Project LPL-346

CONTROL OF EURASIAN WATERMILFOIL BY THE USE OF BENTHIC BARRIERS IN THE FORM OF SUBMERSIBLE FRAMES AND ROLL OUT CARPET ASSEMBLIES

For

The Forest Lake Improvement Association
and
The Department of Natural Resources

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by
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PURPOSE

Benthic barriers have proven to be an effective method for control of macrophytes in swimming areas and alongside docks. However, the application of benthic barriers, especially in large sizes, becomes very difficult and requires scuba divers and weight devices to assure anchorage to lake bottoms and prevent billowing from released gases.

This feasibility project attempts to resolve some of the disadvantages of benthic barriers by utilizing various materials, design constructions and procedures, while also evaluating their effectiveness to control the Eurasian watermilfoil (hereafter referred to as EWM) infestations in Forest Lake, Fond du Lac County.

Where feasible, native aquatic plants were collected and planted in areas cleared of EWM. They were evaluated for re-establishment success and suitable methods and devices for replanting.

BENTHIC BARRIER METHODS

Two (2) major construction designs were utilized in this project. The first was 16 benthic barriers attached to 7' x 9' submersible frames. The second was four (4) 10' x 40' benthic barriers constructed in the form of a roll out carpet. Design specifications and methods of application, along with their advantages and disadvantages, are included.

SUBMERSIBLE FRAMES

The basic design of submersible frames was designed in 1995 (Figures 1 and 8). The 7' x 9' portable assemblies are constructed of 3" PVC tubing, to which is attached a benthic barrier of 12 mil scrim reinforced black polyethylene. The barrier is attached to the tubing with 1" diameter body washers and sheet metal screws. Holes are drilled in the tubing to allow the entrance and escape of water and air.

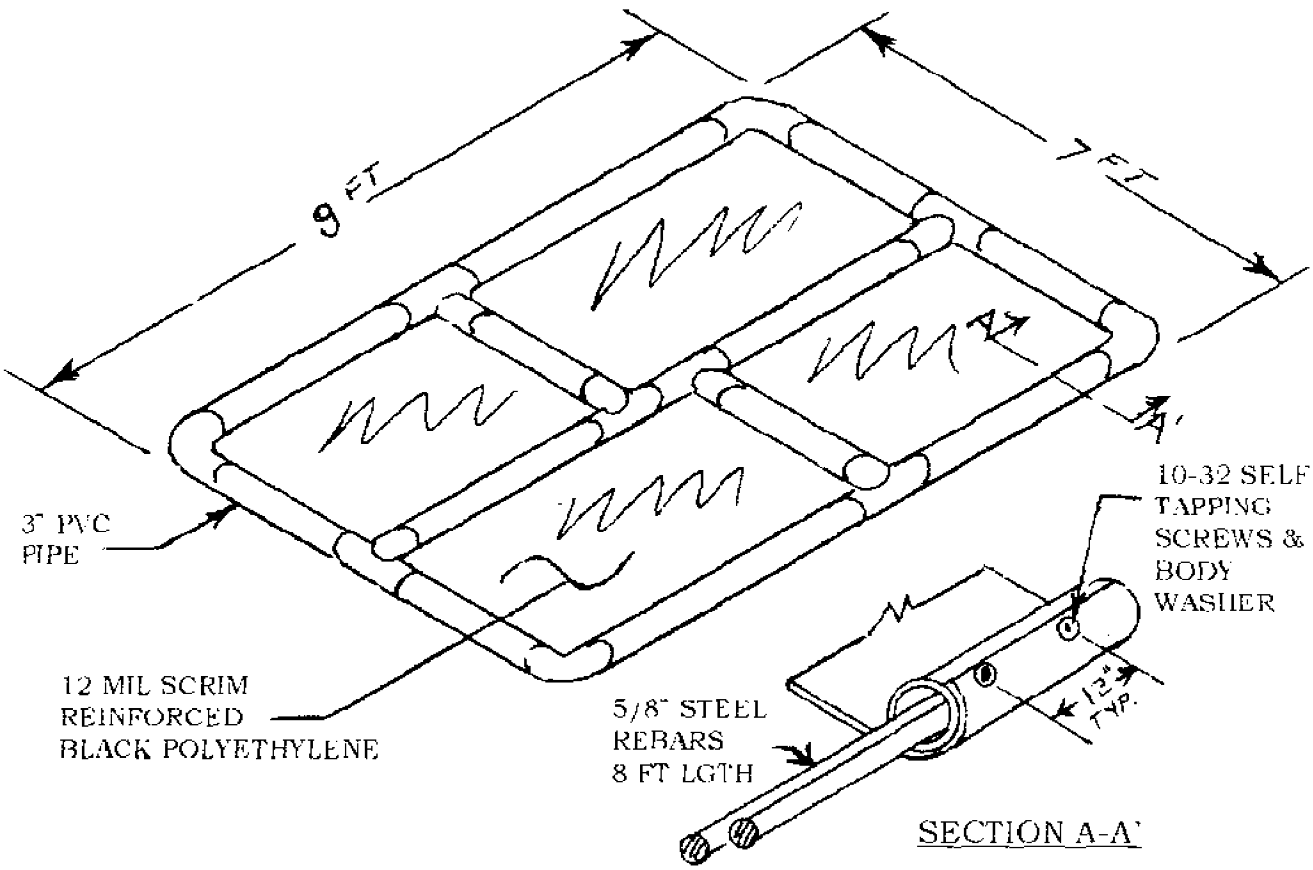


Figure 1

SUBMERSIBLE FRAME

Numerous methods to raise and lower the frames into position were evaluated:

1. Compressed Air (Figure 2)
2. Rope Ratchet Pulley and Bouy attachments at four (4) corners (Figure 3)
3. Rope Ratchet Pulley and Bouy attachment at center (Figure 4)
4. Winch Apparatus to frame center (Figure 5)

1. **Compressed Air** (Figure 2)

Special fittings for connecting to air lines and water inlet and outlet valves were installed to the frames. Compressed air was supplied by air tanks in nearby boats or an accessory tank attached to a diver. The divers were required to connect and disconnect the air supply hoses and opening and closing of the water inlet valves. In water depths exceeding 4 ft., as the frames were raised to the surface, they did not maintain a horizontal position and emerged from the water at a steep angle, edge first, making them difficult to straighten out to a horizontal plane.

The air supply required quickly depleted the divers' tanks and/or portable pressure tank.

This method was not pursued any further.

2. **Rope Ratchet Pulleys and Bouys at Four (4) Corners** (Figure 3)

The frames were modified by attaching rope connectors at each of the outer corners. Holes (1/2") were drilled 12" apart along the top surface of the outer 3" piping to allow the entrance and escapement of air and water. Four (4) 5-gallon bouys were each attached to four (4) rope ratchet pulleys.

SUBMERSIBLE FRAME METHOD

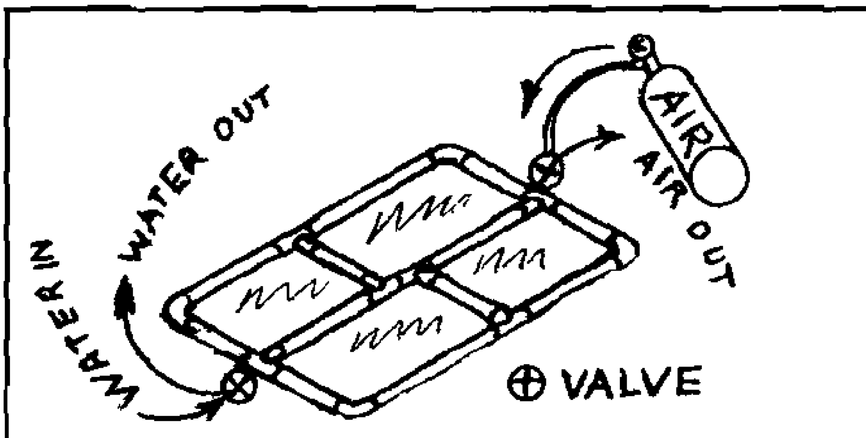


Figure 2
COMPRESSED AIR

- diver required
- air depleted
- uncontrolled raising

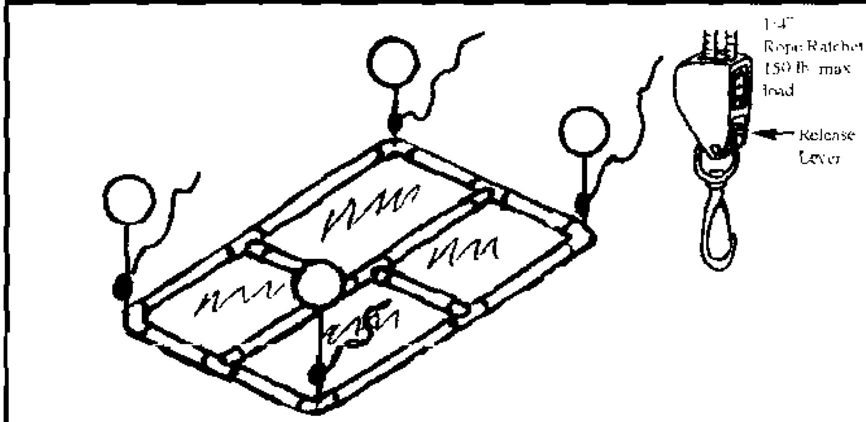


Figure 3
FOUR (4) BOUYS
& ROPE RATCHET

- diver required
- diver entanglement in ropes
- raise and lower time 20 minutes

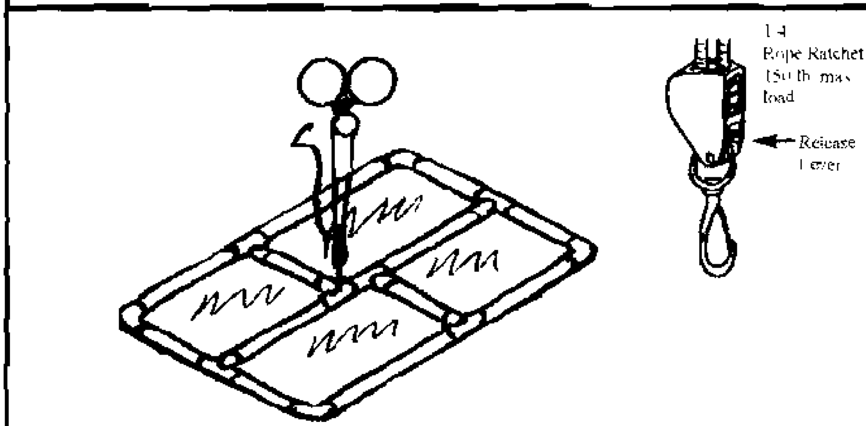


Figure 4
ONE BOUY,
ROPE RATCHET &
PULLEY AT CENTER

- diver required
- minimum entanglement
- raise and lower time 10 minutes

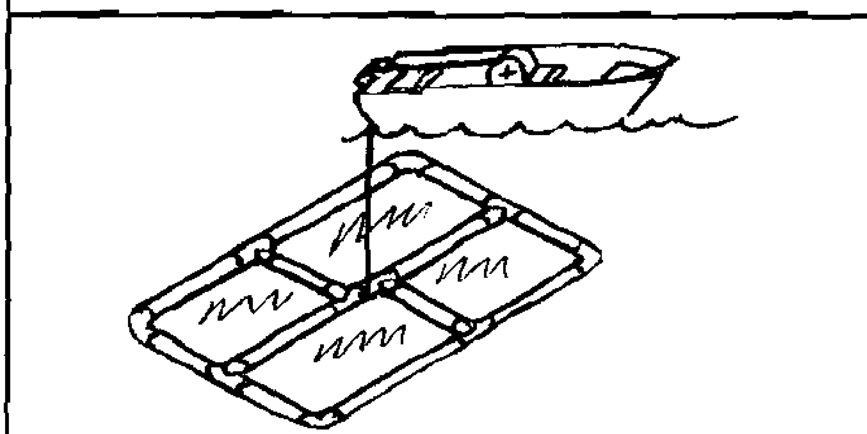


Figure 5
WINCH
APPARATUS

- no divers
- no rope entanglement
- raise and lower time 6 minutes

To raise the frames, a diver would descend to the frame and attach the end of the pulley and bouy assembly to the four-corner rope connectors. The diver would then pull on the ratchet cord to pull up each corner in 2 ft. increments until the frame reached the surface. To lower the frame, the diver would release the ratchets in approximately 2 ft. increments until the frames compressed the EWM to the sediment level, and then he would disconnect all ratchet and bouy assemblies.

This method was not deemed suitable because (1) it was time consuming, (2) required the services of a diver, and (3) created a safety hazard caused by the diver's entanglement in the many cords required.

3. **Rope Ratchet with Pulley and Bouy at Center** (Figure 4)

Frames were modified by adding a single rope connector at the center of the frames. A ten (10) gallon bouy was attached to a rope ratchet and pulley arrangement.

To raise the unit, a diver would descend to the frame and attach the end of the pulley and bouy assembly to the frame's center. He would then pull on the ratchet rope to raise the unit to the water surface, being careful to maintain the frame in a horizontal position.

To lower the unit, the diver would release the ratchet mechanism and guide the unit into position as it compressed the milfoil to the sediment level.

This method minimized the safety hazard of rope entanglement, but required the services of a diver.

4. **Winch Apparatus** (Figure 5)

Frames were modified by permanently attaching a 3/8" diameter nylon rope to the center of each frame. The length of the rope was approximately 1 ft. longer than the water depth. A metal snap fastener attached to the rope end acted as a weight causing the rope to form a loop below the water surface, thereby keeping the rope below the water surface out of the way of boaters and swimmers, when the frame is submersed.

A 600 lb. capacity winch assembly was attached to the bow of a boat (as shown in Figure 6). The usual hand crank was replaced by a circular hand wheel to eliminate a spinning crank from hitting the operator during the lowering operation.

To raise a frame, the looped frame rope was located and snagged with a hook and then attached to the rope on the winch.

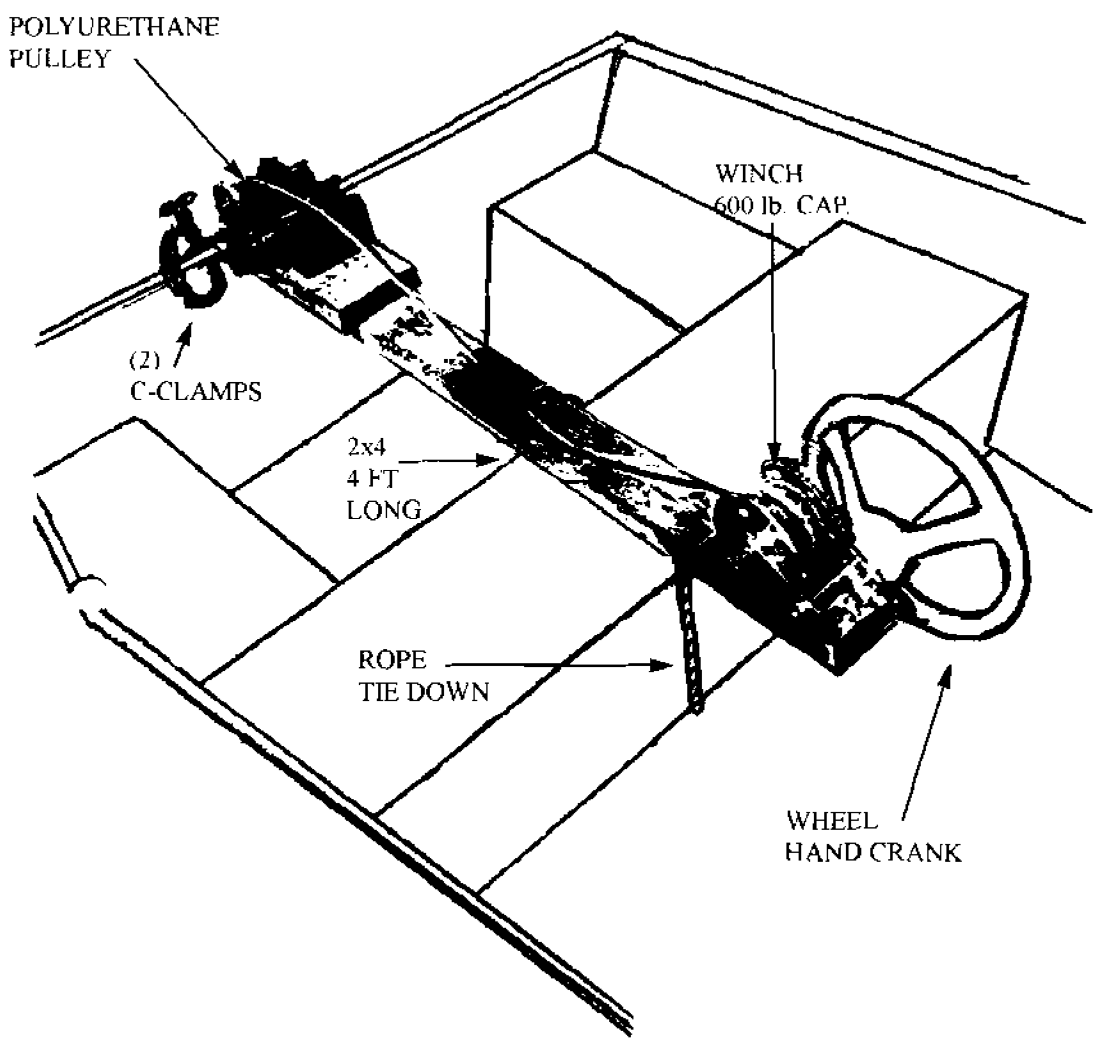


Figure 6

WINCH ASSEMBLY

The operator then proceeded to wind the winch, thereby raising the frame to the surface. The boat and attached frame was then moved to the next location.

To lower the frame, the operator released the winch locking cam, allowing the winch to spin free and the frame to descend. The speed of descent was governed by the hand pressure on the spinning wheel. After the frame compressed the EWM and rested on the sediment level, the frame rope was released from the winch rope.

This method proved to be the most practical way of utilizing benthic barriers in the form of 7' x 9' submersible frames. It did not require the use of divers and eliminated the safety hazard from rope entanglements.

Difficulty in placing frames accurately adjacent to each other caused milfoil plant growth between the frames (as shown in Figure 9). This problem could be partially corrected by overlapping frames.

The average wait time to raise, relocate and lower a frame to an adjacent location was 6 minutes.

Figure 7

SUBMERSIBLE FRAME CARRIED TO SHORE

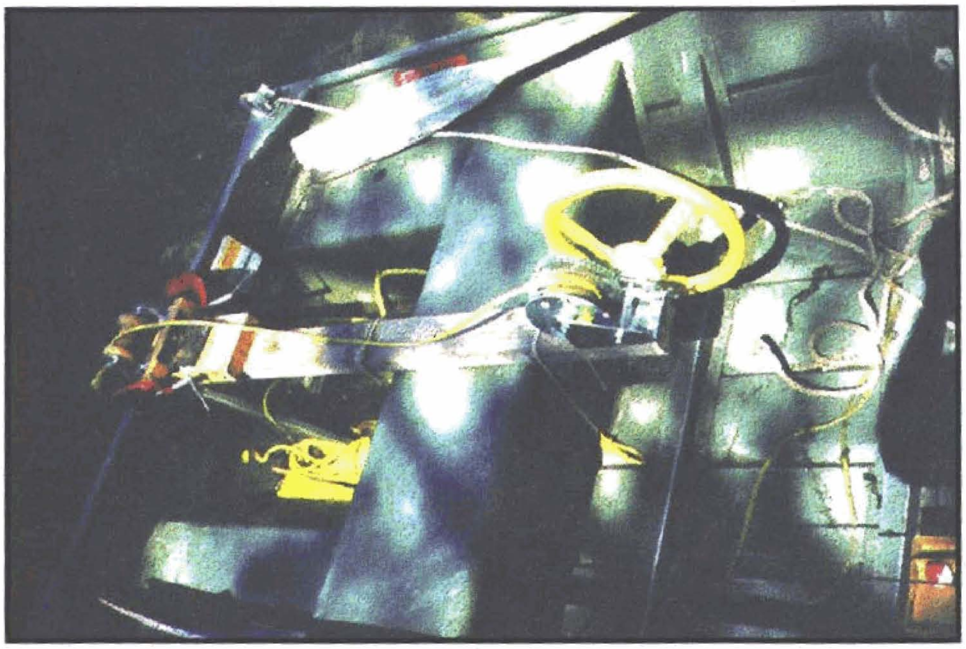


Figure 8

WINCH ASSEMBLY MOUNTED TO BOAT

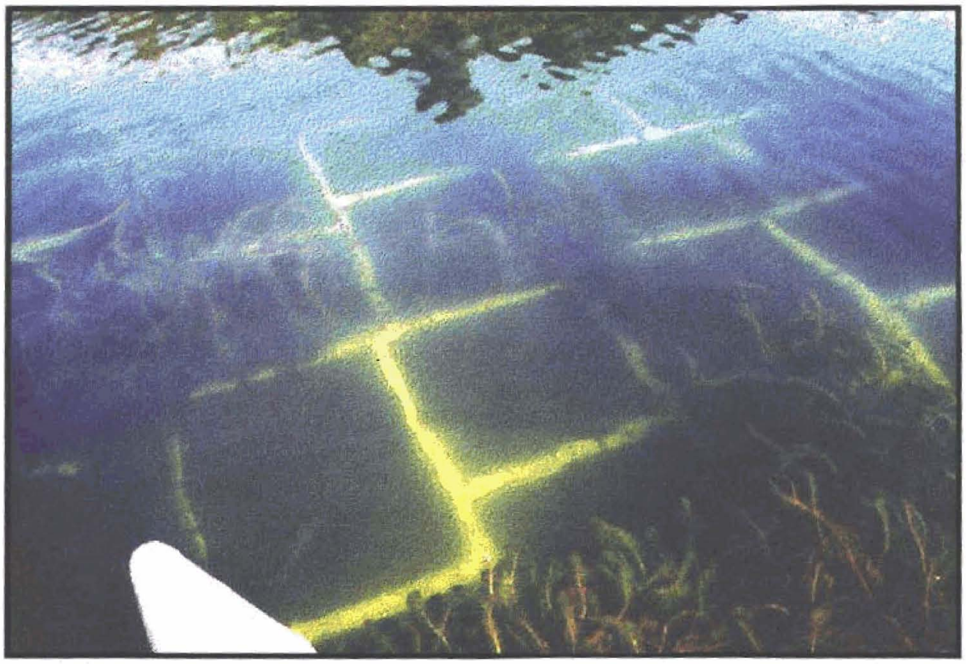


Figure 9

SUBMERSED SUBMERSIBLE FRAMES IN 8 FT. DEPTH ADJACENT TO EACH OTHER

ROLL OUT CARPET BENTHIC BARRIERS
(Figures 7, 10 and 18)

Objective:

To create a means of applying large sheets of benthic barriers, without the need of divers and performable by two persons.

Description:

10' x 40', 30 mil heavy vinyl sheets were attached to two (2) 12 ft. long 3" diameter PVC pipes on the 10 ft. wide edges, with 3/8" sheet metal screws and large body washers at 1 ft. increments.

To stiffen the barrier sheet, five (5) 10' long, 2" diameter PVC pipes were mounted to the vinyl sheet at 6 ft. intervals. To prevent billowing due to entrapped gases, the sheets were punctured with a screw driver at 1 yard intervals. To facilitate the handling of these benthic barriers, two (2) 3/8" nylon ropes, approximately 10 ft. long, were attached to each of the 3" diameter pipes to form a triangular configuration. Depending on the desired position of the benthic barriers from the shoreline, two (2) 3/8" nylon ropes were attached to the triangular form of the 10 ft. ropes and were extended to the shoreline.

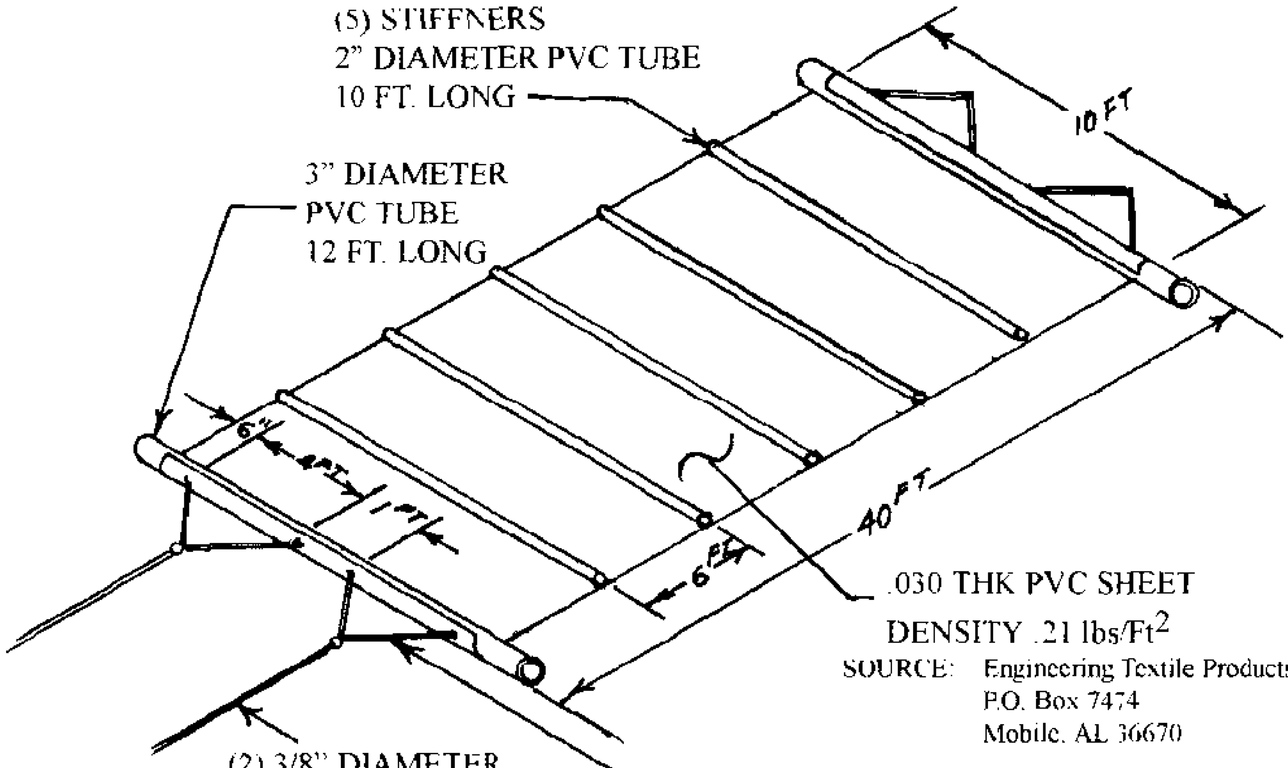


Figure 18

ROLL OUT BENTHIC BARRIER

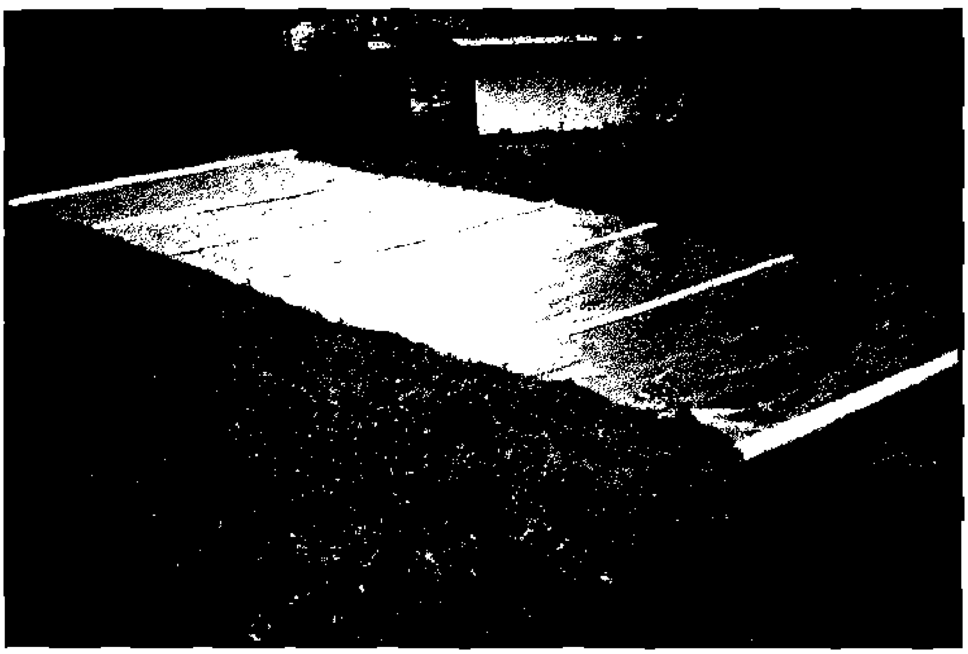


Figure 10

ROLL OUT BENTHIC BARRIER

Figure 11

CARRYING ROLL OUT BENTHIC BARRIER TO SHORELINE

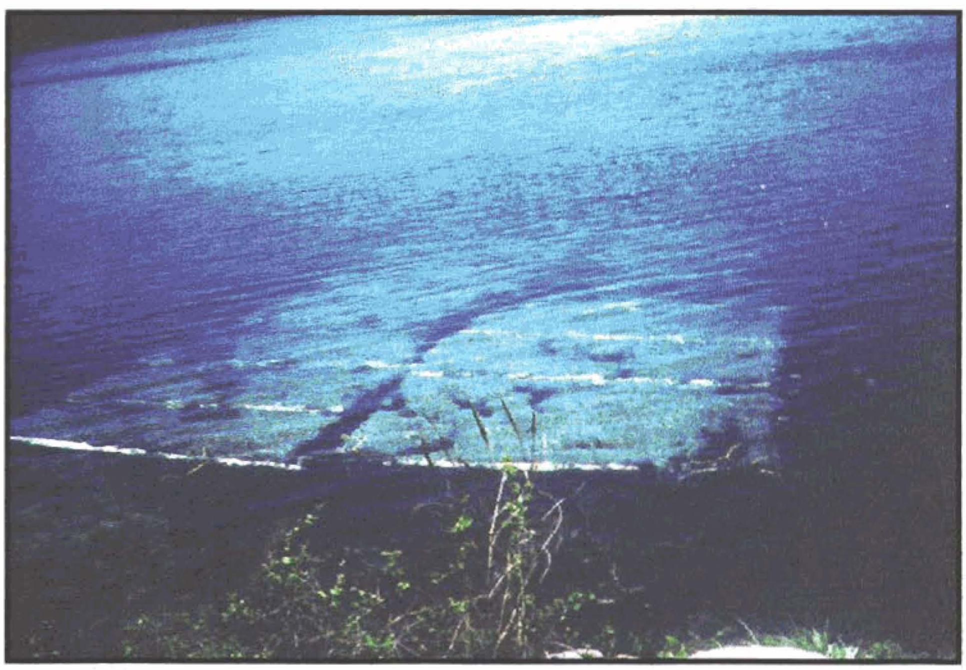


Figure 12

TWO (2) ROLL OUT BENTHIC BARRIERS ADJACENT TO EACH OTHER

Figure 13

PULLING IN ROLL OUT BENTHIC BARRIER

Figure 14

ROLLING UP A ROLL OUT BENTHIC BARRIER AS IT IS PULLED IN AT THE SHORELINE

ROLL OUT BARRIER PROCEDURE

The 10' x 40' barrier sheet and pipe assembly was rolled up on one of the 3" PVC pipes. The rolled up assembly was carried by two (2) persons (Figure 11) and placed on the bow of a boat. As shown in Figure 15, the roll was released at its desired distance from shore, parallel to the shore. The boat slowly proceeded to the shore, slowly unrolling the barrier as it went along. After reaching the shore, the nylon ropes extending to shore were pulled taut to eliminate buckling of the barrier sheet and tied to stakes at the shoreline to prevent movement of the sheet.

After being in place for 4 to 7 weeks, the barrier was removed by pulling on the two ropes which were extended to the shoreline (Figure 13). As the pulled sheet reached the shoreline, it was rolled up on the 3" diameter pipe (Figure 14). The sheet was pulled and alternately rolled up and any debris splashed off with pails of water.

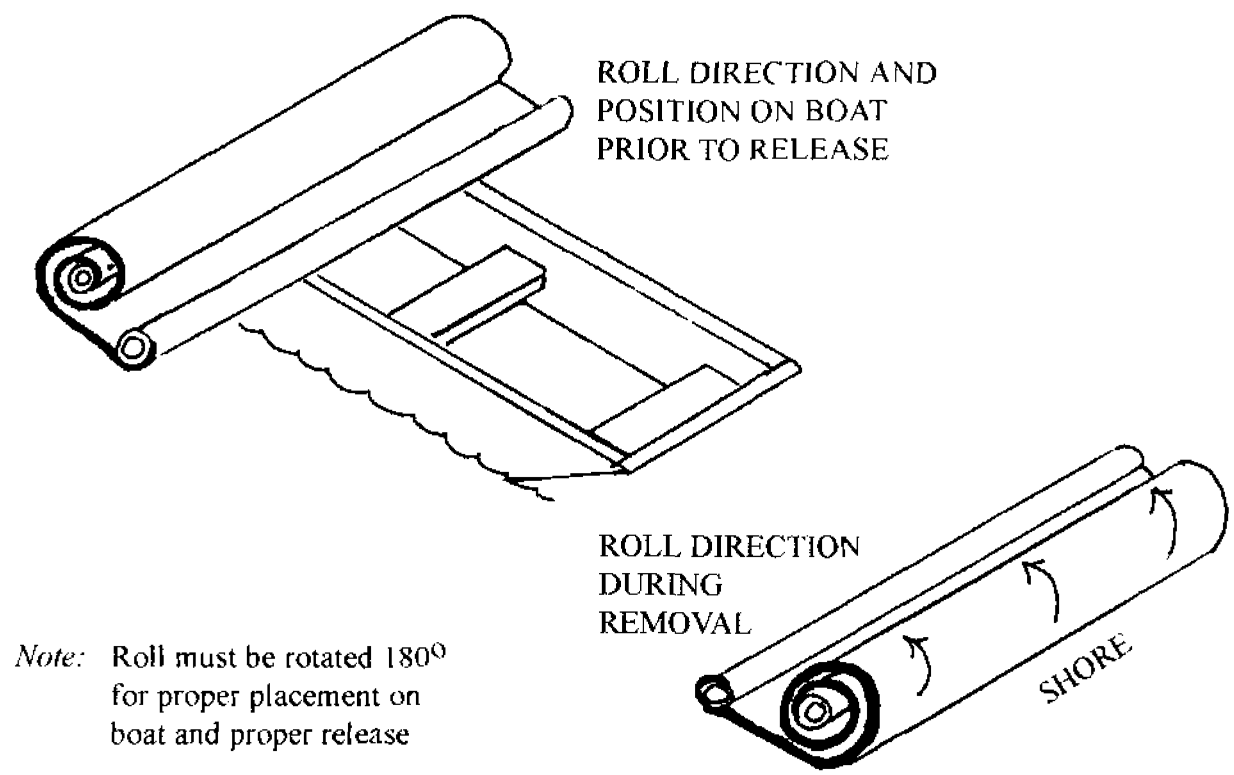


Figure 15

ORIENTATION OF ROLL OUT BENTHIC BARRIER

When the barrier was completely rolled up, the roll was rotated 180^0 (as shown in Figure 15) to place it in the proper position for placement and released from the boat unto the next milfoil infested area.

The major advantage of the Roll Out Barrier design is that a large 10' x 40' barrier can be easily applied and removed by two persons, without entering the water. The Roll Out Benthic Barrier is limited by reasonable proximity (max. 200') to a shoreline. Because the vinyl sheets become slippery in the water, it is prudent not to apply the roll out carpet barriers in shallow wading and swimming areas.

TRANSPLANTATION OF NATIVE AQUATIC PLANTS

Four species of native aquatic plants (Figure 16) have been evaluated for replanting in the areas cleared of Eurasian Watermilfoil:

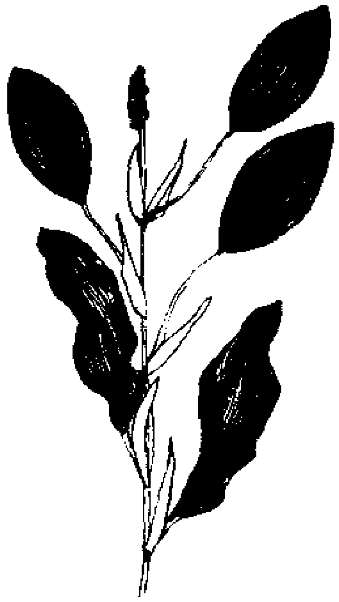
1. *Najas flexilis* - bushy pondweed
2. *Potamogeton amplifolius* - large leaf pondweed
3. *Potamogeton zosteriformis* - flat stemmed pondweed
4. *Vallisneria americana* - water celery

The transplanted plants from past and recent summers were visually inspected to assess the success of re-establishment.

Potamogeton amplifolius and *P. zosteriformis* have done very poorly as transplants and did not become established in milfoil cleared areas.

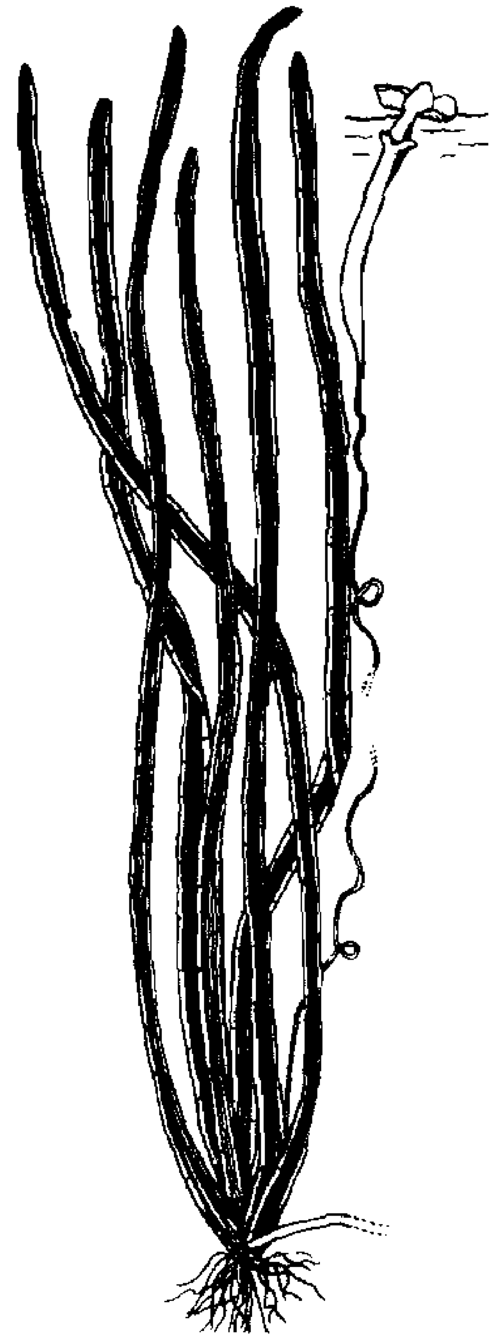
Najas flexilis and *Vallisneria americana* were successful in becoming established and remained established over a two-year period.

LARGE-LEAF PONDWEED
Potamogeton amplifolius



FLAT-STEMMED PONDWEED
Potamogeton zosteriformis

WATER CELERY
Vallisneria americana



BUSHY PONDWEEDS
(*Najas* spp.)

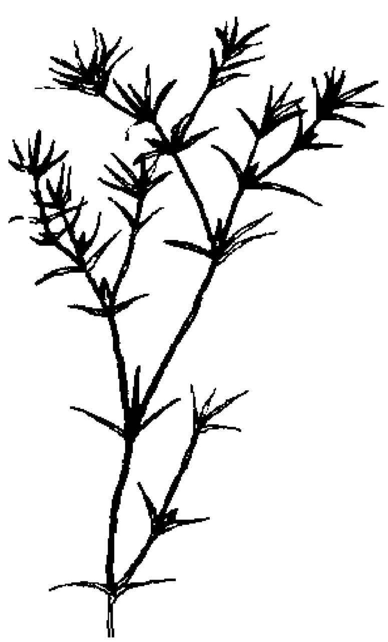


Figure 16

NATIVE AQUATIC PLANTS PLANTED IN CLEARED MILFOIL AREAS

	Horizontal Characteristics		Vertical Characteristics				Transplant Success in Forest Lake
	Patchy Distribution	Expansive Meadow	Low Growing Meadow	Vertical Open Architecture	Vertical Dense Mass	Mat Forming	
Vallisneria americana	✓			✓			Good
Potamogeton amplifolius	✓			✓			Poor
Potamogeton zosteriformis	✓		✓				Poor
NAIADS		✓	✓				Good
Eurasian watermilfoil		✓			✓	✓	

Modified from: Aquatic Vegetation Management Guidance Manual, Vol. 1, p. 2.7
Midwest Aquatic Plant Management Society

Figure 17

THE PHYTO-ARCHITECTURAL ATTRIBUTES OF SEVERAL SUBMERSED AQUATIC PLANT SPECIES

Najas flexilis

Najas flexilis were transplanted by collecting mature plants available only during late summer months and preparing them by placing them in a string tied cheese cloth bag configuration, along with a portion of their original sediment over a handful of small stones for weight. The plants were kept under water during transportation and dropped into the lake into a milfoil cleared area from a boat.

Vallisneria americana

Vallisneria americana plants were prepared for transplantation by inter-weaving plants in 3' x 4' planting frames (Figure 18) which contained a 100% biodegradable coconut fiber mat (C125 BN - North American Green Co., Evansville, Indiana).

Two (2) small concrete bricks were placed on wood pegs to weigh down the frame and woven plants to the sediment level. A diver was required for placement and prevention of tipping over during submersion.

Vallisneria americanas were also successfully transplanted by surrounding the plant stem immediately above the roots with a 1" diameter ball of uncolored plasticized modeling clay. The plants were dropped into a selected cleared area from a boat.

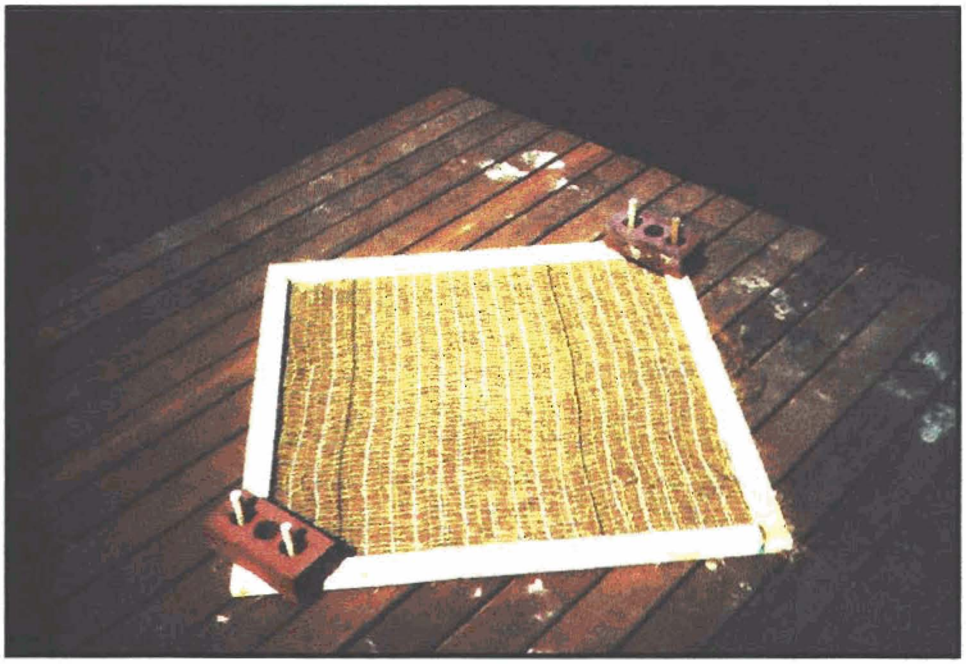


Figure 18

TRANSPLANTATION FRAME WITH CONCRETE BRICK WEIGHT

Figure 19

APPLYING NATIVE AQUATIC PLANTS TO TRANSPLANTATION FRAME

Figure 20

UNDERWATER PHOTO OF SUBMERSED TRANSPLANTATION FRAME WITH NATIVE AQUATIC PLANTS

SUMMARY

Benthic barriers in the form of 7' x 9' submersible frames are suitable for controlling small isolated areas of Eurasian watermilfoil infestations in shallow or deep water depths. Winch mechanisms as a means to raise and lower the frames has proven to be the most suitable and safe method for handling the frames and took an average of 6 min. to raise, move and locate to a nearby adjacent location.

Benthic barriers in the form of a roll out carpet assembly proved to be a practical means of killing milfoil infestations in larger areas (400 ft^2). It was limited by proximity to shorelines within a 200 ft. distance. Two persons utilizing a 10' x 40' barrier were capable of collecting, moving and relocating it within a 15 min. period.

Comparing the two construction designs, submersible frames vs. roll out benthic barriers, for square foot coverage per hour by two persons:

7' x 9' portable frames	63 ft^2/6 min.	=	630 ft^2/hour
10' x 40' roll out assembly	400 ft^2/ 15 min.	=	1600 ft^2/hour

For transplantation of native plants into areas cleared of Eurasian water-milfoil, *Najas flexilis* and *Vallisneria americana* are suitable candidates based on their ability to become re-established. Due to the need for diversity of aquatic plants, there is a need for continuous research in selection of native aquatic plants, along with an analysis of seeding time and additional cost effective techniques of transplantation.

Aerial photos taken in 1997 and 1998 indicated that the EWM was rapidly spreading throughout Forest Lake. When the banthic barrier project was initiated in 1996, 10,000 ft^2 of surface emerging EWM was targeted for elimination by benthic barriers. Although 16,000 sq. ft. of milfoil were eliminated during the study, the rate of growth of milfoil far exceeds any progress made with the barriers. At present, Eurasian watermilfoil occupies 7 acres of the 50 total acres and 25% of the 30-acre littoral zone which occupies 60% of the lake.