

# SUSQUEHANNA RIVER MONITORING:

## Monitoring the water quality and fecal coliform bacteria in the upper Susquehanna River, summer 2001

Kevyn Hill<sup>1</sup>

### ABSTRACT

In an ongoing study at the Biological Field Station, the upper Susquehanna River was monitored during the summer of 2001 to ensure that water quality standards were being maintained within regulated limits below the Village of Cooperstown's Sewage Treatment Plant. Every week, the river was monitored for fecal coliform bacteria, as well as other chemical and physical characteristics. Results show that temperature, conductivity, total phosphorus, nitrite+nitrate nitrogen and fecal coliform bacteria levels were higher this year than previous summers, while pH and dissolved oxygen were lower.

### INTRODUCTION

During the summer of 2001, physical water characteristics, nutrient levels and fecal coliform concentrations were monitored. Samples were collected weekly from nine sites along the river between the mouth of the river and the confluence with Oaks Creek (Figure 1). After elevated counts of fecal coliform were found below site 6, three new sites were added between site 6 and site 8 to try to determine the source of contamination. Fecal coliform bacteria are indicative of fecal contamination, sources most commonly being inadequately treated sewage or agricultural runoff. Total phosphorus and nitrate+nitrite nitrogen levels may also indicate pollution from these sources. Organic pollution, direct or that generated by algal production augmented by excessive nutrient loading, leads to depressed dissolved oxygen levels due to bacterial respiration. The Village of Cooperstown's Sewage Treatment Plant discharges into the Susquehanna River and is responsible for maintaining water quality standards in the river below the plant. Since the ability of the river to assimilate nutrients and organic materials is limited, it is pertinent to limit unauthorized pollution sources. This research is intended to verify compliance by the Village as well as to locate other possible sources of pollution so that they can be abated.

---

<sup>1</sup> Kevyn Hill, Mecklenburg research intern, summer 2001. Current Affiliation: St. Lawrence University, New York.

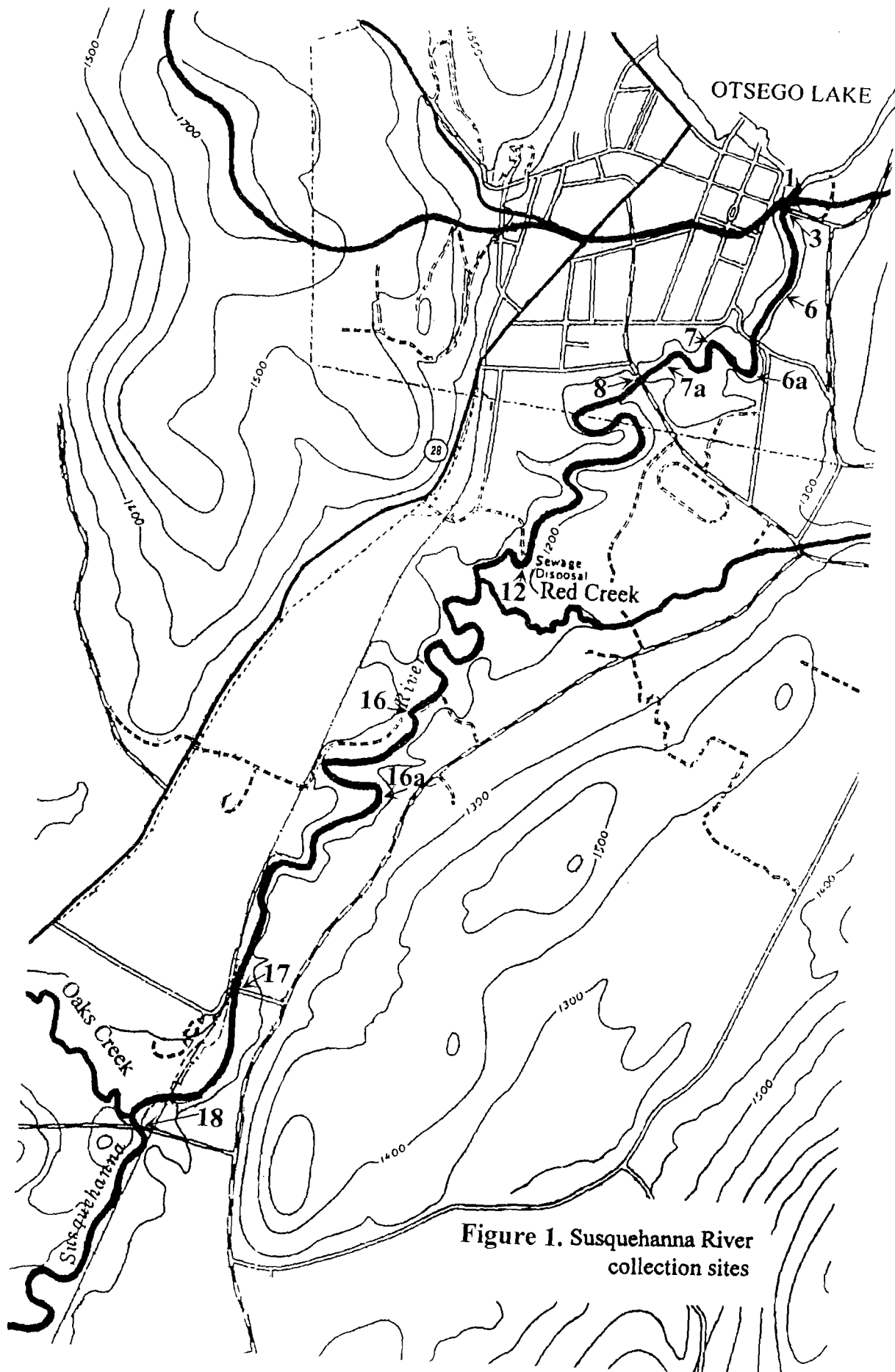


Figure 1. Susquehanna River collection sites

## METHODS

Nine sites along the river (Figure 1) were visited once a week between 5 July and 9 August 01 in order to sample the water for fecal coliform bacteria, phosphorus, and nitrogen. A Hydrolab Reporter™ was brought into the field to measure temperature, pH, dissolved oxygen, and conductivity of the water. Three additional sites were added mid-way through the summer in an attempt to gain insight into the source of a water quality anomaly.

At each site, a sample was collected in a sterilized bottle for fecal coliform and nutrient analyses. Total phosphorus levels were evaluated using presulfate digestion followed by single reagent ascorbic acid method (EPA 1993). Nitrate+nitrite nitrogen was analyzed using the cadmium reduction technique (APHA, 1992).

Water samples were tested for fecal coliform bacteria by means of the membrane filter technique (APHA, 1992). All glassware was sterilized in the autoclave for 15 minutes at 121° C and 15 PSI. All Petri dishes, filter pads and filters were purchased pre-sterilized. All equipment was sterilized between the processing of samples from different sites. Forceps were sterilized using 95% ethyl alcohol then burned off over a Bunsen burner. Funnels were rinsed 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, APHA, 1992). Also, to ensure that aseptic conditions were maintained, a filter was processed with dilution water between each site.

Samples of 10 ml, 50 ml, and 100 ml were filtered in triplicate, which generally provided appropriate counts of 20-80 colonies per 100 ml at one volume. After filtering, filters were placed in the appropriate Petri dish which contained 2.2ml of culture media specific to fecal coliform bacteria. These dishes were then placed in a water bath at 44.5 ° Celsius +/-0.2 ° for 24 hours. Colonies could be distinguished by their bright blue color (Miller, 1996). All samples having the appropriate range of colonies were counted, recorded, averaged, and reported as colonies per 100 ml. All Petri dishes were sterilized prior to disposal.

## RESULTS AND DISCUSSION

In general, the results from summer of 2001 differed from information collected during previous summers. Average temperature, conductivity, total phosphorus, nitrite+nitrate nitrogen and fecal coliform levels were elevated, whereas dissolved oxygen and pH were lower than last year's readings. Fecal coliform bacteria levels were extremely elevated compared to summer 2000 (Hill, 2000), being more similar to those encountered in 1998 (Dewey, 1998). All these difference are likely due, at least in part, to meteorological variability. The summers of 1998 and 2000 were quite warm and dry, while that of 1999 was relatively cooler and considerable wetter. The average values at

each site are depicted graphically and compared to the data from 1998-2000 in Figures 2-7.

### Temperature

The average temperature of the Susquehanna River (Figure 2) was higher this year than last, with a reading of 21.99°C. This is a difference of +1.25°C from last year's readings. This temperature reflects the hot, dry weather that prevailed this summer. A high temperature of 26.39°C was reached on 9 August, at site 18. A low temperature of 18.0°C was reached on 5 July, at site 17. Figure 2 shows the average temperatures of the river at each site.

### pH

The pH readings of the Susquehanna River were slightly lower this year with an average reading of 7.90, compared to 8.08 in 2000. A high pH of 8.41 was reached on 8 August, at site 1. A summer low was reached on 12 July, at site 12, with a reading of 7.13. Figure 3 demonstrates the average pH readings for each site during the summer.

### Conductivity

Conductivity of the Susquehanna River (Figure 4) was slightly higher than last year. An average reading of 274 umho/cm was 17 umho/cm higher than last year's average. Conductivity was highest on 17 July at site 18 with a reading of 321 umho/cm. Also on 17 July, a low reading of 211 umho/cm was recorded at site 16A.

### Dissolved Oxygen

The levels of dissolved oxygen (DO) in the Susquehanna River this summer were slightly lower than in the previous years. The average DO reading for the summer was 7.46 mg/l, compared to an average of 7.77 mg/l last year. This is possibly due to the hot, dry weather experienced this summer, since DO concentration is inversely related to temperature (Hutchinson, 1957). The high concentration was reached on 2 August at site 1 with a reading of 12.03 mg/l. The lowest concentration recorded this summer was found on 5 July, at site 16, with a reading of 4.97 mg/l. Figure 5 demonstrates the average concentrations at each site along the river.

The Cooperstown Village Waste Treatment Plant discharges effluent into the river just below site 12. The Plant is regulated by the State and is required to maintain a DO concentration of at least 5.00 mg/l downstream from the plant. This is due to the fact that organic material depletes the oxygen in the water when it decomposes. Sewage discharge from the plant may depress the levels of dissolved oxygen through the introduction of organic material (i.e. biological oxygen demand). Waste discharge may also lower DO levels via the introduction of nutrients. This would promote plant and algae growth,

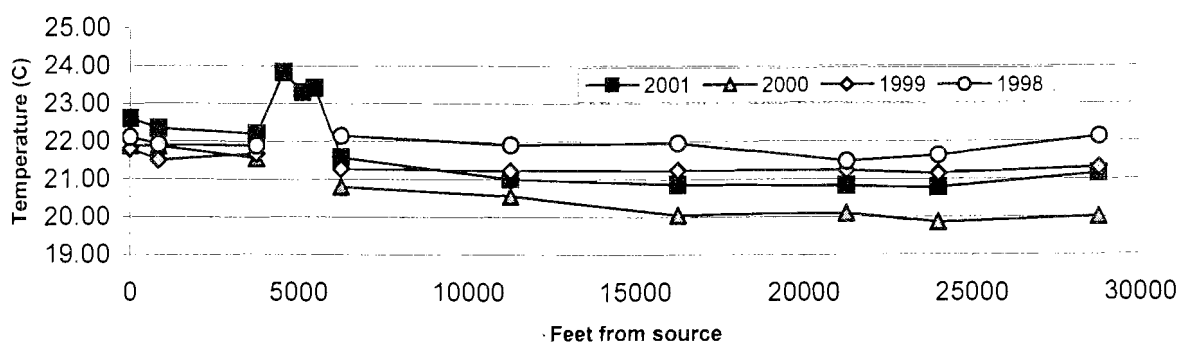


Figure 2. Profiles of mean temperature for the summers of 1998 (Dewey, 1999), 1999 (Deitz, 2000), 2000 (Hill, 2001) and 2001.

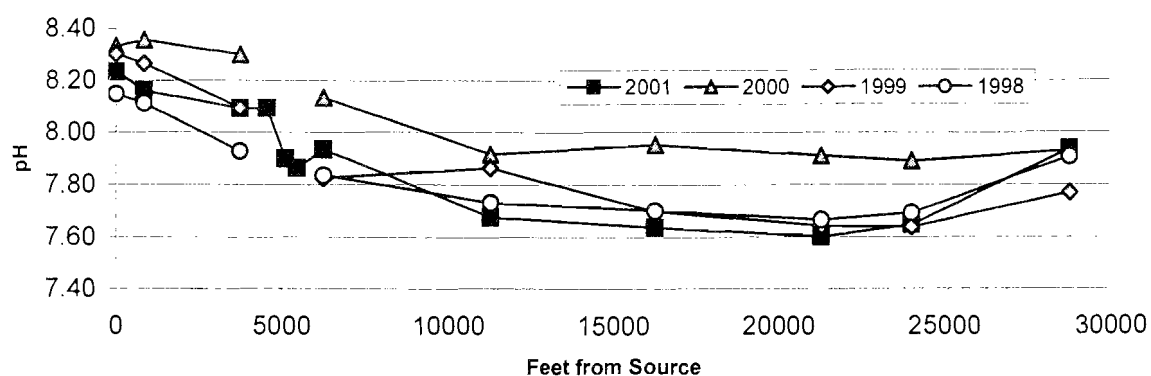


Figure 3. Profiles of mean pH for the summers of 1998 (Dewey, 1999), 1999 (Deitz, 2000), 2000 (Hill, 2001) and 2001.

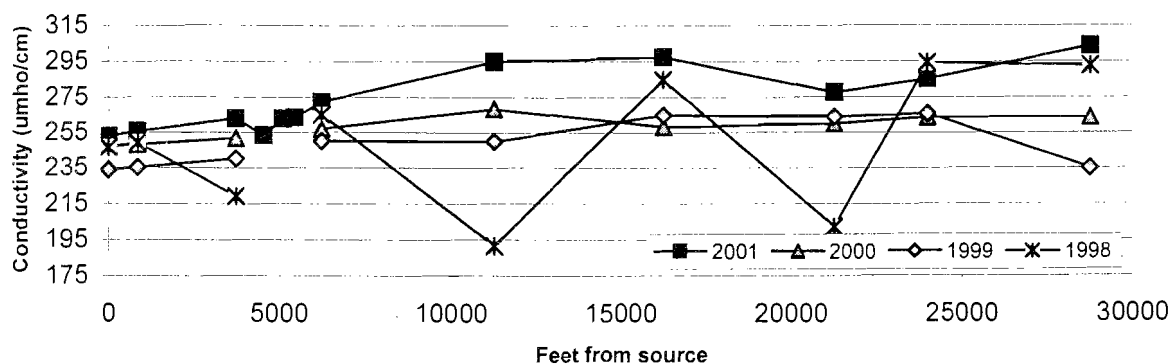


Figure 4. Profiles of mean conductivity for the summers of 1998 (Dewey, 1999), 1999 (Deitz, 2000), 2000 (Hill, 2001) and 2001.

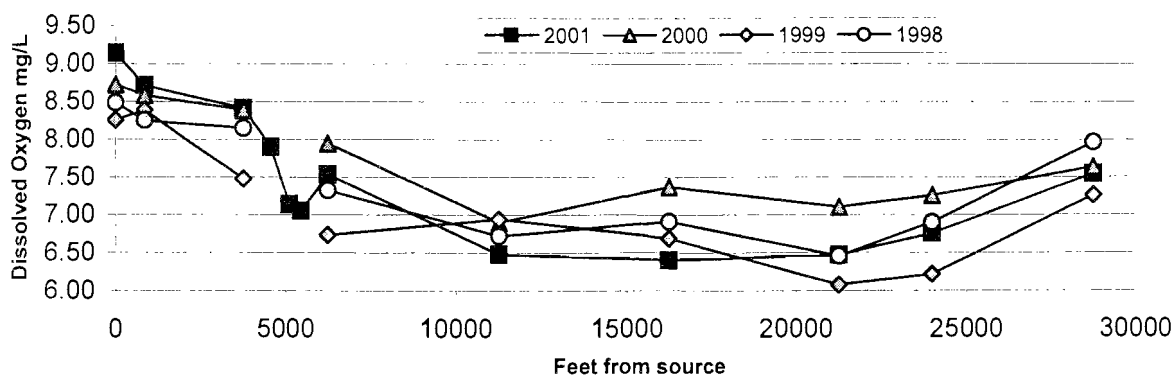


Figure 5. Profiles of mean dissolved oxygen for the summers of 1998 (Dewey, 1999), 1999 (Deitz, 2000), 2000 (Hill, 2001) and 2001.

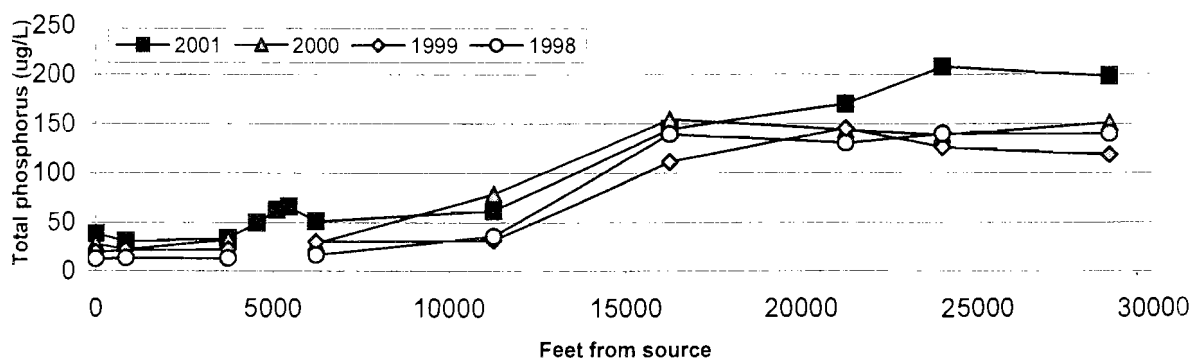


Figure 6. Profiles of mean total phosphorus for the summers of 1998 (Dewey, 1999), 1999 (Deitz, 2000), 2000 (Hill, 2001) and 2001.

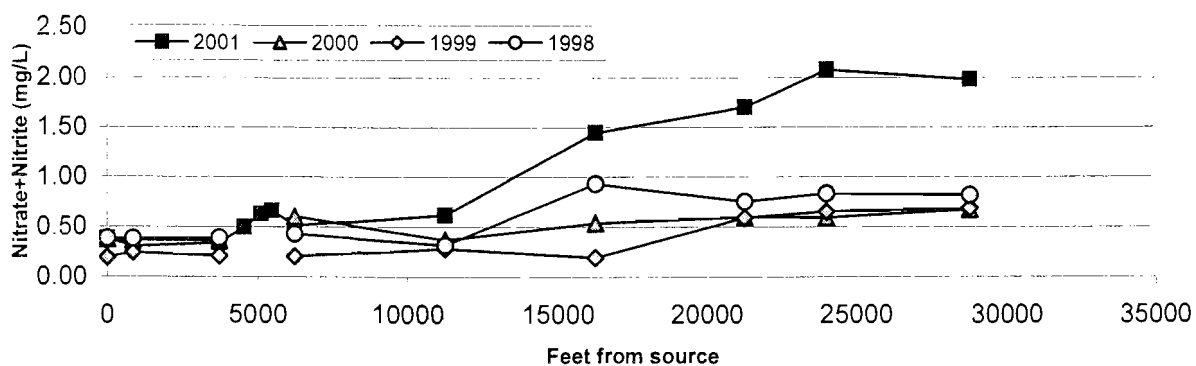


Figure 7. Profiles of mean nitrite+nitrate nitrogen for the summers of 1998 (Dewey, 1999), 1999 (Deitz, 2000), 2000 (Hill, 2001) and 2001.

pollution. The next sampling data, though, resulted in numbers that were relatively normal. A pasture located after site 6A and before site 8 is a likely source of contamination. Another factor to consider regarding the high counts on 26 July is the heavy rain the night before the sampling date. The rain would cause runoff from the pasture into the river, elevating the counts of bacteria colonies. Laboratory problems with fecal coliform incubation prevented the collection of data during the week of 6 August to 10 August. Figure 8 demonstrates the average fecal coliform counts for the summers of 1998-2001.

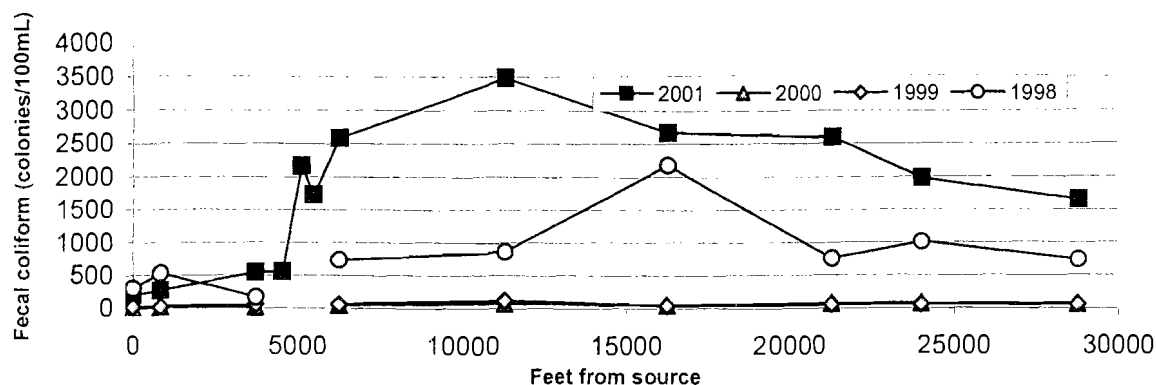


Figure 8. Profiles of mean fecal coliform concentrations for the summers of 1998 (Dewey, 1999), 1999 (Deitz, 2000), 2000 (Hill, 2001) and 2001.

## SUMMARY

It seems that the hot, dry summer experienced this year resulted in low river discharge. That led to higher temperatures and lower dissolved oxygen concentrations. Also, decreased dilution of the Villages sewage resulted in higher concentrations of total phosphorus and nitrite+nitrate nitrogen below the outfall. All parameters typically linked to organic pollution (those noted above, as well as fecal coliform bacteria) indicate such a pollution source upstream of the Sewage Treatment Plant, between the parking lot south of Bassett Hospital (site 6a) and Susquehanna Avenue (site 12).

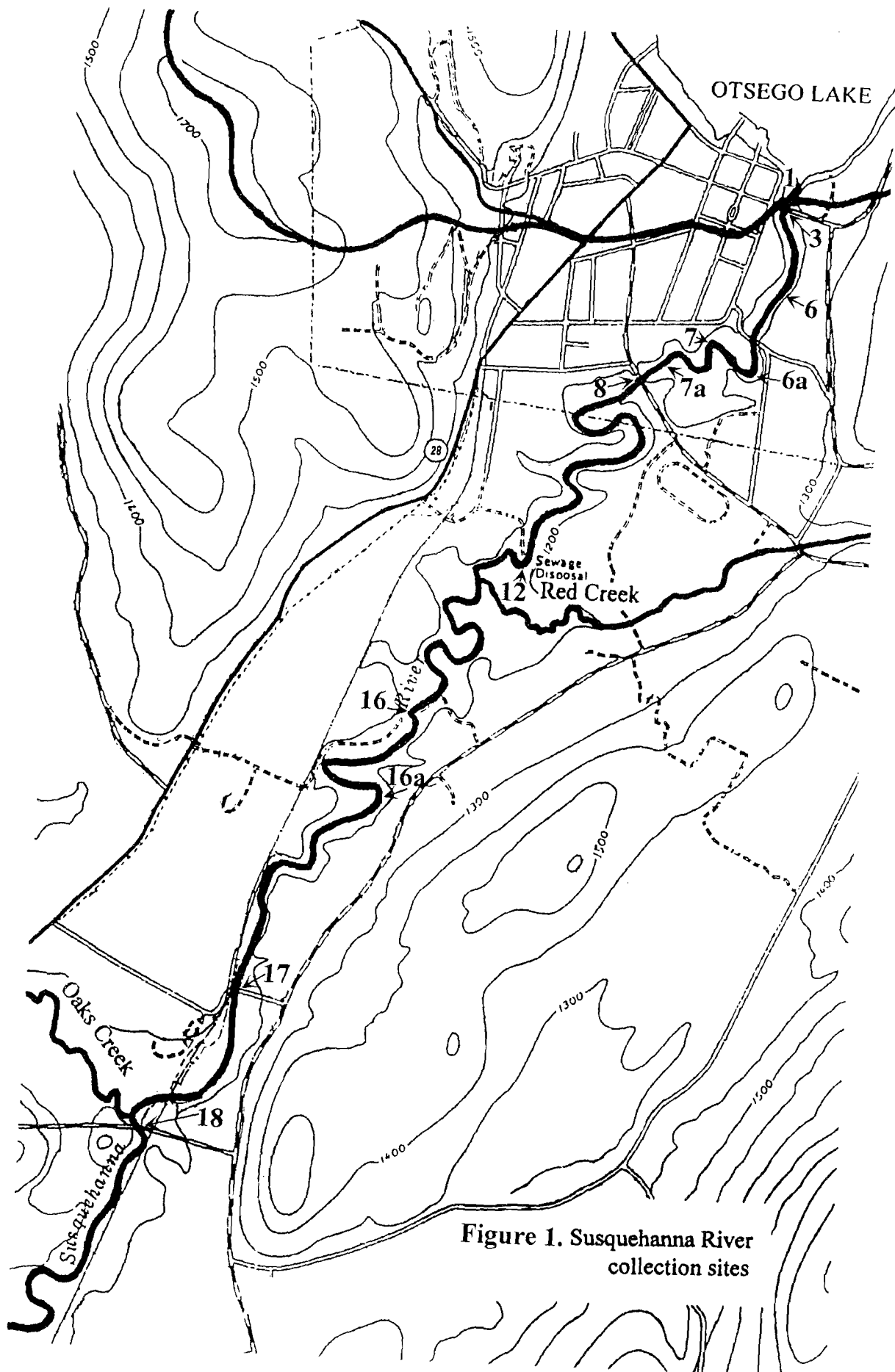


Figure 1. Susquehanna River collection sites

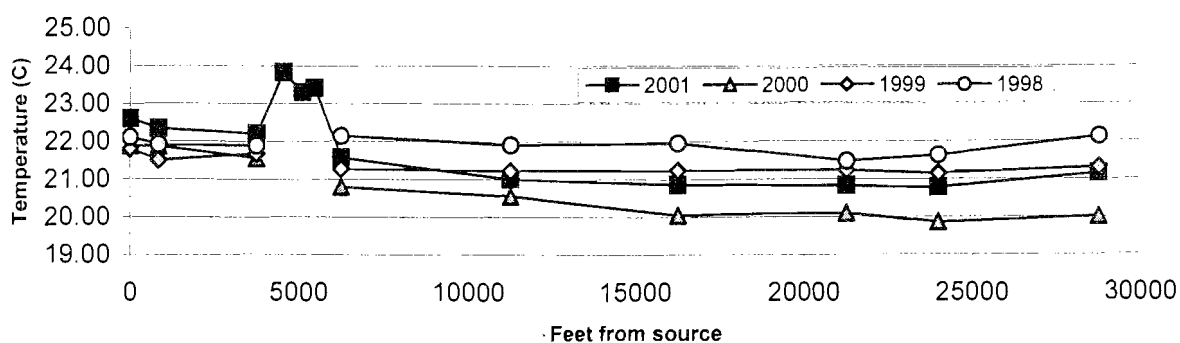


Figure 2. Profiles of mean temperature for the summers of 1998 (Dewey, 1999), 1999 (Deitz, 2000), 2000 (Hill, 2001) and 2001.

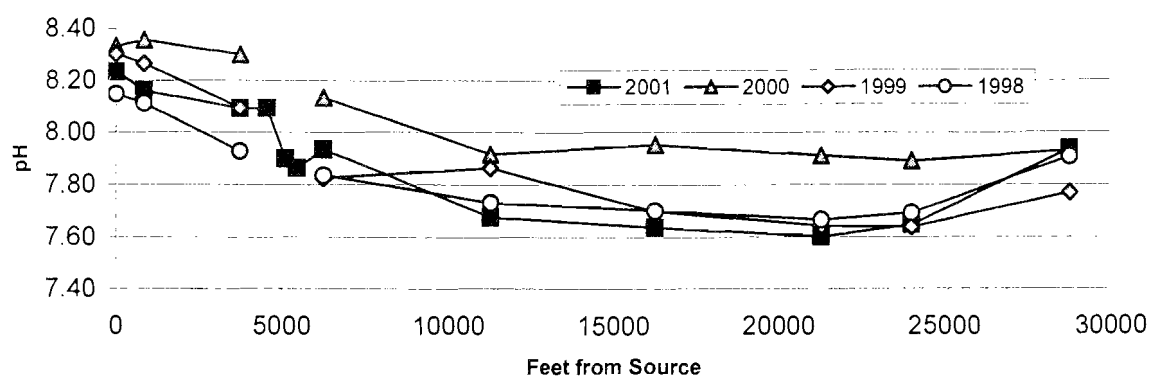


Figure 3. Profiles of mean pH for the summers of 1998 (Dewey, 1999), 1999 (Deitz, 2000), 2000 (Hill, 2001) and 2001.

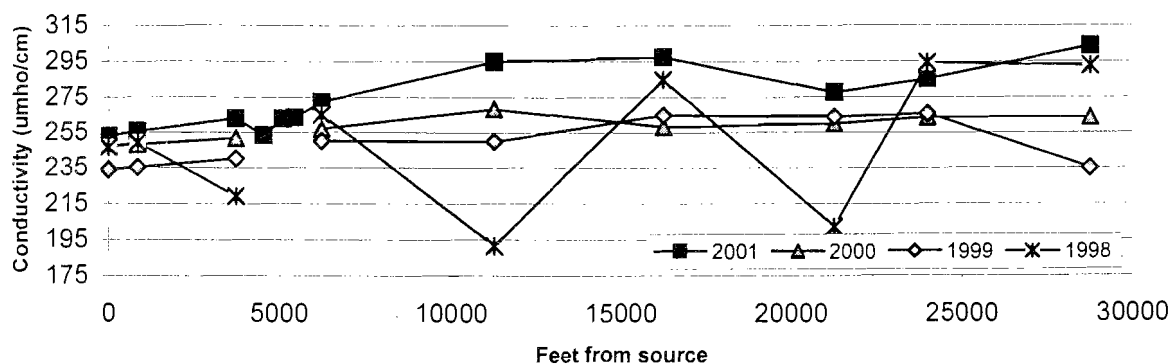


Figure 4. Profiles of mean conductivity for the summers of 1998 (Dewey, 1999), 1999 (Deitz, 2000), 2000 (Hill, 2001) and 2001.

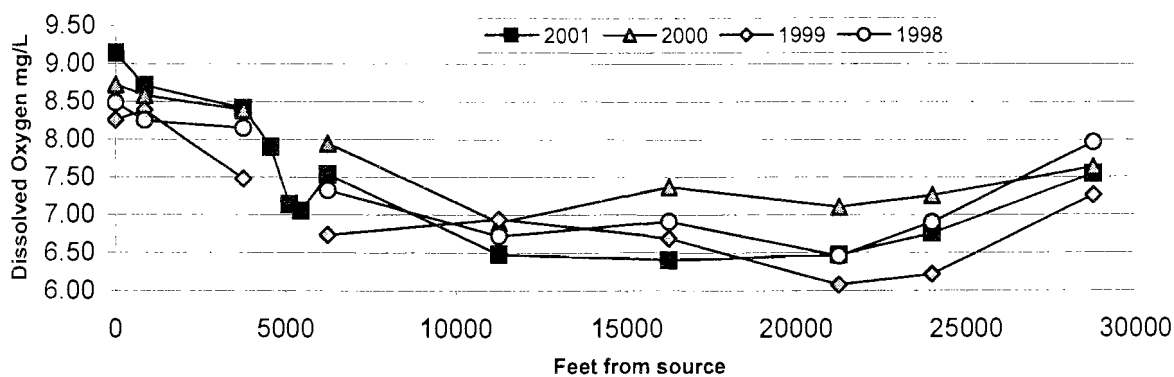


Figure 5. Profiles of mean dissolved oxygen for the summers of 1998 (Dewey, 1999), 1999 (Deitz, 2000), 2000 (Hill, 2001) and 2001.

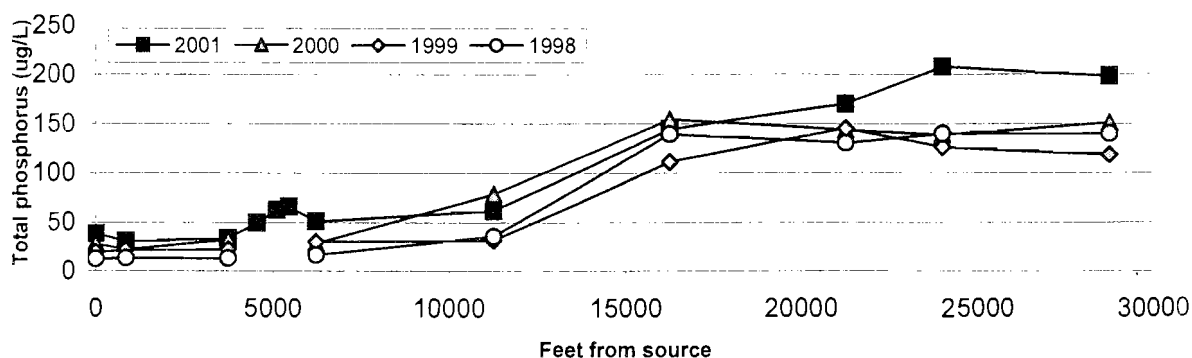


Figure 6. Profiles of mean total phosphorus for the summers of 1998 (Dewey, 1999), 1999 (Deitz, 2000), 2000 (Hill, 2001) and 2001.

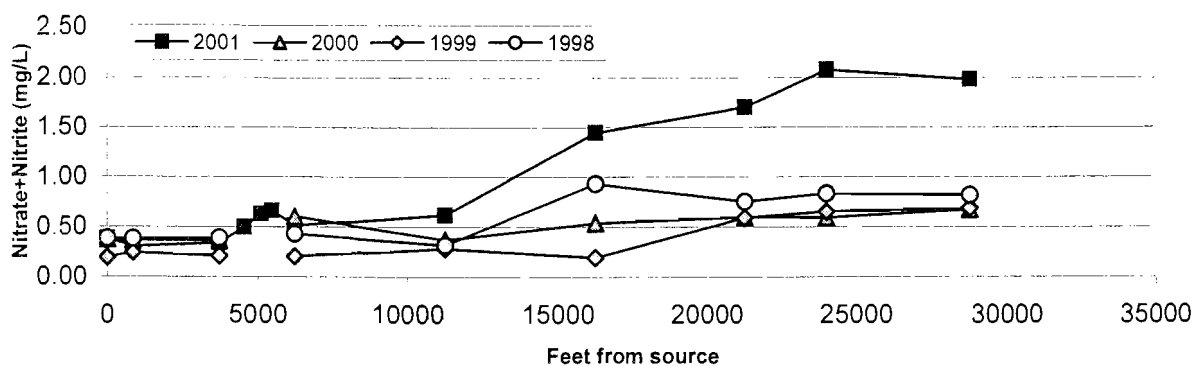


Figure 7. Profiles of mean nitrite+nitrate nitrogen for the summers of 1998 (Dewey, 1999), 1999 (Deitz, 2000), 2000 (Hill, 2001) and 2001.

which would in turn consume oxygen through respiration and decay. However, as seen in previous years, site 12, which is above the site of discharge at the plant, generally has one of the lowest DO concentrations. This would indicate another source of nutrient loading somewhere upstream of the plant. This summer, however, while DO concentrations did drop considerably from site 8 to site 12, the site with the lowest average DO concentration was 16, which is the first site after the outfall of the plant. Due to the rivers limited assimilative capacity, locating and correcting the source of this problem would provide a greater volume of “disposable” oxygen with which to work.

### Total Phosphorus

Total phosphorus levels were elevated slightly from last year, with an average of 93 ug/l. Site 17 routinely had the highest concentrations, ranging from 84 ug/l to 313 ug/l, which was also the record high for the summer, recorded on 26 July. Higher concentrations are probably a function of the drier weather, and resultant lower river flows, as concentrations of point-source pollutants tend to be inversely related to flow. Figure 6 demonstrates the average total phosphorus concentrations for the summer.

### Nitrite+Nitrate

The average nitrate+nitrite concentrations were considerably higher than previous years. A high concentration of 3.13 mg/l was reached on 26 June at site 17. Concentrations below the treatment plant were generally above 1.50 mg/l; throughout previous summers, concentrations there were below 1.0 mg/l. Figure 7 demonstrates the average nitrate+nitrite concentrations for the summers of 1998-2001.

As with total phosphorus levels, elevated nitrite+nitrate levels probable indicate nutrient loading from the Village Waste Treatment Plant. Currently, the plant is not required to remove such nutrients through tertiary treatment. Both nutrients promote plant life in the river, which would in turn affect the dissolved oxygen levels through respiration and decay.

### Fecal Coliform

The levels of fecal coliform bacteria in the Susquehanna River this summer were extremely elevated compared to last. Last year’s average was 48 colonies/100 ml; this year’s was 607colonies/100 ml. The high was recorded on 26 July at site 12 with a reading of 2,647 colonies/100 ml. It again should be noted that although the sewage treatment plant is located at site 12, the outfall of the plant is below the sampling site. This indicates that there is a source of pollution above site 12. Site 8 also had high readings on that date, yet levels at site 6 were not abnormally high. This indicates a source of pollution between site 6 and site 8. Three new sites (6A, 7, and 7A) were added prior the next sampling date (2 August) in order to try and ascertain the source of

pollution. The next sampling data, though, resulted in numbers that were relatively normal. A pasture located after site 6A and before site 8 is a likely source of contamination. Another factor to consider regarding the high counts on 26 July is the heavy rain the night before the sampling date. The rain would cause runoff from the pasture into the river, elevating the counts of bacteria colonies. Laboratory problems with fecal coliform incubation prevented the collection of data during the week of 6 August to 10 August. Figure 8 demonstrates the average fecal coliform counts for the summers of 1998-2001.

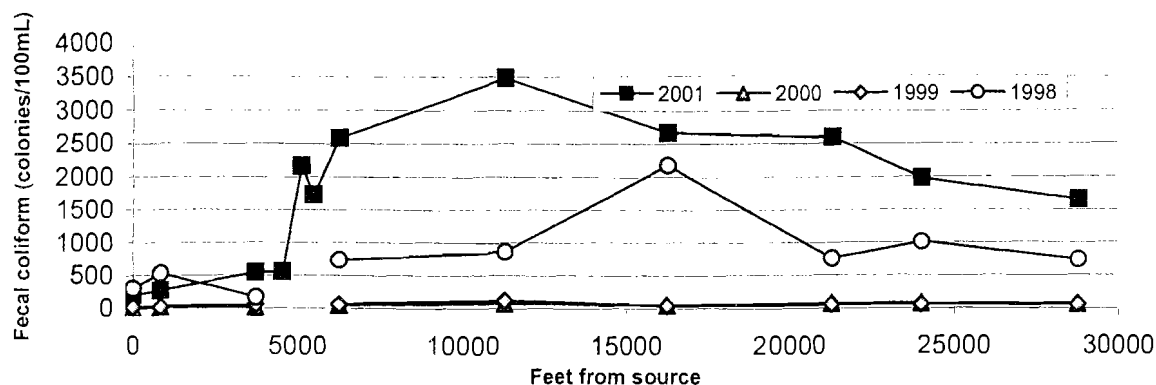


Figure 8. Profiles of mean fecal coliform concentrations for the summers of 1998 (Dewey, 1999), 1999 (Deitz, 2000), 2000 (Hill, 2001) and 2001.

## SUMMARY

It seems that the hot, dry summer experienced this year resulted in low river discharge. That led to higher temperatures and lower dissolved oxygen concentrations. Also, decreased dilution of the Villages sewage resulted in higher concentrations of total phosphorus and nitrite+nitrate nitrogen below the outfall. All parameters typically linked to organic pollution (those noted above, as well as fecal coliform bacteria) indicate such a pollution source upstream of the Sewage Treatment Plant, between the parking lot south of Bassett Hospital (site 6a) and Susquehanna Avenue (site 12).

pollution. The next sampling data, though, resulted in numbers that were relatively normal. A pasture located after site 6A and before site 8 is a likely source of contamination. Another factor to consider regarding the high counts on 26 July is the heavy rain the night before the sampling date. The rain would cause runoff from the pasture into the river, elevating the counts of bacteria colonies. Laboratory problems with fecal coliform incubation prevented the collection of data during the week of 6 August to 10 August. Figure 8 demonstrates the average fecal coliform counts for the summers of 1998-2001.

## SUMMARY

It seems that the hot, dry summer experienced this year resulted in low river discharge. That led to higher temperatures and lower dissolved oxygen concentrations. Also, decreased dilution of the Villages sewage resulted in higher concentrations of total phosphorus and nitrite+nitrate nitrogen below the outfall. All parameters typically linked to organic pollution (those noted above, as well as fecal coliform bacteria) indicate such a pollution source upstream of the Sewage Treatment Plant, between the parking lot south of Bassett Hospital (site 6a) and Susquehanna Avenue (site 12).

## REFERENCES

- Albright, M. 2001. Personal communication. SUNY Oneonta Biological Field Station, SUNY, Oneonta.
- APHA, AWWA, EPA. 1992. Standard Methods for the Examination of Water and Wastewater. 18<sup>th</sup> Ed. American Public Health Association, Washington, D.C.
- Deitz, M. 1999. Monitoring the Water Quality of the Upper Susquehanna River. In 32<sup>nd</sup> Ann. Rept. (1999). SUNY Oneonta Bio. Fld. Sta., SUNY Oneonta.
- Dewey, G. 1998. Monitoring the Water Quality of the Upper Susquehanna River. In 31<sup>st</sup> Ann. Rept. (1998). SUNY Oneonta Bio. Fld. Sta., SUNY Oneonta.
- Hill, K. 2000. Monitoring the Water Quality and Fecal Coliform Bacteria of the Upper Susquehanna River. In 33<sup>rd</sup> Ann. Rept. (2000). SUNY Oneonta Bio. Fld. Sta., SUNY Oneonta.
- Miller, C. 1996. Fecal coliform bacteria in major Otsego Lake tributaries and the Susquehanna River. In 28<sup>th</sup> Ann. Rept (1995). SUNY Oneonta Bio. Fld. Sta., SUNY Oneonta.
- Salo, J. 1997. Analysis of Fecal Coliform Bacteria Concentrations of the Upper Susquehanna. In 30<sup>th</sup> Ann. Rept (1997). SUNY Oneonta Bio. Fld. Sta., SUNY Oneonta.
- Willis, D. 1997. Water Quality of the Upper Susquehanna River. In 30<sup>th</sup> Ann. Rept. (1997). SUNY Oneonta Bio. Fld. Sta., SUNY Oneonta.