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The Use of Stream Delta Surveillance as a Tool for Early Detection of Eurasian Watermilfoil

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ABSTRACT

Since the 1985 discovery of Eurasian watermilfoil *(Myriophyllum spicatum L.)* in Lake George, NY, a program to characterize its spread and to study its impact upon the native plant community has been ongoing. Approximately 6-12 newly invaded sites are discovered yearly. Through 1999, 134 locations have been found within the 125-mile shoreline encompassing the littoral zone. Yearly stream delta surveys by SCUBA were instituted in 1987, with between one half and one third of the deltas surveyed each year. The survey provides a definitive procedure for locating new sites with Eurasian watermilfoil, including the establishment of a regular, defined search pattern. Stream deltas were chosen as readily identifiable points that historically harbor a diverse community of native aquatic plants. When all stream deltas were taken collectively, less than one quarter of the sites contained milfoil in 1987. By 1999, the number had doubled. Although management efforts have eliminated or reduced milfoil in 120 of the 134 known locations, reintroduction has occurred in over 75% of the sites resurveyed in a three-year cycle. In the last lakewide cycle (1997-1999), Eurasian watermilfoil was ranked 13th by relative abundance (a function of percent cover) and 28th by frequency of occurrence for the 50+ species of submerged aquatics in the lake. Control of milfoil has been vastly improved with early detection, which has helped to minimize the ecological impact to native species.

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INTRODUCTION

Throughout the north temperate U.S. and Canada, introduction of exotic Eurasian watermilfoil (*Myriophyllum spicatum* L.) continues to occur at an alarming rate. Clearly the prevention of introduction to a lake is the best strategy. However, once introduced, effective management practices can be implemented to slow its spread and reduce deleterious impacts on the native aquatic plant community. Surveillance is most effective when logically planned and executed.

Stream deltas with nutrients and suspended sediments derived from the watershed are prime habitats for the establishment of Eurasian watermilfoil. Delta areas are disturbed habitats as a result of sedimentation of terrestrially derived materials and scouring of existing sediments during times of accelerated runoff. The combination of changing sediment conditions and habitat disruption make tributary deltas prime locations for milfoil infestation (Madsen et al. 1989).

Around the 125-mile perimeter of Lake George, NY, there are 132 stream tributaries (Eichler et al. 1997, 1998, 1999). Stream delta surveys were initiated in 1987, with 2 years required to survey all 132 stream deltas. A second lakewide stream delta survey for the presence of Eurasian watermilfoil was completed between 1989 and 1990. Lakewide stream delta surveys were extended to 3 years in 1991, in order to balance the number of tributary sites surveyed in each year and to stabilize the cost of the survey. Approximately 45 tributaries are surveyed each year in a three-year cycle with a south, central, and north component of nearly equal numbers of

stream deltas. Since these are readily located sites for which the presence or absence of milfoil is known from previous surveys, regular revisits provide data on whether appreciable new infestation, re-invasion, or natural mortality of earlier infestations has occurred. Data from each lakewide survey cycle, 2 or 3 years, is pooled for comparison purposes. Since 1987 stream delta surveys have provided a means for rapidly finding new sites with milfoil, including the establishment of a regular search pattern to ascertain the relative distribution of milfoil among the native plant communities in the lake.

The long-term implications of this research program are to 1) determine the rate of spread of an introduced species in a northern temperate, lake system, 2) provide survey support for an aquatic plant management program and 3) document ecological changes in the aquatic plant community over time.

MATERIALS AND METHODS

Lake George is an oligotrophic lake (average depth 20 m; average secchi measurements 7-10 m) located in the southeastern quadrat of the Adirondack Park in upstate New York (Figure 1). It is part of the Lake Champlain drainage basin. Lake George is a multi-purpose water body, combining intense recreational use with a potable water supply. This large lake (28,000 acres) supports a diverse assemblage of submersed aquatic plants with approximately 48 species reported (Ogden et al. 1976).

Prior to the initial survey in 1987-88, one hundred and thirty two tributaries to Lake George, NY, were identified, marked and numbered on topographic maps of the lakeshore. Tributaries included both seasonal and continuously flowing streams. Each stream delta was located by topographic map and GPS coordinate set. A survey crew consisted of two SCUBA divers, knowledgeable in aquatic plant identification. Once a stream delta was located, one diver initiated a search of the littoral zone for the presence of Eurasian watermilfoil. With the point at which the stream meets the lake as the midpoint, the diver inspected an area bounded by 50 m on either side of the intersection of the stream with the lake. The search pattern commenced at the lakeshore and extended to the outer margin of rooted plant growth, generally 7 to 8 m water depth. In shallow bays, the search zone was limited to a maximum of 100 m from shore, thus creating a search area of 10,000 m^2. Prior to 1991, the second diver provided logistical support and safety surveillance.

In 1991, records of presence and relative abundance (percent cover) of all aquatic plant species present at stream deltas were incorporated into the survey design. In the ensuing survey years, the second diver recorded all aquatic plant species present with their percent cover from the lakeshore to the maximum depth of rooted aquatic plants. The diver was equipped with a waterproof data form to log all observations underwater. These diver swimover transects were completed at each site to characterize species presence and distribution in the macrophyte community, as well as, to estimate the abundance of all aquatic plant species at each 1 m depth interval using the abundance classes shown in Table 1.

Divers determined depth intervals with a calibrated line attached to a surface float (dive flag). By applying tension to the line until the float is directly overhead, water depth was determined. Depth was also verified by dive console depth gauges, which are accurate at depths greater than 2 m.

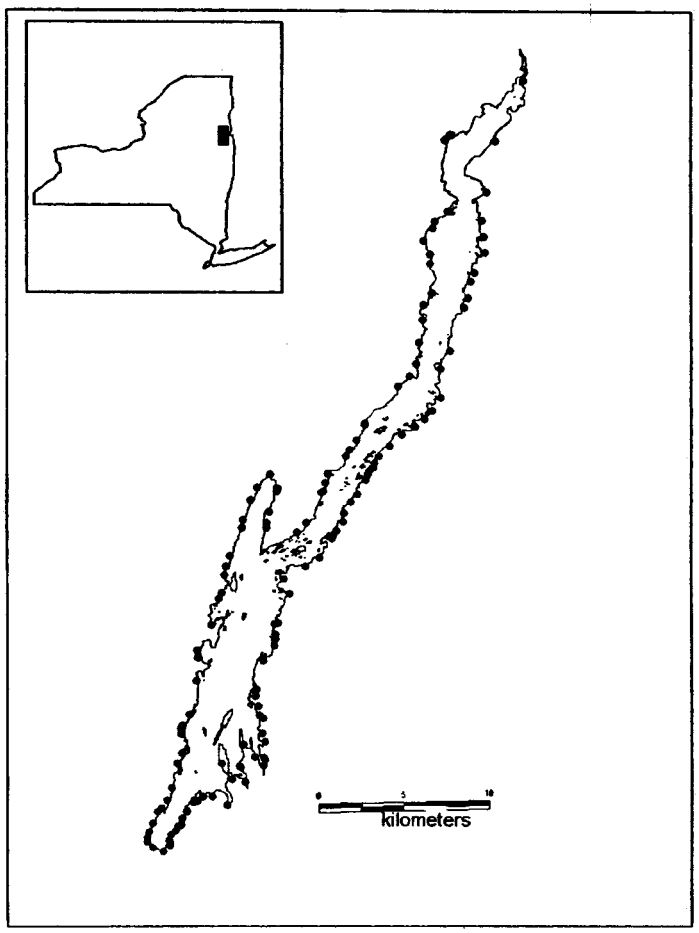

Figure 1. Map of Lake George, NY showing location of stream delta survey sites.

Percent cover data provide both the average depth distribution of all aquatic plants present and an estimate of the relative abundance of species at each stream delta site. Data are expressed as median values of the percent cover estimates. Such information is important for future management decisions concerning milfoil control alternatives and environmental regulatory permit applications required as part of any management strategy.

TABLE 1. ABUNDANCE CLASSES USED IN DIVER SWIMOVER TRANSECTS TO ESTIMATE PLANT SPECIES ABUNDANCE.

Classification	% Cover Range	Median
Abundant	Greater than 50% cover	75.0%
Common	25% to 50% cover	37.5%
Present	15% to 25% cover	20.0%
Occasional	5% to 15% cover	10.0%
Rare	Less than 5% cover	2.5%

RESULTS AND DISCUSSION

From the standpoint of anticipating where milfoil will become established in the lake, stream delta surveys have been successful. Of the 134 sites throughout the littoral zone where milfoil has been found, 76 (57%) have been associated with stream deltas. However, it should be noted that 6-12 new sites are found yearly throughout the lake; consequently, half of these are stream delta sitings. When stream delta surveys were initiated in 1987-1988, 28% of the sites in the basin were found to already support milfoil. By 1997-1999, this percentage had increased to 48%, with an overall rate of colonization for the lake of 8-10% per year (Eichler et al. 1997, 1998, 1999).

In the last two survey cycles (6 years), milfoil occurrence by lake section has averaged 42% for the south basin, 22% for the central portion, and 43% for the northern basin of the lake, compared to 30%, 15% and 22%, respectively, for the three portions of the lake when the survey began in 1987-1988. Milfoil occurrence throughout the lake associated with stream deltas is shown in Figure 2. In the bar graph, each lakewide sampling cycle is pooled to present a whole lake view. Since the program began there has been a steady rise in the cumulative number of sites which have ever supported milfoil (open bars), reflecting the discovery each year of sites at which milfoil had not previously occurred (black bars). For each lakewide cycle a substantial number of milfoil sites are recolonized, following previous milfoil management efforts (striped bars). Physical management has been applied to the majority of stream delta sites on an annual basis. Hand harvesting of moderate stands of Eurasian watermilfoil has been determined to be 85% efficient (Boylen et al. 1996); suction harvesting of larger densities of plants is less efficient. Consequently, some milfoil plants will always remain. The comparison of the cumulative number of sites to the current number of sites represents the long-term effectiveness of the physical management program. We feel our overall management strategy is successful if the number of current sites (Figure 2) stays level or declines, even though the cumulative number of sites continues to increase.

Even in those small numbers of sites where removal is 100% effective, there is no guarantee that in a later survey milfoil will not reestablish itself. For example, the 1999 survey of the northern basin identified 3 new sites out of the 41 stream deltas (7%) with milfoil present for the first time since the survey had begun in 1987. However, a total of 18 sites (44%) had milfoil present at the time of the survey in 1999, reflecting either incomplete harvesting during the previous survey cycle or reinfestation.

In 1991, the surveys moved from a strictly presence/absence protocol for Eurasian watermilfoil to one that also determined frequency of occurrence and percent cover of all native species as well as Eurasian watermilfoil. In the first lakewide cycle of community assessment (1991-1993), milfoil was ranked 16th, 28th, and 19th by frequency of occurrence in the south, central and northern sections of the lake, respectively. In the most recent cycle (1997-1999), milfoil ranked 24th, 29th, and 28th, respectively. The decline in frequency of occurrence of milfoil can be attributed to the removal of milfoil by hand harvesting and other management techniques, and thus an overall reduction in the frequency of occurrence relative to native plant species.

Average percent cover data for all sites have shown the stream deltas to support a highly diverse assemblage of native species. Of the 48 species of submersed aquatic plants identified for Lake George (Ogden et al. 1976), 46 species were found at stream delta sites. Depth distribution and average percent cover can be used to highlight changes in aquatic plant distribution over time. When coupled with other survey efforts, these techniques can describe the impacts of Eurasian watermilfoil expansion on native aquatic plant species. The average percent cover and depth distribution for the 6 most common native species (Figure 3) indicate distinct depth preferences for most species. *Potamogeton robbinsii* is the most common native species with respect to percent cover, present over a wide range of depth intervals, without clear dominance in any depth interval. *Vallisneria americana* ranked 2nd,

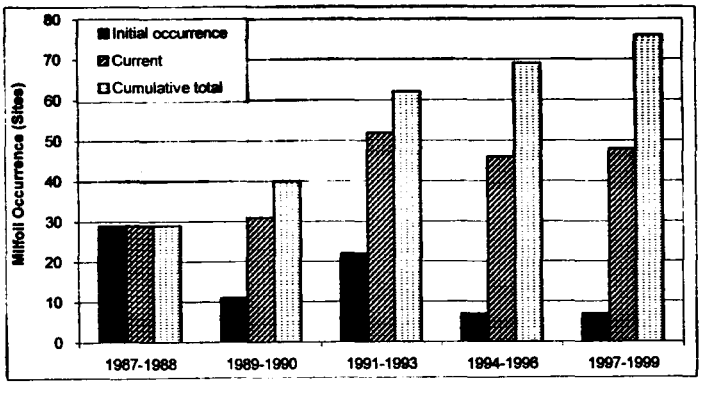

Figure 2. *Myriophyllum spicatum* occurrence in stream deltas of Lake George, NY since 1987. ***Initial occurrence*** refers to the first occurrence of milfoil at a stream delta site, ***current*** refers to the presence of milfoil at a site in the most recent survey year, and ***cumulative*** refers to the number of sites where milfoil has been found at any time during the 13 years of surveys.

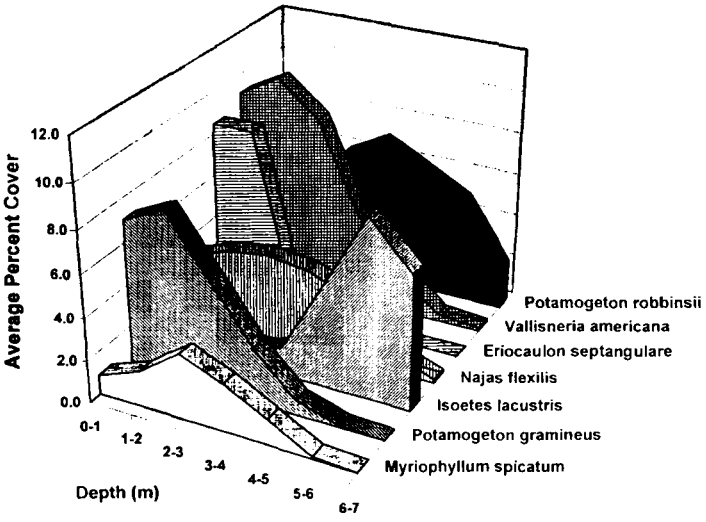

Figure 3. Average percent cover estimates of the 6 most abundant submersed native species and *Myriophyllum spicatum* inhabiting the stream deltas of Lake George, NY.

and *Eriocaulon septangulare* ranked 3rd; both display distinct depth preferences. Eurasian watermilfoil, ranked 13th by average percent cover, is also shown for comparative evaluation. Species with preferred depth ranges overlapping those of Eurasian watermilfoil will be the most likely to be impacted by unabated expansion of this species.

Although the number of observations is limited for development of a statistically reliable rate of colonization, new sites continue to be colonized on a year-to-year basis. The rate of increase of Eurasian watermilfoil occurrence at the 132 stream delta sites over the 12-year span of the study is approximately 6-12 new sites per year, or a 9% annual rate of colonization. At the current rate, all remaining stream deltas would be colonized by Eurasian watermilfoil over the course of the next several years. The occurrence of milfoil at sites that had been cleared by management efforts in previous years also indicates that continued surveillance and maintenance of milfoil sites is necessary. The more sobering indication from the recurrence of milfoil at previously harvested sites is that there is no evidence of natural mortality of Eurasian watermilfoil in Lake George. Although milfoil populations at numerous locations in the lake may not expand for several years, clearly they are not dying off on their own.

Results of stream delta surveys in combination with the Eurasian watermilfoil management program (Eichler et al. 1997) demonstrate the need for continued management of Eurasian watermilfoil in Lake George. The management program encompasses several different techniques reflective of different stages of milfoil development. Stream delta surveys provide a means of mapping the rate of milfoil colonization, and the management program provides a means of limiting the rate of spread once these sites have been located. Increasing public awareness of the effects that milfoil has on the Lake George ecosystem, and how the public can help reduce further introduction into the Lake George watershed is an additional benefit to limiting the spread of milfoil.

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