

Water quality monitoring of five major tributaries in the Otsego Lake watershed, summer 2003

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INTRODUCTION

The Biological Field Station has documented increased rates of eutrophication in Otsego Lake in recent years (Harman et al. 1997; Albright 1998; 1999; 2000; 2001; 2002). Nutrient enrichment is thought to be the main cause of such eutrophication through the stimulation of algal growth resulting in decreased water clarity and deep-water dissolved oxygen concentrations. Such changes in lake dynamics negatively impact the biota of the lake, reduce the recreational value of the lake, and reduce the ability of the water body to function as a potable municipal water supply.

Lake quality is a reflection of the water flowing off of the contributing land area, and a function of the land uses employed upon those lands (Albright 1996). Although the highest rates of nutrient export to Otsego Lake flow from waters associated with an urbanized basin (Albright 1996), the area is small and the nutrient volumes are relatively low. Changes in winter road management in that basin have, in part, addressed that concern (Albright in press). In contrast to this situation is that of the northern portion of the watershed, where the agriculture is the predominant land use. Actively farmed drainage basins generally have intermediate export rates, yet because agriculture accounts for nearly half of the watershed's land use, the nutrient load contributed is significant. Such nutrients from agricultural fertilizers and livestock waste have been identified in the United States as the primary cause of anthropogenic eutrophication in freshwater inland lakes, such as Otsego (Daniel 1994).

Due to the degradation of water quality resulting from nutrient loading, the USDA Natural Resources Conservation Service (NRCS) has directed a great deal of its effort toward addressing nutrient and sediment runoff from farms through the implementation of Best Management Practices (BMPs). Much of the funding for these improvement programs has come from the Environmental Quality Incentive Program (EQIP), which was established under the 1996 Farm Bill with the directive of assisting crop and livestock producers in dealing with environmental and conservation improvements on the farm (USDA 1996). Funds obtained through EQIP were matched by the Otsego County Conservation Association (otherwise the responsibility of the landowner) which have provided for the establishment of 22 BMP sites throughout the northern watershed at a total cost of \$383,000 (Figure 1) (Pullano 2000). Best Management Practices are a set of guidelines and methods suggested by the USDA-NRCS to control non-point source pollution that can be tailored to individual situations and needs. Suggested agricultural BMPs include conservation tillage, contour strip-cropping, sediment

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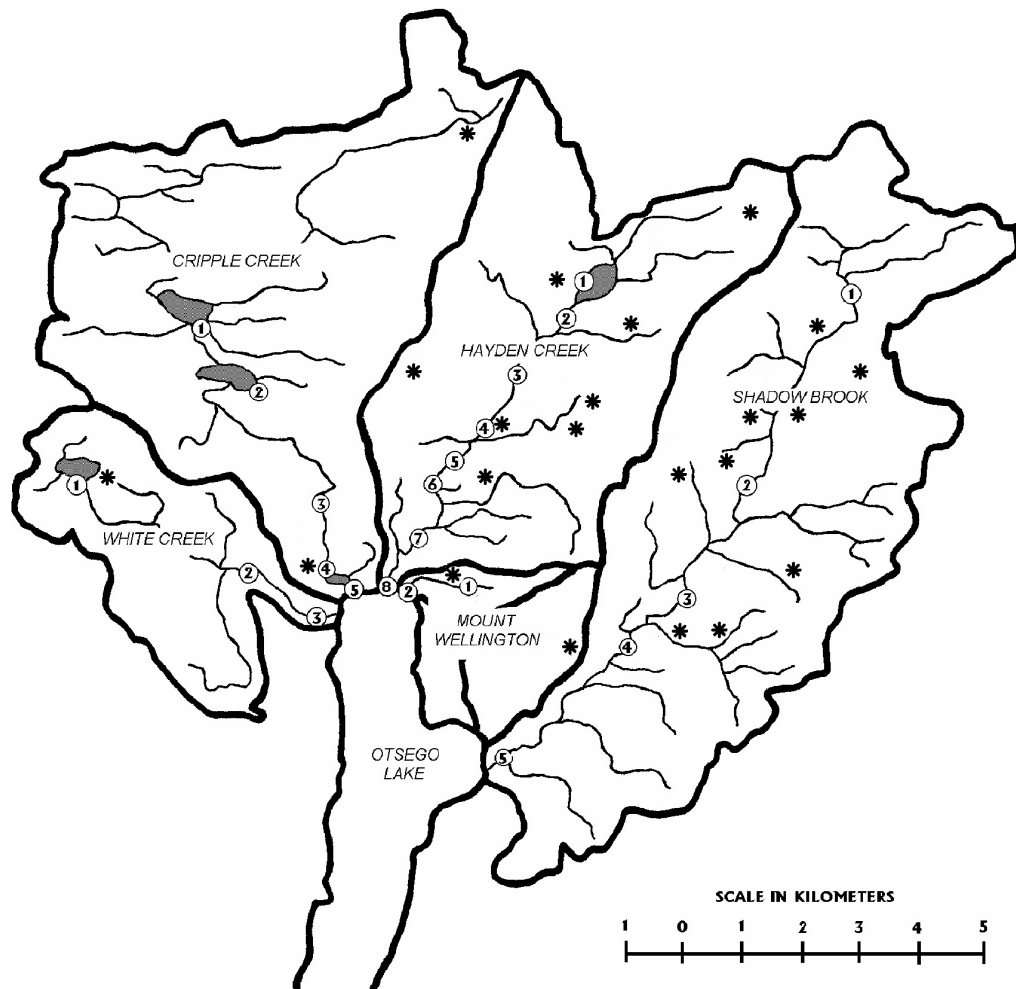


Figure 1. Map of the monitored tributaries showing the sampling stations (numbered) and locations of agricultural BMPs (asterisks) completed by summer 2003 (Pullano 2004).

retention ponds, alternative drinking sources for livestock, streambank fencing, cattle crossings over streams and manure storage facilities (EPA 2001).

The northern watershed of Otsego Lake consists of five drainage basins that include White Creek, Cripple Creek, Hayden Creek, Shadow Brook and a small stream that drains Mount Wellington. This study aims to evaluate that effectiveness of the Best Management Practices located in these stream basins via the measurement of nutrient contributions in the form of nitrate+nitrite nitrogen and phosphorous concentrations, dissolved oxygen and temperature along designated sections of each tributary. Similar data have been collected during the summers of 1995 (Heavy 1996), 1996 (Hewett 1997), 1997 (Miller 1998), 1998 (Poulette 1999), 1999 (Collins and Albright 2000), 2000 (Miner 2001), 2001 (Parker 2002) and 2002 (Meehan 2003). In addition to these studies, a precipitation-based study is currently underway to evaluate variations in nutrient flows and dynamics in the Shadow Brook drainage basin (Albright 2004).

That particular basin contains the greatest amount of acreage used for agricultural practices in the watershed (Harman et al. 1997) and has had BMPs implemented on it for the greatest length of time.

METHODS

Water samples were collected weekly at 23 sites on five tributaries in the northern watershed of Otsego Lake (Figure 1) between 20 May and 22 July 2003. The sites were established by Heavy in 1995 (1996) and expanded in 1996 by Hewett (1997). Best Management Practices that were completed by the conclusion of the 2003 monitoring period are indicated in Figure 1. Detailed sampling site descriptions are provided in Table 1.

Temperature and dissolved oxygen readings were taken on site using a YSI Model 95 Dissolved Oxygen and Temperature System[®]. The system was calibrated directly before use and two or more times in the field, as per the manufacturer's protocol (YSI 1998). Water samples were collected and analyzed weekly for total phosphorus using the ascorbic acid method following persulfate digestion (APHA 1992) and bi-weekly for nitrate+nitrite nitrogen using the cadmium reduction method (APHA 1992).

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.

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

<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.
<u>Hayden Creek 8:</u>	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.
<u>Shadow Brook 1:</u>	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.
<u>Shadow Brook 2:</u>	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.
<u>Shadow Brook 3:</u>	N 42° 48.788'	W 74° 49.852'	Private driveway (Box 2075) leading to a small wooden bridge on a dairy farm.
<u>Shadow Brook 4:</u>	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.
<u>Shadow Brook 5:</u>	N 42° 47.436'	W 74° 51.506'	North side of large culvert on Mill Road behind Glimmerglass State Park.
<u>Mount Wellington 1:</u>	N 42° 48.864'	W 74° 52.594'	Stone bridge on Public Landing Road adjacent to an active dairy farm.
<u>Mount Wellington 2:</u>	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

Water temperature affects aquatic organisms both directly and indirectly. Many species of aquatic biota are stenothermal and can tolerate only a narrow range in temperature. Temperature is inversely related to dissolved oxygen concentrations, thus having an indirect affect on the biota as well. Mean temperatures ranged from 14.39°C at CC3 to 21.95°C at HC1. These minimum and maximum averages are slightly lower than those observed in the summer of 2002 (Meehan 2003), likely as a result of the monitoring period beginning two weeks earlier, and the summer in general being slightly cooler. The mean temperature for all watershed sites is given in Figure 2.

Dissolved Oxygen

Aquatic ecosystem health is determined in part through the amount of dissolved oxygen concentrations in the waters. Low concentrations 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 1994), though concentrations should be greater than 6 mg/L in order to support a diversity of aquatic biota, including species of the cold water fishery (Harman et al. 1997). Average dissolved oxygen values ranged from 6.03 mg/L at CC1 to 11.04 mg/L at SB4 (Figure 3). Mean dissolved oxygen concentrations were slightly higher for this summer than those recorded for the summer of 2002, perhaps due to the lower average temperatures observed throughout the watershed.

Nitrogen

Nitrogen is a nutrient that is often concentrated in agricultural runoff and is also a key contributor to lake eutrophication. The concentrations determined ranged from 0.18 mg/L at CC1 to 2.70 mg/L at MW2. The average nitrate+nitrite concentrations for all sites are seen in Figure 4. The mean concentrations determined for most sites were very similar to those obtained in the summer of 2002, though six sites showed increases in mean concentrations from those determined in between June and August of 2002. The most dramatic decrease in mean nitrate+nitrite concentrations occurred at HC8, going from 2.09 ug/L in 2002 to 1.62 ug/L in 2003. One would hope such decreasing trends are indicative of positive effects of management practices on water quality, though years of data are required in order to account for yearly variations that may be a function of precipitation and varying farm activities. Levels in the Mount Wellington drainage have shown increases despite the implementation of management practices in the spring of 2000 (Parker 2002).

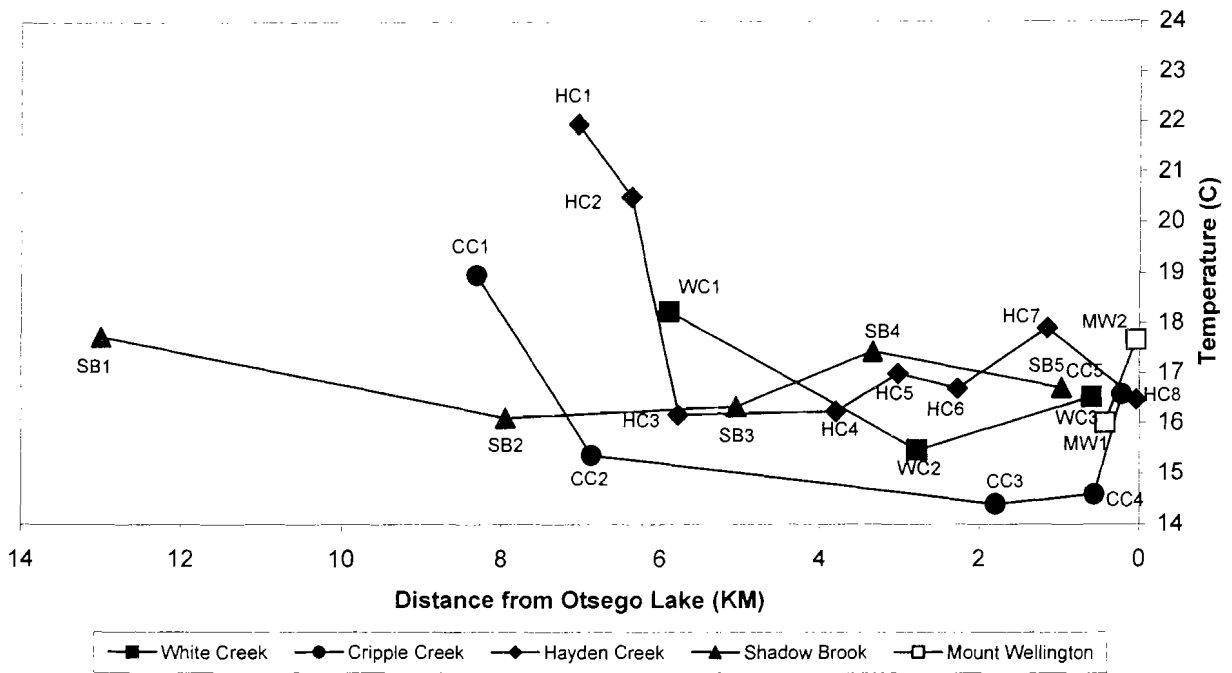


Figure 2. Average temperature (C°) at tributary sites in the Otsego Lake watershed, summer 2003.

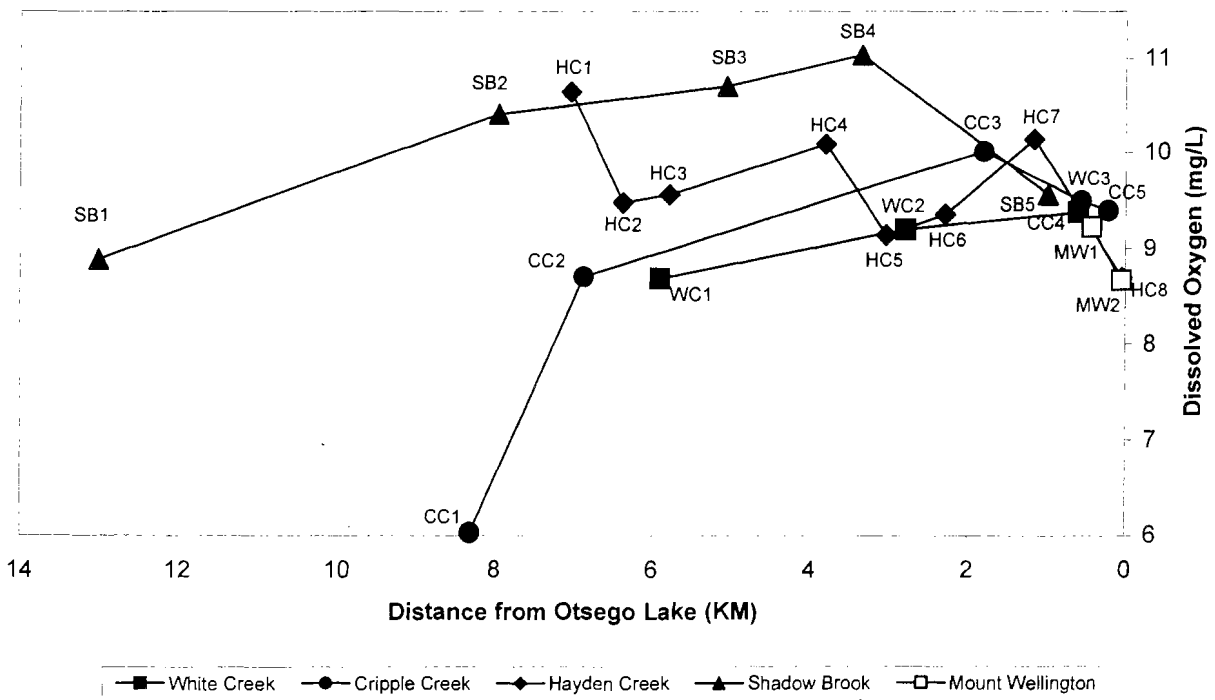


Figure 3. Average dissolved oxygen (mg/l) at tributary sites in the Otsego Lake Watershed, summer 2003.

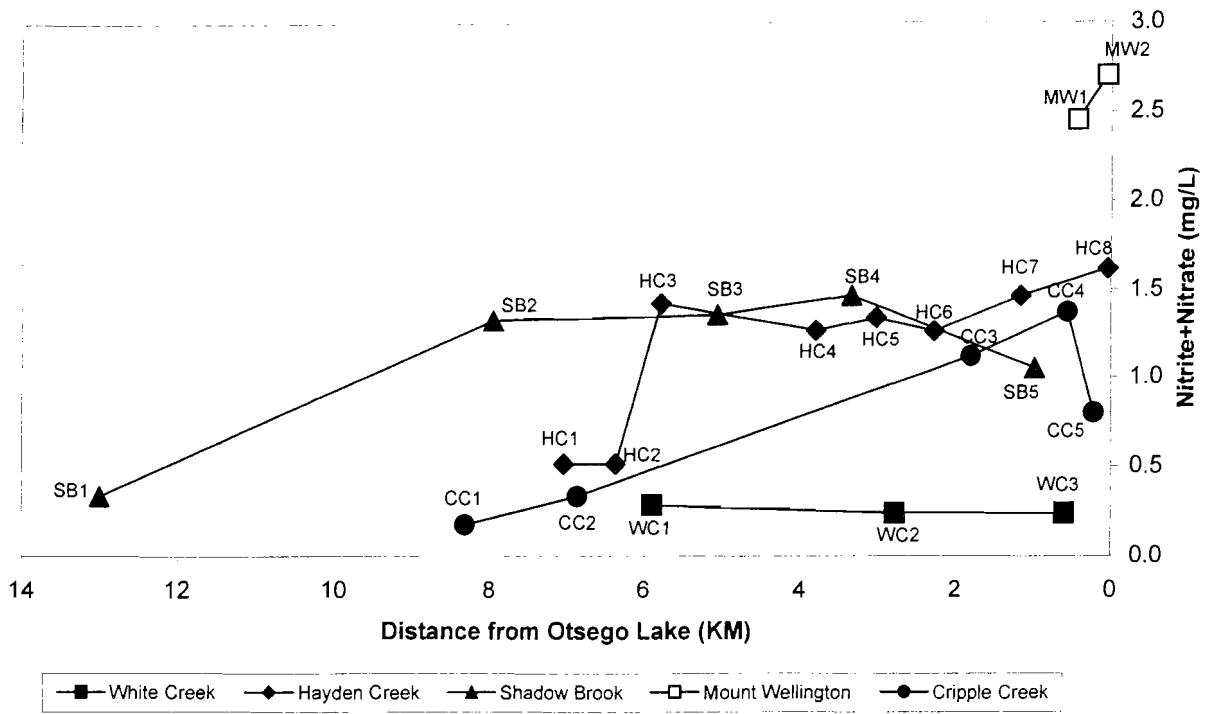


Figure 4. Average nitrite+nitrate (mg/l) at tributary sites in the Otsego Lake watershed, summer 2003.

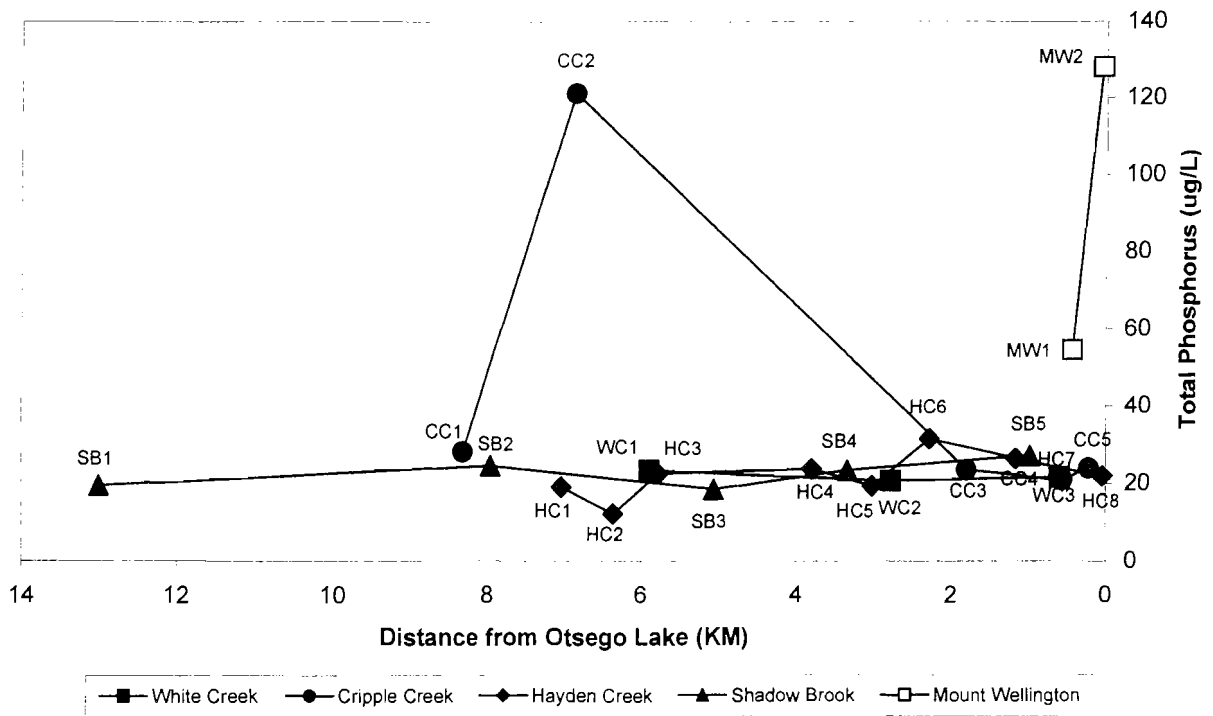


Figure 5. Average total phosphorus (ug/l) at tributary sites in the Otsego Lake watershed, summer 2003.

Phosphorus

The productivity of Otsego Lake is limited by phosphorus (Harman et al. 1997). Nutrient loading to the lake has increased most likely through the use of agricultural fertilizers, including nutrient recycling via manure applications, and quite possibly septic leachate (Meehan 2004). Phosphorus is the single most important nutrient to manage in order to control accelerated eutrophication in freshwater lakes (Daniel 1994). Mean phosphorus concentrations ranged from 12.2 ug/L at HC2 to 121.11 ug/L at CC2, with results varying from last year across the majority of sites. The greatest increase and decrease in determined total phosphorus came at CC1 and CC2 respectively. Mean total phosphorus concentrations at the outlets of Cripple Creek, Hayden Creek, and Shadow Brook decreased from 2002, while those at White Creek and Mount Wellington showed increases from the summer of 2002 (Figure 6).

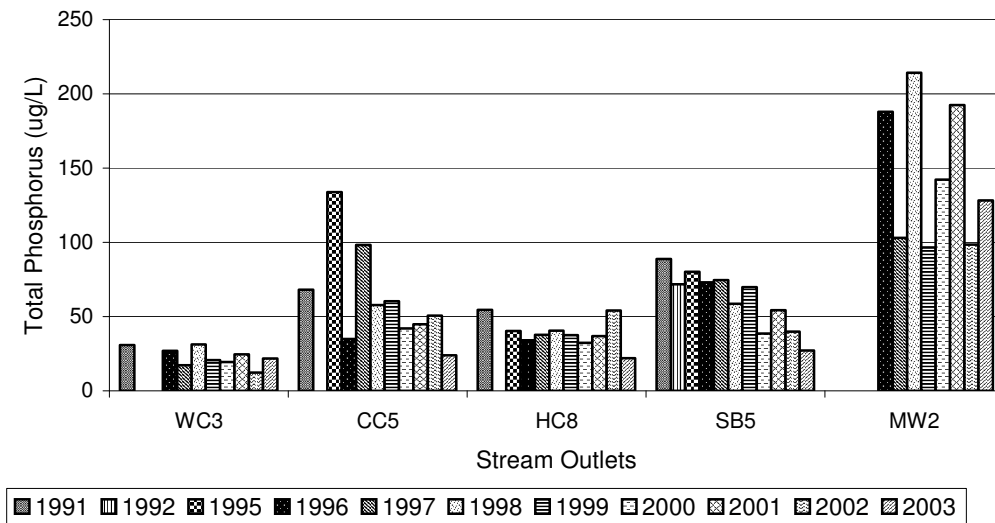


Figure 6. Mean total phosphorus concentrations at the stream outlets of each tributary monitored, summers of 1991, '92, and '95-'03 (modified from Poulette, 1999).

CONCLUSIONS

Water quality across the five major tributaries has shown general improvement since monitoring began in 1991, with continued improvement at the outlets of three of the five streams. No new BMPs have been implemented in the watershed, as EQIP ended in the summer of 2001 (Parker 2002). Hayden Creek has ten BMPs in its basin, the most in the watershed. Nitrite+nitrate levels in this creek have shown a slight decreasing trend, though levels at HC5 have increased since last summer.

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