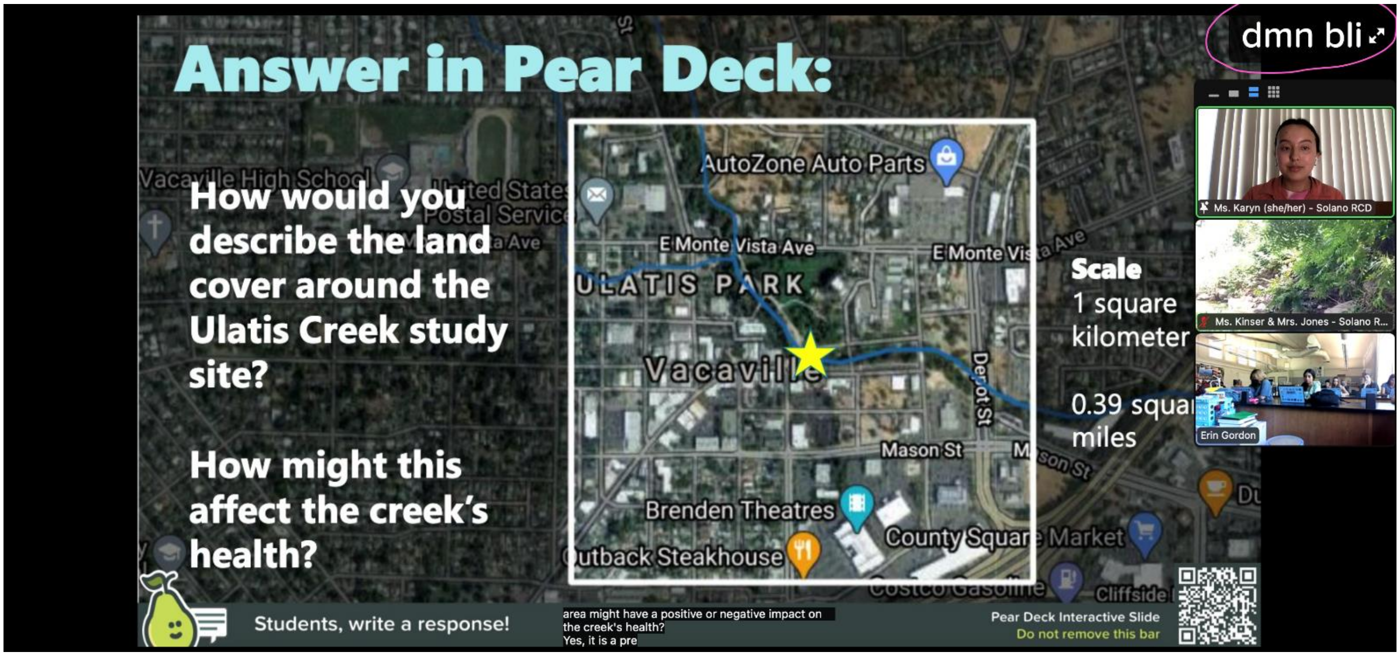
Solano County
Biomonitoring Program



2021-2022 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

1170 N Lincoln Street, Suite 110, Dixon, CA 95620
phone: (707) 678-1655 **web:** solanorcd.org

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.

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;
- ways to improve surface water quality;
- the value of community science in watershed management;
- professional opportunities in the field of environmental science.

The guiding questions for the Biomonitoring Program are:

Why do healthy creeks matter for our watershed? How do we determine if a creek is healthy? How can we improve creek health?

From these guiding questions, the program is designed with the following goal in mind:

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

Due to the COVID-19 pandemic, this year's program was delivered virtually, so students did not participate in the data collection. However, they were active participants in evaluating creek health *using* the data provided by program staff.

AUDIENCE

This year, approximately 582 students from 23 classes participated in the virtual Biomonitoring Program. Some teachers and classes elected to participate only in the pre-program Nearpod and live virtual field trip. Those classes are indicated by an asterisk (*) in Table 1 below.

Table 1. *Summary of Program Enrollment by City or District* *(continued on next page)*

School by City	Teacher	Course(s)	Total # Classes	Total # Students
BENICIA				
Benicia High	Emily Hudson	AP Environmental Science	1	18
FAIRFIELD				
Fairfield High	Heather Handa	Environmental Science	3	70
Armijo High	Peter Smith	International Baccalaureate Biology	2	56
Rodriguez High	Tamara Moore	Biology	3*	93
TRAVIS				
Vanden High	Jennifer Ault	AP Environmental Science	1	14
VACAVILLE				
Vacaville High	Erin Gordon	AP Biology	2	65
Will C. Wood High	Kevin English	AP Environmental Science	1	20
VALLEJO				
Vallejo High School	Vivet Beckford-Nelson	Freshman Biology	3	97

Vallejo High School	Melgene Tubal	Biotechnology	5	105
Mare Island Technology Academy	Michael Wee	AP Environmental Science	2*	51
2022 PROGRAM TOTALS			**23**	**589**

CURRICULUM

Student Instruction

In a typical program year, students participate in two preparatory classroom lessons and 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 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.

Due to continued uncertainty related to the COVID-19 pandemic, this year's Biomonitoring Program was held virtually. Solano RCD staff collected data used for the lessons ahead of time, and students used that data to make determinations about the health of the creek. The education staff also updated our curriculum to offer three virtual lessons and a virtual field trip, as well as optional pre-lesson and post-lesson digital Nearpod activities. Virtual lessons and the virtual field trip were made interactive through the Peardeck platform, where students answered questions posed by Program Educators and shared their observations about lesson content.

Pre-Lesson Nearpod 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 video introducing the program, 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: Education program staff guided students through a live, virtual lesson and discussed why healthy creeks matter, as well as how to use biological, chemical, and physical data to determine creek health as part of a live, virtual lesson.

Lesson 2: Students learned how to identify aquatic macroinvertebrates by studying macroinvertebrate structure and behavior during a live, virtual lesson. Students also explored how creek health can be determined based on the number and types of macroinvertebrates sampled in a stream.

Virtual Field Trip: Solano RCD education program staff introduced students to a creek near their school and guided them through the scientific procedures performed by environmental scientists to assess the biological, chemical, and physical characteristics of the creek and determine its overall health.

Lesson 3: Students analyzed the biological data collected from the creek to calculate the Index for Biological Integrity (IBI) Score and determine creek health. Upon reflecting on the creek's health and potential causes of its condition, students discussed ways to improve creek health on an individual and a community-based level.

Optional Post-Lesson Nearpod: Students could complete a post-lesson Nearpod module at their own pace, reinforcing many of the concepts taught in Lesson 3, including how to calculate the IBI score from the macroinvertebrate data from a local creek provided by Solano RCD. This was especially useful for the classes that only participated in a virtual field trip, but not the virtual lessons.

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. Edwards' 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 three-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 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.

3. **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.

Assessment Results

We assess understanding of creek ecology and restoration with a brief three-question quiz. Participating high school students completed a pre-assessment quiz before engaging with the Solano County Biomonitoring Program. At the program's completion they took the same quiz again, and we compared their answers.

Pre-assessment

- 414 students completed the pre-assessment quiz, and we analyzed a 20% random sample of those instruments. In the aggregate, 78% of students provided correct or partially correct answers to the 3 pre-assessment questions. 94% of students correctly or partially correctly listed reasons that healthy creeks matter to the watershed. 72% of respondents were able to identify the information needed to determine creek health. 67% of students correctly or partially provided one or two correct strategies to improve creek health and function.

Post-assessment

- There was 29% attrition in the post-assessment quiz participation. We analyzed a 20% sample of these instruments. Students who completed the post-assessment demonstrated a 16% increase in their understanding of the curriculum, providing 94% correct or partially correct answers to the three questions in the aggregate. Specifically, 97% of respondents were able to correctly or partially correctly explain the importance of healthy creeks; 92% of respondents were able to the list the factors that impact creek health, and 95% of students correctly or partially correctly listed viable ways to improve creek health and function.

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 – *2022 Biomonitoring Results*

Report: 2022 Analysis of the Solano RCD Stream Monitoring Data

Prepared for the Solano RCD by Patrick Edwards, Ph.D., Portland State University

June 2022

Summary

For the past fourteen years, the Solano Resource Conservation District (RCD) has developed and implemented watershed health curriculum and partnered with high school teachers and students to collect 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 indicating that stream conditions are degraded to impaired. Overall, Ulatis and Sulphur have the highest IBI scores while Alamo, Hanns, Chabot and Union have the lowest IBI scores.

Relationships between IBI scores and environmental conditions were relatively weak, likely due to the fact there is only two years of stream water chemistry data in the 2022 analysis. IBI scores were significantly positively correlated with climate conditions, likely 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 macroinvertebrate collection methods and water chemistry measurements.
- 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.
- Develop an IBI specifically for use with Solano data.

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's education program. To this 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 the Solano Conservation district 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.

Methods

Field methods

This year, RCD staff collected macroinvertebrates with a d-net and sorted them using a non-lethal method modified from Edwards (2016). At each reach, staff collected 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.

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

In 2021, Solano RCD began collecting stream water chemistry with a probe and Hach kits. For 2022, stream chemistry data were analyzed using the 2021 and 2022 data. To evaluate the relationship between IBI scores and environmental conditions, 2022 IBI scores were correlated against mean 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 2009-2022.
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.

Ordinations

Ordinations were used to evaluate the community assemblage of stream invertebrates at each stream using the mean counts of invertebrates for all available data. Ordinations are two-dimensional representations of the stream invertebrate community of each stream. Ordinations can be viewed as a "map" of the invertebrate community wherein points that are closer together have more similar assemblages than points that are further apart. A vector-fitting analysis was used to overlay the mean climate and stream water chemistry data on the ordinations of stream invertebrates. The vectors show the direction and magnitude of the variables in relation to the points on the ordination and allow for interpreting the relationship between the stream invertebrate community and the climate and stream water chemistry data.

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 have the highest IBI scores while Alamo, Hanns, Chabot and Union have the lowest IBI scores.

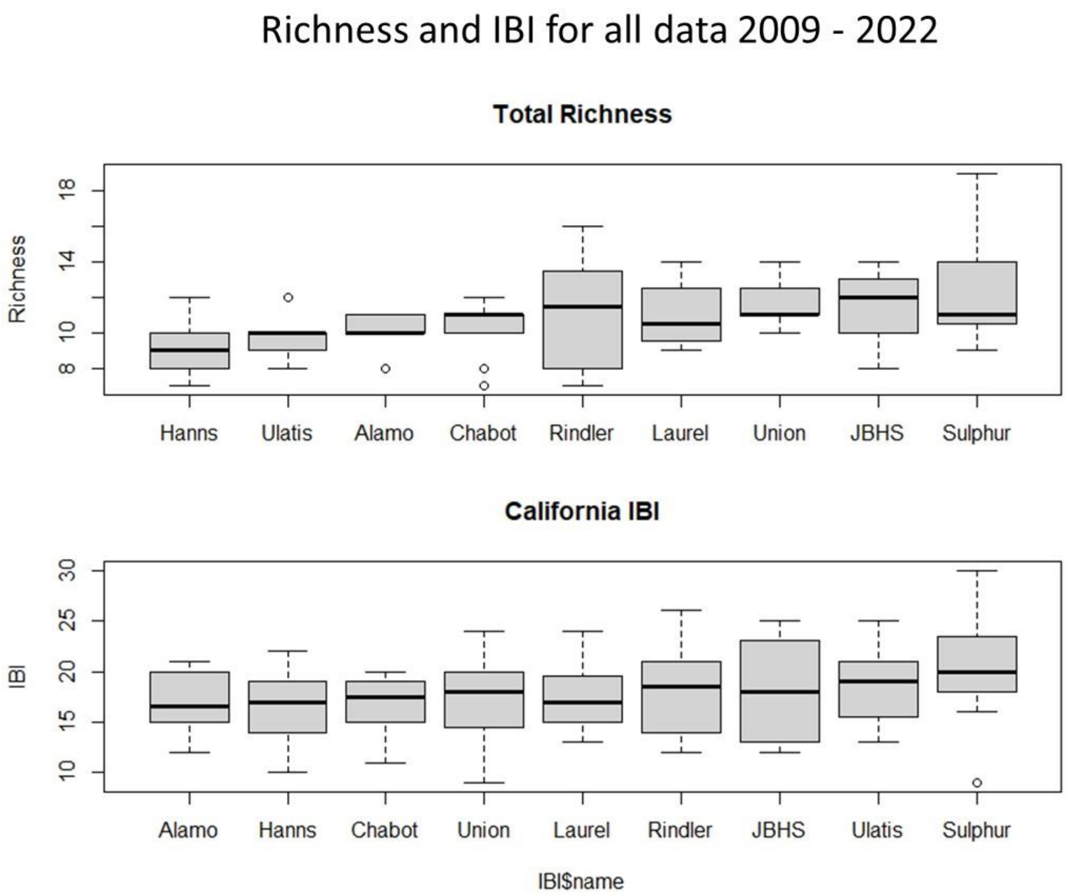


Figure 1: Richness and IBI scores from 2009-2022 for all streams. Not all streams have data for each year.

The IBI scores from 2009-2022 (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 2022, 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 2009-2022. Not all streams have an IBI score for every year.*

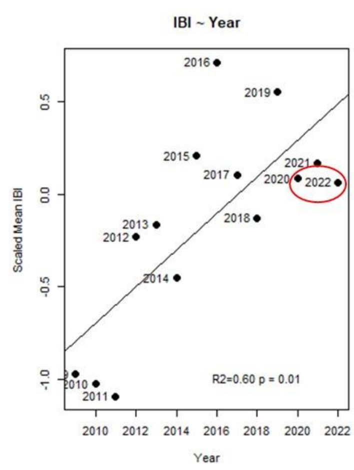


Figure 3: *Mean Scaled IBI values as a function of year.*

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, Hanns, Rindler and JBHS 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).

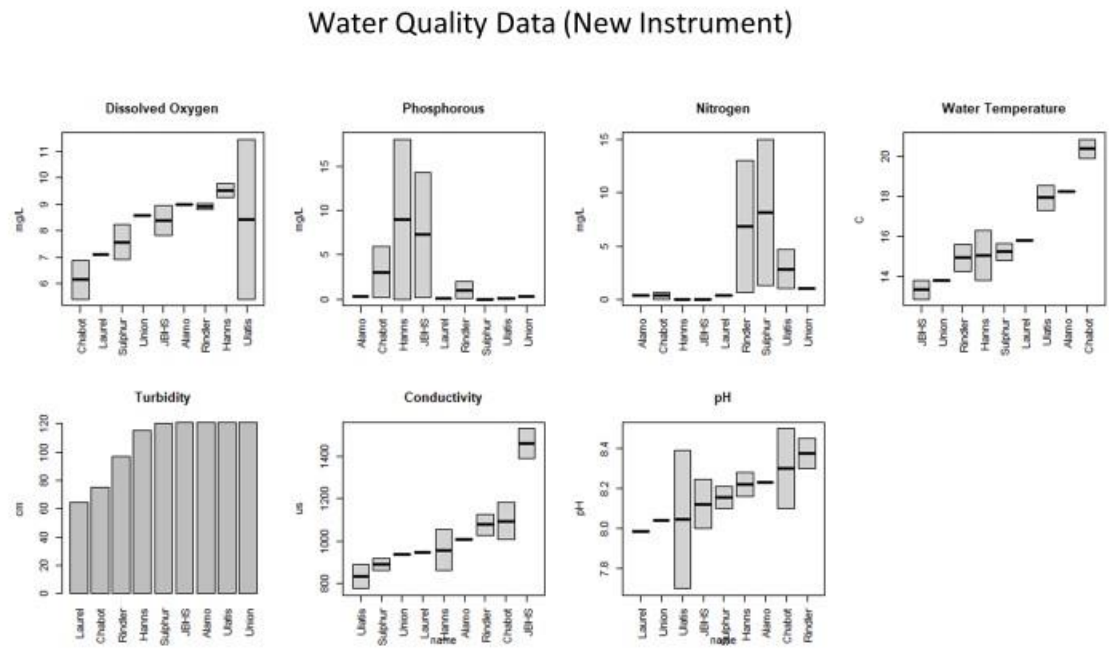


Figure 4: *Stream water chemistry in all streams*

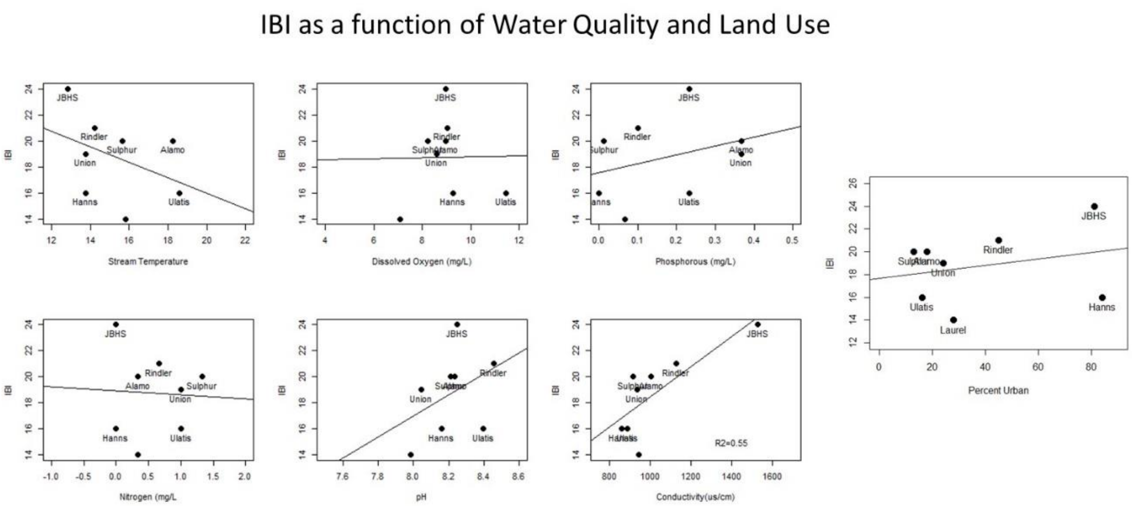


Figure 5: *Scatterplots and R^2 values for mean IBI scores as a function of mean stream water chemistry and percent urban in the land use.*

Urban land use was highly variable across the region with Rindler, JBHS and Hanns have the highest percentage of the watershed with urban land use and Sulphur, 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).

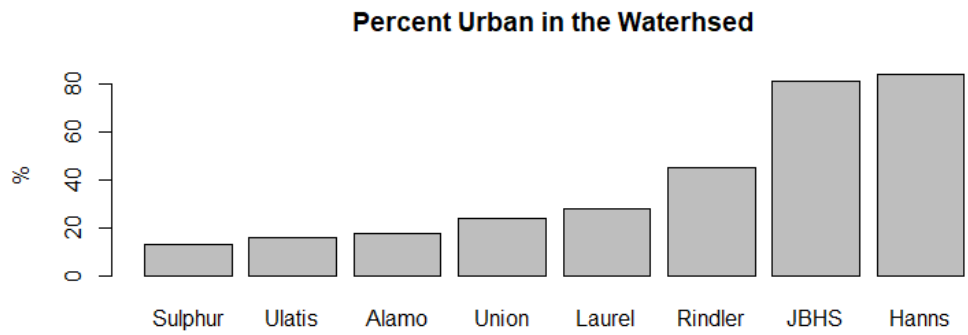


Figure 6: *Percentage of urbanization in each watershed.*

Climate data

The results of the climate analysis show that IBI score is positively correlated with air temperature (Figure 7, R^2=0.30, p = 0.06) and temperature the ENSO MEI (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).

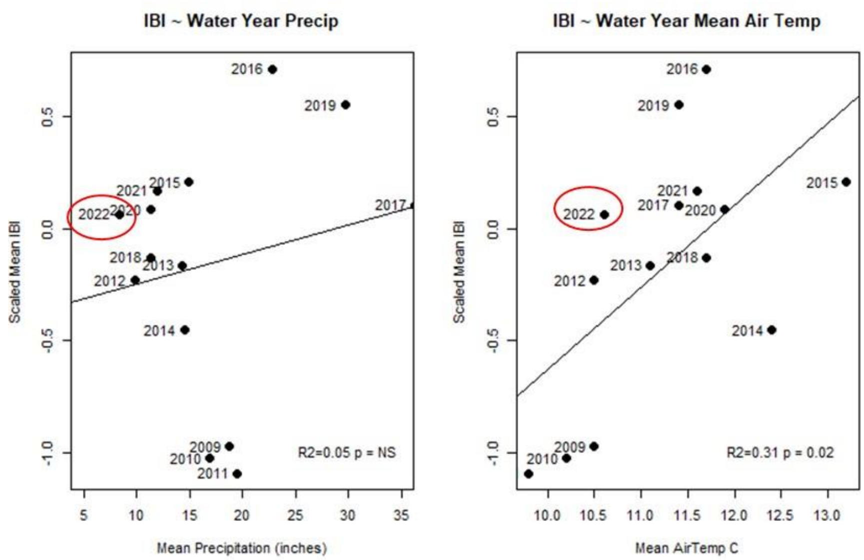


Figure 7: *Scaled IBI values as a function water-year precipitation and water-year air temperature. 2022 values are circled.*

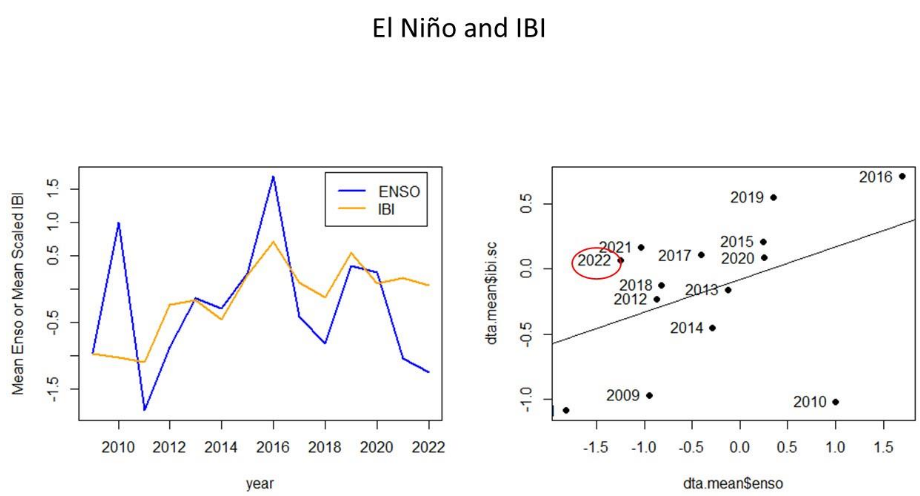


Figure 8: *Relationship between IBI and El Niño strength (ENSO) from 2009 to 2022.*

Ordinations and Vector Analysis

Ordinations revealed three distinct groups of stream invertebrate communities (Figure 9, Panel A). Group 1 contained Ulatis and Hanns creeks. Group 2 contained Alamo, Laurel and Rindler. Group 3 contained Sulphur, JBHS, Union and Chabot. The group 1 streams are associated with relatively sensitive insect macroinvertebrates such as the mayflies and caddisflies (Figure 9 Panel B). Group 2 is associated with tolerant taxa such as flatworms and aquatic worms (Figure 9, Panel B. Group 3 is associated with non-insect taxa such as snails, scuds and clams (Figure 9, Panel B). Vector analysis of environmental data showed that DO and turbidity were significantly related to the ordination x axis and were associated with the group 1 sites (Figure 10). All other vectors were insignificant.

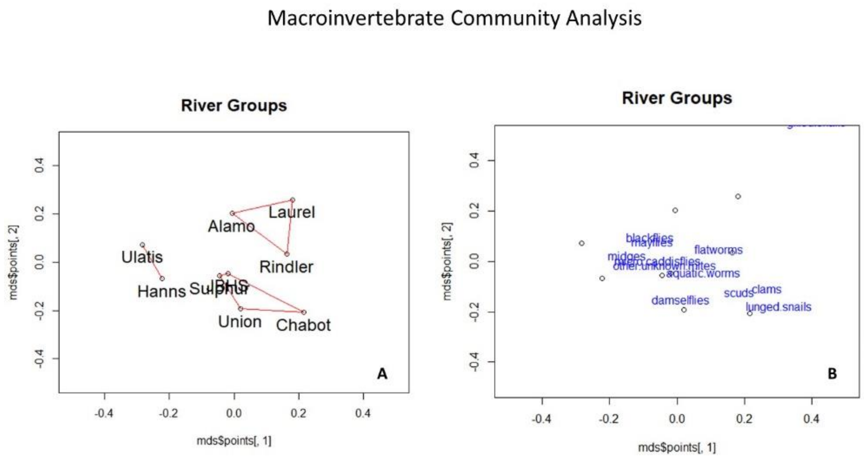


Figure 9: Ordinations of the macroinvertebrate community at all streams. Ordinations based on the relative abundance of all macroinvertebrates collected from 2009-2022

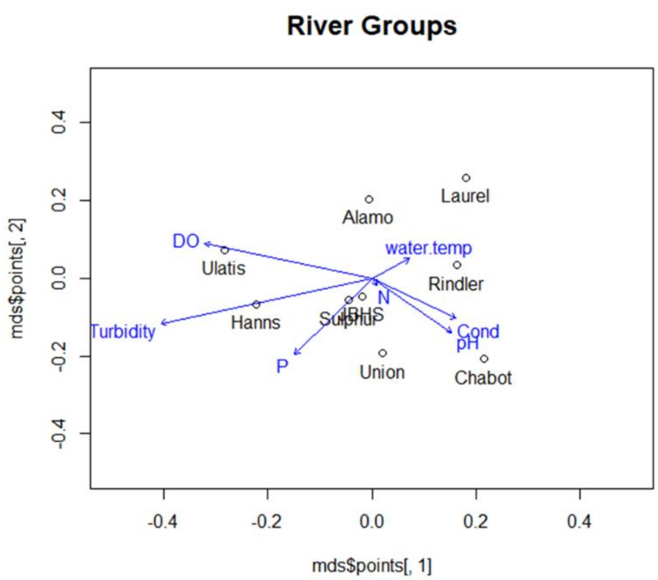


Figure 10: Vector analysis of environmental data.

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 2022 IBI scores appear 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 of participants' 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. It may be possible to refine the IBI scoring criteria to better reflect the unique nature the Solano study streams.

The weak relationship between the stream chemistry and IBI values may be due to low sample size (n=2 for 2022) 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 analyzed.

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 (figures 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.

Analysis of the macroinvertebrate ordinations revealed three distinct groups of streams. Vector analysis suggest that DO may be an important environmental variable in structuring stream groups; however, this is hard to confirm because of the limited environmental data.

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 staff in 2022 show that:

- All streams are dominated by tolerant macroinvertebrate taxa.
- IBI scores remain steady or are returning to the high IBI values observed in 2016. The majority of IBI values are in the poor or fair category.
- Hanns and Ulatis showed largest decreases in IBI scores while Union and Alamo showed largest increases in IBI scores.
- IBI scores appear to be related to ENSO, but the 2010 IBI scores are a major outlier in this data set and are a main factor in the poor model performance.

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.
- Consider developing a revised IBI for use in Solano streams.

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 Feedback*

Teacher Feedback

"Solano Resource Conservation District allowed my students to see what it means to have a healthy watershed in their local community. Even though it was virtual, my students did get a lot of useful real life experiences. Cannot wait until we could do this in person."

- Emily Hudson, Science Teacher, Benicia High School

"ALL of the Program Educators did a fantastic job breaking down the specific science of each test, method or measurement in a way that students could easily understand. I appreciated how each educator also used their own experiences or referenced something they have done or are passionate about while teaching to help students relate to them!"

- Anonymous

"A former student who graduated from Will C. Wood in 2020 and had taken AP Environmental Science, recently reached out to let me know that they were attending Oregon State University and majoring in Environmental Science. The program required her to choose an emphasis and because of the experience she had sampling along the creek with the Biomonitoring Program, she decided to choose aquatic biology as her emphasis. She said the field experience made her realize how important it is to protect our watersheds and she hopes it will lead to career where she can make a positive difference."

- Kevin English, Science Teacher, Will C. Wood High School

APPENDIX D – *Press Coverage*

DAILY REPUBLIC
Solano County's News Source
FAIRFIELD-SUISUN CITY, CALIFORNIA

Students take part in the Solano County Biomonitoring Program in 2017. (Courtesy photo)

Hundreds of high school students finishing Biomonitoring Program

By Daily Republic Staff

FAIRFIELD — Nearly 600 Solano County high school students, by the end of the school year, will have participated in the Solano County Biomonitoring Program.

“Students have learned about their local watershed, observed the hands-on methods used to monitor the creeks in their neighborhoods, and joined in the assessment of the health of these creeks,” according to a statement released by the Solano Resource Conservation District.

The Solano County Biomonitoring Program teaches students how to evaluate watershed health through physical, chemical and biological assessments, according to the statement. Students learn the relationship between stream ecology and water quality; the extent of local water quality issues and ways to improve surface water quality; and the value of community science.

“For over a decade, high school students from the county have participated in this community science project and provided valuable data for scientific study,” the district statement said.

This year’s program delivered lessons and field trips virtually due to the Covid-19 pandemic.

The program aims to inspire students to explore career paths in the sciences like a former Will C. Wood High School student who is now studying environmental science.

“Because of the experience she had sampling along the creek with the Biomonitoring Program, she decided to choose aquatic biology as her emphasis,” Kevin English, a science teacher at Will C. Wood, said in the district statement. He added the student’s field experience “made her realize how important it is to protect our watersheds and she hopes it will lead to a career where she can make a positive difference.”

The program is paid for by the Solano County Water Agency, Solano County, Benicia and the Vallejo Flood and Wastewater District. Participating schools include Armijo, Benicia, Fairfield, Rodriguez, Vacaville, Vallejo, Vanden and Will C. Wood high schools, as well as the MIT Academy.

Printed in the May 29, 2022 edition on page A3 | Published on May 28, 2022 |
Last Modified on May 28, 2022 at 12:19 pm

APPENDIX E – *Photo Documentation*

Program Educator Paula Marckesano-Jones shows Vallejo High students the results of the dissolved oxygen test.

Program Educators Don Broderson and Paula Marckesano-Jones demonstrate how to use a turbidity tube during a virtual field trip at Laurel Creek for Vanden High students.

SRCD staff identify and count macroinvertebrates.

Assistant Program Manager Lidia Tropeano and Program Assistant Andrew Fulton use a D-net to collect macroinvertebrates.