US Army Corps
of Engineers
Waterways Experiment
Station

Aquatic Plant Control Research Program

VOL A-92-1 January 1992

Submersed macrophyte invasions and declines

by
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Dense algae-covered Eurasian watermilfoil growth a few years after invasion (water lilies in foreground)

Aquatic plant control can be optimized by identifying natural population controls and adjusting management strategies to act in concert with them. Once these controls are better understood, it should be possible to identify where management is most necessary, where it is most likely to succeed, and where specific techniques may be counterproductive. Coordinating management with natural controls can potentially reduce the effort required to maintain long-term control of problem species.

Clues to the identity of innate population controls can be discovered by examining naturally occurring variations in the vigor and longevity of exotic plant populations. Differences in vigor associated with exotic plant invasions and declines are particularly promising sources of information. Development of management strategies that hasten natural declines may be possible.

Invasions and declines

Aggressive weedy aquatic plant species, such as Eurasian watermilfoil (*Myriophyllum spicatum*) and hydrilla (*Hydrilla verticillata*), invade a wide variety of water bodies, but are not equally successful in all of them. In some instances, native species have been replaced by invaders, while in others the invaders have been restricted primarily to previously unoccupied habitat (see sidebar, next page).

Differences in invasion success among lakes are poorly understood. One possibility is that replacement of native species occurs primarily on nutrient-rich substrates, and the abundance of adequately rich substrates varies between water bodies. Disturbance undoubtedly facilitates invasion by aggressive aquatic plants, although the mechanisms involved and relative effectiveness of different types of disturbances are not known.

The study of naturally occurring submersed plant declines is a very promising avenue for the discovery of natural population controls. For example, Eurasian watermilfoil populations characteristically decline approximately 10-15 years after achieving dominance. The reasons for the decline are essentially unknown, although a number

of possible suggested causes include:

- Nutrient depletion.
- Toxin accumulation.
- Shading by phytoplankton or attached algae.
- Parasite(s) or pathogen(s).
- Harvesting/herbicides.
- Climatic fluctuations.
- Competition from other macrophytes.
- Insect herbivory.

Several of these causes (discussed below) seem more likely than others.

Nutrient depletion from sediments may be an important factor contributing to declines by several possible mechanisms. Previous studies have focused on phosphorus (P) nutrition and found that P concentrations were depleted in the sediments in which declining milfoil plants were rooted, but declining plants showed no physiological evidence of P limitation.

More recent studies have identified nitrogen (N) as more limiting than P for the growth of rooted aquatic plants. The possibility that N depletion from sediments contributes to declines has not been adequately investigated. Other sediment alterations may also be important.

Vigorous growth of nuisance species can contribute to rapid accumulation of organic matter in sediments. Accumulation of organic matter dilutes sediment nutrients, thereby making them less available for plant growth. Organic matter from some plant species, including Eurasian watermilfoil, may also contain materials which inhibit the growth of aquatic plants.

The role of herbivores, especially insects, in contributing to the decline of submersed plant populations also deserves study. High densities of herbivorous insects accompany some milfoil declines. Several insects, including a caddisfly, several moths, several weevils, and one or more chironomid species, may be important in this regard. Even if herbivorous insects alone cannot control the growth of nuisance submersed plants, they may be very important when other factors slow plant growth.

Whatever the causes of declines, some evidence indicates that intense management may prolong the dominance of exotic aquatic plants. Luxuriant growth of Eurasian watermilfoil persisted in frequently harvested areas of Lake Wingra, Wisconsin, long after the species had declined elsewhere in the lake. In two additional well-documented cases, in which Eurasian watermilfoil did not decline after 10 or more years (the upper TVA reservoirs and the Okanagan area lakes), the lakes were more intensely managed than those where declines were recorded (Table 1). Although disturbance appears to favor invasion by aggressive exotics, it is not clear why management would permit their continued dominance.

Replacement of native plant species by Eurasian watermilfoil

- Lakes Wingra and Mendota, Wisconsin, had near complete replacement of *potamogetons, vallisneria*
- Devil's Lake, Wisconsin, had some replacement of *elodea*
- TVA Reservoirs had no replacement, but watermilfoil invaded new habitat as reservoirs flooded
- Lake Opinicon, Ontario, Canada, had no replacement, but watermilfoil invaded open habitat in deep water

Future research

Scientists at the US Army Engineer Waterways Experiment Station (WES) are initiating a study of

Table 1
Apparent relationship between management and Eurasian watermilfoil persistence

Location	Management Technique(s)	Approximate Percentage of Milfoil Affected	Decline
Chesapeake Bay	None	~0	Yes
Lake Wingra	Harvesting	<5	Yes
Devil's Lake	None	0	Yes
Guntersville Reservoir	Herbicides Drawdown	7 100	No
Okanagan Lakes	Many	18	Locally
Cultus Lake	Rototilling	33	No
Shuswap Lake	Many	44	No

factors influencing invasions and declines of exotic submersed plants. Previous research within the ecological technology area of the Aquatic Plant Control Research Program (APCRP) has examined the response of submersed aquatic macrophytes to a diverse array of environmental factors. The new research focus will tie together understanding gained from past work with observations and experiments designed to identify factors influencing specific invasions and declines.

Investigation of the causes of submersed plant invasions and declines will begin by examining areas where these phenomena are occurring, while they are in progress. The search for natural population controls will begin by tracking the occurrence of invasions and declines and looking for patterns. Eurasian watermilfoil is well established in much of North America. Invasion of many areas took place 10 to 20 years ago. Significant long-term declines have been reported in the Chesapeake Bay; Currituck Sound, North Carolina; the Kawartha Lakes, Ontario, Canada; and the Madison, Wisconsin, area lakes. Populations of Eurasian watermilfoil are thought to be declining in the Okanagan Valley, British Columbia, Canada, lakes. Populations in Tennessee Valley Authority (TVA) reservoirs and portions of the Tennessee-Tombigbee waterways appear to be declining, although these declines may only be temporary. Recent invasions of Eurasian watermilfoil have been reported in Lake George, New York; Fish Lake, Wisconsin; and Lake Minnetonka, Minnesota.

A variety of analyses will be performed on plants, water, and sediment collected from decline sites (Table 2). Herbivorous invertebrate populations on the plants and a number of environmental parameters will be measured and the condition of plants recorded. Bioassays will evaluate the ability of sediments from decline sites to support plant growth and the growth rate of plants from the site when rooted in a standard reference sediment. Attempts will be made to isolate pathogens from plants that appear diseased. Laboratory analyses will be conducted to examine the nutrient levels in plants and sediment and the physical composition of the sediments. Identical analyses will be conducted in areas supporting vigorous plant growth.

Success of this work will depend on locating as many sites as possible where submersed nuisance species are currently invading or declining. A form for reporting invasions and declines appears as an insert to this bulletin. If you are aware of any areas where these are occurring, please fill out the form as completely as possible and contact WES. All invasions and declines will be recorded and as many as possible will be investigated. Invasions and declines of Eurasian watermilfoil are of particular interest, but reports on other submersed plant species are welcome as well.

Table 2
Factors to be evaluated during initial screening of declining plant populations

Plants	Water	Sediment
Condition	Clarity	Physical composition
Growth/photosynthetic rate	Temperature	Chemical content
Nutrient content		Plant growth bioassays
Pathogens		
Herbivore populations		

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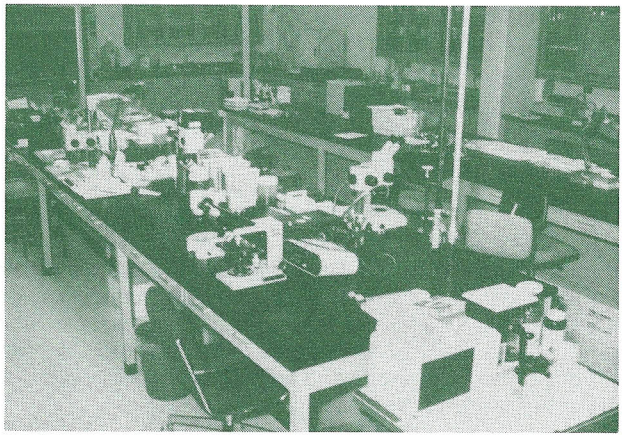
BASS representatives meet with APCRP managers

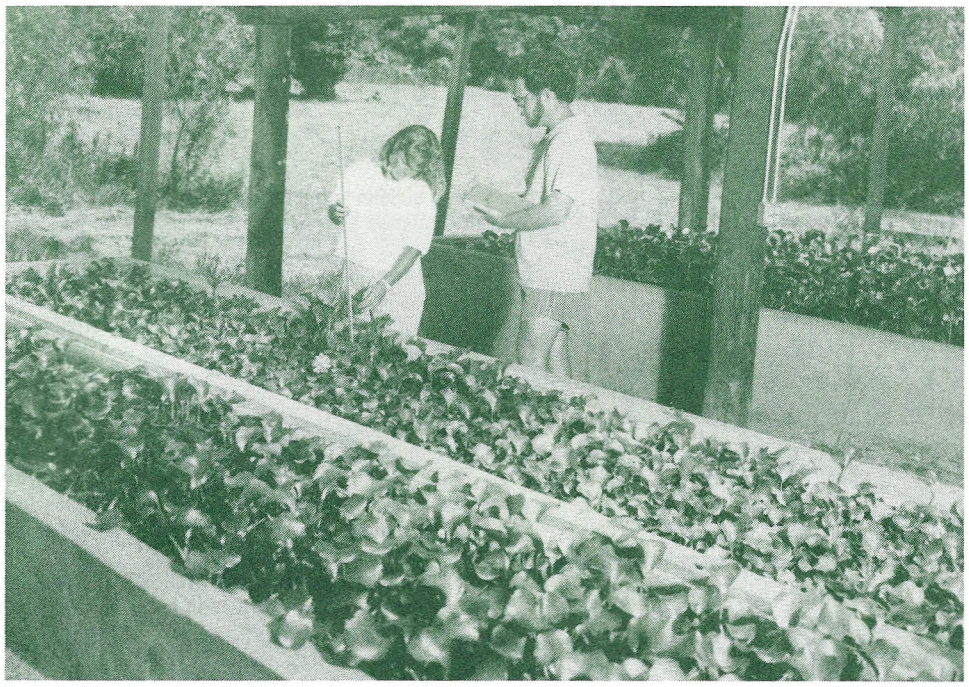
On December 10 and 11, Al Mills, Environmental Director of the Bass Anglers Sportsmans Society (BASS), and Margaret Cleveland, Assistant, visited the US Army Engineer Waterways Experiment Station (WES) to gather information concerning the Aquatic Plant Control Research Program (APCRP). They toured research areas and computer facilities where APCRP simulation models are developed. One important development of the meeting was a planning session to identify future partnership efforts, some for the near future.

BASS representatives visited WES as a result of an invitation from Lewis Decell, Program Manager, APCRP, extended during a public meeting of the Tennessee Valley Authority-Corps of Engineers Joint Agency Guntersville Project. The invitation was to provide a better dialogue between fishermen and personnel involved with aquatic plant management, both in research and operations.

Organizations such as BASS have an interest in aquatic plant management techniques because, even though managers consider fisheries management on a scientific basis in implementing aquatic plant control techniques, they are not able to effectively consider the requirements of fishermen, which are often intuitively based.

A February visit of the APCRP Program Manager to the BASS facilities is planned to continue discussions. The developing partnership between BASS and the Corps of Engineers should prove productive in adding the input of fishermen into aquatic plant control management practices.





An open greenhouse structure at the Lewisville Aquatic Ecosystem Research Facility

26th Annual meeting, Aquatic Plant Control Research Program

During the week of November 18-22, 1991, the Aquatic Plant Control Research Program (APCRP) held its 26th Annual Meeting in Dallas, Texas. The meeting included presentations of current research projects, examination of current operations activities and problems, and the Civil Works Research and Development Program Review for the APCRP. Representatives from US Army Corps of Engineers Headquarters, Divisions, Districts, and the Waterways Experiment Station; other Federal, State, and local organizations; universities; and private industry were among the 130 attendees.

The meeting included a tour of the new Lewisville Aquatic Ecosystem Research Facility located in Lewisville, Texas. The facility consists of 55 excavated ponds and an extensive laboratory facility. The facility expands the Corps' aquatic research capabilities by filling the gap between short-term, small-scale laboratory studies and large-scale field testing. Scientists and engineers at the facility are studying the biology and ecology of aquatic plants as well as methods for controlling excessive growth of these plants.

The meeting also included a poster presentation and computer demonstration session, a meeting of the Federal Aquatic Plant Management Working Group, and a meeting of the principal investigators for the Joint Agency Guntersville Project. At the request of the Texas Aquatic Plant Management Society (TAPMS), the TAPMS Annual Meeting was held on November 18 in conjunction with the 26th Annual Meeting of the APCRP.

Aggressive weedy aquatic plant species, such as Eurasian watermilfoil and hydrilla, invade a wide variety of waterbodies, but are not equally successful in all of them. Differences in invasion success among lakes are poorly understood. The study of naturally occurring submersed plant declines is a very promising avenue for the discovery of natural population controls. This issue reports on a new study of factors influencing invasions and declines of exotic submersed plants. The 26th Annual Meeting of the Aquatic Plant Control Research Program is also reported on.

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 aquatic plant management, 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, US Army Engineer Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, or call AC 601/634-3494.

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