REPORT TO ONTARIO COUNTY WATER RESOURCES COUNCIL

MACROPHYTE COMMUNITIES IN SENECA LAKE, NY

BIN ZHU, PH.D.
RESEARCH SCIENTIST
FINGER LAKES INSTITUTE
HOBART AND WILLIAM SMITH COLLEGES
GENEVA, NY 14456
(315) 781-4384

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INTRODUCTION

Water quality directly affects distribution, abundance, and diversity of aquatic macrophytes in lakes because it controls the amount of algae and light availability (Wetzel 2001). Therefore, aquatic macrophytes can be an index of water quality. In addition, macrophytes can directly or indirectly alter the physical and chemical environment by shaping light, temperature, and nutrient dynamics. They also define the littoral zone, provide physical living or nursery habitats for many zooplankton, invertebrates, and fish, and play a significant role shaping the structure and dynamics of pelagic and benthic food webs in lakes (e.g., Jeppesen et al. 1997). Consequently it is of great importance to understand the response of submerged macrophytes to water quality changes.

Of the eleven Finger Lakes, only Honeoye Lake has received continuous study of macrophytes in the last three decades (Gilman 1985; 1994). In summer 2007, an intensive macrophyte survey was conducted in Owasco Lake through the collaboration of Finger Lakes Community College and the Finger Lakes Institute (Gilman et al. 2008). Additional studies in the Finger Lakes, such as Seneca Lake will enable a comparison of aquatic macrophytes in lakes forming a gradient of water quality. Comparisons of macrophyte distribution and diversity in the three or more lakes will provide more meaningful and informative results related to the responses of macrophytes to water quality changes. Therefore the objectives of this study were to 1) inventory aquatic plants in Seneca Lake, aiming to quantify long-term macrophyte changes in response to changes in water quality; and 2) compare the species diversity across the Finger Lakes.

STUDY SITE AND METHODS

Seneca Lake is the deepest lake of all the Finger Lakes with an average depth of 89 m and a maximum depth of 188 m (Bloomfield 1978). It is also the largest lake in terms of water volume (16 km^3) and the longest lake in terms of length (61.4 km). The water surface is 173 km^2. The water quality is generally good but it faces many possible pollution sources such as agricultural, industrial, and commercial land uses (Callinan 2001).

This study investigated the diversity and localized growing environment of submerged macrophytes in Seneca Lake, comprising the second year of study in the long-term research of responses of macrophytes to water quality changes in this lake. Macrophytes were collected at 15 sites (12 on the northern end and 3 on the southern end) using SCUBA and 11 sites (all on the southern end) using rakes in late August 2008 when macrophytes reach their peak in growth (Figure 1). At each diving site, all macrophytes were collected through SCUBA using a submerged 0.5 m^2 quadrat frame and three rake samples were collected for each rake site. Plant samples were rinsed *in situ*, transported to the laboratory, separated by species, placed in paper bags, and dried in the dry oven. All dried macrophytes were counted for species richness and weighed for biomass. In order to assess the localized growing environment, sediment samples were also collected and measured for total phosphorus concentration following the EPA standard methods (APHA 2000).

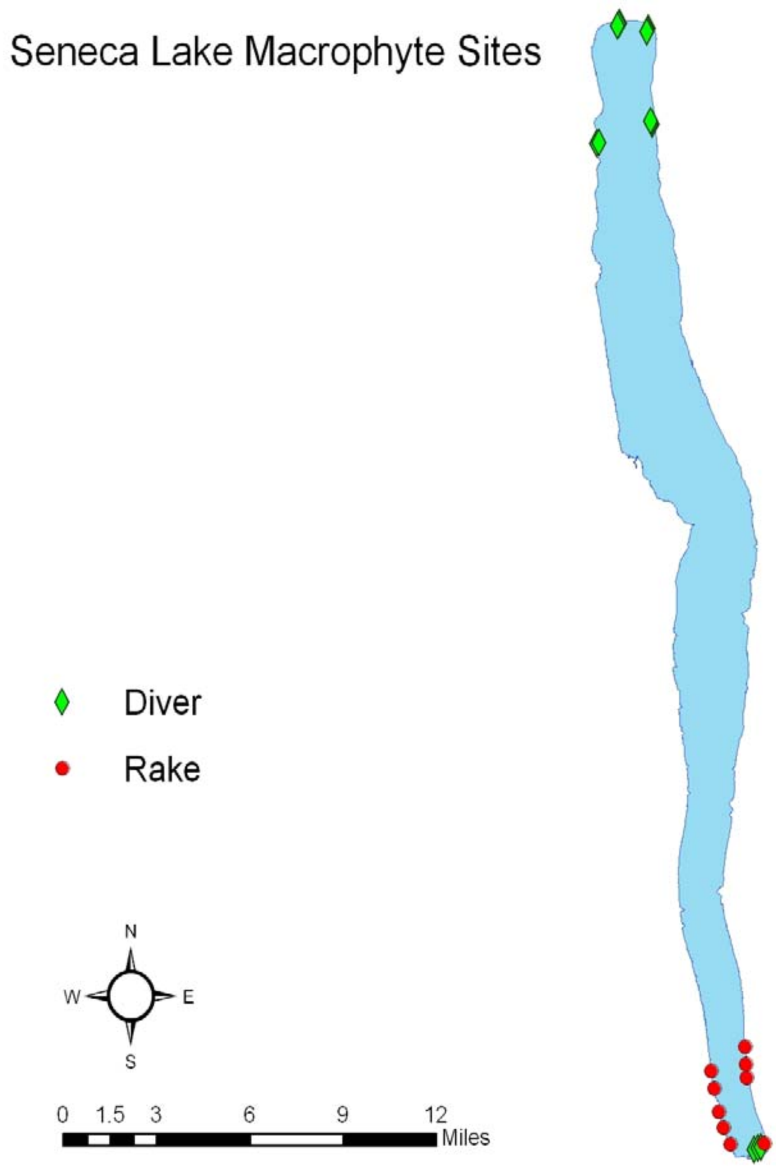

Figure 1. Macrophyte sampling sites in Seneca Lake in 2008.

RESULTS

Total Phosphorus in Seneca Lake

Seneca Lake has relatively low total phosphorus (TP) concentration in water. For example, TP averaged 9.8±2.9 µg/L in 2008, 8.9± 3.0 µg/L in 2007, and 8.4± 2.7 µg/L in 2006 (John Halfman, Hobart and William Smith Colleges, unpublished data). The lake ranks in the middle among the eleven Finger Lakes for TP.

Total phosphorus concentrations in sediment collected from the diving sites of Seneca Lake ranged from 210 to 950 µg P/g dry sediment, with an average of 498.3 ± 70.8 µg P/g dry sediment. These were similar to other measurements (200-1000 µg P/g dry sediment, Dr. Tara Curtin, Geology Department, Hobart and William Smith Colleges, unpublished data). However, the mean concentration in Seneca Lake was almost twice that in Owasco Lake (mean 287.2 ± 24.0 µg P/g dry sediment and range from 120 to 660 µg P/g dry sediment, Gilman et al. 2008), suggesting nutrient enrichment in sediments in Seneca Lake.

Macrophyte Communities in Seneca Lake

A total of ten vascular plants and one type of algae (stonewort) were found in Seneca Lake from diver surveys with the most abundant species being Eurasian water milfoil (128 g/m^2) followed by sago pondweed (22 g/m^2, Table 1). These two species were dominant as their densities were significantly higher than others. For example, the density of stonewort was only 3.5 g/m^2, but it was the third highest abundant species. Elodea had slightly less density than stonewort and ranked the 4^{th}. There were five different pondweeds in the lake and large-leaf pondweed was the most abundant one among all these pondweeds. These results were similar to a preliminary study conducted in 2007 in the northern end of Seneca Lake. However, two new species were found in the 2008 survey, an invasive species of curley-leaf pondweed and another pondweed – large-leaf pondweed, which ranked 5th of a total of 11 in abundance.

Table 1. Submerged Aquatic Plant Density in Seneca Lake from Diver Surveys

Common Name	**Scientific name**	**2008 Density (g/m^2)**	**2008 Rank**	**2007 Density (g/m^2)**
Coontail	*Ceratophyllum demersum*	1.38		3.06
Stonewort	*Chara* spp	3.49	3	8.46
Elodea	*Elodea canadensis*	3.42	4	3.86
Eurasian water milfoil	*Myriophyllum spicatum*	127.77	1	128.87
Slender Naiad	*Najas flexilis*	0.15		5.44
Large-leaf pondweed	*Potamogeton amplifolius*	3.11	5	
Curly-leaf pondweed	*Potamogeton crispus*	0.20		
Leafy pondweed	*Potamogeton foliosus*	0.33		0.13
Sago Pondweed	*Potamogeton pectinatus*	22.05	2	29.06
Richardson's pondweed	*Potamogeton richardsonii*	0.96		9.76
Eelgrass	*Vallisneria Americana*	0.72		0.41

There was less species richness in rake sampling at the southern end of Seneca Lake (five compared with eleven in diver surveys, Table 2). This is mainly due to the dominance of Eurasian water milfoil in the southern end which reached the density of at least several hundred times more than other species.

Table 2. Submerged Aquatic Plant Density in Seneca Lake from Rake Sampling

Common Name	**Scientific name**	**Density (g/rake)**	**Rank**
Elodea	*Elodea canadensis*	0.21	2
Eurasian water milfoil	*Myriophyllum spicatum*	113.71	1
Curly-leaf pondweed	*Potamogeton crispus*	0.17	3
Leafy pondweed	*Potamogeton foliosus*	0.07	5
Sago Pondweed	*Potamogeton pectinatus*	0.14	4

Comparisons of Macrophyte Richness in the Finger Lakes

The total species found in Seneca Lake was 11, less than the 18 found in Owasco Lake and 20 in Honeoye Lake (Gilman 1994; Gilman et al 2008). However, the mean species richness at each site showed a hump-back relationship with concentrations of total phosphorus (TP) in the Finger Lakes (Figure 2). The highest richness was observed in the median TP levels, such as Otisco Lake.

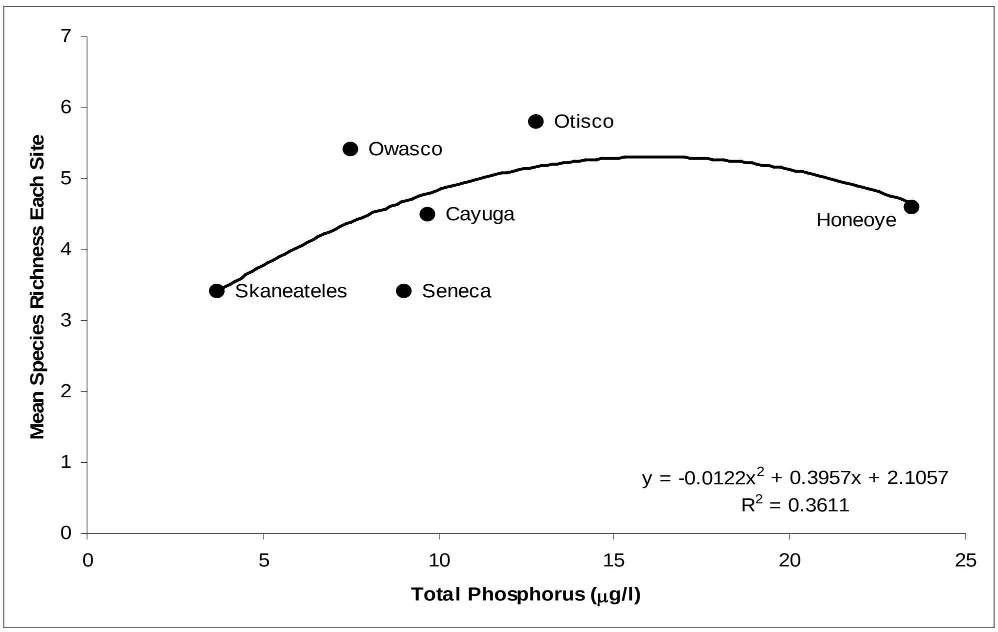

Figure 2. The relationship of mean species richness and total phosphorus in the Finger Lakes.

DISCUSSION

It is not surprising that Eurasian water milfoil was the most abundant species in Seneca Lake as it is one of the most abundant species in the region including Oneida Lake, Sodus Bay, Chaumont Bay, Owasco Lake, and Honeoye Lake (Gilman 1994; Zhu et al. 2006; Zhu et al 2007; Gilman et al 2008). These suggest that this invasive species is common and has significant negative impacts in the lakes. According to an on-line survey conducted by the Northeast Aquatic Plant Management Society, this species is the No. 1 species to cause the most problems in the Northeast. Therefore, it is necessary to control or eradicate its population in the lakes with concerns. The eradication project in Skaneateles Lake is a good example of current efforts for controlling this species.

While comparing the whole macrophyte communities in Seneca Lake with other Finger Lakes, higher richness occurred in median levels of total phosphorus. This is consistent with other findings that mesotrophic lakes usually support more macrophyte species than oligotrophic and eutrophic lakes (Murphy 2002). Less species richness was observed in Seneca Lake than Owasco Lake and Honeoye Lake largely due to a less intensive survey of macrophytes. There were over 90 sites in Owasco Lake and 100 sites in Honeoye Lake whereas there were only 26 sites in Seneca Lake (Gilman 1994; Gilman et al 2008). These sites were also limited in the southern and northern ends of Seneca Lake. As shown in the relationship of mean species richness and total phosphorus, Seneca Lake showed the lowest mean species richness at each site, the same as in Skaneateles Lake where TP is much lower. This again suggested that the macrophyte richness might be underestimated in Seneca Lake. Therefore more intensive surveys in Seneca Lake are needed in the future.

Macrophyte composition and richness provide useful information about water quality and ecosystem health. However, only long-term studies of macrophyte changes can provide critical information about changes in water quality. Consequently, long-term studies in aquatic macrophytes in the Finger Lakes will be necessary and essential for watershed management and protection of these valuable and unique water resources.

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