Water quality monitoring of five major tributaries in the Otsego Lake watershed, summer 2001

Caitlin A. Parker[1]

INTRODUCTION

Enhanced rates of eutrophication in Otsego Lake have been documented by the Biological Field Station for over 30 years (Harman et al., 1997), and in recent years as well (Albright, 1998; 1999; 2000; 2001). Eutrophication occurs when a body of water becomes enriched in dissolved nutrients. The increase in nutrients stimulates aquatic plant growth and often results in a depletion of dissolved oxygen. Drinking water that comes from a eutrophic source possesses undesirable tastes, odors and colors. Dissolved organics created by algal blooms can and will react with chlorine (used to disinfect drinking water) to produce harmful carcinogens. It is important to maintain high standards for the water quality of Otsego Lake, not only for ecological reasons, but because it acts as the main water source for the Village of Cooperstown and many lakeside residents (Harman et al., 1997). Low levels of dissolved oxygen, caused by an increase in aquatic plant growth, raises concern for the cold-water fisheries of Otsego Lake.

The quality of the water flowing into a lake determines the nature of the lake. And, the water quality is dependent upon landforms and land uses in the watershed (Albright, 1996). Water quality mirrors the composition of water as affected by natural causes and man's cultural activities (Novotny and Olem, 1994). One confounding element that has complicated the relationship between eutrophication and external loading is the introduction of a non-native fish to the lake (Warner, 1999). Since the appearance of the first alewife (*Alosa pseudoharengus*) in 1986, the lake has shown increasing symptoms of eutrophy, making it difficult to determine the effects of agriculture. The purpose of this ongoing study is to monitor the northern watershed of Otsego Lake, which contributes two-thirds of the water to the lake and is largely used for agricultural purposes.

The northern watershed is comprised of five drainage basins. The tributaries include White Creek, Cripple Creek, Hayden Creek, Shadow Brook and a small one on Mount Wellington. Otsego Lake has a north-south orientation and drains into the Susquehanna River. Its glacially over-deepened U-shaped basin helps the lake conceal many of its eutrophic indicators. Forty-four percent of the Otsego Lake watershed is used for agriculture Albright, 1996). Cultural development and agricultural activities on nutrient-rich local limestone soils in the northern watershed have created many problems (Harman et al., 1997). Nutrients from agricultural fertilizers and livestock waste have been identified in the United States as the number one cause of anthropogenic eutrophication in freshwater inland lakes (Daniel, 1994).

[1] Rufus J. Thayer Otsego Lake Research Assistant, Summer 2001. Present affiliation: Cornell University.

The Environmental Quality Incentive Program (EQIP) was established under the 1996 Farm Bill to assist crop and livestock producers in dealing with environmental and conservation improvements on the farm (USDA, 1996). The Otsego County Conservation Association has matched EQIP funds to institute 22 Best Management Practice (BMP) sites throughout the northern watershed (Figure 1) (Pullano, 2000). Best Management Practices are methods or measures selected by the UDSA-NRCS to satisfy non-point source control needs; they include, but are not limited to, structural and non-structural controls and operations (Novotny and Olem, 1994). Examples of agricultural BMPs include conservation tillage, contour strip-cropping, sediment retention ponds, providing an alternative drinking sources for livestock, streambank fencing, a cattle crossing over the stream and manure storage facilities (EPA, 2001). Most water quality and ecosystem problems are best solved at the watershed level instead of at the individual waterbody (EPA, 2001).

The goal of this study is to evaluate the effectiveness of the Best Management Practices in the northern watershed by measuring the nutrient contributions along designated sections of each tributary. However, the most effective, but costly, way to monitor the results of a BMP and determine nutrient loading is by conducting a precipitation-based study. Such a study is currently underway on the Shadow Brook drainage basin (Albright, 2002). The Shadow Brook tributary contains the most acreage used for agricultural purposes in the watershed (Harman et al., 1997) and has had BMPs implemented on it for the greatest length of time. Also concurrent with this work is an evaluation of fecal coliform bacteria at the same 23 site monitored here. It is expected that BMPs successfully addressing nutrient runoff would also suppress coliform numbers.

METHODS

Between 31 May and 31 July 2001, water samples were gathered weekly at 23 sites on five tributaries in the northern watershed of Otsego Lake (Figure 1). The sites were first established in 1995 (Heavey, 1996) and expanded upon in 1996 (Hewett, 1997). The tributaries include White Creek, Cripple Creek, Hayden Creek, Shadow Brook and the stream that drains Mount Wellington. Best Management Practices that were completed by the end of 2001 monitoring are indicated in Figure 1. Detailed sampling site descriptions are given in Table 1. All sites given have been monitored yearly since at least 1996.

Temperature and dissolved oxygen readings were taken on site using a YSI Model 95 Dissolved Oxygen and Temperature System®. The system was calibrated immediately prior to use and twice in the field following manufacturer's protocol (YSI, 1998). Due to equipment failure temperature and dissolved oxygen measurements were unable to be recorded 25 June. Data from previous years were used to establish baseline readings for conductivity and pH for all sites (Miner, 2001). The water samples collected were analyzed weekly for total phosphorus using the ascorbic acid method following persulfate digestion (APHA, 1992). Due to laboratory error, total phosphorus concentrations were not available for 6 June. Samples were also analyzed bi-weekly for nitrite+nitrate nitrogen using the cadmium reduction method (APHA, 1992).

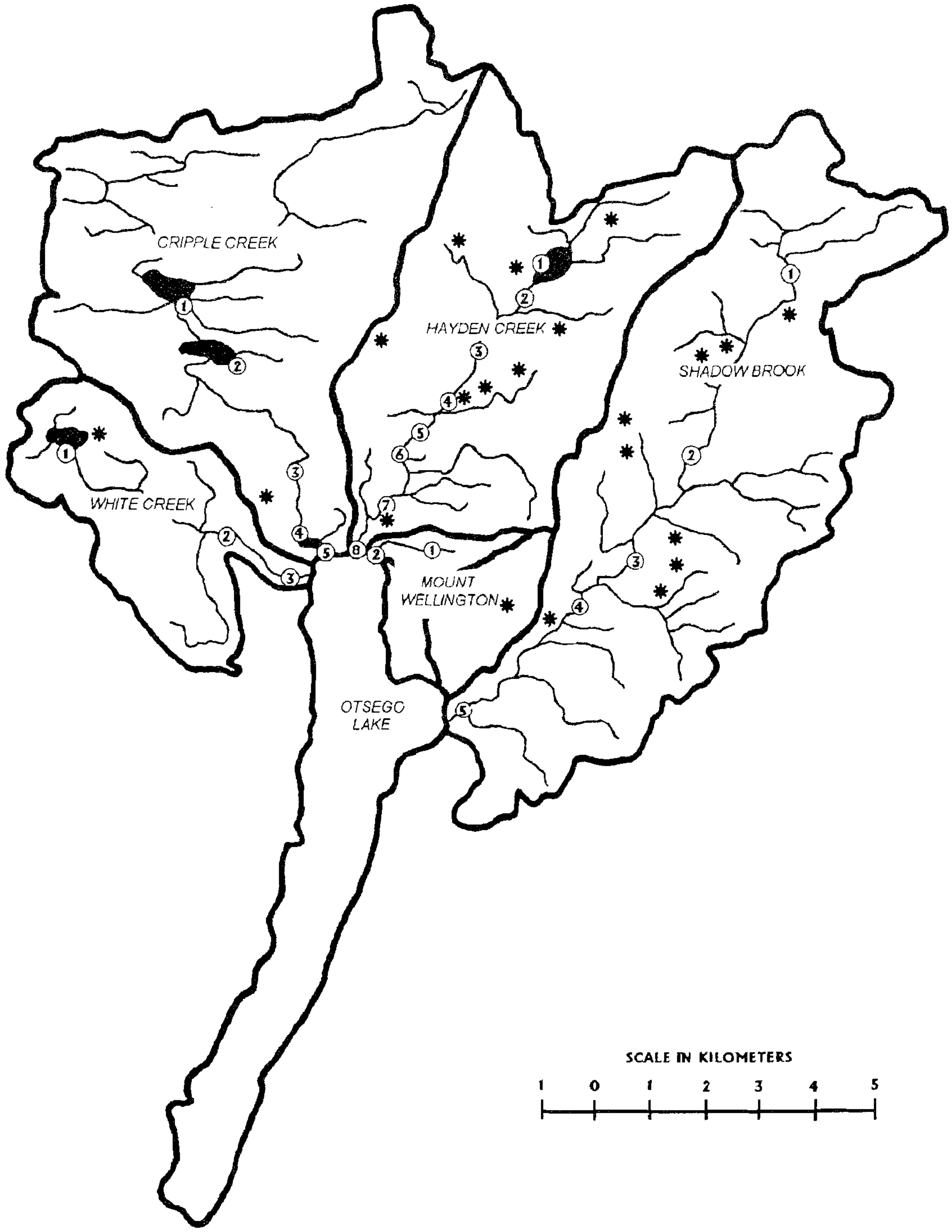

Figure 1. Map of the five monitored tributaries to Otsego Lake showing sampling stations (numbers). Asterisks represent locations of agricultural Best Management Practices completed by summer 2001 (modified from Poulette, 1999).

Table 1. Physical descriptions and coordinates of sites sampled throughout the summer of 2001 (from Poulette, 1999). Sites are seen in Figure 1.

<u>White Creek 1</u>: N 42° 49.646′ W 74° 56.986′
South side of Allen Lake on County Route 26 near outlet to White Creek. This lake is the water supply for the town of Richfield Springs.

<u>White Creek 2</u>: N 42° 48.931′ W 74° 55.303′
North side of culvert on County Route 27 (Allen Lake Road) where there is a large dip in the road.

<u>White Creek 3</u>: N 42° 48.355′ W 74° 54.210′
East side of large stone culvert on Route 80.

<u>Cripple Creek 1</u>: N 42° 48.919′ W 74° 55.666′
Weaver Lake accessed from the north side of Route 20. Water here is slow moving and there is an abundance of organic matter.

<u>Cripple Creek 2</u>: N 42° 50.597′ W 74° 54.933′
Young Lake accessed from the west side of Hoke Road. The water at this site is shallow; some distance from shore is required for sampling.

<u>Cripple Creek 3</u>: N 42° 49.437′ W 74° 53.991′
North side of culvert on Bartlett Road. The water at this location is cold and swift. This site is immediately downstream of an active dairy farm.

<u>Cripple Creek 4</u>: N 42° 48.836′ W 74° 54.037′
Large culvert on the west side of Route 80. The stream widens and slows at this point; this is the inlet to the Clarke Pond.

<u>Cripple Creek 5</u>: N 42° 48.822′ W 74° 53.779′
Dam just south of Clarke Pond accessed from the Otsego Golf Club.

<u>Hayden Creek 1</u>: N 42° 51.658′ W 74° 51.010′
Summit Lake accessed from the east side of Route 80, north of the Route 20 and Route 80 intersection.

<u>Hayden Creek 2</u>: N 42° 51.324′ W 74° 51.294′
North side of culvert on Dominion Road.

<u>Hayden Creek 3</u>: N 42° 50.890′ W 74° 51.796′
Culvert on the east side of Route 80 north of the intersection of Route 80 and Route 20.

<u>Hayden Creek 4</u>: N 42° 50.258′ W 74° 52.144′
North side of large culvert at the intersection of Route 20 and Route 80. This site is adjacent to an active dairy farm.

<u>Hayden Creek 5</u>: N 42° 49.997′ W 74° 52.533′
Immediately below the Shipman Pond spillway on Route 80.

<u>Hayden Creek 6</u>: N 42° 49.669′ W 74° 52.760′
East side of the culvert on Route 80 in the village of Springfield Center.

<u>Hayden Creek 7</u>: N 42° 49.258′ W 74° 53.010′
Large culvert on the south side of County Route 53.

Hayden Creek 8: N 42° 48.874′ W 74° 53.255′
Otsego Golf Club, above the white bridge adjacent to the clubhouse. The water here is stagnant and murky.

Shadow Brook 1: N 42° 51.831′ W 74° 47.731′
Small culvert on County Route 30 south of Swamp Road. Although flow was recorded throughout the summer of 2001, this site has a history of drying up by mid-summer.

Shadow Brook 2: N 42° 49.882′ W 74° 49.058′
Large culvert on the north side of Route 20, west of County Route 31. There is heavy agricultural activity upstream of this site.

Shadow Brook 3: N 42° 48.788′ W 74° 49.852′
Private driveway (Box 2075) leading to a small wooden bridge on a dairy farm.

Shadow Brook 4: N 42° 48.333′ W 74° 50.605′
One lane bridge on Rathbun Road. This site is located on an active dairy farm. The stream bed consists of exposed limestone bedrock.

Shadow Brook 5: N 42° 47.436′ W 74° 51.506′
North side of large culvert on Mill Road behind Glimmerglass State Park.

Mount Wellington 1: N 42° 48.864′ W 74° 52.594′
Stone bridge on Public Landing Road adjacent to an active dairy farm.

Mount Wellington 2: N 42° 48.875′ W 74° 52.987′
Small stone bridge is accessible from a private road off Public Landing Road; at the end of the private road near a white house there is a mowed path which leads to the bridge. Water here is stagnant and murky.

RESULTS AND DISCUSSION

Temperature

Aquatic organisms are directly and indirectly affected by temperature. Many species of aquatic biota are stenothermal and can only tolerate a narrow range of temperature. Temperature is inversely related to dissolved oxygen concentrations, therefore biota can be affected indirectly as well. Data readings for mean temperature this summer ranged from 15.1 C° at WC3 to 23.8 C° at HC1. The mean temperature for all watershed sites is given in Figure 2. Average temperatures for this summer were slightly higher than those recorded in the summer of 2000.

Dissolved Oxygen

An important factor used to determine the health of an aquatic ecosystem is dissolved oxygen. Low levels can indicate increased amounts of organic matter or excessive temperatures. Large amounts of organic matter consume dissolved oxygen during microbial decomposition. The minimum concentration to support most warm water biota is 3 mg/L (Novotny and Olem). However, concentrations should be above 6 mg/L to support a diversity of aquatic biota (Harman et al., 1997). Average dissolved oxygen values ranged 6.38 mg/L at CC1 to 10.50 mg/L at SB3. The mean concentrations for all watershed sites are given in Figure 3. Mean dissolved oxygen

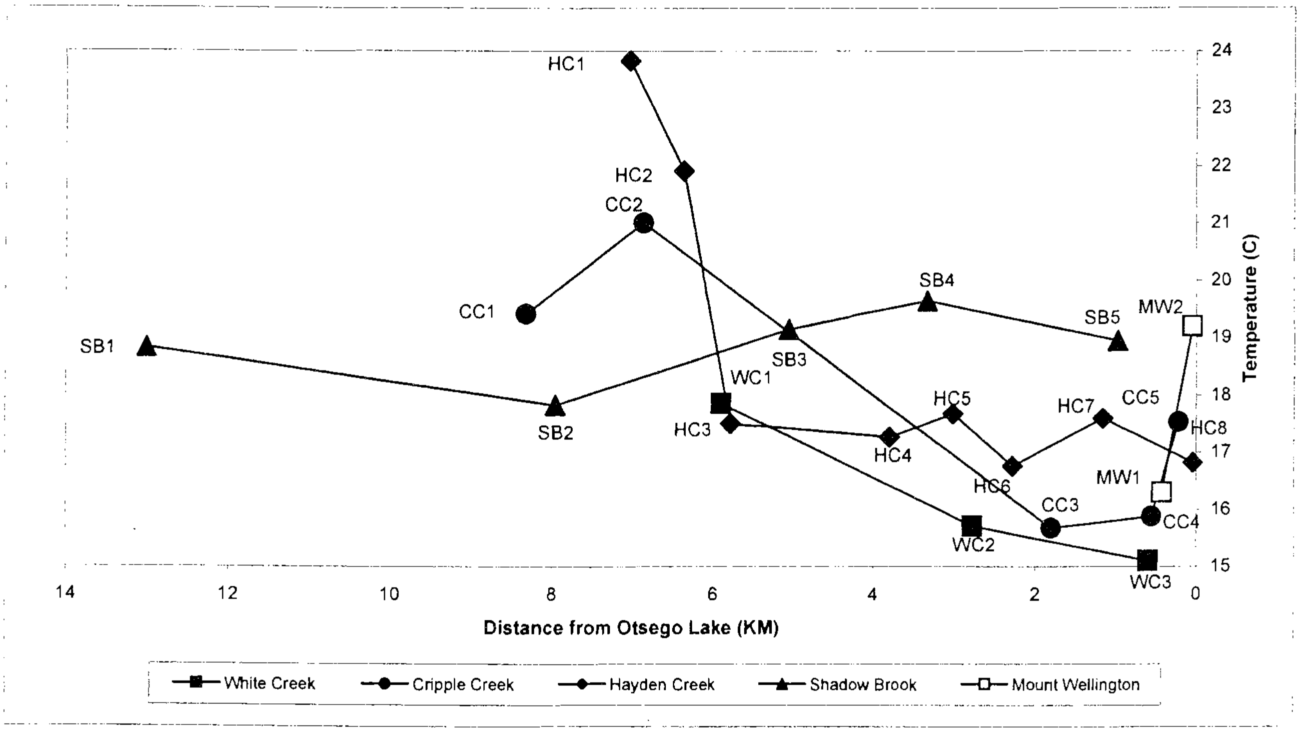

Figure 2. Average temperature (C°) at tributary sites in the Otsego Lake watershed, summer 2001.

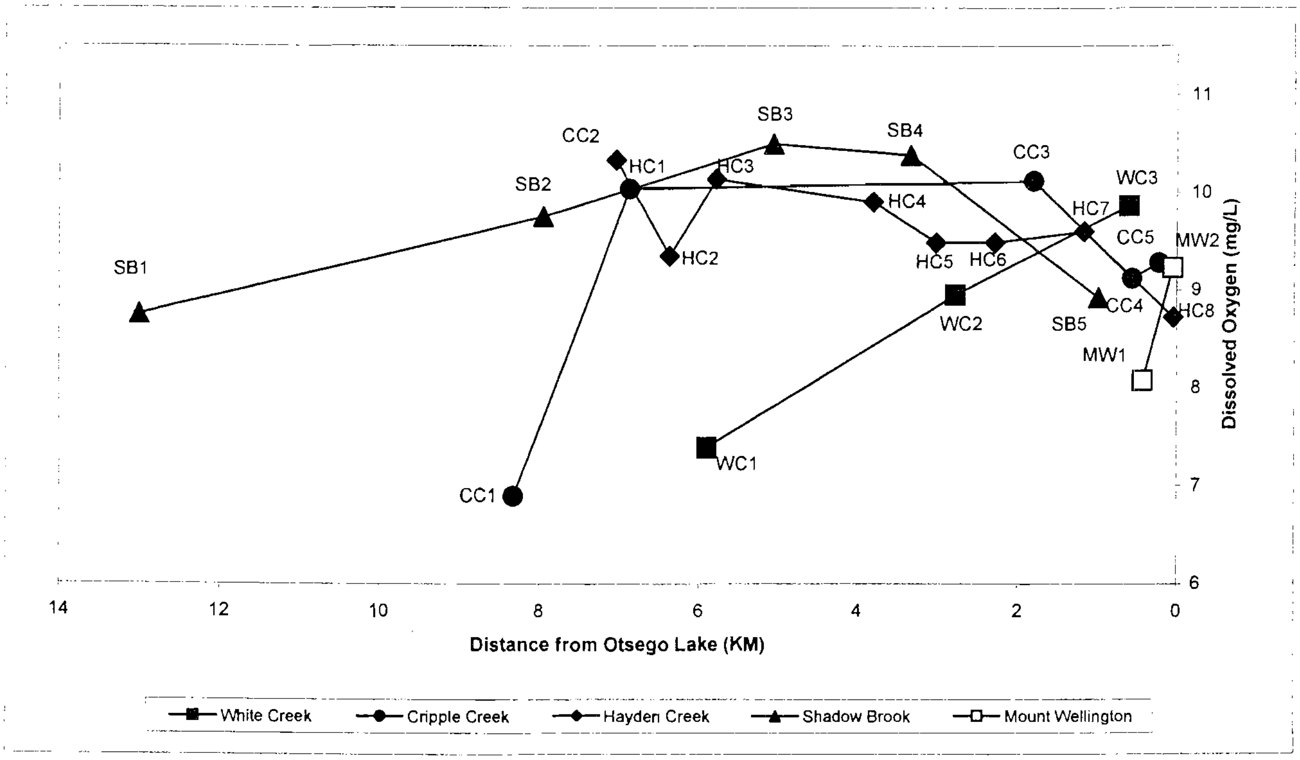

Figure 3. Average dissolved oxygen (mg/l) at tributary sites in the Otsego Lake Watershed, summer 2001.

values were slightly lower for this summer than the ones recorded for the summer of 2000.

Nitrogen

Nitrogen, a nutrient that often is concentrated in agricultural runoff, is one of the nutrients that contribute to eutrophication of the lake. The lowest mean concentration was recorded at CC2 at 0.05 mg/L and the highest mean concentration was 2.00 mg/l at HC7. Average nitrite+nitrate concentrations for all sites are seen in Figure 4. There were increases in nitrogen levels in White Creek, Cripple Creek and Hayden Creek this summer compared to 2000. Nitrogen levels in Shadow Brook decreased slightly from last year's and in Mount Wellington they remained approximately the same compared to 2000.

Phosphorus

The United States consumes twenty-five percent of the world's phosphorus. Seventy-six percent of the phosphorus we consume is used in agricultural fertilizers (Kramer, 1972). Otsego Lake's productivity is limited by phosphorus (Harman et al., 1997). The use of agricultural fertilizers, including nutrient recycling through manure applications, and possibly septic leachate, has presumably increased nutrient loading to the lake. Phosphorus is the single most important nutrient to mange in order to control accelerated etrophication in freshwater lakes (Daniel, 1994). Average phosphorus concentrations ranged from 16.8 *u*g/L at HC2 to 192.4 *u*g/L at MW2, which consistently had the highest concentration of any site monitored. Mean total phosphorus values for all sites are shown in Figure 5. Total phosphorus levels in White Creek and Mount Wellington both increased compared to last year, while levels at Cripple Creek, Hayden Creek and Shadow Brook showed no overall increase or decrease, but only fluctuations in individual site concentrations.

CONCLUSION

Monitoring of the five major tributaries to Otsego Lake since 1991 has shown overall improvement of water. However, results did not show an improvement in water quality since the summer of 2000. This year is the last year of the Environmental Quality Incentive Program; therefore no new BMPs in the watershed are currently scheduled. There was one barnyard improvement project added to the Mount Wellington drainage basin last spring, but nutrient levels continue to be high despite the new development. The small tributary's contribution to the lake is negligible compared to the other tributaries in the watershed. Hayden Creek has ten BMPs in its basin, the most in the watershed. Nitrite+nitrate levels in this creek have increased since last summer.

Figure 6 shows total phosphorus at the stream outlets for the years 1991, 1992 and 1995-2001 where available.

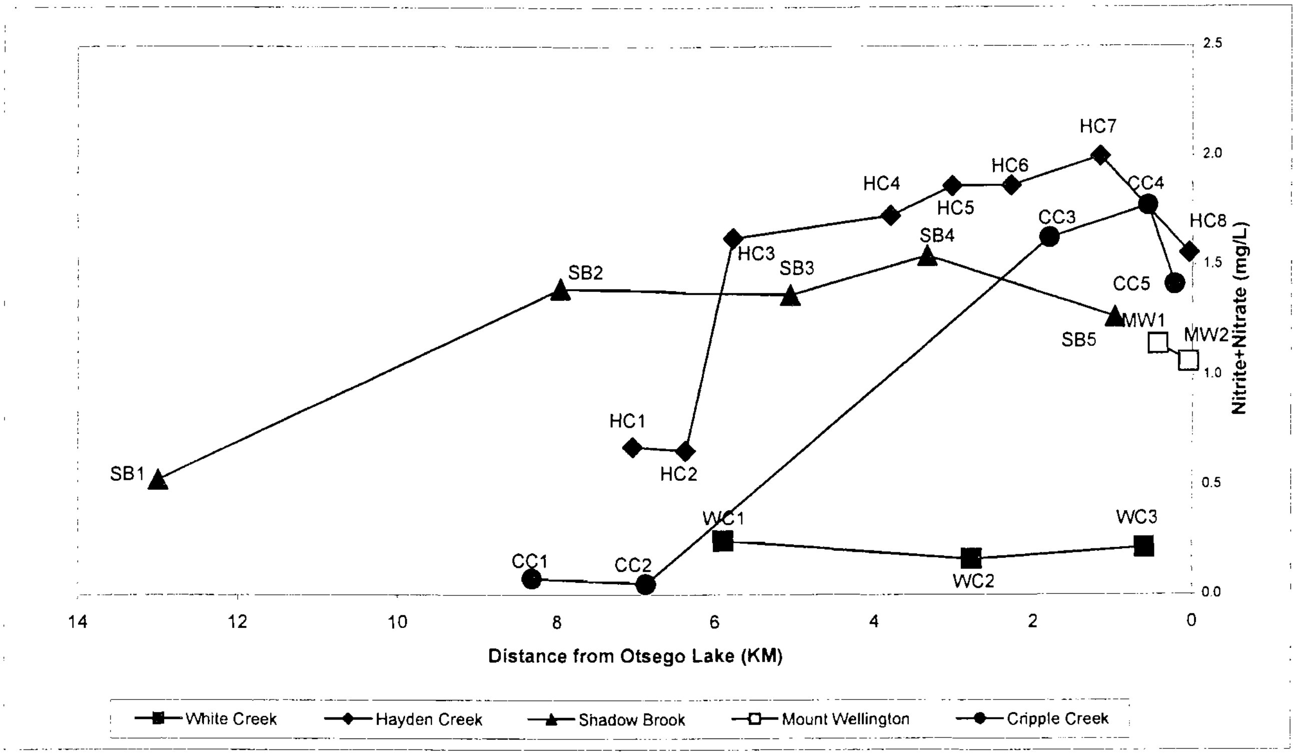

Figure 4. Average nitrite+nitrate (mg/l) at tributary sites in the Otsego Lake watershed, summer 2001.

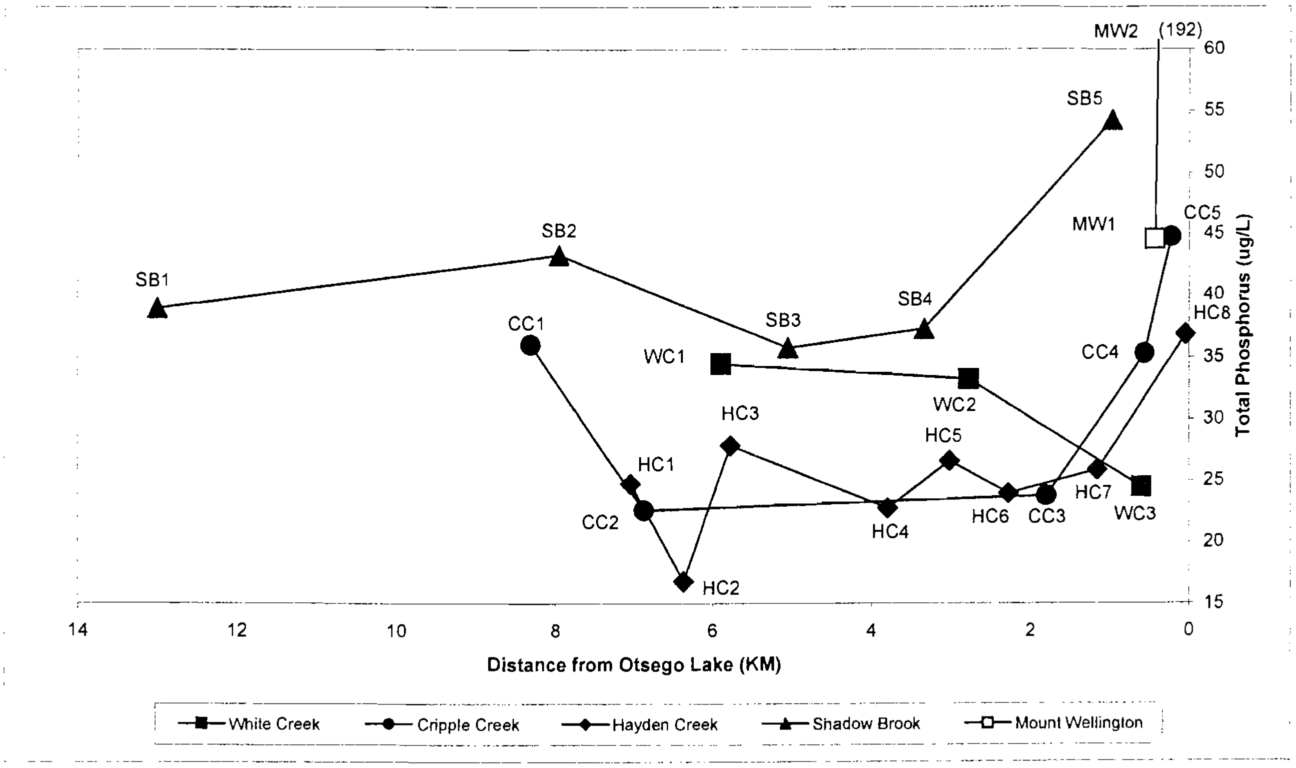

Figure 5. Average total phosphorus (u g/l) at tributary sites in the Otsego Lake watershed, summer 2001.

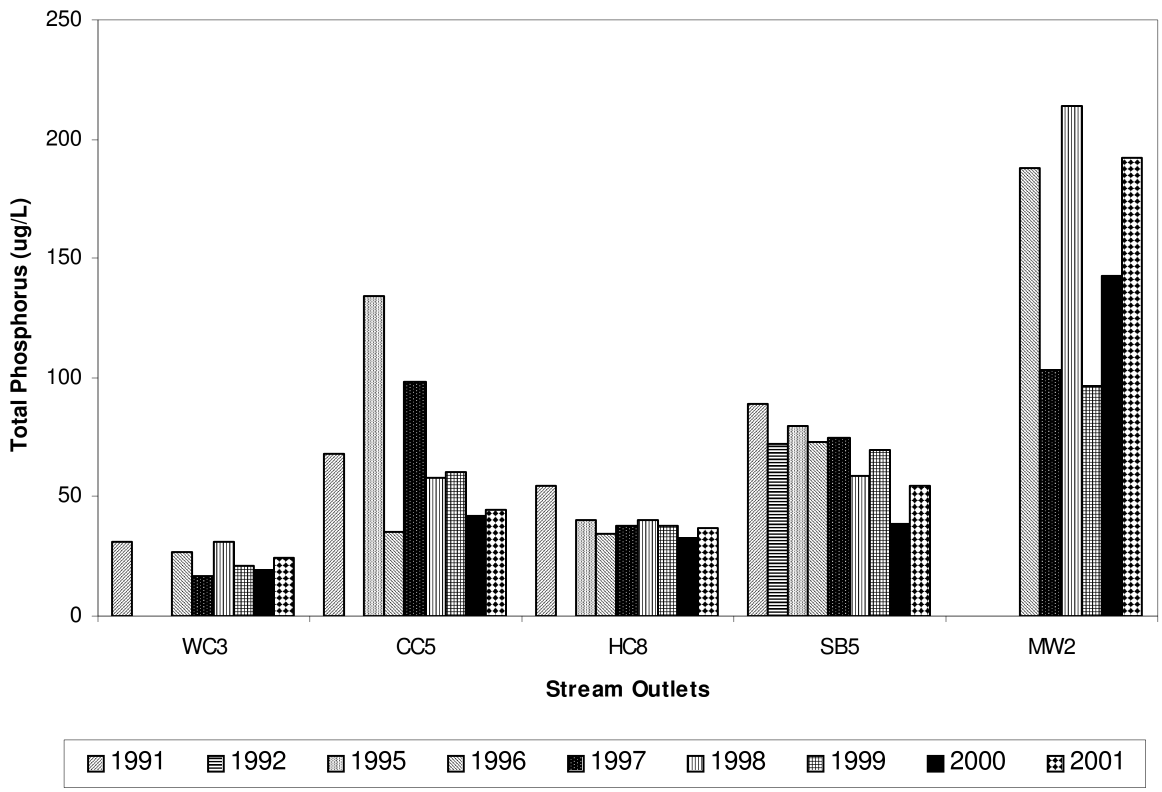

Figure 6. Mean total phosphorus concentrations at the stream outlets of each tributary monitored, summers of 1991, 92 and 95-01 (modified from Poulette, 1999).

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