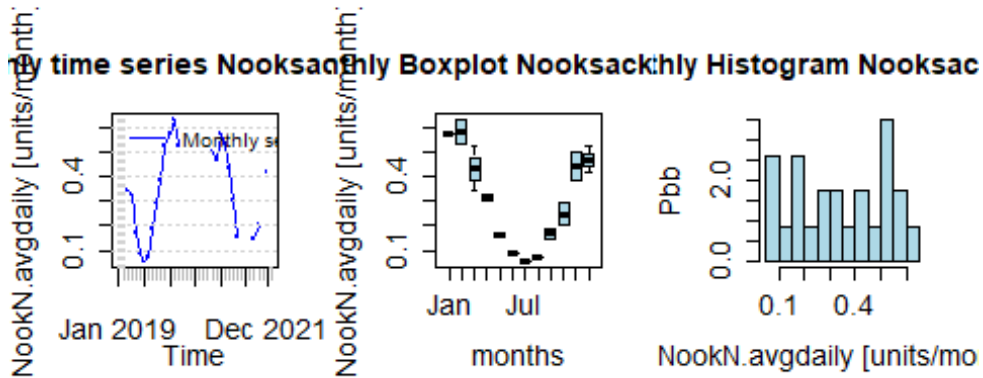
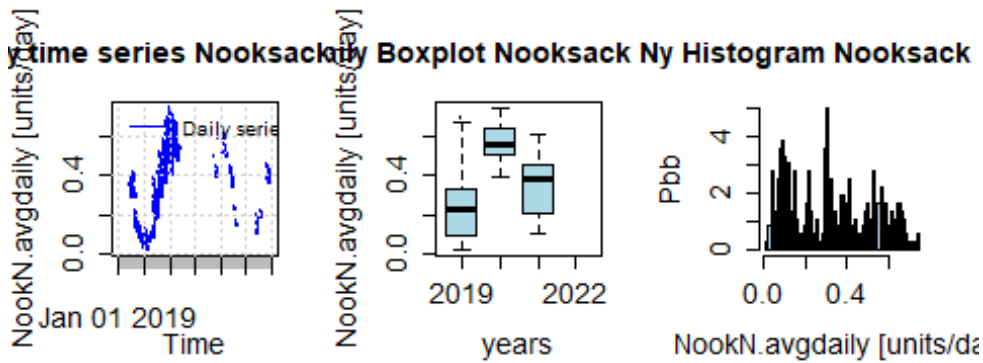


Plot Nooksack data

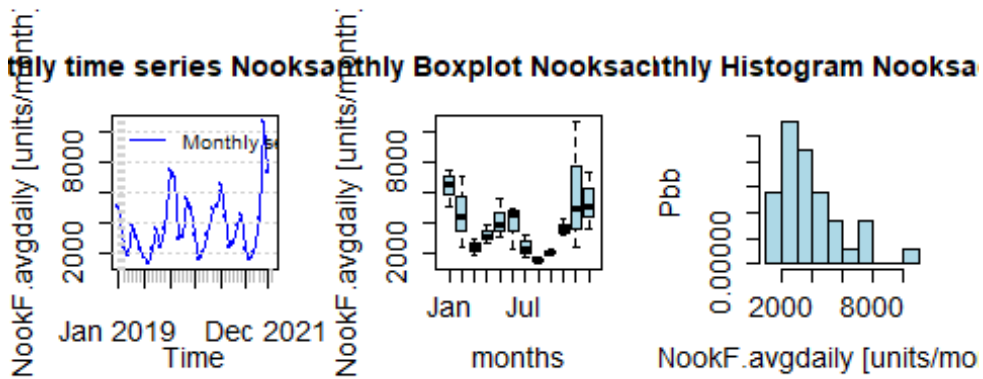
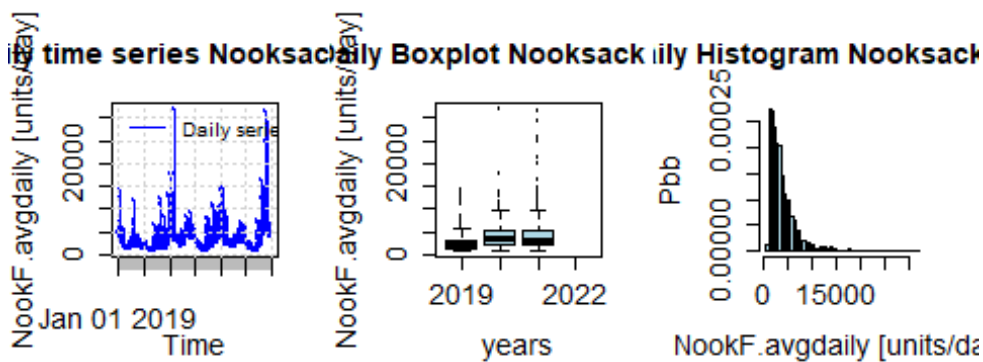
```
# par(mar=c(5,5,5,5)) #sets the size of the plot window

# plot(Nook$dateTime, Nook$X_99133_00000,
#       ylab=variableInfo$variableName[4],
#       col="blue", type="l",
#       xlab="" )
# par(new=TRUE)
# plot(Nook$dateTime, Nook$X_00060_00000,
#       col="red", type="l", xaxt="n", yaxt="n", xlab="", ylab="", axes=FALSE
#       )
# axis(4, col="red", col.axis="red")
# mtext(variableInfo$variableName[2], side=4, line=3, col="red")
# title(siteInfo$station_nm[1])
# leg.text <- c(variableInfo$unit[2], variableInfo$unit[4])
# #legend("topleft", leg.text, col=c("red", "blue"), lty=c(1,1))

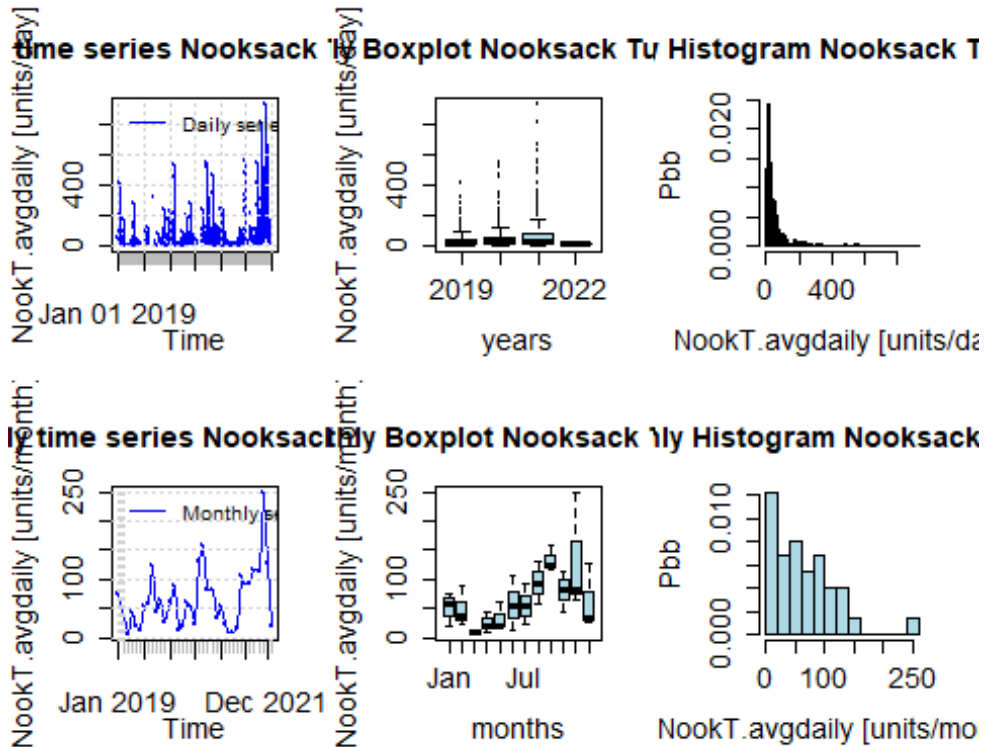
#read in data and creates nitrate hydroplots for the Nooksack River
Nook.Date <- as.POSIXct(Nook$dateTime, tz="America/Los_Angeles")
NookN.xts <- xts(Nook$X_99133_00000, order.by = Nook.Date)
NookN.avgdaily=subdaily2daily(NookN.xts, FUN=mean, na.rm=F)
hydroplot(NookN.avgdaily, FUN = "mean", main="Nooksack Nitrate", pfreq = "dm", from="2019-01-01")
```



```
#creates flow hydroplots for the Nooksack River
NookF.xts <- xts(Nook$X_00060_00000, order.by = Nook.Date)
NookF.avgdaily=subdaily2daily(NookF.xts, FUN=mean, na.rm=F)
hydroplot(NookF.avgdaily, FUN = "mean", main="Nooksack Flow", pfreq = "dm", from="2019-01-01")
```



```
#creates turbidity hydroplots for the Nooksack River
NookT.xts <- xts(Nook$X_63680_00000, order.by = Nook.Date)
NookT.avgdaily=subdaily2daily(NookT.xts, FUN=mean, na.rm=F)
hydroplot(NookT.avgdaily, FUN = "mean", main="Nooksack Turbidity", pfreq = "dm", from="2019-01-01")
```



Plot Fishtrap data

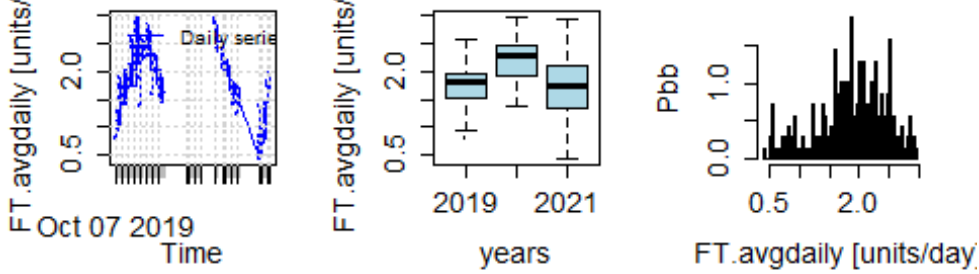
```
# par(mar=c(5,5,5,5)) #sets the size of the plot window

# plot(FT$dateTime, FT$X_99133_00000,
#       ylab=variableInfo$variableName[4],
#       col="blue",type="l",
#       xlab="" )
# par(new=TRUE)
# plot(FT$dateTime,FT$X_00060_00000,
#       col="red",type="l",xaxt="n",yaxt="n",xlab="",ylab="",axes=FALSE
#       )
# axis(4,col="red",col.axis="red")
# mtext(variableInfo$variableName[2],side=4,line=3,col="red")
# title(siteInfo$station_nm[2])
# leg.text <- c(variableInfo$unit[2],variableInfo$unit[4])
# #legend("topleft", leg.text,col=c("red", "blue"),lty=c(1,1))

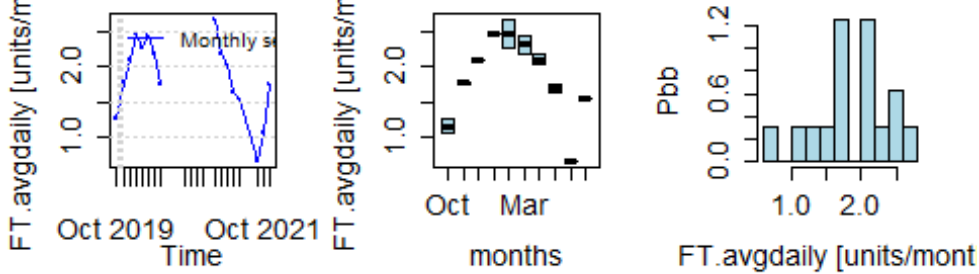
#read in data and creates hydroplots for Kamm Creek
FT.Date <- as.POSIXct(FT$dateTime, tz="America/Los_Angeles")
FT$X_99133_00000 <- as.numeric(FT$X_99133_00000)
FT.xts <- xts(FT$X_99133_00000, order.by = FT.Date, na.rm = T)

FT.avgdaily=subdaily2daily(FT.xts, FUN=mean, na.rm=T)
hydroplot(FT.avgdaily, FUN = "mean", main="Fishtrap", pfreq = "dm", from="2019-10-07")
```

Daily time series Fisht Daily Boxplot Fishtra Daily Histogram Fisht



Monthly time series Fish Monthly Boxplot Fisht Monthly Histogram Fish



Download the daily values from the 3 sites

#Right now we are unable to use daily data because USGS has yet to complete gathering and upload daily Nitrate data

#get available daily data

```
whatcom_N_dv <- readNWISdv(siteNumbers=c("12211390", "12212050", "12213100"),
  parameterCd=c("00010", "00060", "00065", "63680", "99133"),
  startDate="2019-01-01", endDate="2021-01-01")
```

```
nrow(whatcom_N_dv)
```

```
## [1] 1464
```

```
names(whatcom_N_dv)
```

```
## [1] "agency_cd"      "site_no"        "Date"           "X_00010_00003"
## [5] "X_00010_00003_cd" "X_00060_00003" "X_00060_00003_cd" "X_00065_00003"
## [9] "X_00065_00003_cd"
```

```
whatcom_N_dv <- renameNWISColumns(whatcom_N_dv)
```

```
names(whatcom_N_dv)
```

```
## [1] "agency_cd" "site_no" "Date" "Wtemp" "Wtemp_cd" "Flow"
## [7] "Flow_cd" "GH" "GH_cd"
```

```
dailyData <- whatNWISdata(siteNumber = c("12211390", "12212050", "12213100"), service = "dv")
```

```
names(dailyData)
```

```
## [1] "agency_cd"      "site_no"        "station_nm"
## [4] "site_tp_cd"     "dec_lat_va"     "dec_long_va"
## [7] "coord_acy_cd"  "dec_coord_datum_cd" "alt_va"
## [10] "alt_acy_va"    "alt_datum_cd"  "huc_cd"
```

```

## [13] "data_type_cd"      "parm_cd"          "stat_cd"
## [16] "ts_id"            "loc_web_ds"       "medium_grp_cd"
## [19] "parm_grp_cd"      "srs_id"           "access_cd"
## [22] "begin_date"       "end_date"         "count_nu"

dailyData$parm_cd

## [1] "00010" "00010" "00010" "00060" "00065" "00010" "00010" "00010" "00060"
## [10] "00065" "63680" "63680" "63680"

#gets parameter codes and puts them into a format usable by 'grep' function.

write.csv(whatcom_N_dv, "C:\\Users\\jporco\\Desktop\\DailyValues.csv", row.names = FALSE)

```