Susquehanna River Monitoring:

Upper Susquehanna River Water Quality Monitoring, summer 2017

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INTRODUCTION

The Susquehanna River is located in northeastern United States. It is the longest river on the east coast, spanning over 444 miles. The river’s main branches begin in Cooperstown, New York and western Pennsylvania and then merge in the Susquehanna River Valley near Northumberland. Eventually, the Susquehanna ends up emptying into the Chesapeake Bay in Maryland. The Susquehanna is a major tributary that provides the Chesapeake Bay with a substantial amount of water (50% of its supply). It flows at a rate of 446 million gallons of water per day into the Bay during peak flow (Shaw 2015).

Since the summer of 1991, the SUNY College at Oneonta’s Biological Field Station has monitored the Susquehanna in order to assess the river for a number of different factors dealing with water quality. The data collected each summer are analyzed to determine if any changes have occurred to the river over time. These observations allow for the correct action to be taken in order to solve the issue at hand. An example of this would be the implementation of the wastewater treatment plant in Cooperstown to ensure water of adequate quality is being maintained in the river below the treatment plant (Shaw 2015).

Historically, secondarily treated wastewater was introduced directly into the Susquehanna River between sites 12 and 16 (see Table 1). Beginning in June 2010, the effluent was diverted through a treatment wetland that had been designed to further reduce nutrients prior to its introduction to the river (Albright 2018). Since 2016, aluminum sulfate has been used to reduce phosphorus from the effluent prior to its distribution to the treatment wetland (Albright 2018).

METHODS

The upper Susquehanna River water was monitored from 5 July to 9 August over the summer of 2017. In total, nine sites were sampled and tested weekly for 6 consecutive weeks. Several different properties were analyzed including: temperature, specific conductivity, pH, dissolved oxygen, and nutrient content.

A YSI 6820 V2-2 multi-probe sonde was used in this study in order to obtain the data necessary for water quality assessment. The sonde of this unit was placed in the current at each site and allowed to stabilize. The YSI was used for finding information on water temperature,

pH, conductivity, and dissolved oxygen. In order to ensure that the readings obtained from the YSI were accurate, the machine was calibrated each time before going into the field.

To analyze nutrient content, a water sample was taken at each site in a 125ml acid washed Nalgene® bottle. These samples were then taken back to the lab to be preserved using 1ml of sulfuric acid. The water samples were then processed using a Lachat® QuickChem FIA Water Analyzer to test total phosphorus, nitrite and nitrate, and nitrogen content (Couter 2016).

Table 1. The nine Upper Susquehanna River sited tested, summer of 2017.

<table>
<thead>
<tr>
<th>Site</th>
<th>Distance from Source</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>1012m</td>
<td>Located below the dam at Bassett Hospital. Accessed from the northern corner of the lower parking lot of Bassett Hospital.</td>
</tr>
<tr>
<td>7</td>
<td>1533m</td>
<td>Located below the dam at Bassett Hospital (further down than site 6). Accessed from the southern corner of the lower parking lot.</td>
</tr>
<tr>
<td>8</td>
<td>1724m</td>
<td>Located under the Susquehanna Avenue bridge, west of the Clark Sports Center. Accessed by the slope beside the bridge.</td>
</tr>
<tr>
<td>12</td>
<td>4119m</td>
<td>Located above the sewage discharge of the Cooperstown Wastewater Treatment Plant, near the Cooperstown High School. Accessed by an opening in the fence and down the sloped river bank.</td>
</tr>
<tr>
<td>16</td>
<td>5460m</td>
<td>Located at a small bridge perpendicular to the road on Clark Property. Accessed by entering a gated cattle grazing field.</td>
</tr>
<tr>
<td>16a</td>
<td>5939m</td>
<td>Located at a distinct bend in the river along the Clark Property. Accessed by going through a field and then down a long path found in the right corner of the field.</td>
</tr>
<tr>
<td>17</td>
<td>8143m</td>
<td>Located on Phoenix Mill Road at an abandoned bridge.</td>
</tr>
<tr>
<td>18</td>
<td>9867m</td>
<td>Located at a trolley bridge about 220m north of the railroad crossing on Route 11. Accessed by walking down the railroad tracks.</td>
</tr>
<tr>
<td>20</td>
<td>18509m</td>
<td>Located on Clintonville Road which is a dead end with a closed bridge at the end. Accessed by a steep slope beside the bridge through a crack in two big concrete walls.</td>
</tr>
</tbody>
</table>
RESULTS AND DISCUSSION

Temperature

In general, a rivers ecosystem is very dependent upon water temperature; high temperatures create very different outcomes within the animal and plant species living there when compared to lower water temperatures. Temperature can also effect water chemistry,
dissolved oxygen levels, and conductivity as well. All of these factors play vital roles in creating a balanced river ecosystem overall.

Water temperature values taken during the summer of 2017 were within the normal range when compared to temperatures taken in summers past. This is exemplified in Figures 2 and 3 below.

Figure 2. Average temperature measurements taken for the Upper Susquehanna River, summer 2017.

Figure 3. Average temperature measurements taken for the Upper Susquehanna, summers 2004-2017 (Hill 2005), (Bauer 2006), (Zurmuhlen 2007), (Coyle 2008), (Matus 2009), (Heiland 2010), 2010 (Bauer 2011), (Scott 2012), (Katz 2013), (Bianchine 2014), (Freehafer 2015), (Shaw 2016), (Courter 2017). Site #20 is not included in here so the full scale across years could be maintained.
Specific Conductivity

Specific conductance of a solution is its ability to allow electric current to pass through it. Compounds that can be dissolved in a solution such as salts and inorganic materials create ions within the solution that can transmit electrical current. The more ions that the solution contains, the higher its specific conductance will be (Fondriest Environmental, Inc. 2014). Transmittance of electric current plays a vital role in signaling if any hazardous or unnatural material is contained within the solution. This is important in this study because it indicates if there is any accidental sewage leakage into the Susquehanna or if there is any illegal activity involving disposal of materials into the river. This means that if there is any unauthorized discharge into the river, specific conductivity levels would likely increase rapidly at any of the 9 sites tested along the Susquehanna.

For this study, there were no alarming spikes in specific conductivity levels when compared to summers past. This can be observed below in Figure 4 and 5.

![Graph showing specific conductivity measurements for the upper Susquehanna River, summer 2017.](image)

Figure 4. Average specific conductance measurements taken for the upper Susquehanna River, summer 2017.
Figure 5. Average specific conductance measurements for the upper Susquehanna River, summers 2004-2017 (Hill 2005), (Bauer 2006), (Zurmuhlen 2007), (Coyle 2008), (Matus 2009), (Heiland 2010), 2010 (Bauer 2011), (Scott 2012), (Katz 2013), (Bianchine 2014), (Freehafer 2015), (Shaw 2016), (Courter 2017). Site #20 is not included in here so the full scale across years could be maintained.

**pH**

pH stands for “potential hydrogen” and is determined by the amount of hydrogen and hydroxyl ion concentrations within a solution. If a solution contains more hydrogen ions than it will be more acidic, controversally if a solution contains more hydroxyl ions, then it is more basic (Kohlmann 2003). pH runs on a scale from 0 to 14; 7 is a neutral level, lower values are acidic and higher values are basic. By measuring pH values within rivers and streams it provides indications of acid rain occurring due to pollution (Shaw 2016). pH values can affect the aquatic ecosystems as well because abnormal variances in pH levels can stress an animal’s system causing reduction in survival and reproduction rates.

The pH values collected during the summer of 2017 along the Susquehanna were within the typical ranges measured in previous years. This observation can be noticed in Figure 6 and 7 below.
**Dissolved Oxygen**

The level of dissolved oxygen is important when accessing water quality because its level has a major impact on the animals and plants living within an aquatic ecosystem. The amount of free oxygen is influenced by many factors. Bacterial respiration of organic material...
(decomposition) reduces oxygen, and it is influenced by temperature and how fast or slow the water flow is (Fondriest Environmental, Inc. “Dissolved Oxygen.”).

The levels of dissolved oxygen measured in the Susquehanna for the summer of 2017 were relatively normal when compared to previous studies. This comparison can be observed in Figure 8 and 9 below.

![Figure 8. Average dissolved oxygen measurements taken for the upper Susquehanna River, summer 2017.](image1)

![Figure 9. Average dissolved oxygen measurements taken for the upper Susquehanna River, summers 2004-2017 (Hill 2005), (Bauer 2006), (Zurmuhlen 2007), (Coyle 2008), (Matus 2009), (Heiland 2010), 2010 (Bauer 2011), (Scott 2012), (Katz 2013), (Bianchine 2014), (Freehafer 2015), (Shaw 2016), (Courter 2017). Site #20 is not included in here so the full scale across years could be maintained.](image2)
**Phosphorus**

Total phosphorus is the sum of all the different types of phosphorus within a sample, both dissolved and particulate. Phosphorus is a very important nutrient needed for all biotic organisms to sustain life processes (Mueller and Helsel 1999). It plays a major role in algal growth and in general, the more phosphorus present in the water, the more algal growth there is. This is important to note because excess algae blooming can lead a declination in the populations of other organisms such as fish or invertebrates living within the same region, since algal decomposition reduces dissolved oxygen. Some major sources of excess phosphorus in freshwater ecosystems such as the Susquehanna include sewage effluent, agricultural runoff, and urban runoff (Shaw 2015).

The total phosphorus concentrations for the 9 sites tested during the summer of 2017 are on the lower side of average when compared to values obtained in previous year; this is shown in Figure 10 and 11 below. The Village of Cooperstown has been removing phosphorus from its sewage using aluminum sulfate since 2016 (Albright 2018).

![Figure 10](image_url)

**Figure 10.** Total phosphorus measurements obtained for the upper Susquehanna River, summer 2017.
Figure 11. Total phosphorus measurements obtained for the upper Susquehanna River, summers 2004-2017 (Hill 2005), (Bauer 2006), (Zurmuhlen 2007), (Coyle 2008), (Matus 2009), (Heiland 2010), 2010 (Bauer 2011), (Scott 2012), (Katz 2013), (Bianchine 2014), (Freehafer 2015), (Shaw 2016), (Courter 2017). Site #20 is not included in here so the full scale across years could be maintained.

Nitrogen

Nitrogen is a common element found in several different forms within the environment. Some of the most abundant forms of nitrogen include ammonia, nitrogen gas, nitrite, nitrate and organic compounds. Nitrogen is used by living organisms to reproduce, grow, and make proteins (Mueller and Helsel 1999).

The total nitrogen concentrations for 2017 were typical of what was expected based on previous years measurements. This is shown in Figure 12 and 13 below.
Figure 12. Total nitrogen measurements obtained for the upper Susquehanna River, summer 2017.

Figure 13. Total nitrogen measurements taken for the upper Susquehanna River, summers 2004-2017 (Hill 2005), (Bauer 2006), (Zurmuhlen 2007), (Coyle 2008), (Matus 2009), (Heiland 2010), 2010 (Bauer 2011), (Scott 2012), (Katz 2013), (Bianchine 2014), (Freehafer 2015), (Shaw 2016), (Courter 2017). Site #20 is not included in here so the full scale across years could be maintained.

Nitrate+ Nitrite

Nitrate+ nitrite are both forms of nitrogen found in the environment. Nitrate dissolves very easily in water and stays relatively stable over a range of different kinds of environments. Nitrite is not as common in water because it gets converted into nitrate by bacteria very quickly.
Excess amounts of these forms of nitrogen can be harmful to both humans and wildlife as high concentrations can cause several different diseases (U.S. EPA Office of Water 2017). It can also stimulate algal blooms.

The levels of nitrate and nitrite in the Susquehanna River for the summer of 2017 were relatively normal when compared to summers past. This is evident in the data values shown in Figure 14 and 15.

![Figure 14. Total nitrate and nitrite measurements obtained for the upper Susquehanna River, summer 2017.](image1)

![Figure 15. Total nitrate and nitrite measurements taken for the upper Susquehanna River, summers 2004-2017 (Hill 2005), (Bauer 2006), (Zurmuhlen 2007), (Coyle 2008), (Matus 2009), (Heiland 2010), 2010 (Bauer 2011), (Scott 2012), (Katz 2013), (Bianchine 2014), (Freehafer 2015), (Shaw 2016), (Courter 2017). Site #20 is not included in here so the full scale across years could be maintained.](image2)
CONCLUSIONS

After doing water quality monitoring on the upper Susquehanna River for 7 weeks during the summer of 2017, there were no abnormalities present in the data acquired. It was observed that total phosphorus measurements obtained were lower than typical, suggesting that efforts to remove that nutrient by the wastewater treatment plant have been successful. All other measurements taken were within expected ranges for the 9 sites tested. This information provides reassurance to the surrounding communities that the water contained within the Susquehanna is up to standards for the many needs they rely on it for. These various applications include: irrigation, transportation, energy generation, fishing, etc.

The implementation of the wastewater treatment plant and wetland in Cooperstown has had significant impacts on nutrient concentrations within the Susquehanna River. Specifically, the average phosphorus and nitrogen concentrations have decreased between sites 12 and 16 since 2010 when the plant and wetland was introduced (Shaw 2016).

The new site (SR20) located further down on the Susquehanna was monitored during the summer of 2017. Information obtained here indicates no meaningful changes in most parameters between the river just above its confluence with Oaks Creek and this new site some 10,000m further downstream.

REFERENCES


