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New pond facility for aquatic plant biocontrol research

by
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The U.S. Army Engineer Waterways Experiment Station (WES) and the Tennessee Valley Authority (TVA) entered into a cooperative agreement in 1990 to research, demonstrate, and use a variety of technologies for managing Eurasian watermilfoil and hydrilla at Lake Guntersville, Alabama (Bates, Decell, and Swor 1991). This cooperative venture, known as the Joint Agency Guntersville Project (JAGP), has provided a wealth of information that can be applied to managing aquatic plants on large reservoir systems. The use of insect biocontrol for aquatic plant management is one of the promising technologies being investigated.

An abandoned biowaste aquaculture facility located on the TVA Reservation in Muscle Shoals, Alabama, was partially renovated and transformed into a research facility. This series of small ponds proved useful to WES and TVA personnel in conducting both foundational and applied research for the JAGP. Future applications of this pond facility offer additional opportunities for research of significance throughout the United States, at both the national and local levels.

Value of pond-scale experimentation

Currently, only two methods are used for testing and evaluating biocontrol agents released for aquatic plant management: small-scale laboratory and greenhouse studies using containers, aquaria, or tanks; and releases of agents into field sites. Unfortunately, when only these methods are used, researchers are unable to obtain some important information on establishment and efficacy of the biocontrol agents.

Small-scale experimentation offers a high degree of control over many environmental parameters. Researchers can select optimum growth conditions in which to rear both the plants and agents. Often, a small-scale setup is used for rearing large numbers of insects for field release, since this allows a high degree of control over ambient environmental conditions. Small-scale experiments also allow for more frequent observations on the experimental progress. Actual feeding can be observed over extended periods, which can result in improved understanding of the mechanisms involved in declines that are caused by the agents.

However, the exclusive use of small-scale studies results in several limitations. The most important of these is the fact that such studies do not approximate field conditions. The containers are small; water quality usually differs from that found in the field; and the variety of natural population regulatory factors (for the biocontrol agents and plants) is incomplete, at best. Therefore, the plants usually do not grow as well as they do in the field, and the control agents act without impediments such as predators, parasites, and disease.

The limitations of small-scale experiments are avoided by releasing the agents at field locations. Such releases allow investigators to improve procedures for establishing viable populations of the agents, examine their overwintering mechanisms, and quantify impact to the plants. At field sites, the agents can be evaluated under natural conditions

and population controls—the true test of their effectiveness.

Unfortunately, a number of unknowns and problems are typically encountered when using field sites. In many cases, the sites are located in remote areas, which decreases the ability of researchers to record frequent or extended observations of the agents and their impacts. Also, field sites are prone to disruption by human intervention and by natural changes in the immediate and surrounding aquatic systems. Such changes, if they occur during the critical initial establishment period, may slow or prohibit the agents from becoming successfully and permanently established.

Another limitation is that field sites differ from one another in many important environmental parameters. This effectively eliminates most opportunities to design replicated experiments that provide additional information on how agents become established and impact the plants. The "bottom line" is that most field sites offer little or no opportunity to control or modify ambient conditions to increase the chances for first-time establishment. This capability is especially important in developing release and rearing techniques for operations.

After comparing the advantages and limitations of small-scale experiments and field site studies, it is apparent that the pond-scale facility can fill an important gap in biocontrol research. In most cases, ponds closely simulate natural field conditions but are small enough to be manipulated to some extent. For instance, it is relatively easy to manipulate parameters such as water depth, fertilization level, plant species composition, and number of insects released. Ponds offer the opportunity to design and implement replicated experiments in which each experimental unit is comparable.

Also, the pond facility is easily accessible and is convenient for collecting detailed observations on the agents.

The Lewisville Aquatic Ecosystem Research Facility is a larger WES pond facility located in Lewisville, TX (Smart 1990, Smart and Decell 1994). These ponds are not available for insect biocontrol research, however, because of the highly mobile nature of the agents. Insects can move quickly from pond to pond, resulting in contamination of ponds on the facility that are devoted to totally unrelated research. Because such contamination is nearly impossible to control, a pond facility dedicated entirely to biocontrol research objectives is highly desirable.

Description of pond facility

The TVA pond facility consists of 26 usable ponds (Figure 1) that range in size from 90 square meters to 1.2 hectares, with depths ranging from 1.5 to 2.7 meters. Many of the ponds have earthen sides and bottoms; 16 ponds are constructed with nearly vertical sides covered with wooden boards (Figure 2). These boards are bolted together from pond to pond to minimize erosion and collapse.

Several of the ponds are similar in size, shape, and construction, allowing for experiments that require identical experimental units or replications. For example, the 16 wooden-sided ponds, each about 3 square meters and 1.8 meters in depth, can be used for replicated experimentation. To increase strength and minimize leakage, the wooden sides of eight of these ponds were covered with Gunite, a sprayable form of concrete (Figure 3).

Water for filling the ponds can be obtained from a variety of sources, depending on circumstances and need. To fill the ponds to working depths, water directly from the Tennessee River is delivered via a pipeline that runs along the side of the facility. As the result of evaporation and small amounts of leakage, the ponds must have water added continually to maintain constant levels. A 1.2-hectare reservoir pond provides this water. As a backup, water can also be obtained from wells located on the property and from city water. These alternative water sources are used primarily during peak demands and in emergency situations.

Water source and filling rate for all but a few ponds can be controlled individually through a series of valves located in an enclosed pumphouse, as well as from valves located at each pond. Currently, water fills each pond directly from simple polyvinyl chloride (PVC) pipes. However, if the need arises, it is possible to equip each input pipe with a device to eliminate various-sized aquatic organisms with little difficulty. In addition, most of the ponds can be emptied from drains located on the bottom of the pond. By using this drainage system, the ponds can be maintained at desired depths by manipulating the height of standing PVC and metal pipes which cover the drains (Figure 4).

Several additional ponds that were constructed but never filled are being renovated for use. When this work is completed, the total number of usable ponds will be increased to 33.

Current pond facility uses

Since 1991, the pond facility has undergone a significant amount of renovation and repair. Leaks have been greatly reduced, and valves and piping have been repaired or replaced as needed. Greenhouses have been constructed over two of the 3-square meter ponds by

covering the ponds with a PVC frame and equipping them with heaters and fans (Figure 5). The PVC frames can be easily covered during the winter months with greenhouse plastic to extend growing and rearing times of both plants and insect agents.

About 60 percent of the ponds are currently planted with aquatic species. Most of the research to date has concentrated on the use of insects to control hydrilla, although other research has included the culturing of *Pontederia* and American lotus for plant competition work and studies to test the efficacy of various herbicides on Eurasian watermilfoil.

During 1991-1992, more than 40,000 hydrilla leaf-mining flies, *Hydrellia pakistanae*, were released from cultures maintained at WES and TVA in two ponds on the facility. Since those initial releases, permanently established colonies of *H. pakistanae* can be found throughout the facility. This represents the most northern population of *H. pakistanae* in the United States.

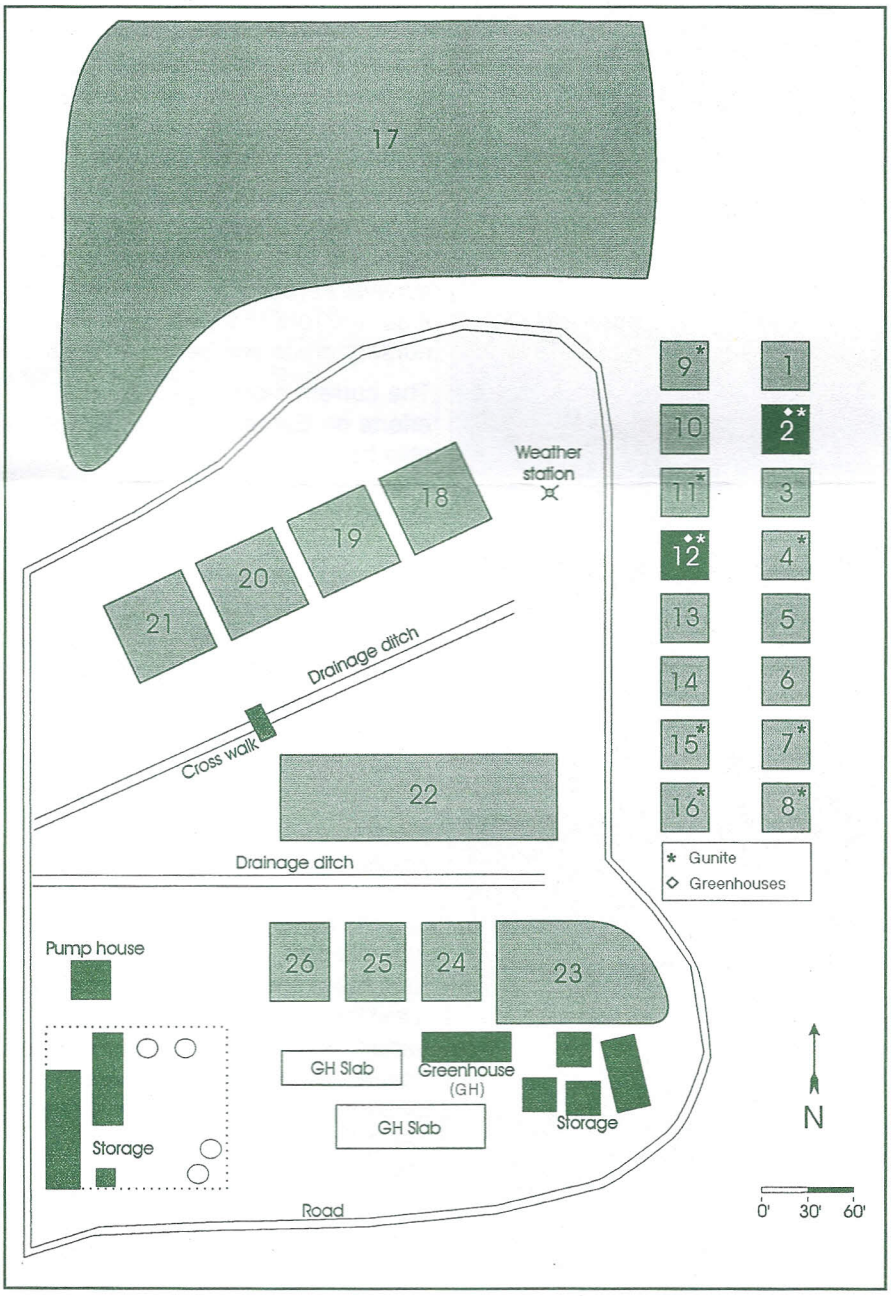

Figure 1. Aerial view of ponds, summer 1993

The pond facility, because of its accessibility, has allowed scientists to collect quantitative estimates of *H. pakistanae* population dynamics and associated damage (Figure 6, Grodowitz and others 1995). Detailed observations have also been collected on qualitative relationships between increases in fly population and overall impact to hydrilla. The release, establishment, and sampling procedures developed from research at this pond facility are being applied at other *H. pakistanae* and *Hydrellia balciunasi* release sites throughout the country.

About 6,000 *Bagous hydrillae*, the hydrilla stem-feeding weevil, were released at one pond on the facility in 1993. Small numbers of viable adults of what is believed to be *B. hydrillae* have been collected as recently as spring 1994, more than 160 days after the initial release. This species has proven to be very difficult to establish at other U.S. sites. However, the ability to continually modify bank conditions and to make daily observations has apparently aided in its establishment.

The ponds have also been used as nursery areas for releases of *H. pakistanae* in other parts of the country. In December 1992 and January 1993, more than 2 million *H. pakistanae* were transported to sites on Lake Seminole, Georgia, and Lake Boeuf, Louisiana, when the hydrilla from one pond on the facility was harvested (Figure 7). At other times, adults have been collected, and their progeny subsequently released.

Figure 2. Construction detail of ponds with vertical sides, using wooden boards to minimize leakage and erosion

Figure 3. Ponds with wooden sides after application of sprayable concrete to further minimize leakage

Use of this pond facility has allowed for the development of a viable program for releasing and establishing insect biocontrol agents of hydrilla for TVA water bodies as well as other U.S. sites.

Future plans

Plans are under way to continue renovating and expanding the Muscle Shoals pond facility. This will allow for the continuation of many TVA and Corps research projects that depend on use of this facility. One of the more important among these projects is the continued monitoring of population dynamics and associated impact of insect agents of hydrilla.

Equally important is the continued study of the effects of hydrilla control agents on plant growth and survival in replicated experiments. Also, the role of the ponds as nursery areas will be expanded.

The current biocontrol research efforts on Eurasian watermilfoil will also benefit from this facility. As watermilfoil continues to spread and cause problems throughout the Tennessee Valley and the northern United States, the ponds can in the future be used as a testing area for insect biocontrol agents currently in quarantine.

Plans also include use of the facility in studying the use of pathogens for aquatic plant management. The ponds will function as large-scale testing areas for new strains and species of pathogens that directly impact aquatic plants. An advantage is that the ponds can be manipulated to achieve the best possible conditions for the trials. More importantly, a small-scale flow-through tank or mesocosm system can be constructed onsite using the existing plumbing. This mesocosm would allow for simultaneous testing of several formulations of pathogens under both static and flow-through conditions.

Summary

The conversion of a biowaste aquaculture facility on the TVA Reservation in Muscle Shoals, Alabama, into a biocontrol research facility had added greatly to the study of biocontrol of aquatic plants. This facility allows for field-like testing of insect biocontrol agents without many of the problems associated with field experimentation. Since 1991, important information on the population dynamics and associated damage of *Hydrellia pakistanae*, a leaf-mining fly introduced for the management of hydrilla, has been collected. The ponds have also served as an important source of insect biocontrol agents for Lake Guntersville releases, as well as releases at other sites such as Lake Seminole, Georgia, Lake Boeuf, Louisiana, and numerous sites in southeastern Texas.

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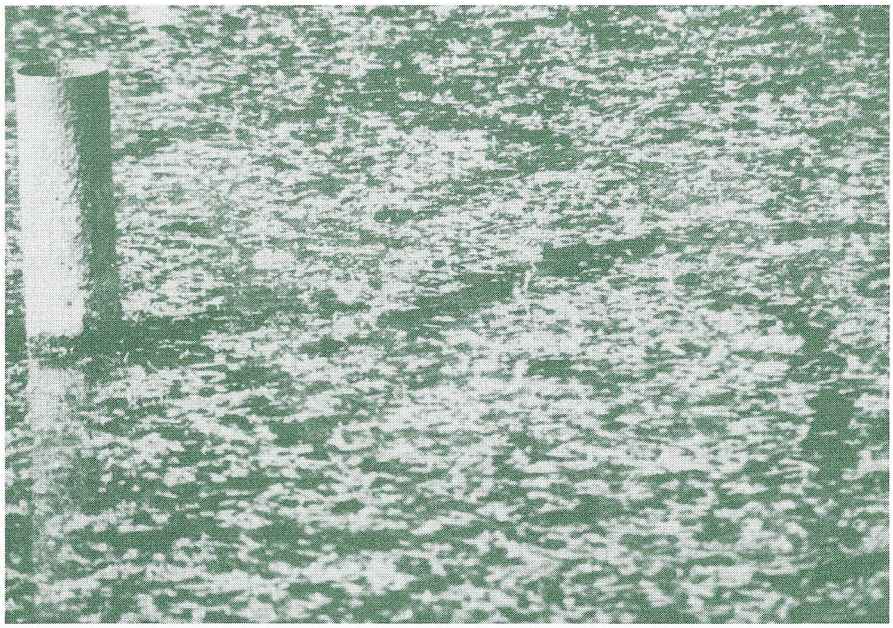


Figure 4. Standing pipes used to maintain constant water level

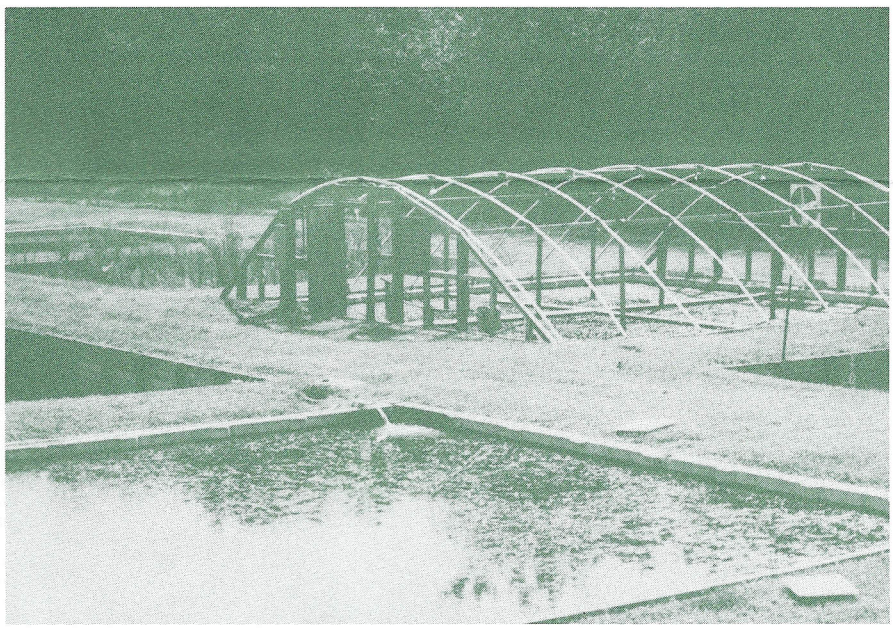


Figure 5. One of two ponds that have been fitted with a PVC frame to allow for attachment of greenhouse plastic

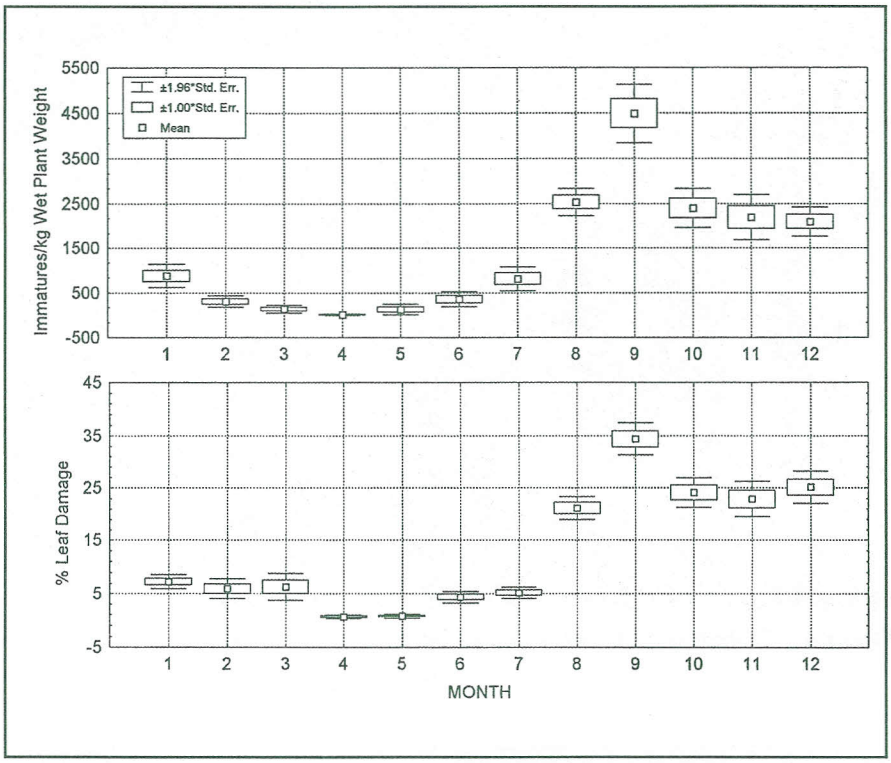


Figure 6. Mean number of immatures per kilogram of wet plant material and percent leaf damage, Muscle Shoals pond facility, 1993

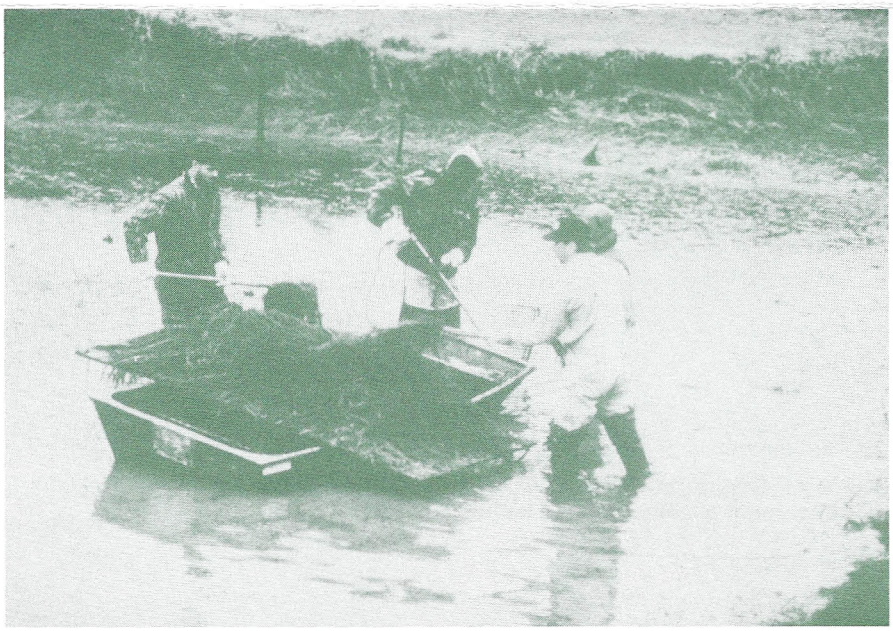
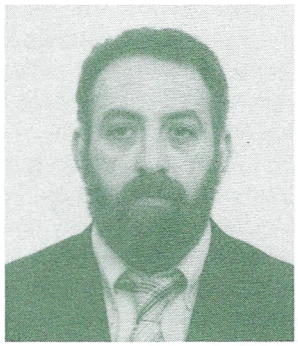


Figure 7. Harvesting of hydrilla for subsequent transportation to other *H. pakistanae* release sites, Lake Seminole, Georgia



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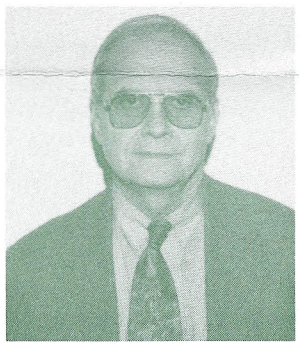

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Aquatic Plant Resource Operations & Planning Online Support

APROPOS, the Aquatic Plant Resource Operations and Planning Online Support system, is a computer-assisted management strategy planner being developed to allow Corps aquatic plant managers to integrate the vast quantity of information available to them.

Components of this integrated information system will include the Planner, literature databases, simulation tools, field technique and control technique toolboxes, a database menu, and a Help menu.

To make APROPOS a success, the system developers need input from all sources—Corps researchers and field personnel, state cooperators, and interested individuals.

To obtain this much-needed input, a questionnaire is now online via the APBBS (Aquatic Plant Bulletin Board System). Details on the APBBS are available in Vol A-95-1 (Jan 1995) of *Aquatic Plant Control Research.*

In a future bulletin, an in-depth article on APROPOS will describe how the system is being developed, as well as its components and capabilities.

APROPOS system developers strongly encourage you to respond to the APROPOS questionnaire via the APBBS, at (601) 634-3018. Questions or comments concerning the Bulletin Board System can be referred to one of the System Operators: Carolyn Schneider, (601) 634-3657, and Joel McAllister, (601) 634-3751.

General comments on APROPOS can also directed to the system developers: John Madsen, (214) 436-2215, and Joel McAllister, (601) 634-3751.

The goal of the APROPOS system is to improve aquatic plant management by making it easier to use current technology.

Calendar of events

July 9-12, 1995 — **35th Annual Meeting, Aquatic Plant Management Society, Inc.**, Hyatt Regency Bellevue, Seattle, WA, POC: Terry McNabb, (206) 754-3460

The Joint Agency Guntersville Project, a cooperative venture between the U.S. Army Engineer Waterways Experiment Station and the Tennessee Valley Authority, has provided a wealth of information that can be applied to managing aquatic plants on large reservoir systems. This issue describes the pond facility and future research plans.

AQUATIC PLANT CONTROL RESEARCH PROGRAM

This bulletin is published in accordance with AR 25-30 as one of the information dissemination functions of the Environmental Laboratory of the Waterways Experiment Station. It is principally intended to be a forum whereby information pertaining to and resulting from the Corps of Engineers' nationwide Aquatic Plant Control Research Program (APCRP) can be rapidly and widely disseminated to Corps District and Division offices and other Federal and State agencies, universities, research institutes, corporations, and individuals. Contributions are solicited, but should be relevant to the management of aquatic plants, providing tools and techniques for the control of problem aquatic plant infestations in the Nation's waterways. These management methods must be effective, economical, and environmentally compatible. The contents of this bulletin are not to be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official endorsement or approval of the use of such products. This bulletin will be issued on an irregular basis as dictated by the quantity and importance of information to be disseminated. Communications are welcomed and should be addressed to the Environmental Laboratory, ATTN: J. L. Decell, U.S. Army Engineer Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, or call (601) 634-3494.

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