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Variability of Water Quality in Relation to Farming Along the Raccoon River in West Des Moines, Iowa

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Variability of Water Quality in Relation to Farming Along the Raccoon River in West Des Moines, Iowa

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Abstract

Agriculture regularly impacts surrounding surface water via the runoff of chemical applicants. Manure runoff and nitrogen-based fertilizer runoff are largely responsible for heightened levels of contaminants such as nitrates. Contaminants have larger impacts as they travel through the hydrosphere to aquatic systems and water resources. This work aims to determine the impact of farming activities on surface water quality along the Raccoon River in West Des Moines, Iowa. In the most recent assessment by the Iowa Department of Natural Resources, the section of the Raccoon River covered in this research was listed under impaired following an integrated report of varying parameters. Other previous assessment cycles consistently showed *E. coli* and nitrates as impairments on this river. This analysis over the selected portion of the Raccoon River assesses how water quality varies spatially and temporally throughout the crop season and how the surface water quality of the Raccoon River is impacted by surrounding land use (urban vs rural). Data collected included temperature, PH, conductivity, total dissolved solids, total suspended solids, turbidity, alkalinity, phosphate, and concentrations of chlorine, nitrate, and sulfate. Seven sampling locations were selected over five sample dates spanning from before planting to after harvesting. Water quality variance over time at each sampling site and variation in water quality across separate sites was determined following data collection. The total alkalinity across the river ranged from 119 ppm to 197 ppm, showing a steady increase over the sampling period. Across all seven sampling sites, nitrate (NO_3^-) values peaked in the summer, averaging around 20-30 mg/L across all seven sampling locations. Rural locations were of similar values, ranging from ~20 – 40 mg/L. A gradual decrease in nitrate concentration followed, resulting in not detectable levels (less than 0.5 mg/L) across all sites in early August/September. Phosphate levels ranged from an average high of 9.4 ppm in rural locations to an average of 5.4 ppm at the creek tributary. TDS and TSS values remained relatively consistent, both showing peaks in the June month that was over 100 mg/L over the baseline value at most locations. Correlation between the application of fertilizers in early crop growth and nitrates increase in surface water was observed. This analysis can be used to help the state regulatory agencies develop their best management practices and assess Iowa's current nutrient reduction strategies.

Keywords: *water quality, runoff, land use, farming, chemical application*

Purpose

In Iowa and other similar agriculture states, the crop farming season regularly impacts surrounding surface water via the runoff of chemical applicants. The chemical content of surface water within highly farmed watersheds is subject to change during this time frame. This research is focused on determining the impact of the farming activities on surface water quality in West Des Moines, Iowa along the Raccoon River.

Literature Review

Agricultural practices can frequently be causes of poor water quality, especially in rural states such as Iowa. The runoff from farm fields and livestock lots can lead to high levels of contaminants in the surrounding water sources[1]. Specifically, manure runoff and nitrogen-based fertilizer runoff are largely responsible for heightened levels of contaminants such as nitrates. These contaminants can have much larger impacts as they travel through the hydrosphere including aquatic systems and human water resources. Knowing that fertilizers are applied throughout the season in which the crops are in the ground is important to understanding when the contaminants are entering the system. The water quality difference between rural and urban settings for pollutants such as nitrates can also be accounted for by the proximity to agricultural land.

The Iowa Department of Natural Resources (DNR) does water quality assessments through their Water Monitoring sampling programs[2]. The assessments determine the quality of water through quantitative data and are generated under guidance of the Federal Clean Water Act (Sections 305(b) and 303(d)). The assessments are done every two years and provide data on the impairments to the quality of a given body of water.

The segment identifications for the parts of the Raccoon River used in this research are 1117, 1181, and 1123. For quantitative data purposes segment 1117 (Figure 1) is used to review previous assessments of water quality in this area. As seen in Figure 1, this is the segment of the river after the north and south tributaries combine, before it enters the suburbs of Des Moines[3].

Figure 1. Map of Section 1117, Raccoon River, Iowa[3]

In 2022, section 1117 was ranked as follows:

Class A1 - Primary contact recreational use. Recreation involves full body immersion for a prolonged period.

Class BWW1 - Capable of supporting a wide variety of habitats and aquatic life, including game fish.

Class C - Raw water sources of a potable water supply.

Class HH - Fish are routinely collected for human consumption.

The 2022 assessment cycle covers data collected from 2018-2020. Below is the quantitative data collected from this cycle. While there is more data included in the report, only the tables relevant to the data of interest is included here. The data below shows Class BWW1 as supported while Class A1 and Class C were not supported.

Table 1. Assessment Explanation for Class A1

Class A1 - Indicator Bacteria:

Site ID	Data Source ID	# Samples / # Years	2016 Geometric Mean	2017 Geometric Mean	2018 Geometric Mean	Annual Geometric Mean Violation	# Violations	% Violations	Significantly >10% Violations	Assessment Type	Support Level
17250001	12	23 / 2	261.32	275.54	NA	Yes	13	57%	Yes	Monitored	Not

Table 2. Assessment Explanation for Class BWW1

Class BWW1 - Conventional Parameters:

Site ID	Data Source ID	Parameter Name	# Samples / # Years	Maximum Value	Mean Value	Median Value	# Acute / Chronic Violations	% Acute/ Chronic Violations	Significantly >10% Violations	Assessment Type	Support Level
17250001	12	Ammonia	39 / 2	0.28	0.04	0.02	0 / 0	0% / 0%	No	Monitored	Full
17250001	12	Chloride	3 / 2	25	21	20	0 / 0	0% / 0%	No	Monitored	Full
17250001	12	Dissolved oxygen	39 / 2	13.3	10.2	10.2	NA / 0	NA / 0%	No	Monitored	Full
17250001	12	pH	39 / 2	8.745	8.31	8.31	0 / NA	0% / NA	No	Monitored	Full
17250001	12	Sulfate	4 / 2	33	30	30	0 / NA	0% / NA	No	Monitored	Full
17250001	12	Temperature	39 / 2	30.2	17.8	21	0 / 0	0% / 0%	No	Monitored	Full

Table 3. Assessment Explanation for Class C

Class C - Conventional Parameters:

Site ID	Data Source ID	Parameter Name	# Samples / # Years	Maximum Value	Mean Value	Median Value	# Violations	% Violations	Significantly >10% Violations	Assessment Type	Support Level
17250001	12	Inorganic nitrogen (nitrate and nitrite)	39 / 2	15.6	8.79	9.2	16	41%	Yes	Monitored	Not

As seen in Table 1, Class A1 was not supported due to a moderate magnitude of *E. coli* with an unknown source. Ambient monitoring is continued by the Corps of Engineers. Table 3 shows Class C was not supported due to a high magnitude of nitrate sourced from agriculture. Greater than 10% of samples failed to meet the criteria and ambient monitoring is continued by the municipal water supply.

This cycle assessment on section 1117 scored an Overall Integrated Report Category 4. In this case this means that the water is impaired, and a Total Maximum Daily Load (TMDL) has been completed and the Raccoon River is included on Iowa's section 303(d) list of impaired waters. A TMDL requires all sources of pollution in a watershed be reviewed and a plan to implement water quality standards is developed. The TMDL impairments found in this river included nitrates and *E. coli* (as noted before). These TMDL impairment findings are consistent going back until the 2014 assessment, which was created under previous US Environmental Protection Agency guidelines (although still showed similar data). Assessment cycles all showed *E. coli* and Nitrates as impairments consistently.

A water quality improvement plan prepared by the Iowa DNR, the US Geological Survey, and Center for Agriculture and Rural Development was developed for the Raccoon River[4]. The plan includes a description and history of the Racoon River, TMDL for nitrate, TMDL for *E. coli*, a watershed model, an implementation plan, and a monitoring plan.

Water samples in this research were obtained from the north and south tributaries of the Raccoon River, as well as the main Raccoon River as it runs into Des Moines. The 2022 Impaired Waters Map (Figure 2) shows the south tributary (in red) as a category 5 - the river is listed in

Iowa's section 303(d) list of impaired waters, the river is impaired and a TMDL is required[2,5]. The north tributary (in blue) has no records of impairment and as discussed above, section 1117 (in yellow - the area after the tributaries meet) has category 4 impairment.

Figure 2. Iowa's 2022 Impaired Water Map Along the Raccoon River[5]

Relevant conclusions to be drawn from this review include high nitrate measurements in the river derived from farming, the consistent appearance of excess nitrates and *E. coli* over the last decade, and the noticeable spatial variation in water quality across the north, south, and main Raccoon River.

Research Question

There are two research questions posed for this work:

1. How does the surface water quality across the seven selected sites on the Raccoon River vary spatially and temporally throughout the main crop season?
2. How is the surface water quality of the Raccoon River impacted by surrounding land use (i.e. urban vs rural)?

Methodology

Through the collection of water samples over the main crop season, overall water quality was analyzed both temporally and spatially. Samples were collected from each identified location over the period of study. Seven sampling locations were used for five different sampling dates spanning from April to November. These samples were analyzed for chemical contents to determine water quality variation throughout this time period.

Measurements for *E. coli* in the water samples were not taken due to the lack of nearby incubation equipment. The Raccoon River is approximately a two-hour drive from the University of Northern Iowa and the time frame necessary to being incubation of the collected samples was frequently unable to be met given the collection and transportation time of the samples.

<u>Analytical Methods</u>

Handheld/portable meters were used to measure temperature, total dissolved solids, conductivity, pH, dissolved oxygen, and turbidity at the site directly after each sample was taken. Once the samples were transferred to the lab, ion chromatography was used to measure specific ion concentrations (such as chloride, sulfate, and nitrate). The total suspended solids were determined using filtration.

The data were analyzed in two ways: temporally and spatially. For temporal analysis, data for water quality variance over time at each location was used. Data for variation in water quality across separate sites in a given sampling set was used for spatial analysis.

Data was recorded using excel in a manner that organizes sampling date, location, and parameter. Observations and photos of the surrounding environment were recorded during sampling to understand how land use may affect water quality.

<u>Sampling Methods</u>

The main farming season generally runs from the beginning of April to late October/early November. The season is highly dictated by the climate during this period so this had an impact on the final sampling dates. Five sample cycles were planned throughout this time span. The first set of samples was used as a baseline and completed before any crops were planted. The next three sample sets were taken throughout the growing time of the crops. The final sample set was taken after the crops had been harvested.

The dates that the five sampling sets were collected are as follows:

1. April 8th
2. June 9-10th
3. August 10-11th
4. September 16-17th
5. November 5th

There were seven sampling locations initially selected. Two on the North Raccoon River tributary, two on the South Raccoon River tributary, one after the two tributaries combine into the main Raccoon River, one before the river enters Des Moines, and a final one in Des Moines right before the Raccoon River combines with the Des Moines River. The north and south tributaries both run through rural farmland until eventually joining together. Sampling from each individual tributary and again after they have combined allowed for the identification of certain water pollutants. A sample collected before the river enters Des Moines and another collected at the end of the river helped in the analysis of how an urban setting may also affect the contents of the water.

Sampling Locations:

1. H Avenue Access
2. Dallas County Fair Access
3. Puckerbrush Ramp Access
4. Old Portland Road/Magnolia Farms Access
5. Booneville Boat Ramp Access
6. Lounsbury Landscaping Access
7. Gray’s Lake Park Access

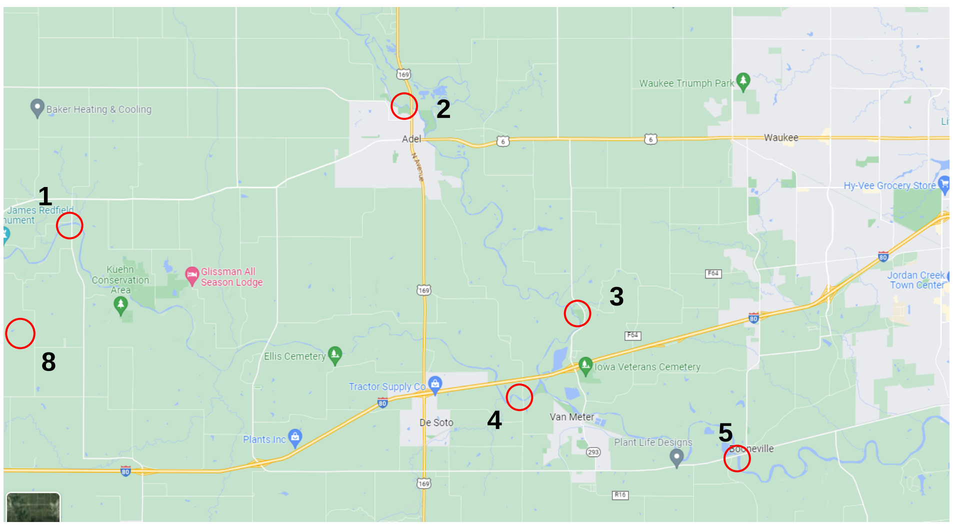

Figure 3a. Map Indicating Sampling Sites.

Sites are numbered as followed: 1. H Avenue Access, 2. Dallas County Fair Access, 3. Puckerbrush Ramp Access, 4. Old Portland Road/Magnolia Farms Access, 5. Booneville Boat Ramp Access, 6. Lounsbury Landscaping Access

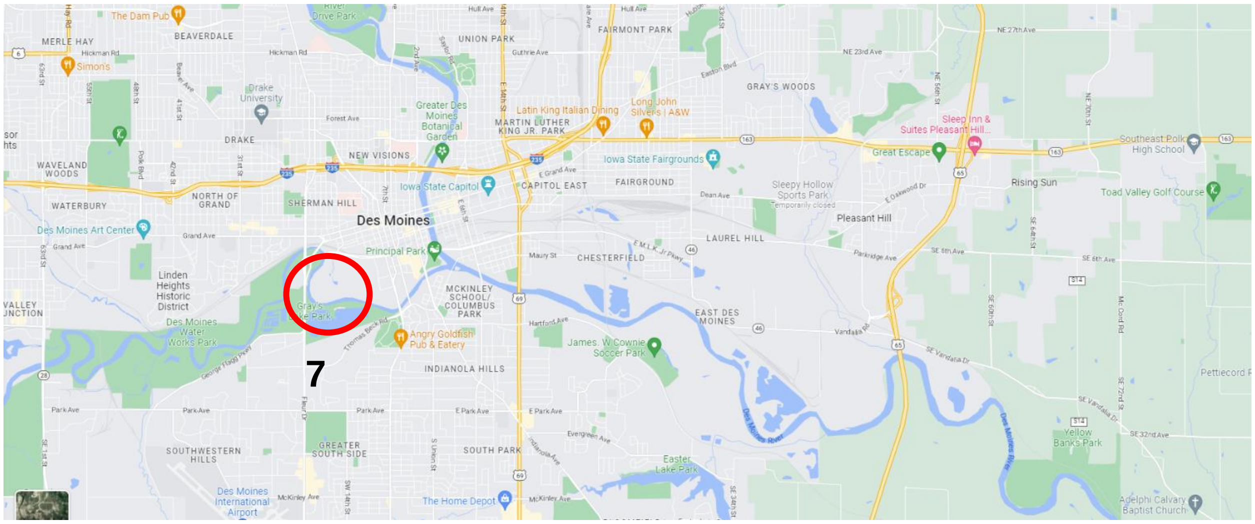

Figure 3b. Map Indicating Sampling Site 7

Sites numbered: 7. Gray's Lake Park Access

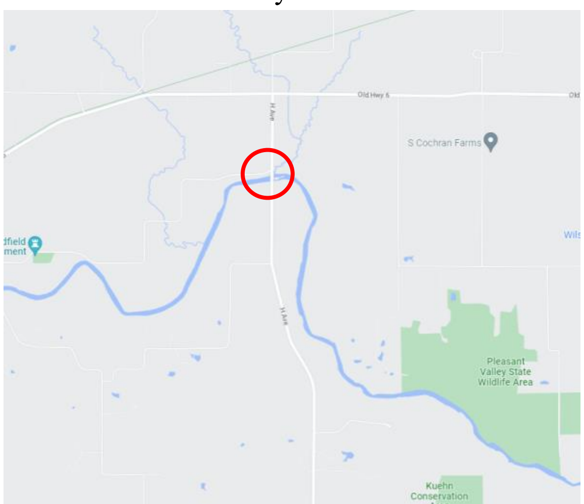

Figure 4a. Site 1: H Avenue Access

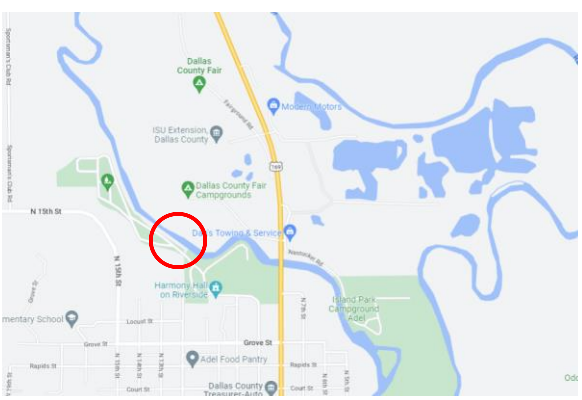

Figure 4b. Site 2: Dallas County Fair Access

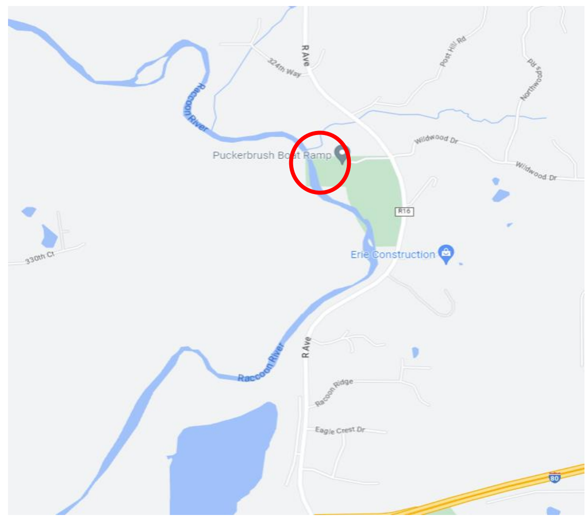

Figure 4c. Site 3: Puckerbrush Ramp Access

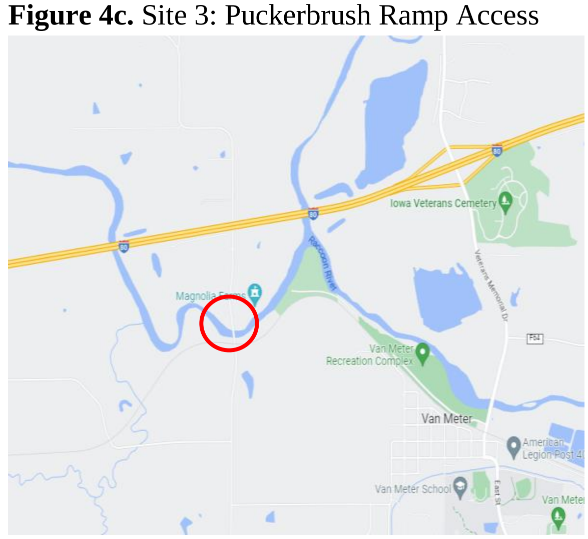

Figure 4d. Site 4: Old Portland Road/Magnolia Farms Access

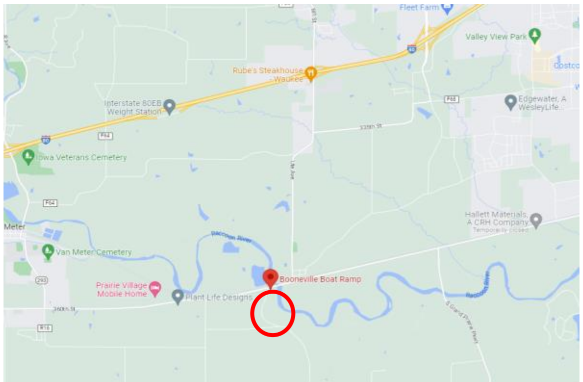

Figure 4e. Site 5: Booneville Boat Ramp Access

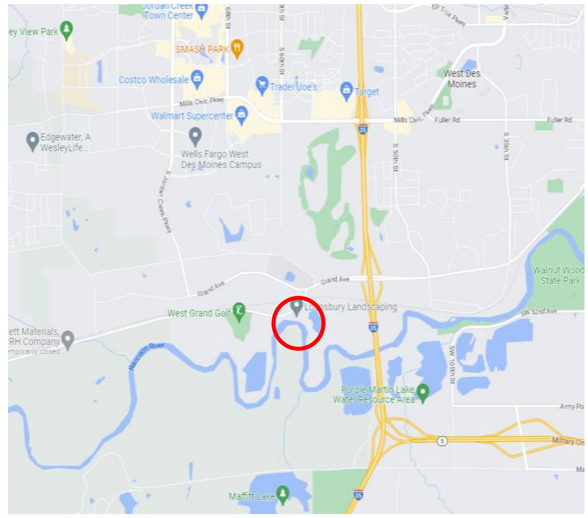

Figure 4f. Site 6: Lounsbury Landscaping Access

As field work commenced, it was found that site 6 (shown in Figure 4f) was inaccessible due to ongoing construction. At this point, the decision was made to forgo the use of site 6 for this research. In placement of site 6 a new site was added which from here on will be referred to as 'Site 8' as seen in Figure 5.

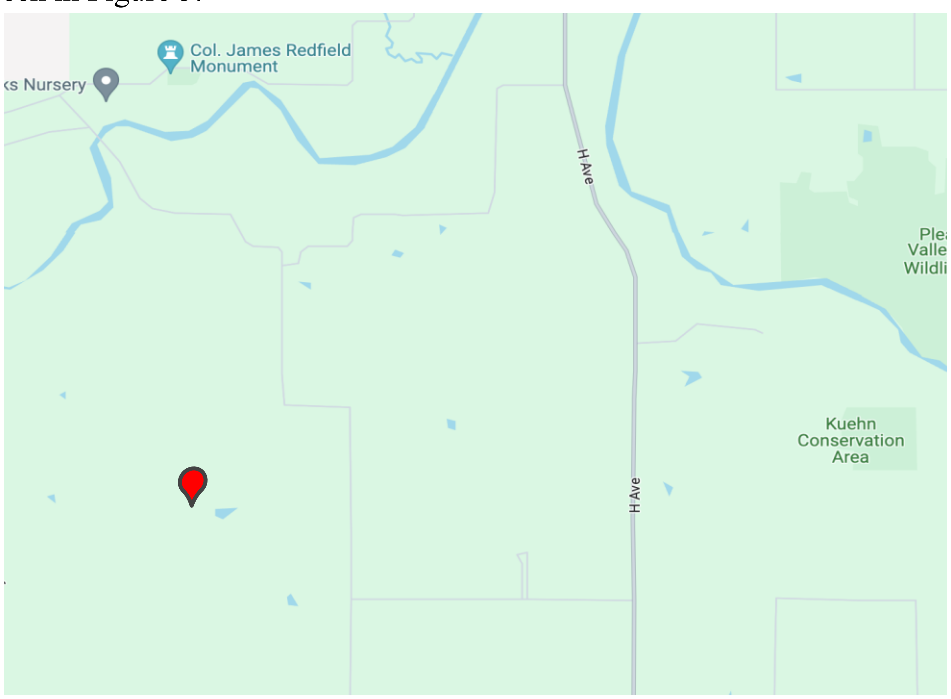

Figure 5. Map Showing Location of Added Site: Site 8

Site 8 lies slightly south-west of Site 1 (located at the intersection of H Avenue) on the South Raccoon River tributary. This sampling site is a creek located on private land that ultimately adjoins with into the South Raccoon River. The creek is surrounded by timber and farm fields used for hay which have little to no application of pesticides and minimal fertilizer application. The creek originates at a small pond partially surrounded by cropland, which is the only agricultural exposure it receives. The decision in adding this site to the sampling sets was based on the insight that the data could provide by looking at a tributary that had little runoff from adjacent farms compared to the main tributaries of the river. This site could serve as a sort of 'control' due to limited exposure and runoff from farmland and give insight to the water quality before entering the main tributary.

<u>Locations</u>

Figure 6a. Site 1, H Avenue Access

Figure 6b. Site 2, Dallas County Fair

Figure 6c. Site 3, Puckerbrush Access

Figure 6d. Site 4, Old Portland Road

Figure 6e. Site 5, Booneville Access

Figure 6f. Site 7, Downtown Des Moines

Figure 6g. Site 8, Creek Tributary

Anticipated Results

In response to the first research question: How does the surface water quality across the seven selected sites on the Raccoon River vary spatially and temporally throughout the study? Analysis of the data was used to answer how the water quality of each site compares to the others at a given point in the season. Analysis of how the water quality of a specific site changes over the course of the crop season was done as well. From this, conclusions can be made on how the crop season affects water quality of the Raccoon River and more specifically, what areas of the river are most affected.

In response to the second research question: How is the surface water quality of the Raccoon River impacted by surrounding land use (i.e. urban vs rural)? Data obtained from the rural locations were compared to the data from site seven, in Des Moines. Discrepancies in water quality can be determined and used to generate further hypotheses on notable changes in quality as the surrounding land use of the river changes.

The collected data and analysis can be used to help the state regulatory agencies develop best management practices (BMP) and assess Iowa's current nutrient reduction strategies.

Results and Discussion

A GIS land analysis of the watersheds that drain into the areas of interest along the Raccoon River was created. As shown in figure 7, it can be observed that the drainage area surrounding sites 1-5 and Site 7 are significantly composed of cropland. The upstream watersheds are also shown to reflect the drainage conditions of the river leading into the sampling sites, which again is a high proportion of cropland. As the river flows towards the final site, Site 7, in downtown Des Moines, it can be noted that the final fifteen miles (approximately) are a majority urban with limited agricultural use. When performing temporal and spatial data analysis, it is important to recognize and analyze the contribution of land use to the water quality findings of the research.

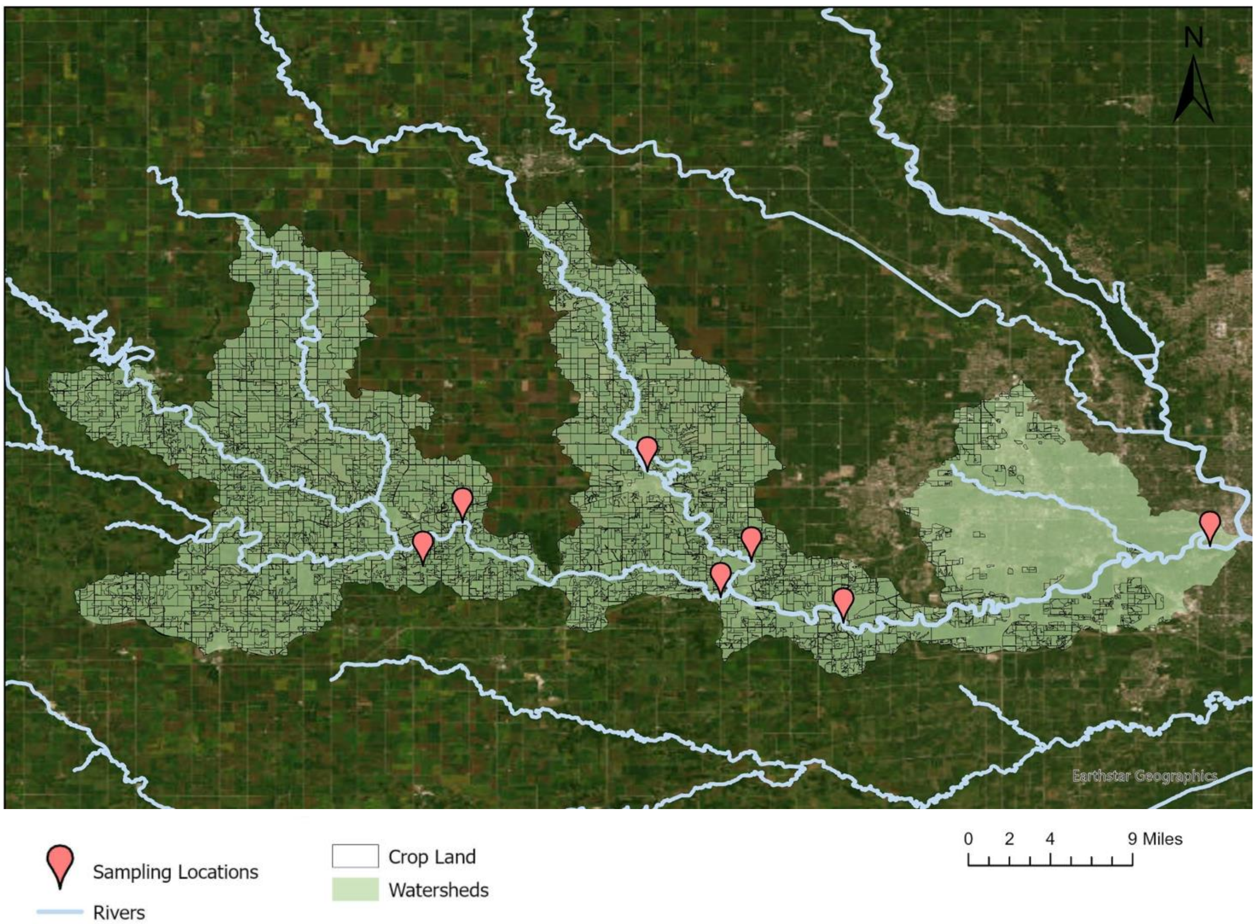

Figure 7. Map of farmland within watersheds surrounding the North, South, and Main Raccoon River and site location along the rivers. Data of the major watersheds was downloaded from the Iowa Department of Natural Resources and the cropland data was retrieved from the United States Department of Agriculture, Natural Agriculture Statistics Service.

Surface water systems have natural pH levels typically between 6.5 and 8.5, depending on varying environmental factors. One factor that can affect the pH of surface water is the amount of dissolved ions. A higher ion content can result in a higher or more basic pH as acidic water works to further dissolve minerals in the rock surrounding. Alkalinity is a measurement of the buffer capacity of the water, meaning its resistance to a lowering of pH, i.e. increased acidity.

One way alkalinity can increase is when there is an increase in dissolved ions from surrounding materials. In Des Moines, the bedrock is mainly limestone, so a lot of carbonate minerals are being dissolved and entering the aquifer systems. Naturally occurring minerals can contribute to higher alkalinity during the summer months. Another way to increase alkalinity is an increase of dissolved ions entering into the water from runoff. Across the sampling sites there was a trend of total alkalinity increasing over the seven-month period of the crop season as shown in Figure 8. From April to November alkalinity increased by roughly 75 parts per million. As temperature increases, there can be an increase in chemical reactions, which will result in more dissolution of ground materials. This likely explains part of the large jump from April to June. Increased ions from runoff also likely played a part in the overall growth trend of the total alkalinity. Ions entering the hydrologic system can be sourced from pesticide and fertilizer applicants applied to fields within the watershed.

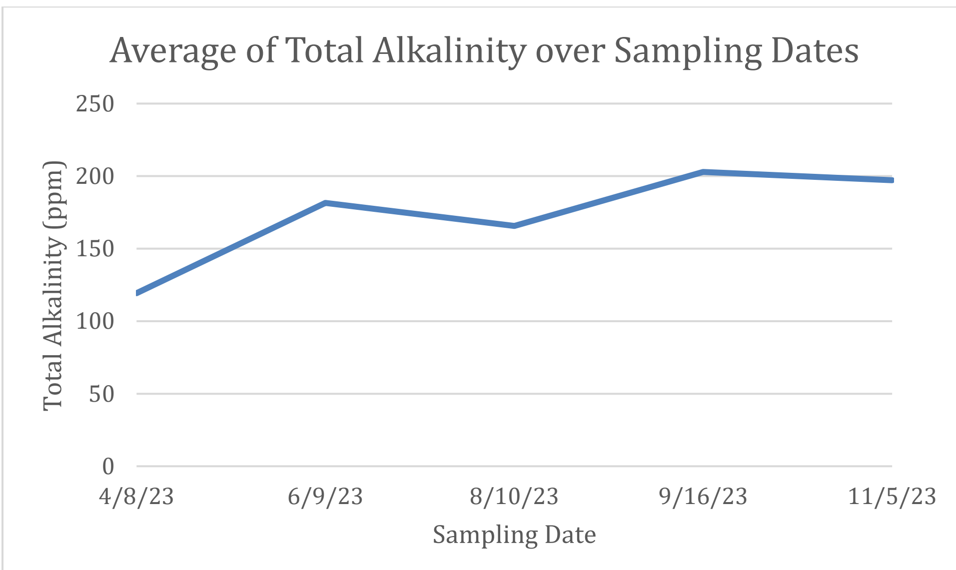

Figure 8. Average total alkalinity across all sites on each sampling date.

One of the most prominent indicators of farm runoff is dissolved nitrate ions (NO_3^-). Nitrate is a common component of chemical fertilizers that is applied on crop fields. Figure 9 shows the average nitrate concentration of all of the sites over the sampling period. When looking at the data, all of the sites showed a similar overall trend in nitrate concentrations with the main differences being the magnitude of the peak observed in June. Nitrate values peaked in the summer, averaging around 20-30 mg/L across all seven sampling locations. A gradual decrease in nitrate concentration followed, resulting in not detectable levels (less than 0.5 mg/L) across all sites in early August/September. The differences in the magnitude of nitrate concentration can likely be attributed to amount of farmland within the watershed along with the individual farmer's use of fertilizers on their fields (which is difficult to report and quantify). Based on the large jump in concentration to over three times the starting amount, it can be seen that this is the period in which most of the fertilizer applicants are being applied. Under the Iowa DNR's water quality assessment, guided by the Federal Clean Water Act, the values measured in June would result in an impairment of the river in the form on nitrate concentrations.

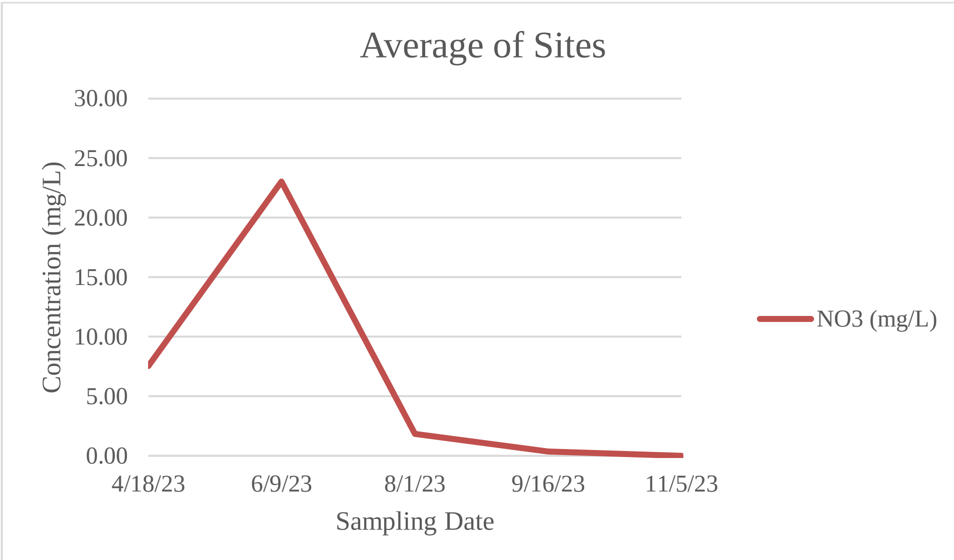

Figure 9. Average nitrate (NO_3^-) concentrations over all sites during the sampling period.

There is a general trend observed when looking at the pH along the river. Site 5 is located on the main Raccoon River after the north and south tributaries meet. As shown in Figure 10a, the overall change in pH over the sampling period is a drop of about 0.5 with similar values. There are drops in pH in June and September with a peak in August.

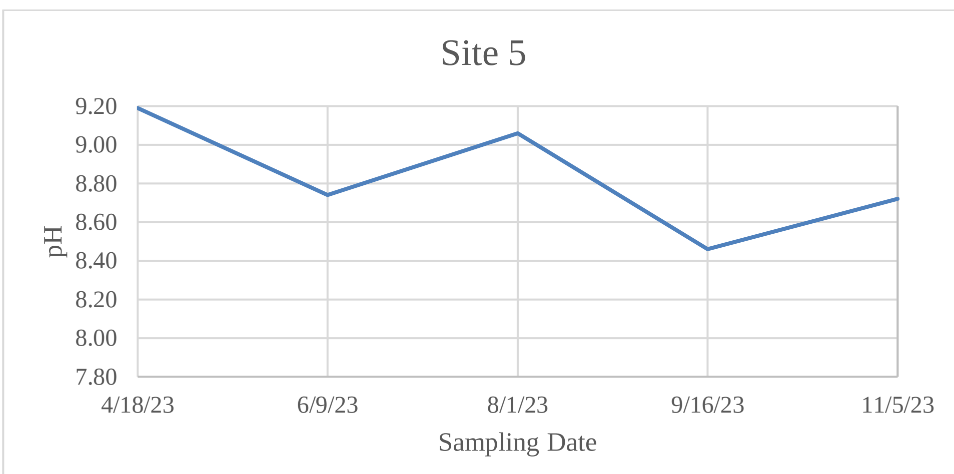

Figure 10a. pH changes over the sampling period at Site 5 (Main Raccoon River)

Figure 10b shows the urban sampling site, Site 7, in downtown Des Moines. The same trend of a pH drop is observed with a drop of 0.35 over the sampling period. The drops and peaks are much milder in this data set which may be attributed to the water treatment plant located upstream of this site.

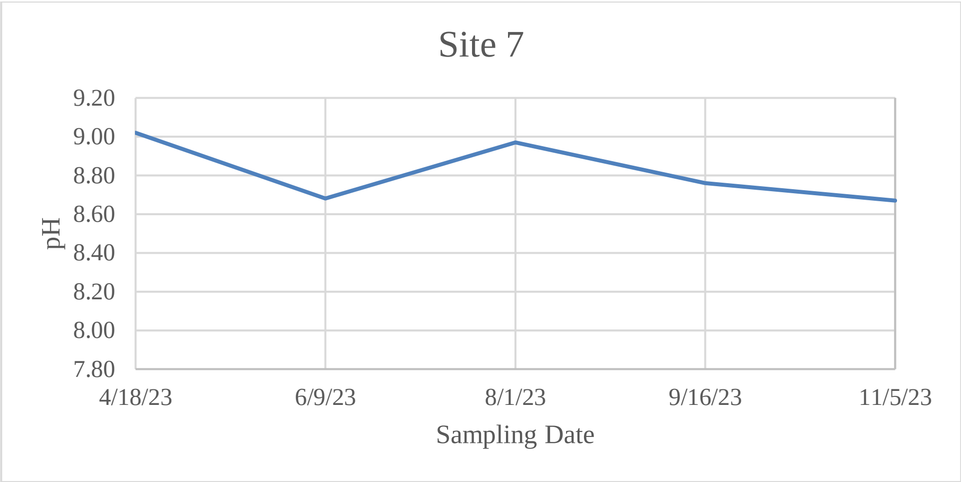

Figure 10b. pH changes over the sampling period at Site 7 (Urban site)

Site 8, located on a creek tributary to the South Raccoon River provides some insight to conditions before combining with the main river. The overall drop in pH is around 0.4 but both the starting and ending pH are about 0.3 below the original pH and the value getting below a pH of 8 at one point. The overall lower pH values can be indicative that there are less ions dissolved in the water at this site which has less farm applicant runoff than sites located on the main rivers. Sometimes aquatic plants can release high amounts of carbon dioxide in the water, this process of plant respiration can cause the pH of the water to go down temporally.

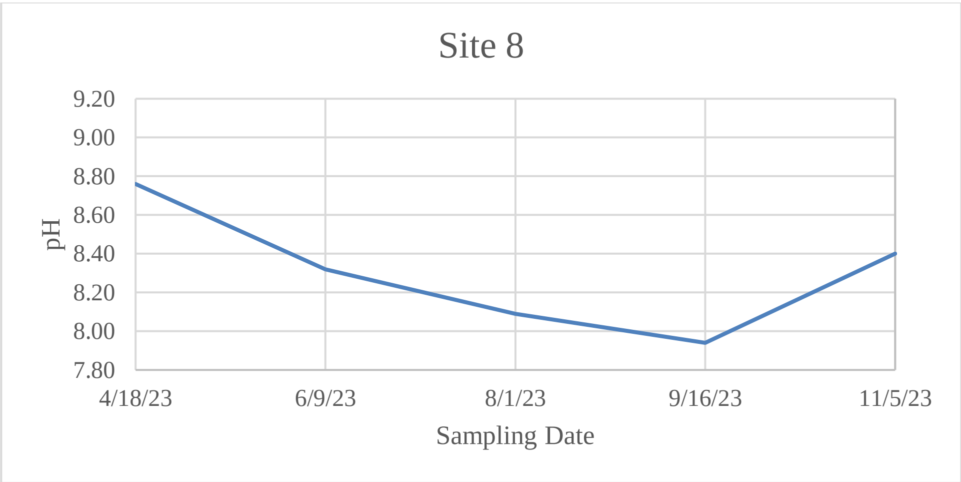

Figure 10c. pH changes over the sampling period at Site 8 (Creek Tributary)

Many of the pH measurements show a decrease in pH in the June sampling set. This is not necessarily an expected observation as there is a large increase in the nitrate ion concentration of the water at this time. Interestingly, the urban site (Site 7 shown in Figure 11a) and the creek tributary site (shown in Figure 11b) both follow the same general pattern. The urban site receives flow from both tributaries, so it is apparent that the high nitrate concentration is maintained as the water moves downstream, out of high-volume crop ground. Site 8, however, is interesting as it is located within private property not directly surrounded by crop land. Although, as noted before, the origination of this creek is a small pond that serves as a collection site for surrounding crop land off one farmer's field. The lower volume of water in this creek lead to less dilution of the fertilizer runoff - which lead to what was the highest concentration at this sampling date across all sites. During this sampling date there was an observed high amount of algae blooming in the creek which also indicated high concentrations of nitrates in the water. Aquatic plants can release high volumes of CO_2 in water.

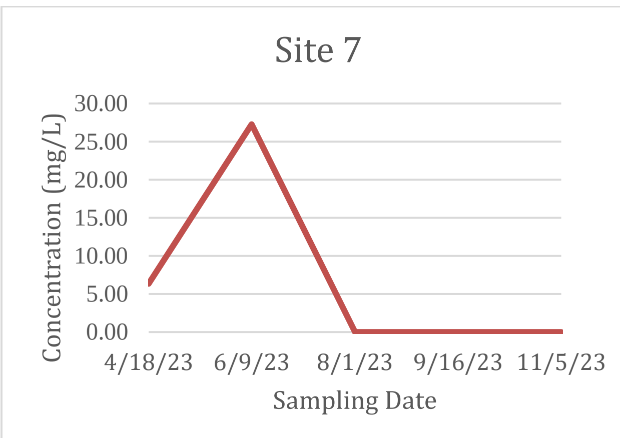

Figure 11a. Nitrate concentrations at Site 7 (downtown Des Moines) over the sampling period.

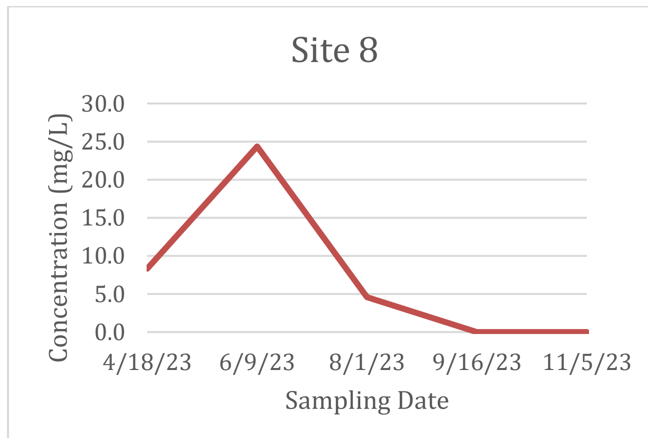

Figure 11b. Nitrate concentrations at Site 8 (creek tributary) over the sampling period.

Site 1, which is located the furthest upstream on the South Raccoon River tributary, provided the most varied result. This site showed relatively low nitrate concentrations across all dates with a very low increase at the June sampling date. This is likely related to the amount of farmers using fertilizers in this area but it would be difficult to determine that relationship. Notably, Site 7 flows into the south tributary slightly before Site 1 and although it is a much smaller volume of water flowing into the river, there is a stark variation in nitrate concentration at this sampling date to be observed.

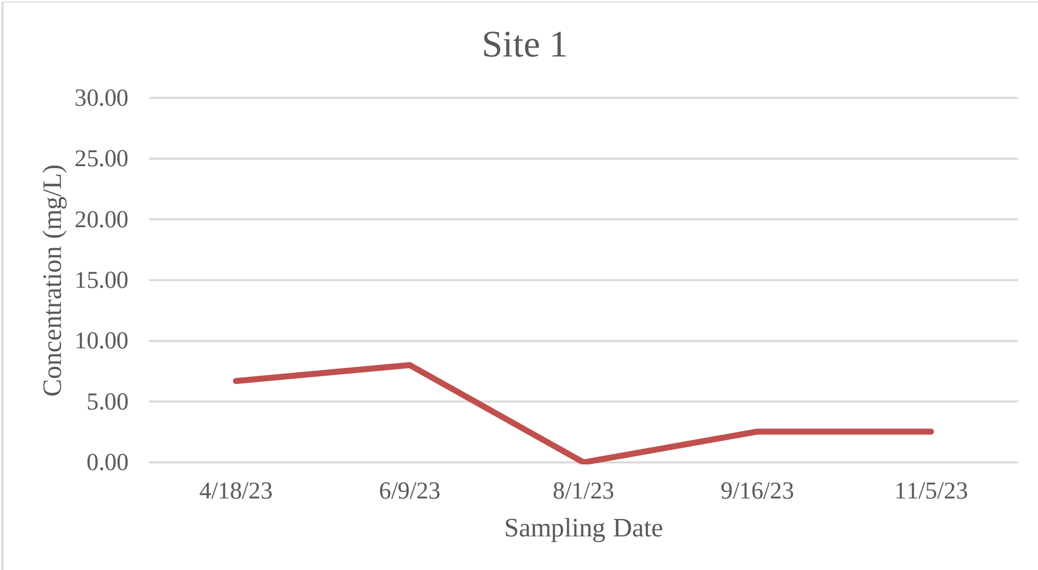

Figure 11c. Nitrate (NO_3^-) concentration at Site 1 during the sampling period.

Another ion commonly attributed to fertilizer application is phosphate. Figure 12 shows the average phosphate concentration across the sites throughout the sampling. The most notable component of this data is the low phosphate concentration at Site 8, the tributary location. Again, this site is runoff from mostly timber land with exposure to only one crop field surrounding the pond where it originates. While the other sites show higher levels of phosphate, the average for site 8 is 5.4 ppm. This information shows a relationship to the exposure of crop land runoff and the phosphate ion concentration in the water. Many of the other sites are around 9 ppm (with the exception of Site 4 which is around 7 ppm) and downstream as far as downtown continues to show heightened levels of phosphate when compared to a water source like Site 8. A large percentage of percentage comes from farm fields being piggy backed on eroded soils.

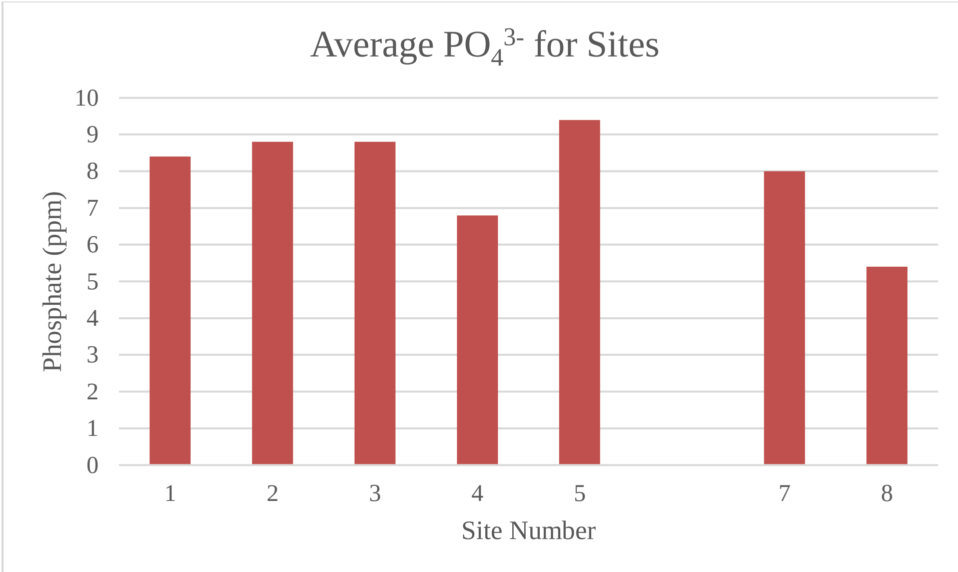

Figure 12. Average phosphate (PO_4^{3-}) concentration for each site during the sampling period.

The common trends in dissolved ions (sulfates, nitrates, and chlorine) is summarized by Figure 13 showing the dissolved ions at site 2 over the sampling period. There is a rise in dissolved ions in the water during the June/summer sampling date. This aligns with the trends seen in nitrates across all sites, as well as the peak in alkalinity at this date. The other sites along the river followed a similar trend, showing an increase during the summer months.

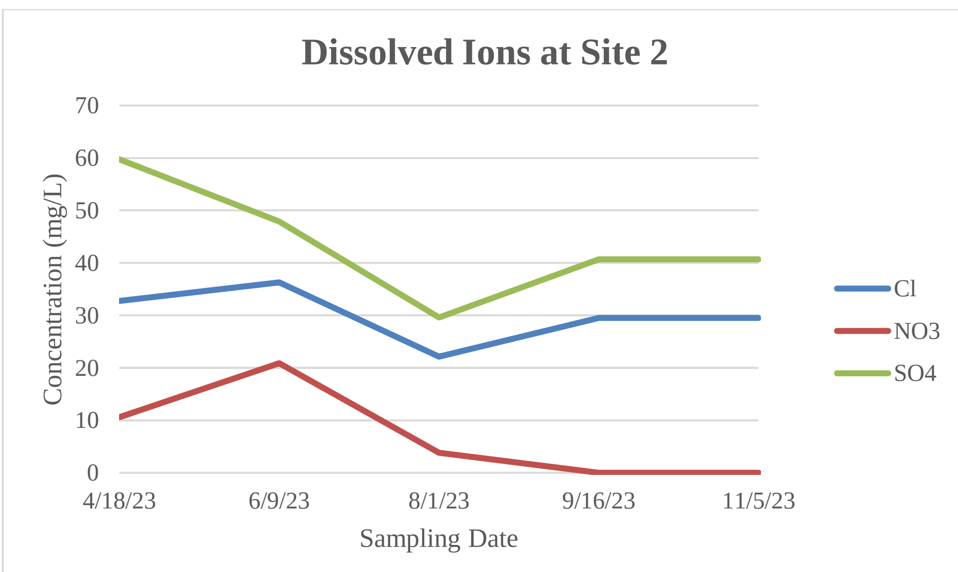

Figure 13. Dissolve ions (Cl, NO_3^-, PO_4^{3-}) at Site 2 over the sampling period.

Further supporting the flux of contaminants entering the river in the summer months, the data for dissolved and suspended solids shows a similar trend. Figure 14 shows the TSS and TDS for Site 1 over the sampling period. A peak in the concentration of both suspended and dissolved solids can be seen in the June sampling date. This trend was observed across most other sites.

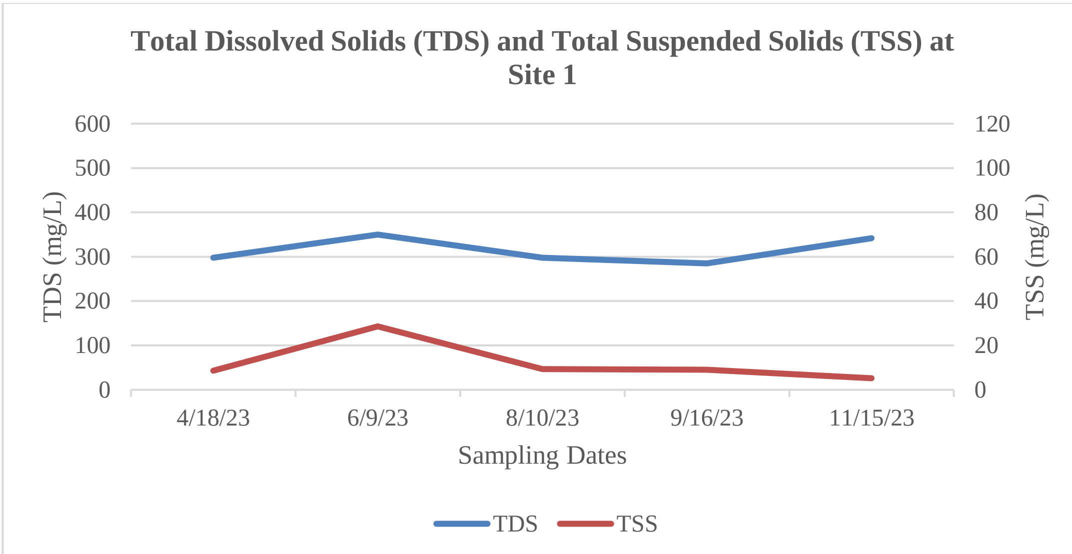

Figure 14. Total Dissolved Solids (TDS) and Total Suspended Solids (TSS) at Site 1 over the sampling period.

The urban site, Site 7, shows a peak in the total suspended solids for the summer month with a higher increase in TSS than observed in Figure 15. Notably, the TDS values are elevated at Site 7 for all sampling dates. This may be due to the water treatment plant located within a mile upstream. Regardless, the urban site still maintains a similar trend to the rural locations when looking at contaminants in the water. At times when TSS is high, the suspended materials can serve as a source of TDS within the water. Soft sediments on the stream bed can also be a significant source of dissolved solids as well.

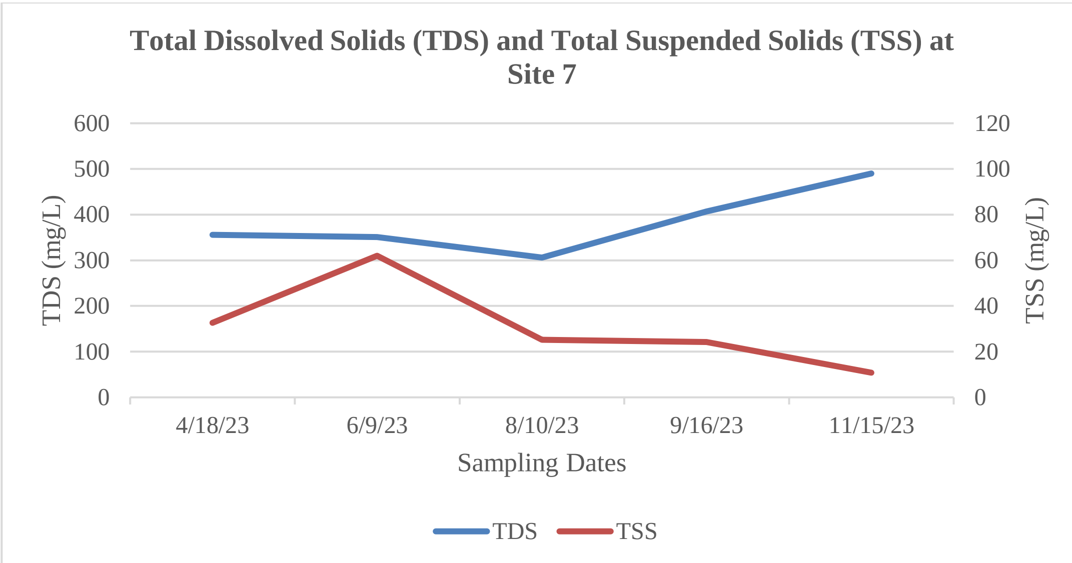

Figure 15. Total Dissolved Solids (TDS) and Total Suspended Solids (TSS) at Site 7 over the sampling period.

The general trend when looking at dissolved ions, dissolved solids, suspended solids, and alkalinity is that there is an influx of dissolved and suspended material in the water across the entire Raccoon River system in the summer months. The high nitrate and phosphate composition indicates that farm applicants are likely a cause of this influx shown across the data sets.

Conclusion

The data collected in this study showed similar trends across many of the parameters used. The total alkalinity across the river ranged from 119 ppm to 197 ppm, showing a steady increase over the sampling period. The average nitrate peaked in June with a value of 23 mg/L, tapering off to not detectable levels by the end of the sampling period. Phosphate levels ranged from an average high of 9.4 ppm in rural locations to an average of 5.4 ppm at the creek tributary. TDS and TSS values remained relatively consistent, both showing peaks in the June month that was over 100 mg/L over the baseline value at most locations.

From the data collected in this study, correlation between the application of fertilizers in early crop growth and increase in contaminants in the surface water was observed. Specifically, there was an observed increase in nitrates and other dissolved ions in during the summer and a steady increase in alkalinity throughout the entire sampling period, which is due to increased ion concentrations in the water. Phosphate concentrations were higher in the sampling sites located on main tributaries that received runoff from the surrounding farmland and was prevalent downstream into the urban location. Suspended solids and dissolved solids in the water also showed a pattern of increasing within the summer sampling months. Based on the Iowa Department of Natural Resources water quality standards from the Federal Clean Water Act, the Raccoon River would continue to be classified as impaired based on the observed nitrate concentrations alone. The state should look to further updates their best management practices (BMP) and assess Iowa's current nutrient reduction strategies. The data derived in this analysis can be used to help the state regulatory agencies improve the water quality along the Raccoon River and apply other reduction strategies across the state.

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