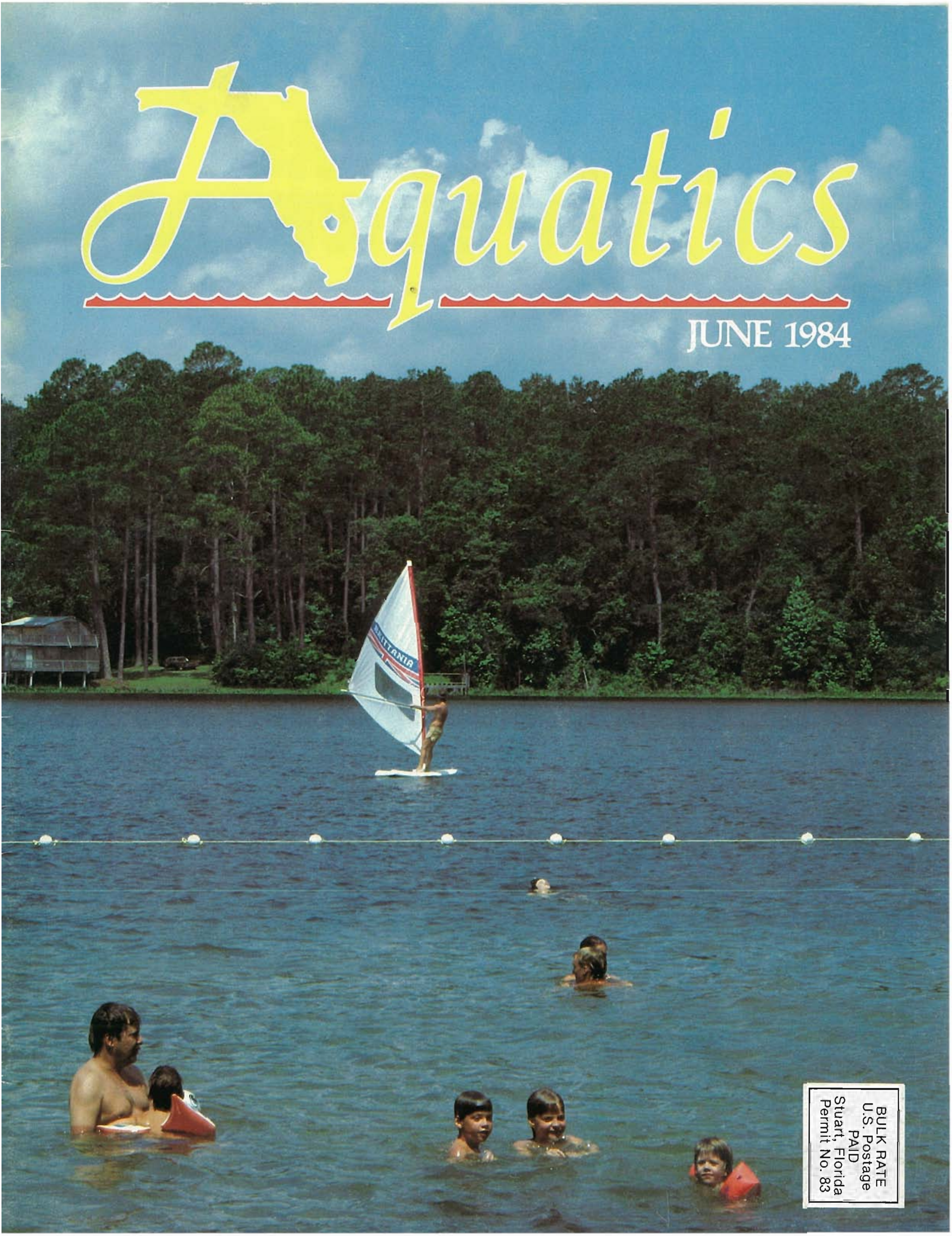
# Aquatics

JUNE 1984



## EDITORIAL

*Unfortunately, most important economical issues as well as environmental issues are driven and controlled mostly by politics. To say that surface water, wetlands and ground water concerns are politically hot is similar to calling Lake Okeechobee a good sized pond. In the past, we in Florida have had our share of controversy deciding what agency is responsible for directing aquatic weed control activities. Finally the E.P.A., Florida Dept. of Agriculture, Fla. D.E.R., H.R.S., Fla. Game & Freshwater Fish Commission, DNR, State universities, water management districts and even fish camp owners came to the American Assembly Conference in 1979. They structured an aquatic weed management lead agency to end the battle between DNR and the Fla. Game and Fish Commission. The solution consisted of DNR being the lead agency and would control permitting and funding of aquatic plant weed activities. None of DNR's trust fund was to go to the Commission. The Fla. GFC would be out of the aquatic weed business except in dealing in biological agents. Resolved — right? Wrong.*

*Each year since then the Game Commission mysteriously receives a very substantial portion of DNR's trust fund budget. It started with approximately $300,000 and now has grown to $400,000. DNR does* **not** *make the transfer voluntarily nor does the Game Commission reportedly "seek" the funding. How and why does the transfer happen? Legend has it that a "good fairy" is on the Governor's staff and makes this annual delivery. Why?*

*If the Game Commission desires to work with new exotic fish each year and use DNR money on a dual permitting system then they should use their own funds, not DNR's aquatic weed trust fund money which is needed for weed control.*

*Aquatic managers in Florida are often referred to as rabble rousers — because many are. Maybe we just want things done right and above board in order that the public be properly served.*

## THE COVER

Summertime is here. Water recreation is the way to go on Lake Hall, McClay Garden in Tallahassee. Photo by David P. Tarver

Aquatics

FLORIDA AQUATIC PLANT MANAGEMENT SOCIETY, INC. ESTABLISHED 1976

JUNE 1984/Volume 6, NO. 2

# CONTENTS





AQUATICS: Published quarterly as the official publication of the Florida Aquatic Plant Management Society. This publication is intended to keep all interests informed on matters as they relate to aquatic plant management, particularly in Florida.

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# Spikerushes

by
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The spikerushes, genus *Eleocharis*, are included in the Cyperaceae or Sedge family. This is a large family of plants composed of 83 different genera with about 3,200 species distributed throughout the world. They are particularly abundant in the subarctic and temperate regions of both the northern and southern hemispheres. These plants are found in damp, boggy, marshy, or riparian habitats.

The Sedge family is characterized as fibrous-rooted grasslike herbs with very minute flowers subtended by chaffy bracts. These bracts are specialized leaves and the flowers arise from their axils. The stems, also commonly called culms, are mostly solid, often triangular, generally unbranched below the inflorescence (flower), and frequently leafless.

The spikerushes are separated from the other members of the Sedge family by the formation of a solitary terminal spikelet without obvious subtending bracts, hence the name spikerush. In some species the spike is thicker than the supporting stem below it while in others the spike is not distinctly thicker than the stem.

*Figure 1. Spike of* Eleocharis geniculata *with flowers and achenes. The distance between each bar is 1.0 mm.*

Physical aspects of the achenes (small dry indehiscent fruit with a relatively thin wall surrounding a single seed) are used to separate the species (Figure 1). The genus is also characteristically without leaves so that the culm carries on the photosynthetic activities of the plant.

The genus name *Eleocharis* is derived from the Greek 'hele' or 'helos' for marsh and 'charis' for grace as described by Robert Brown in 1810 (7). The name is actually closer to the Greek 'helodes' for marshy and 'charisma' for favor or gift.

At times this genus has also been called *Heleocharis.* This spelling has been rejected by most taxonomists but may occasionally appear in the literature. The species may also be called by the common name of hairgrass.

Some confusion exists in the literature as to the identification of the various spikerush species. In 1929 Svenson (7) separated the genus into 11 series each representing a natural group. Each group contained very similar appearing plants, and the grouping still provides a useful starting point for the identification of the spikerushes.

The species are difficult to identify because of their simple gross anatomical structure which consists primarily of a modified stem, the culm. The achenes must be examined for positive species identification, however they are so small that they must be examined microscopically to distinguish their characteristic markings.

Long and Lakela (3) list seven species occurring in south Florida, and Godfrey and Wooten (1) list 33 species present in the southeastern United States of which 29 are listed for Florida.

Those spikerushes which are listed as occurring in the Panhandle of Florida include *Eleocharis interstincta* (Vahl) R. & S.; *Eleocharis robbinsii* Oakes; *Eleocharis radicans* (A. Dietr.) Kunth; *Eleocharis acicularis* (L.) R. & S.; *Eleocharis obtusa* (Willd.) Schultes in R. & S.; *Eleocharis olivacea* Torr.; and *Eleocharis tortilis* (Link) Schultes in R. & S. Those found throughout Florida include *Eleocharis quadrangulata* (Michx.) R. & S.; *Eleocharis elongata* Chapm; *Eleocharis cellulosa* Torr.; *Eleocharis montana* (HBK.) R. & S.; *Eleocharis flavescens* (Poir.) Urban; *Eleocharis geniculata* (L.) R. & S.; *Eleocharis atropurpurea* (Retz.) Kunth; *Eleocharis fallax* Weath.; *Eleocharis baldwinii* (Torr.) Chapm.; *Eleocharis parvula* (R. & S.) Link; *Eleocharis rostellata* Torr.; *Eleocharis nigrescens* (Nees) Steud.; *Eleocharis melanocarpa* Torr.; *Eleocharis minima* Kunth; *Eleocharis microcarpa* Torr.; and *Eleocharis albida* Torr.; *Eleocharis montevidensis* Kunth; and *Eleocharis vivipara* Link. A few species such as *Eleocharis equisetoides* (Ell.) Torr.; *Eleocharis tuberculosa* (Michx.) R. & S.; and *Eleocharis nana* Kunth are found primarily in the central to the northern portion of the state. *Eleocharis tricostata* Torr. is found in north Florida.

*Figure 2. An airboat trail cuts through an extensive stand of* Eleocharis cellulosa *in Lake Okeechobee.*

In south Florida *E. microcarpa* is present in the Fisheating Creek area near Lake Okeechobee, and *E. baldwinii* is found in many canals. Both of these plants grow submersed and may be confused with some of the small-leaved pondweeds or naiads.

During the 1982 survey for

continued on page 9

# AQUATIC HERBICIDE BREAKTHROUGH


Sonar EPA Experimental Use Permit No. 1471-EUP-67


At last there's a new generation aquatic herbicide that manages a host of undesirable vascular plants without mismanaging the good life. Sonar® from Elanco.

## Weed management.

One treatment of Sonar provides control during the critical growing season of many submersed and emersed aquatic weeds. Weeds controlled include hydrilla, elodea, water milfoil, pond weeds, torpedograss, paragrass, southern naiad and numerous other troublemakers.

Hydrilla

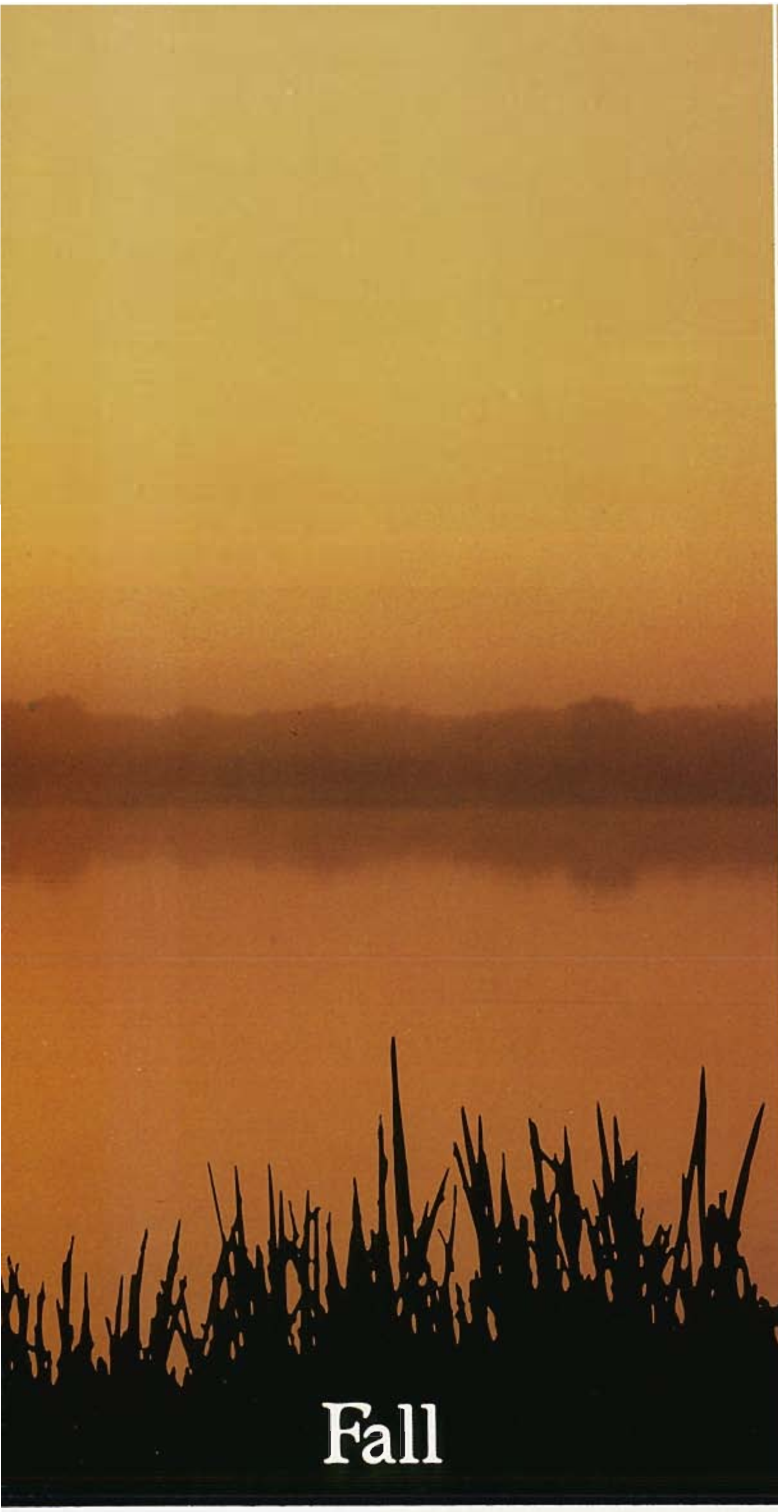
When you make Sonar part of your weed control program, you get effective management of your valuable water resources.

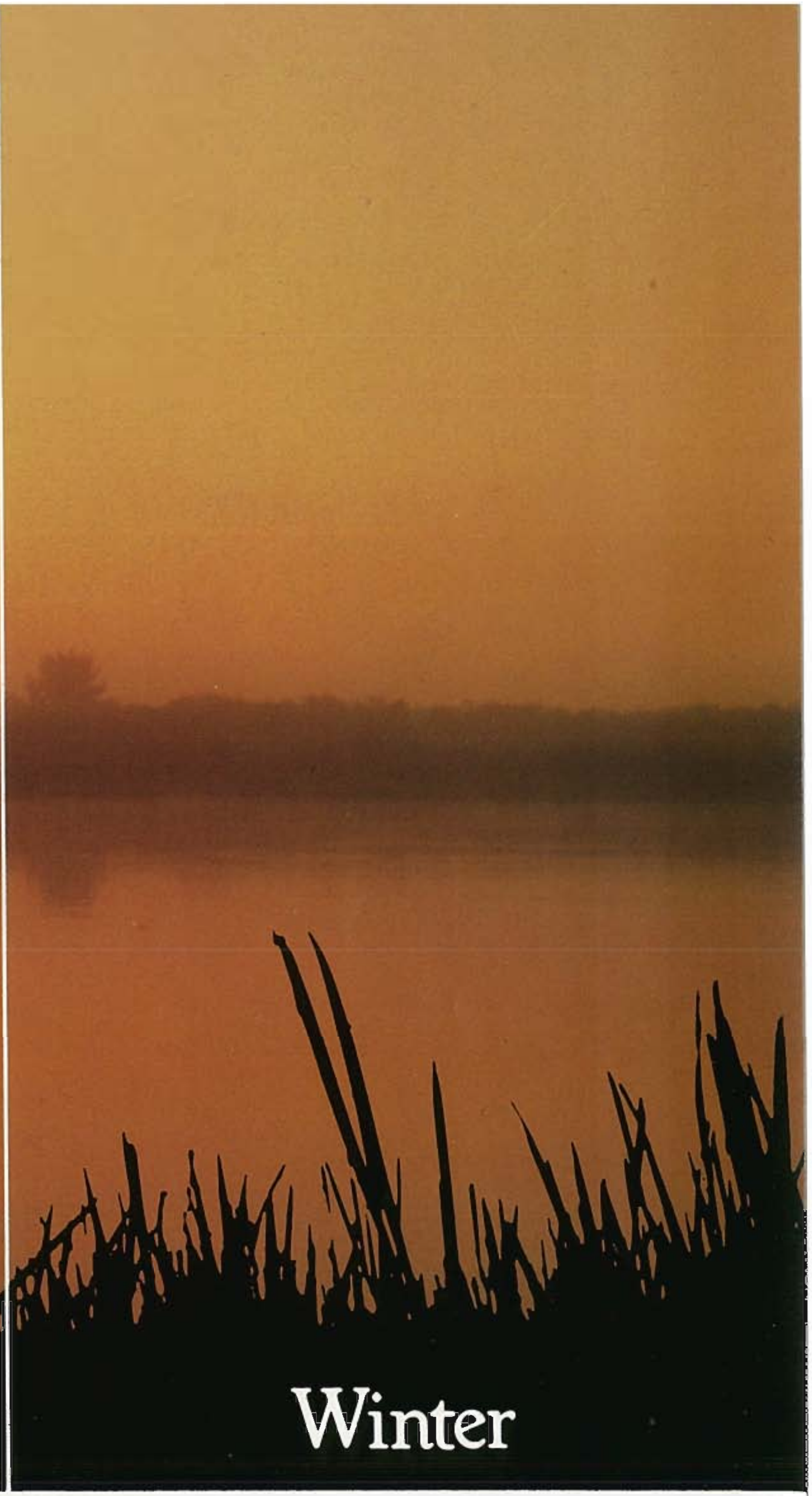
Elodea

## Slow but sure action.

Four to six weeks after treatment, Sonar takes its toll on undesirable vegetation. And because of its slow action, there is no rapid oxygen depletion. This makes Sonar highly compatible with the aquatic environment and makes fish kills a thing of the past. Applied as directed, Sonar will not harm fish,

Water milfoil



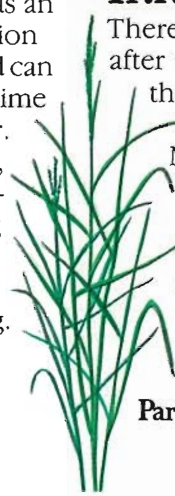

wildlife, or nearby trees and shrubs.

## Flexible application.

Sonar can be applied to the entire surface of a pond or up to ten percent of larger bodies of water. Depending on existing equipment and user preference, Sonar is available as an aqueous suspension or 5% pellet and can be applied any time during the year. For best results, the label recommends applying Sonar when weeds are actively growing.

Pond weeds

Torpedograss



Paragrass

## Inherent value.

There are few restrictions after application, and they are detailed on the product label. Make Sonar part of your management program. It's the simple, gentle way to put nature back in balance.

water flow, navigation, and general water use.

In south Florida spikerushes may be seen growing along the edges and shallow water areas of canals when submersed weeds are controlled. Under these conditions the spikerushes are generally not considered as problems.

Little information is available on the control of spikerushes. In general, they are somewhat resistant to most herbicides and their control requires high rates of those chemicals used for submersed weeds. □

**Acknowledgment**

Partial support for studies on the spikerushes is being supplied by the U.S. Department of Agriculture, Agricultural Research Service (ARS) through their Cooperative Agreement No. 58-7B30-0-177.

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# Male-flowering Hydrilla is Triploid in North Carolina

by
[1]Steve M. Harlan
[1]Graham J. Davis
[2]George J. Pesacreta

Hydrilla (*Hydrilla verticillata*) growing in lakes in Wake County, North Carolina, was identified by William Haller in 1980 and had apparently been established in the area for several years. In September 1982 Dr. Thai K. Van identified staminate (male) flowers on plant material being maintained at Fort Lauderdale, Florida, which was originally obtained from Washington, D.C. (Vandiver et al. 1982). Following Van's identification of male flowers in Florida we established that male flowers were being produced in North Carolina at the same time.

Two different hydrilla genotypes have been found for the United States based on chromosome counts and isoenzyme studies (Verkleij et al. 1983). USA hydrilla II (2N=16) has been found in Washington, D.C., Maryland, and Delaware while USA hydrilla I (2N=24) has been found elsewhere (except for a tetraploid in Alabama). Formerly, male flowers were only considered to be associated with diploid plants (USA hydrilla II); however, chromosome counts on North Carolina male-flowering populations thus far indicate that they are triploid.

Hydrilla in North Carolina (2N=24) and USA hydrilla I in Florida (2N=24) evidently have different phenologies. Tuber production in North Carolina begins in late June and continues to early November whereas in Florida (USA hydrilla I) this occurs from October to May (Haller 1978). Although floral initiation appears to coincide with tuber production in both North Carolina and Florida, male flowers have not been observed on Florida plants. Hydrilla in North Carolina (2N=24) and USA hydrilla II (2N=16) are similar in that both produce male flowers and tuber production in USA hydrilla II begins by August in Delaware (Joe Joyce, personal communication). Until chromosome counts were made, we assumed that North Carolina hydrilla would be the "northern" variant (USA hydrilla II). Apparently this is not the case.

During the summer of 1983 male flowers were found in all four lakes studied in North Carolina (Lakes Anne, Wheeler, Crabtree, and Big Lake). Plants collected from all study lakes appeared to be monoecious (male and female flowers on the same plant). Female flower production began in early to mid-July and continued to late October. Male flower production was evident by mid-August and also continued to late October. Flower density was 140-165 per $m^2$ for female flowers and 70-130 per $m^2$ for male flowers. Neither fruits nor seedlings have been found.

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Haller, W. T. 1978. Hydrilla: A new and rapidly spreading aquatic weed problem. Inst. of Food and Agr. Sci. Circular S-245, University of Florida, Gainesville. 13 pp.

Vandiver, V. V., T. K. Van, and K. K. Steward. 1982. Male hydrilla recently found in the United States. Aquatics 4:8.

Verkleij, J. A. C., H. P. M. Staphorst, and K. K. Steward. 1983. Identification of two different genotypes of *Hydrilla verticillata* (L.fil.) Royle in the USA by means of iso-enzyme studies, pp. 251–261. *In* Proc. Int. Symp. Aquat. Macrophytes, Nijmegen, The Netherlands. □

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# Waterhyacinth Control In California

## by Larry Thomas
## Co-Author Dr. Lars Anderson

### Sacramento-San Joaquin Delta

The Sacramento-San Joaquin Delta, originally a tidal marsh formed in an overflow area of the Sacramento and San Joaquin Rivers, is generally considered to be the area bounded by the City of Sacramento on the north, the City of Stockton on the east, the City of Tracy on the south, and the Suisun Bay on the west. Prior to 1910, the Delta area was utilized primarily for livestock grazing; however, by 1924 after more permanent levees were constructed, the Delta became one of the major cropland areas of California, producing agricultural commodities worth in excess of $400 million in 1981. The Delta includes approximately 270,000 acres of farmland considered to be one of the most fertile agricultural areas in the United States, containing 100 tracts and islands with the land surface ranging from 20 feet above sea level to 25 feet below sea level. The area is unique in that it is both a prime agricultural and recreational area as well as an invaluable fresh water resource and an important producing area of high quality natural gas.

The Delta, with approximately 150 marina facilities, provides a unique recreational opportunity for the entire State of California accounting for about 80 million dollars of recreational expenditures annually while providing 12 million recreational days for the public.

The Delta has approximately 700 miles of channels and sloughs which are utilized very heavily for navigation and irrigation. The Sacramento and San Joaquin River channels within the Delta are maintained for deep draft navigation to the cities of Sacramento and Stockton respectively. The remaining waterways of the Delta have water depths ranging from 5 to 10 feet at low water and are heavily used by both the boating public and the general public.

The Delta also plays a major role in the State of California's water transport system. Water storage in the foothill and mountain areas of northern California is released through the Delta during low flow periods. One-third of California (64,600 square miles) drains through the Delta area with outflow varying from 10 to 46 million acre feet annually with an annual average of 20 million acre feet. The major north to south water export point is on Old River near the City of Tracy where both the State of California and the Federal Bureau of Reclamation pump water from the Delta for export to the south. During periods of low flow in the Delta, this water exportation from the southern part of the Delta actually creates a reversal of flow in Old River downstream from the pumping plants as well as in other waterways of the Delta.

Additionally, Delta waters also support a large population of resident fish and anadromous fish ascending and descending the Sacramento, Mokelumne, Stanislaus, Calaveras, and San Joaquin River systems. The California Department of Fish and Game estimates that 25 percent of the State's warm water and anadromous sportfishing and 80 percent of the commercial salmon catch is dependent upon the Delta.

### Background and History of Waterhyacinth Introduction

Waterhyacinth plants have been known to exist in California as early as 1904 when their presence was discovered in Yolo County in a slough near the City of Clarksburg. By 1947, waterhyacinths had become a problem in some areas of the Sacramento-San Joaquin Delta. The Bureau of Reclamation experimented with methods of chemical control and actually made some chemical applications in Rock Slough west of Delta Road. In 1972, the Army Corps of Engineers was asked to investigate, as a possible flood hazard, the blockage of the Merced River by waterhyacinths. The Corps indicated their subsequent investigation did not reveal a flood hazard. The problem occurred again in 1973; however, the Corps did not feel they could economically justify implementation of a long-term control program utilizing the herbicide 2,4-D but did recommend and offer to participate in an annual investigation of the river.

From 1973 until the drought years of 1976-77, there are very few recorded problems with waterhyacinths in the Sacramento-San Joaquin Delta or the San Joaquin River drainage basin.

Following and possibly because of the drought years with their resultant reduced flows through the drainage areas upstream of the Delta, the annual flushing of hyacinth plants through the system did not occur. The resultant increase in over-wintering plant material allowed sudden and severe summer growth which became an immediate and publicly apparent problem to the varied users of the Sacramento-San Joaquin Delta region.

The outcry of those impacted by the waterhyacinth population brought about the introduction of Senate Bill 1344 on January 13, 1982, authored by Senator Garamendi and co-authored by Assemblyman Patrick Johnston.[1] SB 1344, which became effective immediately upon signature by the Governor on June 14, 1982, appropriated $125,000 from the Harbors and Watercraft Revolving Fund to the Department of Boating and Waterways as the designated lead agency to implement a short-term program for waterhyacinth control and develop a long-range control program for the Sacramento-San Joaquin Delta and the Suisun Marsh.

In July, 1982, the Department formed a Waterhyacinth Task Force comprised of representatives of those agencies either most directly affected by the waterhyacinth problem or those having expertise in the area. Listed below are the agencies and their respective representatives.

**State Agencies**

- Department of Boating & Waterways: Bill S. Satow/Larry J. Thomas
- State Water Resources Control Board: Doug Albin/John Cornacchia
- Central Valley Regional Water Quality Control Board: Wilton Fryer/Rudy Schnagl
- Department of Food & Agriculture: James Wells
- Department of Fish & Game: Brian Finlayson
- Department of Health Services: Richard McMillan/Robert Hultquist

**Federal Agencies**

- U.S. Department of Agriculture, Agricultural Research Service Aquatic Research Laboratory at U.C. Davis: Dr. Lars Anderson
- U.S. Bureau of Reclamation: Carl Tennis

**Local Agencies**

- San Joaquin County Agricultural Commissioner: Erwin Eby
- Contra Costa County Agricultural Commissioner: John H. deFremery

The purpose of the task force was to develop the conditions under which herbicides could be applied and the protocol for water quality monitoring to ensure that an economical and environmentally safe program was undertaken.

**Control Plan**

Long before the legislation was signed by the Governor, a series of meetings was held with State, Federal and local governmental agencies, private citizens groups, and the general public to determine the extent of the problems and to gather information relative to possible control measures. During this problem assessment period, a considerable amount of time was expended by the Department evaluating various control methods. The Department asked the Corps of Engineers' Waterways Experiment Station (WES) to develop both a short and long term control plan. A draft of this plan was available in April 1982 and was then presented to the appropriate Federal and State agencies for review and comment. Very little revision was necessary, and the final plan was submitted to the Department on May 3, 1982.

The plan developed by WES recommended an integrated program utilizing chemical, mechanical and

[1]Assembly Joint Resolution No. 64, authored by Assemblyman Patrick Johnston and filed with the Secretary of State on June 11, 1982, requested the U.S. Army Corps of Engineers to cooperate with the State in undertaking an aggressive program for waterhyacinth control.

biological control measures (a detailed biological control plan was submitted later with specific sites identified for release and monitoring of biological agents).

The recommended short-term measures were to utilize mechanical and chemical means with the introduction of biological agents to provide the long-term control. Theoretically, as the biological agents become established, the need for chemical and mechanical controls can be reduced with a resultant decrease in the cost of the program.

**Mechanical Methods**

The WES plan identified several possible mechanical control measures, such as in situ chopping of the plants and/or mechanized removal as well as the use of barriers to retain or to redirect the movement of the plants. The Department staff met with numerous people to review the various mechanical means that might be possible for physically removing hyacinths from the Delta. However, it became apparent after investigating the mechanical removal methods and the costs associated with this type of control that the Department did not have the funding capability to carry out a sufficiently large removal program. The use of barriers, on the other hand, did appear to be a low cost mechanical measure that could have a significant benefit.

A test barrier was installed in Fourteen Mile Slough in the fall of 1982 to evaluate the feasibility of this method. This test indicated that barriers could, in fact, be successfully utilized to retain material in the nursery areas and prevent large masses of floating plants from blocking the navigable channels until the winter high flow period in the Delta. This concept is also being used to retain hyacinths in selected areas to provide habitat for the biological agents.

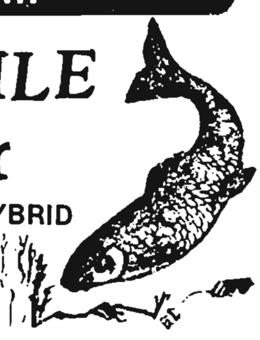
**Chemical**

The use of herbicides was identified in the plan as the major part of the short-term control program. The herbicides registered for use in California for this purpose in the summer of 1982 were Weedar 64® (2,4-D) and Diquat®. In the summer of 1983, Rodeo® (a formulation of glyphosate) was also registered. The chemical control program was to use 2,4-D wherever possible and to use Diquat® in those areas where 2,4-D could not be used.

Because the waterhyacinth control program was an entirely new program for the State of California and because of the multiple use of the Delta waters, it was necessary to develop a sophisticated water monitoring program for each herbicide application to be absolutely certain the label requirements were met and to build public confidence that herbicides could be used to control the hyacinth infestation without any degradation of the existing water quality. Therefore, in the summer of 1982 under the direction of Dr. Lars Anderson of the USDA/ARS Aquatic Weed Control Research Laboratory, two types of tests were conducted to determine the amount of 2,4-D or Diquat® that would enter the water following application of these herbicides for control of waterhyacinth. In one type of test, the actual amount of herbicide that reached the water surface after passing between waterhyacinth plants (or in some other way penetrating between foliage) was determined by using "floating" bottle samplers that were placed beneath the waterhyacinth canopy at the water surface. These float samplers contained known amounts of either distilled water or Delta water and were retrieved after application of 2,4-D or Diquat® in a test area. The amount of 2,4-D or Diquat® was then determined by standard analytical methods.

In the second type of testing, water samples were taken before and at various times after application of the herbicides to waterhyacinth mats. The locations of these water samplings were made so that the amount of herbicide entering the water immediately adjacent to the mats and at various distances downstream could be determined. The results from the first type of testing indicated that from 8 to 12 percent of the amount of herbicide applied to the plants was able to reach the water surface. These tests also





indicated that, in the case of Diquat®, very little residue was detectable in the float samplers containing Delta water. This is primarily due to the rapid adsorption of Diquat® to dissolve and particulate organic materials in the Delta water. The results of the second type of testing showed that occasionally 2,4-D residues of 5 to 15 or 20 ppb were found immediately adjacent to the sprayed waterhyacinths, and that downstream, even less than one-fourth of a mile, levels were generally non-detectable or below 10 ppbw.

The information gained by these tests during 1982 was used to develop the monitoring and water sampling protocol for the operational program in 1983. Through the cooperative agreement between WES and the Department, in the fall of 1982, WES staff persons implemented larger scale field tests using both 2,4-D and Diquat® to determine the efficacy of the herbicide program developed by the task force and what residues could be anticipated. During this test period, a series of 1, 2 and 5 acre test plots were treated with 2,4-D using approximately 4 pounds per acre. Again, water sampling and analysis conducted by the USDA/ARS Aquatic Weed Laboratory indicated that the maximum level of residue found during this test was 13 ppb. Larger test areas were treated with Diquat®; however, these tests were primarily to determine the effect on late summer growth because the earlier tests by Dr. Anderson indicated that Diquat® residue is tied up so quickly due to the clay particles and organic material in the water that residue a few yards from the application site was non-detectable. The results of these tests and the water data gathered from them were used as the major data source in establishing the 1983 control program.

**Biological Agents**

Meetings were held with biological control specialists from the U.S. Department of Agriculture, WES, and the California Department of Food and Agriculture to determine which biological agents were effective in waterhyacinth control. The decision was made to initially introduce *Neochetina bruchi*, a small, host-specific weevil. Dr. Lloyd Andres, Research Entomologist with the USDA/ARS in Albany, California, had done experimental work with this weevil and was familiar with the necessary background data that must be available to the reviewing agencies before permission could be obtained to import a non-native biological control agent into California. Therefore, he agreed to make inquiries of the control agencies. After receiving the necessary clearances from the controlling agencies and importing sufficient numbers of weevils, a positive identification and checks for any possible diseases were made. The weevils were maintained on waterhyacinth at the ARS Aquatic Weed Laboratory for several weeks before the first releases of the waterhyacinth-eating weevil, *Neochetina bruchi*, were made in Old River on July 2, 1982, with a second release on July 15.

Following the initial releases of *Neochetina bruchi*, Dr. Andres also obtained permission to introduce *Neochetina eichhorniae* and *Sameodes albiguttalis*. The weevils, *Neochetina bruchi* and *Neochetina eichhorniae*, were all collected from the field by WES personnel and then imported by Dr. Andres where they were positively identified and checked for pathogens before they were released into the nursery areas of the Delta. The *Sameodes albiguttalis*, a moth species, is being raised in the laboratory of the State Department of Food and Agriculture by the Biological Control Unit personnel and is then released into the selected sites.

The *Neochetina bruchi* have over-wintered in California and are spreading from the initial release sites. The other biological agents have not been in the field long enough to determine if they will over-winter and reproduce; however, it is anticipated that they will.

**The 1983 Program**

In developing the 1983 program, because of the limited funding, it was apparent that the most economical control method would have to be employed if any degree of control could be expected and, further, this control would have to be directed only at known problem areas. After discussions with WES, it was determined that a chemical control program would be the most cost efficient plus a limited amount of mechanical control. The mechanical means to be employed would be the mechanical barriers rather than mechanical removal of the plant material. Additionally, continued releases of the biological agents were scheduled for four sites, with a subsequent release the latter part of October 1983 in a fifth site.

The major area of waterhyacinth infestation in the Delta is that area bounded on the north by State Highway 12, on the south by Old River, on the east by Interstate 5, and on the west by the Sacramento River. This large area was divided into four approximately equal smaller areas for herbicide treatment. Each of the smaller areas was assigned a team to be responsible for that specific area.

In California, permits are required from the County Agricultural Commissioner before the restricted herbicide 2,4-D can be applied, and the permit must be "site" specific. Based on the amount of hyacinths that might be expected in any specific area and the water data gathered in the 1982 field tests done by Dr. Anderson and WES, the major infestation area was divided into 2 to 3 mile "sites." Prior to any chemical applications being made, an overall county permit was obtained from each Agricultural Commissioner; and, before field operations began in any site, a Notice of Intent was filed for each site at least 24 hours prior to application of herbicide. Although the process may appear to have been rather cumbersome, in actuality it went very smoothly and did not delay the program.

During the field operations, a control team could treat a maximum of five acres per "site" and then had to bypass an adjacent site before beginning treatment again. The rationale for this limitation was based on the water data obtained from the 1982 field work done by Dr. Anderson and WES as a means to insure a wide safety margin. The Task Force felt confident that the water residue would be minimal if a maximum of five acres per site were treated.

During the chemical control effort, Dr. Anderson's staff, under the field direction of Robert Pine (ARS) took samples of the water before and immediately after each herbicide application and per-

EXAMPLE
Summary of 2,4-D Residues in Sacramento Delta

| Date | Location | Site | Time | 2,4-D (ppb) | |
|---|---|---|---|---|---|
| 6/1/83 | Paradise Harbor | Pre | 0900 | 1A | 0.1 |
| | | | | 1A | 0.2 |
| | | | | 1B | 0 |
| | | Post | 0957 | 2A | 0.4 |
| | | | | 2B | 0.2 |
| | | | | 2C | 0 |
| | | | 1159 | 3A | 1.5 |
| | | | | 3A | 0.9 |
| | | | | 3B | 0.3 |
| | | | | 3B | 0.1 |
| | | | | 3C | 0.4 |
| | | | | 3C | 0.7 |
| | | Pre | 1330 | 1A II | 0 |
| | | | | 1B II | 0 |
| | | Post | 1408 | 2A II | 0 |
| | | | | 2B II | 0 |
| | | | | 2C II | 0 |
| | | Post | 1510 | 3A II | 0 |
| | | | | 3B II | 0 |
| | | | | 3C II | 0.8 |
| | | | | | 0.7 |

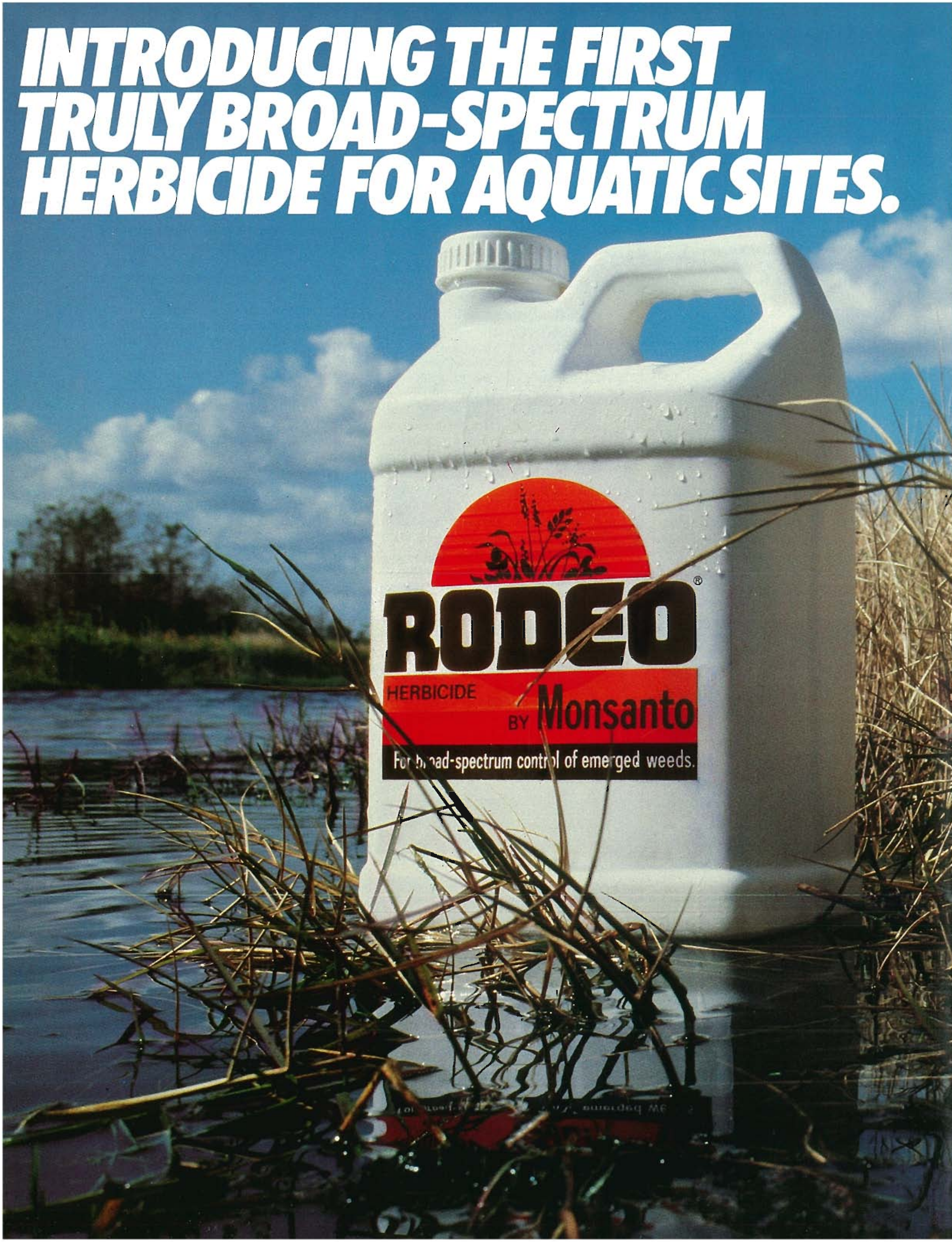
formed the water analysis for 2,4-D. Throughout the chemical control effort, the water analysis detected only minimal (if any) residue that was well below Federal tolerances of 100 ppbw. An example is shown in the following table.

The County Agricultural Commissioner's staff provided field data regarding the specific location of any sensitive agricultural crops. Because of their input into the waterhyacinth control program, there was no reported damage to any agricultural commodity in any county.

**Environmental Concerns**

When the use of herbicides was proposed as the major short term control method, the Contra Costa Water District became concerned because the water district extracts water from Old River at Rock Slough and transports the water across the Delta to the East Bay for use as a domestic water supply to several cities. Throughout the discussion of the use of herbicides to control waterhyacinth in the Delta, the representatives of this district had expressed their concerns relative to the use of 2,4-D in the Delta and in particular anywhere close to Rock Slough. The California Department of Health Services wrote a letter to the Contra Costa Water District which indicated that they felt 2,4-D could be used safely and that their opinion was based on water analyses from earlier test plots as well as their experience in working with 2,4-D. The Health Department stated that they felt the residue would be minimal or non-detectable. In addition, the water treatment facilities use activated charcoal in treating the water for domestic consumption which will remove any 2,4-D from the water. However, the district still expressed concern so an agreement was reached whereby no spraying would occur in Rock Slough or in Old River one mile above or below the intersection of Rock Slough and Old River or in Werner Dredger Cut north of the railroad track at Orwood Resort.

Throughout the 1983 program, beginning in the late spring, there were a number of environmental concerns raised by some State legislators, local political leaders, the Contra Costa Water District and a few private citizens in Contra Costa County. Those few private citizens petitioned the Superior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RODEO®
HERBICIDE
BY Monsanto
For broad-spectrum control of emerged weeds.

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| | | |
|---|---|---|
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| CATTAIL | MAIDENCANE | SPATTERDOCK |
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*Partial Control.

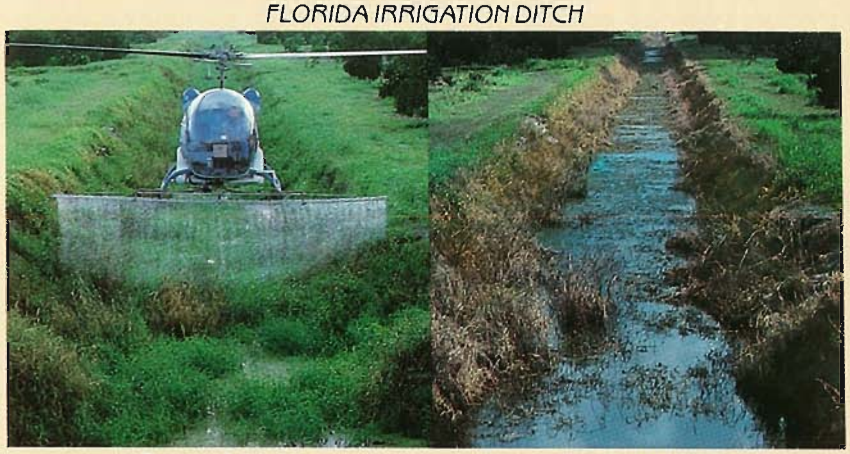
Now there's <u>one</u> aquatic herbicide that can handle a broad spectrum of obstructive emerged weeds. New Rodeo® herbicide† keeps the constant spread of even your toughest weeds within manageable limits, from perennial grasses like torpedograss and paragrass, to broadleaf weeds like alligatorweed, to brush species like willows. In fact, Rodeo does the job of many aquatic herbicides, controlling more than 90 kinds of weeds, roots and all.

When applied with surfactant[I] to the foliage of emerged, labeled weeds, Rodeo translocates to the root system, destroying the entire plant.

**RODEO KEEPS WEEDS IN CHECK, LEAVES NATURE IN BALANCE.** Rodeo is compatible with your environmental standards. When applied according to label directions it is virtually non-toxic to mammals, birds and fish. Rodeo breaks down into natural products and does not bioaccumulate in the food chain. What's more, Rodeo has no residual soil activity so it won't leach into non-target areas.

**RODEO CLEARS THE WAY IN FLOWING OR STANDING WATER.** You can use Rodeo in most aquatic sites, in recreation or utility areas, in flowing or standing water. This includes canals, ditches, lakes, rivers, streams and ponds.[II]

FLORIDA IRRIGATION DITCH



Treated 10/21/82 — Results 11/23/82

Get to the root of your toughest weed problems with this truly broad-spectrum aquatic herbicide. Ask your herbicide dealer for details about how Rodeo can make your waterways more manageable. Or call TOLL FREE for a technical manual on Rodeo, 1-800-621-5800.

†Label approval pending in California.

I. X-77 at 0.5% v/v.

II. Rodeo cannot be applied within a half mile upstream of domestic water intake points, in tide-water areas, or rice levees when flood water is present.

# RODEO. BROAD-SPECTRUM CONTROL FOR AQUATICS.

Monsanto

ALWAYS READ AND FOLLOW LABEL DIRECTIONS FOR RODEO.

continued from page 17

variety of substrates, from coarse gravel to fine organic soils. High yields result more from climate and nutrient availability than from the type of substrate in which they are growing. It is thought that most of the nutrients are derived from the soil, but when the stems are subjected to nutrient-enriched water, finely branched roots form on the lower portions and uptake from these structures probably is quite significant. Reed stands are often monospecific and the shading from the canopy is substantial, effectively reducing competition from other plants. The plant has a high leaf area index which allows for an efficient utilization of incoming radiation.

The Common Reed displays a great amount of morphological variability which is due to the plant's genetic diversity. Chromosome numbers vary greatly, from 2n=24 to 2n=96; the most common number is 2n=48. Even between adjacent clones there can be marked physical differences in appearance of the plants.

The plant has had a long history of use by man. Ancient Egyptians used the stems as building material for houses and rafts. In England and other European countries it has been used for many years as thatching (Figure 2). The Romanians have used the plant extensively, establishing large areas that have been under cultivation in the delta area of the Danube River since 1956. Most of the reeds are turned into pulp for the production of printing paper. Other products are cemented reed blocks, synthetic fibers, alcohol, fuel, cardboard, cellophane, insulation materials, and fertilizer. The annual harvests are very substantial and have become an important part of the Romanian economy. Scientists from Germany found the plant to

*Figure 2.*
*A building in Europe thatched with Common Reed (Photograph courtesy of David L. Sutton).*

be an effective biological filter for waste water renovation as have scientists from Australia. The Swedes have found the plant to be a viable alternative energy source. They compress the harvested aerial stems into bales, pellets, or brickets which are then burnt in modified furnaces.

High yields of this plant are dependent upon an array of environmental factors, two very important ones being nutrients and water. To exploit that fact, we initiated studies in south Florida for determining what sort of biomass yields we could obtain by growing the plants in high nutrient concentrations with unlimited water. This was accomplished by using composted sewage sludge as the growth medium and constantly irrigating the plants with secondarily-treated sewage effluent. Both of these are waste products which are enriched with nutrients. By the second year of growth, the plants were almost 5 m tall (see Figure 3) and harvests of the aerial stalks yielded an average of 95 metric tonnes dry weight per hectare per year. This approaches the reported values for waterhyacinth which is claimed to be the highest yielding

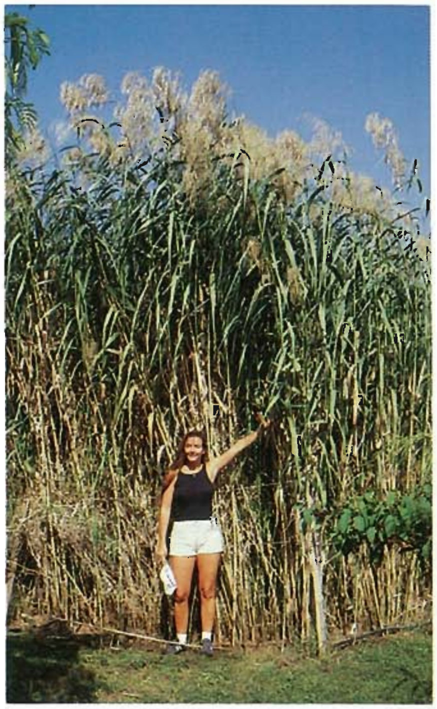


*Figure 3.*
*Common Reed grown in composted sewage sludge and irrigated with secondarily-treated effluent in south Florida.*

plant in the world. What is interesting about our results is that they are only for the above-ground portions of the plant which probably only constitute 25% of the total plant biomass. The remaining 75% is below-ground, giving rise to the next year's growth.

These preliminary results and knowledge of the reeds biology would indicate that this plant should have tremendous potential as an energy crop, an alternative to our dependency on fossil fuels. In addition, its wide dispersal and genetic variability (which should be able to be manipulated through genetic engineering) should give the plant universal appeal. □

# Herbicides and Hybrids

**Dr. John A. Osborne[1]**
**and**
**Ms. Janine L. Callahan[2]**

## INTRODUCTION

The hybrid grass carp, a cross between the male bighead carp, *Hypophthalmichthys nobilis* Rich. and the female grass carp, *Ctenopharyngodon idella* Val., has a characteristic low feeding rate associated with slow growth; feeding rates (consumption expressed as a percent of body weight per day) for 1980 hybrid grass carp have been reported to vary between 24% (Callahan and Osborne, 1983) and 35% (Hestand et al., 1983). Due to this low consumption rate, the hybrid grass carp, in most field trials in Florida, has been incapable of hydrilla control even when stocked at relatively high rates (118 fish metric ton$^{-1}$-fresh weight hydrilla) (Osborne, 1982$_a$). On the other hand, grass carp have been shown to eliminate

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hydrilla when stocked in spring at the rate of 20 1-year old fish metric ton$^{-1}$-fresh weight hydrilla. Since large grass carp (greater than 11 kg) have a feeding rate similar to the hybrid grass carp and much lower than 1-year old grass carp (Callahan and Osborne, 1983; Osborne and Sassic, 1979) and are known to control hydrilla when assisted with herbicide (Lake Jane, Orlando, Florida), it was thought that perhaps hybrid grass carp might be useful under similar circumstances, i.e. used as a bio-regrowth-control agent after vegetation reduction with herbicide. A herbicide-hybrid trial was undertaken in Blue Lake, Longwood, Florida to determine the feasibility of this approach.

**Methods and Materials**

Blue Lake, a 1.0 acre hydrilla infested pond, had been used as a test site for 1979 hybrid grass carp previous to this study (Osborne, 1982$_b$). Blue Lake was renovated with rotenone in August, 1979, to remove the wild fish before the 1979 hybrids were stocked. At the termination of the 1979 hybrid grass carp trial, Aquathol (150 lb/acre) was applied to the lake in June, 1981. The 1981 hybrid grass carp, purchased from J. M. Malone and Son Enterprises, were stocked into Blue Lake to start the herbicide-hybrid trial at the rate of 750 fish acre$^{-1}$ (80 fish metric ton$^{-1}$-fresh weight hydrilla) in November, 1981. Blue Lake was again treated with herbicide (Aquathol, 100 lb/acre and Diquat, 2 gal/acre) in August and September, 1982 to reduce the hydrilla biomass in order to remove the hybrids. The hybrids were removed with 0.1 ppm rotenone in October, 1982 (after 325 days). These fish were housed in an experimental pond on the UCF campus until February, 1983, at which time they were returned to Blue Lake (224 fish). An additional 65, 1981 hybrid grass carp were stocked into Blue Lake making a total of 289 hybrids (667 fish metric ton$^{-1}$-fresh weight hydrilla). After 209 days and following an application of herbicide (Aquathol K, 5 gal/acre) to reduce the vegetation biomass, the hybrid grass carp were removed in September, 1983 using 0.1 ppm rotenone.

The effect of the herbicides and hybrids on the hydrilla in Blue Lake was determined by monitoring the vegetation biomass on a bimonthly schedule (October, 1981-October, 1983) using the Osborne submersed aquatic plant sampler (APHA, 1981).

**Results**

Of the initial number of hybrid grass carp stocked in Blue Lake in November, 1981, only 41.1% remained by October, 1982; this accounted for an average loss of 42 fish month$^{-1}$. A total of 308 fish were removed from the lake. Since Blue Lake did not contain a wild fish population, the high mortality of the hybrid grass carp was probably due to genetic deficiencies caused by hybridization. The 1981 hybrids had a mean growth rate of 1.3 gm fish$^{-1}$day$^{-1}$ and a mean weight of 504.8 gm fish$^{-1}$; the growth rate of these fish was 28.2% faster than for the 1979 hybrid grass carp that had been previously stocked into Blue Lake (Osborne, 1982$_b$). For comparison, grass carp stocked into Florida hydrilla infested lakes generally have a growth rate approaching 15 gm fish$^{-1}$ day$^{-1}$. The mean total length of the 1981 hybrid grass carp increased from 18.3 cm to 34.7 cm within the 325 day trial. There was little variation between the size of individual fish.

The hydrilla biomass in Blue Lake at the time of the initial stocking of the 1981 hybrids was 1.88 kg m$^{-2}$-fresh weight (December, 1981). At this time, the hydrilla biomass began an immediate increase which continued throughout the 1982 growing season. By August, 1982 the hydrilla biomass had reached 3.99 kg m$^{-2}$-fresh weight, Figure 1. The percent frequency of occurrence (coverage) over the sampling period (December, 1981-August, 1982) was 100%. There was no indication of feeding by the 1981 hybrid grass carp on the hydrilla. It is suspected that the hybrid grass carp, being principally a leaf feeder (Osborne, 1982$_b$), probably stimulated the high rate of plant production in Blue Lake by causing the hydrilla to branch.

After herbicide was applied in September, 1982 the hydrilla biomass declined rapidly, Figure 1. It had decreased to 1.42 kg m$^{-2}$-fresh weight by October, 1982 at which time the 1981 hybrid grass carp were removed. The biomass continued to decline throughout the winter and was only 0.08 kg m$^{-2}$-fresh weight in February, 1983 when the 1981 hybrid grass carp

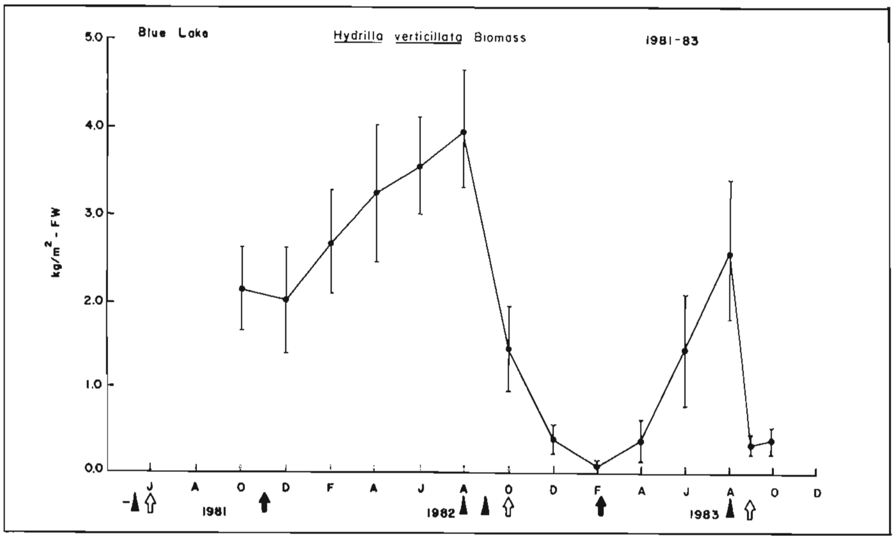


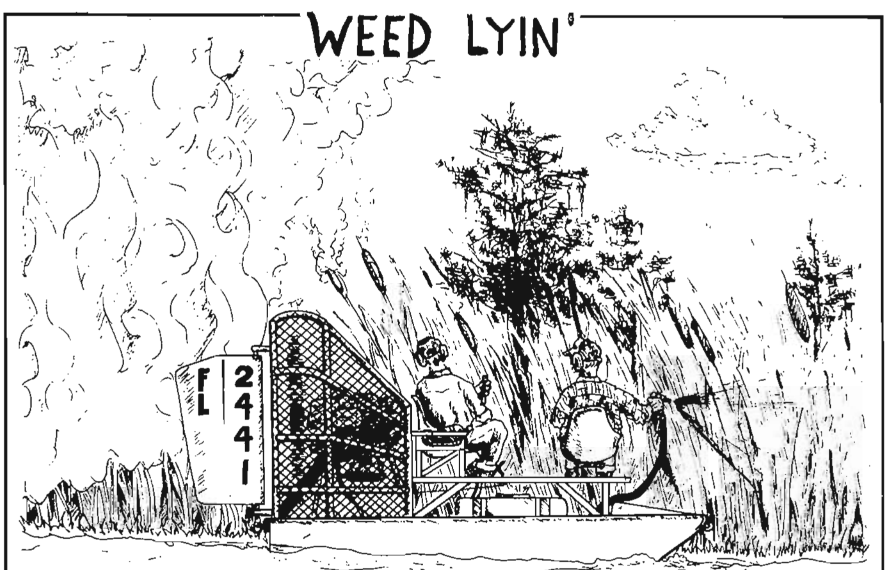

*Figure 1. Monthly mean fresh weight biomass for* Hydrilla verticillata *(L.f.) Royle in Blue Lake, October, 1981-October, 1983. Solid triangles=herbicide treatment, solid arrows=stocking of 1981 hybrid grass carp, open arrows=removal of hybrid grass carp.*

were restocked. The restocked 1981 hybrids had a mean weight of 490.5 gm and a mean total length was 34.4 cm. Even though their stocking rate (667 fish metric ton$^{-1}$-fresh weight hydrilla) was nearly 34 times higher than that required of grass carp to eliminate hydrilla (20 fish metric ton$^{-1}$-fresh weight hydrilla), the growth of hydrilla appeared unimpaired during 1983. The biomass of hydrilla rebounded during 1983 to reach 2.60 kg m$^{-2}$-fresh weight by August, 1983, Figure 1. From a comparison of the growth curves for the 1982 and 1983 growing seasons, it appeared that the growth rate of hydrilla was even higher during 1983.

The 1981 hybrid grass carp were removed in September, 1983; they had a mean weight of 1,098 gm and a mean total length of 45.0 cm. Their mortality was 45.7% (20 fish mo$^{-1}$). Of the fish that survived, their mean growth rate was 2.9 gm fish$^{-1}$ day$^{-1}$; 79% of the fish weighed less than 1,300 gm. The largest fish weighed 3,402 gm, while the smallest fish weighed 284 gm.

**Conclusion**

While it may be considered premature to make a decisive conclusion based upon the two field trials conducted in Blue Lake, it does appear (based upon the high stocking rates tested) that it would not be feasible to use the hybrid grass carp for hydrilla regrowth control in Florida. The Florida Game and Fresh Water Fish Commission utilizing 13 central Florida sites has arrived at a similar conclusion. Vegetation regrowth was only maintained in 5 of their 13 central Florida trials; the Florida Game and Fresh Water Fish Commission concluded that the use of hybrid grass carp for regrowth control produced inconsistent results (Hestand et al., 1983).

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**Acknowledgment**

The authors would like to thank Mr. Clark Hudson (Chevron Chemical Company) and Mr. William Moore (Penwalt Corporation) for the donations of the herbicides used in this study and Mr. Jim Malone for supplying the fish. □

**FAPMS Annual Meeting**

The annual meeting of the Florida Aquatic Plant Management Society will be held at the Plant City Holiday Inn October 23-25, 1984.

# AQUA-VINE

### DNR

Brian Nelson has accepted a different position within the Bureau of Aquatic Plant Research and Control. He currently has filled John Rodgers vacant position in the Survey and Permitting Section. Brian's former position in the Research and Technical Transfer Section has not been filled. John Rodgers moved to Tampa and established another field regional botanist position office.

### Bill Maier Leaves Florida

Bill Maier has left the Bureau of Aquatic Plant Research and Control to assume a position in sales with Monsanto. Bill is now living in Chico, California. He has always been active in promoting professionalism among aquatic plant applicators and for the entire aquatic plant control spectrum. As the first editor of *Aquatics*, Bill had a difficult task to get this magazine off the floor. Bill has also held most of the officer positions in the FAPMS at one time or another, including President. He will definitely be missed by all.

Bill's new address is P.O. Box 516, Chico, California 95927 Phone 916-894-5434.

### St. John's Water Management

Jim Wilmoth has left his position with the St. John's Water Management District to venture into private business. Jim has formed a private applicator company and is wished the best of luck.

### Letter to the Editor

Dear David:

A big hand for the March issue, I know it took a lot of work to get all the authors in line. The results are worth it.

I enjoyed the update on the problem species particularly the hyacinth problem and hydrilla. One of our people recently returned from the Sudan, his description of the hyacinth problem suggest that it is almost out of control.

Florida had made tremendous strides in containing hyacinth, this recent survey may suggest that "mother will take advantage of every opportunity to fill a void" constant vigilance and search and destroy programs remain our best defense.

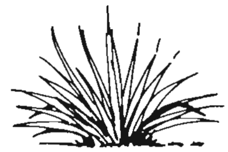
Once again I did enjoy the issue and will spread it around.

Best regards,
John E. Gallagher
Senior Product Specialist
Aquatics, Phenoxy & Non-Crop Chemicals
Union Carbide Agricultural Products Co., Inc.

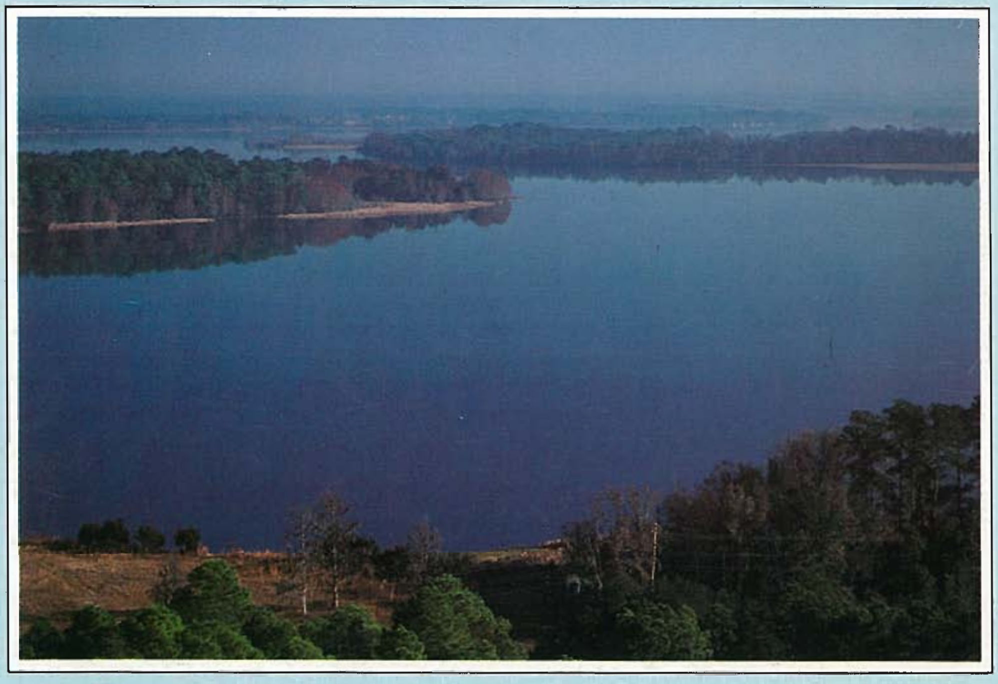
### Diquat Suspension Rescinded

The Florida Department of Natural Resources has rescinded its March 1, 1984 letter requesting aquatic plant managers to discontinue the use of all diquat products. Dr. Elton Gissendanner, Executive Director, states in his June 11, 1984 letter to aquatic plant permit holders, "After analyzing samples from diquat containers and field test sites monitored by the Department of Agriculture and Consumer Services, the Department of Environmental Regulation, this Department and two independent laboratories, it has been determined that Ethylene Dibromide (EDB) levels in diquat do not pose a significant environmental danger or hazard to human health when used in non-potable waters."

For further information contact the Florida Department of Natural Resources Bureau of Aquatic Plant Research and Control (904) 488-5631.



# Responsible aquatic weed management



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