Susquehanna River Monitoring

Monitoring the Water Quality and Fecal Coliform in the Upper Susquehanna, summer 2005

Emily Bauer[1]

ABSTRACT

During the summer of 2005, the Upper Susquehanna was monitored weekly as a continuation of an ongoing study. Since 1992 the Biological Field station has conducted this study to monitor the Village of Cooperstown's sewage discharge and its effects on biotic and abiotic factors. This research was done to insure that the concentrations of nutrients and fecal coliform in the river are being assimilated at a healthy rate and to record any unauthorized sources of pollution. Every week 12 sites were sampled and tested to determine nutrient levels, fecal coliform bacterial concentrations, and physical and chemical parameters. Generally, results seemed to follow those expected given the warm, dry weather of the study period. Oxygen levels were lower, while the concentrations of nutrients increased, likely due to lower dilution rates because of lower flows. Fecal coliform bacteria levels also increased

INTRODUCTION

The Susquehanna River serves as the main freshwater tributary to the Chesapeake Bay. Extending a total of 444 miles, the Susquehanna drains a watershed that spans approximately 27,500 sq. miles. Cooperstown lies at the head of this river and depends on the Susquehanna for the discharge of its wastewater. The Cooperstown Village sewage treatment plant serves about. 3,000 permanent residents, as well as a sizeable population of seasonal tourist each year. In addition to the treated waste drained daily into the river, animal waste and agricultural runoff can result in nutrient loading.

By performing limnological studies at 12 locations that lie between the source of the river and its convergence with Oaks Creek, the Susquehanna's ecosystem can be evaluated and potential sources of pollution can be identified and scrutinized. In excess, the above mentioned sources of pollution can endanger the overall health of an ecosystem, such as the Susquehanna, by surmounting the natural rate of assimilation. Low concentrations of dissolved oxygen are characteristic of wastewater discharge, bringing about elevated nutrient levels which then contribute to increased algal production. Certain levels of dissolved oxygen must be maintained in order to sustain a diversity of aquatic life. Game fish as well as the recreational value of the Susquehanna could be threatened should nutrient levels rise to a detrimental point.

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[1] F.H.V. Mecklenburg Conservation Fellow, summer 2005. Present affiliation: Wayland Cohocton C.S., Cohocton, NY.

To ascertain the existence and affects of sewage and/or agricultural runoff in a water supply, fecal coliform bacterial colonies were analyzed. Fecal Coliform bacteria aid in the digestive process of all mammals. Although relatively harmless themselves, the presence of fecal coliform is indicative of the existence of fecal contamination and potentially harmful pathogens in the water (APHA 1992).

The state of the Upper Susquehanna was monitored weekly at 12 sites along the river, from the outlet of the river at SR-1 to its confluence with Oaks Creek (Figure 1). Additional sampling was done at a site on Oaks Creek, although results from this site were not recorded on the graphs, which detail the spatial variation of the river itself. The sampling of sites SR-16 through SR-18 occurred one day after the sampling of the first seven sites along the river. The point of discharge of wastewater from the sewage treatment plant lies between sites SR-12 (11,254 ft. from source) and SR-16 (16,241 ft. from source). Since last year, the site SR-12 has been moved to account for the change in treatment methods used by the sewage treatment facilities. Methods of disinfection have altered from chlorination of waste water to the more effective use of ultraviolet radiation.

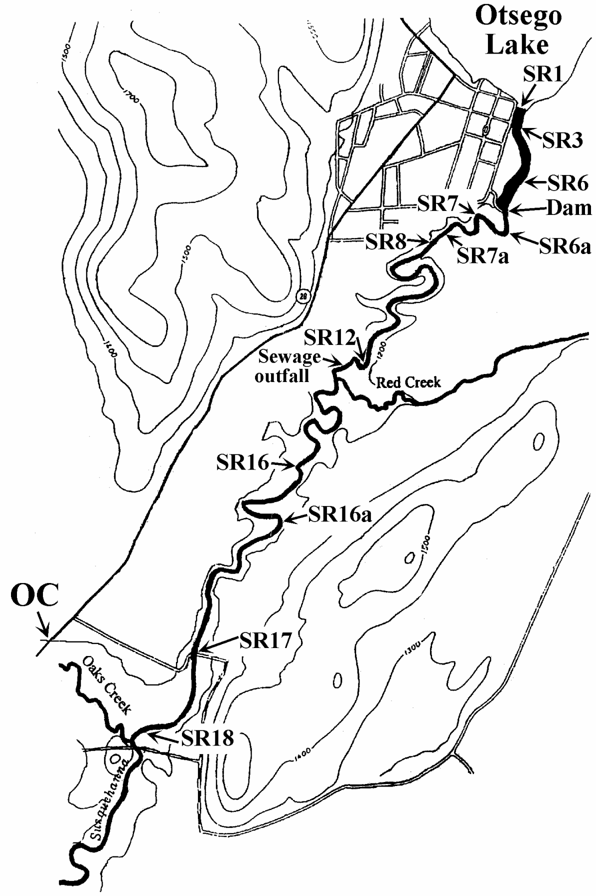

Figure 1. Upper Susquehanna River displaying sampling sites

METHODS

The Upper Susquehanna River was monitored weekly from July 11th to August 23rd. To characterize the state of the river, many different properties had to be taken into consideration and assessed. Physical parameters, including temperature, pH, conductivity and dissolved oxygen levels, were analyzed using a Scout 2 ® Hydrolab. Before each use the Hydrolab was calibrated in accordance with its instruction manual (Hydrolab Corp. 1993)

Chemical and biological attributes were determined by testing water samples collected from the sites. Nitrate + nitrite concentrations were ascertained manually using the cadmium reduction technique (APHA 1992) or through the use of the Lachet Auto Analyzer (QuickChem ® method 10-107-04-1-C). Water samples were tested for total phosphorus, which was determined using persulfate digestion followed by the single reagent ascorbic acid method (ALPHA 1992).

The membrane filter technique was utilized in the analysis of the concentrations of fecal coliform bacteria in the water of the Susquehanna. All materials were sterilized prior to the test as to insure that the nothing was contaminated with bacteria from an outside source. All glassware was autoclaved for 10 minutes at 121 ºC and 15 PSI. All Petri dishes, filters, and pipettes were pre-sterilized by their manufacturer, while forceps and filtering apparatuses were repeatedly washed in ethanol and rinsed to avoid possible contamination. Using this technique, specific volumes of water (5mL, 10mL, 50mL, and 100mL) were run through a filter, resulting in numbers of bacterial colonies that were usually within the target range of 20-80 per filter. The samples were run in triplicates for each volume. Blanks were run between different volumes to assure that cross contamination was not occurring. Processed filters were then placed in a Petri dish containing 2.2mL of growth media and placed in an incubator at 44.5 ºC. (+/- 0.2 ºC). After a period of 24 hours the cultures were removed and the distinguishable blue fecal coliform bacterial colonies were counted, results averaged, and the number of colonies per 100mL was determined.

RESULTS AND DISCUSSION

Limnological studies done during the summer of 2005 offer different perspectives on the dynamic ecosystem of the Susquehanna River. General trends showed an overall increase in fecal coliform bacteria, and lower dissolved oxygen concentrations downstream from the Cooperstown Waste treatment facility. Dissolved oxygen levels were depressed in comparison to recent years, likely as a result of the warmer temperatures experienced during summer, although they remained above the regulated 5 mg/l. The averaged results of the study are graphically depicted in Figures 2-8.

Temperature

The average temperature for the summer was found to be 23.27 ºC, compared to last years average of 20.30 ºC (Hill 2004). This change of 2.87 ºC is probably due to the difference in the climate of the summer, with this year's hot, dry weather contrasting last summer's weather, which was cold and wet. The high this year was 25.25 ºC, recorded at SR-12. The lowest temperature was found to be 19.56 ºC observed at the site SR-16.

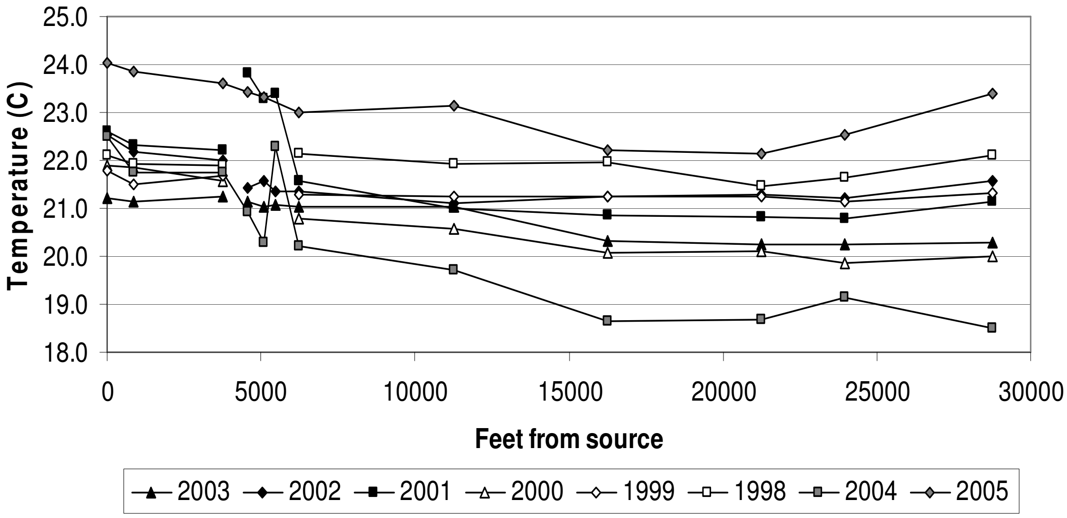

Figure 2. Profiles of the average temperatures of the Upper Susquehanna River for the summers of 1998 (Dewey 1999), 1999 (Deitz 2000), 2000 (Hill 2001), 2001 (Hill 2002), 2002 (Schlierman 2003), 2003 (Polus 2004), 2004 (Hill 2005), as well as 2005.

pH

The pH is a measure of the acidity of a sample. The mean pH for the year was 7.91, dropping from last years average of 8.05. As shown in Figure 3, a general drop in pH has been recorded from SR-1(0 ft.) to SR12 (11,254 ft.). The relative stability, both spatially and temporally, of pH is probably a function of high concentrations of calcium carbonate flowing from Otsego Lake, which tends to buffer against fluctuations in pH (Albright 2005).

Conductivity

Figure 4 illustrates the conductivity levels observed on the Upper Susquehanna from 1998 to 2005. There is no widespread significant difference between the conductivity levels found at each site. The mean conductivity level for the year was determined to be 298 umho/cm, comparable to those recorded in recent years. The highest conductivity was 369 umho/cm, which was recorded at SR-16 (16,241 ft. from source). The lowest level of conductivity was 252 umho/cm and was collected at the site SR-1 (0ft from source).

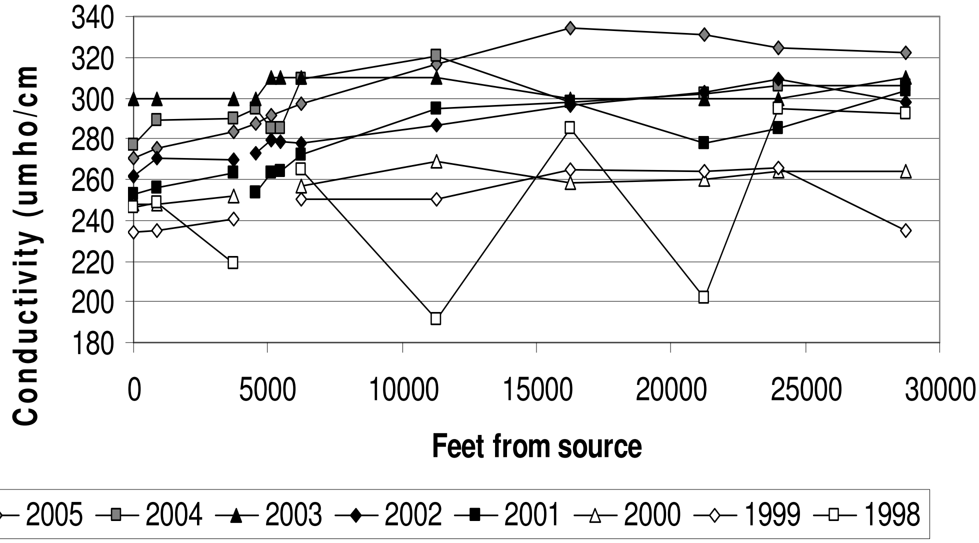

Figure 3. Graphical presentation of the average pH collected from the Upper Susquehanna during the summers of 1998 (Dewey 1999), 1999 (Deitz 2000), 2000 (Hill 2001), 2001 (Hill 2002), 2002 (Schlierman 2003), 2003 (Polus 2004), 2004 (Hill 2005), and 2005.

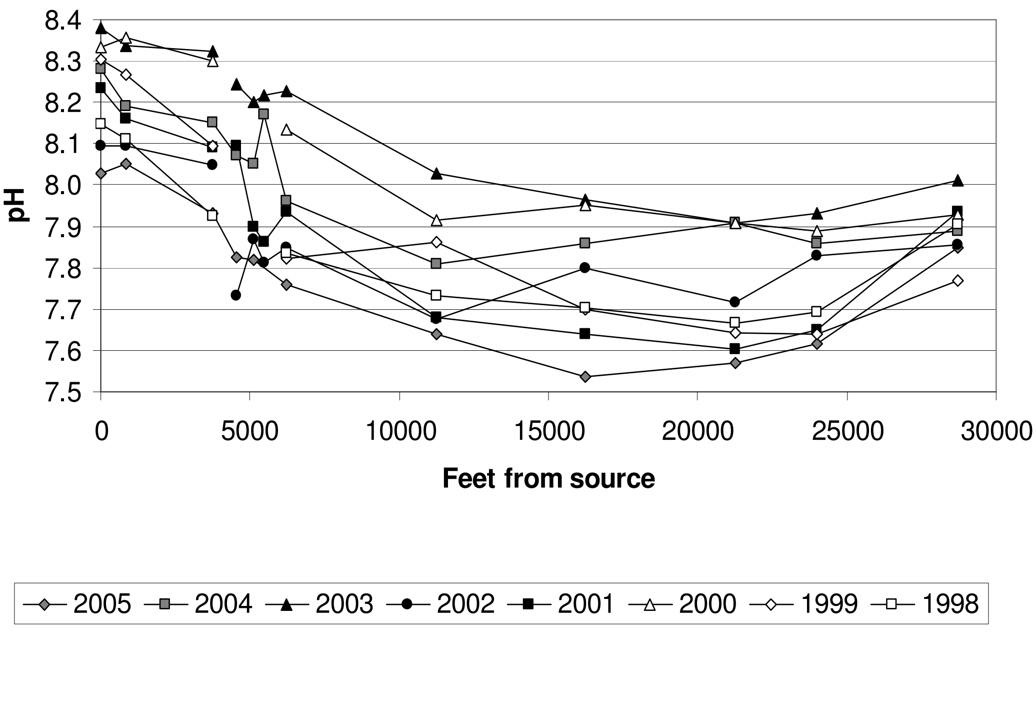

Figure 4. Graphical analysis of the average conductivity levels collected from the Upper Susquehanna during the summers of 1998 (Dewey 1999), 1999 (Deitz 2000), 2000 (Hill 2001), 2001 (Hill 2002), 2002 (Schlierman 2003), 2003 (Polus 2004), 2004 (Hill 2005), and 2005.

Dissolved Oxygen

Dissolved oxygen can be used as a constant from which water quality is assessed. High levels of oxygen depletion can alter the balance of an ecosystem, rendering it unable to support certain species such as game fish. Due to these risks, the Village of Cooperstown wastewater treatment plant has been placed under certain restrictions. In order to safeguard the ecosystem in the face of such a chemical and biological stress, the NYSDEC mandated that the dissolved oxygen level remain above 5 mg/l below the point of wastewater discharge (Polus 2004). Wastewater is released into the river directly below SR-12 (11,254 ft. below source).

Figure 5 displays the dissolved oxygen levels in the Susquehanna from 1998 to present. The concentrations of dissolved oxygen in the water were depressed from those of last year. The recorded mean of this year was 7.2 mg/l, a decrease of 0.34 mg/l in comparison to the previous year. This difference could be the result of the elevated temperatures experienced this summer. A general decline in oxygen levels after SR-8 is suggestive of another source of oxygen-depleting pollution upstream from the waste treatment facility. The low concentrations of dissolved oxygen downstream of the sewage treatment plant are characteristic of wastewater discharge, indirectly a function of elevated nutrient levels which lead to algae overproduction.

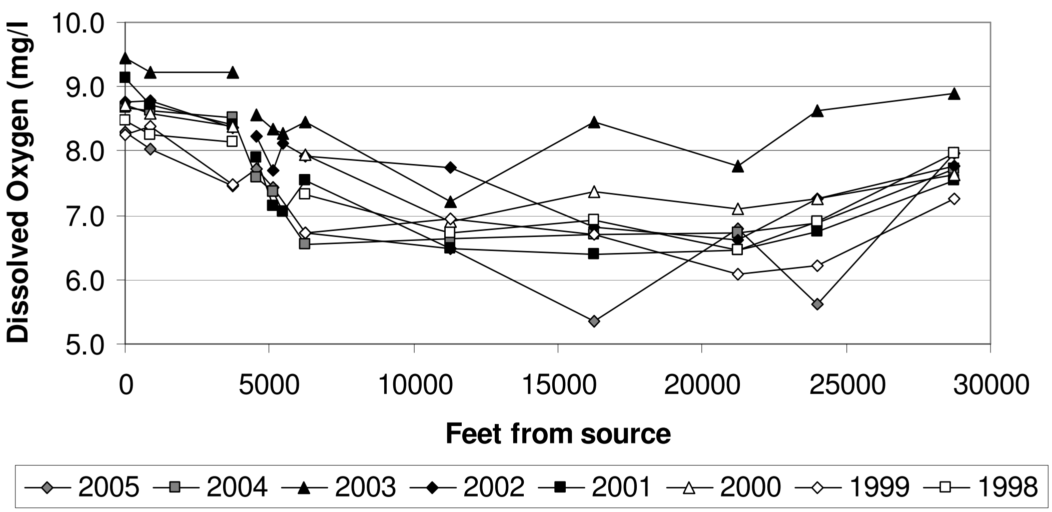

Figure 5. Profiles of the dissolved oxygen levels in the Upper Susquehanna during the summers of 1998 (Dewey 1999), 1999 (Deitz 2000), 2000 (Hill 2001), 2001 (Hill 2002), 2002 (Schlierman 2003), 2003 (Polus 2004), 2004 (Hill 2005), and 2005.

Total Phosphorus

Figure 6 is representative of the summer's phosphorus concentrations in the Upper Susquehanna. The spike in nutrient levels after SR-12 (11,254 ft. from source) indicates the point at which wastewater is discharged from the sewage treatment plant. Since last year the levels of nutrients downstream from the discharge point have increased, a trend that might result in higher algal productivity. This is likely due to lower dilutions this summer because of lower flows in the river.

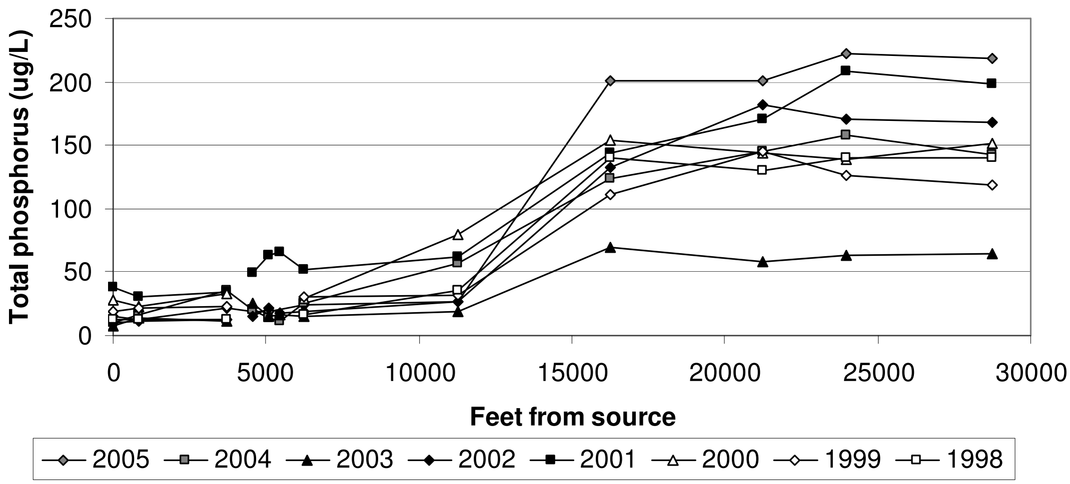

Figure 6. Graphical analysis of the total phosphorus concentrations in the Upper Susquehanna during the summers of 1998 (Dewey 1999), 1999 (Deitz 2000), 2000 (Hill 2001), 2001 (Hill 2002), 2002 (Schlierman 2003), 2003 (Polus 2004), 2004 (Hill 2005), and 2005.

Nitrate + Nitrite

The Nitrate + nitrite concentrations for the summer were comparatively similar to those of past years. The average for the year was 0.418 mg/L. Figure 7 provides a summery of mean concentrations at each site for years during which this parameter has been monitored.

Fecal Coliform

The year's fecal coliform concentrations were found to be elevated when compared to previous studies done on the upper Susquehanna River (Figure 8). In comparison to last year's depressed concentrations of bacteria, this year the Susquehanna experienced an increase of 614 colonies/100mL, with a mean of 724 colonies/100mL. This swell in population may well be due to higher temperatures triggering an increase in bacterial production. Fecal coliform thrive best in temperatures at and around 37 ºC (APHA 1992), with the effect that as temperatures rise their populations could increase. A general increase after SR-1 could be indicative of sources of pollution upstream from the waste treatment plant. A decrease was observed immediately below the sewage outfall, implying that this is not a source.

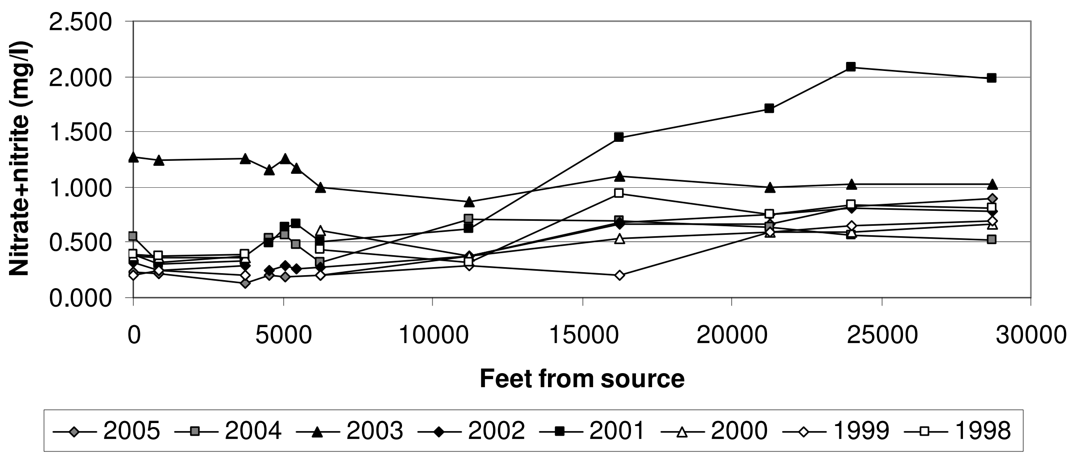

Figure 7. Graphical analysis of the nitrate + nitrite concentrations in the Upper Susquehanna during the summers of 1998 (Dewey 1999), 1999 (Deitz 2000), 2000 (Hill 2001), 2001 (Hill 2002), 2002 (Schlierman 2003), 2003 (Polus 2004), 2004 (Hill 2005), and 2005.

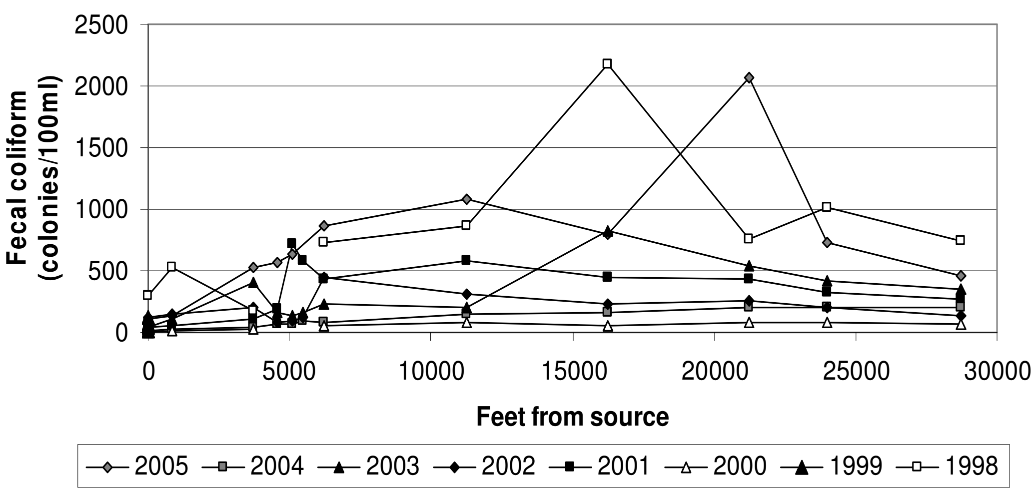

Figure 8. Profiles of the fecal coliform bacterial concentrations in the Upper Susquehanna during the summers of 1998 (Dewey 1999), 1999 (Deitz 2000), 2000 (Hill 2001), 2001 (Hill 2002), 2002 (Schlierman 2003), 2003 (Polus 2004), 2004 (Hill 2005), and 2005.

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