Solano County High School Biomonitoring Program

2020-2021 Program Summary

Solano RCD is grateful to the program funders:

Solano County Water Agency

Vallejo Flood and Wastewater District

Solano County Department of Resource Management

City of Benicia

Written and Administered by
Solano Resource Conservation District

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PROGRAM OVERVIEW

Solano County Water Agency, Vallejo Flood and Wastewater District, Solano County Department of Resource Management, and the City of Benicia contracted the Solano Resource Conservation District ("Solano RCD") to design, manage, and implement the 2021 Solano County Biomonitoring Program, a watershed education program engaging high school students in conducting community science and monitoring at several urban creeks located throughout Solano County.

Marianne Butler provided program oversight with assistance from Allison Martin, who also managed the curriculum and teacher relations. Laura Morgan was the field trip lead, Program Educator Gaia Pazienti facilitated live, virtual lessons and field trips, and Program Educators Arianna Oneto and Doug Darling supported field trip activities.

GOALS AND OBJECTIVES

The Biomonitoring Program focuses on a micro-perspective, looking at a single reach of a single creek and evaluating watershed health through physical, chemical, and biological assessments. Participants leave the program understanding:

- the relationship between stream ecology and water quality;
- the extent of local water quality issues and ways to improve surface water quality;
- the value of citizen science and habitat restoration in watershed management;
- professional opportunities in the field of environmental science.

The guiding question for the Biomonitoring Program is:

> *How can we investigate and describe the health of Solano County watersheds, and furthermore, why is having a healthy watershed important?*

From this guiding question, the program is structured on the following goal:

> *All participating high school students will investigate and collect data to serve as evidence for scientific questions regarding the health of their local watershed*.

Beyond its educational component, the Biomonitoring Program also aims to provide long-term data to water agencies, resource managers, and watershed scientists to support stream monitoring, mitigation, and restoration efforts. Long-term biological, chemical, and habitat monitoring of creeks through standardized procedures helps to describe local watershed health and research opportunities for local scientists, stakeholders, and watershed managers.

According to Dr. Patrick Edwards with Portland State University, it is rare locally and internationally to have such long term data collected primarily by high school students, and therefore this program is valuable not only in its support of educating students on environmental stewardship practices and science, but also in providing valuable and consistent data to the scientific community and regional stakeholders. By comparing results year by year, we can help stakeholders distinguish positive and negative trends in each watershed.

AUDIENCE

This year had the highest number of participants in the program's history, with 896 students enrolled from 31 total classes. 42% of classes were from Vallejo; 23% from the Fairfield-Suisun Unified School District; 16%

from Dixon; and 10% from Vacaville. The remaining classes came from Benicia Unified School District and the Travis Unified School District. Rio Vista High School elected not to participate due to conflicting schedules and coursework.

Some teachers and classes elected to participate only in the pre-program Nearpod and live virtual field trip. Those classes are indicated by an (*) in Table 1 below.

Table 1. *Summary of Program Enrollment by City or District*

School by City	Teacher	Course(s)	Total # Classes	Total # Students
BENICIA				
Benicia High	Josh Bradley	Environmental Science	2*	55
DIXON				
Dixon High	Kaitlin Benner	AP Environmental Science; Freshman Biology	5	140
FAIRFIELD				
Fairfield High	Heather Handa	Environmental Science	2	50
Armijo High	Peter Smith	International Baccalaureate Biology	2	60
Rodriguez High	Tamara Moore	Freshman Biology	3*	75
TRAVIS				
Vanden High	Jennifer Ault	AP Environmental Science	1	16
VACAVILLE				
Vacaville High	Erin Gordon	AP Biology	1	37
Will C. Wood High	Kevin English	AP Environmental Science	2	55
VALLEJO				
Vallejo High School	Vivet Nelson, Malgene Tubal	Freshman Biology; BioTechnology; Sophomore Chemistry	7	245
Jesse Bethel High	Mariella De la Cruz	Freshman Biology	4*	107
Mare Island Technology Academy	Michael Wee	AP Environmental Science	2	56
2021 PROGRAM TOTALS			**31**	**896**

METHODOLOGY

Student Instruction

In a typical program year, students participate in two preparatory classroom lessons and two field studies conducted alongside Solano RCD staff at a local creek. All events emphasize a hands-on approach to researching, collecting, and interpreting stream ecology data by 1) measuring stream habitat; 2) collecting water chemistry data; and 3) sampling, identifying, and counting benthic macroinvertebrates. After the second field study, students calculate the stream's Index of Biological Integrity (IBI score) and use the chemical and physical data to help identify environmental stressors influencing creek health.

In response to the COVID-19 pandemic, all Solano County K-12 public school students were required to participate in virtual, online instruction for the 2020-2021 school year. To accommodate this new instruction style and continue offering the Solano County Biomonitoring Program, Solano RCD updated the program to be offered virtually:

> **Pre-Lesson Activity:** Students were introduced to the program and basic ecology concepts by completing a Nearpod module (interactive online learning platform). In the Nearpod, students watched a past program video, took quizzes, experimented with a stormwater runoff simulator (Model My Watershed - Runoff Simulation) and responded to a series of questions that helped them develop an understanding of how watershed health is connected to urban stormwater runoff.
>
> **Lesson 1:** A Program Educator guided students through a discussion on why healthy creeks matter and how to use biological, chemical, and physical data to determine creek health as part of a live streamed, virtual lesson.
>
> **Lesson 2:** A Program Educator used PearDeck, an interactive web-based application, to engage students through macroinvertebrate taxonomy and identification.
>
> **Field Trip:** A Program Coordinator, Program Educator and Program Assistant guided students through the scientific procedures taken by student scientists to assess the biological, chemical, and physical characteristics of the creek and determine its overall health.
>
> **Lesson 3:** Either through a Nearpod or a live streamed virtual lesson, students analyzed the biological data collected from the creek to calculate the Index for Biological Integrity (IBI) Score and determine creek health. Upon reflection of the creek's health and potential causes, students discussed ways to improve creek health on an individual and a community-based level.
>
> **Optional Post Lesson Activity:** Students wrote a scientific report outlining the methods and results of the biomonitoring program.

Streamside Assessment

This was the thirteenth year that the program collected stream health data using the California Streamside Biosurvey, a streamside bioassessment protocol previously used by the California Department of Fish and Wildlife before the statewide implementation of SWAMP, or the Stream Water Ambient Monitoring Program. This program continues to use the California Streamside Biosurvey protocols to maintain data coherence and applicability in a student-based setting.

Without students attending the programs in person, all chemical and biological data was collected by Solano RCD education program staff. A total of nine creek sites were assessed, including: Upper and Lower Blue Rock Springs Creek, Rindler Creek, Sulphur Springs Creek and Chabot Creek in Vallejo; Union Avenue Creek and Laurel Creek in Fairfield; and Alamo and Ulatis Creeks in Vacaville. Please see **Appendix A** for a map of sample locations.

All data is analyzed and interpreted by Dr. Patrick Edwards of Portland State University, who has been specializing in citizen science biomonitoring programs since the early 2000s and provides an annual creek analysis for this program. Dr. Edward's 2021 analysis is available as **Appendix B** of this report.

PROGRAM EFFICACY

We assess gains in student knowledge about the stream monitoring and stewardship concepts taught in the Solano County Biomonitoring program using a two part assessment quiz. Students take the first quiz prior to participating in any component of the program, allowing us to capture the baseline knowledge students already have. Participants take the second quiz after the final lesson, allowing us to measure the knowledge students possess after participating.

The five question pre and post assessment instruments attempt to measure understanding about the importance of stream health, ways to measure that health, and stewardship strategies. We also ask an open-ended pre and post question about students' general interest in stream monitoring and stewardship:

1. **Why do healthy creeks matter?**
   Desired Response: It's important to have healthy creeks because creeks are connected to larger bodies of water (watersheds) that we use for drinking, irrigation, and recreation. This can affect our health and our community's health. Healthy creeks also mean healthier ecosystems (plants and animals).

2. **What might affect creek health?**
   Desired Response: Chemical and physical pollution, water temperature, and streamflow affects creek health (by affecting the amount of dissolved oxygen, pH, and turbidity). All of these can be affected by habitat/vegetation loss and increased impermeable surfaces like roads.

3. **What information is needed to decide if a creek is healthy?**
   Desired Response: Count the number and types of benthic macroinvertebrates (biological assessment) to calculate the IBI score, test the water chemistry (chemical assessment), and analyze the habitat (physical assessment). Compare the data year by year and look for trends.

4. **How can we improve creeks that aren't healthy?**
   Desired Response: Increase the amount of permeable surfaces to reduce runoff/erosion (e.g., use mulch, plant trees and native grasses); reduce stormwater pollution (e.g., follow instructions for fertilizer/pesticide application); habitat restoration (e.g., plant along or near creeks); educate others and ask for school/community support to address local water issues.

5. **Pre Only:** What do you hope to learn from this program?
   Post Only: What do you still want to learn after being in this program?

The COVID-19 pandemic response required us to convert this year's program to an entirely online environment, including the assessments. This resulted in notable issues with the assessment process, particularly a drop off in the number of classes completing the post assessment. The marked difference in sample sizes is not ideal, and teachers provided us with no reasons for the drop off in participation. Three classes comprised of 126 students submitted no post assessments, and their pre-assessment data collected was disqualified from our data set.

We also offered an abbreviated program to schools, an option chosen by 23% of participants, and differences in quiz performance were analyzed as well. It should also be noted that 16% of our full program participants were ninth graders; all other participating students were AP Biology, AP Environmental Science or IB Biology/BioTech II students.

Assessment Results

- **Pre-Assessment:** 554 students completed the pre-assessment questions, and a sample of 335 responses were examined. In the aggregate, 85% of students provided correct or partially correct answers to the fixed answer questions (questions 1-4), with 93% of students engaged enough to make a serious attempt at the open-ended question (question 5).
    - Only 1% of students came into the program able to correctly identify factors that impact creek health (question 1), while 87% were able to provide partially correct answers.
    - The two other questions about creek health generated similar responses: few students could provide a completely correct answer, but a large majority could provide partially correct ideas. This pattern was similar across both participant cohorts (full program participants and abbreviated program participants).
    - 9th grade students were able to provide more fully correct answers (12%) and slightly fewer partially correct answers.
- **Post-Assessment:** The number of students who completed the post assessment dropped 51.5% in the aggregate, but those who completed the quiz improved their ability to express understanding of the concepts for every question.
    - Students who completed the post assessment provided correct or partially correct responses to 98% of the questions, and provided incorrect or no answer to just 2% of the questions. These results were similar across both cohorts.
    - Students who participated in the abbreviated program performed slightly better, providing 99% correct or partially correct and answers, and 23% correct answers, an improvement of 7% from the pre-assessment.
    - Students who participated in the full program also demonstrated gains, improving their ability to answer correctly by 11 percentage points. The 9th grade cohort's improvement was slightly less (3 percentage points) but the group was still able to provide correct or partially correct answers 97% of the time.

APPENDIX A – *Maps of Creek Study Sites*

Figure 1. The location of the four study sites in Vallejo. A fifth site (Sulphur Springs Creek) is located to the northeast in the Sulphur Springs Mountains and studied by Benicia High School students.

Figure 2. The location of the two study sites in Vacaville.

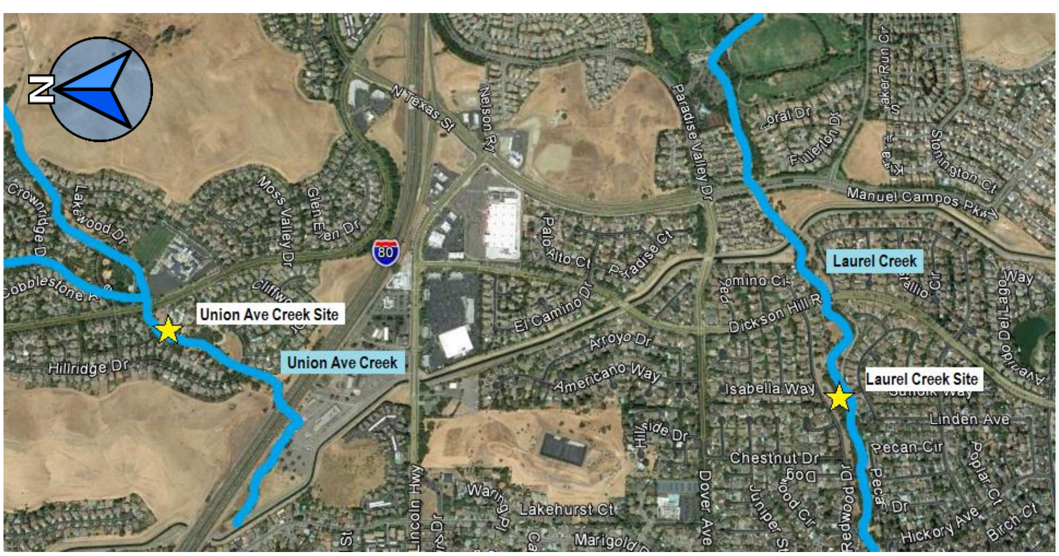


Figure 3. The location of the two study sites in Fairfield.

APPENDIX B – *2021 Biomonitoring Results*

2021 analysis of the Solano RCD stream monitoring data

Prepared for Solano Resource Conservation District
by Patrick Edwards, Ph.D., Portland State University

Summary

For the past thirteen years, the Solano Resource Conservation District (RCD) has developed and implemented watershed health curriculum and partnered with high school teachers and students to collect aquatic macroinvertebrates and stream water chemistry data from nine streams in Solano County.

In 2021, California Streamside Biosurvey Index of Biotic Integrity (IBI) scores are returning from the peak observed in 2016-2017. Most of the 2021 IBI scores fall in the poor or fair category, an indication that stream conditions are degraded to impaired. Overall, Ulatis Creek in Vacaville and Sulphur Springs Creek in Vallejo (Carquinez Strait Watershed) have the highest IBI scores while Alamo (Vacaville), Lower Blue Rock Springs Creek in Hanns Park (Vallejo), Chabot Creek (Vallejo), and Union Avenue Creek (Fairfield) have the lowest IBI scores.

Relationships between IBI scores and environmental conditions were relatively weak, likely due to the fact there is only one year of quality stream water chemistry data in the 2021 analysis. IBI scores were significantly positively correlated with climate conditions, likely through precipitation and atmospheric temperature patterns associated with El Niño conditions. IBI scores were not associated with the amount of urbanization in the watershed, which is likely due to a poor characterization of land use within the basin.

Based on the results of the analysis and my understanding of the overall goals of the project, I make the following recommendations:

- Continue using modified collection methods.
- Continue using the digital water chemistry meter and make sure to calibrate it before the 2022 sampling season.
- Acquire more detailed and accurate GIS information about the land use, including agriculture, for use in analyzing the effect of land use on IBI scores.

Introduction

The purpose of this analysis is to examine year-to-year and long-term trends in the macroinvertebrate data collected by students participating in Solano RCD's education program. To that end, the data for each year are organized and analyzed for each year and across the life of the program. The data collected through this project represents valuable information that can be used by stream managers to monitor the overall health of the streams in Solano County and to examine the impact of stream and watershed restoration efforts.

The objective of this report is to 1) summarize and evaluate the macroinvertebrate data collected through the Solano RCD project, 2) examine temporal and spatial relationships of the data, and 3) make recommendations for future programmatic implementation.

Methodology

Field methods

In a typical year, high school students collect macroinvertebrates with a D-net and sort them using a non-lethal method modified from Edwards (2016). At each reach, students collect three samples from the left, center and right-hand side of the stream and subsampled and counted at least 100 insects. Three reaches from each stream are sampled and the data are combined across all reaches in the study stream. Macroinvertebrate identifications are generally at the family and order level.

This year, the collection methods were implemented only by Solano RCD staff due to COVID-19 social distancing requirements.

Bioassessment data

Bioassessment data were analyzed using the California Streamside Biosurvey Index of Biotic Integrity (IBI). Composited macroinvertebrate data for each stream were used to generate IBI scores. IBI scores were compared among streams and over the 13-year sampling period.

Environmental data and analysis

From 2009-2020, stream water chemistry including Dissolved Oxygen, Nitrogen, Phosphates and temperature were collected using Hach kits or thermometers. Due to the low precision and accuracy of the Hach test kits, staff begin collecting chemistry data with a digital meter; however, nitrogen and phosphorus are still being collected using a Hach Kit. Stream chemistry data were analyzed using only the 2021 data. To evaluate the relationship between IBI scores and environmental conditions, 2021 IBI scores were correlated against 2021 stream chemistry data and percent of the watershed developed as urban. Land use was categorized using the USGS StreamStats application https://streamstats.usgs.gov/ss/). Each basin was sub-delineated from the data collection point and the percent urban land use in the watershed was calculated. Percent urban land was not calculated at Chabot creek site due to its location just below the dam for Lake Chabot.

Climate Analysis

The relationship between invertebrates and climate was examined using precipitation, air temperature, and El Niño strength data. Precipitation and temperature data were obtained from NOAA's National Center for Environmental information (Station # USC00042934). El Niño strength was obtained from NOAA's ENSO MEI page (http://www.esrl.noaa.gov/psd/enso/mei/table.html). ENSO MEI values are published as a scaled value with negative values indicating a La Niña condition and positive values indicate an El Niño Condition. Mean MEI index values ranged from -3 to 3. The ENSO MEI values are frequently used in studies of stream invertebrates to characterize general climate conditions in the study area (Mazor et al 2009).

Environmental data (Temperature, precipitation and ESNO MEI) were summarized using data for the year prior to collecting (November to March) and scaled so that the means of all data are zero and each data point is expressed as a deviation from the mean in terms of standard deviation. Environmental data was expressed as total precipitation, mean average air temperature and ENSO MEI for the water years 2009-2020.

For the climate analysis, the mean scaled IBI value for each stream over the entire study period were correlated with temperature, precipitation and the ENSO MEI value. The strength of the relationship was determined using linear regression.

Results

Bioassessment Scores

Over the 13-year study period, bioassessment data for all streams ranged from 6 to 29 (Figure 1). Most of the IBI scores fall in the fair to poor category, indicating that stream conditions are degraded or impaired. Overall, Ulatis and Sulphur Springs have the highest IBI scores while Alamo, Lower Blue Rock Springs (Hanns Park), Chabot and Union Avenue have the lowest IBI scores.

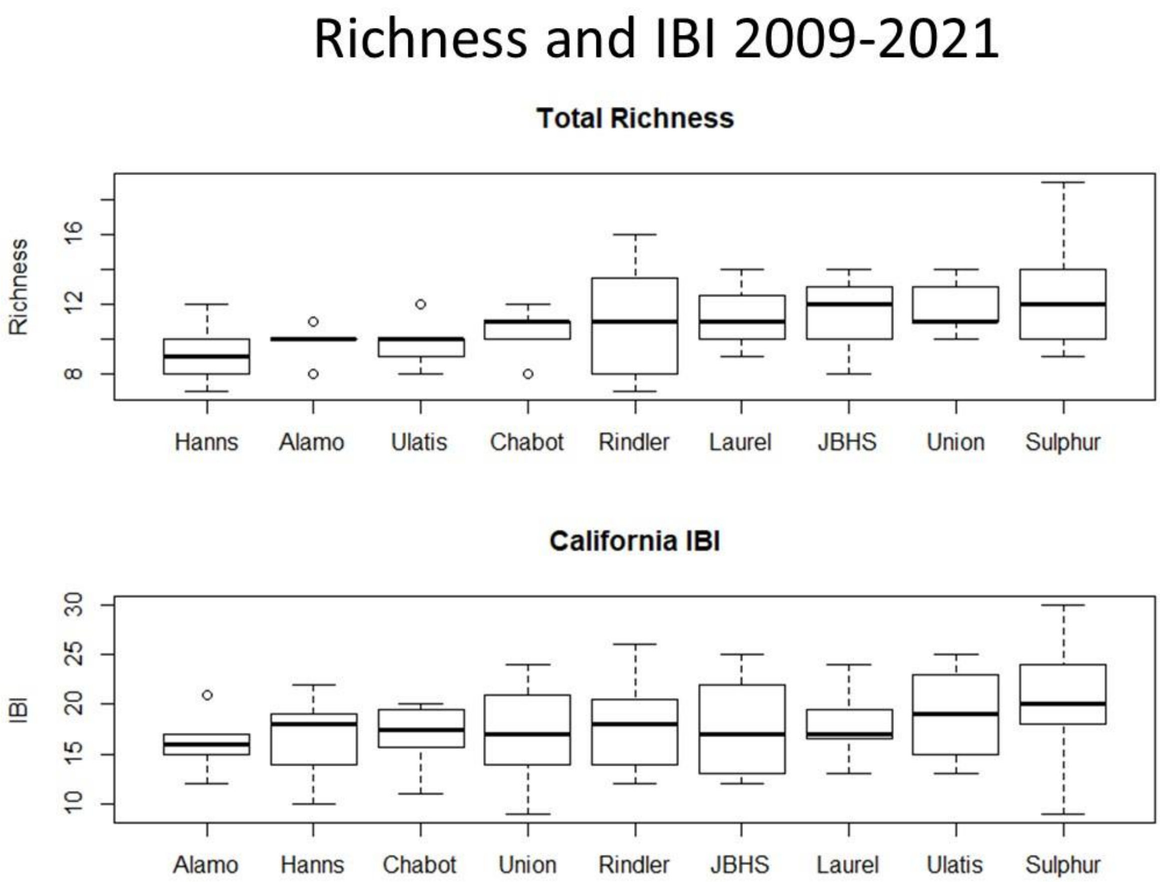


Figure 1: *Richness and IBI scores from 2009-2021 for all streams. Not all streams have data for each year.*

The IBI scores from 2009-2021 (Figure 2) continue to be highly variable but a generally increasing trend (R^2=0.60, p = 0.01) for all streams can be observed in the data (Figure 3). In 2021, many of the streams showed an increase from the low IBI values observed in the 2017 -2018 data; however, most of streams have not returned to the maximum values observed in 2016.

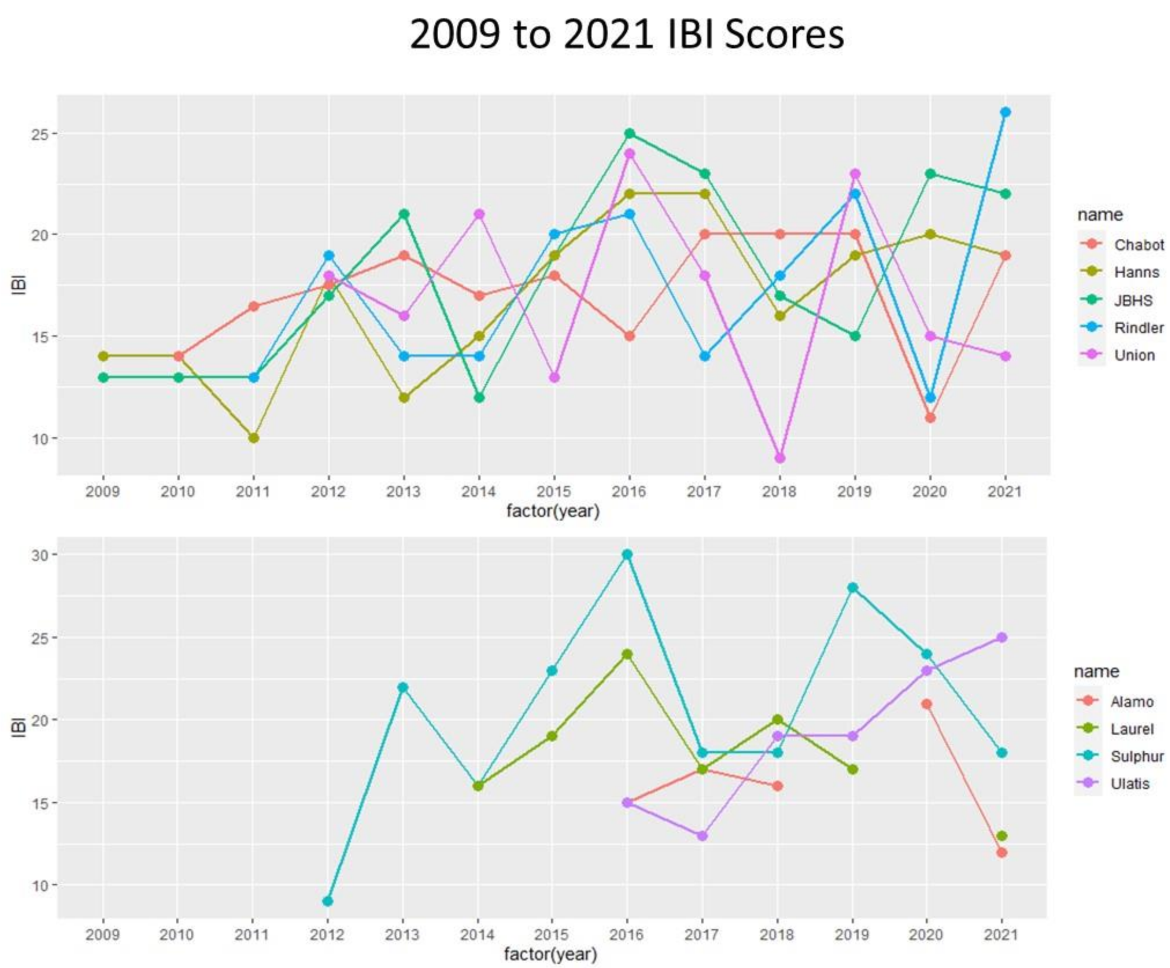


Figure 2: *IBI scores for all streams from 2009-2021. Not all streams have an IBI score for every year.*

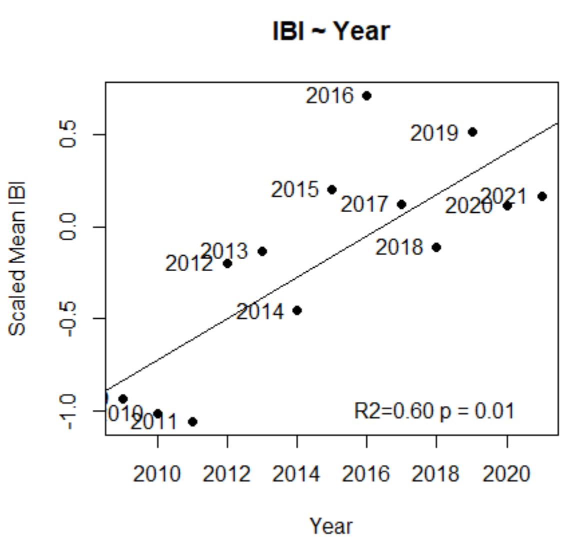


Figure 3: *Mean Scaled IBI values as a function of year.*

Environmental data

Stream water chemistry data were highly variable between streams. The observed values were typical of urban streams with high levels of dissolved materials and relatively warm stream temperatures (Figure 4). In general, Lower Blue Rock Springs (Hanns Park), Rindler and Upper Blue Rock Springs Creek (below Jesse Bethel High School) had the highest dissolved oxygen, lowest temperature and highest conductivity. Stream chemistry data were poorly correlated with IBI scores and none of the linear models were statistically significant (Figure 5).

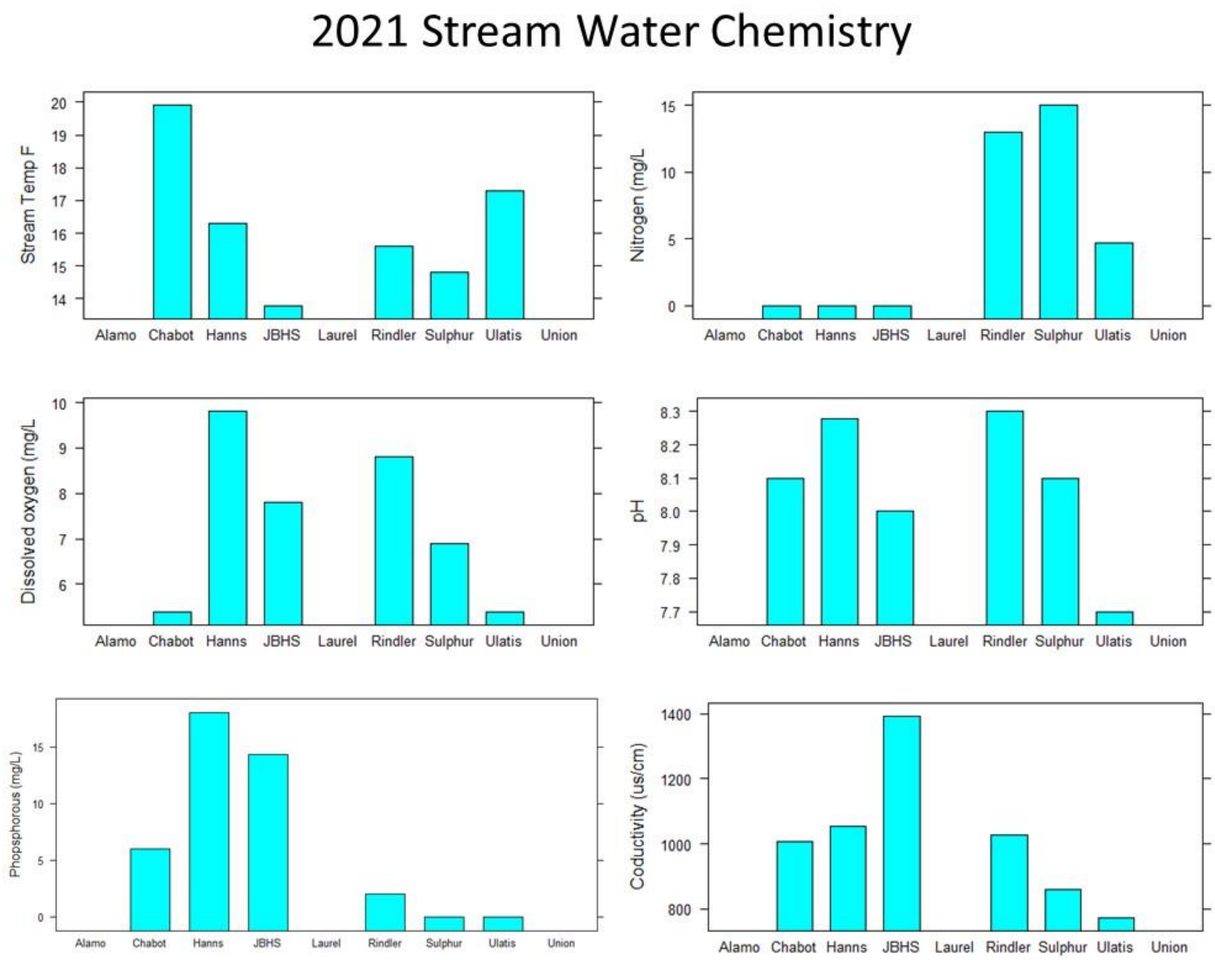


Figure 4: *Stream water chemistry in all streams.*

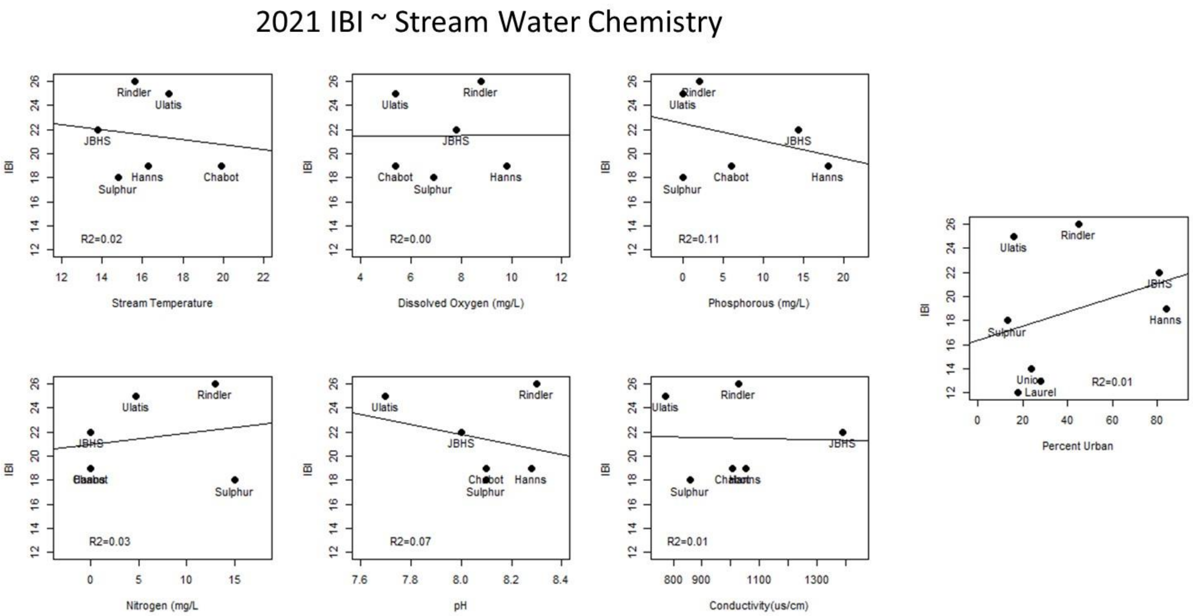


Figure 5: *Scatterplots and R^2 values for IBI scores as a function of stream water chemistry and percent urban in the land use.*

Urban land use was highly variable across the region with Rindler, Upper and Lower Blue Rock Springs have the highest percentage of the watershed with urban land use and Sulphur Springs, Ulatis and Alamo with the lowest (figure 6). Percentage of the watershed with urban land use was poorly correlated with IBI scores (Figure 5, right panel).

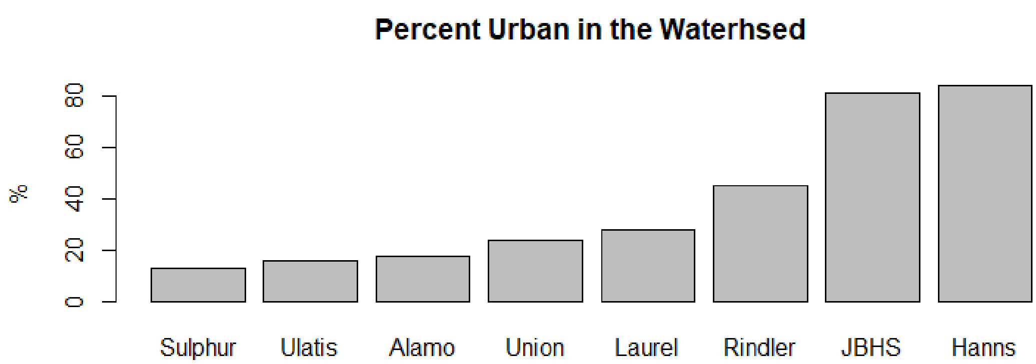


Figure 6: *Percentage of urbanization in each watershed.*

Climate data

The results of the climate analysis show that IBI score is positively correlated with the ENSO MEI (Figure 7, R^2=0.30, p = 0.06) and water year mean annual air temperature (R^2=0.41 p = 0.02). IBI was not correlated with water-year precipitation. Long-term data show the relationship between IBI and the ENSO value (Figure 8).

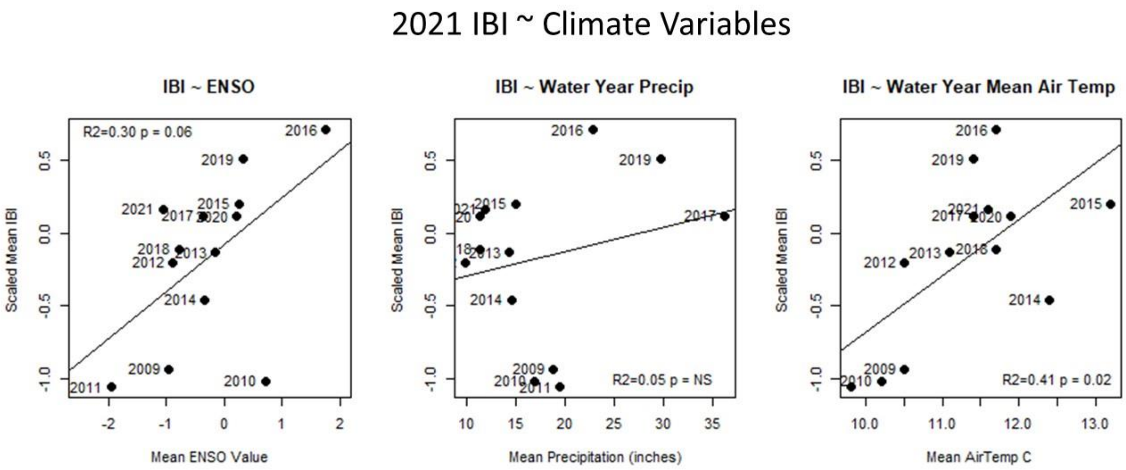


Figure 7: *Scaled IBI values as a function of El Niño strength (ENSO), water-year precipitation and water-year air temperature.*

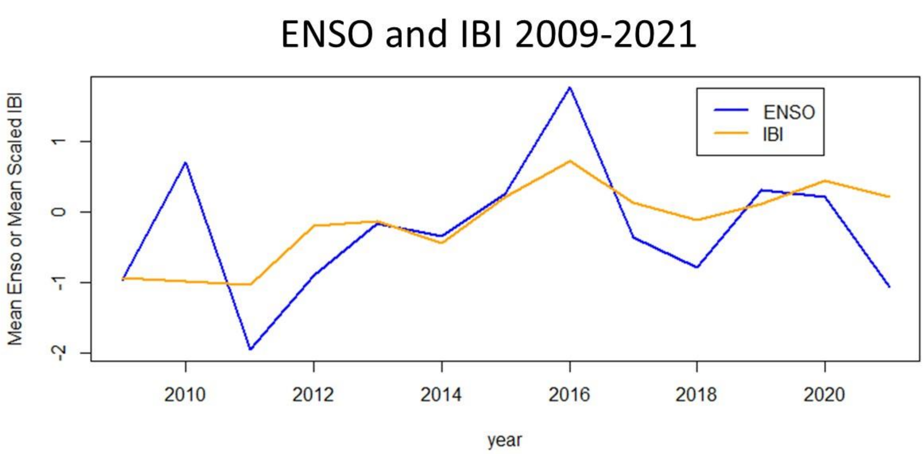


Figure 8: *Relationship between IBI and El Niño strength (ENSO) from 2009 to 2021.*

Discussion

The assemblage of macroinvertebrates in the streams consists of taxa that are well-known to be generally tolerant to poor stream conditions. For example, most streams in this project were dominated by very tolerant dipterans, mayflies and non-insect taxa. This pattern has been observed in other urbanized stream systems (Brown et al 2005).

In general, the 2021 IBI scores appears to be stable after a slight decline from the peak IBI levels observed in 2016-2017. Overall, the IBI scores across all streams are generally increasing. There are two possible explanations for this pattern – the stream condition may be improving and this is reflected in the increasing IBI scores. However, this pattern could also be the results in participant increasing ability to distinguish different macroinvertebrate taxa and thus increasing richness and subsequently the IBI scores.

The negative effect of urbanization on stream macroinvertebrate communities is a well-known phenomenon (Mazor et al 2009); however, in the study the relationship between IBI scores and urbanization was not observed. This is likely due to the spatial data used to characterize land use in the stream basins. USGS StreamStats provides only the percent urbanization and percent impervious surfaces in the delineated basins, but many of the stream basins in this study region also contain extensive areas of agriculture. Furthermore, the highly modified nature of the overall tributary network in the region and the presence of extensive aqueducts and irrigation make it challenging to accurately sub delineate watersheds. These factors make it difficult to generate accurate watershed-level data and likely explains the lack of a correlation between IBI's and urban observed in this data.

The weak relationship between the stream chemistry and IBI values may be due to low sample size (n=1 for 2021) but it could also be related to the generally high tolerance of the macroinvertebrate community whose habit requirements are within the observed stream conditions. These relationships may become more evident in the future when there are more data analyze.

The temporal variability observed in the IBI scores is likely associated with both anthropogenic and climactic factors. The climactic component can be observed in the relatively strong relationship between ENSO strength and IBI scores (figure 6 and 7). This relationship is likely due to atmospheric conditions including temperature and precipitation. The results of this study suggest that air temperature may be a primary driver of the correlation between ENSO and the IBI scores. The relationship between macroinvertebrates and temperature has been observed in other studies (Vannote et al 1908). Further data analysis will be required to understand the anthropogenic component responsible for the variation in IBI scores.

Conclusion and Recommendations

The Solano RCD in collaboration with high school teachers and students is continuing to collect valuable data for the management of the regional streams while at the same time educating students and the public about watershed health and stewardship. In conclusion, the data collected by students and staff in 2021 show that:

- All streams are dominated by tolerant macroinvertebrate taxa.
- IBI scores remain steady or returning to the high IBI values observed in 2016. The majority of IBI values are in the poor or fair category.
- Overall Alamo, Lower Blue Rock Springs and Chabot have the lowest mean IBI scores while Laurel, Ulatis and Sulphur Springs have the highest IBI scores.
- Rindler and Ulatis show largest increase in 2021 IBI values.
- IBI scores appear to be related to ENSO, but the mechanisms of this relationship remain unclear.

Based on the results of the analysis and my understanding of the overall goals of the project, I make the following recommendations:

- Continue using modified collection methods.
- Continue using digital water chemistry meter and make sure to calibrate it before the sampling season.
- Acquire more detailed and accurate GIS information about the land use, including agriculture, for use in analyzing the effect of land use on IBI scores.

Citations

Brown LR, Burton CA, Belitz K (2005) Aquatic assemblages of the highly urbanized Santa Ana River basin, California. In American Fisheries Society Symposium. 47: 263-287.

Edwards, P. M. (2016). The value of long-term stream invertebrate data collected by citizen scientists. PloS one, 11(4).

Mazor R, Purcell A, Resh VH (2009) Long-term variability in benthic macroinvertebrate bioassessments: A 20-year study from two northern Californian streams. Environmental Management. 43: 1269-1286.

Vannote RL, Sweeney BW (1980) Geographical analysis of thermal equilibria: a conceptual model for evaluating the effect of natural and modified thermal regimes on aquatic invertebrate communities. American Naturalist. 115: 667–695.

APPENDIX C – *Teacher and Student Feedback*

Teacher Feedback

"Solano Resource Conservation District provides an important opportunity for students to learn about the community they live in. It allows them to learn about the creeks in Vallejo and how they can protect them. I am grateful for the extent to which the presenters make learning interesting and hands-on for the students."

- **Vivet Beckford-Nelson, Freshman Biology Teacher, Vallejo High School**

"I am just so grateful to have my students engaging with the amazing experience that [Solano RCD] planned and are providing to my students. They have gone above and beyond throughout the pandemic to provide quality experiences for students. When school was shut down a year ago due to COVID-19, I could have never envisioned that we would be able to attend a virtual field trip that is a direct reflection of what students would do in the field.... Thank you again for creating this opportunity for my AP Biology students to learn about the importance of our watershed, conservation and how to conduct citizen science."

- **Erin Gordon, AP Biology Teacher, Vacaville High School**

"We all know distance learning doesn't come close to the real deal in-person experience, but I can tell that [Solano RCD] did everything [they] could to make it a special experience. I really hope that some of the digital components of the program continues in future years, like the Nearpod in place of any pre-reading! That was extremely well done."

- **Kaitlin Benner, AP Environmental Science and Freshman Biology Teacher, Dixon High School**

"My students were just super stoked to be learning about something locally relevant to them, and hearing it from enthusiastic teachers like Gaia [Pazienti], Allison [Martin], and Laura [Morgan]. We can't wait to be back at the creek with everyone next year."

- **Michael Wee, AP Environmental Science Teacher, Mare Island Technology Academy**

Student Reflections & Responses

"Now that I've done this program, I'm hoping to learn more about things we can do on an individual level to help our creeks." **- Benicia High**

"I learned how important a creek is to a watershed and how that impacts me, but also how certain human activities in throughout a watershed affect individual creeks." **– Rodriguez High**

"Now that I've done this program, I really want to learn more about macroinvertebrates. They really are such cool little critters and I never thought I'd like them, but I do." **– Will C. Wood High**

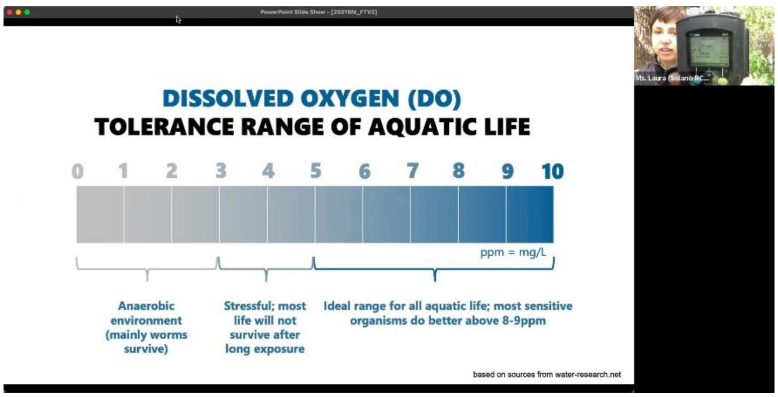
"I had no idea what to expect with this program but everyone was really informative, and I really liked learning about local creeks. I never realized that water in Lake Chabot is going to the Napa River, San Pablo Bay and the ocean, and now I'll be thinking about it every time I am at Six Flags by there." **– Mare Island Technology Academy**

"Because of this program, I think I might actually start paying attention in chemistry. Who knew." **– Vallejo High**

APPENDIX D – *Photo Documentation*

Program Educator Gaia Pazienti guides Jesse Bethel High School students through a warm up activity prior to the start of their virtual field trip.

Program Coordinator Laura Morgan explains the water probe used to collect and verify water chemistry data.



Students interpret the health of the creek by assessing the result of the dissolved oxygen data collected by the probe.

Laura Morgan explains how to measure turbidity using a manual turbidity tube.

Program Assistant Doug Darling demonstrates the macroinvertebrate assessment method using a D-net.

Laura Morgan shares an adult crayfish found in upper Blue Rock Springs Creek in Vallejo.