Identifying the Source of Excessive Nitrates in Garrett City Ditch

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Abstract

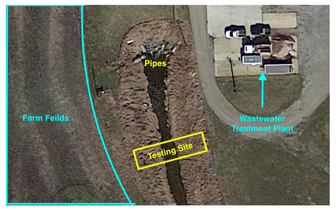
In a previous experiment in 2019, we established consistent evidence of elevated nitrate concentrations (>40 ppm) throughout the deep channel (>3.0 m) of Garrett City Ditch. Our current research aimed to identify the source of this pollution. According to the USGS, nitrates leaking into water ways via agricultural runoff is quite common (Nitrogen and water). This led us to assume the same had occurred at our test site. Our project was designed to determine if the agricultural runoff was the culprit of the excessive nitrates within Garrett City Ditch. The results of this project clearly demonstrated that the excessive nitrates in the test site were not due to agricultural leaching but rather due to the effluent waters of the Garrett Wastewater Treatment Plant. We believed that the amount of nitrates from agricultural runoff was nearly inconsequential based on our previous research and assessment of soil nitrate concentration based on our soil sample data.

Research Question

This is a continuation of a previous project where we discovered that Garrett City Ditch–a local runoff ditch–had an unusually high level of nitrates. High nitrate levels can be dangerous to the environment, making it important to keep track of. In this project we are investigating where the elevated nitrate levels in Garrett City Ditch are coming from. Our hypothesis is that the source of the extra nitrates is likely the chemicals and fertilizers used on the surrounding farm fields leaching into the water via the surrounding soil.

Introduction

Garrett City Ditch (locally known as Dirty Ditch) originates from the wastewater treatment plant and flows into Cedar Creek. This means high nitrate levels will not be isolated to just this but could make it's way into Cedar Creek and beyond. Nitrification is the natural process of breaking ammonium in the soil down into nitrate (Fernandez & Kaiser, 2018). Nitrogen enters both the soil and water naturally through nitrification and the nitrogen cycle, rainfall, or from nitrogen fertilizers put on fields. With these processes in action, you can run the risk of too much nitrate in the local environment. Excessive nitrate levels can be harmful to humans and the environment (Ahmed et al, 2017; McCaslan et al, n.d.; Soil Association, n.d.; US EPA, 2019). Nitrates are quite unstable, which means they easily leach into groundwater and runoff when it rains. Over-fertilized soils with elevated nitrate concentrations results in nutrient pollution seeping into local waterways, creating harmful algae blooms and potentially killing local wildlife (US EPA, 2019). This is why we believe the excessive nitrate levels in Garrett City Ditch are coming from the nearby field.



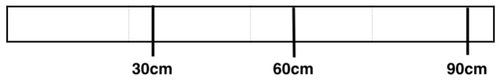
Research Methods

Materials

- Measuring Tape
- Rope/string
- Stakes
- Soil Corer
- Distilled Water
- LaMotte Model EL - Turf and Garden kit
- Vernier GoDirect Nitrate Ion Selective sensor
- Notebook and writing utensil

Methodology

String a line across the ditch to establish a reference point for your sample sites. From the line measure downwards one meter and plant a stake in the site. Repeat this process for two meters, three meters, etc. until you hit the water. Do the same on the other side, making sure you stay parallel to the line. At each stake, use the soil corer to bore one meter horizontally into the bank. As you collect samples, be sure to keep the column close to intact. Pouring distilled water down the hole can loosen compact soil and clay as you get deeper. Use the LaMotte Model EL - Turf and Garden kit to test the nitrate level of the soil at 30, 60, and 90cm along the column. Repeat this process for each site.



At a later date, we used the Vernier GoDirect Nitrate Ion Selective sensor to test the nitrate levels of the water discharge of each drainage tile at the mouth of the ditch.

Figure #1

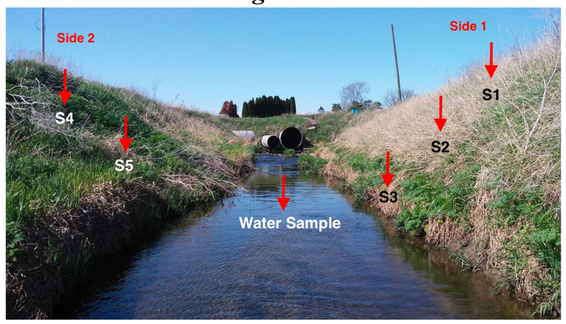
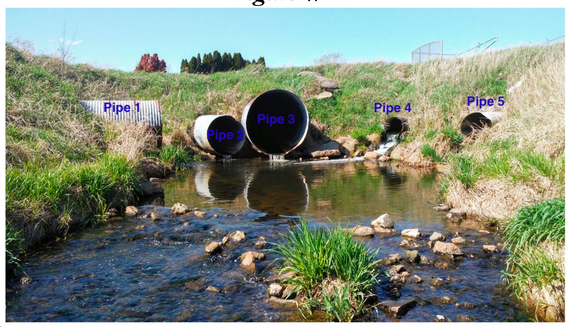


Figure #2



Results

Analyzing Data

Across the board, we found no trace of nitrates in the soil.

Figure #3

		Horizontal Depth (cm)		
		30	60	90
Sample Site	S1	0	0	0
	S2	0	0	0
	S3	0	0	0
	S4	0	0	0
	S5	0	0	0

After confirming this, we decided to investigate the pipes at the mouth of the ditch. Pipe 1 had an average nitrate level of 2.681 ppm, pipe 2 was 0.759 ppm, pipe 3 was 0.518 ppm, and pipe 5 was 0.042 ppm. All of these pipes are storm drains, so these numbers are not surprising. On the other hand pipe 4 had an average nitrate level of 16.65 ppm. When we tested the same pipe a different day, numbers reached up to 20 ppm. The water in this pipe comes directly from the wastewater treatment plant.

Figure #4

Pipe	1	2	3	4	5
Nitrate level (ppm)	2.681	0.759	0.518	16.65	0.042

Discussion

Interpreting Data

Our data confirmed that there were no measurable nitrates in the soil, regardless of depth in the soil column (as measured by S1 – S5). This mean that the excessive nitrates in Garrett City Ditch must have come from some other source. We decided to investigate the drainage tiles at the mouth of the ditch. We used a Vernier GoDirection Nitrate Ion Selective sensor to measure nitrates in the effluent waters of each tile (Figure 2). Our readings were as follows, in average Parts Per Million: Tile (1), 2.681ppm, Tile (2), 0.759ppm, Tile (3), 0.518ppm, Tile (5), 0.042ppm, Tile (4), 16.65ppm. Four of the tiles had extremely low nitrate concentrations, with the exception of Tile 5, whose concentration was nearly eight times that of Tile 1. Without any doubt, it is clear that the main contributor to nitrates within Garrett City Ditch is Tile 5. Tile 5 is the effluent discharge for the City of Garrett's wastewater treatment plant. Considering our data and after speaking with Garrett water treatment employees, we were able to confidently confirm the source of the excess nitrates.

Conclusions

The findings from this study shows how human impact on the environment has far reaching implications beyond most people's knowledge. We were surprised to find that the primary cause of nitrate concentration within Garrett City Ditch was not due to agricultural runoff. Much of the research related to soil nitrate concentrations points to agricultural runoff as the primary source of aquatic nitrate concentrations. We showed definitively that the source of excessive nitrates within Garrett City Ditch was due to the effluent discharge from the wastewater treatment plant. Our next steps is to continue conversations with the wastewater treatment plant managers regarding our findings. Another extension would be to compare the aquatic plant growth within Garrett City Ditch compared to other drainage ditches in our area.

Scan this QR code to view another project which covers the path of the nitrates from Garrett City ditch to Cedar Creek.

Bibliography

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