

# Water quality monitoring of five major tributaries in the Otsego Lake watershed, summer 2006

Caitlin M. Snyder<sup>1</sup>

## INTRODUCTION

Limnological monitoring of Otsego Lake in recent years has been focused around increasing eutrophication rates (Harman et al. 1997; Albright 1998; 1999; 2000; 2001; 2002). Although classified as a chemically mesotrophic lake with flora and fauna characteristically associated with oligotrophic lakes (Iannuzzi 1991), some indicators have suggested a move toward more eutrophic conditions. Eutrophication, or the process by which bodies of water experience enhanced plant growth as a result of excess nutrients, can often create detrimental effects upon the organisms within or near the water (USGS 2006). Increased eutrophication rates in Otsego Lake are attributed to dissolved nutrient loading from manmade sources such as lake front septic systems (Meehan 2004a), agricultural runoff (Murray and Leonard 2005), and residential land use (Albright 2005a). Nutrient influxes can generate algal blooms that ultimately lead to decreases in water clarity and deep-water dissolved oxygen levels. Consequently, aquatic organism diversity, recreational potential (boating and fishing), and aesthetic appeal of the lake can diminish as water quality declines. Additionally, Otsego Lake provides drinking water to the Village of Cooperstown and lakeside residents. Increased algal concentrations play an increasing role in the color, taste, and odor of the drinking water.

The northern portion of the Otsego Lake watershed consists of five major drainage basins that include: White Creek, Cripple Creek, Hayden Creek, Shadow Brook, and a small tributary that drains Mt. Wellington. Nearly 48 percent of the land occupying these drainage basins is used for agricultural purposes, making it the predominant land use (Harman et al. 1997). Actively farmed drainage basins have the potential to have increased nutrient export rates (Reynolds 2006). Since agriculture makes up nearly half of the watershed land use, excessive nutrient loading deriving from livestock wastes and agricultural fertilizers is apt to be considerable. Other potential sources of nutrients include urban runoff on roads, septic seepage, and golf course and residential lawn care fertilizers.

As part of recent efforts to help reduce nutrient loading from agricultural sources and lessen eutrophication of lakes, the USDA Natural Resources Conservation Service (NRCS) has developed a series of guidelines and techniques, or Best Management Practices (BMPs). These environmental management strategies were designed in order to help control pollution associated with construction, forestry, and agriculture (EPA 2006). Efforts have focused on soil erosion, waste management and storage, management of livestock yards, and pesticide and fertilizer usage. Current projects, such as riparian zone management, aim to minimize livestock wastes and erosion in streams by installing fences, gravel pads at crossings, and restoring bank vegetation (NRCS 2006). Thus,

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<sup>1</sup> Rufus J. Thayer Otsego Lake Research Assistant, summer 2006. Present affiliation: Cazenovia College.

riparian zones act as a buffer between potentially detrimental human activities and surface water, while also offering flood protection and habitat for wildlife. Irrigation management has been centered on soil moisture monitoring and water conservation practices. Through livestock grazing and field and crop rotation, soils can be protected against erosion and seasonally replenished with nutrients and moisture. Some Best Management Practices deal with pest control practices. By applying adequate amounts and types of pesticides to the appropriate crops and pests, complications with non-target casualties and over spraying can be significantly reduced. Today there are many alternatives to hazardous pesticides. On top of low toxicity pesticides, biocontrol methods include: introduction of natural predators, crop rotation, and genetically resistant plants (NRCS 2006).

Twenty three sites throughout Otsego's northern watershed are being monitored in order to assess the effectiveness of BMPs in reducing nutrient loading to Otsego Lake. Figure 1 indicates those sampling sites (numbers) as well as the BMPs established to date (asterisks). To date, 22 agricultural projects have been completed in the northern watershed, most by the NRCS, with local cost shares provided by the Otsego County Conservation Association. By analyzing total nitrogen, nitrate+nitrite nitrogen, ammonia, total phosphorus, temperature and dissolved oxygen, the health of these waterways can be evaluated, as can the effectiveness of these projects which are indeed to reduce nutrient influxes into Otsego Lake. Similar data have been collected in 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), 2002 (Meehan 2003), 2003 (Meehan 2004), 2004 (Murray and Leonard 2005), and 2005 (Reynolds 2006).

## MATERIALS & METHODS

The northern region of Otsego Lake's watershed consists of five tributaries (Figure 1). Water quality readings and samples were taken on a weekly basis at 23 sites on these tributaries between 31 May and 8 August, 2006, except for site at Hayden Creek 7. Sampling there was terminated on 27 June 2006 because access was denied by the land owner. The sites were originally established by Heavy in 1995 (1996) and expanded upon in 1996 by Hewett (1997). Best Management Practices that were completed to date are indicated in Figure 1. Detailed sampling site descriptions are provided in Table 1.

Temperature, dissolved oxygen, conductivity, and pH readings were recorded at each site using a Hydrolab Scout 2<sup>®</sup> or a Eureka Amphibian<sup>®</sup> multiprobe. The systems were calibrated directly before use as per the manufacturer's protocol. Water samples (approximately 125ml) were collected at each site and analyzed weekly for total phosphorus using the ascorbic acid method following persulfate digestion (Liao and Marten 2001), total nitrogen using the cadmium reduction method (Pritzlaff 2003) following peroxodisulfate digestion as described by Ebina et. al (1983), ammonia using the phenolate method (Liao 2001), and for nitrate+nitrite nitrogen using the cadmium

reduction method (Pritzlaff 2003). All of these parameters were analyzed using a Lachat QuikChem FIA+ Water Analyser<sup>®</sup>.

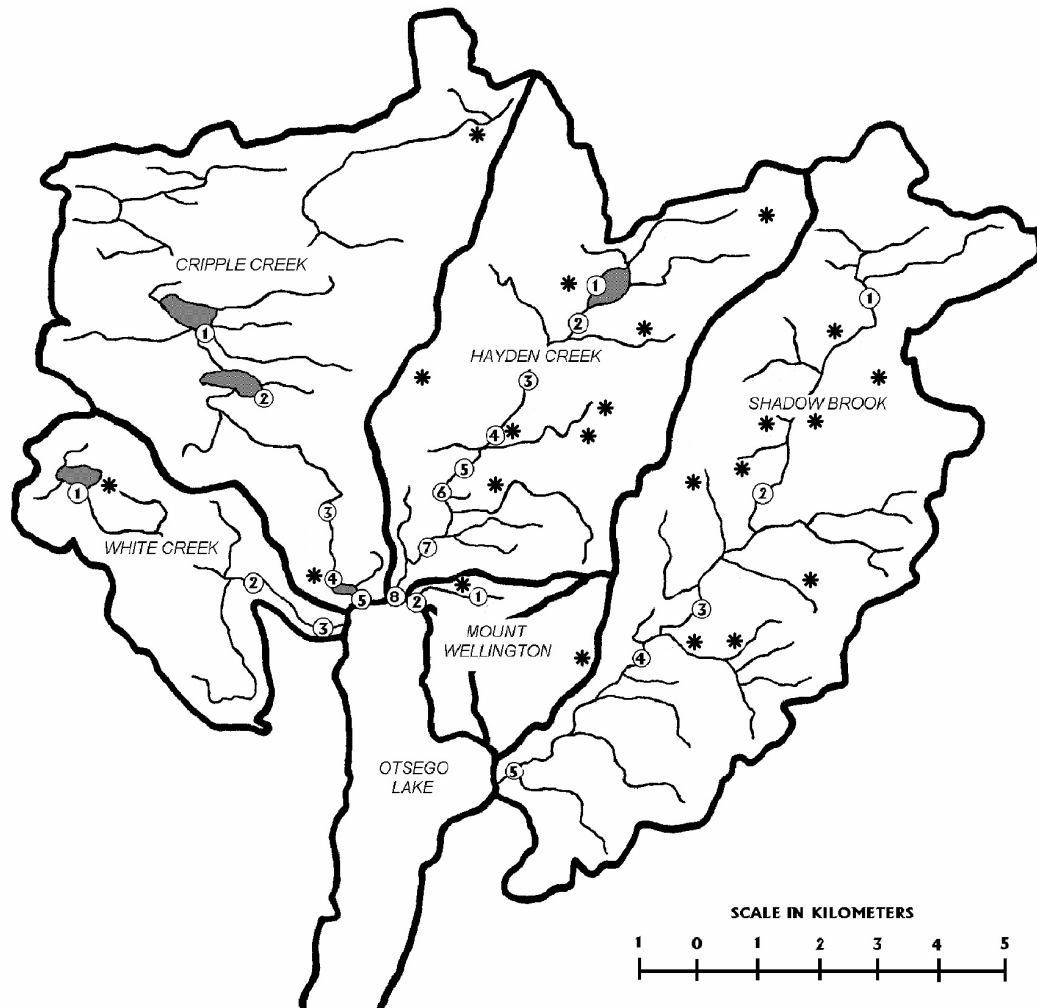


Figure 1. Map of monitored tributaries showing sampling sites (numbered) and locations of agricultural BMPs (asterisks).

Table 1: Descriptions and locations of sampling sites visited weekly from 31 May and 1 August 2006 (modified from Reynolds 2006). Sites can be 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. Major flooding in late June 2006 exposed a large drainage pipe. This lake is the water supply for the town of Richfield Springs.		
<u>White Creek 2:</u>	N 42° 48.93'	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.		

Table 1(cont.) Locations and descriptions of sampling sites visited weekly from 31 May and 1 August 2006 (modified from Reynolds 2006). Sites can be seen in Figure 1.

<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 side 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 west side of Route 80. The stream widens and slows at this point; this is the inlet to 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. A fence was installed during the first week of July 2004, deepening the sampling site slightly. This fence has since been removed.
<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 20 and Route 80.
<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. Note: Data and samples only taken at this location from 31 May to 27 June, 2006.
<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 slow moving 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.

Table 1(cont.) Locations and descriptions of sampling sites visited weekly from 31 May and 1 August 2006 (modified from Reynolds 2006). Sites can be seen in Figure 1.

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. Despite flow being present in previous years, this site was dry several times through the summer of 2006.

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 Rathburn 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 & DISCUSSION

### Temperature

Water temperature is a critical factor within freshwater environments, both in determining water quality, as well as aquatic flora and fauna diversity. Temperature is also inversely related to dissolved oxygen concentrations, thus colder waters typically retain higher amounts of dissolved oxygen. Individual species of both plant and animal have different ideal water conditions that are most efficient for obtaining energy, respiration processes, and reproduction. Mean temperatures ranged from 13.46°C at HC7 to 24.33°C at CC2. Compared to 2005, with a mean low of 17.89°C and a mean high of 26.89°C (Figure 2) (Reynolds 2006), this year's temperatures have been generally cooler. This decrease could be a result of low temperatures and high amounts of rainfall throughout the 2006 monitoring period. The mean temperatures for all watershed sites are given in Figure 2.

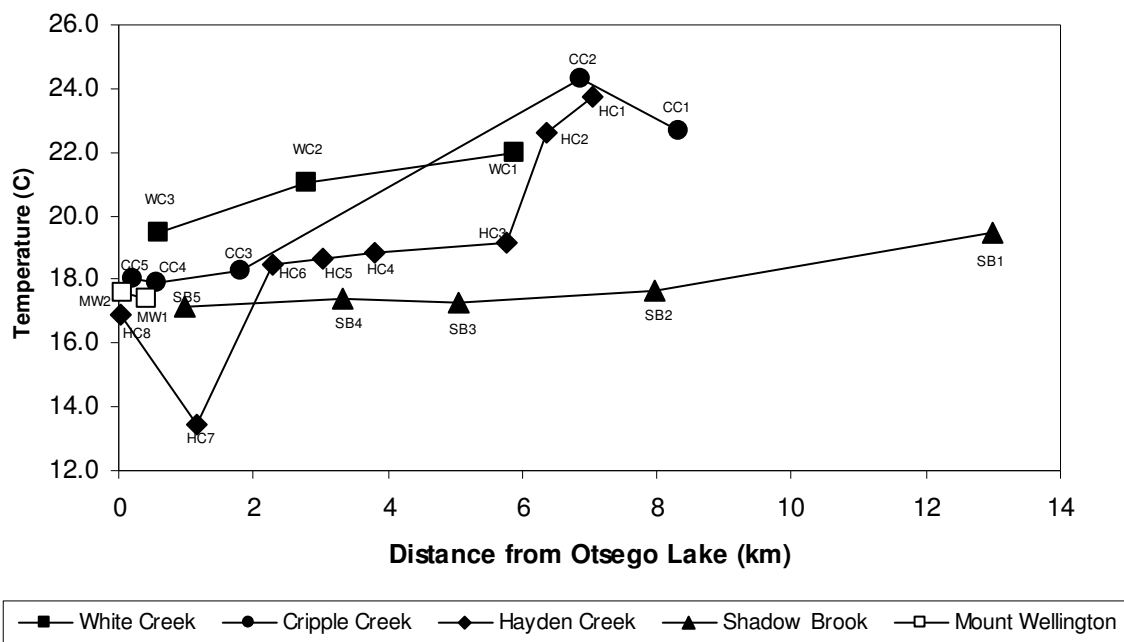


Figure 2. Average Temperature (°C) at tributary sites in the Otsego Lake watershed, summer 2006.

### Dissolved Oxygen

A major indicator of the health of an ecosystem is dissolved oxygen. Low concentrations can indicate increased amounts of organic matter or excessive temperatures (Meehan 2003). In order to support most warm water biota, dissolved oxygen can have a minimum concentration of 3 mg/l (Novotny and Olem 1994). Average dissolved oxygen concentrations ranged from 5.6 mg/l at CC1 to 10.63 mg/l at HC2 (Figure 3). The low mean concentration is comparable to last year, though the high mean concentration has increased slightly. This increase can be attributed to lower mean temperatures observed this monitoring period. The mean dissolved oxygen concentrations for all watershed sites are given in Figure 3.

### Total Phosphorus

The productivity of Otsego Lake is limited by phosphorus (Harman et al. 1997). Significant sources of phosphorus within lakes can be attributed to livestock wastes and agricultural fertilizers, as well as residential septic. In order to maintain oligotrophic conditions, total phosphorus levels should be maintained between 5 and 10 ug/l (Lampert and Sommer 1997). The lowest mean concentrations were found at WC1 with 17.5 ug/l, while the highest mean concentrations were at HC8 with 88.5 ug/L (Figure 4). Contrasted with summer 2005 monitoring, total phosphorus levels have decreased moderately. Mean concentrations from last year ranged from a low of 27.7 ug/l to a high of 147.3 ug/l (Reynolds 2006). Total phosphorus concentrations from the sites nearest the tributary mouths are given in Figure 5.

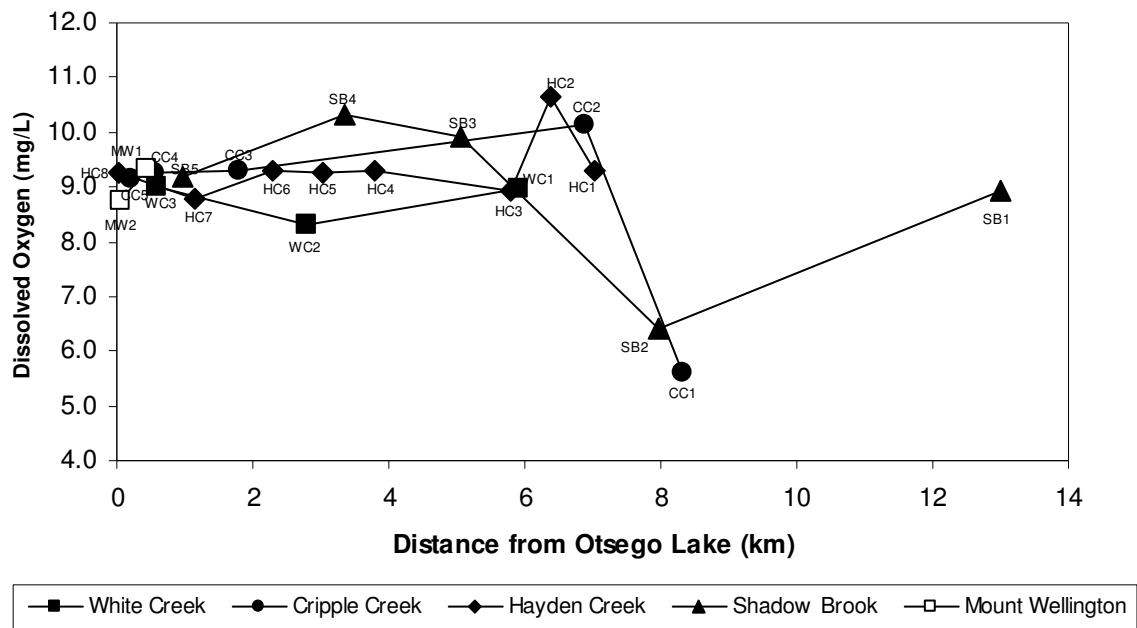


Figure 3. Average dissolved oxygen concentrations (mg/l) at tributary sites in the Otsego Lake watershed, summer 2006.

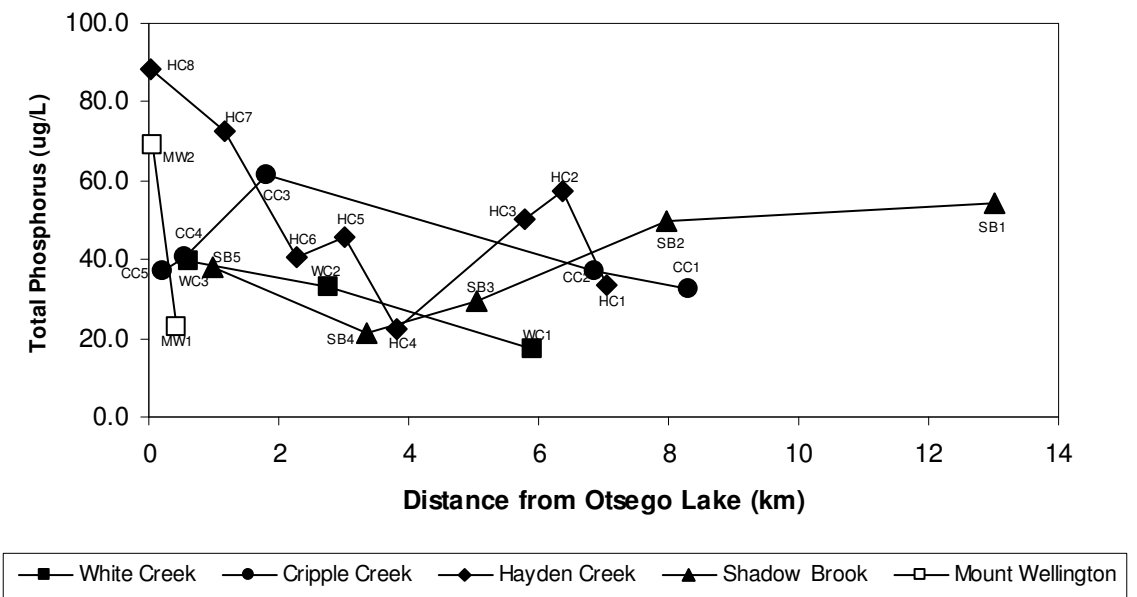


Figure 4. Average total phosphorus concentrations (ug/l) at tributary sites in the Otsego Lake watershed, summer 2006.

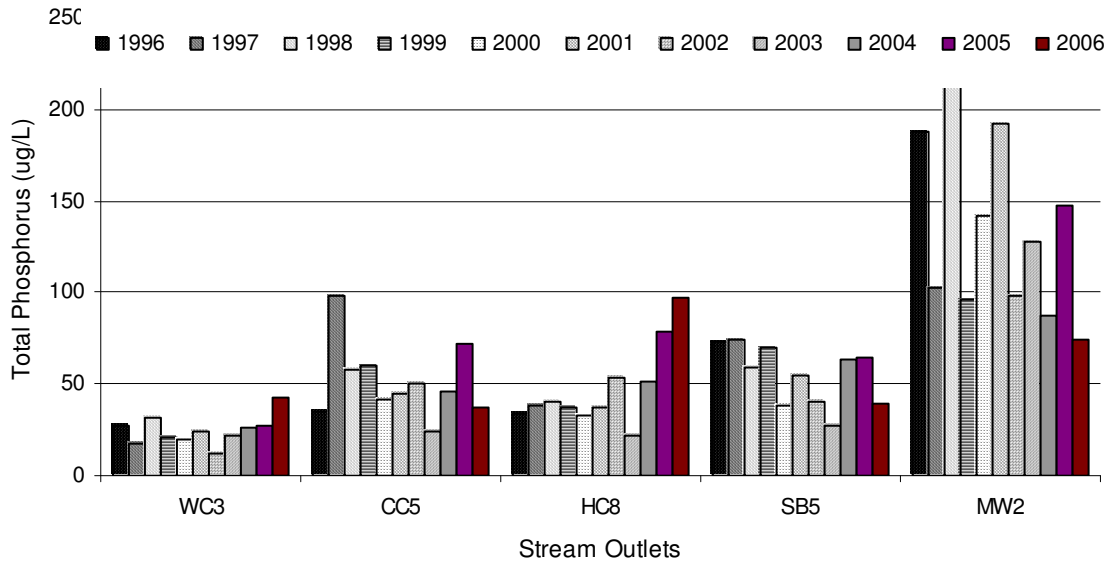


Figure 5. Mean total phosphorus concentrations at the stream outlets of each tributary monitored during the summers of 1996-2006 (modified from Reynolds 2006).

### Total Nitrogen, Nitrate+Nitrite, and Ammonia

In inland bodies of water, nitrogen limits algal production less frequently than phosphorus, although it is still an essential nutrient in plant growth (Cole 1983). Nitrogen enters the lake through surface water, groundwater, and precipitation (Lampert and Sommer 1997). Similar to human-derived phosphorus loading sources, excess nitrogen enters Otsego Lake from septic leachate (Meehan 2004), agricultural fertilizers, and livestock wastes (Albright 2005b). Total nitrogen concentrations are the combination of nitrate, nitrite, ammonia, and organic nitrogen concentrations (Reynolds 2006). Mean total nitrogen for the summer of 2006 ranged from 0.26 mg/l at WC2 to 2.63 mg/l at HC7 (Figure 6). The mean high concentration has increased since last year, during which total nitrogen concentrations were highest at 1.81 mg/l at HC6 (Reynolds 2006). Of the five tributaries, Hayden Creek and Shadow Brook have shown the highest total nitrogen concentrations both from 2005 and 2006, while White Creek as continually shown the lowest concentrations over the past two monitoring periods. Average total nitrogen concentrations for all watershed sites are given in Figure 6.

Mean nitrate+nitrite-N concentrations for the summer of 2006 ranged from those below detection (< 0.02 mg/L) at CC1 to 2.51 mg/L at HC7. Excluding HC7, mean concentrations for 2006 were only slightly higher than 2005, in which concentrations ranged from 0.014 mg/L to 1.26 mg/L. (Reynolds 2006). Average nitrate+nitrite-N concentrations for all watershed sites are given in Figure 7.

Ammonia, a by product of heterotrophic bacterial breakdown of organic substances, is another component of total nitrogen that is known to be toxic to fish at relatively low levels (Cole 1983). Ammonia concentrations were below detection (<0.02 mg/l) at most sites, while mean high concentrations were 0.074 mg/l at WC3 (Figure 8). Average ammonia concentrations for all watershed sites are given in Figure 8.

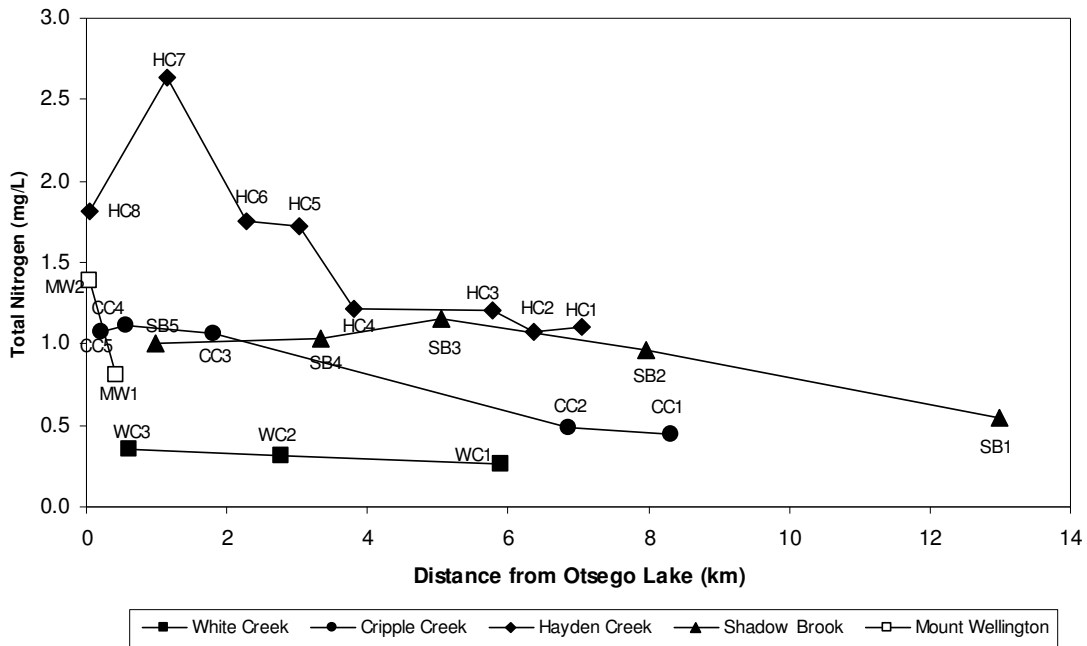


Figure 6. Average total nitrogen concentrations (mg/l) at tributary sites in the Otsego Lake watershed, summer 2006.

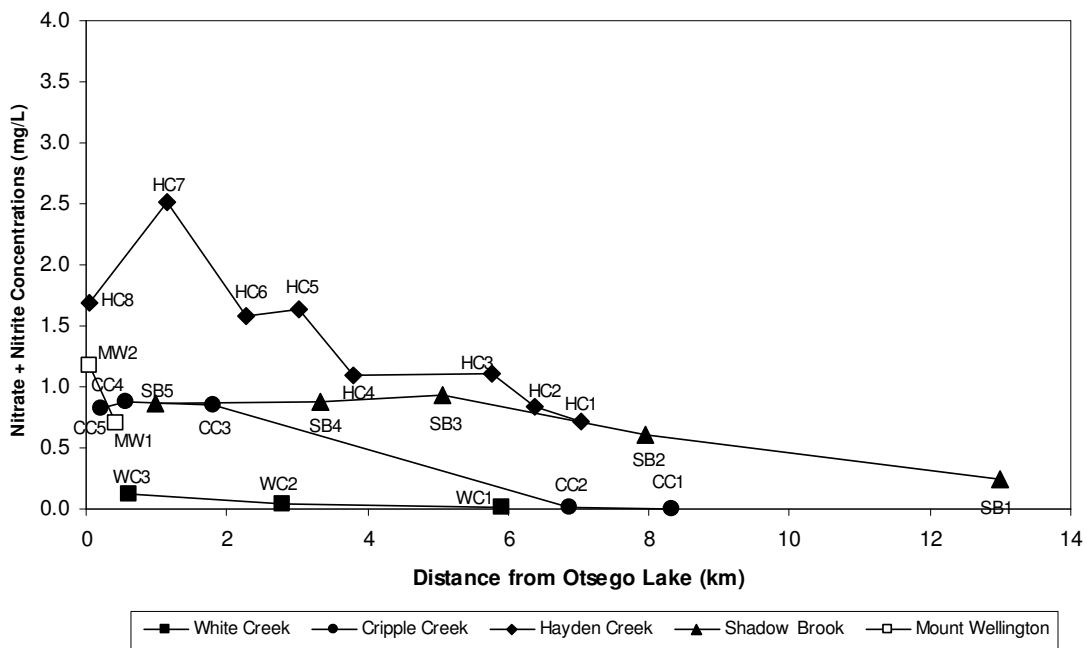


Figure 7. Average nitrate+nitrite concentrations (mg/l) at tributary sites in the Otsego Lake watershed, summer 2006.

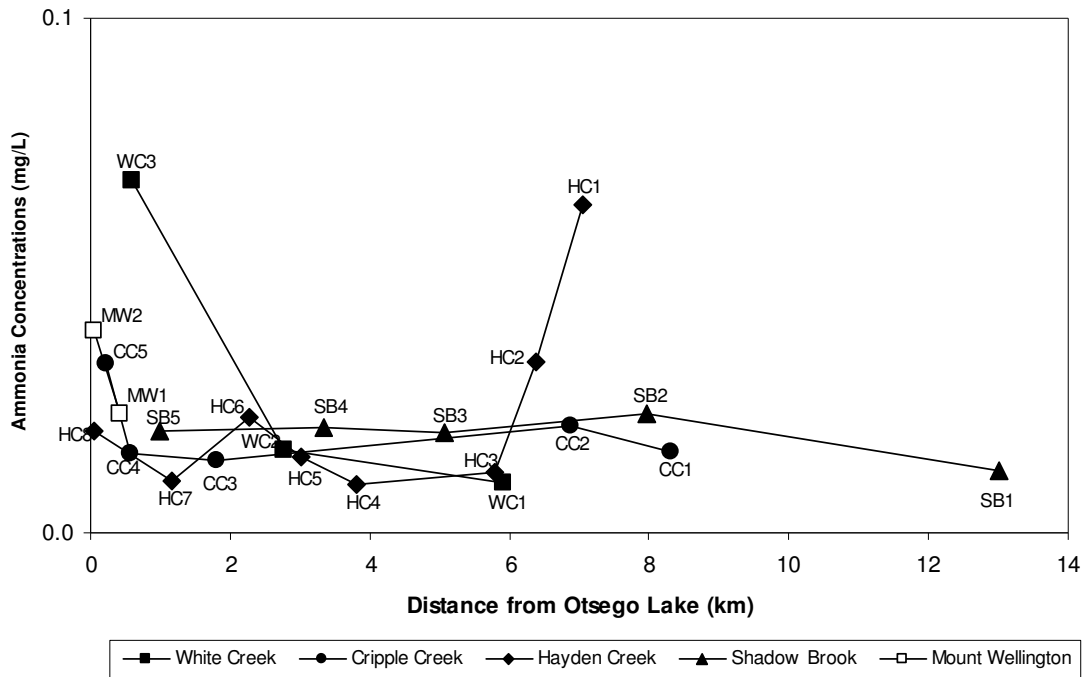


Figure 8. Average ammonia concentrations (mg/l) at tributary sites in the Otsego Lake watershed, summer 2006.

## CONCLUSIONS

Water quality across the five tributaries has shown improvements in some areas, but not in others. Mean nitrate+nitrite concentrations have shown comparable concentrations from last year, despite a few high concentrations. Conversely, total phosphorus levels for 2006 have shown variable results as concentrations have increased slightly at some sites, yet decreased at others. It is not unexpected that results this year were quite variable in that precipitation over the study period was among the highest recorded in the area. From June through July, 22.1 cm (8.7 in) typically fall in Cooperstown. During that period in 2006, 54.4 cm (21.4 in) fell (Blechman 2007). Continued watershed monitoring is expected to eventually overshadow the influence of year-to-year variations of meteorological conditions potentially allowing for any evaluate of the effectiveness of Best Management Practices.

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