An Analysis of Rouge River Water Quality and Study of Issues surrounding the Great Lakes Watershed

Yellow Jackets

Detroit Country Day School

United States of America

Bashar Fakhoury, Solene DeGaynor, Catherine Hiemstra, Sophie Endrud

Faculty Sponsor: Marc Drougel, mdrougel@dcds.edu

Abstract: This paper aims to answer three questions: What are the main threats towards the Great Lakes watershed, how good is the quality of Rouge River water, and what are some methods to improve the water quality of the Great Lakes Watershed. We found that oil dumping, raw sewage entering waterways, and lead pipes leaching into the water have been major threats to the health and biodiversity of the Great Lakes watersheds. We ran Water Quality Index tests on the Rouge River, a local river that flows through the campus of Detroit Country Day School, for two years in a row. We then researched ways to continue to protect and improve the health of the Great Lakes watershed.

Keywords:

1. WQI: Water Quality Index
2. NEPA: National Environmental Protection Act
3. EPA: Environmental Protection Agency

Method of the investigation:

To make conclusions about the quality of our water and garner a holistic overview of the implications of our results, our team gathered information from in-person experimentation guided by an expert on the topic.

Our research centered on three guiding questions:

1. What has the local community's impact been on the quality of the Rouge River and health of the surrounding environment?
2. What species live in and around the Rouge River?
3. In what ways can our community change their behavior to improve the water quality?

To supplement our research, we interviewed local expert Mike Reed, who specializes in performing wildlife research at the Detroit Zoo, to gain first-person insight on how water quality affects wildlife in the body of water we tested.

The interview included the following:

1. In the coming years and decades, how do you believe that the health of southeastern Michigan ecosystems might change? How do you think corporations and the government can effectively ensure its safety?
2. Much of your career has involved the education of citizens about wildlife and water quality. Why do you think it is so important that people in Michigan learn about the waterways and wildlife that make their home unique?
3. How do you believe that average citizens can best contribute to improving the quality and extending the longevity of their local waterways?

These questions were made concerning the framework of our investigation—performing research in order to broaden our understanding of human impact on water and wildlife. We combined this qualitative research with our quantitative data to form conclusions about the health and safety of our local waterways.

Over 20,000 years ago colossal glaciers receded with warming temperatures. As they continued to melt, water filled the chasms that the glaciers left, creating what we now know as the Great Lakes [1]. These lakes play a monumental role in our identity as residents of the state of Michigan, which inspired us to study the role we play in return to help or harm the health of our water. These lakes supply 90% of the freshwater to the United States, and the complex ecological region supports over 3500 different animal

and plant species. Furthermore, over 40 million people depend on the Great Lakes for clean drinking water to survive, making it one of the most valuable natural resources the world has to offer [1].

Despite the great importance of Michigan's waterways, pollution has played a monumental role in their history. On October 9th, 1969, the Rouge River caught fire near Southwest Detroit due to the millions of gallons of waste oil dumped into the waterways each year [2]. After a series of other environmental disasters around the country, the National Environmental Protection Act (NEPA) was passed in January of 1970 [2].

The Flint River, another Michigan waterway, continuously received raw sewage from the local wastewater treatment plant and agricultural and urban runoff from a wide range of factors including the plants looming on the shores. After the birth of General Motors and a rise of prosperity in Flint followed by a crash, Flint found itself in a 25 million dollar deficit in 2011. The Michigan governor, Rick Snyder, and his emergency manager decided in 2013 to end the city's practice of piping treated water from Detroit; instead, they temporarily pumped water from the Flint River until a new pipeline was built to pump water from Lake Huron. The Flint River water was highly corrosive and flowing through old pipes, so lead leached out into thousands of homes in the surrounding area, causing detrimental damages to human health **[3]**. Thus, the tragic state of the Flint River only caught the attention of the people when it directly impacted their health, demonstrating that residents willingly abuse their local waterways until they are forced to face the consequences evident in the quality of the water.

Government agencies like the EPA have done significant work for the protection of the great lakes. The main piece of legislation that protects the Great Lakes in particular is the Great Lakes Water Quality Agreement. This agreement unifies efforts between Canada and the United States in order to restore and protect the Great Lakes [4]. The agency has also created Lakewide Action and Management Plans for each of the Great Lakes. While government agencies such as the EPA have been incredibly helpful to the protection of the Great Lakes, some prominent politicians have actively risked the health of Michigan waterways through poor policy decisions. On multiple occasions, former U.S. President Donald Trump proposed cutting the funding for the Great Lakes by 90%, a decision that Michigan Senator Gary Peters said would "severely hurt" the government's power to protect the rare freshwater [5]. The 270 million dollars he proposed slashing are used to restore harmed habitats, prevent the expansion of invasive species, clean up toxic

substances, and minimize the causes of algal blooms. If former president Trump or other like-minded politicians were successful in cutting Great Lakes funding, the Great Lakes watershed would face catastrophic consequences.

A watershed is “an area of land that drains into a body of water” [6]. The Rouge River Watershed is located in Southeast Michigan, and it drains 467 square miles into the Detroit River. It stretches over 127 river miles, and it is separated into Main, Upper, Middle, and Lower branches [6]. There are over 400 lakes, impoundments, and ponds that accompany the flowing water. 1.35 million people live in the area surrounding the water in Oakland, Washtenaw, and Wayne counties [6]. 50% of the land is urbanized and less than 25% remains undeveloped, which heavily impacts the quality of the water, as impervious surfaces lead to considerable runoff [6].

The river became one of the 43 Great Lakes Areas of Concern in 1985, and the Environmental Protection Agency explains that the extreme population and industrialization in the area “has led to sediment and water contamination from industrial development and discharge, combined sanitary sewer overflows, and nonpoint source pollution”[7].
Additionally, nine of the fourteen “Beneficial Use Impairments” are impaired for the river [7]. The report lists that “sediment and water contamination affect fish and wildlife habitat and populations as well as recreational opportunities” [7]. Furthermore, “contaminants within the watershed include heavy metals, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), mercury, oil and grease” [7]. Evidently, the industries around the Rouge have severely affected the wildlife and overall health of the waterway. In response to the discovery of these effects, the Rouge River Advisory Council was established in 1992 and in 1993, the Rouge River National Wet Weather Demonstration Project was created to allocate several hundred million dollars to stormwater remediation [7].

Flooding and streambank erosion, one of the threats to the watershed, causes sediment to enter the water, which can clog the gills of fish, block sunlight for plants, reduce the amount of dissolved oxygen in the water, and carry with it other pollutants, like phosphorus and heavy metals [8]. Sewer overflows can occur in response to excess stormwater, leading to untreated wastewater discharging into the Rouge [8]. Illicit and illegal discharges occur when individuals or companies introduce polluting materials to surface water through a pipe or through direct dumping [8]. Finally, invasive species are sometimes unintentionally introduced into the

waterway, and they outcompete native species to interfere with the food web [8].

One of the central observations we made near the creek in which we tested (a tributary of the Rouge River) was in regards to shoreline erosion and its impact on the turbidity statistic. The testing location had been notably impacted by the flow of the stream, exposing the roots of shoreline trees and limiting the growth capacity of shoreline plant species such as Clearweed and American Linden. Our observations aligned with the results of our water testing; we recorded the turbidity to be 11.5 NTU, higher than the average turbidity for rivers and streams (around 10 NTU), but not unheard of for seasons with significant amounts of rain and snowmelt [9]. Regardless, the turbidity of the stream and the erosion of the shoreline remains a concern.

To determine the quality of the water in the Rouge River, we ran nine different tests over the course of two years in order to give the Rouge River a water quality index rating. The water quality index is a system that rates freshwater on a range from 1-100 where a higher score corresponds with a higher water quality. To attain this WQI score and get a full understanding of the Rouge River, our team tested for change in temperature, pH, turbidity, total solids, dissolved oxygen, 5-Day biochemical oxygen demand (or BOD), total phosphate, nitrates, and fecal coliform.

The first test run was the change in temperature for the stream. Measured in Celcius, the results for 2021 was 0.5 degrees, while it was 0.4 degrees in 2022. This is on the higher end for ideal water temperature as most small bodies of water should be below negative 5 degrees Celsius [10]. It is imperative to a stream's health that it contains colder water as this allows for more dissolved oxygen to be contained. Increased dissolved oxygen has a positive correlation to wildlife diversity and the carrying capacity of the stream.

We also tested the pH of the water, a measure of the ratio of Hydrogen ions to Hydroxide ions on a scale from 1-14. A pH level between 6.5 and 8.2 is most widely considered proper for small bodies of water. Values that vary drastically from the expected levels can indicate ecological concerns, such as carbonate pollution. Even small changes in pH can massively disrupt an ecosystem. For example, increasing pH slightly makes nutrients such as phosphorus more soluble, leading to increased algae growth and decreased dissolved oxygen [11]. Our own pH measurements were on the high end of the desired values, which could be a possible explanation

for low biodiversity in our school's section of the Rouge River.

Turbidity tests the clarity of water. In healthy water, turbidity levels should not exceed 1 NTU. It is important to keep such levels to a minimum because excessive particles in the water can reduce the amount of sunlight that is able to breach the surface, reducing photosynthetic activity [9]. While in 2021, the turbidity of the Rouge River was excessively high, it did drop into a more moderate range in 2022. However, a turbidity level of 11.5 NTU is still far too high, negatively impacting biological diversity and plant life [9].

Total solids measure the amount of dissolved, colloidal, and suspended solids in the water. This has a large effect on the turbidity of the water. In both years of testing, the total solids measured were approaching high levels, which could be seen in the high turbidity report as well.

Testing for dissolved oxygen is exceptionally important as it is imperative to maintain enough oxygen in the water to support a diverse ecosystem of plants and animals. When DO drops to a too low of a level, organisms can become sick or die as they don't have the proper nutrients to survive [12]. Having a DO level of above 80% saturation is generally indicative of healthy water, a number that was exceeded in both years of reporting [12].

5-Day BOD tests for the amount of oxygen that is used by aerobic respiration, and therefore is an indicator of how much organic matter is in the water. Having excessive levels of organic matter can be an indicator of pollution from areas such as sewage and runoff [12]. Healthy bodies of water have BOD levels as close to one as possible, so while a BOD of 7.7 in 2021 was not ideal, dropping to 2.3 in 2022 indicates a positive trend [12].

Total phosphates is a sum of all the phosphates that are found in a water sample. Excessive phosphate levels cause eutrophication and therefore reduced dissolved oxygen levels, ultimately limiting biodiversity. In both 2021 and 2022, the total phosphate levels were very high.

The nitrate test measures the concentration of nitrate ions in the water, and similar to phosphates, a high nitrate level causes eutrophication. The fecal coliform test measures the concentration of fecal coliform bacteria in order to learn the probability of microbiological organisms contaminating the water [13]. Finally, each test is weighted and the sum is the overall Water Quality Index Rating. The score will fall into a category of excellent, good, medium, poor, or very poor as seen in the tables below.

Water Quality Index Testing: Spring of 2021

WQI Data Table					
	A		B	C	D
Test	Results	Unit	Q-Value	Weighting factor	Subtotal
Temperature, ΔT	0.5	°C	92	0.11	10.12
pH	8.91	pH unit	47	0.11	5.17
Turbidity	20.1	NTU	61	0.08	4.88
Total Solids	800	mg/L	31	0.07	2.17
Dissolved Oxygen	86	% sat.	93	0.17	15.81
5-Day BOD	7.7	mg/L	42	0.11	4.62
Total Phosphate	2.2	mg/L PO_4-P	8	0.10	0.8
Nitrates	1.82	mg/L NO_3^--N	62	0.10	6.2
Fecal Coliform	0	CFU/100 mL	97	0.16	15.52

Score	65.29
WQI Rating	Medium

Water Quality Index Testing: Spring of 2022

WQI Data Table					
	A		B	C	D
Test	Results	Unit	Q-Value	Weighting factor	Subtotal
Temperature, ΔT	0.4	°C	91	0.11	10.01
pH	8.03	pH unit	83	0.11	9.13
Turbidity	11.5	NTU	75	0.08	6
Total Solids	1100	mg/L	31	0.07	2.17
Dissolved Oxygen	90.65	% sat.	97	0.17	16.49
5-Day BOD	2.3	mg/L	71	0.11	7.81
Total Phosphate	0.29	mg/L PO_4-P	41	0.10	4.1
Nitrates	2.6	mg/L NO_3^--N	50	0.10	5.0
Fecal Coliform	100	CFU/100 mL	44	0.16	7.04

Score	67.75
WQI Rating	Medium

Water Quality Index Ratings	
90 –100	Excellent
70 – 90	Good
50 – 70	Medium
25 – 50	Poor
0 – 25	Very Poor

To complement our quantitative testing, we interviewed local expert and zoologist Mike Reed, who assisted us with our observation of the testing site and preliminary research. Mr. Reed works with the Detroit Zoological Society on various wildlife research and protection projects. Our first question concerned the future of the health of southeastern Michigan ecosystems. Mike stressed to us in his response, as emphasized by our research, that Michigan ecosystems are at risk for serious damage due to human carelessness. The amount of impervious surfaces in the area will only continue to grow with higher populations and bigger industries, which leads to more runoff, and thus more erosion and overall damage to the health of the waterways. Once the water is damaged by sediment, phosphates, nitrates, or other products found in the water (which we tested for), the amounts will only biomagnify and bioaccumulate in the ecosystem, causing damage to wildlife on a larger scale. Corporations and the government can ensure the safety of the ecosystem by continuing to work with zoological groups, such as Mike's at the Detroit Zoo, who frequently perform testing and will ensure accurate results. Smaller branches of larger corporations such as the EPA can send out teams to observe the ecosystems and devise solutions for the growing threats.

In response to our second question about educating citizens about wildlife and waterways in Michigan, Mike explained that people often don't realize the

importance of the ecosystem, even the smallest insect, to their lives. He has devoted a lot of his career to education because he believes that children should be encouraged to pursue careers in science and work to understand the natural world. With the increasing prevalence of technology in our daily lives, we must build a personal connection with and pride in our local ecosystems so that we prioritize their preservation over our selfish needs as humans.

In our third and final question, we asked Mike how he believes the average citizen can best contribute to improving their local waterways. While standing beside our creek, a branch of the Rouge River and part of the Rouge River Watershed, Mike advised us to invest our time into observing and testing the forest surrounding the creek and to devote resources to restructuring and improving the health of the forest. Since the water, plants, and microinvertebrates of the waterway depend on the land around them, and the wildlife depends on the waterway, the average citizen can get involved in cleaning up a single piece of the ecosystem and make a positive impact on the whole. They can also donate to a program that researches and improves the health of the area.

Michigan is home to some of the most important freshwater sources in the world, and, by extension, it contains diverse wildlife and complex ecosystems that must be protected. Our research developed our understanding of the basic characteristics of these water sources and allowed us to reach conclusions about the quality of the water in our own backyard. We have also learned about the impact poor water quality has on the surrounding ecosystem, notably, macroinvertebrates and microinvertebrates.

Spending most or all of their lives in water, freshwater invertebrates quickly respond to disturbances or pollution [14]. There is also a wide range of tolerances among invertebrates that allows for relative water quality health to be easily determined. The diversity and quantity of these creatures help indicate how healthy the water is and its ability to sustain life [14].

There are a few key indicators that contribute to freshwater invertebrate health. Dissolved oxygen is often an initial hindrance to the invertebrates. In their immature stage, high levels of dissolved oxygen are required for the proper growth and development of microinvertebrates. Additionally, if the substrate at the bottom of a body of water doesn’t have the proper nutrients, it can lead to a diminishing population of invertebrates. Muddy or sandy substrates are thus often preferred as they contain higher levels of food particles and bacteria. Nutrient enrichment, especially in areas with high human populations, can also pose

an issue to freshwater invertebrates. Runoff from sewers, fertilizers, and trash often results in the unnatural accelerated growth of algae. As the presence of algae increases and results in their inevitable death, dissolved oxygen is required to decompose such large masses of plants [15]. This ultimately leads back to the issue of an inadequate amount of dissolved oxygen [15]. Due to their ranges of tolerance, analyzing invertebrates is an excellent example of how researchers evaluate water quality based on the wildlife that flourishes there [15]. There can, in many cases, be direct correlations between the amount or type of invertebrates in a given water source and the health of said water source; this connection helps us to further understand how water quality impacts living organisms.

Overall, the data we have collected has indicated that the river is healthy and life-sustaining for the organisms and plant life, but it is essential that the water quality is not only
maintained, but improved upon. Our test results were supplemented by our observation of very few invertebrates and insects that populate the stream and the area around it. These observations indicate that improvements in water quality are essential if living organisms are expected to survive and flourish.

Especially considering Michigan's history with water pollution, including the Rouge River fire, local and national legislation is a key aspect of protecting important waterways. Because of this, the United States' 2022 Supreme Court ruling restricting the ability of the Environmental Protection Agency to mandate carbon emissions is extremely concerning [16]. These political responses to vital environmental legislation threaten the ability of the United States government to enact comprehensive laws regarding air and water pollution [16].

Protecting our waterways is dependent on government funding that allows environmental agencies to enact stricter policies regarding the dumping of pollutants and the cleanliness of sewage systems. Thus it is vital that we place emphasis not only on the local groups and agencies that keep our waterways clean, but also on lawmakers and politicians who distribute government funds. Michigan residents can ensure that Great Lakes protection remains on the political agenda by voting for politicians who will support Great Lakes funding in the upcoming midterms.

It is clear that our attentiveness to not only the Rouge River watershed, but the entire Great Lakes watershed, must improve. On a more national level, it

is essential that legislation such as NEPA remain in place and continues to fund the protection of the Great Lakes region. Locally, individual environmental groups can engage in biological surveys of individual testing sites to conduct monthly and yearly WQI testing, observe trends in shoreline erosion, and identify the state of plant life that depends on the water source. Because the creek in which our group tested runs through our school campus, the health of the water and the organisms and plant life that depend on it is, in many ways, directly applicable to our daily lives as students. As such, we have a responsibility to ensure the longevity of the creek, the Rouge River watershed, and the wildlife that depends on the ecosystem in our own backyard.

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Works Cited

[1] "Great Lakes Ecoregion." *National Oceanic and Atmospheric Administration*, 1 Feb. 2019, www.noaa.gov/education/resource-collections/freshwater/great-lakes-ecoregion#:~:text=About%2020%2C000%20years%20ago%2C%20the,their%20present%20shapes%20and%20sizes. Accessed 14 Oct. 2022.

[2] Graham, Lester. "50 Years Ago Today, the Rouge River Caught on Fire." *Michigan Radio*, 9 Oct. 2019, www.michiganradio.org/environment-science/2019-10-09/50-years-ago-today-the-rouge-river-caught-on-fire.

[3] Denchak, Melissa. "Flint Water Crisis: Everything You Need to Know." *NRDC*, 8 Nov. 2018, www.google.com/url?q=https://www.nrdc.org/stories/flint-water-crisis-everything-you-need-know%23sec-summary&sa=D&source=docs&ust=1665785442208516&usg=AOvVaw31PL52oI37pPMvofJSeh2Y. Accessed 14 Oct. 2022.

[4] "Facts and Figures about the Great Lakes." *United States Environmental Protection Agency*, 11 Aug. 2022, www.epa.gov/greatlakes/facts-and-figures-about-great-lakes.

[5] "Trump's 2020 Budget Proposes 90 Percent Cut to Great Lakes Funds." *Advance Local Media*, 12 Mar. 2019, www.mlive.com/news/2019/03/trumps-2020-budget-proposes-90-percent-cut-to-great-lakes-funds.html. Accessed 14 Oct. 2022.

[6] "Our Watershed." *Friends of the Rouge*, 2022, therouge.org/about-us/our-watershed/. Accessed 14 Oct. 2022.

[7] "Rouge River AOC." *United States Environmental Protection Agency*, 2022, www.epa.gov/great-lakes-aocs/rouge-river-aoc. Accessed 14 Oct. 2022.

[8] "Invasive Species in the Rouge." *Friends of the Rouge*, 2022, therouge.org/invasive-species/. Accessed 14 Oct. 2022.

[9] "Turbidity." *Enviro Sci-Inquiry*, 2000, ei.lehigh.edu/envirosci/watershed/wq/wqbackground/turbiditybg.html. Accessed 12 Oct. 2022.

[10] "Why Delta Is The Magic Number For Proactive Diagnostics and Problem-Solving." *Resideo*, 2021, www.resideo.com/us/en/corporate/newsroom/featured-articles/why-delta-t-is-the-magic-number-for-proactive-diagnostics/#:~:text=On%20the%20cooling%20side%2C%20the,

is%20between%2016F%20and%2022F. Accessed 14 Oct. 2022.

[11] "pH of Water." *Fondriest Environmental*, 2022, www.fondriest.com/environmental-measurements/parameters/water-quality/ph/. Accessed 14 Oct. 2022.

[12] "Dissolved Oxygen and Biochemical Oxygen Demand." *United States Environmental Protection Agency*, 6 Mar. 2012, archive.epa.gov/water/archive/web/html/vms52.html. Accessed 14 Oct. 2022.

[13] Notre Dame. "How Pure Is Our Water?" *Notre Dame*, www3.nd.edu/~nismec/summer2010/Waterqualitylesson.pdf. Accessed 14 Oct. 2022.

[14]"Indicators: Benthic Macroinvertebrates." *United States Environmental Protection Agency*, 16 June 2022, www.epa.gov/national-aquatic-resource-surveys/indicators-benthic-macroinvertebrates#:~:text=Why%20is%20it%20important%20to,in%20their%20tolerance%20to%20pollution. Accessed 12 Oct. 2022.

[15] "Aquatic Macroinvertebrates." *Extension: Utah State University*, 2020, extension.usu.edu/waterquality/learnaboutsurfacewater/propertiesofwater/aquaticmacros. Accessed 12 Oct. 2022.

[16] Totenberg, Nina. "Supreme Court restricts the EPA's authority to mandate carbon emissions reductions." *NPR*, 30 June 2022. *NPR*, www.npr.org/2022/06/30/1103595898/supreme-court-epa-climate-change. Accessed 12 Oct. 2022.