owner can't go dig a new pond when the old one becomes choked with weeds," warns Price. Nor can a city build a new lake and relocate itself around it.

The introduction of some tropical exotic plants has been especially disastrous, Price said. He singled out hydrilla verticillata. In the proper growing climate, "it will grow a foot a week." And fragments of plants easily take root when they contact soil.

This can mean that the weed introduced into an irrigation canal (30 feet wide and 4 feet deep), perhaps from the prop of a motor boat that went fishing over the weekend, could become an economic problem within three months, Price estimated.

For those who are responsible for potable water supplies, he tosses out this statistic:

"We found that in one surface acre of water, the aquatic weed hydrilla verticillata displaces 698 cubic feet of water."

Service in Reply to Inquiries

Some agricultural and recreational leaders have recognized the growing weed infestation. Out of their repeated inquiries for solutions has evolved the Pennwalt Application Service.

Pennwalt Corporation, a manufacturer of aquatic herbicides since the early 1950s, began some applicating service in 1963. The service was then formalized by regions, beginning with the Northeast Region in 1963.

"Very few people are knowledgeable about the proper handling of aquatic herbicides," says Price. And the truth is that very many people are highly sensitive about what goes into their swimming, fishing, and drinking water.

"You don't just dump a chemical into a lake to control a certain weed," says Price, "without checking to see if the water flows into an irrigation canal for a citrus grove then continues to a stream through a dairy farm, and finally empties into a river from which a city gets drinking water.

"We initiated the idea — we're pioneers — of a professional service that considers all phases of water management."

"Send us your lake and we'll tell you how to weed it," Pennwalt has advertised as the simple way people with water problems can avail themselves of the service.

Actually, Price advises that the systematic approach is to form a lake association or lake committee. "Then we have a practical group to work with."

How the Service Works

"We'll make a survey to determine if the water can be effectively treated," explains Price. "We'll prescribe the treatment, estimate the cost, spell out the degree of control that can be expected and the number of days to achieve it."

Once details are completed, an agreement is written and signed. The Pennwalt crew obtains all necessary permits and the work begins, using ground spray, airboats, or helicopters, as the situation dictates.

Post application inspections are made to assure that intended results were obtained.

The basic compound of most Pennwalt aquatic herbicides is endothall, with the brand names of the most-used being Aquathol Plus, Potassium Endothall and Hydrothol 191.

"But our applicating service is not limited to the chemicals we make," emphasizes Price. "We'll use any herbicide that's federally registered as one that will control the problem in that particular locale."

Employees Carefully Trained

Providing a high-calibre applicating service eliminates hiring just anybody that knows how to run a boat or point a spray stream.

Price has found that it pays to hire employees who take pride in their work and who want to continuously improve their craftsmanship. When he needs additional help, college students have proved most valuable.

"It takes at least a year to train a good sprayman," estimates Price.

They must learn how to mix a wide variety of chemicals, learn the most effective spray patterns, proper feathering, and boat maneuvers; how to avoid trapping fish in coves; and on occasion how to calm an aroused landowner by carefully explaining what is being done, why, and what effects can be expected.

Seeing a Pennwalt sprayman decked out in rubber gloves, overalls and boots, and wearing a face shield may cause some people to wonder if all that protective gear is necessary, thinks Price.

"But we take pride in our employees, and that's a measure of our interest in their health and safety," he explains.

Examples of Costs

Trying to pin down a cost for the Pennwalt Applicating Service and a time required for accomplishing a given task is next to impossible. About the best that can be done to give some idea of cost is through specific examples.

For a surface aquatic weed, a floater such as water hyacinth, "we're talking about $30 per sur-

Hurricane Fibreglass "Aircat" has proved the ideal vehicle for aquatic weed treatment, floating over the surface without picking up weed particles. Normal operation is to introduce chemicals below the surface as shown here. The airboat is equipped with an F. E. Myers 10 gpm pump.

face acre to clean it up," estimates Price. "The submersed problem is the highest priced with some species requiring as much as $35 *per acre foot.* (A 1-acre pond 10 feet deep would cost $350.)

Concerning time and length of control, an airboat can cover one surface acre in about 30 minutes, and most weeds could be expected to disappear in about a week.

In many situations, broad cost-sharing appears to be the only feasible — and fair — way to handle an aquatic weed problem.

At Winter Park, Fla., for example, Parks and Recreation Director Jay L. Blanchard says:

"We feel that because of the value of the chain of lakes to the city as a whole, it (aquatic weed infestation) is a community problem, a county problem, a state problem, and it is a federal problem."

Residents of Winter Park have at least agreed that aquatic weeds is a community problem by approving a city-wide one-mill levy to become effective on Nov. 1. They approved the levy to finance the fight against aquatic weeds even though only about 10% of the residents are lake property owners.

PENNSALT AQUATIC APPLICATING SERVICE

Pennsalt has become Pennwalt since a recent merger. Assistance and consultation on aquatic weeds are available through four offices, in Tacoma, Wash., Philadelphia, Pa., Montgomery, Ala., and Orlando, Fla.

Winter Park has 14 lakes, either part or wholly within the city limits. The lakes represent 800 acres of surface water and more than 20 miles of shore line.

Working for Winter Park Since '66

The aquatic weed problem has taken on such magnitude that the next year's budget calls for a Lakes Division within the Parks and Recreation Department. The budget will be between $150,000 and $180,000. Eight men out of a 60-man staff work in aquatics full-time. Winter Park has used mechanical harvesters since 1963 and three years ago brought in the Pennwalt Aquatic Applicating Service as added reinforcement.

In the past 2½ years, Winter Park has spread 17½ tons of Hydrothol 191 at a cost of $14,425. The coming year's budget calls for four aquatic herbicide applications at an estimated $20,000.

"We find this herbicide to be very satisfactory, and individual lake front homeowners are pleased with the results," says Blanchard.

Despite the city's mounting attack, in budgetary terms from about $18,000 in 1966 to possible $180,000 next year, the total weed population is increasing.

"Still, we feel the best method is to continue both the mechanical harvesting and herbicide treatments," states Blanchard. "Right now, we feel we've pulled ahead of the game in physical appearance."

An Airboat You Can Build

Need a floating platform to work narrow canals, maneuver among aquatic weed beds, or investigate shallows where motors cannot navigate? Then, consider the outfit put together by Leonard Devine, superintendent of public works at Palm Beach Gardens, Fla.

Devine bought a 12 hp motor, added a screen-enclosed 42-inch propeller, and mounted the outfit on a 14-foot, flat-bottomed boat, 6' 10" in width. Result is a unit weighing about 350 pounds that can be hauled on any trailer. It's truly an air-driven platform that's useful for pesticide application of aquatic weeds.

Hubert "The Boatman" Williams, pilots Palm Beach Garden's aquatic spray boat on a local canal. Lloyd "Tex" Horrell is sprayman and does all of the city's aquatic weed control work.

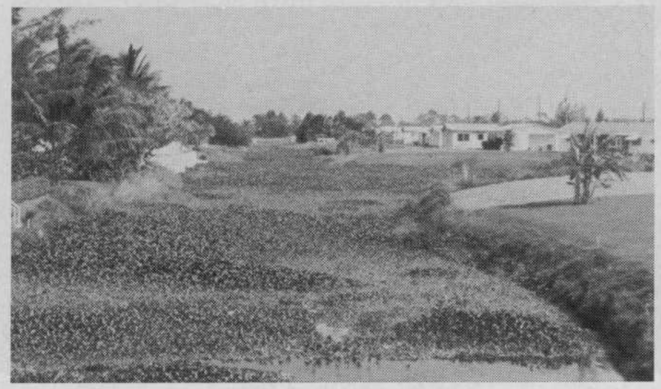
His bill of materials and approximate cost consisted of: (1) Model 300421 Briggs and Stratton 12 hp motor @$231; (2) a 42" propeller with 24" pitch and 1" shaft size, designed for counter-clockwise rotation @$37; and (3) a Monticello aluminum flat-bottom boat @$350; plus miscellaneous screen and mounting brackets.

His regular spray equipment is hauled in the boat. It consists of a John Bean spray pump, hose and tanks, etc.

Devine says it has proved practical for municipal weed control and mosquito spraying and fogging. Because the unit is capable of slow speeds and very maneuverable, it has proved an excellent piece of equipment for close-in work in small canals which are typical of many city problem areas.

When it comes to controlling aquatic weeds . . .

SEEING IS BELIEVING



BEFORE

AFTER

Look at these before and after shots of the same scene in Margate, Florida

In the before picture, notice how water hyacinth and elodea carpeted the canal from bank to bank. Hardly anything but mosquitoes lived there. Certainly few fish. Now study the after shot, showing the canal restored to its original condition. The water again flows freely. Boats again ply there. Fish thrive and fatten.

This miracle of restoration — and, yes, conservation— was achieved by NATIONAL WEED SERVICES, custom applicators of non-toxic herbicides. We could show you many other similar "before and after" pictures. For instance . . . the canals at Miami Country Club . . . the lake at Burning Tree Golf and Country Club in Washington, D. C. . . . Chickahominy Reservoir in southern Virginia . . . Skidaway Lake and canals in Savannah, Georgia . . . the lakes at the U. S. Naval Training Station in Orlando, Florida. Today you can see weeds retreating before our airboats and mixing rigs at Loxahatchee Wildlife Refuge in the Everglades and at General Development Corporation's satellite city of Port Charlotte, Florida.

If you have a waterway that resembles the before picture above, change it to look like the other photograph. You can . . . safely, economically, and permanently . . . through National Weed's continuing maintenance program. Drop us a line or give us a call. We'll make a believer of you. We guarantee it.

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The basic member of Aquamarine's Aqua-Trio is the H-650 Harvester. It cuts a swath eight feet wide and five feet deep. Live bed hold packs weeds automatically, unloads automatically.

Effects and Costs

Aquatic Weed Harvesting

By C. BRATE BRYANT, President
Aquamarine Corporation
Waukesha, Wis.

SINCE the first weed harvesting attempts in the early 1900s, there have been many unanswered questions about the effects of weed harvesting. Even if harvesting is proved beneficial, perhaps an overriding question yet to be answered is that of the cost of harvesting.

It is the purpose of this article to show there are more benefits by harvesting than just the short term removal of the weeds and, secondly, to offer some definitive costs on the removal of submerged aquatics, using the latest harvesting systems.

Since a prime cause of today's weed problems is an over-abundance of nutrients in our waters, it would seem logical that a cutoff of nutrient input would effectively retard weed growth through nutrient starvation.

This weed-algae-nutrient relationship is being recognized. Massive expenditures on better sewage treatment, effluent diversion projects, separation of storm and sanitary sewer systems, and community sewage systems instead of septic tanks are a few of the positive efforts in this direction.

These efforts seem to be a losing battle, with population pressures building faster than our capabilities to cope. To compound our problems, the fertilizer industry has grown exponentially, nearly paralleling the seriousness of the weed problem.

A measure of the scope of the nutrient problem is the fact that 32 states reported production of 20 million tons of fertilizer from July, 1967, to June, 1968. Because of rising demand for wood and paper, the forestry industry is presently planning large scale forest fertilizing to promote "instant trees." A side effect will again be enriched water runoffs into lakes and streams! So, for the foreseeable future, nutrients will be entering our waters at an increasing rate, and weed crops will ever increase—nearly as a direct function of the nutrients present.

Mechanically or Chemically

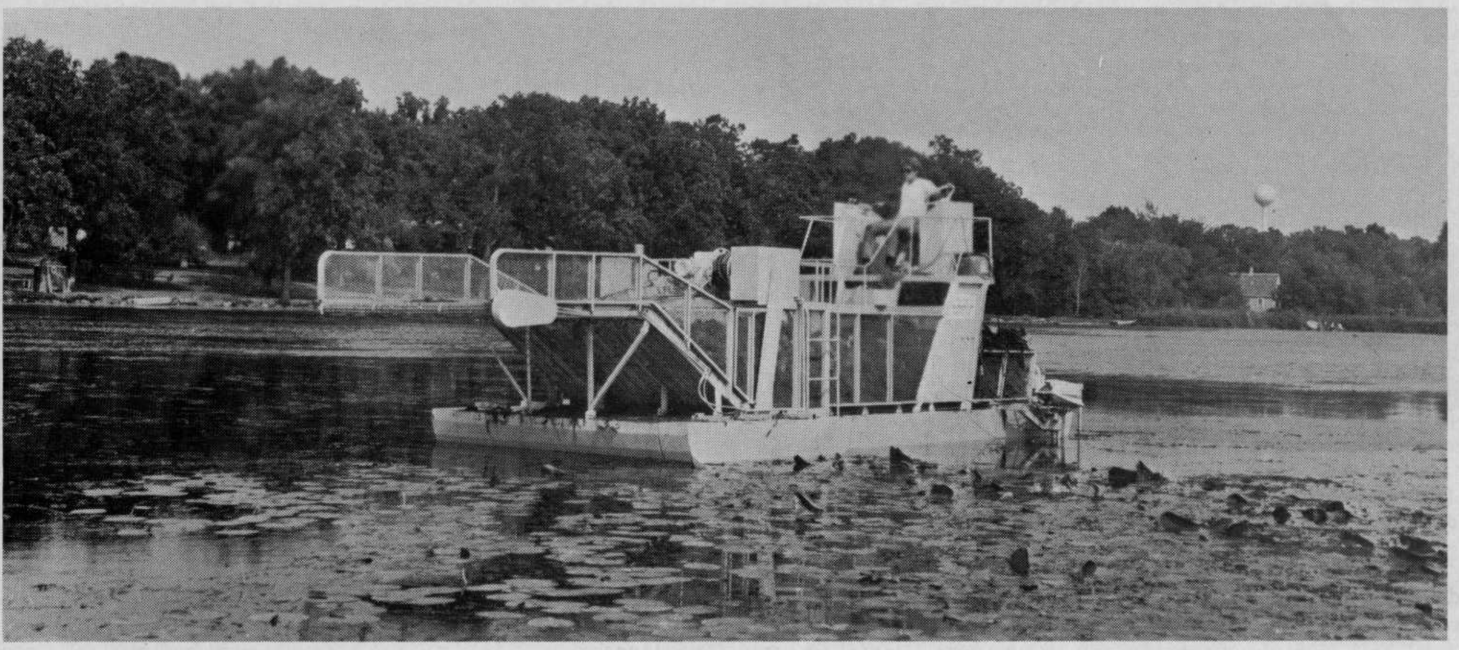
It then is evident that every person in a position of responsibility for weed control eventually has the choice of attacking cause or effect, i.e. nutrients or weeds.

The usual two choices commercially available to people with weed problems are mechanical weed harvesting or chemical herbicides: One attacks the nutrient problem (cause), and one attacks the weeds (effect). Very little has been documented about the former, leaving the field wide open for the latter—and the vacuum is being understandably filled by herbicide manufacturers, because herbicides **do** make weeds disappear.

Lack of documentation on the effects of extracting weeds from the water, plus the thin information available on costs of harvesting, are probably the two most damaging roadblocks to its universal acceptance. However, there seems to be a stirring of curiosity within the "anti-pollution community" to find out what harvesting does do to a lake now that some sophisticated harvesting equipment is being produced.

Weed-Harvesting Research

The Wisconsin Water Resources Center in Madison, Wisc., is presently backing a weed-harvesting research project in Lake Mendota. Professor Grant Cottam, of the Botany



Weeds are transferred from the Harvester automatically to the T-650 Transport, which in turn unloads automatically into the Shore Conveyor (next page).

Department of the University of Wisconsin, is in the third year of a project to analyze the effects of harvesting Eurasion Watermilfoil *(Myriophyllum exalbescens)*.

Monthly samples are cut from each of three one-hundred-square-meter areas in University Bay. Comparisons are then tabulated against three unharvested control areas as regards density (stems/acre), stem length, and dry weight. Regrowth has been averaging less than 20 cm. per month and, most promising, "harvesting also produces an initial reduction of density since all the cut stems do not resprout in a month's time."

Since 99% of milfoil revegetation is through resprouting, removal of the weeds from the lake after cutting is a critical and necessary prerequisite. This is one reason why it is a Wisconsin state law that all weed-cutting programs must incorporate coincidental weed removal.

Although milfoil shows significant growth retardation after harvesting and a cut stem does not resprout in a month's time, what of other species? What if each cut end sprouts six new branches, as it has been said happens with elodea? One of two things (or a combination of both) can happen: If each sprig grows at the same rate as before harvesting, weed tonnage will be produced at six times the former rate in the same area, greatly reducing per-ton harvesting costs the second time around and accelerating nutrient removal. More likely the growth rate of each sprig will slow somewhat due to natural retardant effects of shading, crowding, and nutrient removal. However, net weed tonnage grown will still be largely proportional to the nutrients present.

M. E. Grinwald, who has been harvesting weeds for 20 years in Pewaukee Lake in Wisconsin, reports, "A 2000-foot channel, mechanically harvested for four years of heavy weed growth to open a public access to the lake, did **not** require harvesting a fifth year, while the weed growth on either side of the channel was as dense as ever.

A similar situation seems to have occurred in Rib Lake, Wisc., where after two years of harvesting, practically none was required the third year. Water clarity and fishing con-

Attachable wheels connect easily to the H-650 Harvester, making it quickly mobile. It's easily towed with a minimum loss of cutting time.

ditions have reportedly improved considerably."

Using Herbivore Not Feasible

The nutrients in our waters show up visibly in the form of weeds and algae. A great deal of research is being done to locate some herbivore with a yen for aquatic weeds or a water flea with a voracious appetite for algae. But does this not beg the question?

The successful location and transplanting of this manatee, flea, snail, or whatever, only removes the weeds from sight and transforms them into another form of nutrient on the bottom of the lake, or in solution, ready for another weed growth cycle. It might be argued that this is a better alternative than a solid, floating surface of hyacinth. But if we are successful in controlling the hyacinth without controlling the nutrients, nature will immediately fill the vacuum with elodea, milfoil, or worse.

In consideration of the nutrient problem, Professor A. D. Hasler, Director of the University of Wisconsin Limnology Department, ventured the following in "Natural History" magazine in November, 1968:

"The best that can be said for spraying chemical poisons on lakes in the grip of algae and weeds is that it is usually a futile undertaking. Treating a lake with copper sulfate or other toxic chemicals is no more effective than taking aspirin for a brain tumor. It offers only temporary relief, masking the symptoms of cultural eutrophication. In the long run it makes a lake sicker. Poisoning algae and weeds simply accelerates the natural process of growth, death, and decay, thereby freeing nutrients for another cycle of plant production."

Perhaps the weed problem is so staggeringly massive that we must close our eyes to accelerated cultural eutrophication in exchange for making the weeds go away for awhile. Lacking a potential alternate solution might justify shunting the eutrophication problem into the laps of our children and grandchildren. But harvesting of weeds on a big scale can potentially let us eat our cake and have it, too: Weed control plus nutrient removal.

Detroit Lakes Program

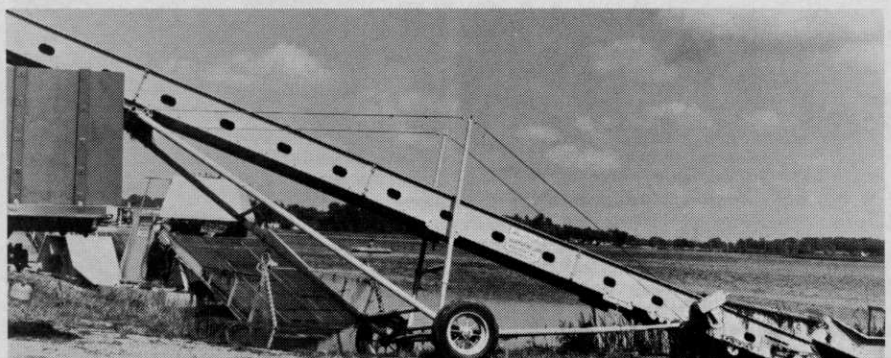
A three-year program to prove such a double benefit is presently under way at Detroit Lakes, Minn. Funded by $140,000, a joint venture of local groups, city and county governments, the Department of Interior, and the Minnesota Conservation Department, has purchased a harvester and is harvesting weeds in Lakes Sallie and Melissa, downstream from the Detroit Lakes sewage plant. It is their hope to remove more nutrients in the form of weeds in the summer months than flow into the lake in a year.

Harvesting Costs

In November of 1968, the City of Maitland, Fla., contracted with Aquamarine Corporation to harvest 20 acres of Florida Elodea as a demonstration of the new AQUA-TRIO system:

Conditions:

1. One 20-acre solid mat of Florida Elodea *(Hydrilla Verticillata)* 2 feet to 4 feet thick on surface of lake (acreage determined from scaled map of lake).
2. Density of freshly harvested weeds, compacted by their own weight in a 3-foot deep pile. 10 lbs./cu. feet.
3. Harvesting system used: AQUA-TRIO manufactured by Aquamarine Corporation, Waukesha, Wis., consisting of one H-650 Harvester, one T-650 Transport, and one S-650 Shore Conveyor, and one dump truck. Note that paddle wheels were furnished on the T-650 Transport instead of outboard motors shown.
4. Average run for transport



The S-650 Shore Conveyor loads weeds automatically into truck. Remote controls allow conveyor and transport to be operated from one position.

Steering mechanism is part of tow bar assembly and makes handling of Harvester easier.

barge—800 feet.

5. Average run for dump truck—1200 feet.

6. Manpower used: One harvester operator, one transport operator, one truck driver.

7. Harvester capacity of 650 cu. ft. loaded to 500 cu. ft., or 5000-lb./load.

Results are shown in Table I.

Conclusions

Before extrapolating these costs into any other waters or weed infestations, adjustments must be made to allow for changes in labor rates, weight of harvested weed, average weight of unharvested weeds per acre of lake, distance of weeds to shore conveyor site, dump truck haul distance, and design of harvesting equipment.

Significant cost reductions could be expected if Figure 1 is studied closely. Note that peek production was hit after the operators became experienced in the capabilities of the system. On Nov. 23, a rate of 9.3 tons per crew hour was achieved or $1.69 per ton cost. The balance of the harvesting was largely clean-up work, reflecting lower production figures and higher costs.

TABLE 1. Mechanical Harvesting Demonstration, Maitland, Fla.

Date 1968	Transport Loads Harvested	Crew Harvesting Hours **	Loads Per Hour	Tons Per Crew Hour
11/13	9.5	5	1.9	4.8
11/14	11	6	1.8	4.5
11/15	16	7	2.3	5.8
11/16	4	1	2.9	7.3
11/18	12	4.5	2.7	6.8
11/19	4	1.5	2.7	6.8
11/20	6	3	2.0	5.0
11/21	11.5	6	1.9	4.8
11/22	15	6	2.5	6.3
11/23	22	6	3.7	9.3
11/25	2	2	1.0	2.5
11/26	3	2	1.5	3.8
11/27	9	7	1.3	3.3
	Total 123	Total 57	2.2 Average	5.5 Average

* Loads and times independently tabulated by K. Downey, City of Maitland.

** Adjusted to account for down time, weather and demonstration delays.

Harvesting Rates:

1. Tonnage harvested: 123 loads at 2½ tons each = 307.5 tons.
2. Weed concentration per acre, average 307.5 ÷ 20 = 15.4 T/acre.
3. Man-hours expended in actual harvesting: 57 × 3 = 171 man hours.
4. Tons harvested, transported, and trucked away per man hour 307.5 ÷ 171 = 1.8 T/man hour.

Costs:

Equipment:	AQUA-TRIO	$44,000.00	
	Dump Truck	3,500.00	
		$47,500.00	
	Weekly depreciation on a 10-year basis		$100.00
Interest: $47,500.00 @ 10% =			100.00
Labor: 40 hours at $8.00/crew hour =			320.00
Maintenance and running costs (estimate)			100.00
		Weekly Cost	$620.00

Tons harvested, transported, and trucked away per 40-hour week:
40 hrs. × 3 men × 1.8 Ton/man hour = 216 Tons/week.
Cost per ton (Lake Maitland) = $620/wk. ÷ 216 Ton/wk. = $2.87/Ton
Cost per acre (Lake Maitland) = 15.4 Ton/acre × 2.87/Ton = $44.20/acre

Chemically and Mechanically

How One City Manages Aquatic Weeds

By JAY L. BLANCHARD
Director of Parks and Recreation
Winter Park, Fla.

Roy Campbell shows how a Prentice grapple hook loader, ordinarily used for handling logs, comes in handy during aquatic weed harvesting. He's refueling a harvester.

WINTER PARK, FLA., a suburban community of 27,000 residents, is engrossed in a major lake weed program that is costing thousands of dollars. It is unique for a city, let alone the Parks and Recreation Department, to be involved in lake weed management.

We have 14 lakes part or wholly within the city. These lakes represent 800 acres of surface water and more than 20 miles of shoreline. The lakes, which vary in depth from 30 to 85 feet, are surrounded by 417 homeowners, and are used by thousands of swimmers, boat owners and water skiers.

We are not troubled by pollution per se, but by eutrophication, caused by society and its affluence. In this enriched water (which is not harmful for recreational use, nor is it devoid of oxygen), plant material such as submerged aquatic weeds grow abundantly. This is the problem we are trying to combat by both mechanical and chemical means.

The problem has been with us for quite some time but not of the magnitude that it is today nor of the same type of weeds. Earlier in 1963, the major weeds in the lakes were:

Vallisneria americana—Eelgrass
Najas gaadalupensis—Southern Naiad
Eichhornia crassipes—Water Hyacinth

Today the lakes have changed in their process of eutrophication to contain almost entirely *Hydrilla verticillata*—Florida Elodea. To observe our three major lakes—Lake Virginia, Lake Osceola, and Lake Maitland—would indeed be a study in lake ecology. Lake Virginia has changed from Vallisneria to almost all Hydrilla in the past two years. Lake Osceola has both Vallisneria and Hydrilla in abundance. Lake Maitland now has many patches of Hydrilla and still contains a large amount of Vallisneria.

Active Program Began in 1963

The City of Winter Park recognizes this problem of lake eutrophication as one that must be managed to preserve our lakes for their economic and aesthetic value. We have been aware of this problem since before 1963, when we began an active program of lake weed management.

Under the guidance of Robert D. Blackburn of the Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, test plots and programs were set up and followed to the point that we do not have a problem with the earlier listed weeds, such as eel grass, water hyacinth, or southern naiad.

In the scientific research area of our program, the City of Winter Park is involved in an aquatic weed research group headed by C. W. Sheffield of the Orange County Water Conservation Department and Rollins College. We are also involved at this time in individual research with the 3M Corporation of St. Paul, Minn., and with Robert D. Blackburn.

Mechanical Harvesters Bought

In October of 1963, the City purchased from the Aquatic Controls Corporation of Waukesha, Wis., an amphibious, self-propelled harvester and an amphibious, self-propelled barge, to help with the aquatic weed problem. This unit was primarily for the harvesting of eel grass.

The harvester and barge work together, requiring an operator each. The harvester cuts the aquatic weeds from 12 inches to 4½ feet in depth. This first harvester is still in operation. In 1966 it removed 1,149 tons of Vallisneria and in 1967 it removed 1,585 tons.

With the advent of the new weed, Hydrilla, and its rampant growth, the city has embarked upon a three-point program: applied research, scientific or basic research, and operational methods.

Lakes Board Formed

To aid in the development of the applied research and operational methods, the city established a Lakes and Waterways Board in January of 1968, with Robert S. Witherell as chairman. This board is composed of active, enthusiastic lake-front homeowners who wish to save our lakes.

Through the action of the Lakes and Waterways Board, we purchased in January a large Scavanger from the Aquatics Control Corporation of Waukesha, Wis., and in August we purchased a second large Scavanger. These new units are one-man operated and combine the operation of the older harvester in that they act

The Prentice loader will transfer a harvester load of weeds to a truck in about three 1,000-lb. bites. In the foreground, Andy Price, Pennwalt Corporation aquatic biologist, visits with Jay Blanchard, Winter Park's director of parks and recreation.

as a cutter and barge in one piece.

They cut aquatic weeds to a depth of 5 feet and unload the harvested weeds on the shore by reversing its process. The three harvesters augmented with a hydraulic grapple loader to load dump trucks, 4 barges, 2 boats with sprayers, and the dump trucks give us more than $135,000 in Lake Weed Management inventory.

With this expanded inventory we harvested last year 9,610 tons of Hydrilla from the lakes, compared with 2,734 tons in 1966 and 1967.

Through August of this year, we have harvested 6,665 tons with three months to go.

Herbicide Usage

Along the herbicidal lines of the program, we have in the past 2½ years spread a total of 17½ tons of Hydrothol 191 at a cost of $14,425.

In the past we have been treating the shoreline on a hit or miss basis with the individual homeowner purchasing the herbicide and the city spreading it for them. This way many areas have been left untreated.

We incorporated a trial program in Lake Osceola in 1968 to herbicide the lake perimeter by the volunteer cooperation of the individual lakefront homeowners. This was accomplished at a cost of $5,300 per application with 2 more applications following in December 1968 and September 1969 as the need arose.

In the 1968 budget year, we expended in labor, operational expense, herbicides, and research more than $42,632, along with $92,000 in capital purchases, giving a total of $134,632 for the year. This compares with $18,160 for 1966 and $25,705 for 1967.

In this year's budget, we formed a Lakes Division under the Parks and Recreation Department and this budget is in excess of $100,000, and by the time some new equipment is added it will approach $180,000.

A city-wide one-mil levy, effective Nov. 1, will bring in money specifically earmarked for our aquatic weed management program.

Operational Approach

We propose not to cut all the weeds in each lake, but to construct islands, or leave islands of aquatic weeds. These will be marked off by floating buoys for all to easily distinguish. These islands will be in various places in the lakes, keeping in mind the boats, water skiing, fishing needs, scenic boat routes, and crew racing lanes.

The islands will be left so there will be a balance between the lake weeds and the excess nutrients. If we tried to remove all the weeds, we would have a good chance of the lakes progressing into another class of eutrophication.

In herbicide management, we treated the entire built-up areas of three lakes out to 35 feet.

To help with this cost, the City either procured the herbicides and applied them at a pro rate per front foot of beach area or subcontracted with Pennwalt or 3M Company.

We also treated only 300 to 400 feet of beach at a time and skipped 300 to 400 feet in order to give fish the chance to leave the area temporarily. After a few days, we returned and treated the skipped 300 to 400 feet.

Along with this treatment, we marked the treated areas with signs to notify the residents so they would not inadvertently use the lake water for irrigation for about 7 days.

The present method of herbicide treatment with liquid Hydrothol 191 at 4 ppm costs the homeowners $33 per 100-foot of beach front.

Herbiciding has proved very effective in the shallower water but is far from being permanent. It must be repeated as is the mechanical operation. We feel both methods have a valuable part in our lake weed management program.

Cost-Sharing Needed

The City of Winter Park does not feel it can adequately tax just the lake-front homeowners for the lake weed problem.

We feel that because of the value of the chain of lakes to the city as a whole it is a community problem, a county problem, a state problem, and it is a federal problem.

Therefore we would like to see the State of Florida and the federal government help municipalities like Winter Park with a 50-50 matching fund program as well as other bodies or agencies. In this manner those cities, counties, areas, districts, and agencies that are trying to combat the problem will get the assistance they need.

USDA Technical Report on Controlling

Hydrilla Verticillata

By ROBERT D. BLACKBURN and LYLE W. WELDON*

* Botanist and Research Agronomist, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, Fort Lauderdale, Fla.

HYDRILLA *(Hydrilla verticillata* Casp.) was first discovered in the United States near Miami, Fla., in 1960. It has dispersed over the entire state and into Georgia and Alabama since its introduction.

Largest infestations in Florida are located along the southeast coast in the slow-flowing canals and conservation areas, in the central area in the clear water lakes, and in the clear water springs and rivers along the central west coast.

Since its introduction, the plant has infested more than 60,000 acres of water in the southeastern United States.

Growth of submersed vegetation is a common occurrence in Florida. Any body of water will be choked with aquatic weeds in a relatively short period. Effective control is not only necessary but essential if the water is going to be used for fish production, recreation or irrigation.

Extensive research under controlled as well as field conditions has shown that there is no universal panacea for controlling submersed aquatic weeds. Control methods must be based on the aquatic species and on the environmental conditions.

It is also necessary to take into consideration the season and the stage of development of the weed. However, it is not logical to expect the same method of control will give even approximately comparable results on all aquatic weeds or under all various climatic and soil conditions.

It is important that the species causing damage be studied intensively from the antecological and the synecological aspects. Knowledge of the plant's habitat, relation to soil and climate, method of dissemination, special plant and animal enemies, power of variability and actual distribution is necessary before work on weed control is taken up.

Research on hydrilla was initiated on a very limited scale at Fort Lauderdale, Fla., in 1962. Early research was conducted under the misconception that hydrilla was elodea *(Elodea canadensis* Michx.). Proper identification was not obtained until 1965. The realization that a new weed species had been introduced into the United States gave substantial support to the need for additional research on physiology, ecology and control.

In subtropical areas it is a very difficult task to check the growth of aquatic vegetation. There are many chemicals which have been used as aquatic herbicides in the United States. It is not advisable for the aquatic weed scientist to recommend these aquatic herbicides for the control of a plant that he knows little about or about which there is little information available in world literature. This investigation was designed to evaluate herbicides and herbicidal combinations on hydrilla in laboratory and field conditions.

Identification of Hydrilla

Hydrilla is a submersed vascular aquatic plant, rooted to the bottom with long branching stems. Lower leaves are opposite and small, whereas the medium and upper leaves are in whorls of fours and eights.

Leaves are verticillate and narrowly lanceolate. Flowers arise singularly from the spathe, and are found at or near the surface and from near the growing tip. The entire flower is inconspicuous and measures no more than four to five millimeters across the tip of a threadlike pedicel.

Seed formation is poor if it occurs at all. Reproduction is both vegetatively and by fruits. Broken shoots develop into new plants which attach themselves in the hydrosoil by fine filiform adventitious roots. Plants also produce subterranean shoots with swollen tips, densely clothed with fleshy, acute or acuminate scale-like leaves which are termed "stem tubers." An additional propagating structure, "the turion," is produced by hydrilla.

In taxonomy keys, elodea and hydrilla seem easily identifiable, but the actual plants are very difficult