Consulting Biologist Jason Cortell inspects some alligator weed research during a tour of USDA's aquatic research facility at Ft. Lauderdale, Fla.

THE ROLE OF HERBICIDES

In the preservation of our urban and industrial water resources

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TODAY, MORE than ever, in the midst of the current indiscriminate attack on herbicides and other pesticides, it seems as good a time as any to review the role of these materials in the use and preservation of our water resources. At no time in our nation's history has the public been as aroused about the quality of the environment and nowhere are these problems more acute than in and around our cities.

In recent years, the urban nature of much of today's water resource problems has become increasingly apparent. The growth of metropolitan areas, particularly along our coastlines and inland waterways, is well documented. Population shifts in the last 50 years have been unparalleled in history. According to the U.S. Census Bureau in 1900, one out of 20 Americans lived in urban areas; and in 1968, 14 out of 20 Americans lived in urban or suburban communities. During the same period, the population doubled, meaning that while the rural population dropped about 30%, the urban population has increased 2,800%. It is estimated that the existing population will double again within the next 30 years and some 80% will live in urban areas.

Use of Water

Spiralling use of potable water has increased over the past 50 years from 30 to 150 gallons per person per day, and the total per capita consumption for all purposes, is 1,600 gallons per day. However, surface water flowing from fertile watersheds into reservoirs and holding areas, have caused the accelerated growth of aquatic weeds and algae, seriously affecting the quantity, if not the quality, of our drinking water. Municipal water systems, private water companies, and state and interstate water resource commissions have raised increasingly vocal concern over the needs for an effective means for controlling nuisance aquatic vegetation in hundreds of thousands of acres of eutrophic reservoir and watershed areas.

According to the U.S. Geological Survey, in 1965, the total use of fresh water resources for all purposes was in excess of 310 billion gallons per day. Of this total, about 54% was used by industry, 38% by agriculture for irrigation, 7% for domestic needs and about 1% for rural domestic and stock use. About 23.6 billion gallons of fresh water per day is consumed for domestic purposes.

Holm, Weldon and Blackburn, in a recent article appearing in *Science*, detail the explosive growth of aquatic vegetation throughout the world. They describe the spread of floating plants, such as water hyacinth, *Salvinia*, and water lettuce in Africa and South America, particularly in connection with man-made lakes and hydroelectric schemes. Additionally, the spread of submersed weeds, such as watermilfoil and *Hydrilla* in navigable waters and canals has had a retardant effect on the industrialization of many developing areas, both in this hemisphere and in other parts of the world.

Another consideration is the use of our water resources for recreation.

The extent and nature of outdoor recreation was the subject of a congressionally authorized $2.5 million three-year study. The Outdoor Recreation Resources Review Commission reported in 1962 that most people seeking outdoor recreation want water to sit by, to swim and fish in, to water ski across, to dive under and to run their boats over. Swimming has become one of the post popular outdoor sports. Boating and fishing are also among the top ten leisure activities.

The Commandant of the U.S. Coast Guard reports in *Boating Statistics—1968* that 4,742,800 pleasure crafts of all description were registered and numbered in the U.S.

In addition to boating, swimming and fishing — camping picnicking, and hiking, are also more attractive near water sites and have thus become part of the multiple-use water concept.

Multiple-Use of Water

The use of aquatic herbicides in and around urban areas is complicated by the multiple-use character of our water resources. Regional and state regulatory agencies, municipal water authorities and districts, private water companies, private industry, local health officials, lake and pond associations, private riperian owners and conservationists all have a stake in the control of aquatic weeds in one form or another.

Unlike the comparative seclusion of the field station or the rural isolation of the single agrarian consumer, the use and evaluation of aquatic herbicides in urban areas is not a simple task. Yet, with the need for control becoming ever more acute, substantial progress in urban areas is still slow.

Evaluation of Herbicides

Currently, thousands of acres of recreational waters are being successfully treated for the control of aquatic vegetation using the present limited arsenal of aquatic herbicides.

In most cases, preliminary field evaluations have been made to further refine the desired project specifications. In still other circumstances, where considerable acreage is involved, post-registration field evaluation is required as a standard practice. On many occasions, this initial series of field trials may be the sponsor's first contact with the new aquatic herbicide.

The individual who carries the

main responsibility for the expenditure involved for chemicals will provide the level of control desired.

But others are also involved — state and local health officers must be satisfied that the new herbicide can be safely introduced into public waters without causing injury. Fisheries and game personnel are interested in the chemical's effect on wildlife, as in the regional extension representative concerned about its effect on irrigation water and agriculture. The manager of an industrial facility which may use the treated water for manufacturing or cooling is also concerned about the chemicals introduced therein as it may affect his manufacturing process or equipment. Lastly, the professional applicator may be concerned about the ability of his personnel and the adaptability of his equipment to handle the new aquatic herbicide.

One can easily see that before the chemical even gets an opportunity to perform, a great deal of preliminary work is required. The responsibility for liaison with all interested parties prior to the development and implementation of a field evaluation plan is usually that of the project engineer.

Landmark Projects

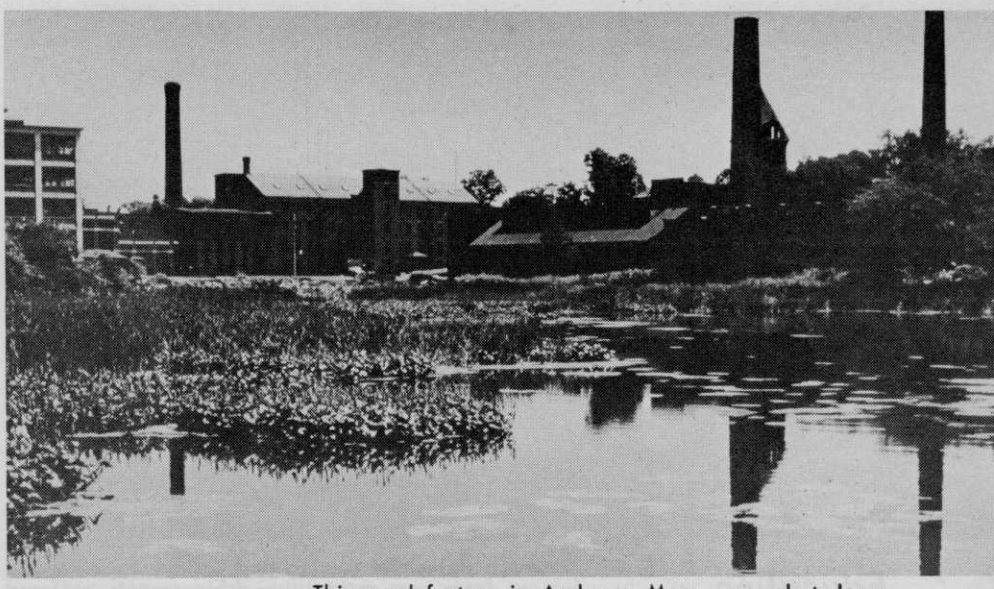
With this as a background I would like to discuss briefly several typical projects which, to one degree or another, have achieved landmark status, illustrating the role of aquatic herbicides in urban and industrial water resource problems.

Let us briefly review the problems particularly associated with the use of aquatic herbicides in potable water systems. Of all areas of research, the need here is substantial.

Copper sulfate has long been used with great success for the control of algae. At one time, one or two treatments a season were enough to control algae growth in an average reservoir or impoundment. Today, however, the influx of nutrients from surface water runoff has accelerated the growth of algae where, in some cases, bi-monthly treatment is required. The American Water Works Association noted in 1968, a 60% increase in total copper used for algae control since 1960.

While today, copper sulfate still provides a satisfactory level of control in potable waters, a pressing need exists for the development of new algicides which are not only more effective, but which do not have the limiting characteristics of copper such as toxicity to fish and build-up of residual copper in mud.

In recent years, the use of 2,4-D



Business Halted

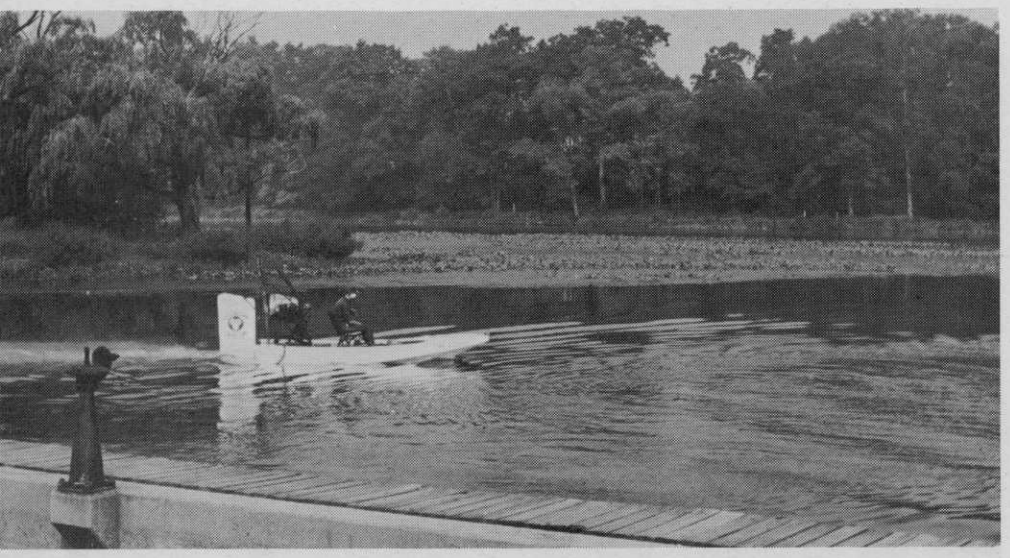
This wool factory in Andover, Mass., was shut down by aquatic weeds. The lake was built in the 1800s to supply water for power and for the woolen process and later as an equipment coolant. Weeds clogged the intake system forcing the factory to close until the weeds were killed.

Flood Control Compromised

Arrowhead, elodea and cattail seriously reduced the effectiveness of this flood control canal winding its way through Chelsea in eastern Massachusetts. The illustrations with this report show typical problems handled by the author's firm, Allied Biological Control, Inc.

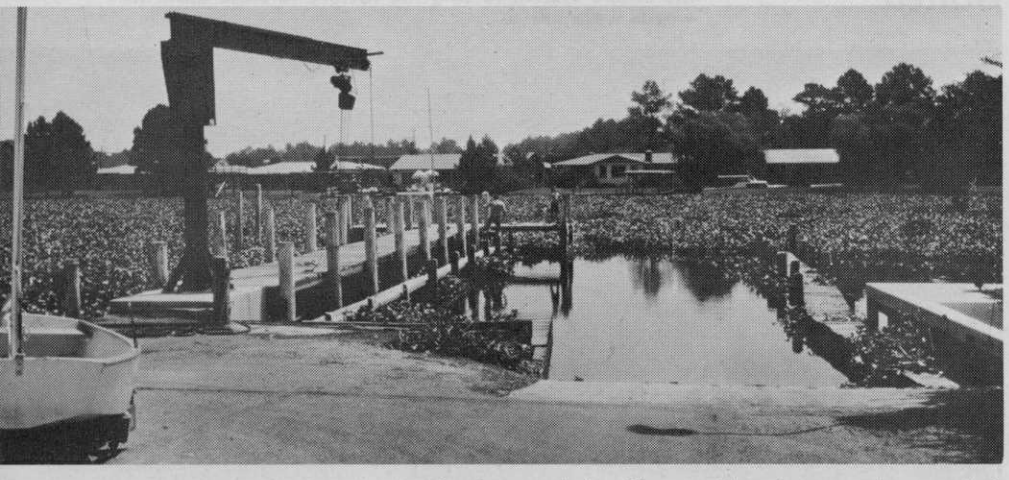
Transportation Endangered

Barely showing behind a formidable "phragmite curtain" is the Boston-Logan International Airport. This weed problem attracts heavy populations of birds, particularly starlings. Flocks of birds present a very real hazard to aircraft landing or taking off.



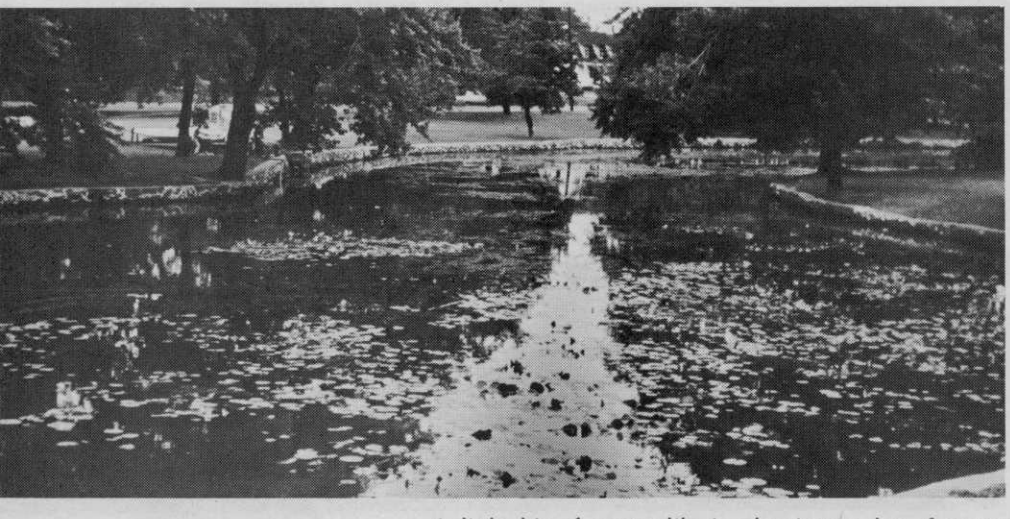
Education Stifled

Princeton University rowing and sailing crews, world famous from past competitive achievements, suffered an ignominious defeat to watermilfoil on their own Lake Cabomba. The sports program was halted until Allied Biological controlled the aquatic pest.



Recreation Prevented

The boat at left without sail and aground on asphalt nevertheless has about as good a chance of moving in the wind as it would on the lake in the background. Water hyacinth closed down this yacht club in the heart of downtown Jacksonville, Fla.



Beauty Impaired

A little bit of water lily is pleasing; a lot of water lily and elodea combined is a problem. This eyesore, before it was cleaned up, was an impoundment of the Wepawag River as it passed through River Park in the middle of Milford, Conn.

Granular for the control of watermilfoil and certain other submersed aquatic species have become a standard operational procedure in many recreational lakes. Early work by Grigsby in Michigan, set the pattern for similar large-scale field evaluations in New Jersey in 1959. Horricks and Smith, with technical assistance from Gallagher, treated more than 750 acres in New Jersey's 2,680-acre Lake Hopetcong. The results obtained from the Lake Hopetcong evaluation work were to set a pattern for operational treatments throughout the decade. Steenis, through the early-1960s, had carried out a series of intensive evaluation studies on the control of eurasian watermilfoil *(Myriophyllum spicatum)* with Granular 2,4-D in Chesapeake Bay, which eventually led to its acceptance as an operational specification. This early work provided a sound basis for future large-scale programs in the TVA reservoirs, North Carolina's Currituck Sound, New York's Chautauqua and Findley Lakes and Rondoe Bay in Canada. Virtually, thousands of weed infested acreage has been cleared in recreational waters using this approach.

Back in 1958, work in Massachusetts by Boschetti and Cortell pointed out that a large group of submersed and floating aquatic plants were susceptible to relatively low rates (0.5 ppm) of silvex. Whereas watermilfoil, elodea, coontail and waterlily represent major problems in this part of the country, silvex has been used extensively for control purposes since that time.

Early field evaluations with diquat in England, Malaysia, Canada and the United States have resulted in the widespread use of this material throughout the world. It has been particularly effective in Florida for the control of water hyacinth *(Eichhornia crassipes)* and waterlettuce *(Pistia stratioites)* in drainage canals. Diquat also has been found to be quite specific for the control of another floating plant — duckweed *(Lemna minor)*. All three of these free floating aquatic plants have a worldwide range and are extremely troublesome when found in the vicinity of hydro-electric water intakes.

Diquat is used widely also in urban areas for the control of numerous submersed aquatic species. Large-scale operational treatments of diquat have been recently carried out in Florida at the Orlando Naval Training Center under the direction of Weldon and in New Jersey's and New York's 1,920-acre Greenwood

Lake by Gilbert. In the latter project, a bottom-release technique was utilized to control flatleaf pondweed *(Potamogeton robbinsii)*.

Another much heralded urban aquatic weed problem is that which besets Winter Park, Fla. Here both chemical and mechanical control procedures are presently being employed by the City's Parks and Recreation Department to abate the rapid growth of Florida elodea *(Hydrilla verticillata)*. At present, about 800 acres of surface water is infested with this and other submersed weeds. Based on extensive work at the U.S.D.A.-A.R.S. Fort Lauderdale Laboratory by Blackburn, numerous herbicidal approaches for the control of *Hydrilla* have been under study. This past year, field evaluation of two endothall products, Hydrothal 191 and 3M System E were made by Pennwalt Corporation and the 3M Company, respectively. While results of this work are still under study, Blanchard reports that municipal officials plan to move ahead on an ever-expanding program which is expected to run in the vicinity of $180,000 this coming year. Other work on *Hydrilla* has been conducted at the Fort Lauderdale Plantation Laboratory by Blackburn and Weldon. Recent field results appear to indicate that a combination of 1 ppm diquat and 4 ppm copper sulfate has given excellent control of *Hydrilla* and other submersed species in non-flowing waters. As a result of these studies, this combination is now being used commercially for *Hydrilla* control in urban sites.

The liquid formulation of 2,4-D Amine has been extremely valuable in controlling both waterhyacinth in the south and waterchestnut *(Trapc natans)* in the northeast. Wunderlich and his co-workers are generally given credit for the early evaluation of this formulation, both in Louisiana and in Chesapeake Bay. The early work of Smith, Greeley and Steenis, on the Mohawk and Hudson Rivers near Albany, further extended the field testing of 2,4-D Amine liquid on waterchestnut already begun by the Corps of Engineers.

Field evaluation of dalapon, in combination with Amitrol-T, back in 1962, for phragmites *(Phragmites communis)* control by workers in Delaware and Massachusetts has proved extremely useful in urban and industrial sites. Treatments with this combination have become an important part of the environment control program at Boston's Logan International Airport in connection with aircraft-related bird control.

Informed Public Wants Action

The foregoing represents a fragment of the evaluation work which has been under way in urban areas for the past decade or so.

We should acknowledge that the general public is more involved, and better informed, today than at any time in history about the problems of environment and the effects of pollution.

Urbanization, in connection with industrialization, has created environmental problems which can no longer be ignored or dismissed as the "price of progress" or the by-product of an expanding G.N.P.

Interest groups from all sectors of the community are now demanding clean air and water, water which is essentially free of undesirable aquatic weeds and algae.

The role of aquatic nuisance control should not be underestimated, as today, the urban dweller is vitally concerned and increasingly articulate about the quality of his drinking water, as well as that of the recreational ponds and lakes nearby.