# Susquehanna River Quality Monitoring:

## Monitoring water quality and fecal coliform Bacteria in the Upper Susquehanna River, summer 2006

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ABSTRACT

In the continuation of an ongoing study since 1992, the Upper Susquehanna River was sampled weekly throughout summer 2006. Both biotic and abiotic factors were monitored to determine whether the Village of Cooperstown's sewage discharge has been affecting water quality in the Susquehanna River. Research is conducted to ensure that nutrients and fecal coliform are assimilated into the river at a low and healthy rate as well as to pinpoint unauthorized sources of pollution. Eleven sample locations were monitored in order to record physical and chemical parameters, nutrient loading, and concentrations of fecal coliform bacteria. Due to several weeks of heavy rainfall and flooding during late June and early July, sample sites along the Upper Susquehanna River were inaccessible and therefore sampling was postponed until floodwaters receded to safe levels. Water quality monitoring throughout summer 2006 saw elevated temperatures and dissolved oxygen levels along the river, as well as extreme dilution of fecal coliform bacterial colonies.

## INTRODUCTION

Draining a watershed that spans approximately 27,500 sq. miles, the Susquehanna River serves as the main freshwater tributary to the Chesapeake Bay. Running 444 miles, the river provides water for municipalities, agriculture, and recreation, as well as being a source of power. TheVillage of Cooperstown is situated at the head of the Susquehanna River and depends upon it for the discharge of its wastewater. Although the village of Cooperstown is home to about 3,000 permanent residents, the treatment plant serves an influx of up to 500,000 tourists each year as well as seasonal businesses and Bassett Hospital. Located approximately two miles from the source of the Susquehanna River, the Cooperstown wastewater treatment plant processes up to 800,000 gallons of sewage per day throughout the summer months. Effluent is discharged into the Susquehanna River just below sample site SR 12 (11254 ft. from source). Since summer 2004, the wastewater has been treated with ultraviolet radiation as opposed to the previous method of chlorination.

Discharge of wastewater, agricultural runoff, animal wastes and pollution from unauthorized sources may all contribute to nutrient loading in the river. The "assimilative capacity" (Steinman and Mulholland 1996) of the Susquehanna may be surmounted by

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the introduction of excessive quantities of the aforementioned pollutants, endangering the ecology of the entire river (Bauer 2006). Monitoring both physical and chemical parameters along the Upper Susquehanna River enables quick warning for the village of Cooperstown in the event of a potential concern, as well as a means of detection of unauthorized sources of pollution. Measures may then be taken to quickly alleviate the problem (Polus 2003). This could include allowing more water to pass over the dam, providing increased dilution downstream. Analyses of population dynamics of fecal coliform bacterial colonies facilitate determination of the effects of the discharge of municipal waste into the Susquehanna. Although fecal coliform bacteria are reasonably harmless in and of themselves, their presence in a stream denotes the presence of the fecal matter of mammals and other potential pathogens (APHA 1992).

## METHODS

Water quality was tested weekly from July 12$^{th}$ to August 16$^{th}$, 2006 at eleven sampling sites along the Upper Susquehanna River between the outlet on Otsego Lake and the confluence of the Susquehanna and Oaks Creek (Table 1.). Samples were collected from seven sites for the first three weeks, and as the study progressed, four more sample sites were added downstream from the Cooperstown Wastewater Treatment Plant.

At each sample location, a Hydrolab Scout 2® multiprobe digital microprocessor was utilized to assess physical parameters such as temperature, conductivity, pH, and dissolved oxygen levels. In accordance with its instruction manual, the Hydrolab was calibrated before each use to ensure accurate readings (Hydrolab Corp. 1993). A water sample was collected into acid washed and autoclaved glassware at each site and processed immediately upon returning to the Biological Field Station. The following chemical and biological attributes were analyzed through the use of a Lachat QwikChem FIA+ Water Analyzer®. Total phosphorus was ascertained by persulfate digestion followed by the ascorbic acid method (Liao and Marten 2001), total nitrogen through the cadmium reduction method following peroxodisulfate digestion (Ebina et. al (1983), ammonia using the phenolate method (Liao 2001), and nitrate+nitrite by the cadmium reduction method (Pritzlaff 2003).

Fecal coliform bacterial colonies were analyzed through the use of the membrane filter technique (APHA 1992). Predetermined volumes (10mL, 100mL) of each sample is passed through a filter and placed in a Millipore® dish containing 2.2mL of coliform growth medium. Samples were then cultured in an incubator bath at 44.5°C ±0.2 for a period of 24 hours, removed, and the distinctive blue-tinged fecal coliform colonies were analyzed to determine the number of colonies per 100mL (Miller 1996). Standards were run between samples to ensure sterility and samples were filtered in duplicate. All materials were sterilized before and after processing commenced as well as between samples. Glassware was autoclaved at 121°C and 12 PSI and placed in an acid bath (10% HCl) for 24 hours while all forceps were constantly rinsed in ethanol, then passed through the flame of a Bunsen burner to ensure disinfection. Filtering equipment was rinsed first in ethanol and then in dilution water (distilled water with trace potassium dihydrogen phosphate and magnesium chloride). All Millipore dishes, filters, and pipettes were pre-sterilized during their manufacture.

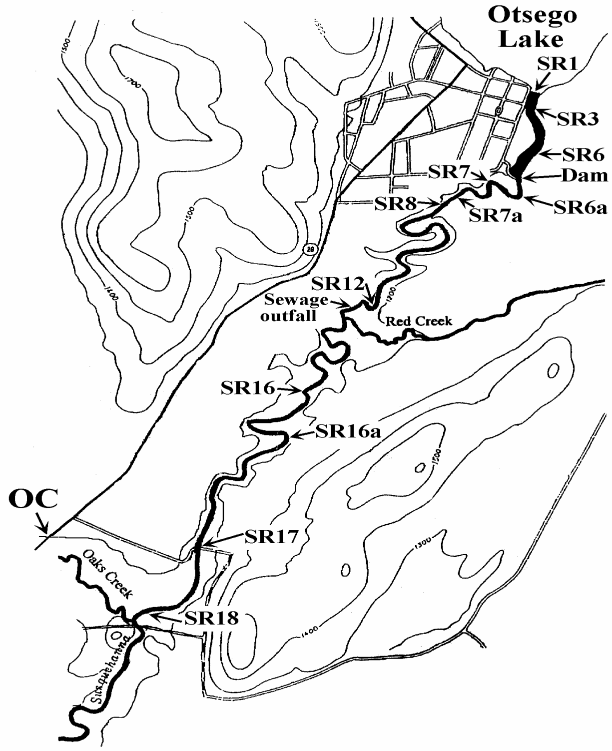


Figure 1.Upper Susquehanna River displaying sampling sites. Site descriptions in Table 1.

Table 1. Locations and descriptions of sampling sites along the Upper Susquehanna River. Sites may be seen in Figure 1.

Susquehanna River 1: N 42°42.056' W 74°55.172
0 ft. from source. Source of the Susquehanna River at the Otsego Lake outlet, accessed by boat

Susquehanna River 3: N 42º41.980' W 74º55.228'
900 ft. from source. Beneath the Main St. bridge, accessed by boat

Susquehanna River 6: N 42º41.735' W 74º55.238'
4500 ft. from source. Across from drainage pipe just north of the dam at Bassett Hospital, accessed by boat

Susquehanna River 6a: N 42°41.597' W 74°55.257'
5500 ft. from source. Below the dam at Bassett Hospital, accessed from the north corner of the lower parking lot

Susquehanna River 7: N 42°41.638' W 74°55.325'
6000 ft. from source. Southern corner of the Bassett Hospital parking lot

Susquehanna River 8: N 42°41.533' W 74°55.615'
6600 ft. from source. Under the Susquehanna Avenue bridge just west of the Clark Sports Center

Susquehanna River 12: N 42°41.132' W 74°55.964'
11254 ft. from source. Just above the sewage discharge at the Cooperstown Wastewater Treatment Plant

Susquehanna River 16: N 42°40.725' W 74°56.271'
16000 ft. from source. Small bridge perpendicular to the gravel road on Clark property (grasslands).

Susquehanna River 16a: N 42°40.608' W 74°56.538'
21300 ft. from source. Distinct bend in river alongside gravel road on Clark property (grasslands), just past railroad tracks.

Susquehanna River 17: N 42°40.038' W 74°56.711
24000 ft. from source. Abandoned bridge on dead-end road directly across from "Pheonix on River Road" (bed and breakfast on Pheonix Mills Rd.)

Susquehanna River 18: N 42°39.795' W 74°56.902'
28500 ft. from source. Railroad trestle about 200m North of the RxR crossing on Rt. 11 going out of Hyde Park accessed by walking along railroad tracks onto trestle; Care must be taken when sampling; trains occasionally do come through, most often in the afternoons

## RESULTS and DISCUSSION

### Temperature

Temperature profiles for the summers of 1998-2006 are summarized in Figure 2. The mean temperature of the Upper Susquehanna River for the summer of 2006 was 23.14ºC, a decrease of 0.13 ºC from last year's average temperature of 23.27ºC (Bauer 2006). The highest temperature observed this year was 25.97ºC at sample site SR 3 (900 ft. from source) on 2 August. The low temperature was 21.48ºC, recorded on 15 August at SR18 (28,500 ft.).

### pH

pH is a measure of the degree of how acidic or basic a water sample is. Consistency in pH along the Upper Susquehanna River may be attributed to a buffer provided in the form of calcium carbonate flowing out of Otsego Lake (Albright 2005). The average pH for this summer was 8.31, an increase from last summer's mean of 7.91(Bauer 2006). Summer 2006 sampling indicated greater alkalinity in the Upper Susquehanna River than in previous years of research. Figure 3 illustrates pH profiles for the summers of 1998-2006

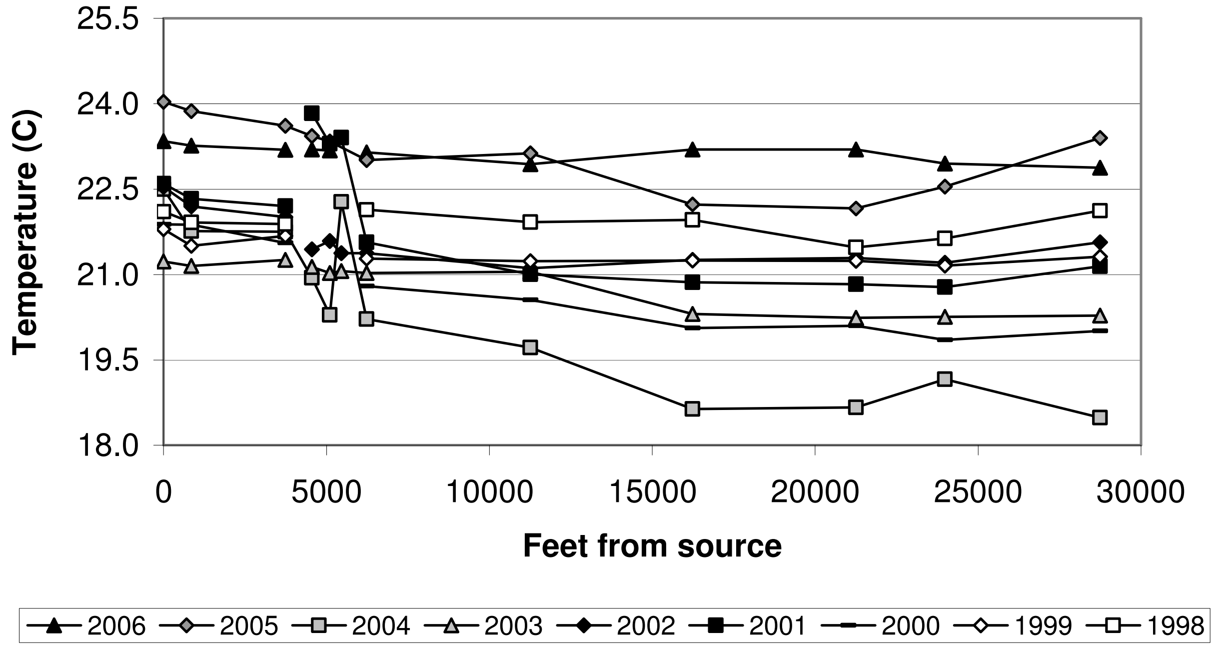


Figure 2. Graphical analysis of mean temperatures in the Upper Susquehanna River, summers 1998 (Dewey 1999), 1999 (Dietz 2000), 2000 (Hill 2001), 2001 (Hill 2002) 2002 (Schlierman 2003), 2003 (Polus 2004), 2004 (Hill 2005), 2005 (Bauer 2006), and 2006.

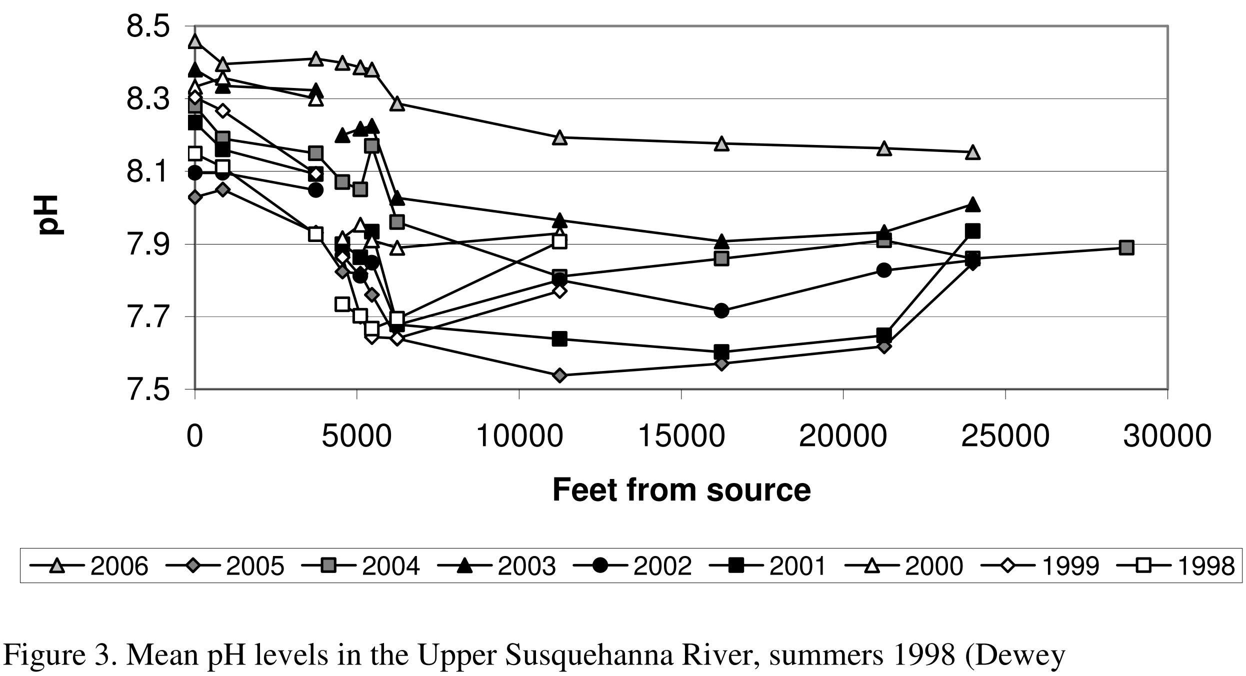


Figure 3. Mean pH levels in the Upper Susquehanna River, summers 1998 (Dewey 1999), 1999 (Dietz 2000), 2000 (Hill 2001), 2001 (Hill 2002) 2002 (Schlierman 2003), 2003 (Polus 2004), 2004 (Hill 2005), 2005 (Bauer 2006), and 2006.

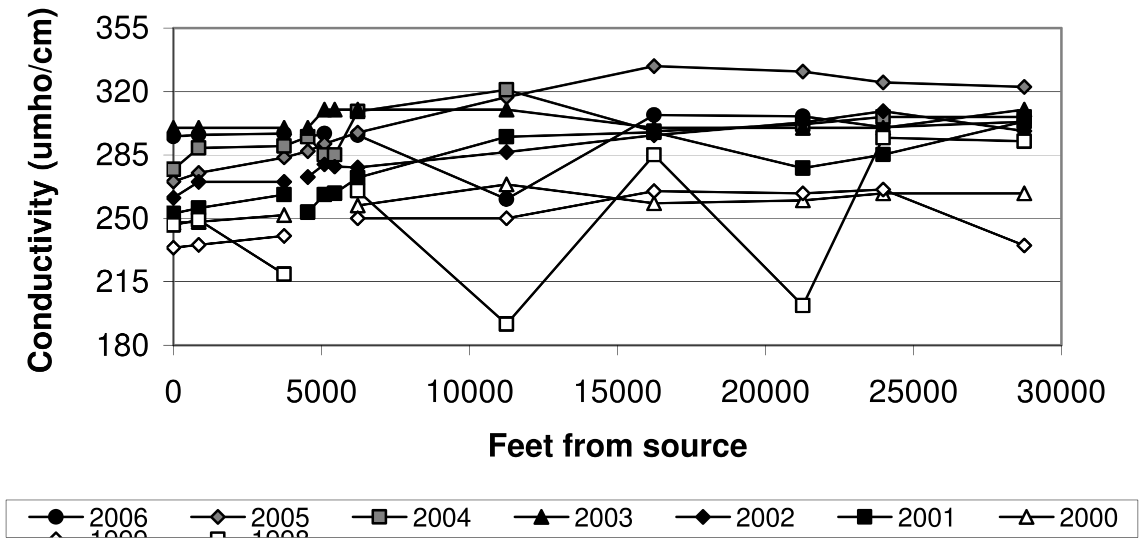


Figure 4. Mean conductivity profiles along the Susquehanna, summers 1998 (Dewey 1999), 1999 (Dietz 2000), 2000 (Hill 2001), 2001 (Hill 2002) 2002 (Schlierman 2003), 2003 (Polus 2004), 2004 (Hill 2005), 2005 (Bauer 2006), and 2006.

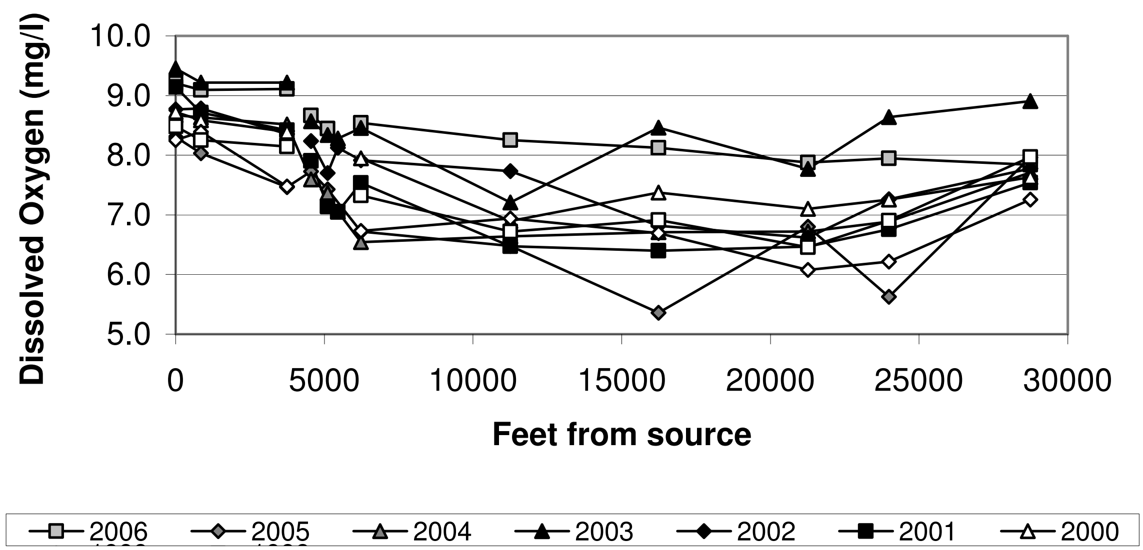


Figure 5. Profiles of mean dissolved oxygen concentrations in the Upper Susquehanna River, summers 1998 (Dewey 1999), 1999 (Dietz 2000), 2000 (Hill 2001), 2001 (Hill 2002) 2002 (Schlierman 2003), 2003 (Polus 2004), 2004 (Hill 2005), 2005 (Bauer 2006), and 2006.

## Conductivity

Mean conductivity levels along the Upper Susquehanna over the past eight years are illustrated in Figure 4. The average conductivity level for the summer was 295.77 umho/cm, consistent with data obtained in recent years. Highest conductivity recorded was 326umho/cm on August 2nd, at SR 16 (16000 ft.). Lowest observed level of conductivity was 276 umho/cm at sites SR 1(0 ft.) and SR 3 (900 ft.) on 15 August.

## Dissolved Oxygen

According to its NYSDEC discharge permit, treated wastewater released into the Susquehanna River from the Cooperstown Sewage Treatment Facilities is required to maintain a dissolved oxygen level minimum of 5.00mg/L downstream from the discharge point (Polus 2004). Low concentrations of dissolved oxygen are indicative of high temperatures as well as nutrient loading, and waste released from the treatment plant may deplete oxygen levels due to the introduction of decomposing organic material.

Dissolved oxygen readings during summer 2006 were elevated compared to previous years; however these levels were fairly stable and consistent throughout the sampling period, both spatially and temporally (Figure 5). The high dissolved oxygen concentration observed was 10.34, at sample location SR 1, while the low this summer was 6.00 at SR 12. Dissolved oxygen data gathered to date indicates that the Cooperstown wastewater treatment plant is not a major contributor of many of the nutrients assimilated into the Upper Susquehanna River.

## Nitrate+Nitrite

Nitrogen is an essential nutrient that may enter rivers and lakes through ground and surface water as well as precipitation (Lampert and Sommer 1997). During summer 2006, mean nitrate+nitrite concentrations were comparable to those of previous summers, with a result of .413mg/L. Profiles of mean nitrate+nitrite concentrations for summers 1998-2006 are illustrated in Figure 6.

## Total Phosphorus

Phosphorus is the limiting factor in many ecosystems; high algal productivity and decreased dissolved oxygen levels may result from nutrient loading in a stream. The increase in phosphorus concentrations downstream from the sewage treatment plant was minimal this summer, perhaps due to the large quantity of water supplementing the stream flow and diluting nutrient levels (Figure 7).

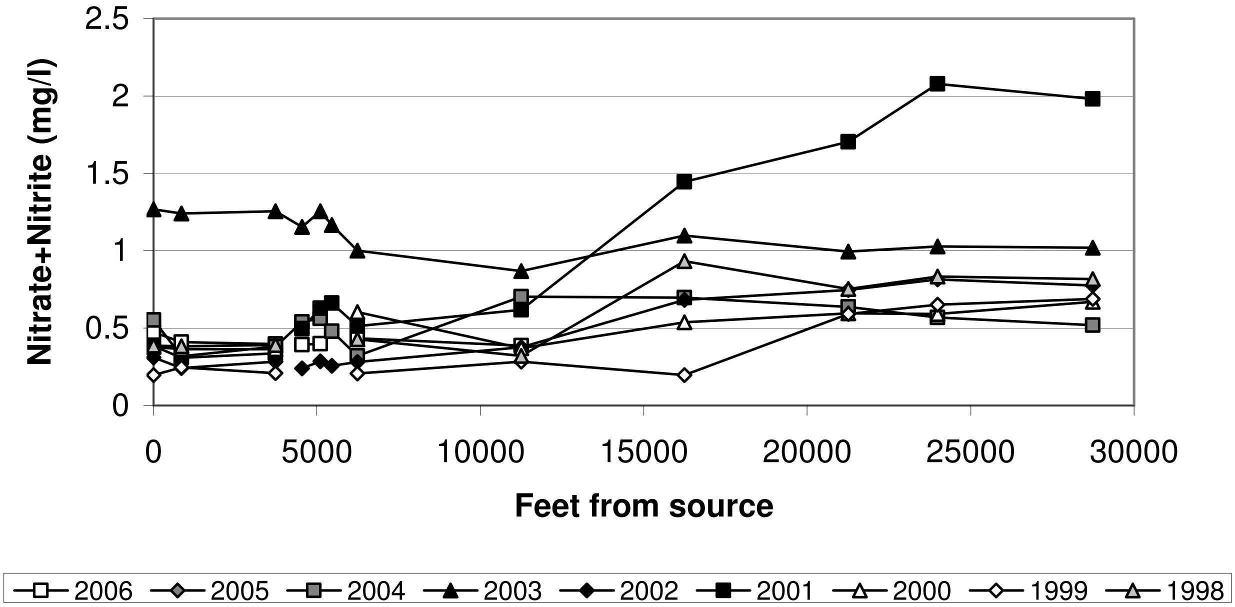


Figure 6. Average total nitrogen/nitrate+nitrite concentrations for the summers of 1998 (Dewey 1999), 1999 (Dietz 2000), 2000 (Hill 2001), 2001 (Hill 2002) 2002 (Schlierman 2003), 2003 (Polus 2004), 2004 (Hill 2005), 2005 (Bauer 2006), and 2006.

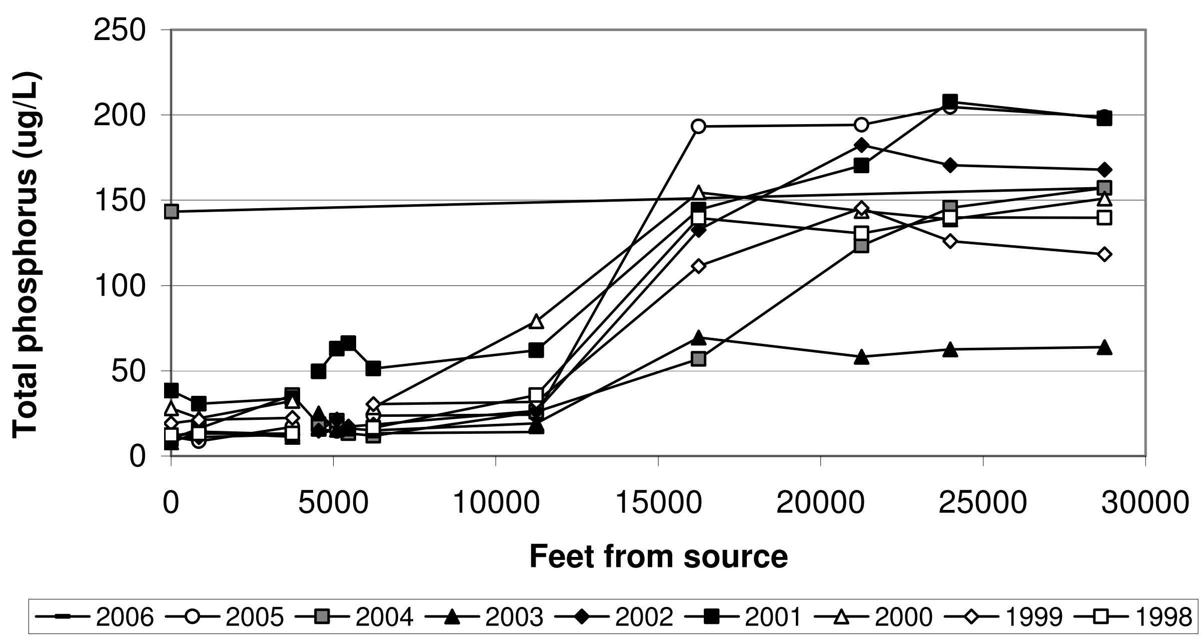


Figure 7. Graphical analysis of total phosphorus levels, summers 1998 (Dewey 1999), 1999 (Dietz 2000), 2000 (Hill 2001), 2001 (Hill 2002) 2002 (Schlierman 2003), 2003 (Polus 2004), 2004 (Hill 2005), 2005 (Bauer 2006), and 2006.

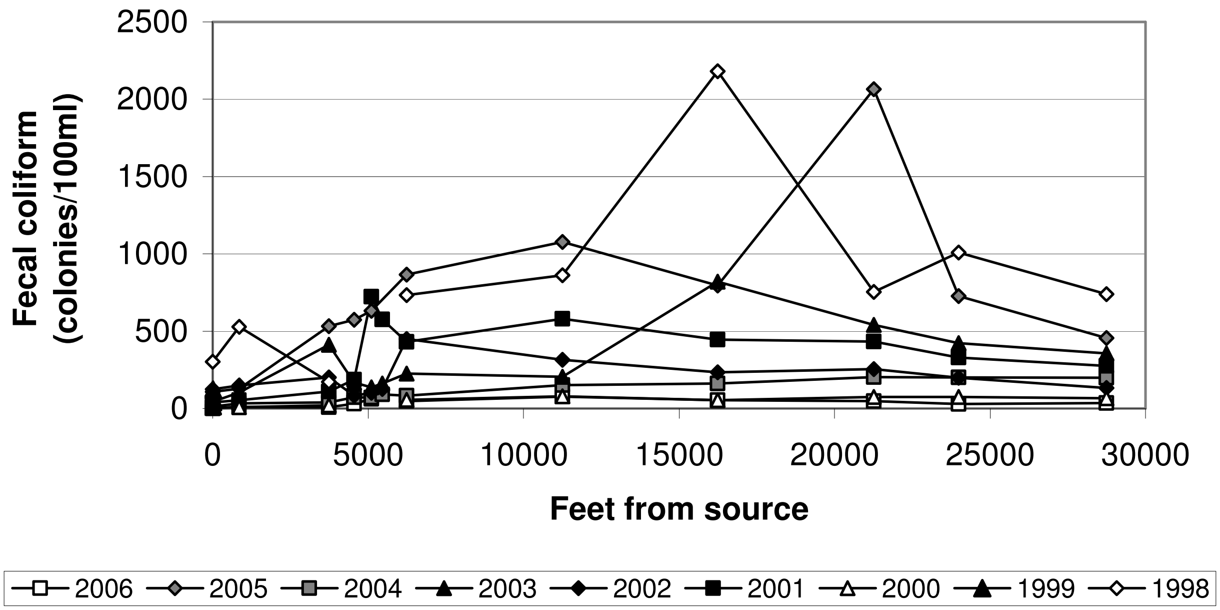


Figure 8. Fecal coliform bacterial concentrations along the Upper Susquehanna River, summers 1998 (Dewey 1999), 1999 (Dietz 2000), 2000 (Hill 2001), 2001 (Hill 2002) 2002 (Schlierman 2003), 2003 (Polus 2004), 2004 (Hill 2005), 2005 (Bauer 2006), and 2006.

## Fecal Coliform

Fecal coliform bacterial concentrations in the Upper Susquehanna River were significantly lower than in previous years, with an mean of 37 colonies/100mL compared to last years average of 724 colonies/mL. This year's depressed concentrations of bacteria may be due to dilution from the heavy rainfall received in early summer. Fecal coliform bacterial concentrations are illustrated in Figure 8.

## SUMMARY and CONCLUSIONS

Temperatures along the river were lower than last summer yet higher than in preceding years, and fecal coliform concentrations are rebounding from the extreme dilution of colonies seen immediately following the flooding. Little variation in each chemical or biological characteristic was noted between sites throughout the Upper Susquehanna; results were fairly consistent throughout the study period. pH monitoring indicated greater alkalinity in the river for the summer and conductivity remained comparable to recant years. Dissolved oxygen maintained elevated levels throughout the length of the Upper Susquehanna while nutrient (nitrate+nitrite, phosphorus) levels were depressed. Extreme dilution of fecal coliform bacterial colonies caused by elevated levels of precipitation during summer 2006 saw the lowest consistent concentrations of coliform bacteria in the Upper Susquehanna in years.

Chemical and physical parameters did nonetheless indicate a source of pollution upstream of the wastewater treatment plant, located between the dam at Bassett Hospital (just south of SR 3) and the bridge on Susquehanna Avenue (SR 8).Water quality along the Upper Susquehanna River is returning to normal after the floods, however it is difficult to account for changes in water quality since summer 2005 because of the disruption of the river due to heavy precipitation and increased stream flow.

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