Water Testing Along the Quittapahilla Creek, Beck Creek, Bachman Run and Snitz Creek

Stephen Newell
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Abstract

The goal of this independent study project is to continue the water testing that has been conducted along the Quittapahilla Creek, Beck Creek, Bachman Run and Snitz Creek. There has been a large amount of testing done during the fall, winter and spring seasons, however, there is little data for the summer months. This study was conducted during the months of June, July, and August 2004. There were a total of six sites. Water and air temperatures, pH, turbidity, alkalinity, dissolved oxygen, nitrate concentrations and phosphate concentrations were recorded for each site. There are many factors influencing the water quality of these streams such as development, industry, wastewater treatment runoff, and agriculture. The concern is not only for the health of these streams but also for the larger bodies of water that they flow in to, namely the Chesapeake Bay. There have been many stream improvements within the Chesapeake Bay Watershed and with the continuation of this monitoring program, the long-term heath of these creeks can be maintained.

Introduction

The six sites that were chosen for water testing were sites recommended by the Quittapahilla Watershed Association. The tests that were conducted were done because of their indications as to the health of the stream. These stream studies that are conducted throughout the Chesapeake Bay Watershed identify areas of particular concern.

Two of the biggest concerns in the Chesapeake Bay are nutrient and sediment input. Much of the watershed has an agricultural landuse, which exposes fields to fertilizer and sediment runoff. There are other practices such as development, wastewater treatment that does not have biological nutrient removal system, and stream bank erosion that can produce nutrient and/or sediment runoff. However, agricultural practices appear to be the main concern within the Quittapahilla Watershed. Since a large percentage of the Bay's freshwater, around 53%, comes from the Susquehanna River, much of the sediment and nutrient inputs are occurring in its tributaries (8).

There were very high levels of nutrients and sediments recorded flowing in the Chesapeake Bay in 2003. There was 353.6 million pounds of nitrogen, 30 million pounds of phosphorous and 18,169.9 million pounds of sediments (8).

Nitrogen and phosphorous are plant nutrients. Normally phosphate levels do not exceed 0.1 ppm in fresh water ecosystem (4). Excess levels of these nutrients, in particular phosphate, which seems to be the limiting factor, from sources mentioned above can lead to eutrophication. Eutrophication creates an excess growth of phytoplankton. This excess phytoplankton, or algae bloom, can block sunlight resulting in the death of submerged aquatic vegetation. In addition, the increase in detritus will cause bacteria populations to increase in an effort to decompose the dead plant/algal material. The bacteria will go through cell respiration in the process, greatly increasing the biological oxygen demand, which may reduce the oxygen available to other organisms.

The U.S. Geological Survey has identified several factors that directly or indirectly relate to the nitrogen cycle that may affect temporal variation in nitrate concentrations. Three of these factors are timing and application of manure and fertilizer, uptake of nitrate by plants, and temporal variations of stream biological activity (9). A USGS study suggests that manure and fertilizer application during the spring is the explanation for the slight increase in nitrates recorded. Regions of the state that had the highest manure applications also had the higher level of nitrates present in the surface water. During the summer months the normal decrease in rain and increase in nitrate uptake by plants would create stabilization or decrease in levels. The levels would increase during the fall due to decrease in plant uptake of nitrate and increase of precipitation that would flush nitrate into groundwater and surface water. The levels of nitrate would be high in early winter and then begin to decrease through the winter until the cycle begins again (9). The USGS study found nitrate levels to be highest during the winter and lowest during the summer (9).

The turbidity of the streams was measured to determine the relative amount of sediments in the water. While it is true that most sediments will settle out before flowing into the Chesapeake Bay, the higher the turbidity of the streams within the Chesapeake Bay Watershed the greater the amount of sediments flowing into the Bay. Streams in this study experienced only brief periods of turbid water due probably to poor streamside buffers and heavy rains. This means that the photosynthetic ability of plants within these streams may only be slightly affected. However, the sediments covering the streambed may negatively affect other aquatic organisms.

Sedimentation has been a major concern of the Trout Unlimited organization and its efforts to improve fish habitat along the Manada Creek. There is a large amount of sedimentation in the creek because of stream bank erosion due to previous practices at Fort Indiantown Gap.

The alkalinity and pH of the six streams were also tested. The pH is the measure of hydrogen ions in solution. This is an important value because many aquatic organisms have an optimal pH range. A very low pH would likely indicate some type of pollution such as acid mine runoff and a very high pH would likely indicate a well-buffered stream as a result of limestone rock. Alkalinity is the ability of a soil to resist changes in pH - the higher the alkalinity, the higher the buffering capacity.

The dissolved oxygen level is also an important measure of the health of a stream; in general the higher the dissolved oxygen, the higher the quality of the water. Within the Chesapeake Bay the value of 5 ppm and above is considered healthy (3). Fish and other aquatic organisms require oxygen for cell respiration. Temperature, turbulence, plant growth and decomposition are several factors that can influence oxygen levels. A dissolved oxygen concentration of less than 5 ppm does not necessarily mean that organisms will die, but the constant exposure to the low levels may make the organisms more susceptible to disease or other environmental stresses (3).

Methods

Water testing was conducted at six sites, two sites on the Quittapahilla, one site on Bachman Run, two sites on Beck Creek, and one site on Snitz Creek. The attached maps indicate the actual testing locations. The sampling was done approximately every other week from June 14, 2004 to August 27, 2004, with a total of six samplings.

Before sampling, a standard nitrate-nitrogen curve was made using 1,3,5,7 and 9 part per million solutions (Fig.1). A standard phosphate curve was made using 0.5,1,1.5,2.5 and 3 part per million solutions (Fig. 2). The solutions were made from Lamotte 1000 part per million standard solutions.

Procedures conducted at the site:

Each of the six sites is at a bridge location where a bucket was lowered to collect the water. A total of six bottles were filled at each site. Three plastic bottles were rinsed and filled for the nitrogen testing. Three glass bottles were rinsed and filled for phosphate testing. Glass bottles are used for phosphate samples because plastic is known to absorb phosphate. The pH level was recorded using the Corning pH meter. The dissolved oxygen level (mg/L) was recorded using the YSI microelectrode array Model 95 dissolved oxygen meter. Dissolved oxygen and pH measurements were not recorded during the first week because of problems with the meters. The water and air temperatures, as well as time of collection, were recorded in addition to any significant rainfall or observed water conditions.

Procedures conducted in the lab:

Once at the lab, the sample water is allowed to adjust to room temperature. The nitrate-nitrogen levels were tested using the cadmium reduction method (5). Nitrate nitrogen absorption was determined using the Spectronic 20^{+} spectrophotometer at 540nm. The phosphate levels were tested using the ascorbic acid reduction (4). Phosphate absorption was determined on the spectrophotometer at 700nm. The concentrations in ppm were then calculated using the equations from each of the standard curves (See Figures 1 and 2 for equations). It should be noted that because of a malfunction of the Spectronic 20^{+} spectrophotometer, the August 12^{th} and August 26^{th} measurements were made with the Genesys 20 digital spectrophotometer.

The alkalinity was determined with the Lamotte's direct reading titrator method and turbidity was determined in Jackson turbidity units using the appropriate Lamotte's test kit.

Results and Discussion

Nitrate-Nitrogen

The nitrate-nitrogen values ranged from 2.12 ppm to 9.28 ppm. With only two exceptions, the nitrate-nitrogen values followed the same trends, increase from June 14 to June 28, decrease from June 28 to July 15, increase from July 15 to July 26, decrease from July 26 to August 12 and increase from August 12 to August 26 (Figure 4). The correlation between the sites at the different dates could be due to heavy rains and cycles of nutrients being washed into the streams.

Site six, Snitz Creek at Dairy Road, was consistently the lowest nitrate-nitrogen concentration with a range of 2.12 ppm to 4.11 ppm. Other studies have indicated similar findings, Brennan 2000 (1). It should be noted that the nitrate-nitrogen measurements of Snitz Creek were taken before flowing past the sewage treatment facility. Further tests should be conducted downstream from the sewage treatment facility to determine if nutrients are being released from the facility. Within the Chesapeake Bay there are 288 major wastewater treatment facilities and only 70 of the facilities have a biological nutrient removal system. These 70 facilities that are updated have the ability to reduce nitrogen discharges to an average of 3 ppm while most of the other facilities only reduce the nitrogen to 8 ppm before discharge into the local streams (2). So while the data does not show the Snitz as a significant source of nitrate flowing into the Quittapahilla, the Bachman Run is a significant source of nitrate to the Quittapahilla. An additional test along the Quittapahilla between the Snitz Creek tributary and Bachman Run tributary would give more indication of the source of nitrate runoff.

The two sites along the Quittapahilla corresponded fairly well with each other with a range of 3.93 ppm to 9.28 ppm, as did the two sites along Beck Creek that had a range of 5.23 ppm to 8.36 ppm.

Bachman Run had the highest average nitrate-nitrogen levels with a range of 7.03 ppm to 8.84 ppm. Additionally, it appears from Figure 6 that the Bachman Run values had the least variation from week to week.

Orthophosphate

Orthophosphates levels were low with a range of 0.08 ppm to 1.51 ppm and the 1.51 ppm value had a very high standard deviation, which may indicate some error in the testing procedures. The orthophosphate values, while relatively low, were greater than previous studies (Brennan, 2000) that only detected orthophosphates on several occasions. They were also greater in most cases than the 0.1 ppm that Lamotte indicates as average for freshwater streams.

The orthophosphate levels were slightly higher than the 0.34 ppm average total phosphate concentration for several sites along the Quittapahilla that were recorded by the AES Ironwood study (Rodriguez, 1997).

There did not seem to be a correlation between increases and decrease in nitrate-nitrogen levels and increases and decreases in orthophosphates at the six sites.

Alkalinity and pH

At the six sites, the alkalinity values ranged from 156 ppm $CaCO_3$ to 312 ppm $CaCO_3$. The pH values ranged from 7.8 to 8.4.

The alkalinity values along the Quittapahilla ranged from 156 ppm $CaCO_3$ to 264 ppm $CaCO_3$. It is interesting to note that on the July 15 collection date, the two sites along the Quittapahilla both recorded very low alkalinity values of 180 at Bellgrove Road and 156 at Glen

Ridge Road. These low alkalinity values correlate with the lowest pH values as well for these two sites.

Dissolved Oxygen

Along the Quittapahilla Creek there was little variation in the dissolved oxygen levels at the two sites over the summer months. The range was 5.53 mg/L to 6.85 mg/L. The resistance to changes in oxygen concentration may be due in part to the fact that the Quittapahilla is a larger stream than the others, which would make is somewhat more resistant to changes in temperature.

Turbidity

Turbidity varied greatly between the six sites. The high turbidity values for June 14 and 15 were likely due to errors in the procedures to test turbidity. The Snitz Creek and Beck Creek were consistently the less turbid of the sites. The higher turbidity values relative to others' studies may be partly explained by the frequent heavy rainfall during the summer of 2004. Additionally, the high turbidity values along the Quittapahilla were a result of some type of stone dust runoff most likely from the nearby quarry. At the Bellgrove Road site the turbidity was 30 JTU's. This is closer to the quarry than the Glen Ridge Road site, which is further downstream and had a turbidity value of 10 JTU's for the August 12th measurement.

Conclusions

This has been a very brief study of water quality along these streams during the summer months of 2004. Being that there is a large amount of data for fall, winter and spring, hopefully this study will provide some information to allow comparisons of year round water conditions on these streams and better explanation of what is having an influence on the quality of the water. Many efforts have been made to restore these streams and educate landowners about the impact they can have on the watershed. Recently this year, the Pennsylvania Fish and Boat Commission provided additional grant money available for a restoration project within the Quittapahilla Watershed as well as Tulpehocken Creek (6).

The most evident trend was that of the nitrate-nitrogen levels. The levels of nitrate-nitrogen at each site increased or decreased during the same week. The levels were high at the Bachman Run site, however, there was only one value recorded above 9 ppm during the course of the summer study.

While there is a great deal of effort being put forth into controlling nutrients within the watershed, the nutrient levels at the sites sampled do not appear to be lowering significantly over recent years when compared to data from Brennan, 2000 (1). These nutrients can create problems within these streams, but the problems are amplified when the nutrients flow into the Swatara, Susquehanna and ultimately the Chesapeake Bay.

However, due to the monitoring programs of these streams, the large-scale misuse and abuse of the streams will not occur without notice. The monitoring will also provide information as to the success of projects such as stream bank restoration, biological nutrient removal at wastewater treatment facilities, control of farm animal waste, and buffer strips around agricultural fields.

References

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