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Suction Harvesting of Eurasian Watermilfoil and Its Effect on Native Plant Communities

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ABSTRACT

Seven sites on Lake George, New York, were selected for control of Eurasian watermilfoil by a diver-operated suction harvester. Prior to suction harvesting, ten 0.1-m^2 biomass samples were collected from each site. Samples were randomized within the area to be harvested, sorted by species, dried and weighed. A grid system of 36 contiguous 1-m^2 quadrats was also located within each of the treatment areas. The species present and their relative percent cover in each quadrat were recorded prior to harvest, shortly after and 1 year postharvest. A substantial reduction in the biomass of milfoil at all sites was noted as a result of suction harvesting. One year after harvest, the impact of harvesting on the native plant community included a greater number of species per unit area and reduced biomass and percent cover at a majority of the treated sites.

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INTRODUCTION

Eurasian watermilfoil (*Myriophyllum spicatum* L.) was discovered in 1985 in Lake George, a large oligotrophic lake (3 km by 50 km; 110 km^2) located in northeastern New York State. Initially found in only three bays, it had spread to over 90 locations by 1991. Herbicides and mechanical cutting programs were unacceptable because the lake is used as a public water supply and the spread of the plant would be accentuated by fragmentation generated by cutting. Management targeted at milfoil was initiated in 1989 as part of a U.S. EPA Clean Lakes Phase II program and utilized physical control techniques such as hand harvesting, benthic barrier, and suction harvesting. In 1990 suction harvesting was proposed as the primary management technique at seven sites where both the effectiveness of control and evaluation of its impact on native plant communities would be documented.

METHODS

Harvesting sites were chosen from throughout Lake George to represent a variety of sediment types, slopes, shoreline orientations, and diversity of native plant communities. Site names and milfoil location numbers are given in Table 1.

The suction harvester was a diver-operated, hydraulic vacuum system that was created by a diesel-powered venturi pump mounted on a 28-ft pontoon boat. The plant material, including vegetative stem and leaves plus roots, was pulled from the bottom by the diver and fed by hand into one of two 4-in. vacuum hoses. The harvested material was pumped via the vacuum hose and venturi system to the surface of the lake and discharged into an aluminum wet well mounted in the deck of a second pontoon boat. The wet well was perforated to allow water and sediment to drain back into the lake, while retaining the harvested plant material.

Prior to suction harvest, each milfoil colony was mapped with the perimeter of the harvest area identified by permanent submerged markers. These provided reference locations for biomass collection and for the placement of grids for percent cover measurements of the plant community. Plant biomass within each treatment site was determined prior to treatment. Within each harvest area, ten 0.1-m^2 biomass samples were collected randomly, sorted to species, and dried to constant weight. A second set of biomass samples was collected 1 year following treatment.

A grid system of contiguous 1-m^2 quadrats was established in each treatment area. Two grids of 3 m by 6 m were installed at sites with sufficient harvest area, while smaller sites received a single 3-m by 6-m grid. The species present in each grid and their relative abundance were recorded prior to harvest, shortly after harvest, and 1 yr later.

RESULTS AND DISCUSSION

Effectiveness of suction harvesting was evaluated by (a) comparison of the weight of milfoil removed during initial harvesting with the weight removed 1 yr later, that is the regrowth, (b) comparison of the number of man-days expended to harvest each site initially and the man-days expended to harvest regrowth 1 yr later, and (c) the dominance of milfoil at each site enumerated by biomass and percent cover data before and after suction harvesting. Total harvest weight, rather than harvest weight per unit area, was used because of the heterogeneity of milfoil distribution within each area harvested.

In 1990, a total dry weight of 710 kg of milfoil was removed by suction harvesting from all the evaluation sites (Table 1). Hand harvesting of regrowth of milfoil during follow-up visits in 1991 yielded 49.6 kg at six of the sites. At the remaining site (M-61), growth of milfoil within the perimeter of a beaver lodge was sufficiently dense to exceed levels which could be readily hand harvested. Discounting this site, 684 kg were removed by suction harvesting and regrowth 1 yr later (49.6 kg) represented only 7% of the initial biomass of milfoil. Stated another way, 93% of the dry weight of milfoil, on average, was removed from each site by suction harvesting. Comparing initial suction harvesting and follow-up hand harvesting 1 yr later (Table 1), removal efficiencies ranged from 86 to 94%. This removal efficiency is comparable to that previously reported for hand harvesting of milfoil in Lake George (Eichler *et al.* 1991b).

A total of 28 man-days was spent suction harvesting milfoil in 1990 (Table 1). This effort is actual time spent in plant management, and does not include man-hours spent in evaluation activities such as percent cover and biomass determinations. On a site-by-site basis, harvesting efforts for regrowth required from 64 to 89% fewer man-hours than initial harvest efforts. Removal of regrowth by hand harvesting in 1991 required 5.7 man-days or 20% of the initial harvesting effort. The use of hand harvesting to remove milfoil during follow-up visits was considerably more labor intensive than suction harvesting on a biomass-removed-per-unit-effort comparison.

Suction harvesting reduced both the biomass and percent cover of milfoil. Milfoil was the most abundant species by

TABLE 1. SUCTION HARVEST SITES, WITH MILFOIL SITE NUMBER (M number) AND AREA OF HARVEST. INITIAL PLANT HARVEST (milfoil dry weight removed and harvest effort) WAS MADE IN 1990 WITH FOLLOW-UP COLLECTIONS IN 1991.

Site	M number	Area (m^2)	Dry weight (kg)		Effort (man-days)	
			Initial	Follow-up	Initial	Follow-up
Westover Lodge	M-29	838	46	5.9	4.4	0.7
Bolton Bridge	M-44	168	51	4.1	3.5	1.2
Smith Bay	M-47	591	74	5.9	3.7	1.3
Eichlerville	M-51	354	40	5.5	3.1	1.1
S. Green Island	M-57	443	357	20.0	5.7	0.9
Camp Andrew	M-60	213	116	8.2	4.7	0.5
Harbor Island	M-61	221	26	—	2.9	—
Total		2828	710	49.6	28.0	5.7

weight in the biomass samples prior to suction harvesting (Figure 1) and declined to the fifth most abundant species after harvesting. Total biomass declined or remained the same following treatment. Substantial decreases in total biomass were observed following harvesting at three sites, M-44, M-57, and M-60.

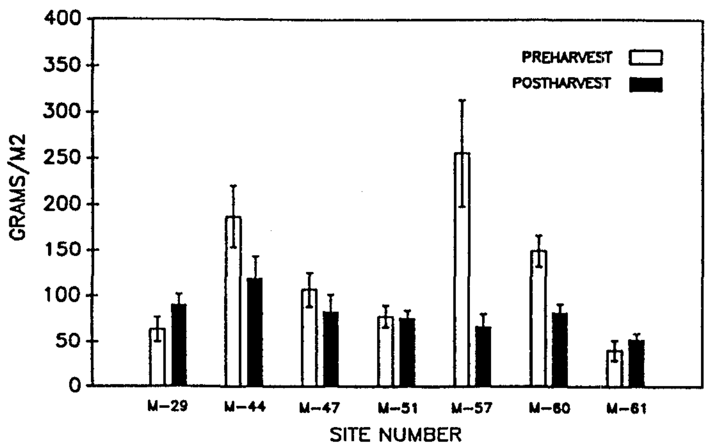

Figure 1. Comparison of aquatic plant biomass before and after suction harvesting. Error bars represent mean values + standard error, n = 10.

Site M-57 displayed the greatest differences in both the number of species present and the total biomass. The depth distribution of milfoil at this site produced plants in excess of 3 m in height. Two species, milfoil and coontail (*Ceratophyllum demersum* L.), dominated, accounting for more than 90% of the total biomass prior to suction harvesting. The dominance of these two species at this site and the tendency for them to be intermingled resulted in a greater proportion of the total plant community being removed by suction harvesting, milfoil and coontail representing 75% of the total biomass by weight. Coontail, lacking roots, is particularly susceptible to removal or relocation by harvesting activities. An increase was observed in the average number of species present in each biomass sample at this site, from 5.7 prior to suction harvesting to 10.0 1 yr postharvesting, while biomass declined from an average of 256.1 g/m^2 prior to harvesting to 66.5 g/m^2 following suction harvesting.

The substantial differences between sites in both the number of species present and total biomass can be attributed to physical characteristics of each site (*i.e.* depth, sediment type, and bottom slope) and dominance of milfoil. At the sites selected for evaluation, sediments ranged from soft silt and clay (M-47, M-57 and M-61) to sand and silt (M-29, M-44, and M-60) and detrital material (M-51). Soft sediments generally supported the greatest biomass and species diversity, harder sediments supported intermediate levels of biomass and species diversity, and detrital sediments supported the most impoverished aquatic plant populations, particularly those overlying hard bottoms.

Results for number of species and total percent cover within the grid systems are presented in Figures 2 and 3. One year postharvest, six of the seven sites had greater numbers of species present than before harvesting and one had fewer. The general increase in the number of species present following the removal of milfoil supports the conclusion that milfoil suppresses native species (Eichler *et al.* 1991a, Madsen *et al.* 1988). The increase in number of species 1 yr after harvesting also indicates that suction harvesting does not have long-lasting negative impacts on plant communities.

Total percent cover within the grid systems declined sharply between preharvest and postharvest ranging from 10 to

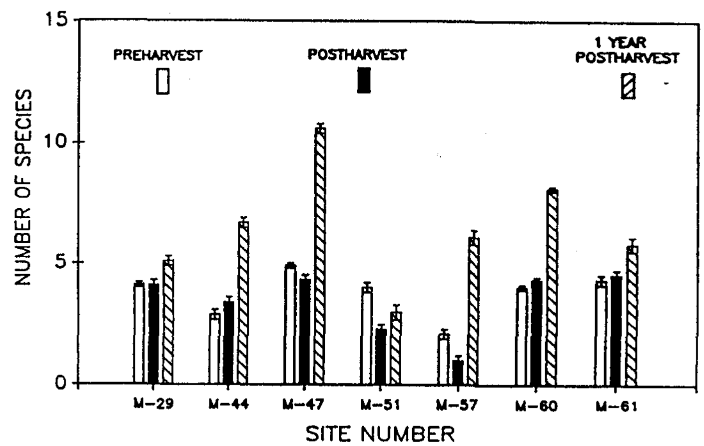

Figure 2. Comparison of number of species per site with grid quadrats inspected before (preharvest), shortly after (postharvest) and 1 yr following suction harvesting. Error bars represent mean values + standard error, n = 36.

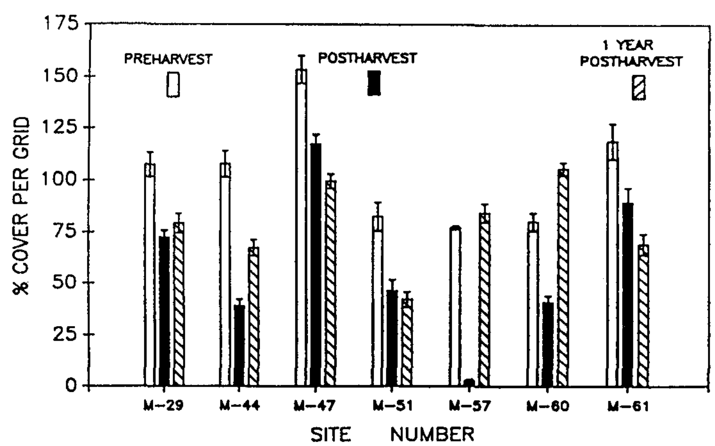

Figure 3. Comparison of relative percent cover within grid quadrats inspected before (preharvest), shortly after (postharvest) and 1 yr following suction harvesting. Error bars represent mean values + standard error, n = 36.

80% as a result of harvesting activities. The most intensively harvested site, South Green Island (M-57), showed the greatest reduction in total percent cover, with the plant community almost completely removed through suction harvesting and physical dislocation of nonmilfoil species as a result of the activities of the divers operating the harvester. Percent cover results 1 yr following harvesting were highly variable relative to percent cover prior to harvesting activities (Figure 3). Five of the seven sites had not returned to preharvest percent cover 1 yr following harvesting.

Reviewing changes in percent cover on a species-by-species basis (Figure 4), milfoil showed the greatest changes as would be expected. From an average preharvest percent cover in excess of 30% for all grids, milfoil declined to less than 5% as a result of harvesting. One year later, milfoil remained at an average of approximately 7% cover. Other species showed variable responses to suction harvesting. A decline in the percent cover of *Potamogeton amplifolius* and *Vallisneria americana* was observed while *P. robbinsii*, *Heteranthera dubia*, *Elodea canadensis*, and *P. gramineus* reflected little change in percent cover relative to harvesting. Both *V. americana* and *P. amplifolius* are perennials, and expand their populations primarily through growth of sub-sediment runners. The inadvertent harvesting of one plant of either of these species frequently removed a number of plants growing from the same runner. *Najas flexilis* showed substantial increases in percent cover relative to suction harvesting. This species is an annual, growing from seed each year. Following harvesting, areas of exposed bottom were present which would encourage species which spread primarily by seeds or turions.

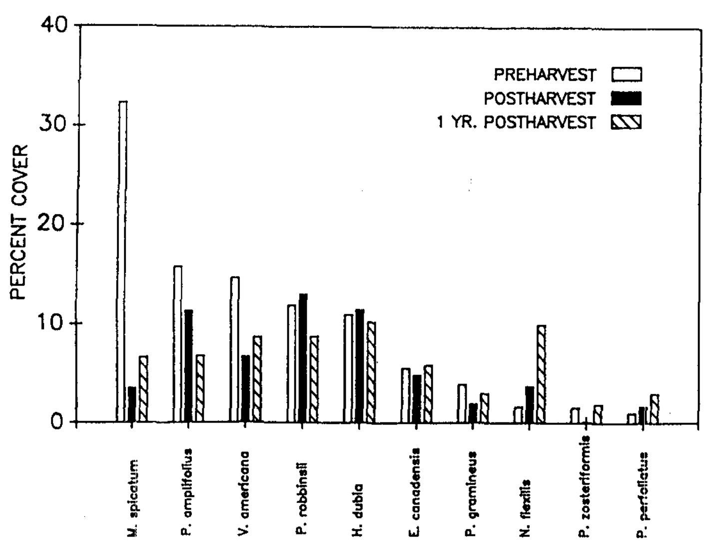

Figure 4. Comparison of relative percent cover determined for the ten most abundant species before (preharvest), shortly after (postharvest), and 1 yr following suction harvesting.

Suction harvesting was found to have a number of limitations, primarily in relation to physical characteristics of the sites harvested. Soft flocculent sediments or shallow waters were not well suited for suction harvesting. Flocculent sediments disturbed easily and reduced visibility. Shallow waters limited diver access and handling of the suction harvester intakes. Suction harvesting is best suited for areas where milfoil reaches moderate to high density infestation levels over limited geographic areas and plant density is too great for hand harvest. Transportation and setup time make this technique impractical for sparsely scattered populations. The principal limitation of this technique for large, dense milfoil populations relates to availability of equipment, manpower, and financial resources for suction harvesting. Disposal of the harvested material also requires substantially more effort for larger areas.

In comparing cost effectiveness per unit effort, one should bear in mind the selectivity of the suction harvesting technique. This technique is applied to areas where the target species (milfoil) is a major component of the total population, but less than a clear dominant. Cost per unit effort is based on an 8 hr man-day at $160 per man-day. Using this base, suction harvesting costs in this program were $6.32 per kilogram dry weight of milfoil removed. On an aerial basis, costs were $1.58 per m^2 or about $15,800 per hectare. These costs are based on labor alone and do not reflect expenses associated with equipment, transportation, survey, and evaluation.

In conclusion, results for suction harvesting indicate that while this technique did not eliminate milfoil populations in a single season of harvesting, a substantial reduction in the biomass of milfoil present and management effort necessary to maintain these locations was achieved. Impacts on the native plant community adjacent to managed areas also appeared to be relatively minor, with benefits including increased number of species and reduced percentage cover of aquatic plants observed at the majority of sites following harvesting efforts.

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