The Crisis Of Our Aquatic Environment

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In talking with old timers here in Florida, you find that many recall when our lakes, rivers and creeks were surrounded by cypress, pine and oak trees, covered with trailing Spanish moss. Water weeds did not flourish in these areas. As populations increased and residential areas expanded to include lake fronts and as residential roads and avenues increased, the lakes began to receive more surface runoff. The runoff from the streets, from the rooftops, from the lawns, all are contributing causes to a change in the pH of the water and a change in the nutrients appearing in the water. The removal of trees and natural underbrush has cut down tremendously in the production of leaves falling into the water, which releases tannic acid. For many years, citrus grove operations near lakes have contributed fertilizer and insecticide residues, but in themselves perhaps this is not a serious hazard; it is the combined fertilizer and insecticide residues draining from the entire beach line of the lakes, from lawns, septic tanks, shrubbery, groves, vegetable farms, and garbage dumps, which contribute their residues to the water supply This has resulted in environmental conditions that are exceedingly favorable for water weed growth.

A weed is any plant in man's way. A chemical that kills weeds is a herbicide. What does the word *control mean?* We need to define clearly the meaning of this word, early in this discussion. Control is the temporary containment of the specific problem at hand. This is not eradication, which is the total elimination of a species in a specified area.

Obnoxious aquatic plants may be classified in three broad groups, based upon the plant's growth habits (1). These are floating, emersed, and submersed. Floating aquatic plants are completely free, or floating on the water, and not rooted to the soil. Examples of the more common of these troublesome plants are water hyacinth (*Eichhornia crassipes*) (Mart.) Solms.), water lettuce (*Pistia stratioites,* L.) and duckweed (*Lemna minor,* L.). Examples of emersed aquatic plants are cattails (*Typha latifolia*), maidencane, (*Panicum hemitomon,* Schult.), spattercock (*Nuphar advena,* (Air.) Ait. f.), water lily (*Nymphaea* spp), smartweed (*Polygonum* spp), pickerelweed (*Pontederia cordata,* L.) and primrosewillow (*Jussiaea peruviana,* B.). Emersed aquatics grow up through the water with a major portion of the plant above the water surface.

Submersed aquatics may or may not be rooted to the bottom. They grow entirely beneath the surface of the water. This group of water plants probably causes the most serious weed problems in drainage and irrigation ditches and in ponds. These weeds may retard the flow of water as much as 90% in some areas of Florida. They are also becoming severe hazards to the use of lakes for swimming, water-skiing, boating and fishing.

In Florida, our principal weeds are Florida elodea (*Hydrilla verticilatta*), eelgrass, (*Vallisneria* spp), water milfoil (*Myriophyllum spicatum*), and southern naiad, (*Najus quadalupensis* (Spreng) Magnus), intermingled and growing on the bottom with spikerush (*Eleocharis acicularis*) and chara (*Chara* spp). Cattails, water-lillies, water hyacinths, and in some areas water lettuce further complicates this picture.

In the beginning, manual and mechanical methods for controlling aquatic weeds were used. Young plants of cattails, maidencane, lillies, and certain other emersed or marsh species were eliminated by hand pulling. This system is effective in small areas with a low population of these weeds; elsewhere, the labor costs will make the method prohibitive.

Special dragline buckets, such as the hyacinth buckets, are fairly effective in removing submersed and floating water weeds in ditches and canals. However, the few plants remaining after bucket removal will spread, making a continuous maintenance program a necessity. Another method of removing submersed and floating weeds is by dragging chains or weighted cables down the channel and then pumping the refuse into a reservoir. Of course, this is satisfactory in a drainage canal or in irrigation ditches, but when faced with the problems in lakes, some of the municipalities and individual homeowners have resorted to underwater mowing equipment. Underwater mowing has long been used with variable results. Self-propelled boats mounting mowers that cut of submersed or emersed weeds below the water surface at depths of 6 inches to 6 feet are being used. In Winter Park, two of these underwater mowers are currently being used in this city's chain of lakes. The mowing and removal of the cuttings by barge to dump truck to an acceptable dumping area requires a continuous expenditure of labor, time and money (2). In 1967 1,585 tons of eelgrass were harvested at an average cost of $10.35 per ton.

Mowing is effective for cattails, rushes, sawgrass and eelgrass control. Some of our aquatic weeds, however, propagate vegetatively and the action of the mower on these species multiplies the problem with every stroke of the blade. True, they do cut down into the water weeds, permitting boat and water-ski travel, but most of the time it is like mowing your grass or topping a hedge. These weeds grow back rapidly. Underwater mowing must be done repeatedly to maintain control.

Man has long been interested in biological control. The U. S. Department of Agriculture, Water Weed Investigations Laboratory at Ft. Lauderdale, the Corps of Engineers of the U. S. Army, as well as other investigators, throughout the nation have made diligent efforts to find a predator, a parasite, a plant competitor, or a disease to suppress or destroy specified aquatic weeds.

Currently, a few species of fish, the Israeli "carp" or mouthbreeder (*Tilapia* spp) are the only organisms that can be recommended to control certain species of submersed weeds. To control branched, filamentous algae (*Pithophora* spp) in Florida, stock the ponds with 50

fingerling Israeli cary, 5 inches or longer, per acre (3), and you can maintain control.

Other organisms under study include certain insects such as flea beetles (*Agasicles* spp) and thrips to control alligatorweed (*Alternanthera philoxeroides,* (Mart.) Griseb.); certain other insects for water hyacinth control (4). In Maryland, investigators, Elser, (5) Bayley, and Southwick (6) are studying a decrease in eurasion watermilfoil correlated with several pathological conditions that have not been completely identified to date. At Fort Lauderdale, Blackburn and Taylor are continuing their investigations with snails (7). Their work has shown that the large tropical fresh water snail (*Marisa cornuarities*) feed voraciously on several species of aquatic weeds. Three small lakes in South Florida stocked with these snails at the rate of 4,000 snails per acre, were free of submersed weeds in 18 months.

This report would not be complete without mentioning the Florida manatee, (*Trichechus manatus latirostries*). Evaluations by *Sguros et al* in 1965 (8) indicated that southern naiad and bladderwort (*Utricularia* spp) were rapidly devoured, while cattails and spikerushes were pulled up by their roots and eaten. Five manatees can make a mile of canal navigable in 2 weeks.

Modern aquatic herbicides are sophisticated chemicals in every sense of the word. They require a positive correlation between the weed species to be controlled, the herbicide program to be used, and applied with highly specialized equipment. The proper chemicals must be used to obtain the most effective control of aquatic weeds and grasses.

Basic Copper Sulfate, 53% Copper: This material has long been used for the control of algae growing on the margin and on the surface of lakes in Florida. Copper sulfate is especially suitable for the control of the filamentous algae that grows on the top of the floating mass of Florida elodea, coontail and southern naiad. Copper sulfate, when applied at 0.25 to 1 ppmw will control filamentous algae. When used in rates exceeding 1 ppmw. copper sulfate will burn-down Florida elodea, and to some extent eelgrass, but under no conditions will this material provide long term control of any underwater weed. Copper sulfate at 1 ppmw is safe for fish, depending upon the kind and age of the fish. Water containing 1 ppmw copper sulfate can be used for irrigation water for most crops. Basic copper sulfate is available locally through garden supply stores and fertilizer plants.

Aqualin Herbicide, Acrolein, acrylaldehyde (2-propenal): This product is manufactured by the Shell Chemical Company and is toxic to fish and all other living plants and animals that it contacts. It must be applied with specialized equipment that has been developed.

Weedazol, amitrole 3-amino-1,2,4-triazole: This product is manufactured by the Amchem Inc., of Ambler, Pennsylvania, and is especially effective for control of cattails and sedges. A special form of Amitrole plus ammonium thiocyanate, called Amitrole-T has also shown considerable promise as a foliage spray on water hyacinth.

Casaron, dichlobenil, 2,6-dichlorobenzonitrile: This product is manufactured by the Thompson-Hayward Chemical Company, and is a relatively new aquatic herbicide. It is formulated on a granule designed to sink rapidly to the bottom of the lake and disintegrate there, releasing its active ingredient into the water where it kills some of the submersed water weeds found in Florida. This is a very slow acting chemical, and for best results should be applied prior to the regrowth of vegetation on the bottom.

Diquat, 6,7-dihydrodipyrido (1,2-a: 2', 1'-c) pyrazidiinium (as dibromide salt): This product is manufactured by the Imperial Chemical Industries and sold in the United States under an exclusive sales arrangement by the Chevron Chemical Company. Even though Diquat will control many kinds of water weeds, it will not control eelgrass. Diquat in combination with copper sulfate, each at 1 ppmw, has been found to be especially active on Florida elodea. Diquat at recommended rates will not kill fish and disappears from the water at the end of ten days. Water treated with diquat at labeled rates can be used for irrigation, spraying, swimming, boating, and fishing 10 days after application. Diquat should not be applied to muddy water since suspended soil particles in water tie up Diquat and make it unavailable for weed control.

Dowpon, dalapon (2,2-dichloropropionic acid): This product is manufactured by the Dow Chemical Company and is especially effective as a foliage spray against grasses and cattail. In drainage ditches and marsh area, dalapon in combination with amitrole applied as a foliage spray between flowering and seed head formation, has provided excellent control of cattail in the Southeastern United States.

Dalapon is almost harmless to fish at normal use rates. Lake emerald shiners apparently suffered no ill effects from three days in 3,000 ppm of Dalapon, but 5,000 ppm proved to be fatal (9).

Hydrothol 191, endothall 53% mono (N,N-dimethylalkylamine) salt of endothall: This product is manufactured by Pennsalt Chemical Corporation and contains two pounds of Endothall acid per gallon. It is also available in a granular form containing 11.2% Endothall acid. This product will control eelgrass in Florida waterways. It is toxic to fish and when used at 0.3 ppmw to 5.0 ppmw, the water cannot be used for irrigation or agricultural sprays on feed crops, for watering livestock, or domestic purposes within 7 days after application and 25 days after application, respectively.

The phenoxy group of herbicides represented by 2,4-D, 2,D,5-T and silvex (2,4,5-TP) are manufactured by several national chemical firms. Spraying plant parts above the water is an effective way to kill many weeds. However, in many aquatic plants, the phenoxy hervicides do not translocate readily to the submerged parts. 2,4-D in aerial or surface sprays has long been a reliable and economical tool for controlling water hyacinth and the use of granular formulations, in still water, shown promise. Investigators have found that most fish, including bass and bream, tolerate the phenoxy herbicides at use levels normally used for aquatic weed control.

Sodium Arsenite. This herbicide is manufactured by several national firms. It is toxic to fish. It can be toxic to the applicators. One-fifth gram of arsenic may kill a man. This chemical can also seriously burn the skin and eyes of the applicators. Sodium arsenite is mentioned only as another example of materials that have been used in water for weed control. In order to be effective, sodium arsenite must be used at a rate of approximately 4 ppm and the utmost of care must be taken when handling this product. Most fish will tolerate up to 12 ppm of sodium arsenite. Water containing more than 0.05 ppm arsenic is not

cleared for human consumption. The use of sodium arsenite will be further regulated by Federal Law on January 1, 1969.

The constant search for more effective herbicides will continue. There are many chemicals yet to be discovered, developed, and labeled. We must learn how to use all such chemicals safely in a correlated program that will not upset the natural biological balance of our aquatic environment.

Lake front property owners expect eradication, not control, and expect to eliminate all obnoxious aquatic weeds with a single, annual application. Actually, there is no herbicide available today that will provide this type of control.

For the time being, a combination of mechanical methods using underwater cutters and selective herbicides for the control of specific weeds occurring in our waterways is a good control program.

When considering a long range weed control program, a water management program must be developed which consists of legislation at the county level to stop the use of our lakes as catch basins for the runoff waters, as sewage assimilation tanks, and as handy areas for the discharge of any undesirable affluent. We must clean up the lakes and restore the balance of nature by replanting cypress trees and other native plants in the marginal areas.

The long range program must, by necessity, include the establishment of a joint effort study group in Florida to be coordinated by university personnel and supported by industrial firms and private citizens as well as with federal, state and county funds. The eventual rehabilitation of Florida lakes, rivers, canals, and ditches would be our goal.

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