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Submersed Aquatic Plant Communities In Western New York: 50 Years Of Change

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ABSTRACT

Chautauqua Lake and the Cassadaga Lakes in western New York have shown substantial changes in the relative abundance of various species in the submersed macrophyte communities over the last 50 years. Many of the *Potamogetons* species, in particular, have declined dramatically and currently two exotic submersed macrophytes, Eurasian watermilfoil (*Myriophyllum spicatum* L.) and (*Potamogeton crispus* L.) are the dominant species. The two lake systems have been subjected to only minor changes in ecological factors during this time period, with the exception that Chautauqua Lake has had extensive aquatic plant management programs for the last 25 years. It has been suggested that these herbicide and mechanical harvesting practices are the major factor causing the submersed plant community changes in Chautauqua Lake and more recent changes are compatible with that hypothesis. However, the Cassadaga Lakes system has shown equally large changes in the plant communities, even though aquatic plant management programs have been much less extensive. It thus appears that aquatic plant management programs, while possibly a contributing factor, are not the major cause of the observed declines in relative abundance of many aquatic plant species.

Key words: macrophyte, relative abundance, herbicides, harvesting.

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INTRODUCTION

Changes in the macrophyte communities of many lakes in the Great Lakes region (and throughout the world) have been documented (*e.g.* Nichols and Mori 1971, Stuckey 1971), but little evidence as to the cause of these changes has been cited. Invasion by two exotics, *Potamogeton crispus* L. and *Myriophyllum spicatum* L, appears to coincide with a sharp decrease in species richness and the relative abundance of species in many temperate lakes of North America (Nicholson 1981). Nicholson indicates that management practices (herbicides and mechanical harvesting) are the most likely cause for aquatic plant community changes in Chautauqua Lake, New York, but evidence presented in this paper suggests that this may be too simple an explanation.

METHODS AND MATERIALS

The study areas consist of two natural lake systems of glacial origin in western New York. Chautauqua Lake is a large (57 km^2) mesotrophic/eutrophic lake which is heavily used for recreational purposes. It consists of two distinct basins, each rather long and narrow. The northern basin is deeper (avg. depth 7.8 m) and is mesotrophic while the southern basin (avg. depth 3.5 m) is eutrophic. There is a large body of information concerning Chautauqua Lake water chemistry, phytoplankton and macrophytes dating from the 1930s, 1970s and early 1980s (extensively reviewed by Mayer *et. al.* 1978).

The Cassadaga Lakes, actually three small, interconnected lakes (40 ha, 10 ha and 40 ha), likely formed as glacial kettle holes and are naturally eutrophic. There are year-round homes and some summer cottages on the lower lake, but swampy areas have minimized shoreline development on both the middle and upper lakes. Population on the watershed has been stable or declining over the past 50 years.

Both lake systems are surrounded by farmland or abandoned farmland reverting to a beech/maple deciduous forest. There is no industrial activity in the watershed of either lake. Population levels and available water chemistry data suggest that overall nutrient loading and other environmental parameters have changed little in the Chautauqua Lake system since the 1930s (Nicholson 1981). There are fewer data available for the Cassadaga Lakes, but alkalinities and pH values have not changed and a severe oxycline at about 3 m which was reported in 1937 still occurs at that depth (Mantai, unpublished data). Water chemistry and geomorphology data from both lake systems indicate that they are very similar in overall characteristics, although the northern basin of Chautauqua Lake is more mesotrophic than the Cassadaga Lakes.

Nicholson (1981) noted that aquatic weed management practices, including herbicides such as diquat and endothall (applied yearly in late June at certain sites) and mechanical harvesting (continuous from late June through September over most of the lake), have been extensively used since the 1950s on Chautauqua Lake and he suggests that weed harvesting is a major factor causing changes in the species composition of aquatic plant communities in this lake.

The Cassadaga Lakes, however, have had little macrophyte management until recently, and on a much more limited scale (Thorp, personal communication). The treatments consisted of diquat or endothall applied in late June to only the most heavily used areas, mostly in the lower lake, or a single mechanical harvesting performed in July or August on areas near cottages or swimming beaches. Large areas of the lakes, particularly the upper lake, have never received any aquatic plant management. Thus the Cassadaga Lakes system can serve as a reasonable comparison to test the hypothesis that weed management practices have a major impact on the relative abundance of aquatic plant species in these lakes.

McVaugh (1938) utilized manual techniques to sample the macrophyte communities on Chautauqua Lake and the Cassadaga Lakes (the time of the year when sampling occurred was not indicated in the paper) while Nicholson (1981) performed very extensive studies on Chautauqua Lake measuring cover, frequency and biomass using hand-picking in shallow water and SCUBA and grappling in water >1 m deep. Numerous quadrats and transects at many sites were sampled from April to October in the years 1972 to 1975. In the study reported in this paper, available resources limited us on Chautauqua Lake to sampling biomass with random 25-cm^2 quadrats only in the shallow water (<1 m) communities. Visual observations from <1 m to 2-3 m in depth were made with SCUBA along transects perpendicular to the shoreline (one at each site). A total of 9 sites (2-4 quadrats per site with a total of 30 quadrats) were sampled in late June and early July and these were among those also sampled in 1972-1975 and in the 1937 study. On the Cassadaga Lakes, visual observations from a boat were made in late May when water clarity is at a maximum and aquatic plant growth was still at a point where individual plants could be discerned. The lakes are small enough so that the macrophyte beds of the entire lake system could be observed. Individuals of each plant species were collected for positive identification. The observations included depths from <1 m to the limit of plant growth (about 3 m). Data are reported as relative abundance (according to McVaugh 1938).

RESULTS AND DISCUSSION

Decreases in relative abundance of some species of aquatic macrophytes were evident in 1991 compared to 1937 and 1972-1975, with several species apparently disappearing entirely from the study sites on Chautauqua Lake (Table 1). Because fewer sites were sampled in 1991 it is not certain that these species are no longer in the lake. Some of the *Potamogeton* species, however, are now totally absent from sites where they formerly were abundant. At some sites where *P. amplifolius* was reported to be common in 1937 and infrequent in the 1970's it is now absent.

The dominant species in the upper basin of Chautauqua Lake are clearly *Myriophyllum spicatum* and *P. crispus*. However, there is a conspicuous zonation of submersed macrophytes in Chautauqua Lake with both *M. spicatum* and *P. crispus* tending to be found in the deeper waters. Our shallow water sampling (≤1 m) thus may have undersampled these species, although the SCUBA transects extended to 2-3 m in depth.

Najas flexilis seems to be increasing in abundance, based on recent work by Storch (personal communication). *Najas*, being a low-growing species, is less susceptible to removal by mechanical harvesters than tall species such as the *Potamogeton* species. Biomass data on shallow sites (1 m) show a virtual absence of *Najas* in the 1970s (Nicholson 1981) but an average of 26% of the biomass in the 30 quadrats sampled in 1991.

Nicholson (1981) reported that in Chautauqua lake in 1972 to 1975 the species richness was essentially unchanged

TABLE 1. RELATIVE ABUNDANCE OF SUBMERSED AQUATIC MACROPHYTES IN CHAUTAUQUA LAKE, NY IN 1937, 1972-5 AND 1991.

Species	Relative abundance[1]		
	1937[2]	1972-5[3]	1991
Potamogeton diversifolius	+	-	-
P. epihydrus	+	-	-
P. vaseyi	P	-	-
P. amplifolius	++++	++	-
P. zosteriformis	++++	+	-
P. gramineus	+++	+	-
P. praelongus	++++	+++	++
P. illinoensis	++	+	-
P. Robbinsii	++	+	+
P. crispus	++++	++++	++++
P. pusillus	++++	++++	+
P. foliosus	++	++	-
P. natans	+	+	+
P. richardsonii	P	++++	+
Heteranthera dubia	++++	+++	++++
Najas flexilis	++++	+++	++++
Megladonta beckii	++	+	-
Elodea sp.	++++	++++	++++
Najas guadalupensis	-	++++	-
Ranunculus trichophyllous	-	+++	-
Myriophyllum spicatum	+++	++++	++++
Ceratophyllum demersum	++++	++++	++++
Valisneria americana	++++	++++	++++
Myriophyllum tenellum	P	++	-

[1]After definitions used by McVaugh (1938): ++++ = common, widespread wherever suitable; +++ = frequent, in 25-50% of characteristic habitats; ++ = infrequent, in <25% of characteristic habitats; + = rare, seen only once or twice; P = abundance not given; - = not found.
[2]McVaugh 1938.
[3]Nicholson 1981.

from 1937, although five species recorded in 1937 were not found and three new species were added. Relative abundance, however, decreased substantially, with 14 species showing declines and only 4 increasing.

Nicholson concluded from his studies that plant management techniques (herbicides and mechanical harvesting) were the primary causes of the observed changes in the relative abundance of macrophyte species in Chautauqua Lake. Data reported in this paper show continued declines in species reported by Nicholson to have low resistance to plant management practices.

Similar plant abundance studies were performed on the Cassadaga Lakes in 1990. In spite of much less human intervention, dramatic changes have also occurred in the aquatic plant communities as indicated in Table 2. Most of the species reported in the Cassadaga Lakes in 1937 to be "common" or "frequent" are now "infrequent," "rare" or were not seen at all. Most of the *Potamogeton* species which were observed in 1990, or in a spot-check in 1992, were seen only as widely scattered individual plants. In almost no cases were there "beds" of plants. The submersed plant community of the lakes is totally dominated by *M. spicatum*, with an understory of *Ceratophyllum demersum*. Unfortunately, we do not know when *M. spicatum* displaced *M. exalbescens* in either Chautauqua Lake or the Cassadaga Lakes as identification is difficult (Aiken, Newroth and Wile 1979) and herbarium specimens from the earlier studies are not available.

McVaugh (1938) in his narrative on the Cassadaga Lakes noted that the lakes "had the most diversified plant life of any lake studied except Chautauqua Lake" (in the Allegheny River watershed), although he also noted that "milfoil" was "particularly abundant" in the lakes. The verbal descriptions of the sampling sites on Chautauqua Lake by McVaugh also provide a useful means to compare the "relative abundance" definitions used in Tables 1 and 2. While there is a certain subjectiveness in describing plant communities in relative terms, a careful comparison of the data obtained in this study with verbal descriptions of the sites in 1937 suggest that the comparisons made among the three studies are valid.

TABLE 2. RELATIVE ABUNDANCE OF SUBMERSED AQUATIC MACROPHYTES IN CASSADAGA LAKES, NY IN 1937 AND 1990.

Species	Relative abundance[1]	
	1937	1990
Potamogeton amplifolius	C	-
P. crispus	I	I
P. epihydrous	F	R
P. gramineus	I	-
P. natans	I	-
P. pusilus	C	R
P. praelongus	C	R
P. robbinsii	F	-
P. vaseyi	F	R
P. zosteroformis	C	R
P. illinoesis	-	R
Najas flexilis	C	-
Elodea canadensis	C	R
Valisneria americana	§	-
Heteranthera dubia	C	R
Ceratophyllum demersum	C	C
Myriophylum spicatum	C	C
Utricularia vulgaris	C	-

[1]After definitions used by McVaugh (1938): C = common, widespread wherever suitable; F = frequent, in 25-50% of characteristic habitats; I = infrequent, in <25% of characteristic habitats; R = rare, seen only once or twice; - = not found; § = reported by Zenkert (1934).

It is clear that large changes in the relative abundance of the various species of submersed aquatic macrophytes have occurred in both Chautauqua Lake and the Cassadaga Lakes over the last 50 years. The *Potamogetons*, in particular, have declined dramatically and some of the large-leafed species which were formerly abundant may now be totally absent from these lakes. In contrast to most other American lakes, these two lake systems have been subjected to surprisingly little increases in human intervention during this time period, except that aquatic plant management practices, both herbicides and mechanical harvesting, have been widespread on Chautauqua Lake for at least the last 30 years. These facts, in part, led Nicholson (1981) to conclude that aquatic plant management practices were the major cause of the changes in relative abundance of aquatic plants in Chautauqua Lake.

The Cassadaga Lakes, however, have not been subjected to aquatic plant management to nearly the extent nor for nearly as long as Chautauqua Lake and yet show an even greater change in the structure of the plant community. Unfortunately, we do not have yearly data for these lakes which would provide a "rate constant" for the changes which have occurred. The data from Chautauqua Lake are compatible with the hypothesis that aquatic plant management practices are a contributing factor in modifying the structure of aquatic plant communities. The Cassadaga Lakes data, however,suggest that other factors, as yet undetermined, have an even greater impact, unless macrophyte control practices produce very large changes in species abundance in a short time and extend to areas of a lake which have not been directly subjected to management. Clearly a great deal more work needs to be done before the effects of herbicides and harvesting on aquatic plant communities can be determined.

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