

PROGRESS REPORT #1

By
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INTRODUCTION

The Lake Committee of the RomeRock Association has retained ACRT to serve as technical advisor for developing a long term lake management strategy. RomeRock Lake is a 20 year old man-made reservoir developed for recreational use by Association members. Lake uses include fishing, swimming, boating (power and sail). The reservoir is also used as a drinking water supply.

The primary problems facing RomeRock Lake include sedimentation, noxious weed and algae growth. These problems are caused by run-off of silt and nutrients from incoming streams and from the shoreline. Nutrient loading may also be occurring from the sediments when anoxic conditions (no oxygen) exist in the hypolimnetic (bottom) waters. This is referred to as 'internal' loading of nutrients.

The goal of the Lake Committee is to determine environmentally sound solutions to the lake's problems on both a short term and long term basis. This report describes the results of a preliminary investigation of the lake during August 1989 and provides recommendations for specific problems and guidelines for continued study and evaluation.

METHODOLOGY

On August 28, 1989, Mr. Newt Bakley and Mr. Monroe Frados accompanied ACRT's Diane Conyers-Rizzo and Beth Buchanan on a site visit to the Roaming Shores reservoir. The shoreline was surveyed

by boat and areas of concern were noted on a map of the reservoir. Mr. John Hanyon joined us for part of the survey and provided some background information concerning management of the reservoir.

Temperature and oxygen profiles, along with secchi disk measurements were taken at six sites. Nuisance rooted plants (macrophytes) were identified, and a water sample was collected for identification of the algae that was covering the reservoir surface on the day of our visit.

DATA

Temperature and oxygen curves are graphed for sites in the main body of the reservoir in Figures 1. The data illustrate that the reservoir is thermally stratified from surface to bottom and that cold anoxic water (without oxygen) begins about three meters (10 feet) below the surface. The thermocline (area of sharp temperature change) is deeper near the dam occurring about 4.5 meters (15 feet). The water below this point is also anoxic. Similar data collected in 1978 by Dennis Cooke, are also graphed in Figures 1 for comparison. The data show that the cold anoxic area began about one meter deeper in 1978 than in 1989.

The secchi disk readings varied between 1.0 and 1.5 meters (3 to 5 feet) with the highest transparency being near the dam. This is a visual measure of suspended and dissolved material in the water and indicates the trophic state of the lake assuming the primary suspended particles are algae cells. Secchi readings in RomeRock Lake indicate the water quality varies somewhat from one end to the other. This is not unusual in a reservoir of this size. The 'trophic state index' (TSI) ranges between 50 and 60 indicating eutrophic conditions. A TSI of 0 - 40 indicates a clean, oligotrophic lake. Refer to Appendix A for a more detailed explanation of measuring and evaluating lake trophic state.

Also included are graphs of data collected in the arms of the tributaries: Rock Creek, Sugar Creek, and Plum Creek (Figure 2). The few macrophytes present during this survey were found in these

areas.

According to residents, these areas are usually plagued with heavy plant cover throughout most of the summer. At the time of the survey, a small amount of Myriophyllum sp. was observed near the mouths of the tributaries and some Potamogeton sp. was found in Rock Creek (See Appendix B).

OBSERVATIONS FROM AUGUST 28, 1989

1. A planktonic algal bloom was covering the entire surface of the reservoir. The algae was obnoxious where it was concentrated on the water surface, in coves, and along the shorelines. The dominant algae was identified as Aphanizomenon sp., a nuisance bluegreen.
2. The water was a brownish color and according to residents, it has been this color throughout the summer. The brown color would be due to dissolved organic compounds in the water, possibly a bloom of diatoms, churning of the water by power boats, and the fact that few plants were present this summer reflecting the green light.
3. Relatively few macrophytes were growing in the reservoir or had been growing this season. A general decrease in the volume and density of rooted aquatic plants was also observed in many other northeastern Ohio lakes this summer as compared to recent years. A possible explanation could be the turbidity created by one and one half months of rain in the spring. Light could not reach the sediment and the rooted plants. The algae that floats on the surface would have been able to utilize the sunlight and, therefore, grow first. The algae would then shade the macrophytes, further inhibiting their growth. This combination of factors is the probably explanation for the change in weed density this year.

4. Areas where plant growth is usually a problem are too large to handle with a Chubb harvester. High speed harvesters are now available for large lakes and reservoirs that are hydraulically operated and will self-load and unload. This is discussed in more detail in 'Recommendations' section of this report.
5. Much of the shoreline is exposed and is severely eroding. Wave action from wind and speed boats will continue to erode the shoreline that is not protected with vegetation and/or structural devices. The erosion will increase the amount of suspended solids in the water and continue to increase the amount of shallow area in the reservoir where rooted plants can grow.
6. Sedimentation basins are necessary to prevent loading of sediment to the reservoir. The basins need to be large enough to handle storm events because, at these times, the high velocity water carries the largest load of sediment. A plant buffer in front of these basins will slow the water flow so that additional sediment will be deposited.
7. A large volume of water in the reservoir is anoxic (no oxygen). This problem may exist in the winter, as well as in summer months, and it is of concern because nutrients are released from the sediment when there is no oxygen at the sediment/water interface. These nutrients become available to the algae following spring turnover.

RECOMMENDATIONS

1. A larger harvester that is hydraulically operated would be the best strategy for controlling nuisance weeds. Harvesting would:

- * eliminate a huge amount of weed mass and thus slow down the filling-in of the reservoir;
- * remove a large quantity of nutrients from the reservoir;
- * enable selective plant removal; buffer zones and fish breeding areas could be left intact.

A hydraulically controlled harvester that self loads and unloads is needed for the large area of weeds usually found in the lake. A cutting bar of 5 feet minimum is required to clear a large area of nuisance plants in a very short time.

Inquires have been made from several companies that sell harvesters. A harvester sold by Aquarius Systems in Wisconsin that would be the appropriate size for Rome Rock Lake would cost approximately \$45,500 plus \$15,500 for a trailer/conveyor combination. This is the H 220 model with a 5 foot cutting bar. It has 280 cubic feet storage capacity and a 6,500 pound weight limit. It would take 90 days to manufacture the harvester and there would be a possibility of trading in the Chubb if the Association is interested.

Another company, UMI, has a variety of harvesters available. Their high speed model with a 14 foot cutting spread and 6000 lbs capacity lists for \$92,100. The tilt deck trailer lists for \$12,720 and the conveyor for \$16,440. This set-up would be state-of-the-art. UMI also has other lower priced machines that could be considered. Orders for next spring delivery must be made by January 1990 and require 30 percent down/net upon delivery. The UMI factory is in New York state and may be worth visiting sometime to find out what is on the market.

Should the Association purchase a new harvester, the possibility of sub-letting/sub-contracting the machine to other lakes when it is not being used on RomeRock should be considered.

More detailed information on this manufacturer as well as others will be provided when the information arrives. Appendix C has general literature on harvesters and companies that make this equipment.

2. Work should continue on the settling basins until they can hold the water from storm events. Existing sedimentation basins need to be improved in order to retain the water from a storm event to allow sufficient settling to occur. The settling basin at the Collinwood residence should also be reinforced to withstand the volume of water that flows through it in a storm. An additional upstream basin should be considered to alleviate the severe storm problems in this run-off area.
3. Inventory the shoreline condition and implement a public education program. The Association should perform an inventory of lots adjacent to the lake and record and track the condition of these shorelines. A database could be set up using addresses and lot numbers. A field survey would then be conducted by boat and data collected and recorded on pre-designed data sheets. Information to be collected would include:
 - * Slope and length of shoreline
 - * percent of shoreline that is bare/eroding
 - * type of vegetative cover
 - * type of seawall or other structures
 - * other

This information would then be entered into the database and letters sent to residents describing the problems along

with guidelines for solving them. Literature could be provided or workshops scheduled to assist the homeowners.

4. **Implement a public relations effort: Lake Committee newsletter and/or fact sheets.** A key to long term success of a lake management program is education of the residents who live adjacent to the lake. ACRT recommends the Lake Committee send out a quarterly, one-page newsletter/fact sheet. This should be brief and informative. It could include a summary of what the Committee is doing and should be used to educate the homeowners on issues such as:

- * why fertilizers should not be applied on lawns bordering the lake; or
- * why soil erosion is a problem in the reservoir, and
- * other topics of interest and concern to the residents.

As residents become interested in the project, workshops can be scheduled to teach homeowners how to build successful erosion control barriers, how to collect useful data, etc. The more involved the residents feel, the more likely they will be to support the recommendations of the Committee. ACRT could assist the Committee in any of these tasks as needed.

5. **Shoreline protection guidelines and specifications should be developed.** The Lake Committee should develop and endorse shoreline protection methods. Specifications for structural and non-structural methods of shoreline protection should be made available to the residents. A paper describing the various methods is found in Appendix D. Other information including the Army Corp's booklet, Low Cost Shore Protection, A Property Owner's Guide, will be provided with this report as a reference. It is important to educate the homeowners so they can correct any erosion problems with their shoreline as economically as possible while maintaining the aesthetics.

6. **Begin a volunteer secchi disk monitoring program.** A secchi disk monitoring program should be started. A secchi disk may be purchased for about \$75, including nylon sounding line (see Appendix E). Volunteers who would want to participate in the program could be trained and a data recording system established.

Secchi disk readings are useful in showing changes in water quality over a single growing season as well as long term trends. Secchi depth data are used to calculate trophic state values which are general indicators of lake water quality. ACRT could assist in the Committee with volunteer training, maintaining records and overseeing record keeping and data analysis.

7. **Periodically measure oxygen and phosphorus in the reservoir.** Oxygen surveys should be done periodically to determine the areas of the reservoir that are anoxic. It would be useful to get some winter measurements, as well as summer, if possible. Long periods of anoxia during the winter may result in winter fish kills. In conjunction with this oxygen survey, phosphorus measurements should be taken to determine the extent of internal phosphorus release from the sediments. Internal sources may be contributing significant amounts of phosphorus to the reservoir, and may need to be controlled.
8. **Conduct a detailed watershed analysis.** The watershed should be evaluated in more detail by foot and by car. ACRT has ordered USGS topographical maps of Orwell and Jefferson quadrangles to better enable us to study the effect the watershed is having on the reservoir. Watershed use is the key to understanding how a reservoir behaves.

9. Do not dredge the lake until the sources of sediment are controlled. Before any dredging operations take place, a sediment control program should be developed and implemented. Judging from the areas that are silting in, the focus would be the three major tributaries and the shoreline.

Inquires were made regarding dredging sediment and re-locating it in deeper areas of the lake. This has been done in other lakes. A 404 permit must be obtained from the Army Corps of Engineers (call Mr. Jim Paybody in Cleveland, 216-522-4957 for application forms/procedures).

This permit application is then reviewed by the Army Corps, the Ohio EPA, Ohio Department of Natural Resources, USEPA and the US Fish and Wildlife Service. The biggest problem will probably be obtaining permission from the Ohio EPA because the reservoir is a drinking water supply. Dredging and moving sediments around in a lake will suspend particles including toxic substances (if any are present) and this is a major concern when drinking water is involved.

10. Determine sources and extent of sedimentation. Observing the runoff following a storm event could give insight as to the stream or streams which are contributing the largest load of sediment to the reservoir.

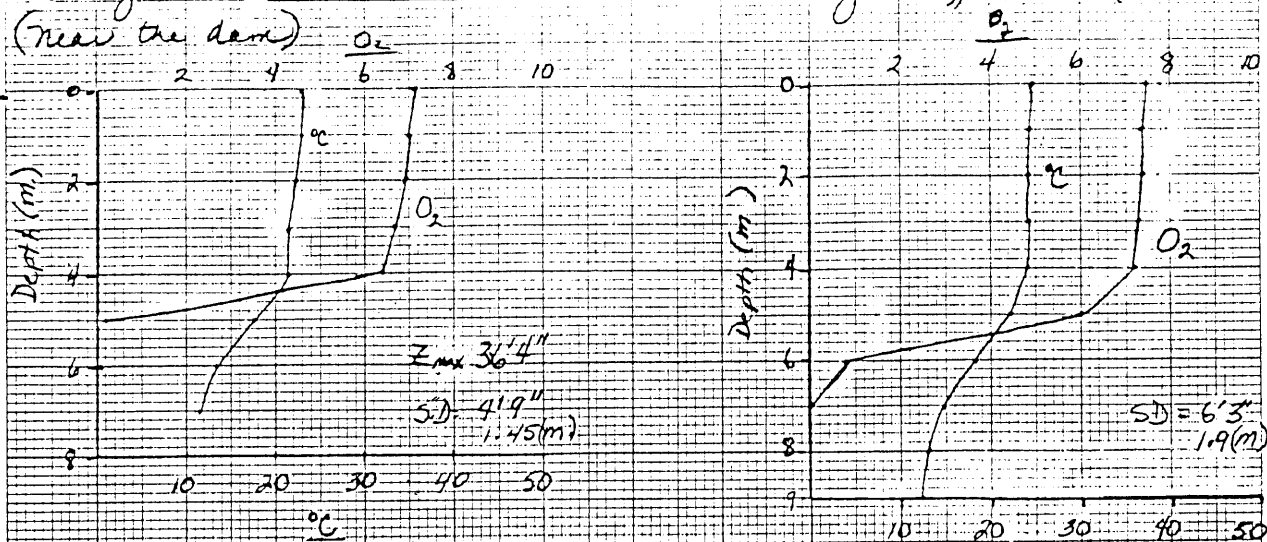
Another possibility for determining fill rate would be to use original depth maps of the reservoir and do sounding to compare original and current depths. By comparing original depths with current depths, an annual sedimentation rate could be estimated.

Figure 1: In-lake sites

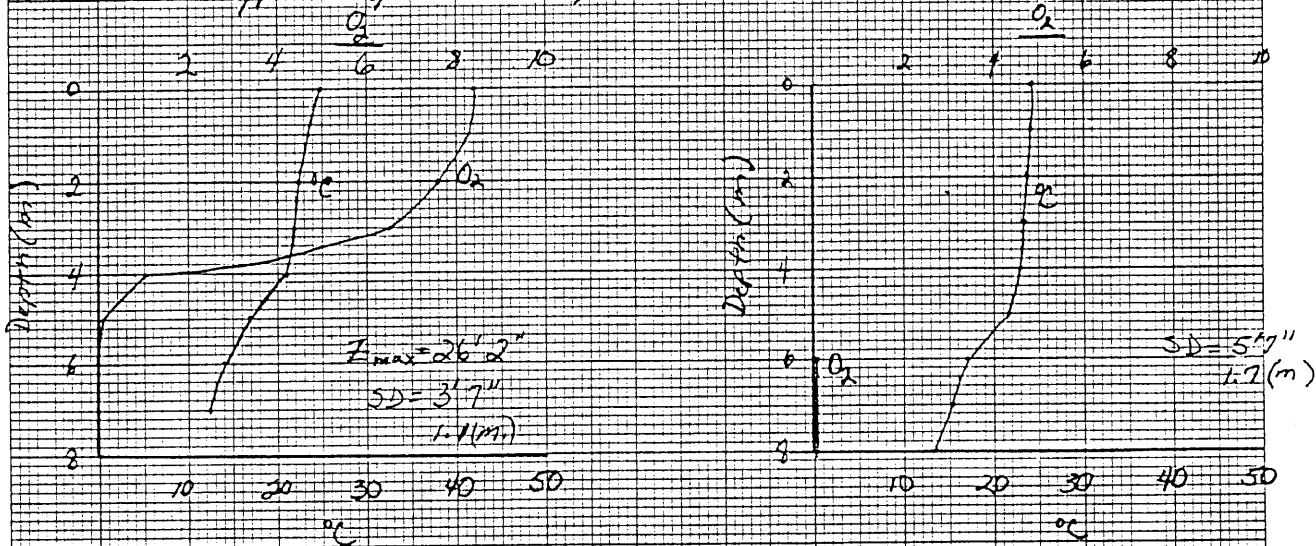
Aug 28, 1989 (ACRT)

Aug 27, 1978 (Cooke)

Fig. 1

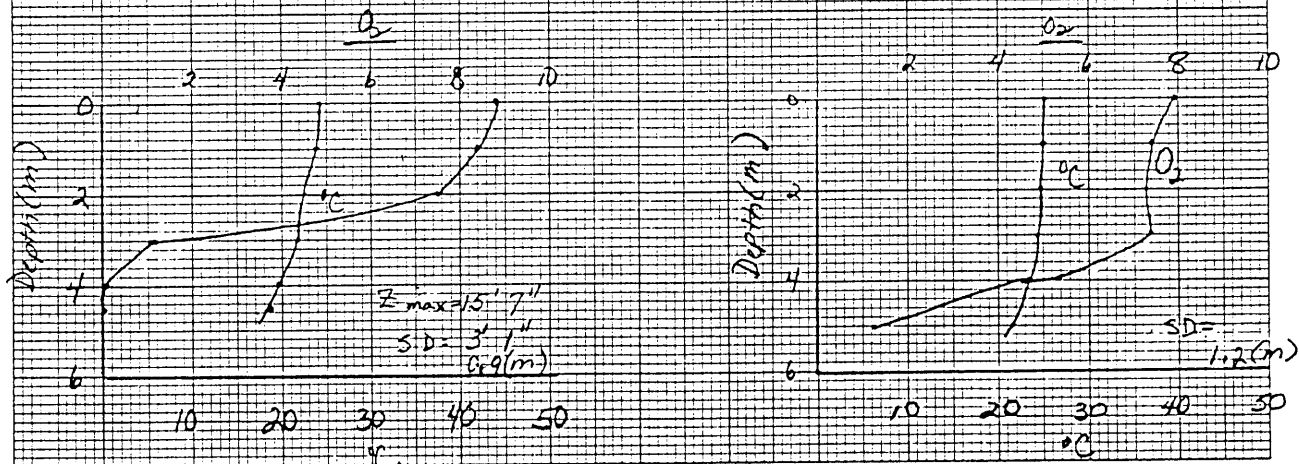


(mid-lake opposite peninsula)



* no O_2 data above 6m.

(mid-lake near island)



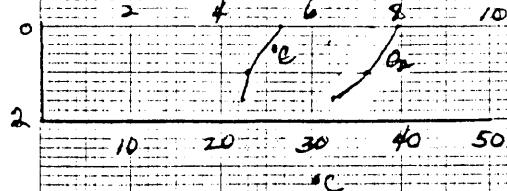
Tributaries Fig. 2

Aug. 28, 1989

- Sugar Creek

$Z_{max} = 7'1"$

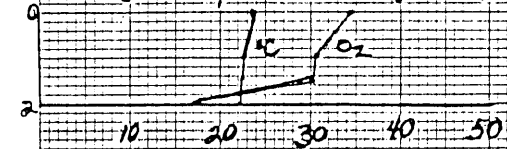
$SD = 3'8"$



- Plum Creek

$Z_{max} = 6'6"$

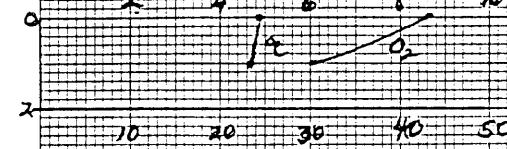
$SD = 3'3"$



- Rock Creek

$Z_{max} = 3'6"$

$SD = 1'11"$



Assessing Trophic State

The concepts *oligotrophic*, *mesotrophic*, and *eutrophic* are descriptive terms, not exact measurements. Lake management began with these concepts, but applying the right techniques required a more exact way of measuring a lake's status. The major factors in eutrophication — phosphorus, nitrogen, and sediment — have been classified into many systems for quantifying lake trophic status. The system most widely and reliably used is Carlson's Trophic State Index (TSI).

Carlson's index is suitable for evaluating many North American lakes. It is appropriate for lakes that are not covered with weeds and have little turbidity (from soil or silt). Colored water also interferes with the successful use of this index. This index assumes that water clarity is governed primarily by algal abundance. The scale runs from 0 to 100. A mesotrophic lake would have a TSI of 40–50. Every 10 points represents a doubling of algal biomass.

In a lake where it is applicable, the TSI is quickly determined by Secchi disk measurements. Many states and watershed districts rely on volunteers to monitor lake status by taking routine Secchi disk readings.

A Secchi disk is a very simple device: a round disk painted black and white attached to a line. The disk is lowered into the water until it can no longer be seen from above. When it is invisible, the disk is pulled back up slowly until it becomes visible again. Using the line attached to the disk, the user reads the Secchi depth directly. If 12 feet of line are in the water (from water surface to disk) the Secchi measurement is 12 feet. This measurement is then looked up in Carlson's chart and read across to the TSI rating. The chart also shows the expected levels of phosphorus and chlorophyll based on Carlson's equations.

This scale gives lake managers a useful tool for determining a lake's present trophic status, comparing lake status over periods of time, and setting management goals. Without some means of quantifying and comparing lake status, it would be difficult to see trends in water quality.

Reprinted From: NALMS Management Guide for Lakes and Reservoirs. by Lynne Moore. 1987.

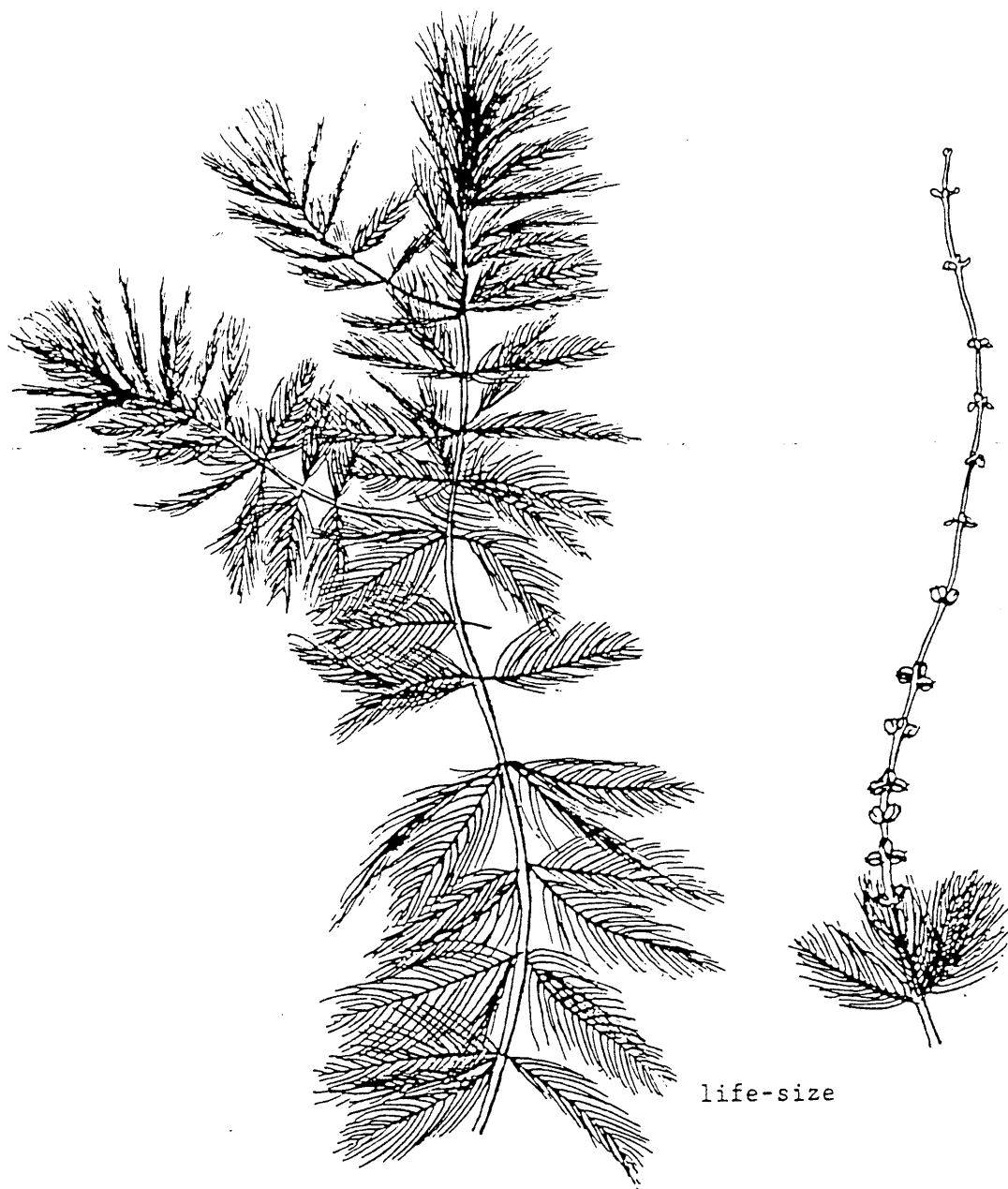
Table 1.—Completed Trophic State Index (TSI) and its associated parameters.

TSI	Secchi Disc (ft)	Surface Phosphorus (mg m-3)	Surface Chlorophyll (mg m-3)
0	210	0.75	0.04
10	105	1.5	0.12
20	52	3	0.34
30	26	6	0.94
40	13	12	2.6
50	7	24	6.4
60	3	48	20
70	19*	96	56
80	10*	192	154
90	5*	384	427
100	2.5*	768	1183

Source: Carlson, R.E. 1977. A trophic state index for lakes. *Limnol. Oceanogr.* 22:363-9.

For instance, suppose a manager wished to reduce algae by half. It is easy to use this index to see what that decision would accomplish. If the lake TSI were 60, a reduction would just barely bring the lake back into mesotrophic status at TSI 50. If the lake TSI were 80, however, a reduction of half the algal biomass to a TSI of 70 would only make the lake less eutrophic — not mesotrophic.

APPENDIX B



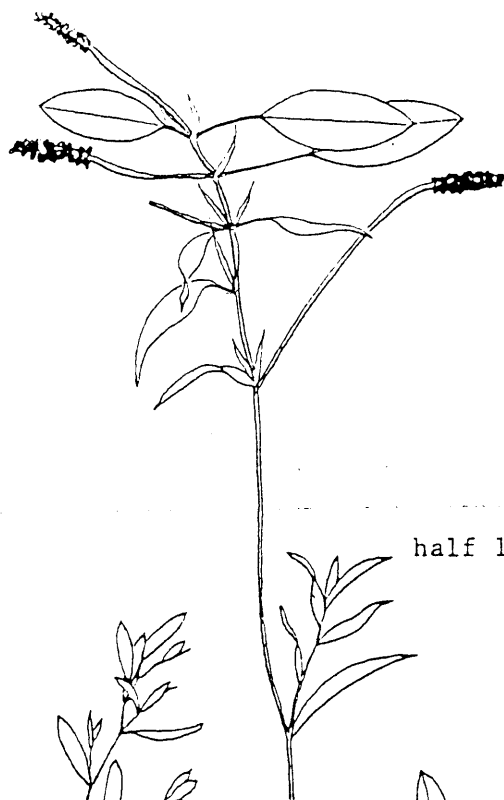
EURASIAN WATERMILFOIL, *Myriophyllum spicatum*

Fresh inland water and fresh to brackish coastal water; California; and Wisconsin to Vermont, Texas, and Florida.

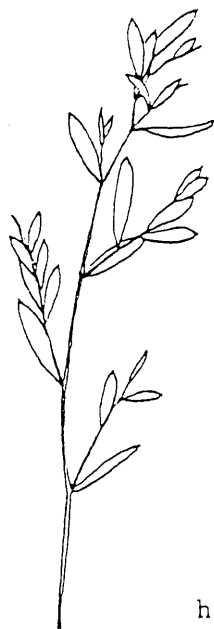
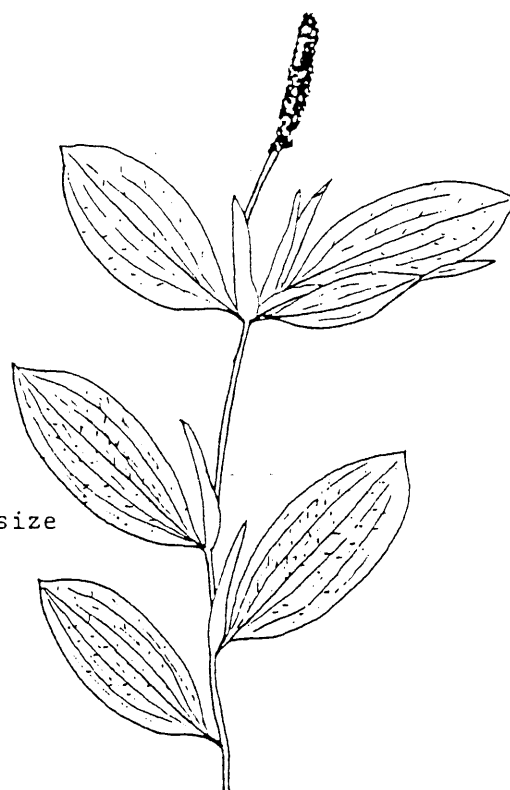
This plant has been in the United States for at least seventy years. Since 1955 it has become very abundant in Upper Chesapeake Bay, the tidal Potomac River, and several Tennessee Valley reservoirs.

Leaves look like weatherbeaten feathers because of their 12-16 pairs of close-together leaflets.

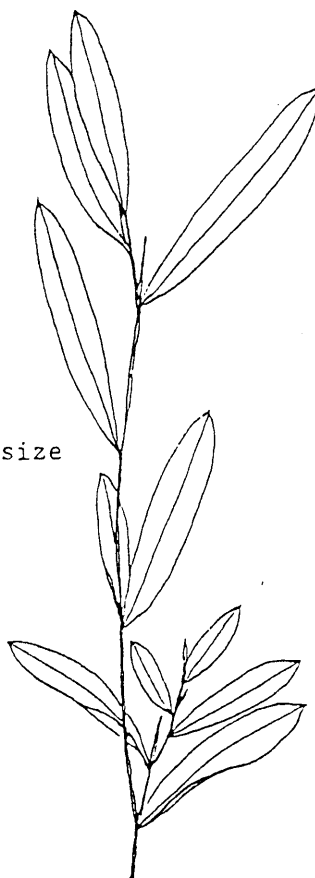
Resembles Northern (page 32) and Whorled (page 34) Watermilfoils, with which it sometimes grows; but can be told from them by its more featherlike leaves.



half life-size



half life-size



VARIABLE PONDWEED,
Potamogeton gramineus
(*Potamogeton angustifolius*, *heterophyllus*,
illinoensis, and *lucens*)

Fresh water, inland
and rarely coastal;
Alaska to Greenland,
California, and Florida.

Usually has floating
leaves.

When it has long
underwater leaves and no
floating leaves it re-
sembles Red Pondweed
(page 81); but Variable
is usually more branched.
Large plants resemble
Longleaf Pondweed (page
92); but Variable has
short-stalked or stalk-
less underwater leaves
which are not long-
tapered at the tip.

Announcements

A NALMS slide show covering lake and reservoir management techniques is available for rent. Contact the NALMS office (202) 466-8550 or write NALMS, P.O. Box 217, Merrifield, VA 22116.

NALMS Lake Management Guides are available for \$6.00 from OLMS. Contact Beth Buchanan (216) 673-8272.



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Call for papers

The Symposium on May 22-23, 1989, will include sessions of contributed papers describing current research in the area of lake and reservoir management or restoration. Abstracts (including title, author(s), address and organizational affiliation) should be limited to 200 words and submitted to OLMS Conference Committee, P.O. Box 14, Struthers, OH 44471 by January 30, 1989.

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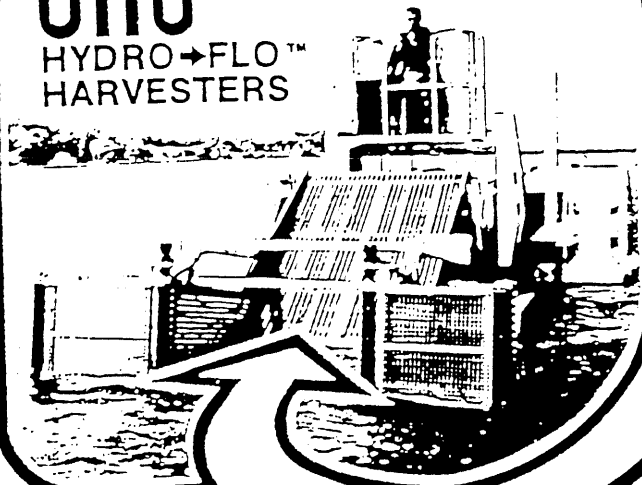
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OLMS Recognition Awards Nominations Sought

The Ohio Lake Management Society will present Distinguished Service and Innovation in Lake Management awards at its 1989 annual meeting and is currently seeking nominations for recipients of these awards. The criteria for selecting recipients and a nomination form are included in this newsletter. If you know of an individual or organization worthy of receiving one of the awards, complete the enclosed form and submit it to the Awards Committee by the end of January. Your cooperation in providing nominations will ensure the success of this new OLMS program.

Distinguished Service Award

(1) Nominee shall be an individual or organization which has, over many years, made significant contributions to the improvement of lake management in Ohio.

(2) Activity or endeavor may be local, regional, or statewide.

(3) Nominee may be a lake manager or lake management organization, government official or agency, teacher or institute of education, consultant or consulting firm, community leader or organization, researcher or research group, etc.

(4) Nominee shall be a resident of or headquartered in Ohio, but need not be a member of OLMS.

(5) Nominee may be currently active in lake management, or retired; the award may also be presented posthumously.

The Innovation in Lake Management Award

(1) Nominee shall be an organization or individual which has developed, demonstrated, and/or imple-

mented innovative lake management practices which have significantly contributed to the state of the art in lake management.

(2) Activity or endeavor shall be associated with a specific lake or lakes within Ohio.

(3) Nominee may be a lake management organization, government agency, private corporation, research group, private lake owner, individual, etc.

(4) Nominee need not be headquartered in or a resident of Ohio and need not be a member of OLMS, but activity or endeavor must be associated with a specific lake or lakes within Ohio.

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Name of Nominee:

Address and Telephone Number of Nominee:

Type of Award Nominated For:

_____ Distinguished Service Award

_____ Innovation in Lake Management Award

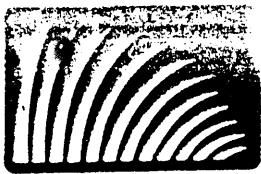
On a separate sheet, describe the activities of the nominee appropriate to the nomination. Please refer to specific guidelines for each award. Also, give some biographical information about the nominee.

Nominated by:

Address and Telephone Number:

Date Submitted:

Submit nominations to: Leonard Black, Awards Committee
Ohio Lake Management Society
3051 Oaklawn Street
Columbus, Ohio 43224



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October 9, 1989

Ms. Diane Conyers-Rizzo
ARCT
P.O. Box 219
Kent, Ohio 44240

Dear Diane;

Thank you for your phone call today regarding our aquatic plant harvesting equipment. We appreciate your interest in our company and product line, and this opportunity to work with you.

Enclosed for your reference are specifications on our two smallest aquatic plant harvesters, and on the support equipment available. Both harvesters have a five foot wide cutting swath.

The major differences between the two harvesters are in their hull design, hydraulic systems, and storage capacities. The H-220 is a deluxe harvester that has a five foot wide cutting swath and a storage capacity of 280 cubic feet (6,500 pounds). It cuts up to five and one-half feet deep. The H-220 is furnished with hydrostatic hydraulics, electric over solenoid hydraulic valving, and a standard 30 h.p. Lombardini diesel engine. The H-220 is also available in a maintenance free stainless steel/aluminum configuration. This model is probably as small as you should go for the 90 acres of weeds.

The economical EH-220 is a scaled down version of the H-220 Harvester. It has a five foot wide cutting swath, cuts up to five feet deep, and stores 200 cubic feet (3,200 pounds) of plant material. The hydraulic system is a variable volume, pressure compensated demand pump, rather than the hydrostatics. It harvests less than the H-220 due to the pontoon barge design and smaller storage capacity. The EH-220 comes with the customer's choice of a 20 h.p. gas or diesel engine. For smaller applications, the EH-220 is quite suitable, but it may be too small and inefficient for your client.

We often recommend the Trailer-Conveyor combination for most harvesting applications. The Trailer-Conveyor serves as a regular over-the-road trailer to haul, launch and retrieve the harvester; install the sidewalls, and unload the weeds from the harvester directly into the storage area. Haul the Trailer-Conveyor to the dumping site, and it will self unload the plant material from the hydraulically operated bi-directional conveyor bed. A Trailer-Conveyor eliminates the need to obtain a dump truck.

October 9, 1989

Page 2

The alternative to using the Trailer-Conveyor is to acquire both a standard Trailer for the Harvester, and a Shore Conveyor. The Harvester unloads the plant material directly into the Shore Conveyor, which elevates it up and into a waiting dump truck.

We have two larger harvesters that your client may wish to consider. The seven foot models also come in the H-Series and EH-Series configuration. The EH-420 has a seven foot wide cutting swath and cuts five feet deep, and holds 400 cubic feet of plant material (7,500 pounds). It has the simpler hydraulic system and a 30 h.p. diesel engine. It lists for \$49,500.

The H-420 has a seven foot wide cutting swath and cuts five and one-half feet deep. It holds 450 cubic feet of plant material (8,500 pounds). It has the better hydraulics and a 37 h.p. diesel engine. It lists for \$58,500. The same TRC-12 Trailer-Conveyor works with all of the 220 and 420 harvesters. Either of the 420 models would be a safe bet to recommend to your client in terms of productivity.


The issue to be most concerned with in comparing harvesters is the storage capacity of the machines--in pounds. How much vegetation can you get on the harvester before making the time consuming trip paddling to back to shore to unload? This is the single most important matter to consider. That is why the EH-220 might not be such a good choice, since it can only handle 3,200 pounds in a load. Too much time will be spent traveling back and forth to shore (unless they have a lot of unloading sites around the reservoir).

A harvester purchase comes with a complete operation and maintenance manual, a one year warranty, up to two days onsite training by factory personnel, as needed, a tool kit and spare parts kit for day to day maintenance. We maintain a complete stock of spare parts, and can usually ship the same day of order.

At this point, if you have any questions or need further information, please do not hesitate to contact us. Thank you for your consideration, and we look forward to working with you again.

Sincerely,

AQUARIUS SYSTEMS
DIVISION OF D&D PRODUCTS INCORPORATED


Jane Dauffenbach,
Sales and Marketing Director

H-220 AQUATIC PLANT HARVESTER STANDARD STEEL CONSTRUCTION MULTI-COAT EPOXY FINISH

The H-220 is the smallest harvester in our fleet of top of the line equipment. The most efficient harvester available for small scale harvesting projects, it has a generous storage compartment that allows up to 281 cubic feet of harvested plant material on board. Storage capacity is the key to efficient aquatic plant control because it reduces the number of trips traveling back and forth to shore to unload.

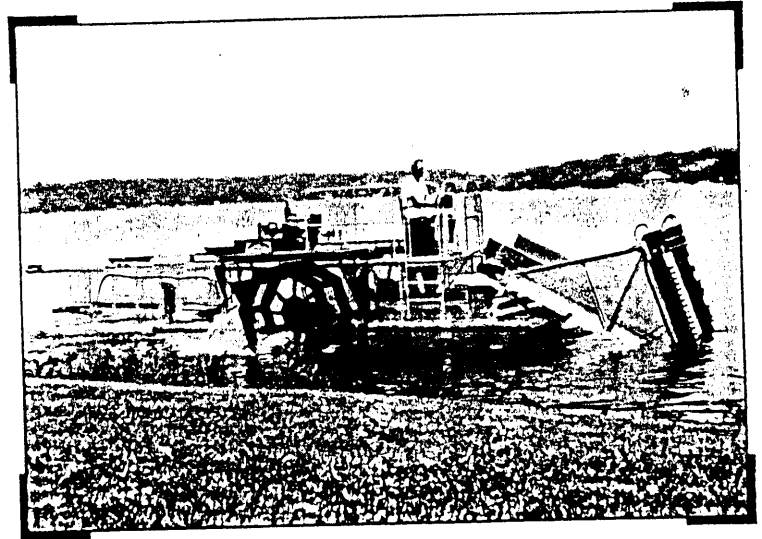
The popular choice of small lakes and newly formed associations alike, the H-220 is easily transported over the road. Its mobility in the water goes unchallenged when powered by the most efficient hydrostatic hydraulic system available for the paddle wheel drive:

Two variable displacement pumps in tandem transfer power directly from the engine to the paddle wheel motors. This direct drive system allows for infinite control of the paddle wheels without residual effects on the other operating systems. One gear pump, mounted in tandem with the hydrostatic pumps, independently operates the balance of the hydraulic system. This superior hydrostatic system operates at a lower temperature, and no energy is lost because of unnecessary heat generation.

Like the larger harvesters, the engine and hydraulics are located as far back from the operator as possible for **safety and comfort**, with easy to use electrical switches at the control panel to activate the harvester's functions. The elevated operator platform allows excellent visibility, has a durable all weather seat, and full instrumentation. Standard paddle wheel guards made of flat expanded metal safely allow complete visibility of paddle wheel activity.

ACCESSORY EQUIPMENT:

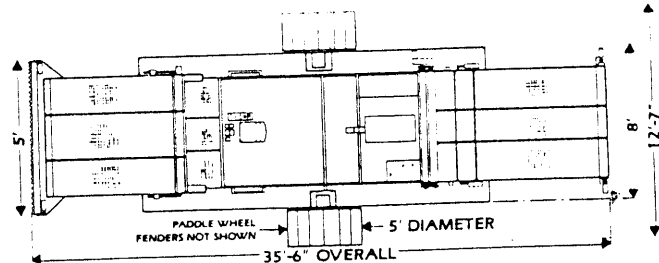
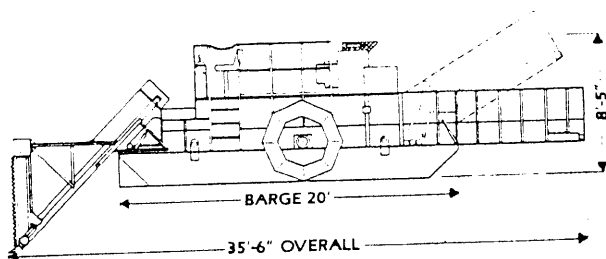
Accessory equipment available includes: Trailer-Conveyors, Trailers, Shore Conveyors, Transports and Mobilizer Assemblies. Custom options are also available to meet the customer's needs.



DETAILED SPECIFICATIONS H-220 HARVESTER

DIMENSIONS:	Length (shipping)	35'-6"
	(operating)	35'-6"
	Width (shipping)	8'-1"
	(operating)	12'-7"
	Height (shipping)	8'
	(operating)	8'-5"
	Weight	7200 lbs.
FLOTATION:	Hull Dimensions	20' x 8' x 22"
	Hull Material	Sheet steel w/internal angle iron structure
	Finish	Epoxy coating after sandblast
	Compartments	3
	Draft (empty)	9"
	(maximum load)	17"
	Displacement Ratio	2.5" per ton
SUPER-STRUCTURE:	Material	Structural steel, sheet steel, flat expanded metal
	Railings	Removable
POWER PACK:	Engine	Lombardini Diesel Mod. #11LD-535-3 30 H.P. @ 3000 R.P.M. Other engines optional
	Hydraulic pumps	2 Variable displacement pumps 1 Fixed gear pump
	Fuel Tank	2 Portable; 6 gallons each
SYSTEM PROTECTION:	Paddle Wheels	2 Cross over relief valves
	Main System	2 Adjustable relief valves
	Hydraulic Reservoir	20 U.S. Gallons
		Visual sight gauge Visual temperature gauge
HARVESTING HEAD:	Cutting Width	5'
	Cutting Depth	5'-6"
	Horizontal Knives	Reciprocating 3" stroke
	Vertical Knives	Reciprocating 3" stroke
	Impact Absorption	2 Independent sets of precompressed springs
LOAD CONTAINER:	Length	26'-6"
	Width	4'-3"
	Height	2'-6"
	Storage Capacity (volume)	281 Cubic Ft.
	(maximum weight)	6500 lbs.
	Unloading Time	90 seconds
	Discharge height	0-5 feet
PROPULSION:	Paddle Wheels	2, Hydraulically driven, independently reversible
	Diameter & Width	60" x 24"
	Paddle Wheel RPM	0 to 50
FASTENERS:	Corrosion Protection	Stainless Steel type 18-8

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HS-220 AQUATIC PLANT HARVESTER

STAINLESS STEEL/
ALUMINUM CONSTRUCTION

Our line of stainless steel/structural aluminum harvesters uses the same design features, quality hydraulics, and easy to use operator controls as the standard steel models. And, in addition to its aesthetic qualities, the stainless steel and structural aluminum offers several major advantages over the traditional steel construction. They include:

- Greater stability in the water because of a lower center of gravity
- Lower long run maintenance costs because periodic disassembly for sandblasting and repainting is not required. This is especially important when brackish water is encountered.
- Longer expected lifetime of equipment

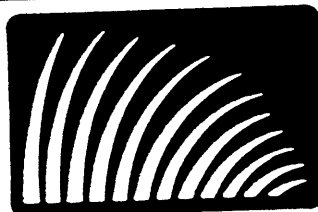
ADDITIONAL FEATURES OF ALL HARVESTERS

1. The efficient hydraulic system on all of the harvesters requires less horsepower to operate, resulting in lower fuel consumption and lower operating costs.
2. American standard 3" agricultural chrome plated cutter knives allow higher velocity operation, greater cutting surface and are readily available at all farm implement dealers.
3. Two independent spring loaded shock absorbing systems on the harvesting head offer exceptional protection from underwater obstacles.
4. The rear storage/discharge conveyor is hydraulically adjustable to facilitate unloading from 0 to 5 feet.
5. Bow is fabricated into a unique "VEE" configuration to lessen resistance while moving through the water, and to improve stability.

DETAILED SPECIFICATIONS HS-220 HARVESTER

DIMENSIONS:	Length (shipping)	35'-6"
	(operating)	35'-6"
	Width (shipping)	8'-1"
	(operating)	12'-7"
	Height (shipping)	8'
	(operating)	8'-5"
	Weight	6600 lbs.
FLOTATION:	Hull Dimensions	20' x 8' x 22"
	Hull Material	Stainless steel w/internal angle iron structure
	Steel Parts Finish	Epoxy coating after sandblast
	Compartments	3
	Draft (empty)	8"
	(maximum load)	17"
	Displacement Ratio	2.5" per ton
SUPER-STRUCTURE:	Material	Structural aluminum, sheet and flat expanded metal
	Railings	Aluminum, Removable
POWER PACK:	Engine	Lombardini Diesel Mod. #11LD-535-3
		30 H.P. @ 3000 R.P.M.
		Other engines optional
	Hydraulic pumps	2 Variable displacement pumps
	Fuel Tank	1 Fixed gear pump 2 Portable, 6 gallons each
SYSTEM PROTECTION:	Paddle Wheels	2 Cross over relief valves
	Main System	2 Adjustable relief valves
	Hydraulic Reservoir	20 U.S. Gallons
		Visual sight gauge Visual temperature gauge
HARVESTING HEAD:	Cutting Width	5'
	Cutting Depth	5'-6"
	Horizontal Knives	Reciprocating 3" stroke
	Vertical Knives	Reciprocating 3" stroke
	Impact Absorption	2 Independent sets of precompressed springs
LOAD CONTAINER:	Length	26'-6"
	Width	4'-3"
	Height	2'-6"
	Storage Capacity (volume)	281 Cubic Ft.
	(maximum weight)	7200 lbs.
	Unloading Time	90 seconds
	Discharge height	0-5 feet
PROPULSION:	Paddle Wheels	2, Hydraulically driven, independently reversible
	Diameter & Width	60" x 24"
	Paddle Wheel R.P.M.	0 to 50
FASTENERS:	Corrosion Protection	Stainless Steel type 18-8

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AQUARIUS SYSTEMS

A Division of D&D Products Inc.

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NORTH PRAIRE, WI 53153 U.S.A.
PHONE: (414) 392-2162
TELEX: 9102408406

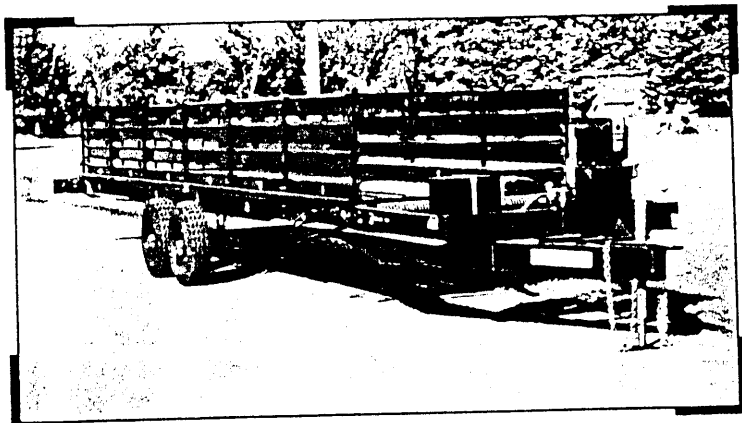
DEALER

AQUARIUS SYSTEMS

TRAILER-CONVEYOR SPECIFICATIONS

	TRC-12	TRC-34
POWER PACK:		
ENGINE	8 Horsepower @ 3600 R.P.M. Air Cooled, Electric Start	16 Horsepower @ 3600 R.P.M. Air Cooled, Electric Start
HYDRAULIC PUMP	Gear Pump- Shaft Mounted	Gear Pump- Shaft Mounted
FILTER	External	External
CONVEYOR:		
LENGTH	23'-6"	27'-6"
WIDTH	5'-6"	6'
CAPACITY	7200 Pounds	13,200 Pounds
BELTING	1 x 1 Flat Wire Galv. Mesh	1 x 1 Flat Wire Galv. Mesh
DRIVE	Hydraulic Motors (2)	Hydraulic Motors (4)
DIMENSIONS:		
LENGTH	31'-11"	35'-11"
WIDTH	8'	8'-5"
HEIGHT, CONVEYOR SIDES	4'-2"	4'-2"
HEIGHT TO TRAILER DECK	2'-7"	2'-7"
TRAILER WEIGHT:	4150 Pounds	4800 Pounds
GVWR:	12,800 Pounds	19,200 Pounds
AXLES:	2	3
GAWR:	6400 Pounds	6400 Pounds
TIRE SIZE:	9 - 14.5 LT	9 - 14.5 LT
RIM SIZE:	14.5 x 9	14.5 x 9
LIGHTING:	Legal	Legal
BRAKES:	12 V Electric	12 V Electric
WINCH:	12000 Pounds 12 V Electric	12000 Pounds 12 V Electric (2)
PINTLE HITCH:	2" Diameter	2" Diameter
JACK STAND:	5000 Pounds	5000 Pounds (2)
COATING:	Steel Surfaces Sandblasted To White Substrate, Multi Coat Epoxy	Steel Surfaces Sandblasted To White Substrate, Multi Coat Epoxy

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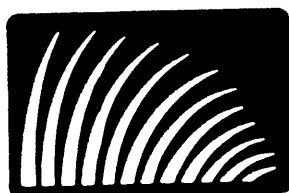
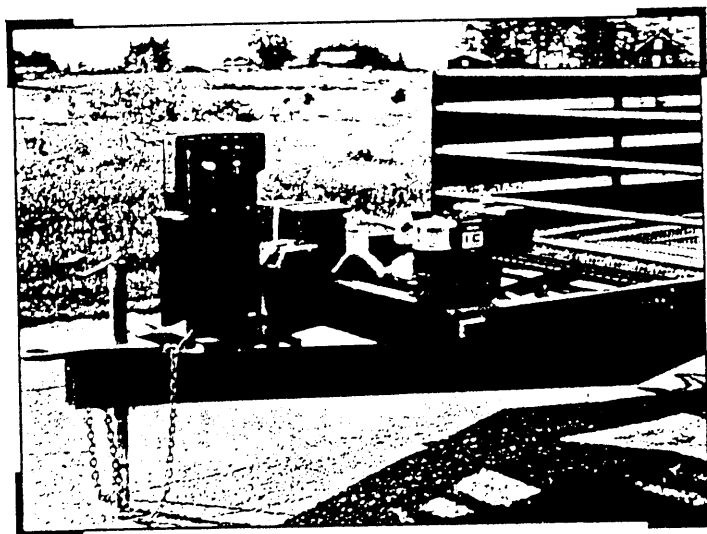
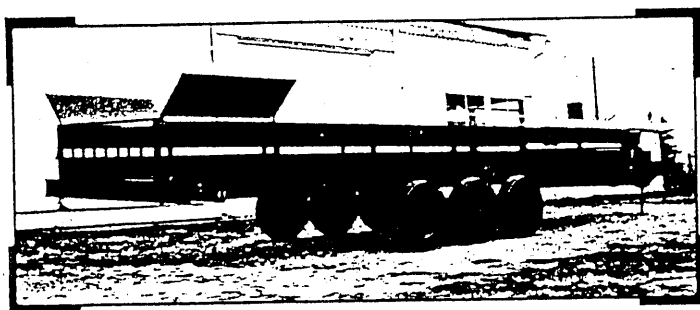


TRAILER-CONVEYOR COMBINATION

The Trailer-Conveyor serves two functions: first, as a road legal trailer to haul, launch and retrieve the harvester; and secondly, after installing sidewalls, to receive and store plant material from the harvester. Tow to the dumping site with a tractor or truck and the Trailer-Conveyor self unloads.

The Trailer-Conveyor is a heavy duty trailer with a self contained hydraulically powered "live bed" conveyor system. A gasoline engine drives a shaft mounted gear pump, which provides hydraulic fluid to a flow direction valve (forward, neutral, reverse). This directs the fluid to hydraulic motors, mounted in parallel circuitry, that drive the conveyor bed. The Trailer-Conveyor has removable sidewalls and end gates for load containment.

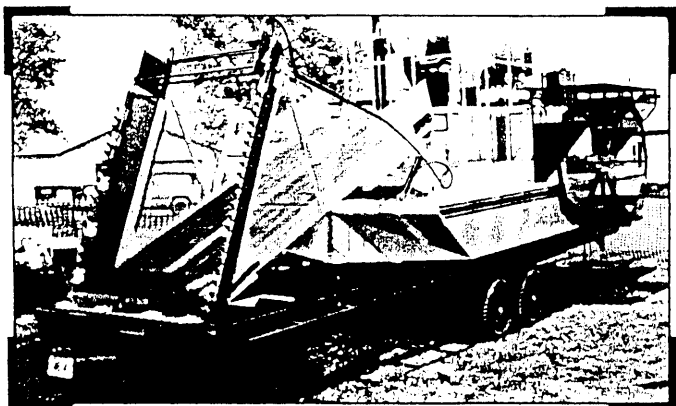
The TRC-12 is designed for use with our current 220 and 420 harvesters, and the TRC-34 is designed for use with the 620 and 820 harvesters.



**AQUARIUS
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A Q U A R I U S S Y S T E M S



STANDARD TRAILER

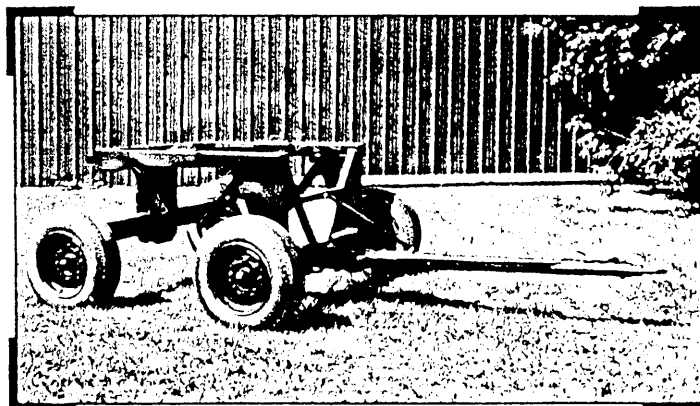
Manufactured in our factory, these heavy-duty road legal trailers assure stability for transporting aquatic plant harvesting equipment. Trailers feature electric winch, brakes and lighting, with guidance system for exact placement of barge on trailer bed.

Trailer TR-12 is designed for use with our 220 and 420 harvesters. Trailer TR-34 is designed for use with our 620 and 820 Harvesters.

STANDARD TRAILER SPECIFICATIONS

	TR-12	TR-34
LENGTH, OVERALL	31'- 9"	35'- 9"
WIDTH	8'	8'-5"
HEIGHT TO TRAILER DECK	2'-7"	2'-7"
TONGUE LENGTH	3'-8"	3'-8"
HITCH STYLE PINTLE RING	2"	2"
TIRE SIZE	9-14.5	9-14.5
WHEEL SIZE	14.5X9	14.5X9
AXLES	2	3
GAWR	6400#	6400#
LIGHTING	Legal	Legal
WINCH	12000# 12 V	12000# 12 V (2)
BRAKES	Electric	Electric
TRAILER WEIGHT	2400#	3000#
GVWR	12800#	19200#
TONGUE JACK	5000#	(2) 5000#

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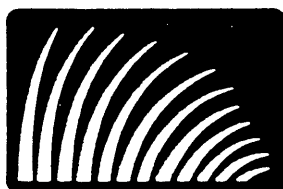
MOBILIZER ASSEMBLY

To move the Harvester or Transport over the roadway, the Mobilizer Assembly was designed as an economical trailer option where hi-speed land transport is not required.

The Mobilizer consists of two axle assemblies. The front axle assembly has a telescoping towing tongue to assist in launching and removing the equipment from the waterway, and attaches directly to the barge section of the equipment with two one inch diameter pins.

The rear axle assembly has a main horizontal pivot pin which allows all wheels to stay in contact with the road at all times. It attaches to the barge section of the equipment with two one inch diameter pins.

The two axle assemblies are bolted together with a special adapter, creating a small four wheel trailer for transport. Maximum allowable speed on the roadway is 15 miles per hour while towing load.



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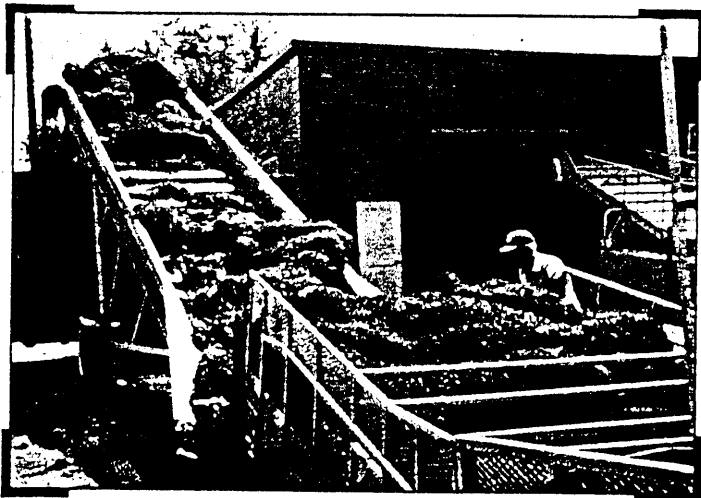
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220 N. HARRISON
NORTH PRAIRIE, WI 53153 U.S.A.
PHONE: (414) 392-2162
TELEX: 9102408406

DEALER

SHORE CONVEYOR

The Shore Conveyor serves both the Harvester and Transport as an unloading link between land and water. Powered off of the Harvester or Transport through hydraulic quick disconnects, the drag angle conveyor system efficiently moves plant material up and into a Trailer-Conveyor or truck.

An optional flotation tank is available to support the input end of the conveyor. Also, an optional power pack consisting of a 16 horsepower engine and self contained hydraulics is available to independently run the shore conveyor.

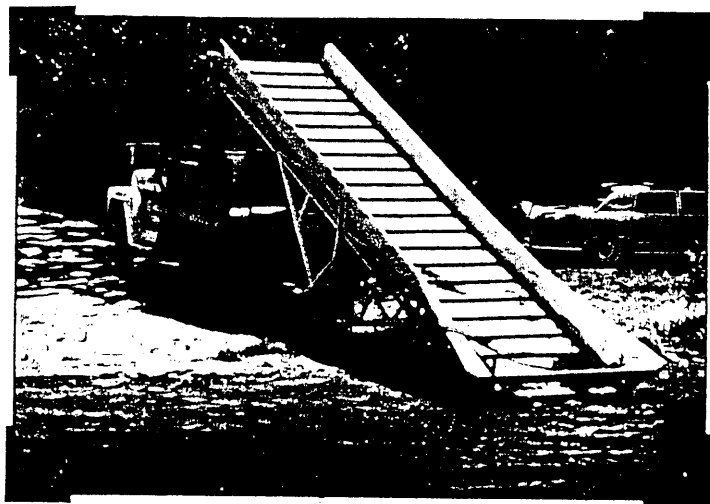


S/C-34 SHORE CONVEYOR

Model S/C-34 serves both the 620 and 820 series Harvesters, and the T-34 Transport.

LENGTH, CONVEYOR	32'
WIDTH	5'
INTAKE, FLARED HOPPER	8'-6"
SIDE WALL HEIGHT	1'
DISCHARGE HEIGHT	12'
CONVEYOR STYLE	Drag angle conveyor, nylatron runners
TONGUE LENGTH	4'
HITCH STYLE	Pintle or Ball (customer's choice)
WHEEL-TIRE SIZE	G 78-15
WEIGHT (APPROXIMATE)	3200 lbs.
ATTACHMENTS	Mating brackets for Harvester
POWER SUPPLY	Standard: Power supplied by Harvester Quick disconnects
OPTIONAL	Independent power supply mounted on shore conveyor; 16 H.P. air-cooled engine with self contained hydraulics

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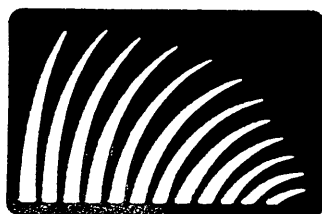


S/C-12 SHORE CONVEYOR

Model S/C-12 serves both the 220 and 420 series Harvesters, and the T-12 Transport.

LENGTH, CONVEYOR	28'-0"
WIDTH	4'
INTAKE, FLARED HOPPER	7'-9"
SIDE WALL HEIGHT	1'
DISCHARGE HEIGHT	10'-6"
CONVEYOR STYLE	Drag angle conveyor, nylatron runners
TONGUE LENGTH	4'
HITCH STYLE	Pintle or Ball (customer's choice)
WHEEL-TIRE SIZE	G 78-15
WEIGHT (APPROXIMATE)	2800 lbs.
ATTACHMENTS	Mating brackets for Harvester
POWER SUPPLY	Standard: Power supplied by Harvester Quick disconnects
OPTIONAL	Independent power supply mounted on shore conveyor; 16 H.P. air-cooled engine with self contained hydraulics

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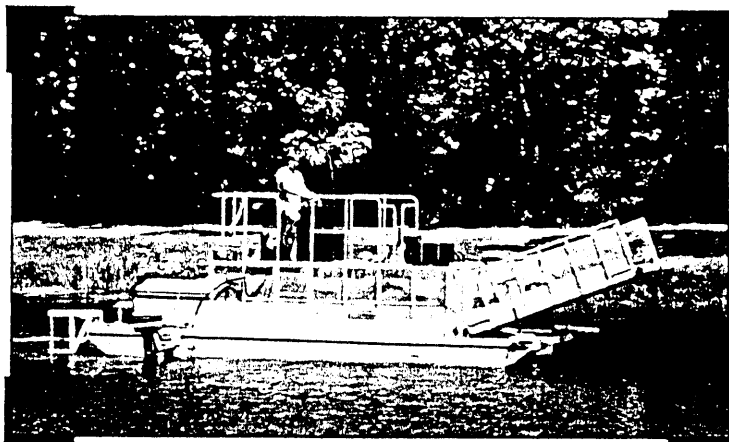
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NORTH PRAIRIE, WI 53153 U.S.A.
PHONE: (414) 392-2162
TELEX: 9102408406

DEALER

TRANSPORT

For larger harvesting projects, and for lakes that have few unloading sites, the Transport plays a major role in productivity and cost efficiency. The Transport drives out and hooks up to the harvester, taking the load of plant material on board. It then returns to shore with the load and empties it into the Shore Conveyor or Trailer-Conveyor. With little time elapsed, the harvester continues cutting where it left off. To power the Transport, an optional stern mounted 65 H.P. industrial engine or twin 30 H.P. side mounted engines are available.

Transports are also available in an optional Stainless Steel/Aluminum configuration.



T-34 TRANSPORT

Model T-34 is designed to work with the 620 and 820 series harvesters.

DIMENSIONS:	Length (shipping)	24'
	Length (operating)	(A) 31'
	Width (shipping)	10'-1"
	Width (operating)	(B) 10'-1"
	Height (shipping)	9'
	Height (operating)	(D) 9'
	Weight	9,500 lbs.
FLOTATION:	Hull dimension	(C) 24' x 10' x 26"
	Hull material	Sheet steel w/internal bracing
	Steel parts finish	Epoxy coating after sandblast
	Compartments	3
	Draft - empty	9.5"
	Draft - maximum load	21"
SUPER-STRUCTURE:	Material	Structural steel tubing, sheet and flat expanded metal
POWER PACK:	Engine	Briggs-Stratton 16 h.p. model #326437
	Hydraulic pump	Fixed gear pump
	Hydraulic reservoir	15 gallons
	Fuel tank	3 portable, 6 gallons each
LOAD CONTAINER:	Length	26'
	Width	8'-9"
	Storage capacity	800 cubic feet
	Storage weight	12,000 lbs.
	Unload time	120 seconds
	Material	Structural steel
	Discharge height	0 - 5 feet
PROPULSION:	Engines:	Two 30 h.p. Evinrude, long shaft model # E30ELCU, electric start
		OPTIONAL: single 65 H.P. industrial engine, electric start, long shaft

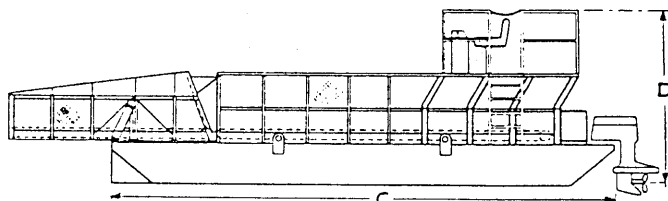
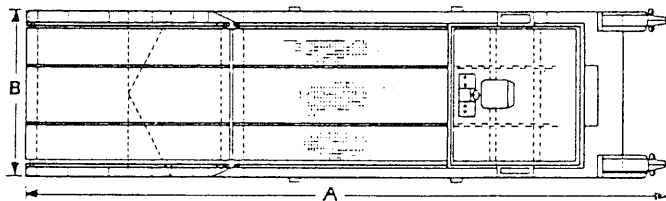
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T-12 TRANSPORT

Model T-12 is designed to work with the 220 and 420 series harvesters.

DIMENSIONS:	Length (shipping)	24'
	Length (operating)	(A) 31'
	Width (shipping)	8'-1"
	Width (operating)	(B) 8'-1"
	Height (shipping)	9'
	Height (operating)	(D) 8'-6"
	Weight	8,500 lbs.
FLOTATION:	Hull dimension	(C) 24' x 8' x 2'
	Hull material	Sheet steel w/internal bracing
	Steel parts finish	Epoxy coating after sandblast
	Compartments	3
	Draft - empty	9.5"
	Draft - maximum load	19"
SUPER-STRUCTURE:	Material	Structural steel tubing, sheet and flat expanded metal
POWER PACK:	Engine	Briggs-Stratton 16 h.p. model #326437
	Hydraulic pump	Fixed gear pump
	Hydraulic reservoir	15 gallons
	Fuel tank	3 portable, 6 gallons each
LOAD CONTAINER:	Length	26'
	Width	6'-9"
	Storage capacity	650 cubic feet
	Storage weight	9,400 lbs.
	Unload time	90 seconds
	Material	Structural steel
	Discharge height	0 - 5 feet
PROPULSION:	Engines:	Two 30 h.p. Evinrude, long shaft model # E30ELCU, electric start
		OPTIONAL: single 65 H.P. industrial engine, electric start, long shaft

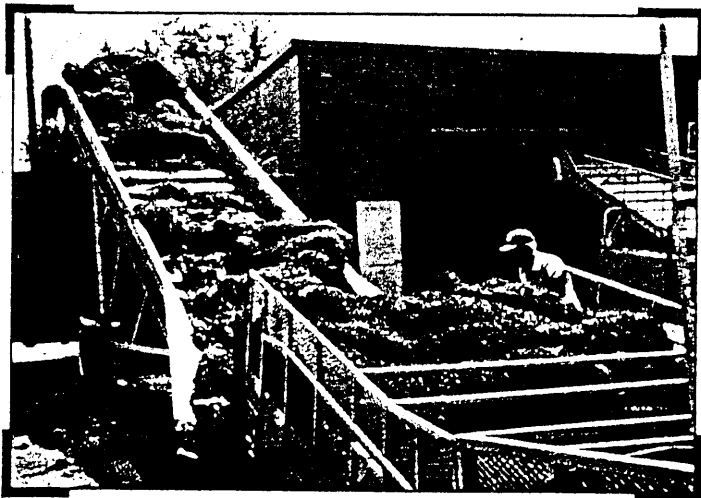
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SHORE CONVEYOR

The Shore Conveyor serves both the Harvester and Transport as an unloading link between land and water. Powered off of the Harvester or Transport through hydraulic quick disconnects, the drag angle conveyor system efficiently moves plant material up and into a Trailer-Conveyor or truck.

An optional flotation tank is available to support the input end of the conveyor. Also, an optional power pack consisting of a 16 horsepower engine and self contained hydraulics is available to independently run the shore conveyor.

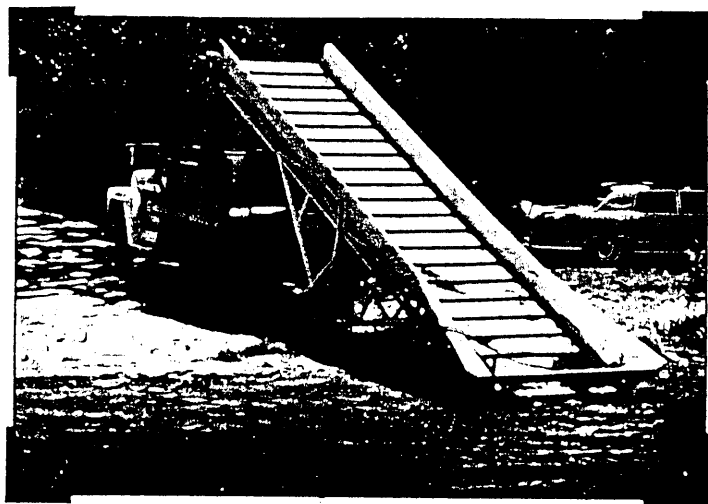


S/C-34 SHORE CONVEYOR

Model S/C-34 serves both the 620 and 820 series Harvesters, and the T-34 Transport.

LENGTH, CONVEYOR	32'
WIDTH	5'
INTAKE, FLARED HOPPER	8'-6"
SIDE WALL HEIGHT	1'
DISCHARGE HEIGHT	12'
CONVEYOR STYLE	Drag angle conveyor, nylatron runners
TONGUE LENGTH	4'
HITCH STYLE	Pintle or Ball (customer's choice)
WHEEL-TIRE SIZE	G 78-15
WEIGHT (APPROXIMATE)	3200 lbs.
ATTACHMENTS	Mating brackets for Harvester
POWER SUPPLY	Standard: Power supplied by Harvester Quick disconnects
OPTIONAL	Independent power supply mounted on shore conveyor; 16 H.P. air-cooled engine with self contained hydraulics

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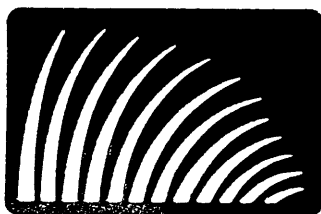


S/C-12 SHORE CONVEYOR

Model S/C-12 serves both the 220 and 420 series Harvesters, and the T-12 Transport.

LENGTH, CONVEYOR	28'-0"
WIDTH	4'
INTAKE, FLARED HOPPER	7'-9"
SIDE WALL HEIGHT	1'
DISCHARGE HEIGHT	10'-6"
CONVEYOR STYLE	Drag angle conveyor, nylatron runners
TONGUE LENGTH	4'
HITCH STYLE	Pintle or Ball (customer's choice)
WHEEL-TIRE SIZE	G 78-15
WEIGHT (APPROXIMATE)	2800 lbs.
ATTACHMENTS	Mating brackets for Harvester
POWER SUPPLY	Standard: Power supplied by Harvester Quick disconnects
OPTIONAL	Independent power supply mounted on shore conveyor; 16 H.P. air-cooled engine with self contained hydraulics

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TELEX: 9102408406

DEALER

AQUARIUS SYSTEMS

H-420 AQUATIC PLANT HARVESTER STANDARD STEEL CONSTRUCTION MULTI COAT EPOXY FINISH

Our mid-sized H-420 Harvester is the efficient solution for medium sized aquatic plant harvesting projects. The full size barge construction allows a generous storage compartment, resulting in its ability to cut and store up to 450 cubic feet of plant material. Such productivity is the key to efficient excessive plant control by reducing the number of trips needed to travel back and forth to shore to unload.

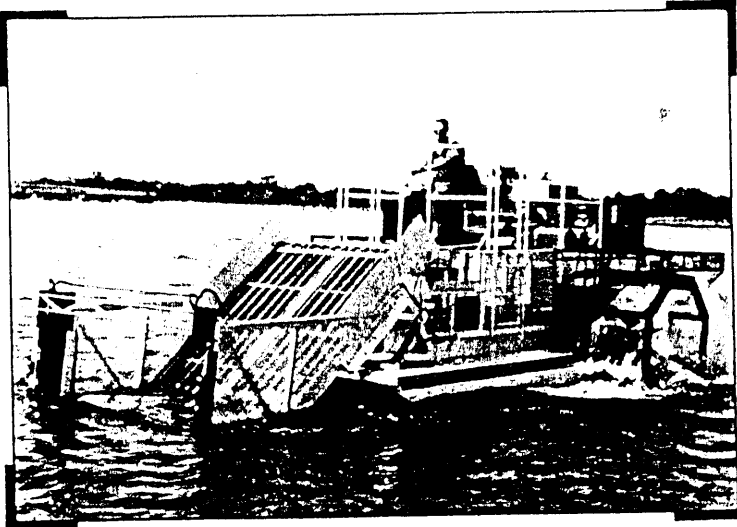
The most popular choice of contractors and municipalities alike, the H-420 is easily transported over the road. Its mobility in the water goes unchallenged when powered by the most efficient hydrostatic hydraulic system available for the paddle wheel drive:

Two variable displacement pumps in tandem transfer power directly from the engine to the paddle wheel motors. This direct drive system allows for infinite control of the paddle wheels without residual effects on the other operating systems. One gear pump, mounted in tandem with the hydrostatic pumps, independently operates the balance of the hydraulic system. This superior hydrostatic system operates at a lower temperature, and no energy is lost because of unnecessary heat generation.

For **safety and comfort**, the engine and hydraulics are located as far back from the operator as possible. Easy to use electrical switches activate the harvester's functions. The elevated operator platform allows excellent visibility, has a durable all weather seat, and full instrumentation. Standard paddle wheel guards made of flat expanded metal safely allow complete visibility of paddle wheel activity.

ACCESSORY EQUIPMENT:

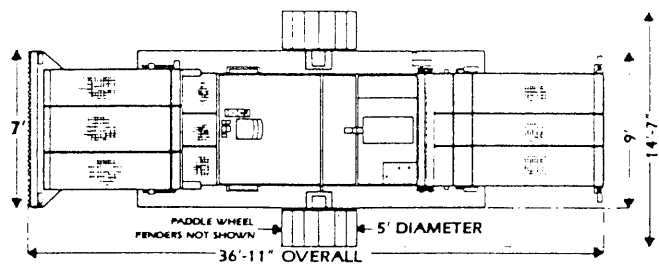
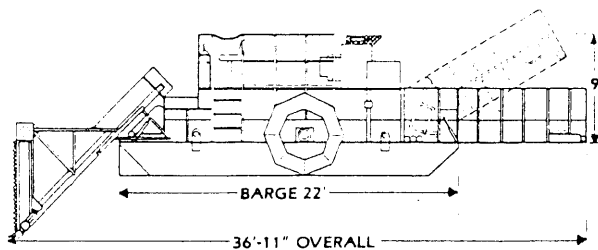
Accessory equipment available includes: Trailer-Conveyors, Trailers, Shore Conveyors, Transports and Mobilizer Assemblies. Custom options are also available to meet the customer's needs.



DETAILED SPECIFICATIONS H-420 HARVESTER

DIMENSIONS:	Length (shipping)	36'-11"
	(operating)	36'-11"
	Width (shipping)	9'-2"
	(operating)	14'-7"
	Height (shipping)	8'-5"
	(operating)	9'
	Weight	9300 lbs.
FLOTATION:	Hull Dimensions	22' x 9' x 2'
	Hull Material	Sheet steel w/internal angle iron structure
	Finish	Epoxy coating after sandblast
	Compartments	3
	Draft (empty)	10"
	(maximum load)	19"
	Displacement Ratio	2.15" per ton
SUPER-STRUCTURE:	Material	Structural steel, sheet steel, flat expand metal
	Railings	Removable
POWER PACK:	Engine	Hatz diesel model 2L40S 37 H.P. @ 3000 R.P.M.
		Other engines optional
	Hydraulic pumps	2 Variable displacement pumps
	Fuel Tank	1 Fixed gear pump 2 Portable, 6 gallons each
SYSTEM PROTECTION:	Paddle Wheels	2 Cross over relief valves
	Main System	2 Adjustable relief valves
	Hydraulic Reservoir	25 U.S. Gallons
		Visual sight gauge Visual temperature gauge
HARVESTING HEAD:	Cutting Width	7'
	Cutting Depth	5'-6"
	Horizontal Knives	Reciprocating 3" stroke
	Vertical Knives	Reciprocating 3" stroke
	Impact Absorption	2 Independent sets of precompressed springs
LOAD CONTAINER:	Length	28'-6"
	Width	6'-2"
	Height	31"
	Storage Capacity (vol.)	452 Cubic Ft.
	(maximum weight)	8500 lbs.
	Unloading Time	90 seconds
	Discharge height	0-5 feet
PROPULSION:	Paddle Wheels	2, Hydraulically driven, independently reversible
	Diameter & Width	60" x 28"
	Paddle Wheel RPM	0 to 50
FASTENERS:	Corrosion Protection	Stainless Steel type 18-8

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HS-420 AQUATIC PLANT HARVESTER

STAINLESS STEEL/
ALUMINUM CONSTRUCTION

Our line of stainless steel/structural aluminum harvesters uses the same design features, quality hydraulics, and easy to use operator controls as the standard steel models. And, in addition to its aesthetic qualities, the stainless steel and structural aluminum offers several major advantages over the traditional steel construction. They include:

- Greater stability in the water because of a lower center of gravity.
- Lower long run maintenance costs because periodic disassembly for sandblasting and repainting is not required. This is especially important when brackish water is encountered.
- Longer expected lifetime of equipment

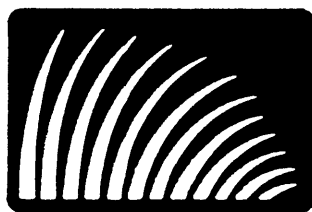
ADDITIONAL FEATURES OF ALL HARVESTERS

1. The efficient hydraulic system on all of the harvesters requires less horsepower to operate, resulting in lower fuel consumption and lower operating costs.
2. American standard 3" agricultural chrome plated cutter knives allow higher velocity operation, greater cutting surface and are readily available at all farm implement dealers.
3. Two independent spring loaded shock absorbing systems on the harvesting head offer exceptional protection from underwater obstacles.
4. The rear storage/discharge conveyor is hydraulically adjustable to facilitate unloading from 0 to 5 feet.
5. Bow is fabricated into a unique "VEE" configuration to lessen resistance while moving through the water, and to improve stability.

DETAILED SPECIFICATIONS HS-420 HARVESTER

DIMENSIONS:	Length (shipping)	36'-11"
	(operating)	36'-11"
	Width (shipping)	9'-2"
	(operating)	14'-7"
	Height (shipping)	8'-5"
	(operating)	9'
	Weight	8500 lbs.
FLOTATION:	Hull Dimensions	22' x 9' x 2'
	Hull Material	Stainless steel w/internal angle iron structure
	Steel Parts Finish	Epoxy coating after sandblast
	Compartments	3
	Draft (empty)	9"
	(maximum load)	19"
	Displacement Ratio	2.15" per ton
SUPER-STRUCTURE:	Material	Structural aluminum, sheet and flat expanded metal
	Railings	Removable, aluminum
POWER PACK:	Engine	Hatz diesel model 2L40S 37 H.P. @ 3000 R.P.M.
	Hydraulic pumps	Other engines optional
		2 Variable displacement pumps
	Fuel Tank	1 Fixed gear pump 2 Portable, 6 gallons each
SYSTEM PROTECTION:	Paddle Wheels	2 Cross over relief valves
	Main System	2 Adjustable relief valves
	Hydraulic Reservoir	25 U.S. Gallons
		Visual sight gauge Visual temperature gauge
HARVESTING HEAD:	Cutting Width	7'
	Cutting Depth	5'-6"
	Horizontal Knives	Reciprocating 3" stroke
	Vertical Knives	Reciprocating 3" stroke
	Impact Absorption	2 Independent sets of precompressed springs
LOAD CONTAINER:	Length	28'-6"
	Width	6'-2"
	Height	31"
	Storage Capacity (volume)	452 Cubic Ft.
	(maximum weight)	9300 lbs.
	Unloading Time	90 seconds
	Discharge height	0-5 feet
PROPULSION:	Paddle Wheels	2, Hydraulically driven, independently reversible
	Diameter & Width	60" x 28"
	Paddle Wheel RPM	0 to 50
FASTENERS:	Corrosion Protection	Stainless Steel type 18-8

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AQUARIUS SYSTEMS

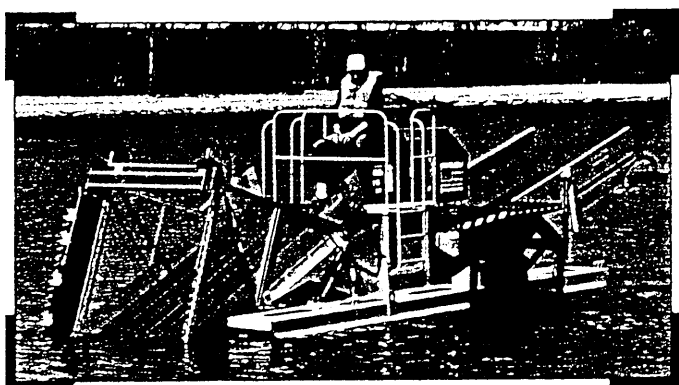
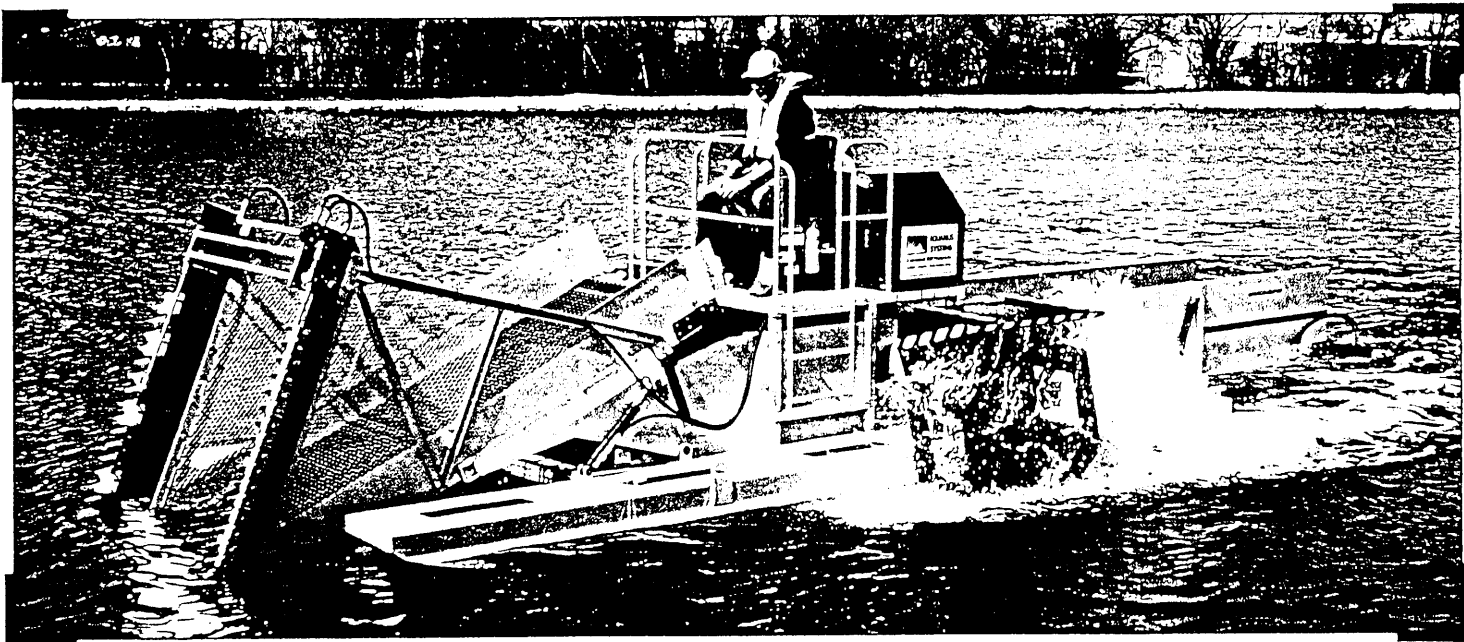
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NORTH PRAIRE, WI 53153 U.S.A.
PHONE: (414) 392-2162
TELEX: 9102408406

DEALER

AQUARIUS SYSTEMS

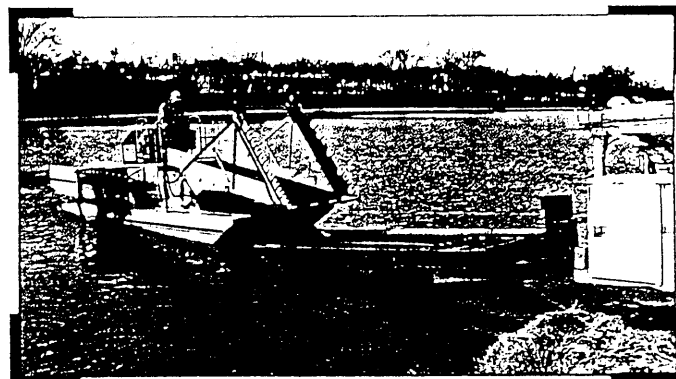
EH-SERIES AQUATIC PLANT HARVESTING EQUIPMENT



EH-SERIES AQUATIC PLANT HARVESTER

The leading manufacturer and designer of Aquatic Plant Harvesters for over 26 years now offers an **economical** version of its sophisticated high performance line of harvesters.

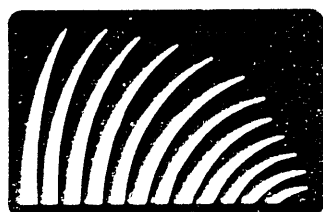
A similar competitive model to other harvesters currently available on the market, the design integrity and performance characteristics of our standard top quality "H Series" harvesters are incorporated in these newer "EH Series" units.



The "EH-220" has a five foot wide cutting swath and is ideally suited for smaller lakes and waterways.

The "EH-420" is a larger more productive harvester with a seven foot wide cut, and is the choice of contractors and medium sized lakes alike.

Both harvesters have an elevated control bridge, safety railings, manual hydraulic controls, full instrumentation, and standard paddle wheel guards. Easy launch, retrieval, transportability and efficiency are additional features.



AQUARIUS SYSTEMS

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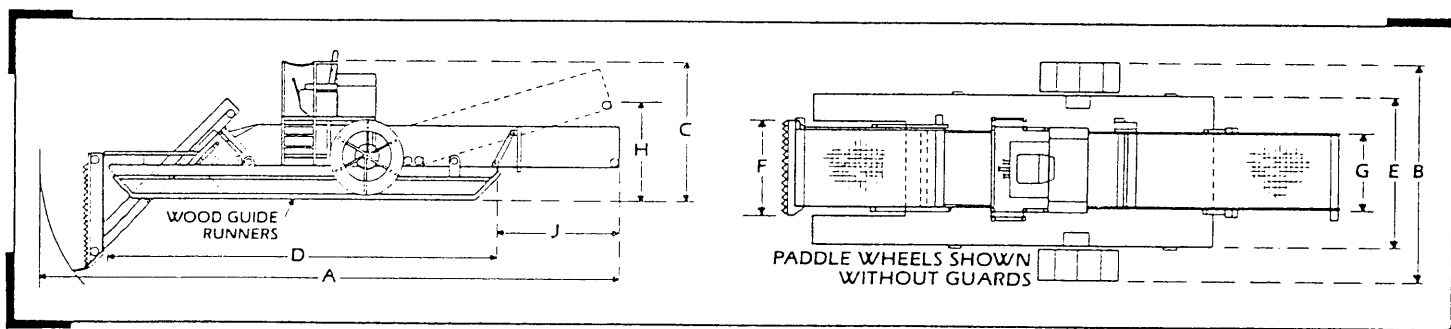
EH-SERIES FEATURES

- For added safety, paddle wheel guards are standard.
- Flexible break away springs on harvesting head absorb shocks and automatically reset.
- To aid in unloading plant material, discharge height is adjustable from 0 to 5 feet.
- Restricted shore access is more easily reached by the extra long discharge conveyor that stretches 6'-7" beyond the rear of barge.
- Two marine outboard fuel tanks are conveniently portable for easy refueling.
- Harvesters are equipped with the customer's choice of a gas or diesel engine.
- American standard 3" agricultural chrome plated cutter knives allow higher velocity operation, greater cutting surface, and are readily available at all farm implement dealers.
- Shear fingers of forged steel protect cutter teeth from damage.
- Wood runners covered with UHMW plastic slider pads protect barge bottom and guide harvester smoothly on and off of trailer.
- Excellent protection against corrosion is provided by thermally cured epoxy finish over white sand-blasted substrate.
- Lockable tool and battery box.
- Accessory equipment available includes: Trailer/Conveyors, Trailers, Shore conveyors and Transports. Custom options are also available to meet the customer needs.

AQUATIC PLANT HARVESTER SPECIFICATIONS

	MODEL EH-220	MODEL EH-420	COMMON CHARACTERISTICS
DIMENSIONS			
(A) Operating Length	31'-0"	35'-0"	
(B) Operating Width	11'-10"	14'-4"	
(C) Operating Height	7'-6"	9'-0"	
Shipping Length	31'-0"	35'-0"	
Shipping Width	8'-2"	9'-2"	
Shipping Height	7'-6"	9'-0"	
Height on Trailer	10'-1"	11'-7"	
FLOTATION			
(D) Barge Length	21'-0"	25'-0"	
(E) Barge Width	8'-2"	9'-2"	
Barge Height	18 1/2"	24"	
Harvester Weight	6,500 lbs.	8,500 lbs.	
Draft Empty	10"	10"	
Draft Max. Load	15"	19"	
Compartments	5	5	
Displacement	3.07" per ton	2.33" per ton	
POWER PACK			
Engine	20 H.P.	37 H.P.	Optional gasoline or diesel
Hydraulic Pump			Variable volume, pressure compensated
Hydraulic Reservoir	18 gal.	25 gal.	Visual sight gauge
Fuel Tanks			Visual temperature gauge
			2 Portable, 6 gallons each
CONTROL BRIDGE			
Hydraulic Controls			Manual-levers
Operator Seat			Adjustable
Systems Control			Full instrumentation
System Protection			Relief Valves
HARVESTING HEAD			
(F) Cutting Width	5'	7'	
Cutting Depth	5'	5'	
Horizontal Knives			Reciprocating 3" stroke
Vertical Knives			Reciprocating 3" stroke
Shear Fingers			Horizontal-forged steel
			Vertical-formed steel
Impact Absorption			Break away springs, automatic reset
Conveyor Belting			1" x 1" Galvanized, standard
LOAD CONTAINER			
Length	22'-0"	26'-0"	
(G) Width	4'-1"	6'-3"	
Height	2'-3"	2'-6"	
Storage (Vol.)	200 cubic feet	400 Cubic Ft.	
(Weight)	3,200 lbs.	7,500 lbs.	
Unload Time	90 seconds	90 seconds	
(H) Discharge Height	0-5 feet	0-5 feet	From rear of barge 6'-7"
(J) Discharge Distance			1" x 1" Galvanized, standard
Conveyor Belting			
PROPULSION			
2 Paddle Wheels			Hydraulic drive, independently reversible
Diameter and Width	48" x 18"	60" x 28"	
Paddle Wheel R.P.M.	Variable 0-50	Variable 0-50	
FASTENERS			
Stainless Steel			Throughout machine

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HARVESTING

THEORETICAL CUTTING AREAS PER HOUR BASED ON CUTTING SPEED OF 1 MILE PER HOUR

	THEORETICAL	PRACTICAL	LOAD
EH-5-220	.610 ACRES PER HR.	.30 ACRES PER HR.	3200 LBS.
H-5-220	.610 " " "	.30 " " "	6500 LBS.
EH-7-420	.850 " " "	.425 " " "	7500 LBS.
H-7-420	.850 " " "	.425 " " "	8500 LBS.
H-9-620	1.09 " " "	.505 " " "	11000 LBS.
H-10-820	1.21 " " "	.61 " " "	14000 LBS.

(A) ABOVE PRACTICAL CUTTING SPEEDS BASED ON TRAVELING AND UNLOADING TIME EQUALLING CUTTING TIME. DISTANCE TO UNLOADING SITE MAY INCREASE OR REDUCE PRACTICAL CUTTING TIME.

(B) WEATHER CONDITIONS CAN EITHER HAMPER OR AID CUTTING TIMES.

(C) OPERATOR SKILL AND PLANNING CAN INCREASE PRACTICAL CUTTING TIME BY 50%.

(D) THE USE OF A TRANSPORT BARGE CAN INCREASE HARVESTER CUTTING TIME UP TO 90% OF THEORETICAL TIME.

(E) SHORE LINE CUTTING, (IE) TRAVERSING BACK AND FORTH TO WATERS EDGE WILL REDUCE PRACTICAL CUTTING TIME BY 30%.

MANY FALSE CLAIMS HAVE BEEN MADE AS TO CUTTING AND HARVESTING SPEEDS. OUR EXPERIENCE THROUGH THE YEARS INDICATES THE ABOVE TO BE MOST ACCURATE.

SHORELINE PROTECTION

Leader:

STEVEN McCOMAS

Applied Research & Technology
St. Paul, Minnesota

Panelists:

DAVID JANSEN

Galena Territory Association
Galena, Illinois

JOE MARTER

Soil Conservation Service—Wisconsin
Beaver Dam, Wisconsin

DON ROSEBOOM

Illinois State Water Survey
Peoria, Illinois

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and International Symposium on Lake
& Watershed Management
Lake Geneva, Wisconsin; Nov. 13-16, 1985
North American Lake Management Society

INTRODUCTION

The objective of lake shoreline or streambank protection is to stabilize and protect these land forms against scour and erosion from forces such as wave action, ice action, seepage, and runoff from upland areas. Shoreline stabilization methods fall into two broad areas: nonstructural (vegetation or beach sloping) and structural (flexible structures like riprap, and rigid structures like seawalls).

EVALUATING THE PROBLEM

Characteristics found at the site determine the protection method. The source of the problem should be determined. Breaking waves or ice pushing onto shore are examples. Overland runoff or ground water seeping through the bank also cause bank failures. Several parameters to evaluate onsite include severity of existing erosion, shoreline use, soil type, slope, fetch of the lake, wave height, and wave runup. After these parameters are evaluated, a form of protection can be prepared.

DEFINITIONS

Fetch. The height of crashing waves on shore is an important design consideration. One factor affecting wave height is the fetch, the length of uninterrupted distance the wind blows over a lake. For detailed designs, the fetch is measured from a number of directions.

Slope. The slope is a measure of bank or shoreline steepness. For example, a basement stairway usually has a slope of about 1:1, meaning for a 1 foot length, there is a 1 foot drop. For a streambank or shoreline with a 4:1 slope, for every 4 feet of length the drop is 1 foot.

Wave Height. The height of waves crashing on shore is related to the fetch of the lake. Table 1 approximates the wave height attained in a 50 mph wind based on the fetch. For most inland lakes, a fetch of 2 miles is about the maximum, and most lakes do not experience wave heights greater than 3 feet above the still water level. Using Table 1, if a 50 mph wind blows across the lake uninterrupted for a distance of 1,500 feet, the expected wave height is 1.2 feet.

Wave Runup. When a crashing wave hits the shoreline,

some runup occurs. The distance a wave will run up onto shore is a function of the wave height and the shore slope (roughness of the shore material is a factor not included in this approximation). Table 2 determines wave runup. For example, for a shoreline area with a slope of 4:1 and a crashing wave of 1.4 feet, the wave runup would be 1.5 times greater than the wave height, or 1.5 times 1.4 feet equaling 2.1 feet of runup.

NONSTRUCTURAL METHODS

Vegetation

Vegetation effectively controls runoff erosion on slopes or banks leading down to the water line; however, vegetation is ineffective against direct wave action or seepage-caused bank slumping. For erosion control, plants can be grouped into three categories: herbaceous plants (includes grasses and ground cover), shrubs, and trees.

The type of vegetation to establish depends on the angle of the slope. If the angle is steeper than 1:1, the soil is probably unstable and the possibility of establishing vegetative cover is slight. If possible, the bank face should be reshaped to a flatter slope. On slopes flatter than 3:1, a mowed lawn is feasible. On slopes between 1:1 and 3:1 a mowed lawn is difficult to maintain and other recommended options include unmowed grasses, shrubs, or trees.

Grass mixtures for slopes flatter than 3:1. Tall fescue and common Kentucky bluegrass mixture is appropriate for a mowed lawn and can be established in one year.

Grass mixtures for slopes flatter than 1:1. Red fescue and common Kentucky bluegrass mixture reaches a mature height of 12–18 inches and can be established in one year. Big bluestem, little bluestem, and switchgrass, reaching a mature height of 36–60 inches, are native prairie grasses and may take several years to become established.

Ground cover plants for slopes flatter than 1:1. These plants can be used instead of grass on slopes. They often are more attractive than unmowed grass and usually require less maintenance. They take one to several years to become established. Representatives include goutweed, bearberry, crown vetch, memorial rose,

Table 1.—Predicted wave height as a function of fetch for a 50 mph wind (from USDA SCS-Wisconsin Technical Guide, 1982).

FETCH DISTANCE (FT.)	WAVE HEIGHT (FT.)
500	0.7
1,000	1.0
1,500	1.2
2,000	1.4
3,000	1.7
4,000	1.9
5,000	2.1
7,500	2.6
10,000	3.0
12,500	3.3

Table 2.—Ratio of runup (R)/wave height(H) for various slopes (from USDA SCS-Wisconsin Technical Guide, 1982).

SHORE SLOPE HORIZONTAL:VERTICAL	RATIO
2:1	2.3
3:1	1.9
4:1	1.5
6:1	0.9
10:1	0.5

bugleweed, creeping juniper, and purple wintercreeper.

Shrubs for slopes flatter than 1:1. Shrubs are woody plants best transplanted in spring when they are dormant. Plant after the ground thaws and the air temperature is above 35° F. Planting can also be done in late autumn after the plants are dormant but before the ground freezes. They take one to two years to become established. Representatives include red chokeberry, gray dogwoods as well as other species of dogwoods, sumac, common juniper, common witch hazel, border privet, snowberry, and tatarian honeysuckle.

Trees for slopes flatter than 1:1. The process of

establishing a woods on a bare slope is time consuming. Sow the area with grass seed and allow volunteer woody plants to grow as well. Use trees on slopes when a lake view is not necessary or a screen to block some other view is desired. Use shrubs where a view is wanted. Representative trees include red maple, silver maple, Junebush, paper birch, white ash, white pine, and black cherry.

When considering vegetation for slope stabilization, the property owner should seek professional advice but can do most of the work associated with planting.

For more information concerning vegetative applications ask for the brochure, *Harmony With the Lake: Guide to Bluff Stabilization* (Ill. Dep. Transportation, Chicago, Ill.). This brochure was used as a basis for most of the discussion in this section.

Erosion Control Mats. Erosion control mats serve as a reinforcing matrix for root systems. The mats, constructed of a nylon mesh or wood excelsior, are placed on top of soil to assist in seed germination, seedling protection, and erosion control. They control erosion on slopes carrying water with a velocity that makes it difficult for unaided vegetation to grow effectively. Different types of mats are recommended for different flow velocities (Table 3). Erosion control mats can be used in channels, in ditches, and on slopes, but are not designed to dissipate energy of direct wave action.

In summary, vegetation alone or combined with erosion control blankets controls erosion originating from the land side of the lake. The next series of protection methods will deal with bank and shore erosion originating from the lake side.

Beach Sloping

Beach sloping takes advantage of the ability of semifluid sands to dissipate the energy of the breaking and receding waves. A typical cross section is shown in Figure 1.

Design considerations:

1. Minimum thickness of the sand blanket is 1 foot.
2. Extend the blanket to a water depth two times the design wave height. If the design wave height is 1.0 foot, then the sand blanket should go into the water to a depth of at least 2 feet. If the final beach slope is 10:1, then the blanket goes into the lake 20 feet from shore (water depth

Table 3.—Ultimate velocities (lineal ft/sec) that various types of erosion control blankets can withstand under different soil conditions (from an American Excelsior Co. fact sheet).

	CLAY CLAY LOAM SILTY CLAY	LOAM SILTY CLAY SANDY CLAY LOAM	FINE SANDY LOAM SILTY LOAM
Regular Curlex (Aspen excelsior, and plastic mesh) \$0.51/yd ²	4.8	4.8	3.9
High Velocity Curlex Blanket (heavy duty Curlex) \$1.25/yd ²	11.0	9.8	8.6
Enkamat 7010 (monofilament nylon mesh) \$4.40/yd ²	13.2	12.5	11.0
Enkamat 7020 (heavy duty monofilament nylon mesh) \$6.70/yd ²	17.5	16.5	14.5

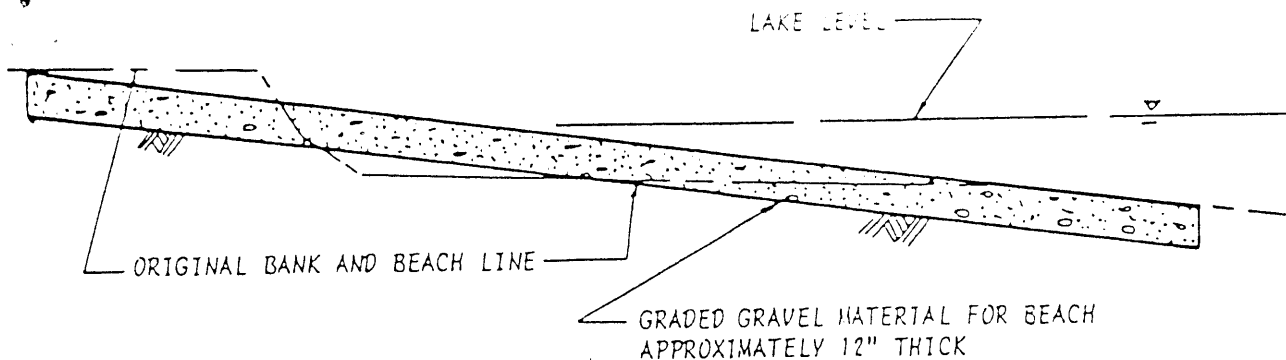


Figure 1.—Cross section of beach sloping: The final slope of the beach line is based on the size of material used.

will be 2 feet at 20 feet from shore at a slope of 10:1).

3. Extend the beach blanket the distance equal to the computed runup plus one foot.

4. The size of the material used and the final slope should be determined by a professional engineer.

One problem with beach sloping is that a strong long-shore current may erode blanket material. Periodic replenishment will be necessary in this case.

STRUCTURAL METHODS

Riprap

Riprap is a flexible revetment (a revetment is a structure to prevent erosion of a bank) constructed of stone and gravel placed either on a natural slope or on an artificially graded shore to protect shorelines from wave action, ice action, and slumping because of seepage. A typical cross section is shown in Figure 2.

Design considerations include the following:

1. Riprap should be placed into the water 1.5 times the wave height below the still water surface.

2. Riprap should extend onto shore the runup distance plus 0.5 foot above the still water level.

3. The median rock size (diameter in inches) for various slopes and wave heights is shown in Table 4.

4. The minimum thickness of the riprap should be 2.5 times the median size.

5. A layer of bedding material to act as a filter should be at least 6 inches thick, or filter fabric should be used.

6. On slopes of 6:1 or steeper, the riprap at the lowest elevation (the toe) should be anchored.

Other Flexible Revetment Structures

Flexible structures move slightly under certain conditions, such as ice jamming, freeze-thaw cycles, and shifting of the bank. Riprap is one of a number of flexible revetment structures. Others include gabions (wire mesh baskets filled with rocks) and interlocking cement blocks that come in a variety of configurations. The Army Corps of Engineers (with stations all over the country) can provide more detailed information on these options, especially in the booklet, *Low Cost Shore Protection*. A Property Owner's Guide. Another source of information is the Soil

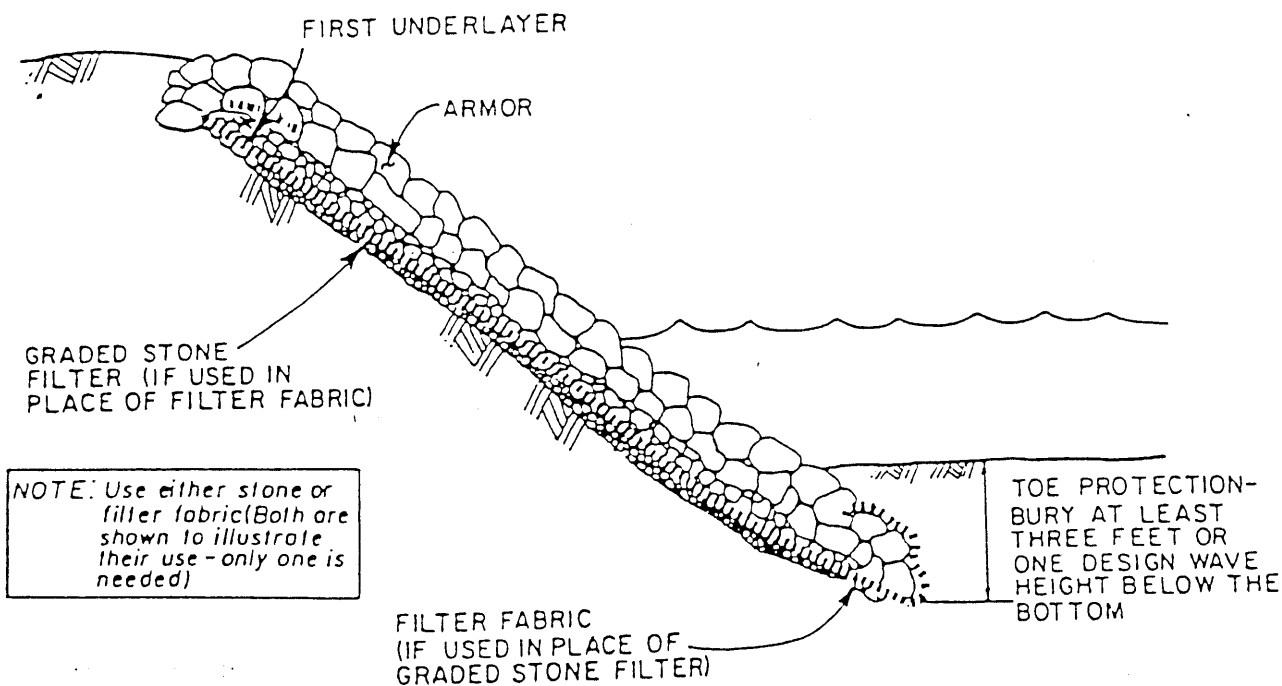


Figure 2.—Cross section of a riprapped shore.

Table 4.—Median rock size for various shore slopes and wave heights (from USDA SCS—Wisconsin Technical Guide, 1982).

SHORE SLOPE (HOR:VERT)	WAVE HEIGHT (FT)	MEDIAN ROCK SIZE (IN.)
2:1	1.0	4
	2.0	6
	3.0	8
3:1	1.0	4
	2.0	5
	3.0	7
4:1	1.0	4
	2.0	4
	3.0	7
6:1	1.0	4
	2.0	4
	3.0	6
10:1	1.0	4
	2.0	4
	3.0	4

Conservation Service in your county.

Seawalls, Bulkheads, and Retaining Walls

The names seawalls, bulkheads, and retaining walls are used interchangeably. These rigid structures are used where steep banks prohibit the sloping forms of protection. The seawall is placed vertically in soils and forms a barrier between the land surface and the waterbody. The land side is backfilled to absorb wave energy. The seawall primarily prevents land masses from sliding from the shore

to the water and secondarily prevents wave action from damaging the shoreline.

Two types of seawalls are shown in Figure 3. A cantilever seawall is a sheet pile wall supported solely by ground penetration. An anchored seawall is similar to a cantilever structure but gains additional support from embedded anchors.

Design considerations include the following:

1. Steel sheet piles can be driven into hard soil and soft rock. Aluminum and timber sheet piles can be driven into softer soil.

2. For a cantilever seawall, the sheet piling should be driven deep enough to resist overturning, which usually requires penetration to a depth two to three times the free-standing height, depending on the foundation characteristics at the site.

3. For an anchored seawall, sheet piling should be embedded to a depth 1.5 to 2 times the free standing height. Again, the foundation characteristics may indicate shallower or deeper penetration.

4. The top of the seawall should be 1 foot plus runup above the stillwater elevation (use 1.5:1 curves for a smooth surface to determine runup).

5. Drain holes should be placed at regular intervals to facilitate movement of water from behind the structure. The drain holes should be backed with filter cloth or crushed stone filters.

6. Wing walls should be used to prevent flanking (erosion at the ends of the seawall). If the ends are not protected, erosion could produce a retreating shoreline at each end of the seawall.

QUESTIONS AND ANSWERS

Q. Is it normal to grow vegetation on a sheer face?

A. No, it is not normal. In the slide we saw, the owner wanted to keep the bank the way it was, so we used vegetation that would hold on a steep grade and made sure that it was not completely exposed to the rain.

Q. When using rocks for shoreline protection, have you

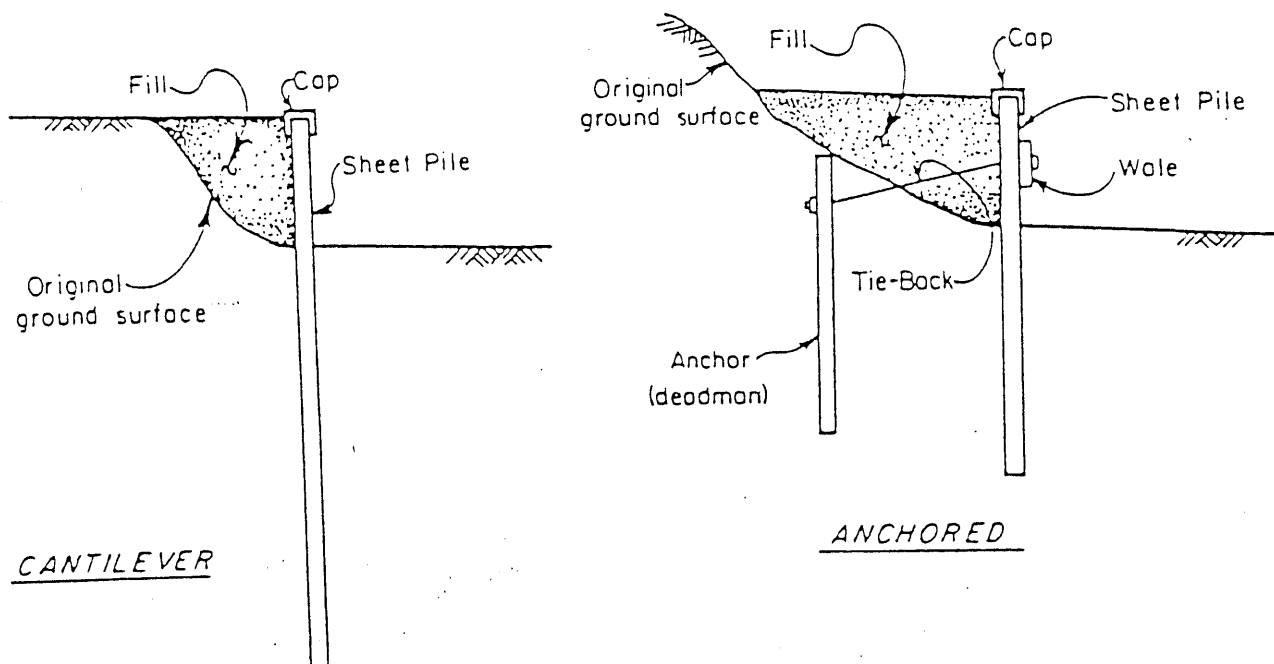


Figure 3.—Cross section of a cantilever and an anchored seawall. If timber is used for the sheet piling, a filter cloth backing should be placed behind the timbers on the land side.

developed a slope recommendation to eliminate ice pushing the rocks back up on shore?

A. Wave height is the primary design consideration. As far as ice action is concerned, the ice may loosen the rocks, but gravity will usually cause them to fall back down.

Q. In Minnesota, we are finding that a 2:1 slope does not seem to prevent ice damage. Would a slope closer to 6:1 make a significant difference?

A. Yes, it would make a difference. If you can get a 6:1 slope, use it.

Q. Would drawing down the water level of a lake 2-3

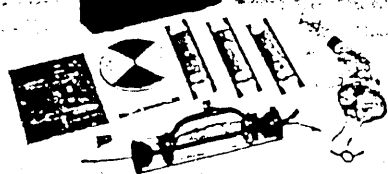
feet, just before winter, help eliminate ice damage?

A. Yes, a drawdown could be helpful, but you want to make sure that lowering the lake 2-3 feet does not put the water level at the toe of other property owners' seawalls. Wave action before freezeup could cause some problems. Also, you want to be sure that the water will return to the normal level in the spring.

Q. Would a metal retaining wall tipped back at a slight angle conquer the ice problems?

A. Yes, it would; a slope of about 15 degrees seems to prevent ice damage that would normally occur to a vertical retaining wall.

APPENDIX E

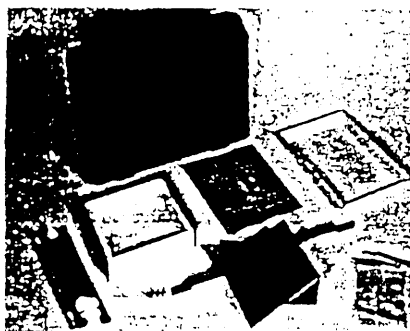
**Bottom Sampling Field Kit**

Includes a stainless steel bottom grab with 15.7 x 17.7 cm (6.2" x 7") sampling area. The release mechanism is activated on impact with the bottom, allowing the grab to close when it is pulled up from the bottom. The sample remains intact as it is raised to the surface. A curved pan fits the sampler and permits careful emptying of the sampler for initial examination. A shallow flat pan allows detailed examination of specimens. An uncalibrated, 20m nylon line, 10 Minigrip bags, and instructions are included. Durable plastic case.

77274 Sh. Wt. 11 lb. \$150.00
77275 Same as 77274 but without pans, bags, case. 115.55

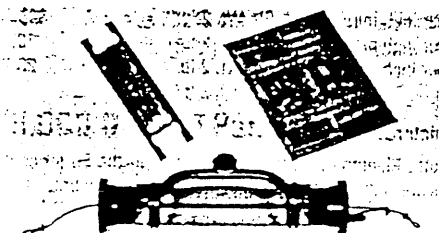
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transparency index, measure water depth to 20m. Includes 1-liter horizontal style clear acrylic water bottle, a 4 oz. tapered nose brass messenger for activating the closing mechanism on the bottle, a thermometer (-40° to +50°C in 1° subdivisions), a 153 micron mesh plankton net, a standard Secchi disk with black and white quadrants, three 20 meter nylon lines, and instructions. Sturdy plastic carrying case.

77273 Sh. Wt. 14 lb. \$269.00

**Water Bottle Kit**

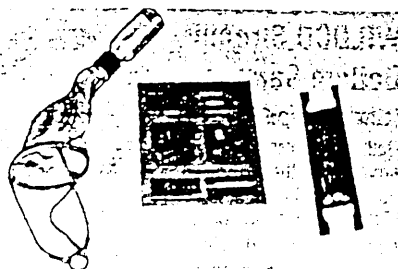
A clear acrylic 1-liter horizontal style water sampler with positive messenger-activated closing mechanism. Includes bottle, 4 oz. tapered nose solid brass messenger, 20m uncalibrated nylon line, instructions.

77276 Sh. Wt. 4 lb. \$146.00

**Plankton Net Kit**

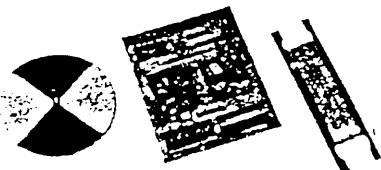
Net is 153 micron Nitex bolting cloth. Includes net, bottle for net, 20m uncalibrated nylon line, instructions. (Additional bottles for net are available in pack of 12).

77277 Sh. Wt. 3 lb. \$65.50

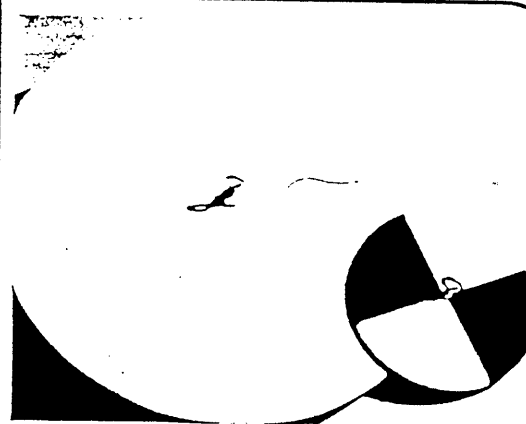
**Secchi Disc/Sounding Weight Kit**

Includes a weighted, 20cm (8") diameter black and white Secchi disc, 20m uncalibrated nylon line, instructions.

77278 Sh. Wt. 5 lb. \$71.95

**Fieldmaster Replacement Parts & Accessories**

77279	Manual for kits described above. Sh. Wt. 2 lb.	Set of 6	\$22.00
77280	Braided nylon line, 20m, uncalibrated, with wood holder. Sh. Wt. 2 lb.	Each	20.35
77281	Plastic collection bottles for Plankton Net Kit. Sh. Wt. 3 lb.	Set of 12	19.25
77282	Sorting pans for Bottom Sampling Kits: 1 curved pan, 1 flat pan. Sh. Wt. 3 lb.	Per Set	27.30
77283	Minigrip bags for Bottom Sampling Kits. Sh. Wt. 2 lb.	Package of 100	15.70
77284	Messenger for Water Bottle Kit. Sh. Wt. 1 lb.	Each	15.75

**SECCHI Discs**

Ideal for determining opacity and/or turbidity of water. Constructed of acrylic plastic and stainless steel fittings. Two types available; oceanographic and limnological.

Oceanographic Secchi Discs. 51cm (20 inches) diameter. White acrylic.

77192 Model XPL-040-SDO. Sh. Wt. 12 lb. \$107.00

Limnological Secchi Discs. 20cm (8 inches) diameter. Color: black and white acrylic one side; white other side.

77193 Model XPL-041-SDL. Sh. Wt. 1 lb. 70.00

LaMOTTE Secchi Disc (not pictured)

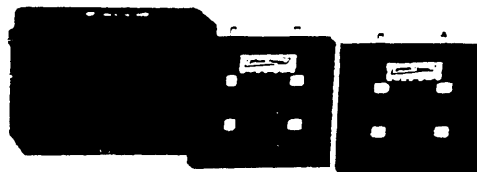
Limnological disc. of white plastic, 20cm dia.

77137 Sh. Wt. 1½ lb. \$25.85

LaMOTTE Sounding Lead**& Calibrated Line (not pictured)**

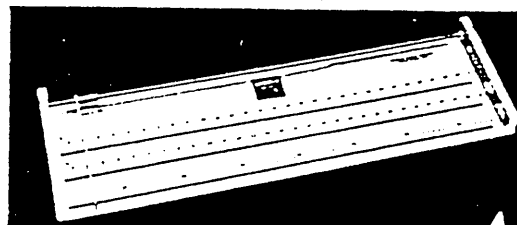
Nylon line marked 0-20m, with 2 lb. lead weight. Includes flotation device to prevent line being lost overboard.

77140 Sh. Wt. 3 lb. \$19.95

**LaMOTTE Forel-Ule Color Scale**

Should be used in conjunction with Secchi Disk above for best results. For analysis of off-shore blue to green waters and in-shore yellowish to brown waters. Employs permanent color standards mounted in Octet comparators.

77138 Model 5907. Sh. Wt. 1 lb. \$39.00

**WILDCO Fish Measuring Board**

• Accurate • Rugged • Dependable

Designed for making fast and accurate fish measurements in the field or laboratory. Measuring boards are acrylic plastic and feature brass bar assemblies, three easy to read scales, and quality workmanship.

Scale No. 1: 0-30 inches (¼" per Div.)

Scale No. 2: 0-30 inches (.1" per Div.)

Scale No. 3: 0-75 cm (1mm per Div.)

77302 Sh. Wt. 10 lb. \$77.00