Mapping and Quantifying Stands of Eurasian Watermilfoil in Conesus Lake, New York

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Abstract- Eurasian watermilfoil (Myriophyllum spicatum) is an invasive submersed macrophyte that in the past fifty years has proliferated in the littoral zones of many lakes in the Great Lakes Watershed and throughout North America. In Conesus Lake, New York, the most Westerly of the Finger Lakes, Eurasian watermilfoil has formed dense stands that exclude native macrophyte species. Variable annual growth patterns of Eurasian watermilfoil are in theory linked in part to the nutrient supplied by a number of streams and rivulets in the watershed. Results from this study showed that many of the large beds are associated with outputs or runoff from streams. The total accumulation of biomass contained in these beds ranged from an estimated 87,425 kilograms total dry weight in the north end to relatively small beds of 507 kilograms total dry weight, near Sutton Point. A correlation between macrophyte abundance at each site surveyed in the summer of 2000 and the concentrations of total phosphorus runoff shows a very strong relationship resulting from a regression analysis performed ($p=0.001$).

Introduction

The North American Great Lakes watershed has become a home to many invasive species. Since the 1800's, 139 aquatic organisms have established themselves in the Great Lakes, with approximately 34% of these species establishing themselves in the past 30 years (Mills et al. 1993). Organisms such as the zebra mussels, quagga mussels, sea lamprey, and alewife have all found their way to this region, rapidly colonizing the area (Mills et al. 1993). Native ecosystems are continuously threatened by the invasion of such species, which can trigger substantial changes in the environment.

The Finger Lakes are a series of long and narrow lakes located in the Great Lakes watershed. Formed by glaciers over 10,000 years ago, this chain of eleven lakes stretches throughout Central and Western New York. The introduction of invasive species has drastically changed the ecosystems in the region. The macrophyte Eurasian watermilfoil (Myriophyllum spicatum) has colonized these lakes and has significantly changed their communities. First seen in the United States in the Potomac River, Virginia in 1881, Eurasian watermilfoil has been difficult to distinguish from its close relative Northern watermilfoil (Myriophyllum sibricum) for nearly a century until the work of C.F. Reed in 1977.

Conesus Lake, New York (42°47' N; 77° 43' W) is the most westerly Finger Lake and is approximately twenty-five miles south of Rochester, New York. Conesus is 12.7 km long and 1.6 km wide with a maximum depth of 20 meters and covers an area of 13.8 km2 (NYSDEC, www.dec.state.us/website/reg8/lakes/conesus.html). Conesus flows from the south to the north, and the perimeter of the lake is peppered with small streams that bring agricultural runoff to the lake from the surrounding watershed.

Conesus Lake has a long recorded and well-documented history of its macrophyte biodiversity. In 1927, Muenschner conducted the first macrophyte survey, observing the diversity and distribution of plants throughout the lake. According to Dr. Herman Forest (1978), Muenschner reported that Myriophyllum, which was originally identified as M. exalbescens, was dominate within the lake. The species first seen by Muenschner is most likely not Eurasian watermilfoil but a native watermilfoil plant known as Northern watermilfoil (Myriophyllum sibricum). Dr. Forest continued surveying the macrophytes in Conesus throughout the 1960's, 1970's and into the mid 1980's, observing the changes within the lake. Today's macrophyte studies in Conesus Lake are performed under the supervision of Dr. Isidro Bosch of the State University of New York at Geneseo. Collections performed by Dr. Bosch and his undergraduate researchers in the summers of 1998 and 1999, revived the long tradition of recording data from the lake (Bosch et al.,1999).

Since the 1960's, macrophyte growth in Conesus Lake has been highly variable. It is difficult to precisely map the spread of Eurasian watermilfoil and the decline of native species such as Northern watermilfoil in Conesus due to erratic sampling in the past. The highest biomasses were recorded during the 1960's and 1970's before the construction of a perimeter sewer. However in the past five years lake residents have expressed concern over an increasing macrophyte problem. Bosch et al. (1999) showed that in 1999 the macrophyte biomasses were actually moderate, but there had been a shift in species dominance. Eurasian watermilfoil was now even more prevalent than in the past.

The precise date at which Eurasian watermilfoil was introduced into Conesus Lake is not known and the environmental impact of this non-indigenous species is difficult to determine. The purpose of this study was to identify and map the locations of Eurasian watermilfoil beds in the lake and to quantify the surface area and biomass. A secondary goal was to evaluate possible factors influencing the growth patterns of watermilfoil in Conesus Lake, New York.

Methods

This survey was conducted from July to November 2000, during the peak months of the growing season. The main objectives of this work were to map beds of Eurasian watermilfoil (Myriophyllum spicatum), and to conduct a survey determining quadrat biomass and locations of standing crops within the littoral zone of Conesus Lake.

The mapping of Eurasian watermilfoil beds was achieved using global positioning satellite (GPS) technology (Trimble Model TSC1, Trimble Navigation Ltd.). Snorkelers and S.C.U.B.A. divers visually delineated the perimeter of the beds while a trail-boat followed closely behind with an on-board GPS operator recording the path of the divers. The UTM points (latitude/longitude, WGS 1972), recorded every 5 seconds, were logged into a laptop computer. Georeferenced maps from the GIS data were created using geographic information systems (GIS) technology (Arcview, Esri Inc.). The GIS data and the high-resolution GIS maps were useful to calculate the surface area of each bed using Arcview.

After mapping the Eurasian watermilfoil beds using GPS/GIS, ten sites were established as locations where quadrat sampling would be conducted, to determine the total biomass of Eurasian watermilfoil at each site. Quadrat biomass was determined using 0.5-inch diameter PVC pipes, fashioned into a square using PVC elbows. Each side of the square was 0.5 meters in length, yielding a total surface area of the quadrate to be 0.25 m2. The walls of the piping were vented by drilling 1/8-inch diameter holes allowing air to escape when the pipes were submerged. S.C.U.B.A. divers lowered the PVC squares from the surface at 3 or 4 random points within the watermilfoil beds. When the squares settled on the bottom, the divers submerged, cutting the plants at the stem and collecting all macrophytes within the quadrat. The collected plants were placed in mesh bags and brought back to the laboratory for analysis.

In the laboratory, fresh macrophyte samples were separated by species. Zebra mussels attached to the plants were removed manually before the samples could be weighed. Bulk plant samples were blotted dry and weighed to the nearest 0.1 gram. To be consistent with previous collections done by Forest and colleagues, the blotted wet-weight was recorded. The blotted wet-weight was converted to a dry-weight using a wet-weight/dry-weight conversion of 0.10 (Forest et al. 1971,1978). Species were identified Borman et al. (1997). Species composition ratios for these beds were created using a simple equation:

$$\%\text{Eurasian watermilfoil} = \frac{\text{Weight of Eurasian Watermilfoil in Sample (kg)}}{\text{Total Sample Quadrat Weight (kg)}}$$

A regression analysis was used to examine the relationship between quadrat biomass and the event phosphorus levels.

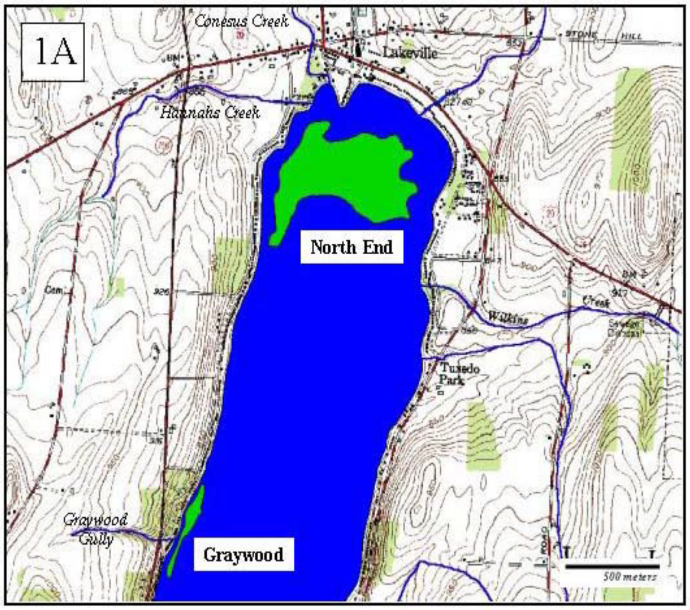

Figure 1A - Location of the major watermilfoil beds in the lake. A. The large bed off Sand Point in the north end.

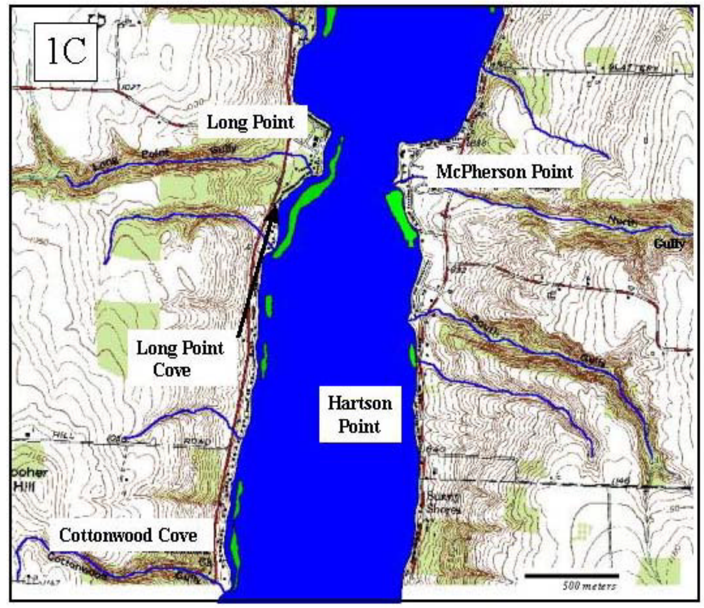

Figure 1C - South of Long Point Cove there are a number of small beds, and a large dense bed immed**i**ately offshore from Cottonwood gully, north of Cottonwood Cove.

Results

Through the use of GIS/GPS technology ten beds were identified as areas that were predominantly composed of Eurasian watermilfoil. Individual watermilfoil beds surveyed with GPS/GIS technology and displayed on high-resolution maps are depicted as figures 1A-D; beginning with those sites in the North Basin, macrophyte beds were located in the North End, and at Graywood Shores (Figure 1A), on Eagle Point, Long Point, Sand Point West, Orchard Point and McPherson's Cove (Figure 1B). In the South Basin; South Long Point, McPherson Point extending south to the Cottonwood area (Figure 1C), finally Figure 1D displaying the Southern tip of the lake. A view of the entire lake depicting the locations where quadrat samples were collected is also shown in Figure 2.

The "North End" bed was the largest with a total area of 337, 547 m2. Beds at Eagle Point (60,574

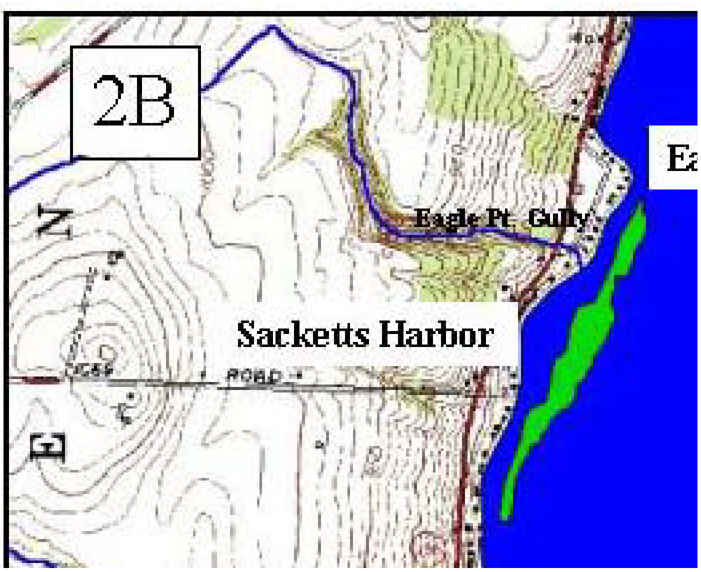

Figure 1B - Large beds in the shallows of the central region of the lake.

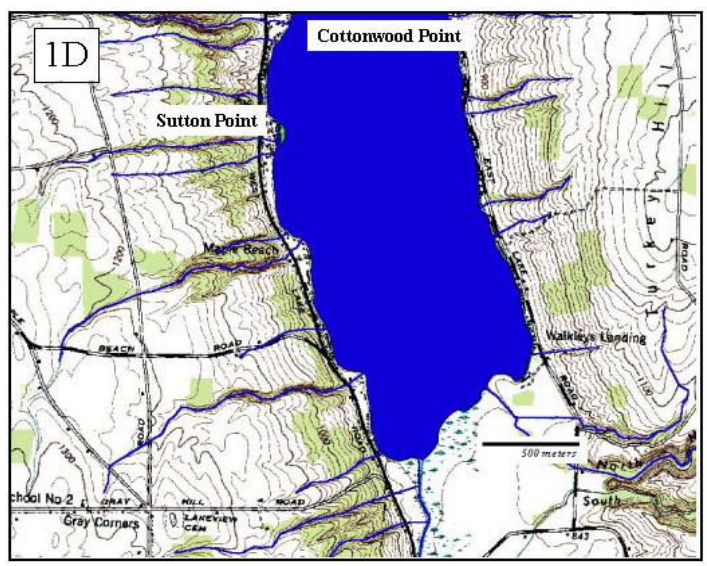

Figure 1D - Due to its steeper slope and generally greater depths the southernmost parts of the lake are virtually devoid of major watermilfoil beds.

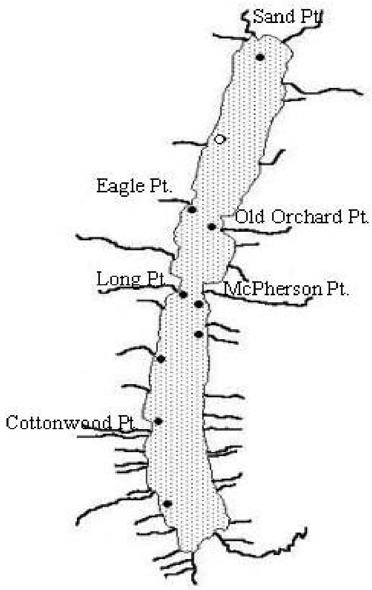

Figure 2 - Locations in Conesus Lake where quantitative surveys were carried out. (· is representative Eurasian watermilfoil bed)

m2), Orchard Point (54,294 m2), Long Point (37,080 m2), were some of the largest found in the lake. Beds at McPherson's Point (23,192 m2), Cottonwood (15,070 m2), Sand Point (9,535 m2), Long Point Cove (4, 852 m2), Booher Hill (4,673 m2), and Sutton Point North (2,756 m2), all contained significant accumulation of macrophyte biomass (Table 1).

The "North End" had both the largest surface area and the greatest total accumulation of biomass approximately 87,425 kg. Other sites had higher concentration of macrophytes per unit area but were sufficiently smaller in size slowing total biomass accumulations (Table 1). Beds at McPherson's Cove, McPherson's Point, Long Point, Long Point Cove, Orchard Point, Eagle Point, Sand Point West, Booher Hill, McMillan Point, Cottonwood, and Sutton Point North, each were determined to have individual species compositions greater than ³95% Eurasian watermilfoil (Table 1). The resulting ratio of Eurasian

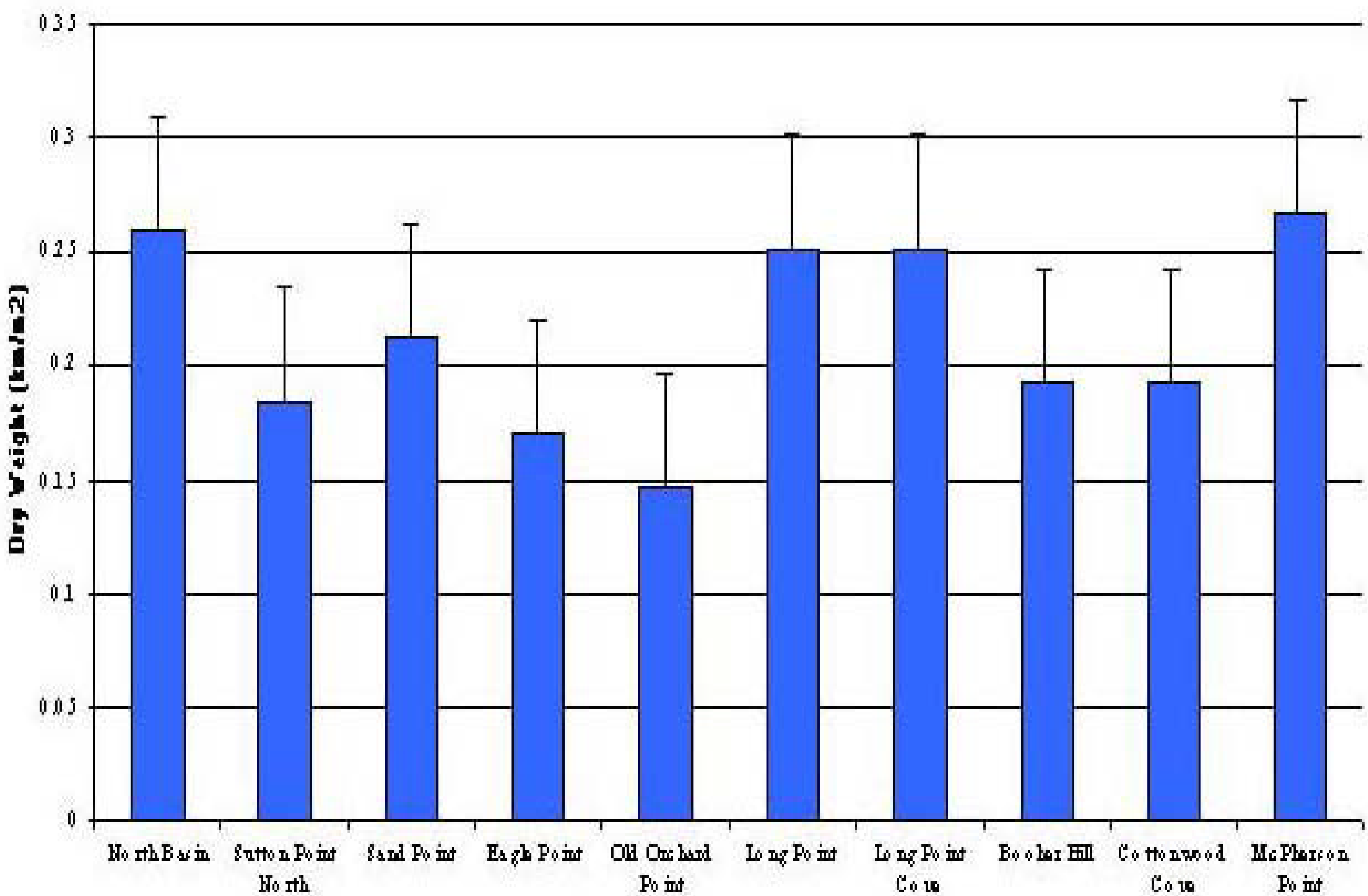

Figure 3 - Mean biomass per square meter for sites throughout Conesus Lake

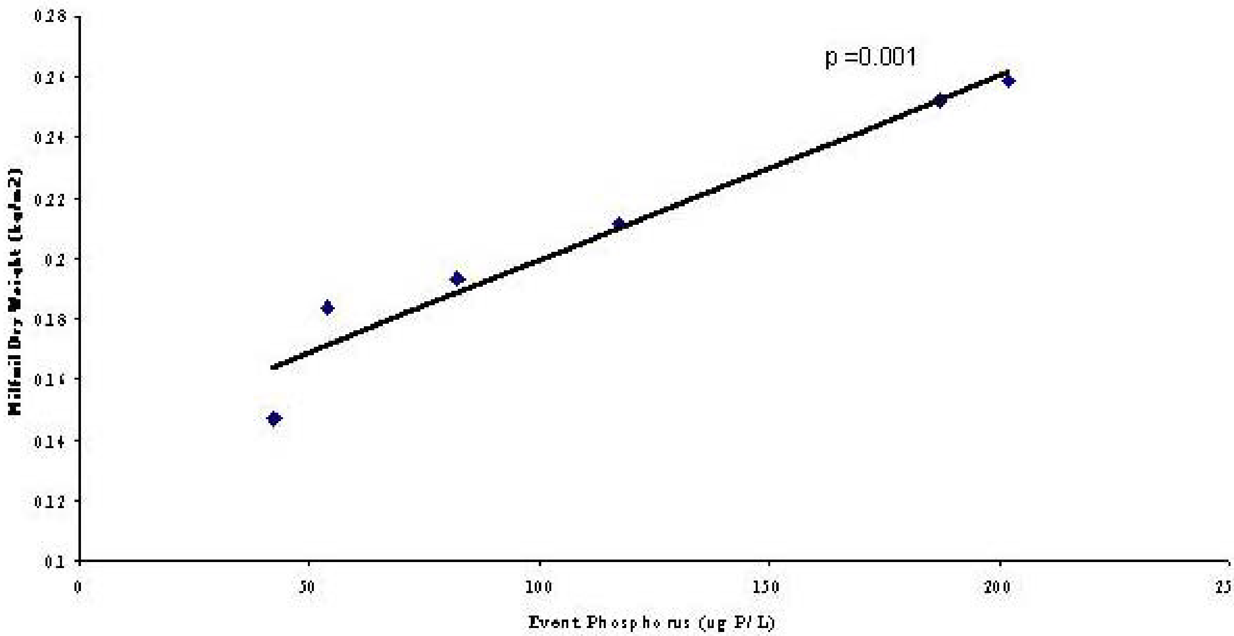

Figure 4 - Regression representing Event Phosphorus loading and Biomass from sites in Conesus Lake, p =0.001, R^2=0.95.

watermilfoil weight to the weights of all other species provided a basis to estimate the total Eurasian watermilfoil biomass in each bed (Table 1). The regression analysis performed on the biomasses and event phosphorous levels, revealed that the data fit the trend-line well with an R2 value equal to 0.9463. The relationship was also statistically significant with a p-value calculated in the regression analysis of 0.001

Discussion

This survey of the submersed macrophyte stands in Conesus Lake, New York reveals that each of the beds mapped during the summer of 2000, was located close to the mouth of a stream. In an attempt to link fluctuations in Eurasian watermilfoil growth patterns a regression analysis of phosphorus loading data was conducted. The loading data were collected during rainfall events from October to December of 2000 (Makarewicz et al. 2001), at common sites surveyed in our study and Makarewicz's study, showed a relationship between the two values (Figure 4). Phosphorus levels in the lake water and stream runoff have often been attributed to increased growth rates of submersed macrophytes.

Table 1 - Area, Biomass and Percent Eurasian watermilfoil in Conesus Lake.

Macrophyte Bed Location	Area (sq m)	Biomass/Area (kg/sq m)	Total Biomass (kg Dry Wt.)	Eurasian watermilfoil Biomass (kg/sq m)	Total Eurasian watermilfoil Biomass (kg Dry Wt.)	Percent Milfoil (%)
North Basin	337547	0.259	87425	0.246	83054	95
Sutton Point North	2756	0.184	507	0.184	507	100
Sand Point	9535	0.212	2021	0.212	2021	100
Eagle Point	60574	0.17	10298	0.162	9783	95
Old Orchard Point	54294	0.147	7981	0.146	7901	99
Long Point	37080	0.252	9344	0.252	9344	100
Long Point Cove	4852	0.252	1223	0.252	1223	100
Booher Hill	4673	0.193	902	0.191	893	99
Cottonwood Cove	15070	0.193	2909	0.193	2909	100
McPherson Point	23192	0.267	6192	0.262	6068	98

Eurasian watermilfoil thrives around the outlets of small creeks and rivulets and is likely due to surrounding farms that spread fertilizers and manure over the fields. Rain events likely wash fertilizers directly into the lake and indirectly into the groundwater. Macrophytes, particularly watermilfoil, grow in response to these nutrients resulting in the tremendous monocultures we see in many of the beds. Close observation of Figures 1A - D, display the relationship between Eurasian watermilfoil beds and the mouth of the streams.

Our results suggest that nutrient input from agricultural runoff may be the single greatest contributor for Eurasian watermilfoil growth throughout Conesus Lake's history. Understanding the relationship between phosphorus loading and watermilfoil biomass will aid in the development of management practices. Moreover it may eventually allow researchers to anticipate macrophyte growth patterns in the future. Modeling the inputs and outputs would be especially useful in understanding the dynamic interactions that result in Conesus Lake.

Makarewicz et al. (2001) state that improvements in water quality in other area of the Great Lakes Watershed such as Irondequoit Bay in Monroe County, New York and areas in Lake Erie, were not fully realized for 20 to 25 years after phosphate abatement programs were implemented. Further investigation into management practices could prevent leaching of nutrients into Conesus Lake. In time this could potentially reduce the environmental degradation associated with the invasion and spread of Eurasian watermilfoil.

Eurasian watermilfoil has proliferated near the mouths of these streams within the littoral zone of Conesus Lake replacing native floral species seen by Menschner in the past (1927). The information collected by these researchers gives Conesus Lake a unique and special recorded history not available in most temperate lakes.

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