SUSQUEHANNA RIVER MONITORING:

Monitoring the fecal coliform bacteria and water quality in the Upper Susquehanna River, summer 2002

Selinda Schlierman[1]

ABSTRACT

As part of a long-term, ongoing study by the Biological Field Station, the Upper Susquehanna River was monitored during the summer of 2002 to ensure that water quality standards below the Village of Cooperstown's sewage treatment plant were maintained within acceptable limits. Each week through the summer, the river was monitored for various physical and chemical attributes as well as fecal coliform bacteria levels using water samples collected from 12 sites from Otsego Lake to the river's confluence downstream with Oak's Creek. Results show that temperature, pH, total phosphorus, nitrite + nitrate levels and fecal coliform bacteria levels were lower than those recorded last summer while dissolved oxygen levels and conductivity were higher.

INTRODUCTION

The Village of Cooperstown, NY, lies on the headwaters of the Susquehanna River, which ultimately forms the largest tributary to the Chesapeake Bay. Cooperstown's secondarily treated sewage is discharged into the Susquehanna approximately two miles below its source. Though Cooperstown's year-round population is only about 3,000, the sewage treatment plant receives waste from a large hospital. This, as well as a seasonal influx of over 500,000 tourists, means that up to 800,000 gallons of waste are discharge into the Susquehanna River each summer day. During this time, the river's flow tends to be quite low. The Village is required in its discharge permit to maintain a flow of at least 12 cubic feet/second to provide adequate dilution to the effluent. They also are required to maintain at least 5 mg/l oxygen in the river below the point of discharge. Since 1992, the Biological Field Station has conducted summertime monitoring on the upper reaches of the Susquehanna River to: 1) provide an early warning to the village should environmental thresholds be approached and 2) to record any anomalous data that might indicate an unauthorized source of pollution. This report is a continuation of that work.

Physical water quality parameters, nutrient levels and fecal coliform bacteria concentrations were monitored weekly during the summer of 2002. Each week between

---

[1] Village of Cooperstown Susquehanna River internship, summer 2002. Current affiliation: SUNY Oswego.

June 26 and August 7, samples collected from twelve different sites along the river (Figure 1) were tested. The twelve sites are located along the river from its origin at Otsego Lake (SR1) to its confluence with Oak's Creek (SR18). The Village's sewage outfall is between sites SR12 and SR16. While dissolved oxygen concentrations are of most direct concern to the Village, nutrient levels and fecal coliform densities are also important indicators of water quality. The presence of fecal coliform bacteria indicate fecal contamination, the source of which is most likely inadequately treated sewage, storm runoff with associated animal waste, or agricultural runoff from nearby farms. While fecal coliforms generally are not disease-causing themselves, their presence is indicative of other pathogenic organisms (APHA, 1989). High fecal coliform levels are also coupled with elevated nutrient concentrations. Excessive levels of nitrogen and phosphorus leads to accelerated plant and algal growth which, upon senescence and decomposition, result in the consumption of oxygen, thereby jeopardizing aquatic organisms.

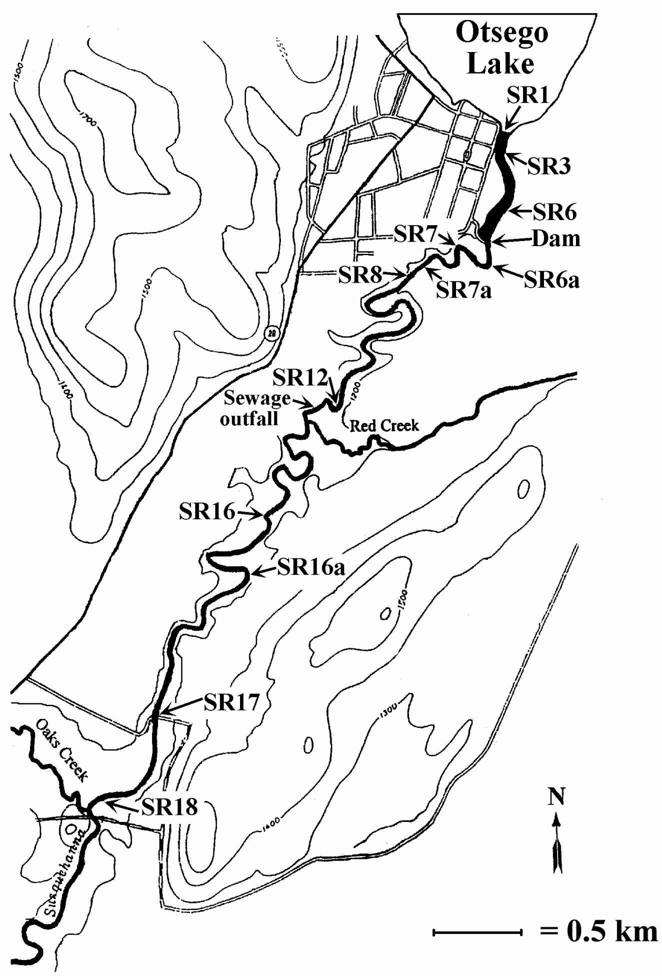

Figure 1. Upper Susquehanna River showing collection sites.

The river's ability to assimilate nutrients, organic matter and bacteria and still remain healthy is limited. It is therefore important to monitor and regulate the introduction of each of these pollutants.

METHODS

Twelve sites along the river were tested weekly between 26 June and 7 August. A Hydrolab Reporter™ was used to measure the temperature, pH, conductivity and dissolved oxygen levels at each site. Water samples were collected for the analyses of total phosphorus, nitrite+nitrate nitrogen and fecal coliform bacteria. Total phosphorus was determined using persulfate digestion followed by single reagent ascorbic acid method (EPA 1993). Nitrate+nitrite nitrogen levels were tested using the cadmium reduction technique (APHA 1992).

Fecal coliform bacteria were analyzed using the membrane filter technique (APHA, 1992). All glassware was sterilized in the autoclave for 10 minutes at 121^0 C at 15 PSI. All filters, filter pads and Petri dishes were purchased pre-sterilized. Between processing each sample, all equipment was re-sterilized with 70% ethyl alcohol then washed off with hot tap water and rinsed with dilution water (distilled water with trace amounts of potassium dihydrogen phosphate and magnesium chloride, AHPA 1992). Forceps were sterilized by submersing the ends in 95% ethyl alcohol and then flaming them with a Bunsen burner. A blank filter processed with approximately 20ml of dilution water was used between the samples from each site to further ensure sterile conditions between each site. Absence of colonies growing the blank demonstrates that aseptic conditions have been met.

For each site's sample, 10ml, 50ml and 100ml samplles were filtered in triplicate. This usually provided the suitable number of colonies 20-80 per filter at one of the concentrations (APHA, 1989).

Following filtration, the filters were placed in Petri dishes saturated with suitable nutrient medium. The nutrient medium is specifically formulated to encourage the growth of fecal coliform and discourages the growth of other bacteria. The Petri dishes were then placed in a water bath at 44.5^0C for 24 hours (+/- 2 hours). The bacteria form colonies which are easily recognized by their bright blue color (Miller, 1996). All filters that exhibited the appropriate growth of 20-80-colonies per filter were counted and reported per 100ml for each sample. All Petri dishes used in the culturing were autoclaved prior to their disposal.

RESULTS AND DISCUSSION

The results collected this summer differed from results collected in previous years. Average temperatures, pH, total phosphorus and nitrogen levels were lower while dissolved oxygen and conductivity were elevated. Average fecal coliform bacteria levels were lower compared to summer 2001 (Hill, 2001). Readings from 2002 most closely resemble those of summer 1998 (Dewey, 1998). The average values of each parameter monitored are depicted graphically and compared to previous years in Figure 2-7.

Temperature

The average temperature of the Susquehanna River for the summer of 2002 (Figure 2) was 21.58^{0}C; 0.4^{0}C lower that that of summer 2001. The high temperature this summer was 24.5^{0C} recorded at site SR1 on 31 July. The low temperature for this summer was 18.7^{0}C recorded at site SR12 on 7 August. Elevated temperatures at sites SR6a-SR7a might be due to the spillway immediately above these sites. Water spills approximately 1.5-2.0 m there, which might facilitate warming.

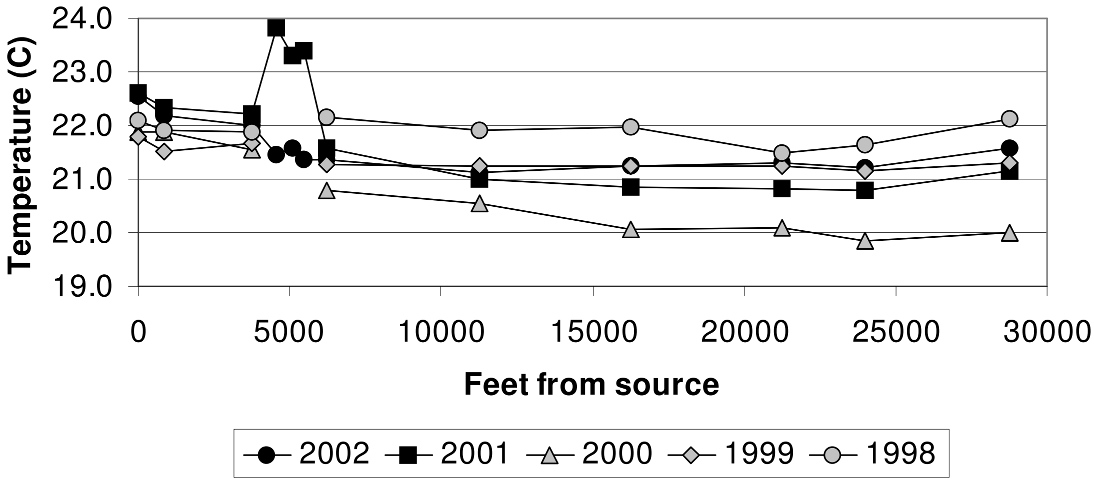

Figure 2. Profiles of mean temperature for the summers of 1998 (Dewey, 1999), 1999 (Deitz, 2000), 2000 (Hill, 2001), 2001 (Hill, 2002) and 2002.

pH

This year the average pH reading was lower than that of last year with a mean reading of 7.86. A high pH of 8.58 was recorded at site SR6 on 17 July. A low pH of 6.89 was recorded at site SR12 on 10 July. Average pH readings from 1998-2002 are depicted in Figure 3.

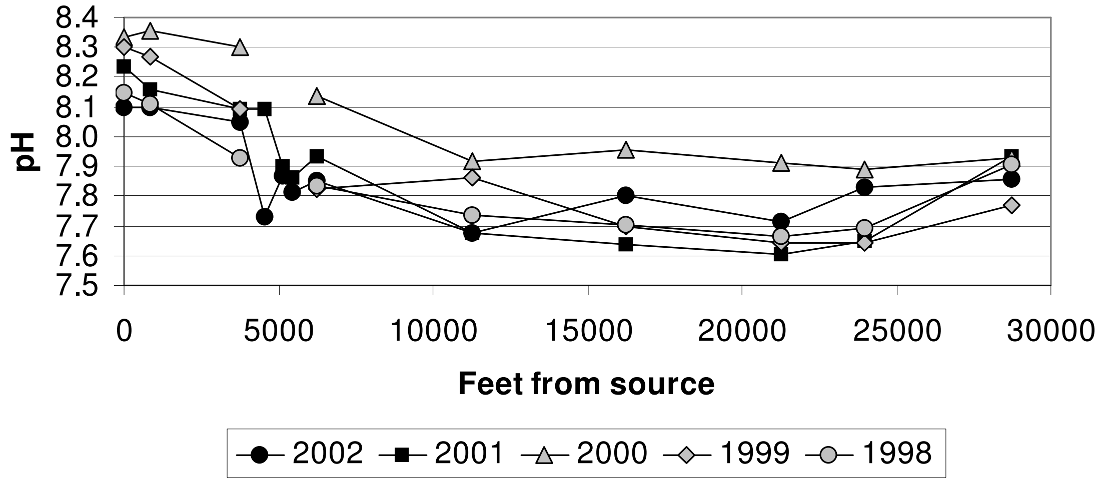

Figure 3. Profiles of mean pH for the summers of 1998 (Dewey, 1999), 1999 (Deitz, 2000), 2000 (Hill, 2001), 2001 (Hill, 2002) and 2002.

Conductivity

Conductivity, an indirect measure of ions in solution, was slightly higher this year, the average being 284 *u*mho/cm, 10 *u*mho/cm higher than last year. The highest conductivity, 352 *u*mho/cm, was recorded on 31 July at site SR16a. The lowest conductivity, 253 *u*mho/cm was recorded on both 10^h and 17 July at site SR1. The average conductivity readings for this year and previous years are represented graphically in Figure 4.

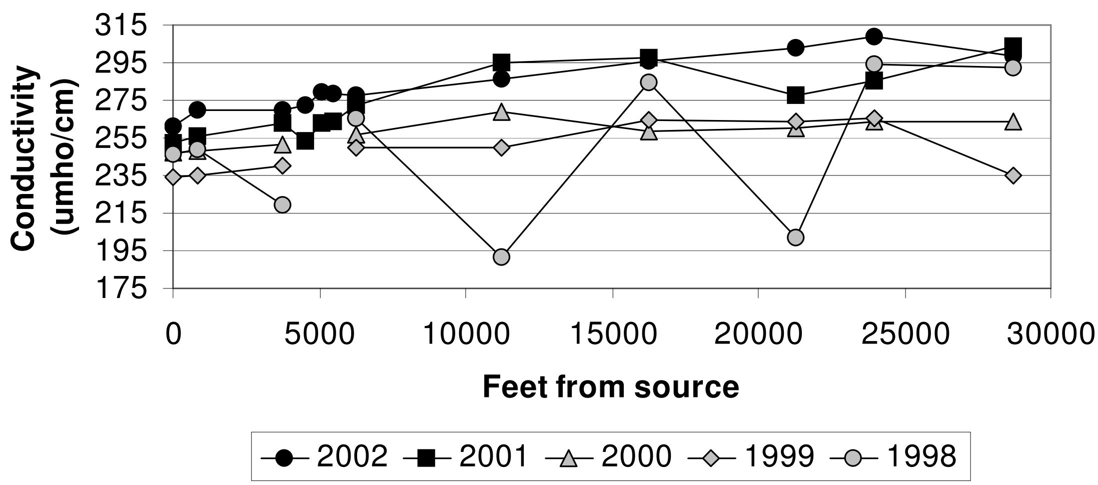

Figure 4. Profiles of mean conductivity for the summers of 1998 (Dewey, 1999), 1999 (Deitz, 2000), 2000 (Hill, 2001), 2001 (Hill, 2002) and 2002.

Dissolved Oxygen

The total levels of dissolved oxygen in the Susquehanna River this summer were slightly higher than those of 2001. The dissolved oxygen for this year was 7.84 mg/l, compared to the average of 7.46 mg/l in 2001. The highest level of dissolved oxygen recorded this summer was 12.45mg/l at site SR16a on 31 July. The higher levels of dissolved oxygen recorded this summer may be due in part to the cooler temperatures prior to the termination of data collection. Dissolved oxygen concentrations increase as water temperatures decrease. Figure 5 shows the average dissolved oxygen at each site monitored.

The Village of Cooperstown wastewater treatment plant is restricted in the amount of effluent that can be released into the river and is required to maintain a flow of at least 12 cubic feet/sec. This is released directly below site SR12. Since this effluent contains organic matter which when decaying can depress dissolved oxygen levels, the treatment plant is required to maintain a dissolved oxygen level of at least 5 mg/l. Discharge by introducing nutrients into the river, can depress oxygen levels by encouraging the growth of plants and algae which use oxygen dissolved in the river water for the processes of respiration and decay. The sites that had the lowest dissolved oxygen levels were SR16 and SR16a. These are the first two sites located downflow of the outfall of the treatment plant. Concentrations began to decline at site SR12 which is above the outfall. Even though sites below the outfall had the lowest dissolved oxygen, their average dissolved oxygen is still higher than the minimum required.

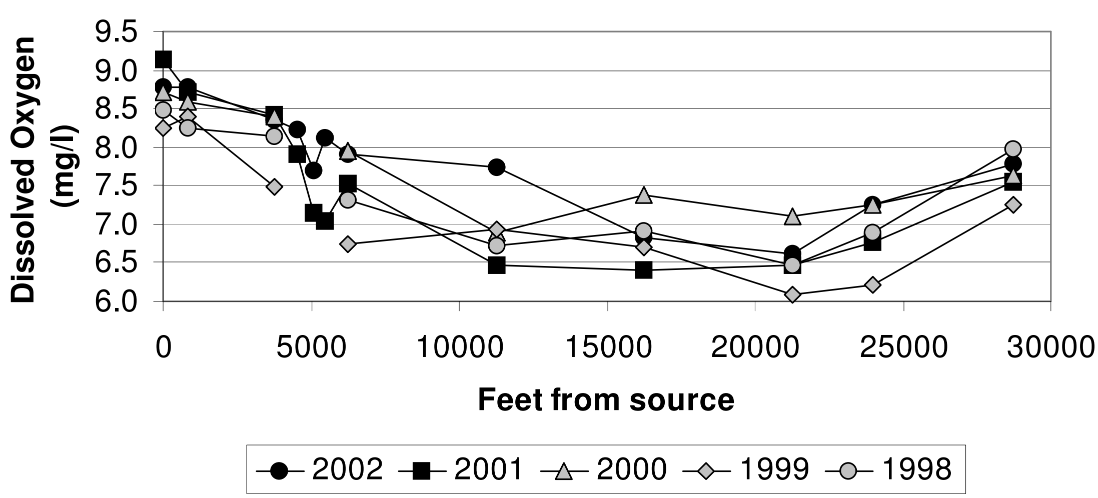

Figure 5. Profiles of mean dissolved oxygen for the summers of 1998 (Dewey, 1999), 1999 (Deitz, 2000), 2000 (Hill, 2001), 2001 (Hill, 2002) and 2002.

Total Phosphorus

The average phosphorus levels for this were lower than last year's. The average phosphorus level this year was 65 *u*g/l, 28*u*g/l lower than last year's average. The highest levels of phosphorus were found at site SR16a, ranging from 162 *u*g/l to 209 *u*g/l (the high level for the summer). The low reached this summer, 8 *u*g/l, was at site SR1 on 31 August. The average concentrations of total phosphorus are illustrated in Figure 6.

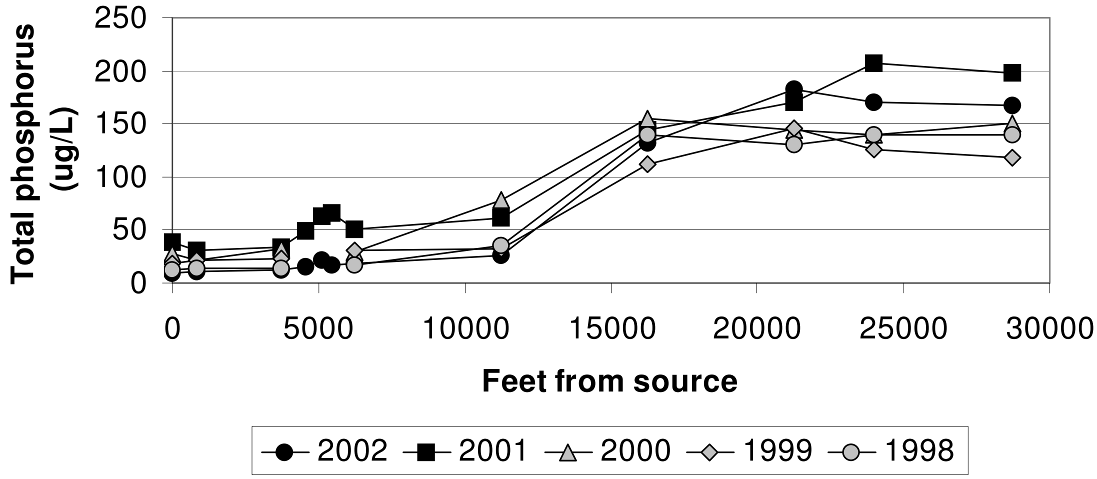

Figure 6. Profiles of mean total phosphorus for the summers of 1998 (Dewey, 1999), 1999 (Deitz, 2000), 2000 (Hill, 2001), 2001 (Hill, 2002) and 2002.

Nitrite+Nitrate

The nitrite+nitrate levels for this summer were considerably lower than those of last year. The highest level, .84 mg/l was recorded on 24 July at site 17, The low, .20mg/l, was recorded on 7 August at site 7a. Results this year resembled those of previous years, excluding last year's results which were extremely higher than past years. Figure 7 represents the average nitrite+nitrate concentrations for the summer.

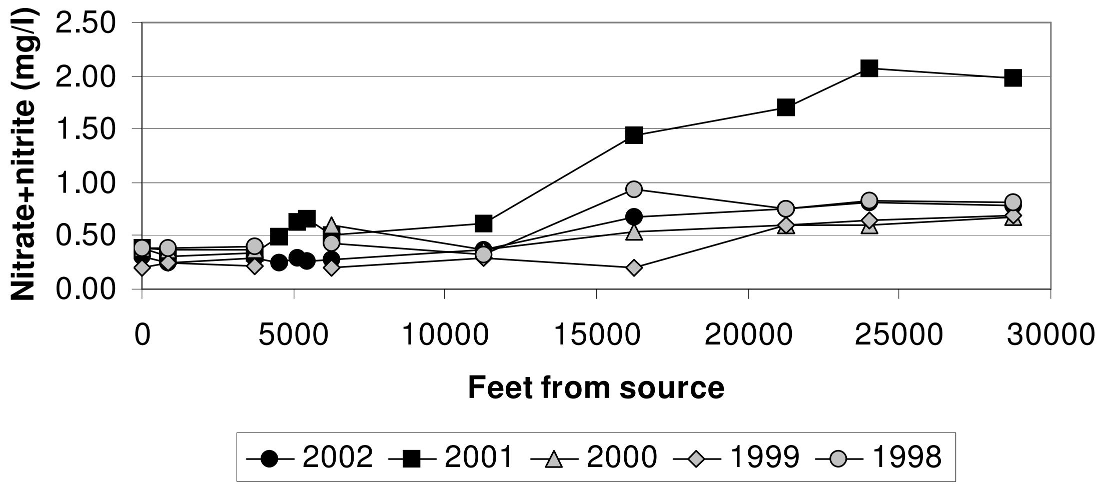

Figure 7. Profiles of mean nitrite+nitrate for the summers of 1998 (Dewey, 1999), 1999 (Deitz, 2000), 2000 (Hill, 2001), 2001 (Hill, 2002) and 2002.

Fecal Coliform

The levels of fecal coliform bacteria in the river this summer were similar to most years since 1999. The summer's average number of fecal coliform bacteria was 195 colonies/100ml. The high concentration recorded this summer, 1987/100ml, was at site SR8 on 11 July. This could indicate a source of pollution exists between site SR7a and SR8. Site SR12 also routinely produced a high number of colonies. Figure 8 shows the average number of colonies for this summer and past summers.

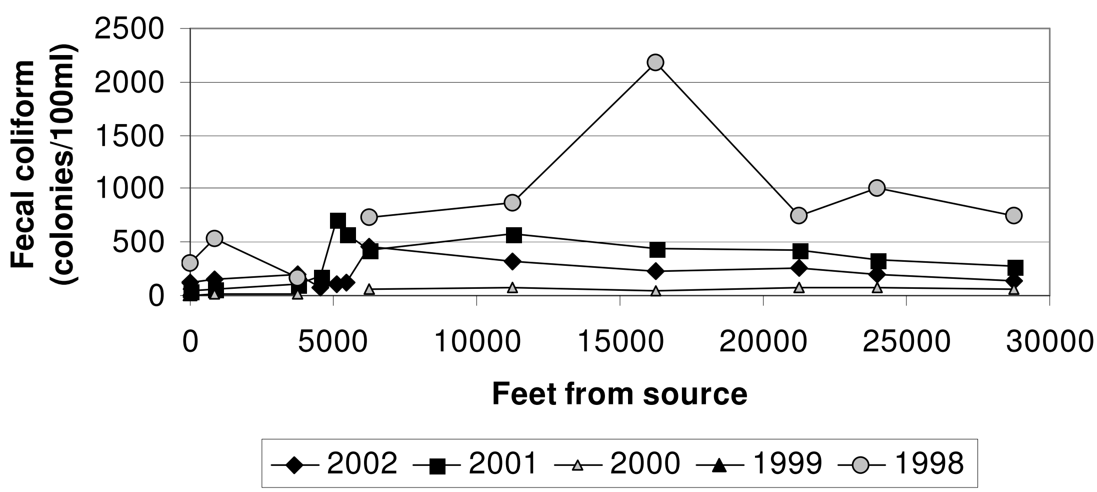

Figure 8. Profiles of mean fecal coliform for the summers of 1998 (Dewey, 1999), 1999 (Deitz, 2000), 2000 (Hill, 2001), 2001 (Hill, 2002) and 2002.

SUMMARY

This year the temperature, pH and fecal coliform colony counts were lower compared to last year. This was probably due, in part, to the first part of the summer being wetter and cooler than most. Data collection ended 7 August, thereby excluding the warmest, driest part of the summer. The cooler weather of the collecting interval also could explain elevated dissolved oxygen levels. As in past years, dissolved oxygen concentrations began declining at site SR12, which is above the Village's sewage outfall. This indicates a potential source of unauthorized discharge of organic pollution. Because the expendable amount of oxygen in the river is limited, that source should be removed so that oxygen loss brought about by the authorized discharge by the Village does not drop concentrations below an acceptable level.

REFERENCES

APHA, AWWA, EPA. 1992. Standard Methods for the Examination of Water and Wastewater. 18th Ed. American Public Health Association, Washington D.C.

Hill, K. 2001. Monitoring the water quality and fecal coliform bacteria in the upper Susquehanna River. *In* 34th Ann. Rept. (2001). SUNY Oneonta Bio. Fld. Sta.,SUNY Oneonta

Hill, K.2001.Monitoring the water quality and fecal coliform bacteria of the upper Susquehanna River. *In* 33rd Ann Rept.(2000). SUNY Oneonat Bio. Fld. Sta., SUNY Oneonta

Deitz, M. 1999. Monitoring the water quality of the UpperSusquehanna River. *In* 32nd Ann. Rept.(1999). SUNY Oneonta Bio Fld. Sta., SUNY Oneonta

Dewey, G. 1998. Monitoring the Water Quality of the Upper Susquehanna River. *In* 31st Ann. Rept. (1998). SUNY Oneonta Bio. Fld Sta., SUNY Oneonta

Salo, J. 1997. Analysis of Fecal Coliform Bacteria Concentrations of the Upper Susquehanna. *In* 30th Ann Rept. (1997). SUNY Oneonta Bio. FLd. Sta. SUNY Oneonta.

Willis, D. 1997. Water Quality of the Upper Susquehanna River. *In* 30th Ann. Rept. (1997). SUNY Oneonta, Bio Fld. Sta., SUNY Oneonta.