# The Use of Fiberglass Screens for Control of Eurasian Watermilfoil

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## ABSTRACT

Vinyl coated fiberglass mesh (64 aperatures/$cm^2$) screening material was placed upon 216 $m^2$ test plots within an embayment of Lake Washington infested with Eurasian watermilfoil (*Myriophyllum spicatum* L.). The screens were immediately effective in providing a plant-free water column. Coverage for 1, 2 and 3 month periods resulted in substantial reductions in plant dry weight biomass relative to untreated control areas. Optimum coverage time was 2 months which resulted in a 75% reduction in biomass with only limited regrowth after panel removal. The screens appear to be well suited for the enhancement of localized areas suffering from nuisance growths of aquatic plants.

## INTRODUCTION

Aquatic vascular plants are generally recognized as characteristic and essential components of many aquatic environments. While the understanding of the overall significance of the growth of aquatic plants in relationship to such basic system processes as energy flow and nutrient dynamics is limited (13), certain features of that growth are too obvious and demand attention. The proliferation of aquatic plants and attendant water use problems is well known. Particularly notable in this regard are several plant species which have been introduced into North American including waterhyacinth (*Eichhornia crassipes* (Mart.) Solms), hydrilla (*Hydrilla verticillata* Royle) and Eurasian watermilfoil (*Myriophyllum spicatum* L.).

In consideration of its more general distribution, Eurasian watermilfoil can perhaps be regarded as one of the most significant of the nuisance aquatic plants infesting many lakes throughout North America. The biological characteristics of this plant have been reviewed by Patten (9), Reed (10) and Grace and Wetzel (5). While it has been reported that the presence of Eurasian watermilfoil does not always lead to major infestations (5), it has been amply documented that in many lake systems Eurasian watermilfoil can completely dominate in a matter of a few years (4, 8, 9, 10, 11).

Recently, excessive growth of Eurasian watermilfoil within various inland waters of the Seattle metropolitan area prompted local agencies to initiate a series of studies to define the local distribution and relative abundance of the plant and to evaluate potential control strategies. The summary of management techniques provided by Nichols (7) was used as the basis for evaluation. While the use of herbicides was recognized as one of the most widely applied techniques, emphasis was given to non-chemical approaches.

Among those non-chemical options evaluated for field application and testing was a vinyl-coated fiberglass mesh screening material known commercially as Aquascreen (Menardi-Southern, division of United States Filter Corp., Augusta, Ga.). The use of this material was first reported by Mayer (6) who demonstrated its potential effectiveness for management of milfoil and other aquatic plants in Chautauqua Lake, New York. This material appeared particularly attractive since it would allow for dissolved substance transfer at the sediment-water interface and was effective after short periods of coverage. Mayer's results suggested that the material required only temporary placement, hence constituting no permanent alteration of the bottom sediments, and that a single panel could be moved from area to area within a single growing season. The environmental impacts associated with the use of the material appeared negligible (6). For these reasons Aquascreen was selected for field testing in this study.

The concept of using blanketing materials in an attempt to control nuisance growths of aquatic plants is not new. Born, et al. (3) reported on the use of sand, gravel and black plastic sheeting in Marion Millpond, Wisconsin. Nichols (7) has summarized similar applications in Windfall Lake, Wisconsin. The results of these applications indicated generally good first year control of aquatic vascular plants. However, growth in subsequent years was such that the benefits derived from the initial applications were largely offset. Various combinations of blanketing materials and gravel have been used in Cox Hollow Lake, Wisconsin with excellent first year results (S. Engle, personal communication). A follow-up evaluation in Cox Hollow Lake is pending.

In the above studies, the blanketing materials were placed either during the winter on the lake ice pack or immediately after ice out but before active plant growth began. The applications were permanent and would represent significant alteration of the bottom substrate.

## METHODS AND MATERIALS

The area selected for test application of Aquascreen was a plant-infested embayment, Union Bay, at the outlet of Lake Washington (Figure 1). Union Bay is relatively large,

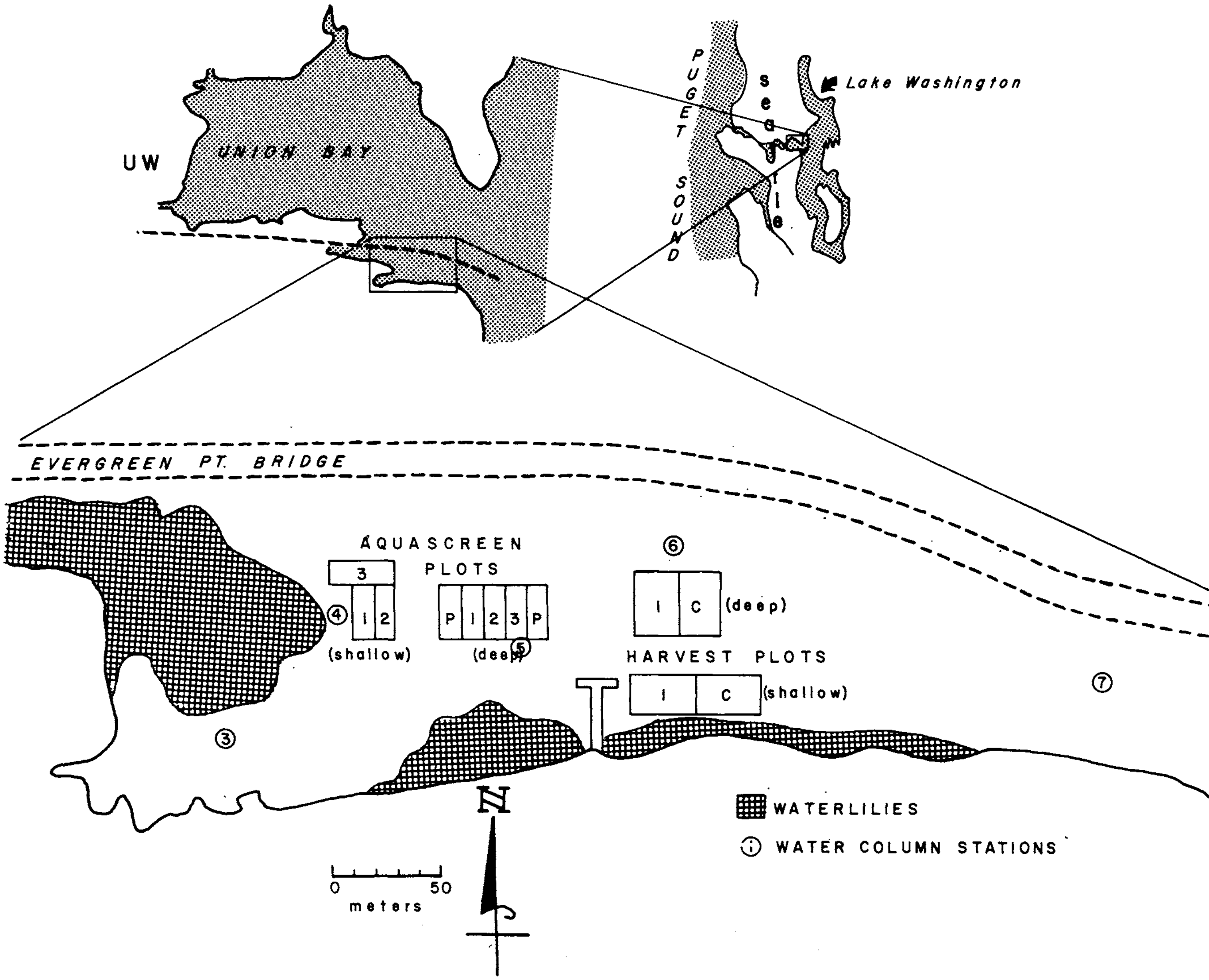


**Figure 1.** Location of water sampling stations[1] and test plots within Lake Washington's Union Bay.

approximately 140 hectares, and shallow with depths averaging 2 to 3 meters. Nuisance growth of Eurasian watermilfoil was first noted in 1973.[1] Presently, approximately 80 to 90% of the bay's area is infested, to varying degrees, with this plant.

Within the study area two test plots were delineated for the use of Aquascreen. The major variable in plot selection was water depth such that a shallow water (0.5 to 2.0 meters) and deep water (2.0 to 3.0 meters) application was tested. The primary objective of the initial application was to determine the relationship between coverage time and effective plant control. Each test plot was subdivided into four treatment plots measuring approximately 9 x 24 meters. Each treatment plot was covered with a screening panel. Panels were removed at one, two, and three month intervals with one panel being left within each test plot for overwinter coverage (Figure 1).

The screening material was the same as that described by Mayer (6), a 400 mesh screen having 64 aperatures per cm$^2$, each aperature measuring 1 mm$^2$. The screens were fabricated to the treatment plot dimensions (9 x 24 meters) and equipped with grommets at approximately 2 meter intervals along the edges. The panels were then folded and transported to the study area by boat. The fiberglass screening material is negatively buoyant (specific gravity 2.54) and sinks upon placement in the water. Working with two SCUBA divers, two surface swimmers and one person in the boat, the leading edge of each panel was staked along a plot reference line using 1.5 meter (5 foot) lengths of 1.9 cm (3/4 inch) concrete reinforcing bar placed through the grommet holes. The boat was then worked slowly backwards allowing the panel to feed out. The panels were spread out as they unfolded from the boat by the surface swimmers and staked at approximately 3 meter intervals by the divers. Overcoming some initial problems, the time required to place one panel was 25 minutes. After removal from the plots, the panels were spread out on shore to dry, swept clear, and then folded and stored for reuse.

Samples for plant biomass were collected by means of a

[1]Aquatic plant control in Lake Washington's Union Bay. Staff Report, Municipality of Metropolitan Seattle (METRO), 1976.

cylindrical sampler of 0.25 m² area with fish netting attached to the top of the cylinder to contain dislodged plant fragments. The sampler was lowered into the bottom and plant materials encompassed by the sampler were removed by diver (SCUBA). In the laboratory, the samples were cleaned of debris, sorted by species, and oven-dried at 60°C for 48 hours before weighing. Plant biomass samples were taken at monthly intervals through November 1978. On each sampling event, five samples were taken from each uncovered treatment plot and from the area immediately adjacent to each plot, which served as the control. Biomass values, where reported in the text, are expressed as the mean $\pm$ 2 standard errors.

Water column characteristics were monitored at 5 stations within the study area. Two of these stations were directly over the Aquascreen test sites and three were placed outside the influence of the screens (Figure 1).

Discrete water samples were taken from the surface, at mid-depth, and from the bottom at each station for the determination of temperature and dissolved oxygen. Dissolved oxygen was determined using the Azide modification of the Winkler titration (1).

Additional water column characteristics were determined on integrated samples collected by means of a weighted Tygon tube sampler. Measurements of total phosphorus, total nitrogen, sodium, calcium, magnesium, pH and alkalinity were included in the analysis. Cations were determined by atomic absorption, alkalinity by potentiometric titration, and total phosphorus by persulfate digestion with an ascorbic acid finish (1). Total nitrogen was determined by ultraviolet digestion in an apparatus similar to that described by Armstrong et al. (2) followed by a phenol-hypochlorite ammonia finish on a Technicon Autoanalyzer. Chlorophyll *a* was also measured on the water column samples using the trichromatic procedure of Strickland and Parsons (12).

## RESULTS

The characteristics of plant growth within the control areas for the shallow and deep water test plots were indicative of conditions throughout the study area. The dry weight biomass of plants for these two areas are summarized in Table 1. Plant biomass increased rapidly in August, reached peak standing crops in October and rapidly declined through November. Biomass within the shallow water area was approximately double that within the deep water area until the November sampling data, Eurasian watermilfoil being the dominant plant throughout the period. In general, for waters within the study area less than 2 meters in depth, milfoil reached the surface and formed a dense canopy with numerous flower spikes in late September. In deeper water, milfoil did not form a surface canopy and flower spike production was much reduced.

The screening panels were placed on the treatment plots in July. One panel was removed from each of the test plots in August, September, and October. The results of the screen application with the shallow and deep water test plots are summarized in Figure 2.

After one month of coverage, plant biomass within both treatment plots had increased substantially, 154% (+ 67 g dry wt. m$^{-2}$) in the shallow plot and 83% (+20 g dry wt. m$^{-2}$) in the deep water plot. Relative to the control areas, one month of coverage resulted in average decreases in plant mass of 25% and 35% for the shallow and deep water plots respectively. The most noticeable effect of one month coverage, particularly within the shallow water plot, was a very extensive milfoil stem elongation. The average stem length within the shallow water control area was 138 centimeters while stem lengths of plants which had been covered for one month averaged 212 centimeters. These elongated stems were discolored, weak and flacid as compared to untreated stems (Figure 3a, b). One month after panel removal (Sep-

TABLE 1. SUMMARY OF AQUATIC PLANT BIOMASS WITHIN THE SHALLOW AND DEEP WATER CONTROL AREAS (GRAMS DRY WEIGHT METER$^{-2}$ $\pm$ 2 STD. ERRORS).

| | Grams Dry Weight Meter$^{-2}$ | | | | |
|---|---|---|---|---|---|
| Shallow Water Area | JUL | AUG | SEP | OCT | NOV |
| *Myriophyllum spicatum* | 43.30 | 137.08 | 166.68 | 244.31 | 86.28 |
| *Ceratophyllum demersum* | 0.16 | 9.99 | 4.13 | 0.75 | 0.02 |
| *Najas flexilis* | — | 0.30 | 0.04 | 0.06 | — |
| *Potamogeton crispus* | — | 0.01 | 1.49 | 0.42 | 0.02 |
| *P berchtoldii var.* | 0.01 | 0.29 | 0.05 | — | — |
| *P. richarsonii* | — | — | 0.04 | — | — |
| *Elodea canadensis* | — | — | 0.13 | 0.02 | 0.01 |
| Total Biomass | 43.5 $\pm$ 23 | 147.7 $\pm$ 16 | 172.5 $\pm$ 34 | 245.6 $\pm$ 81 | 86.3 $\pm$ 26 |
| % Milfoil | 99+ | 93 | 97 | 96 | 99+ |
| Deep Water Area | | | | | |
| *M. spicatum* | 23.95 | 63.46 | 75.67 | 101.11 | 91.36 |
| *C. demersum* | — | 6.02 | 2.61 | 0.06 | 0.02 |
| *N. flexilis* | — | 0.17 | 0.01 | — | — |
| *P. crispus* | — | — | 0.04 | 0.04 | — |
| *P. berchtoldii var.* | — | — | 0.08 | — | — |
| *P. richardsonii* | — | — | — | — | — |
| *E. canadensis* | 0.88 | — | 0.59 | 1.04 | — |
| Total Biomass | 24.8 $\pm$ 17 | 69.65 $\pm$ 29 | 79.0 $\pm$ 26 | 102.2 $\pm$ 45 | 91.4 $\pm$ 20 |
| % Milfoil | 97 | 91 | 96 | 99 | 99+ |

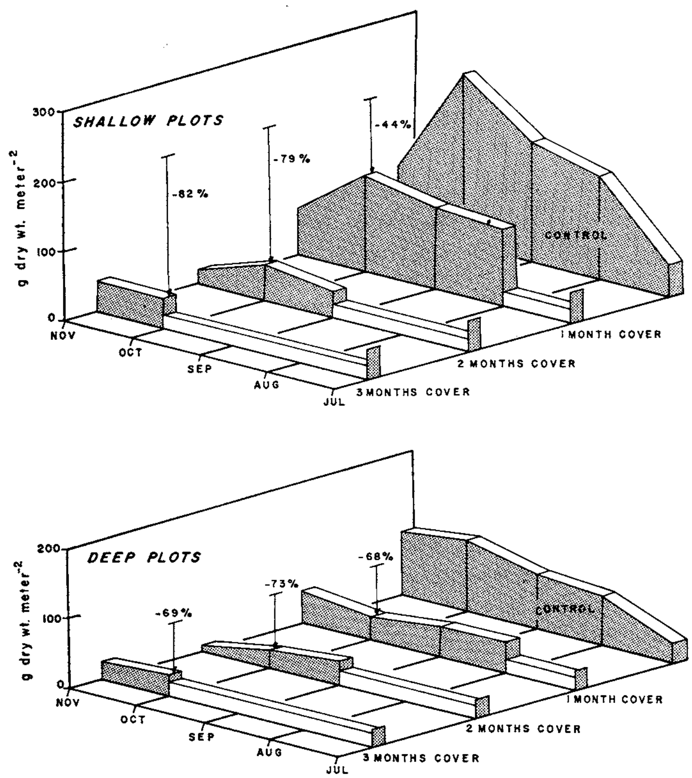


Figure 2. Results of the Aquascreen applications within the shallow and deep water test plots. The percent reductions in dry weight biomass relative to untreated controls are shown for the October sampling date.

tember sampling date) plant growth within the one month coverage plot had not increased significantly. Plant biomass within the shallow and deep water plots were 31% and 45% less than their respective control areas. Two months after panel removal (October) regrowth was evident only in the shallow water plot. Plant biomass within that plot had increased to approximately 138 g dry wt. $m^{-2}$ which represented a 25% increase from the time of panel removal. Plant biomass in the deep water plot had decreased from the previous month. Relative to the October control areas, the plant biomass reductions attributable to one month of screening in July were 44% and 68% within the shallow and deep water plots respectively.

The Aquascreen panels were removed from the two month treatment plots in September. While there was again some milfoil stem elongation, the number of remaining old stems was greatly reduced. Milfoil growth beneath the screens consisted primarily of healthy appearing new shoots arising from the base of existing root crowns. The dry weight plant biomass within the two plots ($37.4 \pm 20$ grams $meter^{-2}$ shallow and $35.0 \pm 11$ grams $meter^{-2}$ deep) was not significantly different from the initial July biomass. Relative to their respective control areas (Table 1) the reductions in plant mass were 78% in the shallow plot and 56% in the deep plot. One month after removal of the two month coverage panels (October sampling), plant biomass within the shallow plot had increased to $50.8 \pm 17$ grams dry wt. $meter^{-2}$ (36%). There was no increase in biomass within the deep water plot. The percent reductions relative to biomass within the controls for the October sampling data were 79% and 73%, shallow and deep respectively.

Removal of the three month coverage panels in October indicated the presence of healthy plant materials but at a level much reduced from that in the surrounding areas. Milfoil again consisted primarily of new shoots coming from the base of root crowns. Plant biomass within the three month plots was again not significantly different from that occuring at the time of panel placement in July. Plant reductions expressed as a percent of the untreated October controls were 82% in the shallow plot and 69% in the deep plot.

The November biomass sampling indicated a general reduction in plant biomass in both the control areas and treatment plots with the exception of the three months coverage plots which maintained approximately the same biomass as present at the time of panel removal in October.

The screening panels appeared to be more effective in preventing the growth of the three species of *Potamogeton* and *Najas flexilis* present in the study area. While these plants appeared to survive one month of coverage, two and three months cover virtually eliminated them. *Ceratophyllum demersum* and *Elodea canadensis* appeared to do equally well with or without the screens but their growth was fairly sparse. Milfoil was always the dominant plant, never representing less than 83% of the total plant material collected from any one plot.

**Water Quality**

The results of the water sampling at the five stations within the study area are summarized in Table 2. For most of the characteristics examined there were no significant differences between stations which could be attributed to the presence of the screening panels. A simple coefficient of variation ($CV = s/\bar{x}$) was calculated for each characteristic on each sampling day. These were then averaged over the period of observation to provide an indicator of characteristic variability. Chlorophyll *a*, total phosphorus, and total nitrogen showed high variability between stations. This variability in total phosphorus and total nitrogen was due primarily to consistently higher concentrations measured at station 3. This particular station was the most isolated of the stations sampled (Figure 1) and was not considered indicative of conditions within the general study area. Station 3 also had lower dissolved oxygen concentrations (minimum observed was 2.8 mg $O_2$ $l^{-1}$ on August 15) which were not observed at any of the remaining stations.

Chlorophyll *a* concentrations were fairly uniform with the exception of station 4 which was located in the area of the shallow water control plot (Figure 1). Higher values of chlorophyll *a* were typically observed at this station. This may have been due to the sloughing of epiphytes from the dense growths of plants at station 4. Such an effect was particularly evident during the October-November sampling dates when milfoil with the shallow water areas was heavily epiphytized by growths of *Spirogyra*. Chlorophyll *a* concentrations at station 4 reached maximum values of 22.4 $\mu g$ $l^{-1}$ in October and 37.7 $\mu g$ $l^{-1}$ in November while the other 4 stations averaged 6.6 and 5.7 $\mu g$ $l^{-1}$ on the same dates.

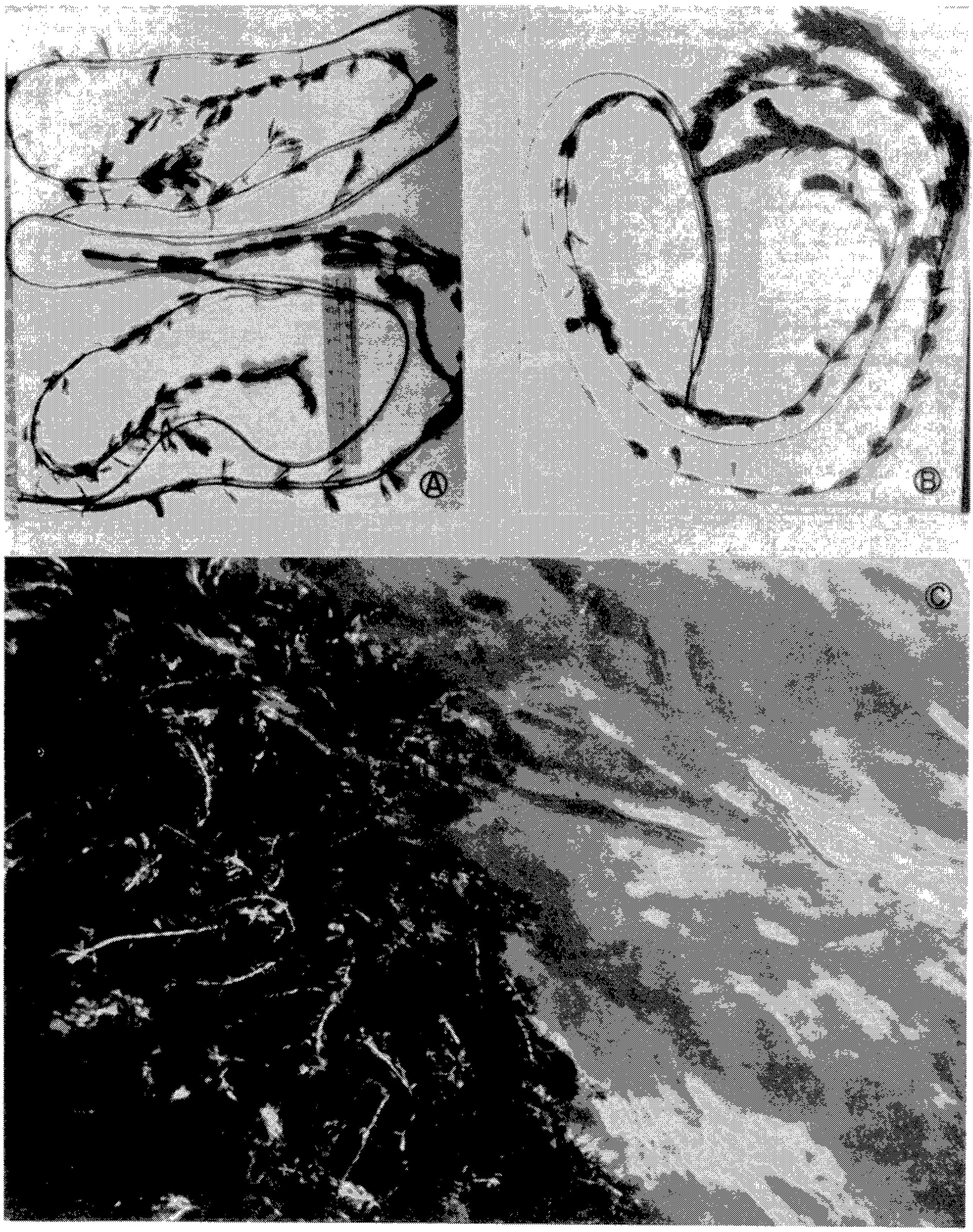


Figure 3. A. Elongated milfoil stem collected from the 1 month shallow water treatment plot in August; B. Healthy milfoil stem collected from the uncovered shallow water control area in August; C. Surface view of the 3 month shallow water screen in late September; water depth is 1.5 meters.

TABLE 2. WATER COLUMN CHARACTERISTICS WITHIN THE UNION BAY STUDY AREA (MEAN VALUES FOR 5 STATIONS ± 95% *C.I.*)

| | JUN | JUL | AUG | SEP | OCT | NOV | AVG CV |
|---|---|---|---|---|---|---|---|
| Parameter Temp (°C) | 20.0 | 21.0 | 19.5 | 16.5 | 13.0 | 8.0 | — |
| pH (Range) | 7.2-7.8 | 7.0-8.2 | 6.1-7.3 | 6.0-6.5 | 6.3-7.2 | 6.5-6.8 | — |
| Alk. (mg•$l^{-1}$ $CaCO_3$) | 38.4±0.8 | 37.9±0.7 | 37.9±2.9 | 35.9±2.5 | 36.6±1.4 | 33.6±1.4 | 0.05 |
| D.O. (mg $O_2$•$l^{-1}$) | 8.8±0.3 | 8.3±1.3 | 7.3±1.6 | 8.7±0.9 | 9.7±0.4 | 10.2±0.9 | 0.17 |
| Tot-P ($\mu$g•$l^{-1}$) | 34.6±12.1 | 23.5±9.1 | 38.0±15.4 | 12.6±8.2 | 28.6±8.9 | 36.4±18.0 | 0.46 |
| Tot-N ($\mu$g•$l^{-1}$) | 347±93 | 336±106 | 292±36 | 331±87 | 366±151 | 291±36 | 0.24 |
| Ca (mg•$l^{-1}$) | 5.5±0.5 | 9.4±0.4 | 8.0±0.3 | 9.9±0.6 | 13.1±0.7 | 12.8±0.4 | 0.07 |
| Mg (mg•$l^{-1}$) | 3.4±0.1 | 3.1±0.1 | 6.3±0.1 | 5.6±0.3 | 6.8±1.0 | 6.9±0.6 | 0.05 |
| Na (mg•$l^{-1}$) | 4.6±0.3 | 4.1±0.5 | 9.1±0.1 | 3.7±0.2 | 3.0±0.5 | 2.8±0.1 | 0.04 |
| Chl a ($\mu$g•$l^{-1}$) | 5.5±3.1 | 4.1±1.6 | 6.3±2.5 | 5.2±1.3 | 9.7±8.5 | 11.4±16.9 | 0.61 |

## DISCUSSION

The results of the Aquascreen applications in Union Bay indicated that the material was highly effective in preventing excessive growths of Eurasian watermilfoil and removing surface obstructions due to the presence of such growths. Upon placement, the screening panels provided a plant-free water column (Figure 3c) and maintained that condition for the duration of placement.

There was evidence of some single milfoil shoots growing through the screen but this was rare. More significant was fragment rooting in debris pockets on top of the screens. Due to our inexperience and a fairly dense growth of plant material, good bottom contact was not obtained with the first two panels placed in the shallow water test plot (1 month panel and 3 month panel). Consequently, these two panels "ballooned" as much as 0.5 to 1.0 meters off the bottom. Bricks were placed on these panels to weight down the center sections with the resulting formation of pockets of accumulation containing sediments, detrital material, and plant fragments. Milfoil fragments rooted and grew quite readily in these pockets. While such growth was profuse, the number of such pockets were not great enough to create a nuisance and the effect was offset when the panels were removed.

Following panel removal, plant biomass was substantially less than that occurring with the untreated control areas. Regrowth within the treatment plots after panel removal was also retarded and a reduced plant biomass was maintained for the duration of the growing season. In Union Bay, the optimum coverage time was two months, which resulted in a biomass reduction of approximately 75%.

The observed milfoil stem elongation under the 1 month shallow panel was most likely due to the ballooning effect previously noted. For reasons discussed below, the mechanism by which the panels worked was probably related to space limitation. The ballooning observed for the 1 month shallow panel simply allowed more room for stem elongation. Where the panels were laid flat over the plots and good bottom contact was obtained, stem elongation was reduced. For the optimum use of Aquascreen, it would seem imperative that good bottom contact be obtained in the initial placement.

Mayer (6) reported that two to three weeks of coverage in Chautauqua Lake, New York, provided a "totally weed free environment" beneath the screen. Clearly, such an effect was not observed under any of the panels placed in Union Bay.

One month of coverage resulted in substantial increases in plant biomass beneath the screens and even two and three months of coverage did not yield a biomass significantly different from that upon which the panels had been placed. The discrepancy between Mayer's observations and ours is not fully explained but may be due to our failure to obtain adequate sediment contact with the large panels used.

Mayer (6) has suggested that the screen effects control partially through the reduction of light available for photosynthesis. Our field observations and laboratory evaluations, however, would suggest that the control mechanism would be more closely related to sediment contact. Light limitation seems to be of less importance. While it was evident that the plants existing at the time of panel placement were in a stressed condition upon panel removal, it was also evident that the plants maintained the ability to grow beneath the screens as indicated by the presence of healthy new shoots coming from existing root crowns. Light measurements made at a depth of 1.5 meters in Union Bay indicated that available light beneath the screens ranged from 25 to 350 $\mu E\ m^{-2}\ sec^{-1}$ (measured as Photosynthetically Active Radiation with a Li-Cor Quantum Sensor, LI-192S and LI-185 meter). Eurasian watermilfoil has a relatively low light compensation point (35 $\mu$E PhAR $m^{-2}\ sec^{-1}$) and a half saturation constant (km light) of 164 $\mu E\ m^{-2}\ sec^{-1}$ (5) hence there should be ample light for plant growth beneath the screens. In laboratory tank experiments, light beneath screening panels was reduced to levels as low as 10 $\mu E\ m^{-2}\ sec^{-1}$ and milfoil still retained the ability to grow. Only when the screens compressed the plants into contact with the sediments were significant reductions in biomass observed.

The results of the water sampling indicated no significant changes in the examined water quality characteristics which could be attributed to the presence of the screens. However, the area of application was fairly open and subject to wind mixing and water movements, which, through dilution, would negate any adverse influence of decomposition products. For enclosed embayments with restricted water movement or in small ponds where the area of treatment might be a significant proportion of the total area, the situation might be somewhat different.

The use of Aquascreen in Union Bay differed from other bottom covering techniques in that the screens were not intended for permanent application. The costs for most blanketing materials are high and the temporary placement and potential reuse benefit must be viewed as desirable.

While there are obvious drawbacks to the use of screening materials, particularly in regard to the economics of large scale applications, the potential benefits to be derived seem significant. For use in situations where the area of concern might be expressed in units of square feet or square meters rather than acres or hectares the labor involved in the application and the materials costs would appear comparable to more established management techniques.

Given the rising costs and somewhat unclear future of herbicides, it would seem imperative that nonchemical means of aquatic plant control be developed. The use of screening materials such as Aquascreen would seem particularly useful in those situations where practical or philosophical constraints imposed limitations upon the control options available.

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