

Aquatic Plant Control Program¹

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INTRODUCTION

The initial responsibilities and interests in aquatic plant control by the Corps of Engineers arose from the widespread and profuse growths of obnoxious aquatic plants that limited navigation in rivers and harbors of the Southern States. Wherever and whenever these aquatic plant infestations constitute a serious and/or economic threat to navigation, flood control, drainage, agriculture, water quality control, and related purposes, control projects are authorized within budgetary limitations set by the Congress of the United States.

It was the rapid infestation of water hyacinths (*Eichhornia crassipes*) in the South Atlantic and Gulf Coastal States with adverse affects on navigation, that lead to the adoption by Congress of the River and Harbor Act, approved in 1899, and subsequent authorizations for projects aimed at removal of this plant species from the navigable waters of these states.

Another introduced aquatic plant which rapidly infested the waters of the Gulf and South Atlantic States is alligatorweed (*Alternanthera philoxeroides*). In 1958, Congress authorized a pilot project for Aquatic Plant Control (Public Law 85-500) for the removal of water hyacinths, alligatorweed, and other obnoxious aquatic growths from navigable waterways, tributary streams connecting channels, and other allied waters.

This legislation which recognized alligatorweed as a weed whose infestations were economically significant and also recognized the need for control and progressive eradication of the sources of weed infestation. The pilot project was geographically located in the States of North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas.

Control operations of the pilot project were extended to a nationwide program, in 1965, to consider the combined interest of navigation, flood control, drainage, agriculture, fish and wildlife conservation, public health, water quality control, recreation, and related purposes. Most of the control operations are still limited to the Gulf States, Florida and Louisiana specifically, because these states have developed active program and the need is greatest in these areas.

The rapid invasion of Eurasian Watermilfoil (*Myriophyllum spicatum*) into the Southeastern Coastal states presented a third aquatic weed species to become a major economic problem in the areas already plagued with a great diversity of aquatic pest plants. In the Chesapeake Bay the plant has spread over 200,000 acres in the past ten years. Currently watermilfoil is established in the Northeast in Massachusetts, Vermont, New York, Pennsylvania, New Jersey, and Delaware. Watermilfoil has also been reported in Ohio, Indiana, Illinois, and Wisconsin (1).

PROJECT AUTHORITY

The expanded project for aquatic plant control of these different species was initiated July 1967. Section 302 of the River and Harbor Act of 1965 (Public Law 89-298) authorized a continuing program based upon the information presented to the 89th Congress on the pilot project as contained in House Document 251 (2) and testimony presented by the Chief of Engineers containing data from the U. S. Department of Agriculture, U. S. Public Health Service, and the U. S. Fish and Wildlife Service to the Subcommittee on Flood Control—Rivers and Harbors of the Committee on Public Works, United States Senate in June of 1965. In the Public Law 89-298 program, provisions of the 1958 and 1962 River and Harbor Acts were further amended to specifically include Eurasian watermilfoil, provisions for research and planning for the program

1. Paper prepared for the National Meetings of the Weed Society of America, 3-5 February 1970, Montreal, Canada.

were included which are borne fully by the Federal Government, and provisions for control operations were made by which local interests must agree to hold and save the United States free of claims that may occur from control operations and participate to the extent of 30 per centum of the cost of such operations. Funds for control operations are allocated by the Chief of Engineers on a priority basis, based upon the urgency and need of each area and the availability of local funds.

PROGRAM DEVELOPMENT

During the early phases of development of the program, many different mechanical devices were designed to cope with the dense infestations of water hyacinths (3). Early control operations were based almost exclusively on mechanical procedures such as gang-saw boats to open up paths for navigation, physical removal by derrick and grapple, the use of hand labor to cut blocks of matted water hyacinths with six-foot timber saws, and the use of special barges equipped with conveyor belts for picking up the plants and depositing them on the shore as well as crusher boats which crushed the plants into a pulp and then deposited the pulp directly into the water (4).

In current projects, cutter or destroyer boats are used to open channels clogged with aquatic growths. Types of mechanical control equipment which have been field evaluated are amphibious tractors, trailers, rolling dollies, wood chippers, an air cushion ground effect machine, and remote controlled equipment. Mechanical methods for control operations spread obnoxious aquatic plants by fragmentation. Research and field operations have shown that chemical control through the use of 2,4-D (2,4-dichlorophenoxyacetic acid) is the most effective method for control of water hyacinth.

Utility, speed, and mobility are essential requirements for efficient and economical operations. The new program includes a wide variety of equipment types ranging from barge mounted saw boats and spray equipment to mobile air-boats which offer efficient maneuverability. Other types of equipment utilized in control operations range from airplanes, helicopters, inboard and outboard motor boats, trailers, barges, quarterboats to the use of backpack sprayers. The easy access by roadways in areas such as Florida has resulted in the utilization of air-boats for herbicide application while in inaccessible areas of Louisiana a mobile base of operations is utilized which provides living quarters and subsistence for the work crews which operate in smaller boats equipped with high pressure spray equipment.

PROJECT PLANNING

At the national level, the Aquatic Plant Control Section has the planning responsibilities for the nationwide program including funding, evaluation, and approval of reconnaissance survey, general state design and feature design memoranda and other types of surveys on aquatic plant problems in accordance with District Corps of Engineers requirements. Since the pilot project was authorized in 1958, dramatic and dynamic changes have occurred in Federal policies concerning the combined interest of the program as authorized by Congress and in particular, the preservation of the nation's natural resources.

On an annual basis or as unpredictable needs arise, Corps of Engineers District offices throughout the United

States are requested to submit their needs for an aquatic plant control program based upon weed infestations of major economic significance or those weeds which have that potential. After approval of the District's request by the Office, Chief of Engineers, the next planning requirement is the preparation of a Reconnaissance Report which is limited to readily available information and data. The information requested in the Reconnaissance Report is categorized into a statement of the problem listing the location of specific weed or weed complex problems and other particulars on the infestations and economic damages; proposed control operation procedures if available and the special control problems anticipated; preliminary cost estimates, and economic evaluations; local cooperation, and coordination with Federal and non-Federal interests. When the Reconnaissance Report is approved, the next requirement is for the preparation of a general design memorandum for each state covering detailed planning and supporting data for all work contemplated. The last requirement is the preparation of a feature design memoranda providing detailed plans and supporting data for work to be done during a fiscal year.

PROJECT RESEARCH

One relatively new tool which offers real potential for planning is the use of remote-sensing devices from aircraft for aquatic plant surveys of waterways. Infrared color aerial photography offers such promise because of the economical coverage which can be attained from large areas, and the ability to synoptically view areas in a short time span during which aquatic plant vegetation usually does not appreciably change. The value of precise ground control in aquatic plant investigations is recognized. The philosophy behind the use of remote sensors is that synoptic small scale views of aquatic plant problems are of real value in properly assessing the problems of a waterway as a whole and reduce the amount of expensive and time-consuming ground control required (5). On Cayuga Lake in New York (6) Lukens has used color infrared aerial photography for rapid and accurate mapping of gross areas of aquatic plants including matemilfoil (*Myriophyllum exalbescens*) in waters up to 18 feet deep. The Corps has not yet been actively involved in this type of reconnaissance.

MISSION ORIENTED RESEARCH

The Aquatic Plant Control research is mission-oriented. The Corps of Engineers does not fund a research project on scientific merit alone, but must consider the combined interest of the program as stipulated by Congress and assure the results can be directly applied and will satisfy the needs of field operations. While the program emphasizes certain areas, administration of the program does deal with a wide range of water resource problems. Thus the research to the full-scale demonstration and testing of aquatic plant control methods, but the prime responsibility is to make certain that in supporting a research proposal various aspects of the mission are fulfilled.

RESEARCH EVALUATION

Research priority is assigned with respect to the specific objectives of the mission, to provide more economical, efficient, and effective methods for using chemical, physical, mechanical, environmental, and/or biological control pro-

cedures for existing and potential plant problems. Technical evaluations, funding, and approval or research proposals are accomplished in the Office, Chief of Engineers. Guidelines and review of research projects are accomplished both within the Corps of Engineers and through the advisements furnished by the Technical Advisory Committee for the Aquatic Plant Control Program. This committee is composed of members from participating Federal agencies and research institutions.

GEOGRAPHICAL LOCATION

The unrestricted geographical location of the new program involves new aquatic plant problems of major economic importance for which research will be required to develop economical and efficient methods for control and/or eradication. Already new plants have been called to our attention as having major economic importance in both the new areas and in the areas previously within the pilot project area. For example, requests have been submitted to control Florida elodea (*Hydrilla verticillata*) *Elodea canadensis*, water primrose (*Jussiaea spp*) Water lettuce (*Pistia stratiotes*), elodea (*Anacharis densa*) and parrot feather (*Myriophyllum brasiliense*), which have not previously been included in control operations. New problem plants listed by the North Atlantic Division in their Reconnaissance Report include Eelgrass (*Zostera marina*), phytoplankton, Filamentous algae (*Cladophora*, *Codium*, *Agardhilla*, *Gracilaria* and *Pithophora*), sea-lettuce (*Ulva latuca*) Water chestnut (*Trapa natans*) and Eurasian Watermilfoil (*Myriophyllum spicatum*). The North Atlantic Division has indicated in their Reconnaissance Report that economically important aquatic plant problems exist in the New York District's Great South Bay, and the Hudson River basin; in the Philadelphia District's Perkiomen Creek Area and Barnegat Bay; in the Baltimore District's Chesapeake Bay, and its tributaries including the Susquehanna watershed; and in the Norfolk District's Back Bay and Rappahannock River areas.

COOPERATIVE RESEARCH PROJECTS

Several cooperative research projects should be briefly mentioned. The United States Department of Agriculture is currently making investigations and host-specificity studies for new biological control insects. In Argentina a stem-boring phycitid moth (*Vogtia malloi*) has been studied and host-specificity investigations have indicated the phycitid moth is host specific. The USDA has requested authority to bring the species into North America. In Uruguay and Argentina preliminary screening of known insect enemies of the water hyacinth and host-specificity studies are currently in progress. In Pakistan and Yugoslavia programs are underway to test insects for biological control of Eurasian Watermilfoil. At Fort Lauderdale, Florida, the USDA is currently conducting chemical, physiological, and ecological research on the control of alligatorweed, waterhyacinth, elodea, and watermilfoil. The U.S. Fish and Wildlife Service, U.S. Department of Interior is conducting studies to determine the effect of Aquatic Plant Control Operations on fish and wildlife resources. The Federal Water Pollution Control Administration, U. S. Department of Interior, monitors control operations and directs research efforts on the improvement of detection methods for herbicide chemicals used in control operations.

Currently the degradation kinetics of propylene glycol butyl ether ester of silvex and the persistence of the acid in water and hydrosol have been studied. The Public Health Service, U. S. Department of Health, Education, and Welfare, monitors field control operations and provides supportive research on the impact of control operations to public health. At the University of Southwestern Louisiana research investigations are currently underway to determine synergistic effects of organic acids in combination with 2,4-dichlorophenoxyacetic acid.

One of the promising new methods for control of obnoxious aquatic plants such as the waterhyacinth, watermilfoil, elodea, and alligatorweed is a powerful laser beam to bombard the plant. This beam, projected by equipment mounted on a boat or helicopter, may be capable of destroying not only floating plants but also those which are submerged or rooted in the bottom (7).

The second breakthrough is the prototype development of a sophisticated carrier system which permits confining herbicides used in weed eradication to selected depth zones, thereby avoiding dispersal of chemical control agents throughout an entire water environment. The carrier system permits slow release of herbicidal and other chemical agents over a period of more than a year, and may be tailored to fit any specific situation.

The principle involved in laser control of aquatic plants was established, and a practical system of application developed, through continuing research being carried out under the Corps program at the Army Missile Command's Redstone Arsenal, Huntsville, Alabama; Athens College, Athens, Alabama, and Auburn University, Auburn, Alabama. The development of the new carrier system for herbicidal control was the product of similar research in progress at the Army's Edgewood Arsenal in Maryland and the Department of Agriculture installation at Fort Lauderdale, Florida. Additional research is underway at the University of Akron, Akron, Ohio.

REFERENCES CITED

1. Crowell, Thomas E., John H. Steenis and John L. Sincovec, 1967. Recent observations of Eurasian Watermilfoil in Currituck Sound, North Carolina, and other Coastal Southeastern States. Report of North Carolina Wildlife Resources Commission, Raleigh, North Carolina and Bureau of Sport Fisheries and Wildlife, U.S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, Maryland, pp. 1-2.
2. House Document No. 251, 89th Congress, 1st Session, 1965. Expanded Project for Aquatic Plant Control. U.S. Government Printing Office, Washington, D.C., 28 July 1965.
3. Guscio, Francis J., Thomas R. Bartley, and Arthur N. Beck, 1965. Water Resources Problems Generated by Obnoxious Plants. *Journal of the Waterways and Harbors Division ASCE*, Vol. 91, No. 4, Nov. 1965, pp. 47-60.
4. Raynes, Julian J., 1966. Problems Related to Aquatic Plant Control. Proceedings of Sixth Meeting, Weed Society of America. St. Louis, Missouri, pp. 2.
5. Robinove, C. J., 1967. Status of Remote Sensors in Water Pollution. Address presented interagency Meeting in Water Quality Research, Ada, Oklahoma.
6. Lukens, John E., 1967. Mapping of Submerged Aquatic Vegetation in Casyuga Lake Using Color Aerial Photography. Division of Water Resources, New York State Conservation Department. pp. 1-12.
7. Scott, Ralph A., 1969. Corps of Engineers Studies on the Use of Laser Energy to Control Weeds. Army Research and Development, Vol. 10, No. 4, pp. 6-8.

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