How Can Aquatic Macroinvertebrates Be Used to Help Determine the Water Quality of the LA River at Glendale Narrows Riverwalk?

Morgan Gaskell

Table of Contents

Background Research

It is crucial to monitor water quality for many reasons. First, testing water quality allows us to get an idea of the flora and fauna inhabiting the water body. Second, it tells us if we are managing waste and other forms of pollution correctly. Because the addition of pollutants can harm aquatic ecosystems, it is important to know if they are present in water bodies. For example, if pollutants contaminated a body of water that was a source of drinking water, water quality tests could inform us of the pollutants and hopefully prevent humans from getting sick. The presence of pollutants in water bodies can also harm the life living there, causing havoc in food webs.

When testing water quality, you are testing for the amount of dissolved oxygen (DO), nutrient enrichment (nitrate, ammonia, phosphates, etcetera), pH, temperature, the presence or absence of pollutants such as fertilizers, oils, and human sewage, turbidity or water clarity, biochemical oxygen demand (BOD), and fecal coliform in the water body.

In order to perform water quality tests, many scientists choose to use chemical analysis. However, chemical tests are costly and must be done frequently for accurate results. Other scientists use aquatic macroinvertebrates to determine the quality of water.

Macroinvertebrates are invertebrates (animals lacking a backbone) that do not require a microscope for identification. Aquatic macroinvertebrates include insects such as riffle beetles, mayflies, water pennies, and dragonflies, lunged and gilled snails, leeches and other aquatic worms, and more. During some part of their life cycle, aquatic macroinvertebrates can be found in or around bodies of water. They are commonly found living attached to rocks, vegetation, logs, and sticks. Aquatic macroinvertebrates can also be found burrowed into the bottom sediments of water bodies.

Aquatic macroinvertebrates are used by the scientist and amateur communities for many reasons. For one, they inhibit water bodies for at least part of their lifecycle. They are also easy to collect and identify with beforehand knowledge and a professional field guide. Third, aquatic macroinvertebrates tend not to migrate, in other words they are sedentary. This is helpful because macroinvertebrates found in one water body most likely lives there. Perhaps most importantly, aquatic macroinvertebrates are sensitive to a range of pollution levels, from being highly sensitive to being able to tolerate it.

Aquatic macroinvertebrates have been used for testing water quality since the 1870s. Their growth, survival, and reproduction is dependent on water quality. Without good water quality, aquatic macroinvertebrate life functions could not be carried out. Aquatic macroinvertebrates can also be used to monitor short term and long term pollution events. The National Park Service (NPS) for example uses aquatic macroinvertebrates as indicators of water quality for the water bodies found throughout national parks.

As mentioned, aquatic macroinvertebrates are able to tolerate a range of pollution levels. Adult riffle beetles, gilled snails, mayfly nymphs, caddisfly larvae, water pennies, and dobsonfly larvae (hellgrammites) are examples of highly pollution sensitive aquatic macroinvertebrates. Mildly sensitive aquatic macroinvertebrates include clams, mussels, crayfish, sowbugs, alderfly larvae, dragonfly and dobsonfly nymphs, whirligig beetle larvae, riffle beetle larvae, fish fly larvae, and scuds. Leeches and other aquatic worms, black fly larvae, midge fly larvae, and lunged snails are all relatively not sensitive to pollution.

Hilsenhoff's Biotic Index (HBI) is used to describe how tolerant to pollution an organism is. Organisms are graded on a number scale ranging from 0 to 10. 0 indicates an organism as being extremely sensitive to pollution and 10 indicates the organism is very tolerant to pollution. To calculate the HBI of a taxonomic family, multiply the family's specific tolerance value (0-10) by the tally of organisms found. Then divide that number by the tally, this is the HBI. Using the HBI, you can determine the water quality and degree of organic pollution. For example, the mayfly family *Baetidae* has a tolerance value of 4. Say I found 2 specimens in that family. 4 (tolerance value) multiplied by 2 (tally) has a product of 8. 8 divided by 2 is 4, the HBI. An HBI of 3.76- 4.25 indicates very good water quality, which means there is only a slight possibility of organic pollution being present in the mayfly's habitat.

How do some aquatic macroinvertebrates cope with pollution while others die soon after the introduction of such pollutants? Some have adaptations that allow them to survive in bad water quality. Others have features that make surviving in bad water quality impossible. For example, gilled snails possess gills that extract oxygen from the water they live in. If the water contains pollutants, they would enter the snail's body and kill it. Lack of dissolved oxygen could also kill the gilled snail. This makes the gilled snail highly sensitive to bad water quality. Lunged snails must surface for air and instead possess a body cavity that allows oxygen to enter and be stored in the snail's body- as a lung would. Hence, lunged snails are relatively not sensitive to bad water quality.

From 1989 to 2010, the National Park Service (NPS) did a study at Agate Fossil Beds National Monument to determine: "How has the aquatic invertebrate assemblage changed over time?" and "According to the invertebrates, how has ecosystem health changed over time?" By analyzing the taxa richness of three different zones relative to the year, they determined that biodiversity was decreasing at the monument. They also analyzed the richness of mayflies (*Ephemeroptera*), stoneflies (*Plecoptera*), and caddisflies (*Trichoptera*), three highly sensitive to pollution families, and discovered similar trends. An analysis of the HBI indexes of the species inhabiting the monument resulted in data showing that species living there had higher HBIs than in previous years. The National Park Service found these results likely to be a result of climate change, agricultural runoff, and the introduction of the invasive yellow flag iris.

The Los Angeles River, better known as the LA River, is a 51 mile waterway. It begins in Canoga Park, through the San Fernando Valley, along Burbank and Glendale cities, along Griffith Park as well as Elysian Park, through Downtown Los Angeles, though Vernon, Commerce, Maywood, Bell Gardens, South Gate, Lynwood, Compton, Paramount, Carson, and Long Beach cities, finally draining into the Pacific Ocean. The bottom of the covered with concrete in 1938, preventing many species from inhabiting the area. Despite such challenges, some plants and quite a few species of bird call the LA River home. There are three sections of the river that have not been paved with concrete. These sections are: Glendale Narrows, Sepulveda Basin, and Willow Street. These locations allow many more species to thrive.

Because of the concrete- free sections, trees, shrubs, and aquatic plants can take root. This means many birds, mammals, insects, and fungi can thrive here too!

Question

“How Can Aquatic Macroinvertebrates Be Used to Help Determine the Water Quality of the Los Angles River, specifically at Glendale Narrows Riverwalk?

Hypothesis

If aquatic macroinvertebrates are sensitive to a range of pollution levels, then they can be used to determine water quality by their presence or absence.

Experiment Overview

To determine the water quality of the LA River at Glendale Narrows, I will collect specimens of aquatic macroinvertebrates, tally them, and, using their tolerance to pollution value, calculate the FBI. The FBI of the collected specimens will help to determine the water quality of Glendale Narrows. Then, I will perform a chemical analysis test to see if the data corresponds with the data I collect during the test using aquatic macroinvertebrates.

Materials

A large, retractable, fine mesh net, a white pan with dimensions of 16 ½” x 10 ½” x 3”, tall rain boots, protective gloves, a field guide, a mobile species identification app such as iNaturalist, a phone for photographing specimens, a notebook, a writing utensil, 3 containers for collecting water samples, and a water quality testing kit including chemicals for testing nitrates, ammonia, and pH.

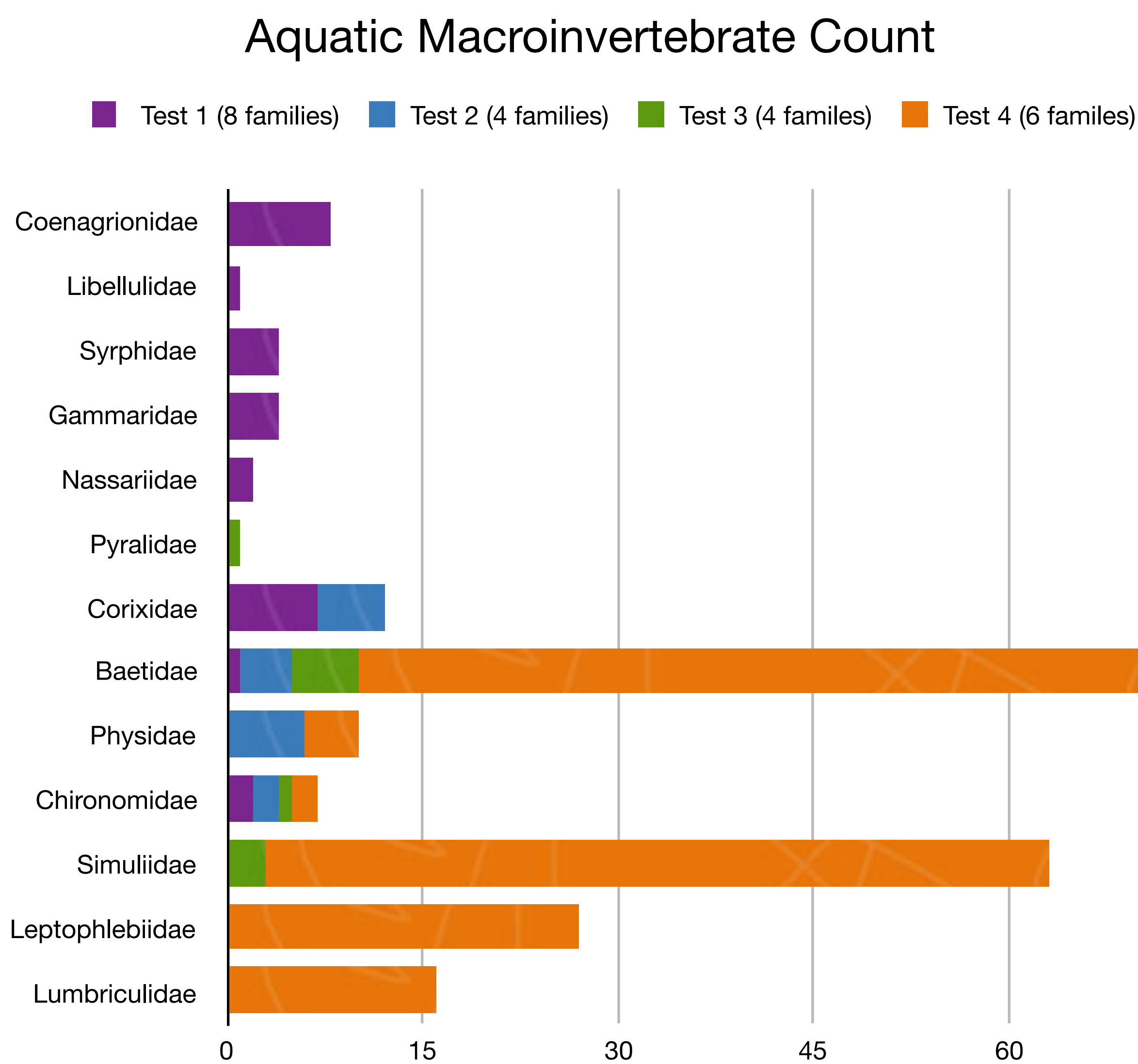
Procedure

1. Gather materials (see above).
2. Drive to Glendale Narrows Riverwalk (300 Paula Avenue Glendale, CA 91201)
3. Walk down to the Glendale Narrows segment of the LA river and assemble materials.
4. Dress in tall rain boots and protective gloves.
5. Fill white pan a quarter way with river water.
6. Set a timer for one hour.
7. Walk into the river and collect sediment. Sediment gathered near vegetation has a greater chance of containing aquatic macroinvertebrates.
8. Pour sediment into white pan.
9. Mix and swirl the water in the pan.
10. Allow sediment to settle and macroinvertebrates to reveal themselves.
11. Tally and identify species by taxonomic order and family. Indicate the common name of the specimen under the family.

12. Calculate the HBI of the specimen by first applying the equation $\frac{Total(n*a)}{Total(n)}$, where n equals the tally of macroinvertebrates collected and a equals the specimen's tolerance value to find the family biotic index. Round to the nearest hundredth. Then determine the water quality using the family biotic index. Lastly, use the water quality to determine the degree of organic pollution.
13. Take a water sample. Using the water quality test kit, test the nitrates, ammonia, and pH of the river water. Does this data correspond with the data collected from the aquatic macroinvertebrate test?
14. Repeat above steps for a total of four times in different locations.
15. Find the average HBI for all four tests as well as the average pH and levels of nitrates and ammonia in parts per million (ppm) to reach a consensus.

(This space was intentionally left blank)

Data



Test 1

Collection Date: November 10, 2019
Weather on Collection Date: Sunny, clear skies
Location of Collection: Marshy area

Test 2

Collection Date: November 17, 2019
Weather on Collection Date: Hot, clear skies
Location of Collection: Near riffle in stagnant water by an overpass

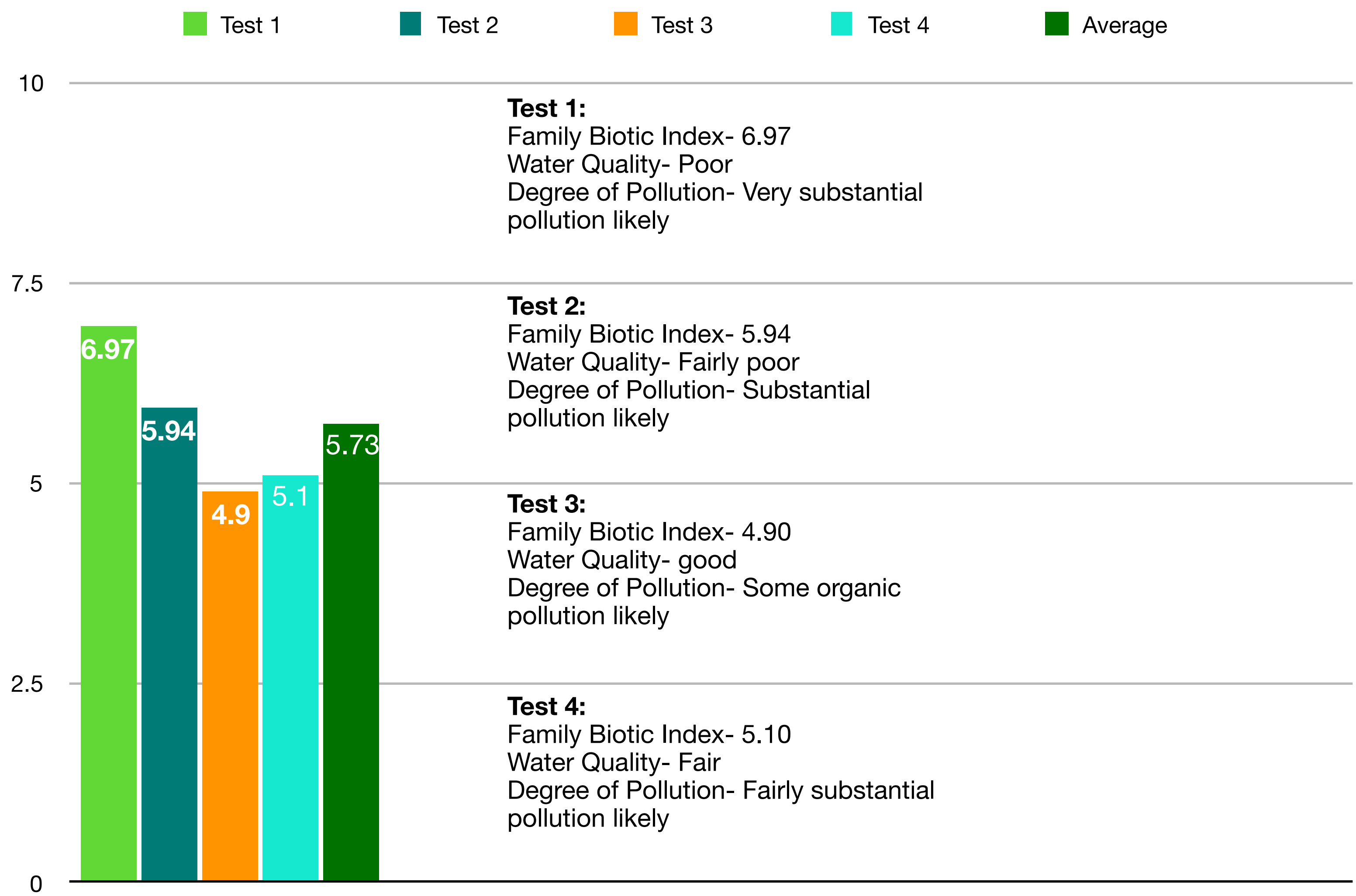
Test 3

Collection Date: February 23, 2020
Weather on Collection Date: Breezy, warm weather
Location: Near overpass

Test 4

Collection Date: March 8, 2020
Weather on Collection Date: Sunny, breezy
Location: Marshy Area
Additional Notes: *Huge* abundance of algae- food source, shelter

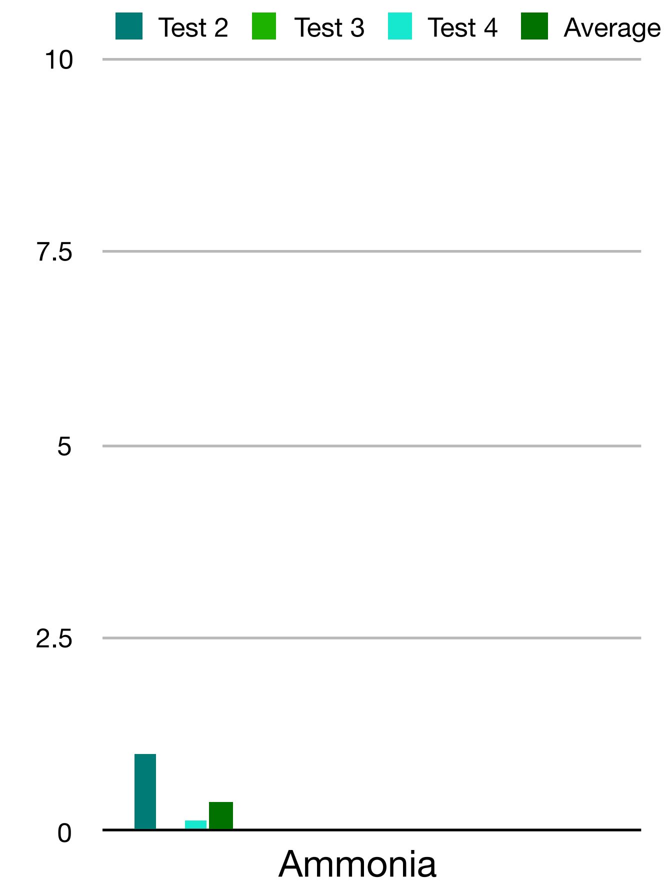
Family Biotic Index (FBI)

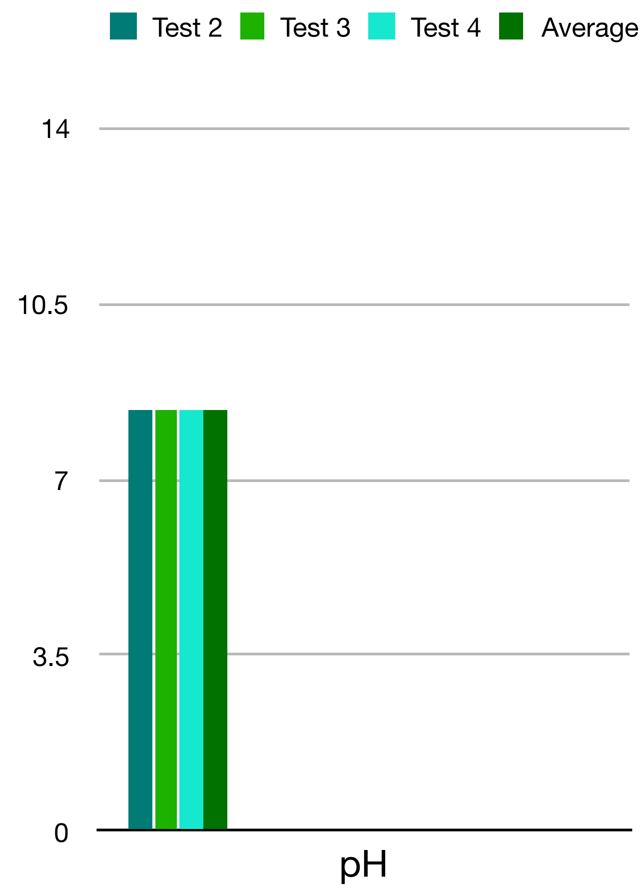


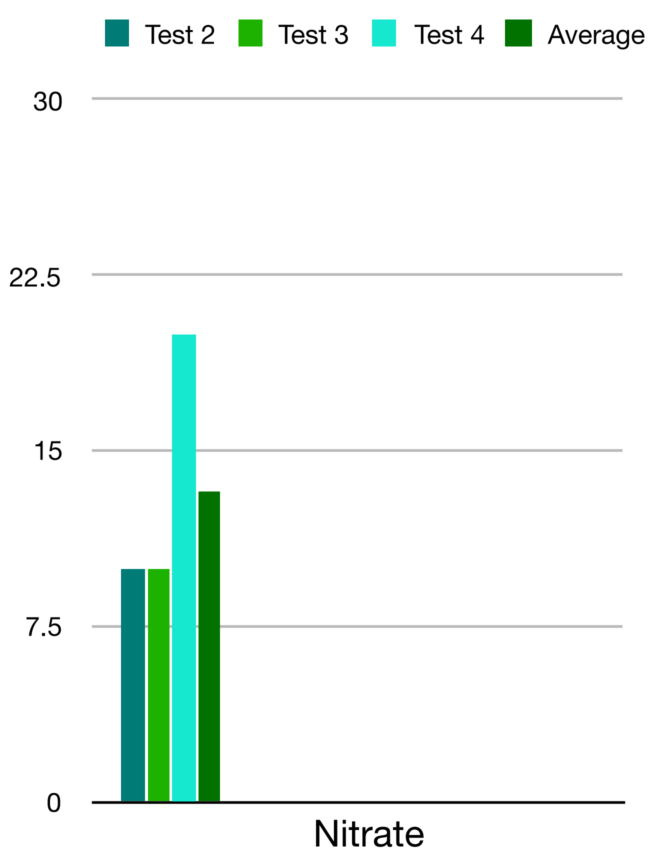
Average
Family Biotic Index- 5.73
Water Quality- Fair
Degree of Pollution- Fairly substantial Pollution likely

Chemical Analysis

In parts per million (ppm)







Data Notes

Test 2 (December 15, 2019)

Collection Location: Marshy area

Weather on Collection Date: Sunny and windy

Possible Error: Previously rained, may have reduced ammonia levels

Test 3 (February 23, 2020)

Collection Location: Marshy area

Weather on Collection Date: Breezy, warm weather

Possible Errors: Previously rained (again), therefor diluting the water, reducing ammonia and nitrate levels

Urban runoff of chemicals such as fertilizers may have replaced lost nitrate quantity (indicated by an increased abundance of algae)

Test 4 (March 8, 2020)

Collection Location: Marshy area

Weather on Collection Date: Sunny and windy

Possible Errors: N/A

Results

Macroinvertebrate Count

Family	Common Name	Tolerance (HBI)	Total Tally
1. Coenagrionidae	Damselfly	9	8
2. Libellulidae	Dragonfly	9	1
3. Syrphidae	Hoverfly	10	4
4. Gammaridae	Gammarus Shrimp/ Scuds	4	4
5. Nassariidae	Eastern Mudsnail	7	2
6. Pyralidae	Aquatic Moth	5	1
7. Corixidae	Water Boatman	5	12
8. Baetidae	Small Mayfly	4	85
9. Physidae	Pouch Snail	8	10
10. Chironomidae	Non-Biting Midge	6	7
11. Simuliidae	Black Fly	6	63
12. Leptophlebiidae	Prong-Gilled Mayfly	4	27
13. Lumbriculidae	Aquatic Earthworm	8	16

Averages			
Hilsenhoff's Biotic Index (HBI)	7		
Family Biotic Index (FBI)	5.73	Fair Water Quality	Fairly Substantial Pollution Likely
Ammonia	0.83 parts per million		
Nitates	13.3 parts per million		
pH	8.4		

Conclusion

The average family biotic index (FBI) was 5.73, the water quality was fair, and fairly substantial pollution in the form of pesticides, fertilizers, trash, and ammonia was likely. The average ammonia content in parts per million was 0.83. the average nitrate content was 13.3 parts per million, and the average pH was 8.4.

In conclusion, aquatic macroinvertebrates *can* be used to help determine the water quality of the LA River and any other given water source.

While testing, I also noticed a lot of trash in the LA River. If we all do our part and prevent pollution from getting into the watershed, the LA River may not be known as a disgusting, unsanitary river, and instead be known as a waterway teeming with life and biodiversity!

Bibliography

Thorp, James H., and D. Christopher. Rogers. Field Guide to Freshwater Invertebrates of North America. Elsevier/Academic Press, 2011.

Hadley, Debbie. “What Aquatic Insects Tell Us About Water Quality.” ThoughtCo, ThoughtCo, 12 Aug. 2019, www.thoughtco.com/water-monitoring-and-aquatic-macroinvertebrates-1968647.

“Taxa Tolerance Values.” Soil & Water Conservation Society of Metro Halifax, 18 June 2015, lakes.chebucto.org/ZOOBENTH/BENTHOS/tolerance.html.

Tronstad, Lusha, and Marcia Wilson. Agate Fossil Beds National Monument Aquatic Invertebrates Resource Brief. National Park Service, 2012, pp. 1–2, Agate Fossil Beds National Monument Aquatic Invertebrates Resource Brief.

United States Environmental Protection Agency. “Indicators: Benthic Macroinvertebrates.” United States Environmental Protection Agency, 16 Aug. 2016, www.epa.gov/national-aquatic-resource-surveys/indicators-benthic-macroinvertebrates.

Los Angeles River Revitalization “About The LA River” Los Angeles River Revitalization, 2019, lariver.org/blog/about-la-river.

Higgins, Lila, et al. Wild LA- Explore the Amazing Nature in and Around Los Angeles. Timber Press Inc., 2019.

CEDEN AdvancedQueryTool, ceden.waterboards.ca.gov/AdvancedQueryTool.php.

Aquatic Bioassesment Laboratory. “List of Californian Macroinvertebrate Taxa and Standard Taxonomic Effort.” CAMLnet, 27 Jan. 2003, www.safit.org/Docs CABW_std_taxonomic_effort.pdf.

Speelmen, Julie, and Carroll, Natalie. “Bioindicators of Water Quality Quick–Reference Guide.” Purdue University-Agricultural Communication, 12 August, www.asec.purdue.edu/natural_resources/Resources/BioindicatorWQ/Pubs,PDF/BioInd,WQ,4-H-1019.pdf.