Flowing Knowledge: Leveraging R software for management and analysis of water quality data on the Bishop Paiute Reservation

By : Sabrina Barlow and Brianda Hernandez

OUTLINE

- BACKGROUND
  - Bishop Paiute Tribe
  - Water Quality Control Program
- Water Quality Monitoring of Bishop Creek and Wetlands
- Data Management and Analysis - leveraging R software
- Resources
- Conclusion - Q&A

BACKGROUND

BISHOP PAIUTE TRIBE

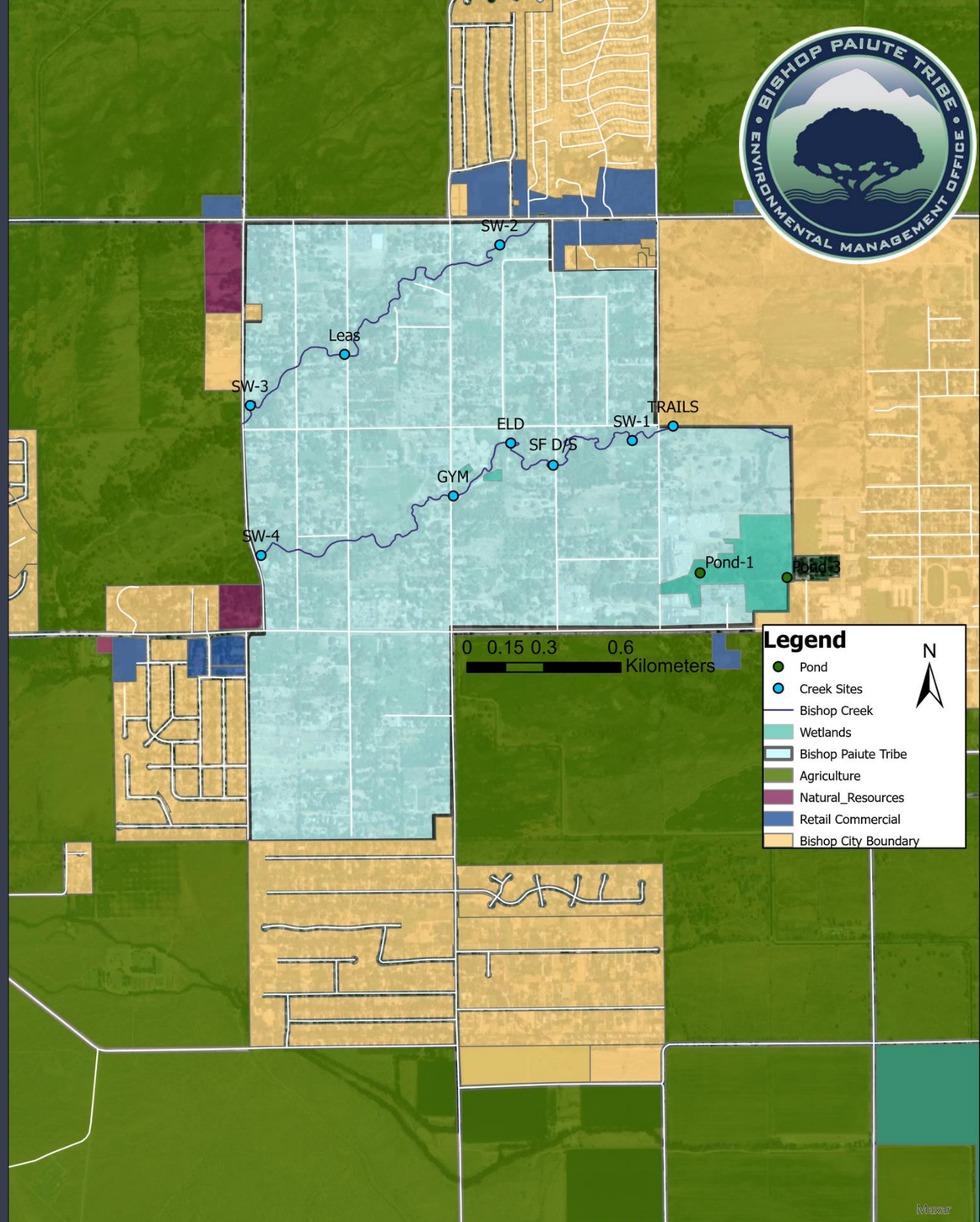
- Federally recognized tribe located on the eastern slope of the Sierra Nevada
- Bishop Paiute is the 5th largest tribe in CA with approximately 2,500 members
- The reservation consist of 875 acres within the Bishop Creek watershed
- Environmental Management Office
  - Water Quality Program – est. 1998
  - Air Quality Program – est. 2001
  - Natural Resources Program – est. 2015
- Bishop Paiute Tribe Environmental Laboratory
  - Est. 1999-2000

WATER QUALITY CONTROL PROGRAM

- **Capacity:**
  - Water Quality Program Coordinator
  - Water Quality Specialist
  - Water Quality Technician

- **Grants:**
  - CWA 106
  - CWA 319 Base
  - CWA 319 Competitive
  - Exchange Network Grant (2019-2023 Ext)

- **106 Guidance Parameters**
  - Dissolved Oxygen
  - Temperature
  - Turbidity
  - pH
  - Phosphorus & Nitrogen
  - Bacteria (Total Coliform + E. coli)
  - BMI
  - Basic Habitat Information



WATER QUALITY MONITORING

Creek Sites

- Continuous Monitoring Sites
  - Four sites - entrance and exit of BC
  - 30 min intervals
  - Text files

- Bacteria and Nutrient Monitoring
  - Total Coliform + E. coli, Phosphorus & Total Nitrogen
  - 8-9 sites

Ditch Sites

- Bacteria and Nutrient Monitoring
  - 18 sites

Wetlands

- Continuous Monitoring - Temp and DO
- Bacteria and Nutrient Monitoring
- 2 Ponds

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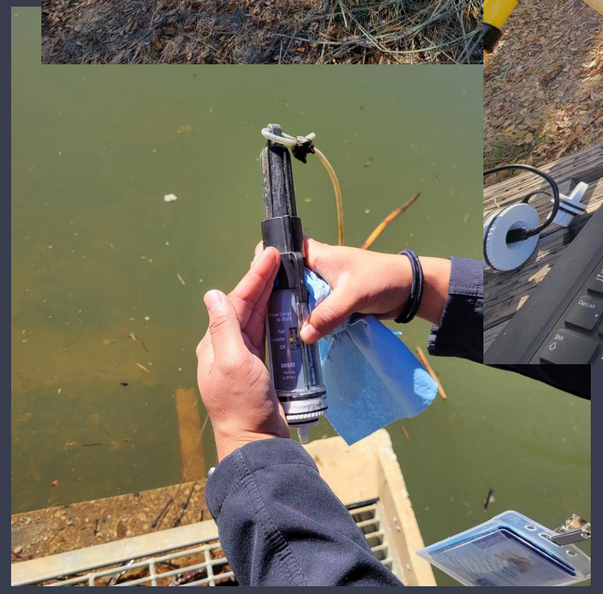
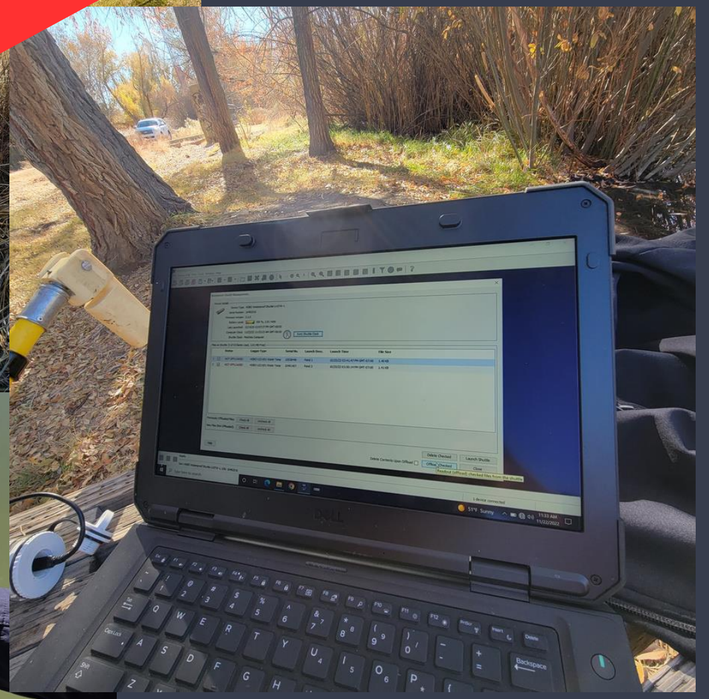
WE ARE GENERATING ALOT OF DATA!





SOLUTION

Exchange Network Grant:

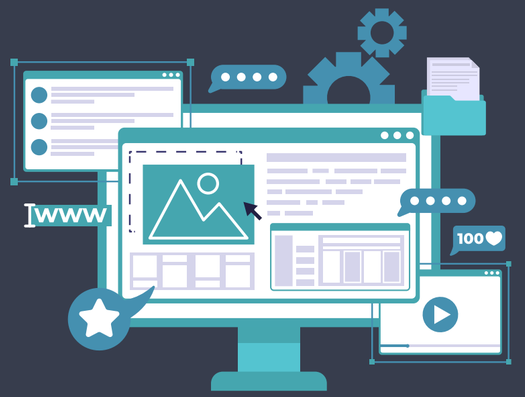
- Proposal submitted and granted in 2019

Goal 1:

- Develop code in R software so users can perform common statistical analyses on a variety of water quality data

Outputs:

- Thorough development, testing, and implementation of the R code will provide users with a useful, effective, and valuable tool to perform streamlined statistical analyses



WHAT IS R?

R is a programming language and software environment primarily used for data analysis, data visualizations, and data manipulation

- High-level programming language
- Open Source
- Data Visualization
- Data Manipulation
- Rich Package Ecosystem
- Reproducible Research

R Studio is an integrated development environment (IDE) for R

- User Friendly interface for writing, executing and debugging R code
- Project organization, package management, data visualization, report generator

LEVERAGING R SOFTWARE

DATA WRANGLING

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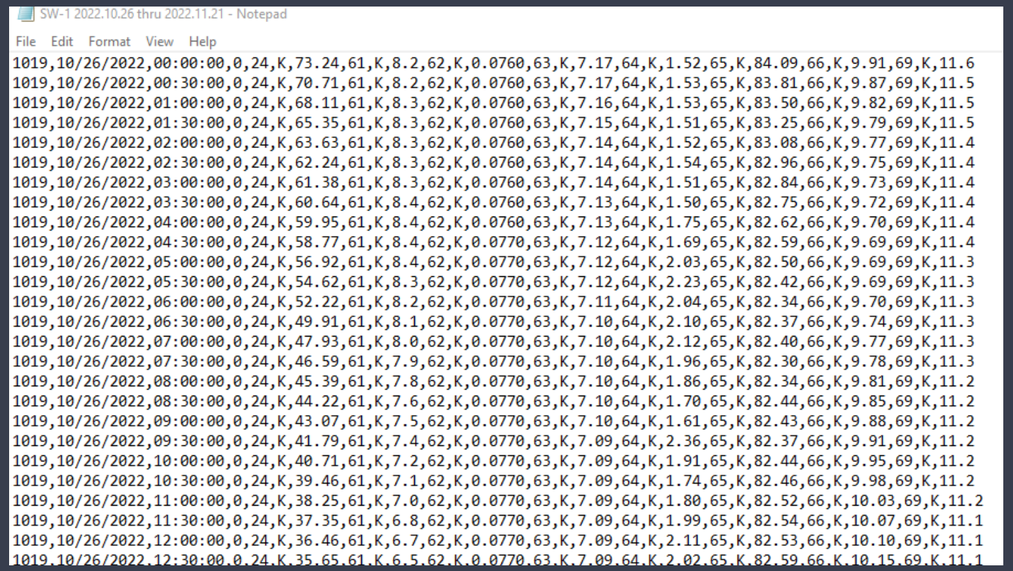
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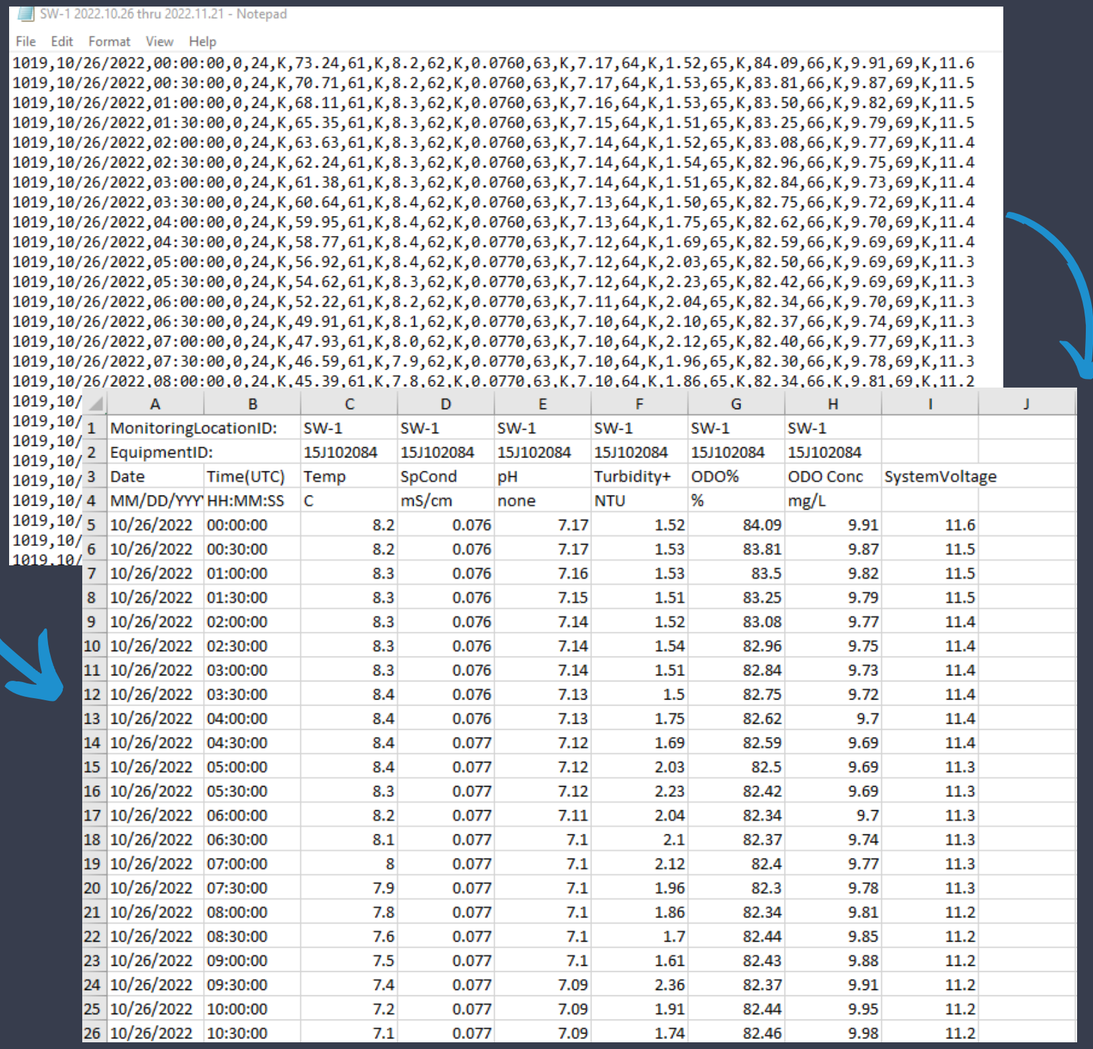

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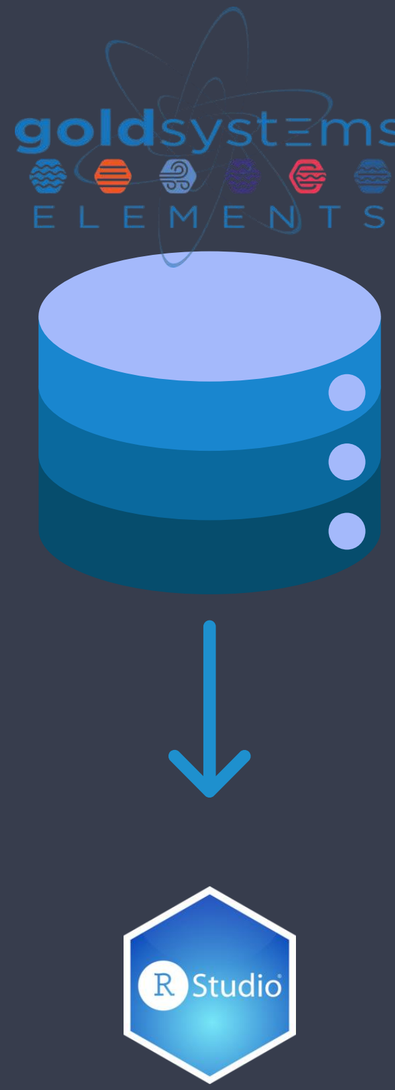
Develop an Application Programming Interface (API): a set of rules and protocols that allows different software applications to talk to each other and share information:

- Pull our WQ data from AWQMS Database directly to R for quicker analysis



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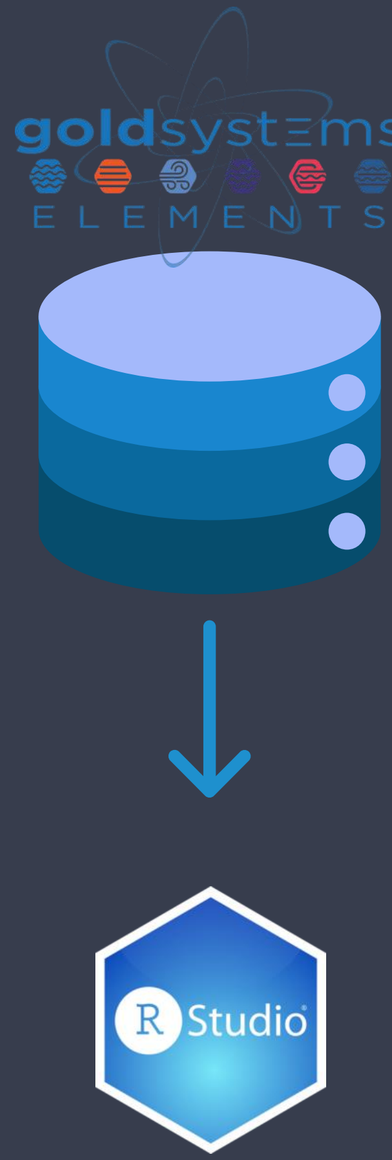
Scripting: writing and organizing code in a modular and reusable manner:

- reuse and adapt specific parts of your code for different projects or analyses



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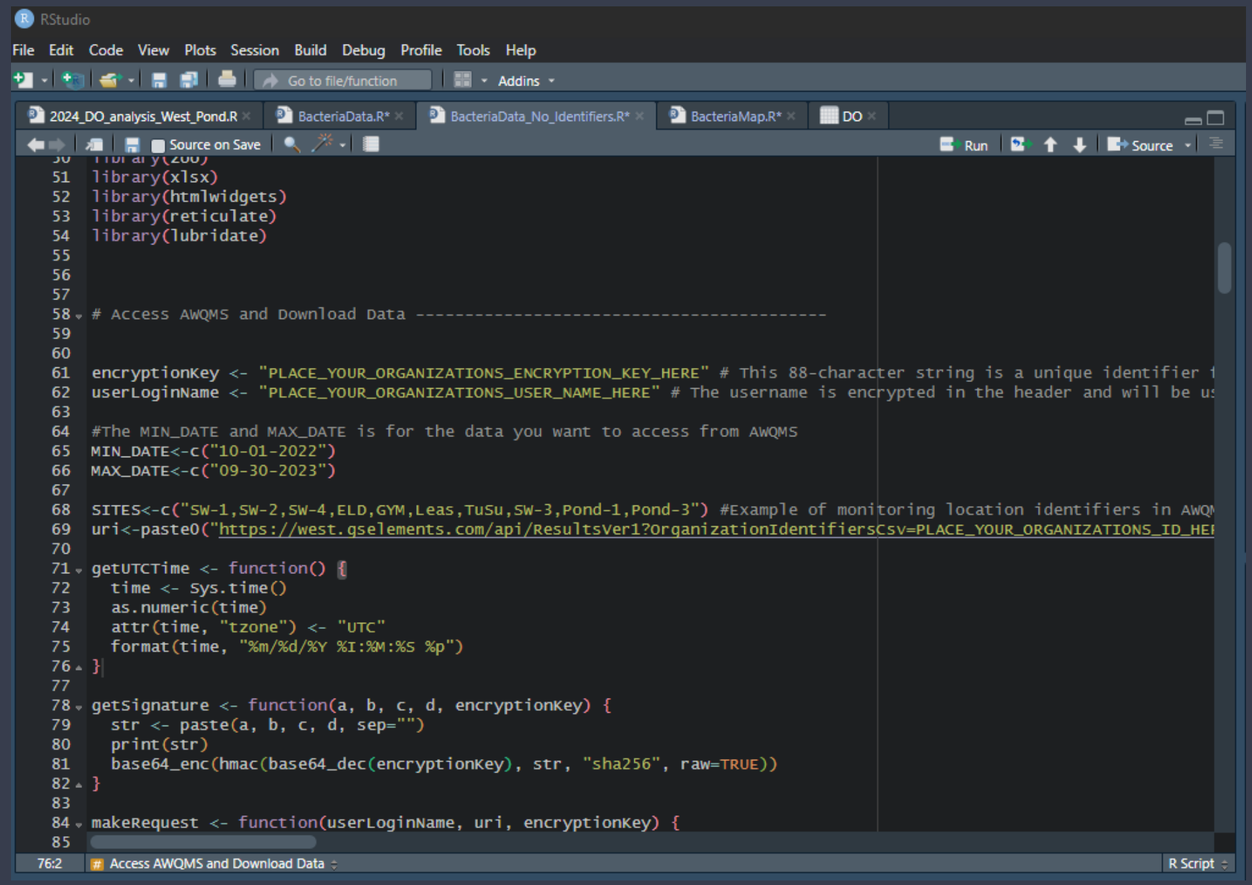
DATA ANALYSIS AND VISUALIZATION

Bacteria

- Calculating Geometric Mean for Bacteria Data



LEVERAGING R SOFTWARE

DATA ANALYSIS AND VISUALIZATION

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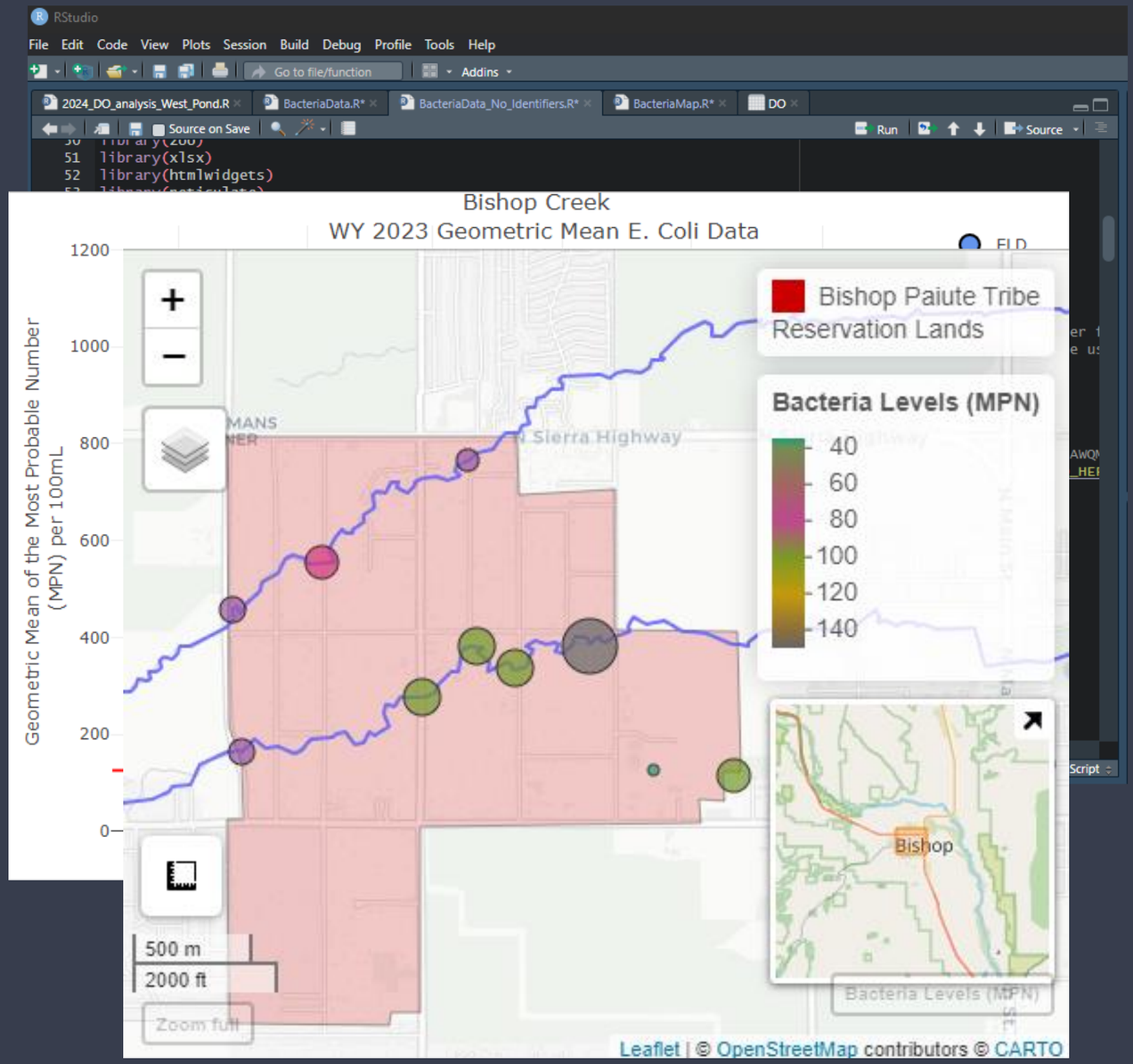
DATA ANALYSIS AND VISUALIZATION

Bacteria

- Calculating Geometric Mean for Bacteria Data
- Data visualization for cleaner display
- Reuse code for spatial visualization of the data

Using R saved time by generating the geometric mean of our bacteria data in seconds and allowed us to reuse code to place data in a spatial visualization to determine the problematic areas



LEVERAGING R SOFTWARE

DATA ANALYSIS AND VISUALIZATION

Benthic Macroinvertebrate (BMI)

- Wrangle complicated BMI taxonomic data

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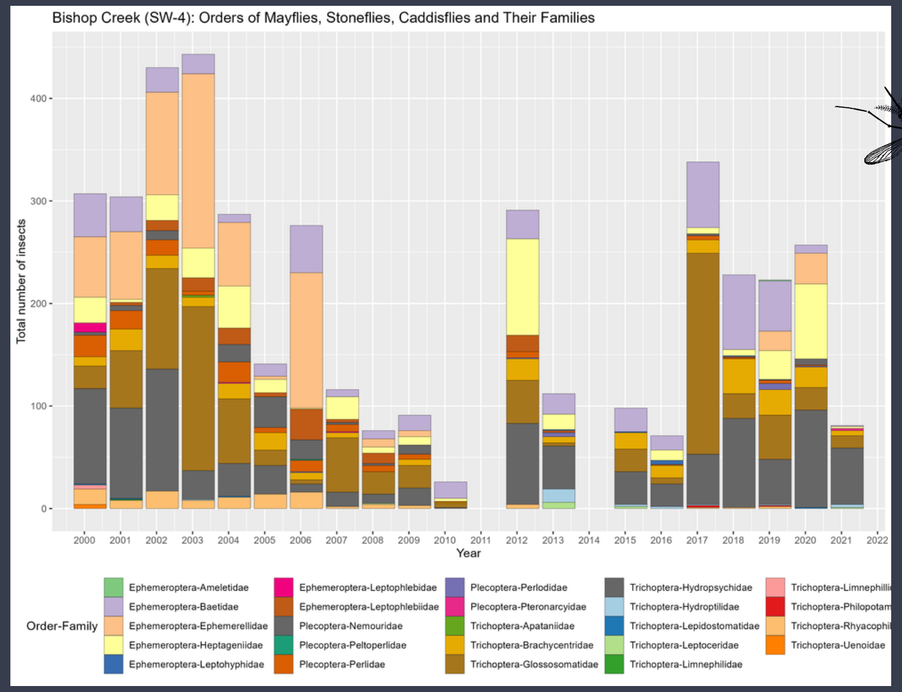
DATA ANALYSIS AND VISUALIZATION

Benthic Macroinvertebrate (BMI)

- Wrangle complicated BMI taxonomic data
- Plot data in a timeseries visualization



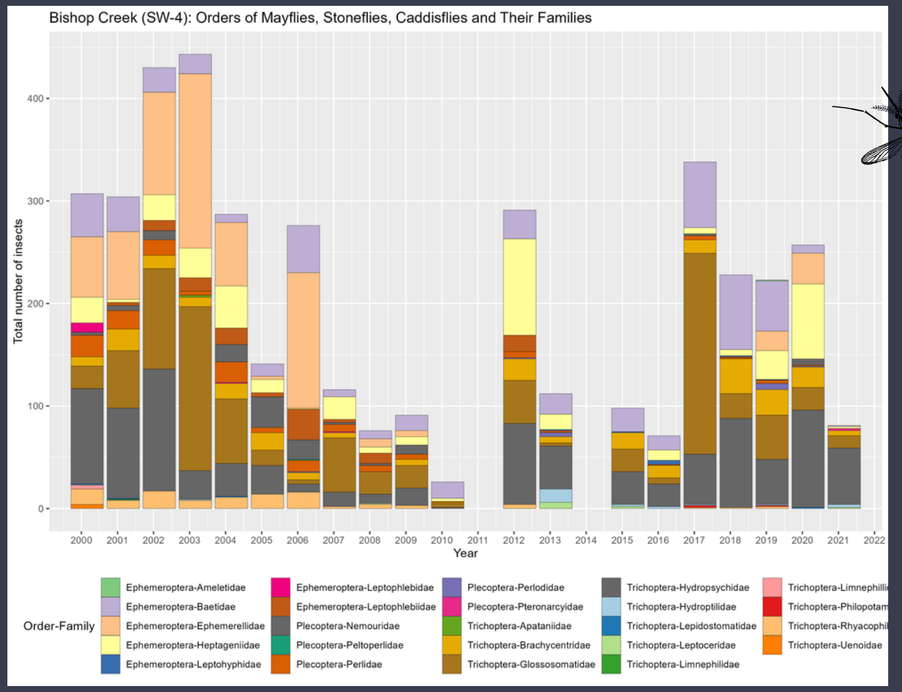
LEVERAGING R SOFTWARE

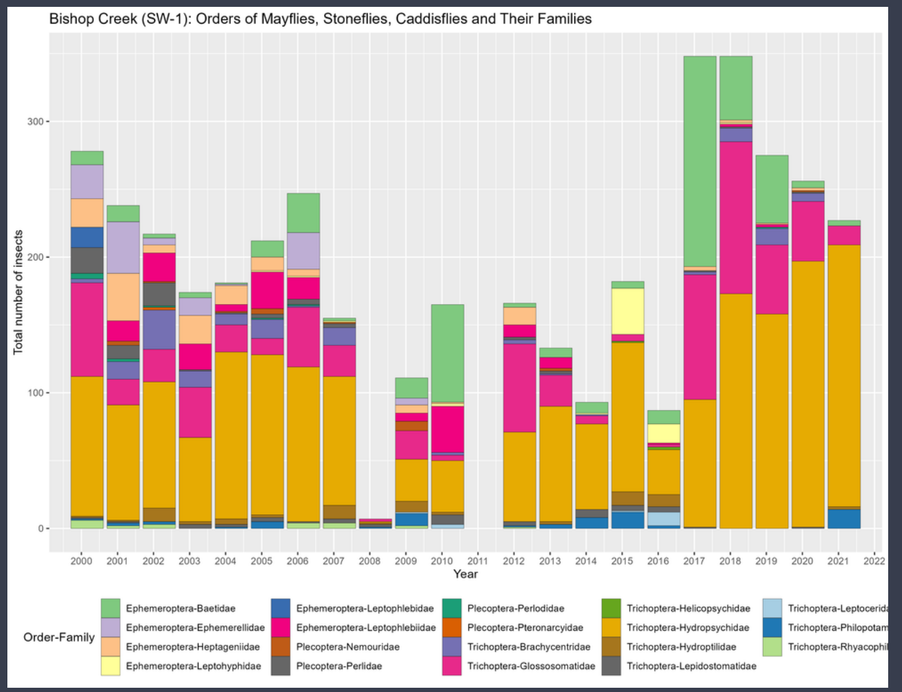
DATA ANALYSIS AND VISUALIZATION

Benthic Macroinvertebrate (BMI)

- Wrangle complicated BMI taxonomic data
- Plot data in a timeseries visualization
- Analyze how BMI changes spatially

R has allowed us to make sense of the BMI data we have been collecting for the last 20+ years by visually displaying the BMI data in a timeseries for each site based on various parameters (Order, Family, etc.)





LEVERAGING R SOFTWARE

REPORT GENERATOR USING R MARKDOWN

R Markdown: a **v**ersatile markup language that combines plain text and R code chunks to generate a dynamic document that integrate data analysis, results and visualizations.

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Water Quality Assessment Report

- Automation and efficiency
- Integration of data analysis and visualization
- Generates HTML, PDF, Word & more documents
- Consistent formatting!

www.bishoptribeemo.com

FUTURE WORK

REPRODUCTIBILITY

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- Adding developed scripts to our GitHub account for other's to reproduce with their data
- Encourage collaboration and feedback
- Expand the impacts of our work that might be beneficial to fellow tribal environmental professionals

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ACCESSIBILITY

- Make water data visualizations available to the Bishop Paiute Tribal community
- Enable other tribal programs with varying levels of expertise to understand and utilize data effectively

RESOURCES

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WWW.EXCHANGENETWORK.NET

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The internet: offers a wealth of resources for learning R, from structured courses on platforms like DataCamp and Coursera to helpful forums like Stack Overflow and the RStudio Community.

R for Water Resources Data

Free training!

QUESTIONS?

Contact Information:

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Sabrina Barlow - Water Quality Specialist
sabrina.barlow@bishoppaiute.org

THANK YOU!