

A close-up photograph of a dragonfly perched on a large, green, waxy leaf. The leaf is covered in small, clear water droplets. The dragonfly has a blue body and dark wings. The background is a soft-focus green.

# Aquatics

March 1991

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# Aquatics

March 1991/Vol. 13, No. 1



The overriding concern of Florida's aquatic plant management program has always been the need for continued adequate funding to manage the most severe aquatic weed problems. This is especially critical in light of recent results which provide the means for maintenance control programs for hydrilla.

The state's current budgetary crisis and changing governmental philosophy dictate that before seeking new tax revenues, best use of all existing resources must be assured. Are the goals and priorities which designated DNR the lead aquatic plant management agency and created the aquatic plant trust fund still guiding the program? Specific concerns are:

- Have the resources and emphasis of the Bureau of Aquatic Plant Management Bureau shifted from support to regulation?
- When funds decrease, as they have, should all programs which receive funding from the aquatic plant trust fund equally share budget cuts, rather than only operations?
- Do common state priorities for the aquatic plant management program exist?

Finally, many opinions exist concerning the organizational function and priorities of Florida's aquatic plant management program. These concerns should be discussed and resolved in an industry-wide forum. This forum was the Aquatic Plant Advisory Council. However, philosophical changes of the Department of Natural Resources management have made relationships more adversarial. The Council should never be a rubber stamp for governmental policy, but a forum to discuss the challenges that the water resource management industry faces. Once united, the challenges can be turned into opportunities to benefit the industry and the public.

—Wendy Andrew

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**About The Cover**  
Blue darner dragonfly on waterlettuce.

Photo by Gene Li, South Florida Water Management District, West Palm Beach

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# The Hydrocharitaceae or Frog's-bit Family

By  
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**Fort Lauderdale, FL**

## Introduction

**W**hy do hydrilla plants cause problems that are so difficult to control? Why would African elodea plants, were they introduced to Florida, be considered a major potential threat to the freshwater ecosystems of the state? For one, these plants belong to the Frogs-bit family or Hydrocharitaceae. Members of this family have been in existence over 70 million years, since the beginning of the Tertiary Era.

An understanding of common traits shared by plants of the

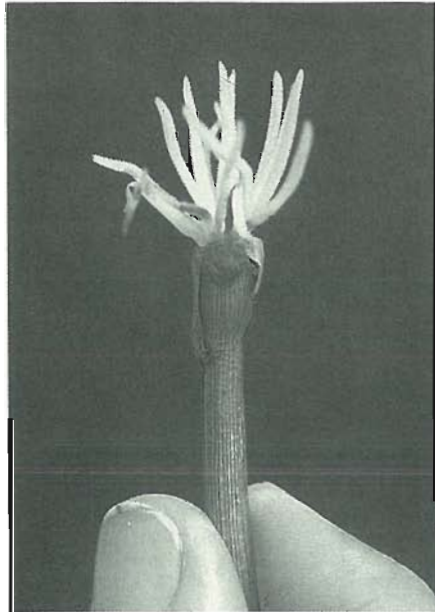


Figure 1. Female flower of American Frog's-bit showing the epigynous arrangement of the flower with the petals positioned above the ovary.

Hydrocharitaceae may provide some insight into strategies these plants have developed to ensure their survival over the millennia. A little herbicide here and a few grass carp there probably do not present major obstacles to the long-term existence of these plants.

## Classification

The Hydrocharitaceae is one of the most interesting aquatic plant families because of its diversity of species, flowering characteristics, and production of vegetative propagules. In the general classification of plants, the Hydrocharitaceae belongs to the monocotyledon group - these flowering plants characteristically having an embryo with only one cotyledon, flower parts usually in threes, leaves with parallel veins, and scattered vascular bundles.

The Frog's-bit family includes both salt and fresh water plants. The family is comprised of 16 genera with 80 to 90 species indigenous primarily to waters of the warmer regions of the world, with a few species extending into temperate climates.

The various genera of the Frog's-bit family have previously been separated by some taxonomists into four distinct families, the Elo-deaceae, Vallisneriaceae, Halophilaceae, and Thalassiaceae. However these genera share the single characteristic of epigyny (Figure 1), a type of flower arrangement where the petals, sepals, and stamens

grow upon the top or appear to grow on top of the ovary, suggesting a natural family unit, the Hydrocharitaceae. The differences among the genera allow the Frog's-bit family to be separated into five subfamilies: (1) Hydrocharitoideae, (2) Vallisnerioideae, (3) Hydrilloideae (=Elodeoideae), (4) Thalassioideae, and (5) Halophiloidae.

## Colonization and Naturalization

Species of the Frog's-bit family have been introduced to many countries around the world and are now naturalized in a number of them. Often these introductions have resulted in the plants becoming weed problems. Even though this family contains several species of some of the most troublesome aquatic plants in the world other species are widely cultivated for their ornamental value, especially for use in home aquaria. Some species in this family are among the most beneficial plants for aquatic systems because they enhance water quality, and provide shelter and nesting sites for a myriad of aquatic organisms.

## General Plant Characteristics

Species in the Frog's bit family are primarily floating and submersed plants with only a few species extending their leaves above the surface of the water. The leaves are radical, crowded, or dispersed on elongated stems, and alternate to opposite or whorled. The appearance of the leaves and stems varies to such an extent that individual species of the same genus may not resemble each other, while other genera contain species quite similar in their general appearance.

Genera of the Frog's-bit family of interest in Florida include (1) *Thalassia*, (2) *Halophila*, (3) *Ottelia*, (4) *Limnobium*, (5) *Lagarosiphon*, (6) *Blyxa*, (7) *Vallisneria*, (8) *Egeria*, (9) *Hydrilla*, and (10) *Elodea* (Table 1).

### 1. *Thalassia* - turtle-grass<sup>1</sup>

In Florida, turtle-grass is the only salt water seed bearing, submersed plant with ribbon- or strap-like leaves similar in appearance to eel-grass. The strap-like leaves are relatively resistant to the destructive forces of wave and under-water currents.

<sup>1</sup>All line drawings except *Lagarosiphon major* reprinted from Godfrey, R.K. and J.W. Wooten. 1979. *Aquatic and Wetland Plants of Southeastern United States: Monocotyledons*. University of Georgia Press, Athens 712 pp.

*Lagarosiphon* drawing reprinted from Ramey, V. (ed.). 1990. *Prohibited Florida Aquatic Plants*. Florida Department of Natural Resources, Bureau of Aquatic Plant Management, Tallahassee.





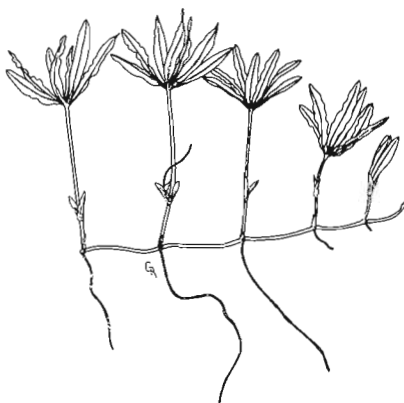
*Thalassia testudinum, plant*

Turtle-grass is found in coastal areas in water to a depth of just over 4 m and often forms extensive underwater mats. Flowering and pollination occurs under water.

**2. Halophila**

Plants of the genus *Halophila* are delicate, submersed, marine plants with horizontal rhizomes and leaves borne at the apex of short stems.

Two species are found in the lagoons, bays, and reefs of the Florida Keys. Male and female flowers are found on the same plant (monoecious), and sometimes both are in the same sheath. Flowering and fertilization occur under water in a manner similar to turtle-grass.



*Halophila engelmannii, plant*

**3. Ottelia**

Plants of the genus *Ottelia* are indigenous to Africa and Asia but have naturalized in Louisiana. These plants are separated from



*Ottelia alismoides, plant*

other members of the family because their very thin-textured leaves are mostly submersed and supported on long petioles. The leaf blades are ovate to broadly elliptical or reniform (kidney-shaped). The plants contain male and female flowers on the same plant. The flowers are fragrant and borne singly on a several-angled stalk.

These plants apparently are not yet present in Florida, nor is it known whether they pose a threat to the fresh waters of the state.

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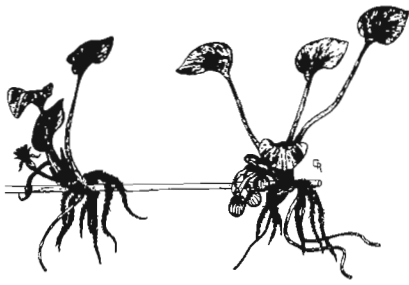
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*Limnobium spongia*, a portion of plant at flowering and fruiting stage

**4. Limnobium - Frog's-bit**

Members of this genus are perennial herbs commonly found floating in dense mats or rooted in mud in shallow areas. American Frog's-bit is native to Florida and generally not considered to be a pest plant. It may, however, form large floating mats which have the potential to cause local problems

American Frog's-bit is often confused with waterhyacinth (*Eichhornia crassipes* (Mart.) Solms) because of similar leaf shape and growth habit. However, American Frog's-bit can be readily identified by an examination of the young plants which often have a thick white to purplish spongy aerenchymatous layer of tissue covering the underside of the leaf. Also, American Frog's-bit does not have the typical swollen bulbous petiole of waterhyacinth.

Small male and female flowers borne on short stalks are found on American Frog's-bit. Although male and female flowers occur on the same plant, they develop at different times to prevent self-pollination. After pollination the female flower coils downward and seed development occurs underwater. New plants form from seeds or develop at the ends of runners.

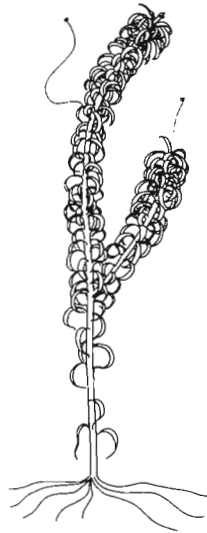
**5. Lagarosiphon**

This genus derives its name from the Greek word "lagaros" for thin and lanky, and "siphon" which means a tube. These plants are commonly called African elodea.

Species of this genus are native to Africa and Madagascar and they have been introduced to several countries around the world. *Lagarosiphon major* is considered to be the most noxious species of the group.

African elodea plants are very

similar in form and growth habit to hydrilla. In countries where these plants have naturalized, they cause problems similar to those of hydrilla. African elodea plants are presently not found in Florida, but are considered to be a major threat if they were introduced; therefore, they are banned in the state.



*Lagarosiphon major*, plant



*Blyxa aubertii*, plant

**6. Blyxa**

Members of the genus *Blyxa*, of which there are about 10 species, are submersed plants with a rosette growth habit and 20 to 50 leaves per crown. The species are indigenous to tropical areas of Asia and Africa. Leaves of these plants are narrow, sessile, pointed at the

apex, and may grow up to 1.5 m in length.

*B. auberti* is the best species for aquarium use. This species grows in mountain streams, tolerates low temperatures, and appears to be the most hardy in this genus. These plants are not known to occur in Florida but are present in lakes and rice fields of Louisiana. Because of their preference for warm water, these plants may grow quite well in Florida.

**7. Vallisneria - eel-grass**

The genus is named in honor of the Italian botanist - Antonio Vallisneria.

The species are very popular in the aquarium industry. These plants with their strap-like leaves are considered among some of the most desirable submersed plants for growth in many bodies of water. They also provide attachment sites for many micro-organisms and cover for small fishes. Plants in this genus are generally not considered pests although at times they may cause minor problems.

Florida has two native *Vallisneria* species: eel-grass and Jungle-val. Eel-grass, also called water-celery and tape-grass, is found throughout much of North America, while Jungle-val appears to be limited to the warmer waters of the continent. These two species are very similar in appearance, with the Jungle-val exhibiting a much wider leaf blade than eel-grass.

Female flowers are formed at the end of a coiled stalk and float on



*Vallisneria americana*, pistillate plant



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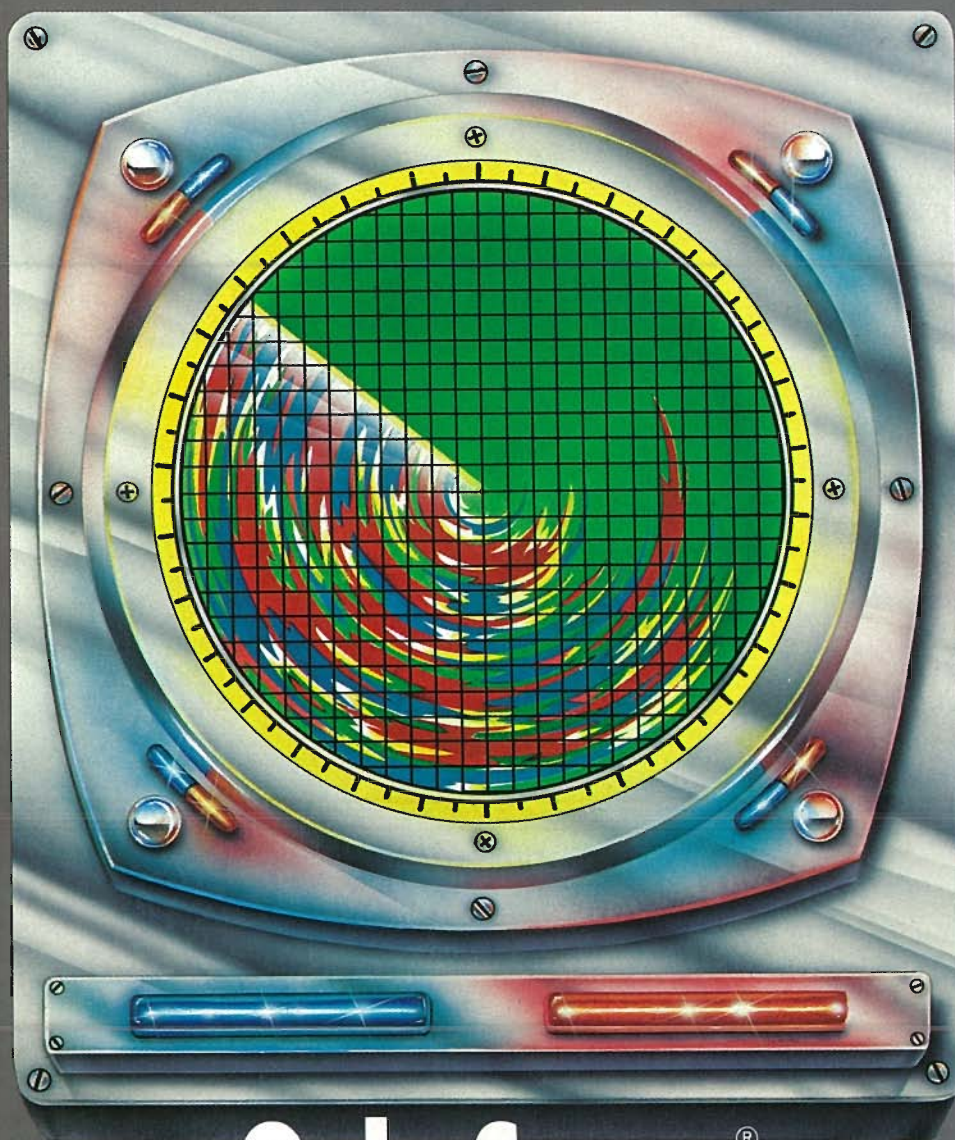
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the surface. The coiling of the stalk helps to ensure that the flower will not become submerged during wave action or periods of sudden increases in water level. Pollen is formed in small capsules located underwater at the base of the plant. When the male flowers are mature, the capsules float up and release their pollen on the surface. The pollen is distributed by wind and wave action to the waiting female flowers. On Lake Okeechobee it is not uncommon to see large mats of white eel-grass pollen that have been blown into sheltered areas.

Reproduction is by seeds and also by formation of new plants from rhizomes. Elongated pods with a tough outer coat may contain several hundred seeds surrounded by a sticky, gelatinous material. Seeds sprout under water.

**8. Egeria**

The genus *Egeria* contains only one species, *E. densa*, which is indigenous to South America. This species is often commonly called Brazilian elodea, anacharis, or egeria. *Egeria* is one of the most favored and widely sold of aquatic plants for home aquarium use. It is generally sold under the name "anacharis". *Egeria* is commonly collected from wild populations for sale in the aquarium industry. The stems and leaves of egeria are eaten by coots, gallinules, and ducks. It is considered a beneficial plant in many locations.



*Egeria densa*, shoot and flower

*Egeria* was introduced to North America from South America. In Florida, it grows well in cool, clear spring-fed water, and is found mainly in the northern and central portions of the state, generally causing few problems. However, *Egeria* is considered a weed in several large lakes in South Carolina and a few other locations. Elsewhere it has naturalized but not extensively.

*Egeria* plants have long, branch-

ing stems and very soft leaves in whorls of four to eight per node. The flowers of egeria are strictly unisexual with three petals about 10 mm long. The flower extends above the surface on a short pedicel about 2 cm above the surface of the water and is pollinated by insects.

Plant fragments of egeria will regenerate new plants from the nodes. It produces no tubers or turions like hydrilla.

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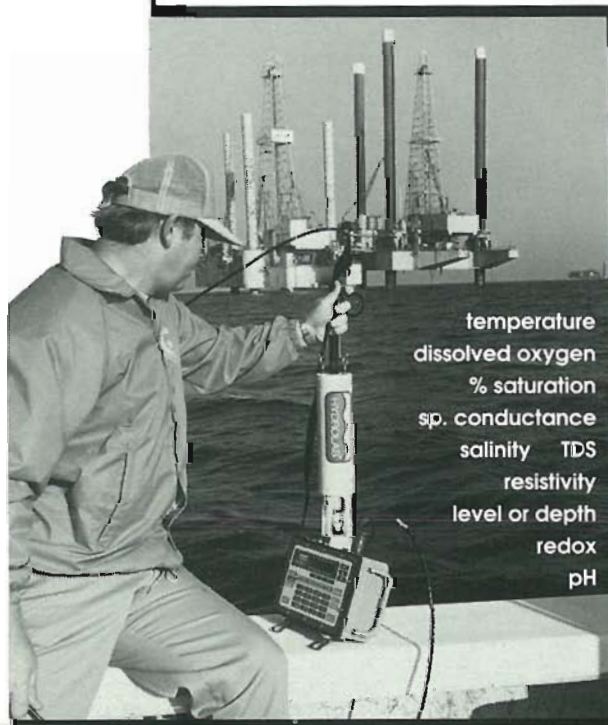
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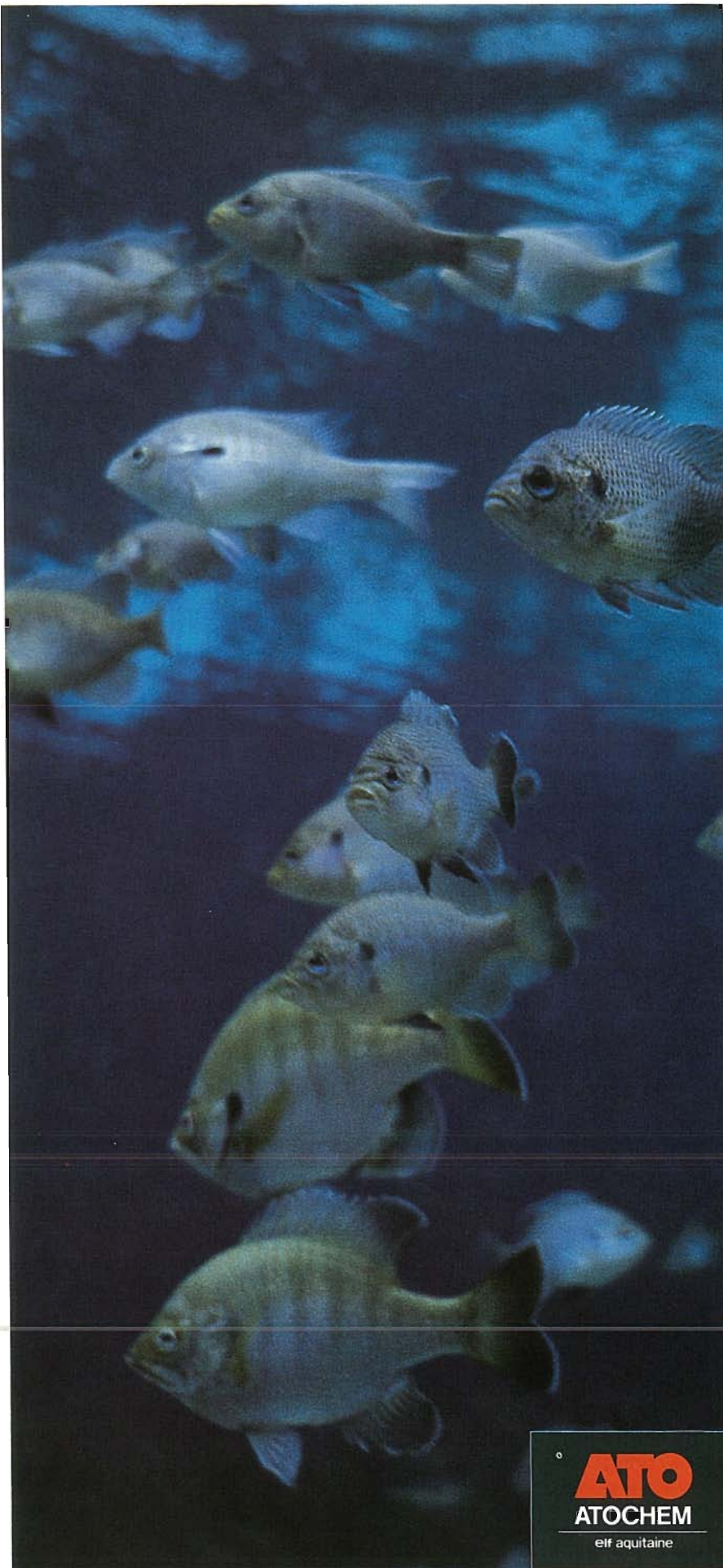
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*Hydrilla verticillata*, plant and turion

**9. Hydrilla**

The genus derives its name from the Greek "hudor" for water. This genus contains a single species, *H. verticillata*, but many races or varieties occur throughout the world primarily in temperate and tropical countries. Hydrilla is thought to have originated in warmer regions of Asia, but it has been spread by man to many countries.

Hydrilla grows in rivers, springs, sinks, lakes, and is adaptable to a variety of habitats. It was brought to the US in the late 1950s and sold as "starvine" and "oxygen plants". Shipment of hydrilla into most states in the US is now prohibited. Hydrilla is considered one of the most troublesome submersed aquatic plant in many countries around the world.

Hydrilla grows completely submersed, although in thick surface mats branches may be forced out of the water occasionally by stems growing up underneath them. Hydrilla stems near the surface have many branches with short nodes, but in deep water, sparsely branched stems with long internodes occur. Leaves are in whorls of three to five and have sharply toothed margins and spines on the underside of the midrib, a good characteristic to distinguish it from superficially

similar *Egeria densa*. Hydrilla is rough in texture, and may cause allergic reactions in some individuals.

Hydrilla plants may be dioecious or monoecious. Flowers of hydrilla arise singularly from a bract near the growing tip. The inconspicuous flower has three petals. Female flowers extend to the surface of the water on a slender peduncle where the delicate petals forming a depression held in place by surface tension. In the leaf axis, the male flower forms a capsule which floats to the surface when mature. The capsule releases its pollen into the air which then rains down upon the receptive female flower. The pollen must land in the small depression created by the petals of the female flower for fertilization to occur (Figure 2). Seed production and subsequent germination appears to be minimal for the monoecious biotype of hydrilla found in some part of the US. Seeds are not formed by pistillate dioecious hydrilla plants growing in Florida.

Reproduction is primarily vegetative. New plants develop from nodes of the stem and rhizomes, from auxiliary turions, and subterranean turions commonly called "tubers".

Diving ducks and coots consume the vegetative parts of hydrilla. Hydrilla is considered an extremely



Figure 2. Female flowers of monoecious hydrilla filled with pollen. Note pollen also floating on the surface of the water.

important plant by some wildlife personnel for use in some waterfowl management programs. Hydrilla plants also provide cover for small fish. Hydrilla plants are beneficial to a lake system when present in low numbers; however, this plant is so aggressive and competitive that it usually dominates a body of water at the expense of native plants.



*Elodea canadensis*, plant

**10. Elodea**

The genus derives its name from the Greek for "elodes" meaning a marsh, a common habitat for these plants. These plants are commonly called by their generic name. In older literature the genus is termed *Anacharis*.

The genus contains about 12 species native to North and Central America. A couple of species have been introduced throughout the world and cause problems in some countries. Florida does not appear to offer suitable habitat for growth of these plants, but they may cause problems in other parts of North America.

An interesting situation occurred after *Elodea canadensis*, commonly called Canadian Pondweed, was found in Down, Ireland in 1836. By the end of the century this species had made its way into a number of waterways throughout Europe and created problems in many areas. Suddenly, for no apparent reason, Canadian Pondweed died back and today is commonly found in no more abundance than native



# Clearly, it just makes good sense to be careful when controlling aquatic weeds!

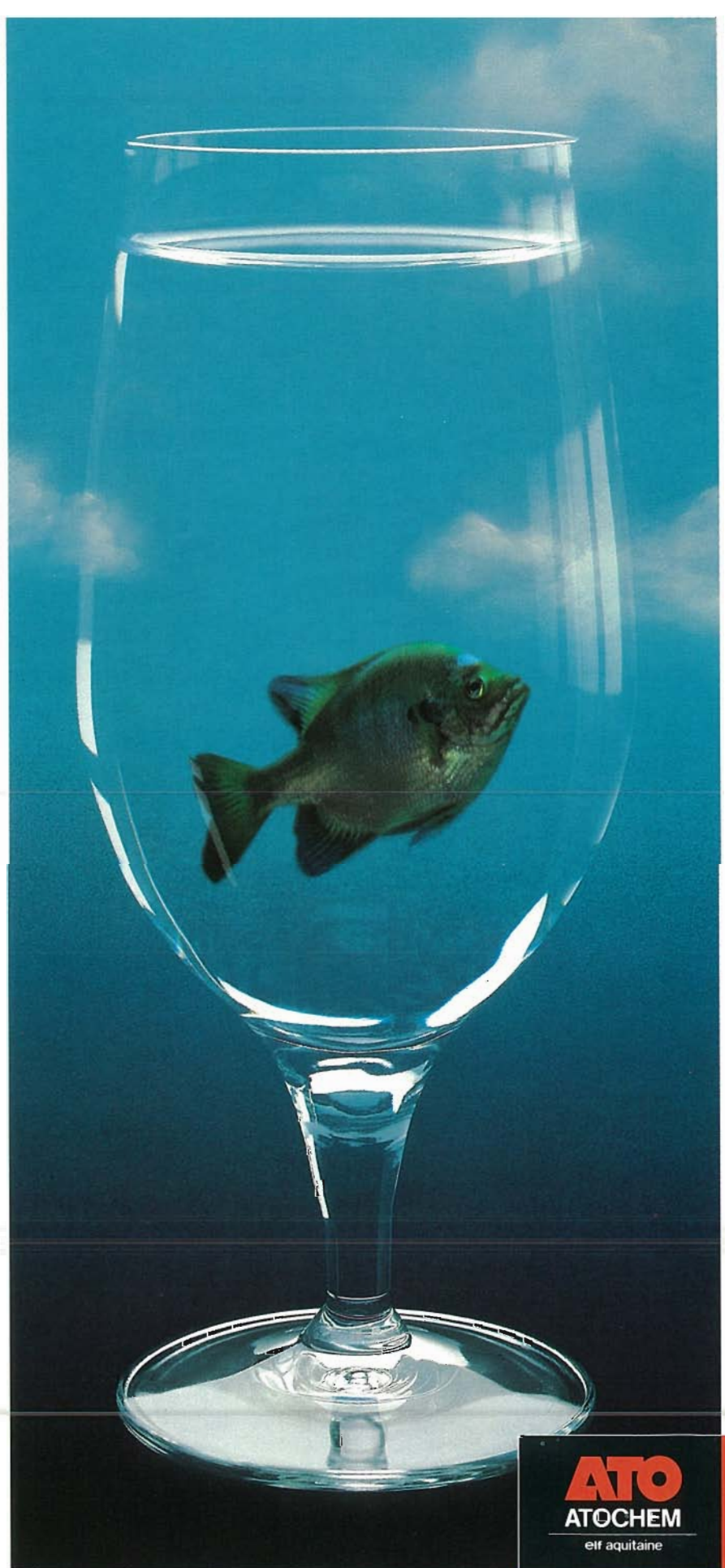
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aquatic plants in these waterways. Because of this rapid decline in the Canadian Pondweed population, there are some individuals who would argue that large populations of naturalized "exotics", given enough time, may collapse on their own.

The similar appearance of hydrilla, egeria, and elodea has contributed to some of the nomenclatural confusion found in the literature. For example, hydrilla in the late 1950's and early 1960's was called Florida elodea because at the time no elodea species were known to occur in Florida and early examination revealed its close association to elodea plants. Later, Florida elodea was correctly identified as hydrilla - a species with anatomical characteristics and growth habits remarkably different from the elodeas.

**Acknowledgements**

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Table 1. *Plants in the Hydrocharitaceae or Frog's-bit family of interest to Florida.*

Genera	Important species	Common name
<b>A. Marine plants</b>		
1. <i>Thalassia</i>	<i>T. testudinum</i> Koenig.	Turtle grass
2. <i>Halophila</i>	<i>H. engelmannii</i> Ascher <i>H. baillonis</i> Ascher	Sea-grass
<b>B. Fresh water, sometime brackish, plants</b>		
3. <i>Ottelia</i>	<i>O. alismoides</i> (L.) Pers.	—
4. <i>Limnobium</i>	<i>L. spongia</i> (Bosc.) Steud.	American Frog's-bit
5. <i>Lagarosiphon</i>	<i>L. major</i> Ridley	African elodea
6. <i>Blyxa</i>	<i>B. aubertii</i> Rich.	—
7. <i>Vallisneria</i>	<i>V. americana</i> Michx. <i>V. neotropicalis</i> Marie-Victorian	Eel-grass Jungle-val
8. <i>Egeria</i>	<i>E. densa</i> Planch	Brazilian elodea
9. <i>Hydrilla</i>	<i>H. verticillata</i> (L.f.) Royle	Hydrilla
10. <i>Elodea</i>	<i>E. nuttallii</i> (Planch.) St. John <i>E. canadensis</i> Rich. in Michx. <i>E. bifoliata</i> St. John <i>E. longivaginata</i> St. John	Elodea Canadian pondweed — —

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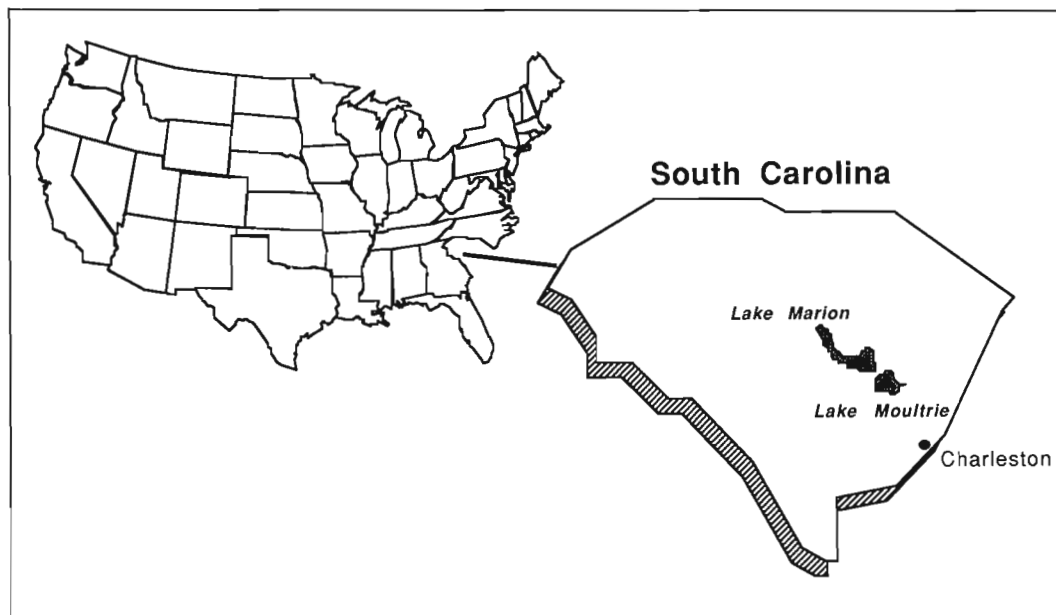


Figure 1. Location of the Santee Cooper Lakes (Lake Marion and Lake Moultrie).

# Lake Marion Sterile Grass Carp Stocking Project

by

Steven J. de Kozlowski  
Manager

South Carolina Aquatic Plant Management Program  
South Carolina Water Resources Commission  
Columbia, South Carolina

Lake Marion is the largest and most heavily used lake in South Carolina. Covering 110,600 acres, Lake Marion is part of a two-lake complex (Figure 1) which also includes Lake Moultrie (60,400 acres).

Together they are commonly referred to as the Santee Cooper Lakes, famous for supporting the first known reproducing population of landlocked striped bass. The lakes were created in 1941 by the South Carolina Public Service Authority (Santee Cooper) as a public works project to provide a source of inexpensive hydroelectric power, flood control, and to improve navigation. Now they support many more uses and are an important recreational and economic resource to the state.

Because of its location in the

coastal plain, Lake Marion is relatively shallow with most of the lake less than 15 feet deep. The lower portion (below the 1-95 bridge) is characterized by its large expanse of open water and numerous embayments, while the upper portion is characterized by its shallow water (averaging six feet deep) and unique combination of open water "flats" and permanently flooded stands of bald cypress and water tupelo. The combination of shallow water, mild climate, and national popularity as a premiere fishing lake make Lake Marion an ideal target for major aquatic plant infestations.

However, it took almost 23 years before submersed aquatic plants really became a problem. Brazilian

elodea (*Egeria densa*) was first discovered in Lake Marion in 1965, and by 1980 almost 6,000 acres of open water were infested—mostly in the popular upper lake area. Although funding for control operations during this period was limited, management was generally successful because applications of approved aquatic herbicides in the spring usually provided relief for the rest of the year. However, what appeared to be a bad, but manageable, aquatic weed problem at the time was to quickly evolve into every lake manager's worst nightmare, a terrible and apparently unmanageable aquatic weed problem.

In 1982, hydrilla (*Hydrilla verticillata*) was discovered growing adjacent to a fishing camp in the



upper lake. Despite attempts to stop its growth and spread by large-scale herbicide applications, hydrilla rapidly replaced Brazilian elodea as the dominant submersed aquatic species and spread into previously uninfested waters. By 1987, hydrilla occurred in over 13,000 acres of both lakes and was most concentrated in the upper portion of Lake Marion.

Large-scale herbicide applications that proved effective on Brazilian elodea had limited effect on hydrilla.

Hydrilla was more resistant to aquatic herbicides and regrew more quickly than Brazilian elodea. Herbicides that require a long contact time and which proved effective on hydrilla in the relatively stagnant lake systems in Florida, were ineffective in upper Lake Marion where inflow from upstream rivers allowed only limited contact time. Where herbicides were effective, they were



*"Hydrilla infestations prevent access and use of upper Lake Marion."*

very expensive; hydrilla regrowth was rapid; and hydrilla continued to spread, threatening at least half the water body and all of its high-use shoreline area. An alternative management strategy was clearly needed.

The South Carolina Aquatic Plant Management Council, a multi-agency board charged with coordinating aquatic plant management operations in the state's public waters, established a special task force in 1987 to review the weed problem on Lake Marion and to recommend a management strategy. After considering numerous management alternatives, the task force recommended an integrated control strategy using a combination of approved aquatic herbicides and triploid (sterile) grass carp. This same approach had been used successfully on many smaller lake systems since 1985 when sterile

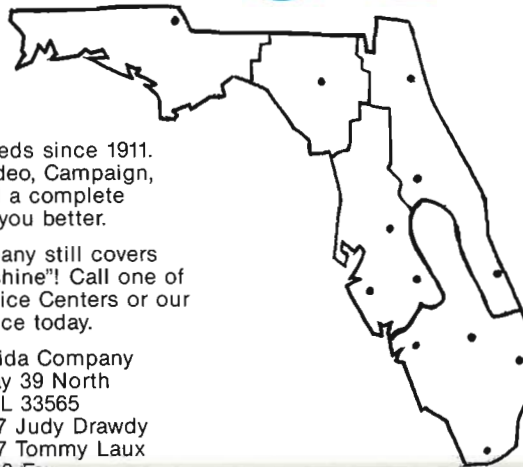
grass carp were first approved for use in the state. However, if implemented this would be the largest lake in the state, and in the country, to be stocked with sterile grass carp.

Public meetings were held around the lake and input to the draft plan was solicited from natural resource agencies, environmental organizations, fishing clubs, and lake-associated interest groups. Support for the stocking plan was overwhelming, and in 1988 the S.C. Aquatic Plant Management Council, with consent from the S.C. Wildlife and Marine Resources Commission, gave final approval for the overall management strategy and stocking plan.

The timing and rates selected for stocking grass carp in Lake Marion were based on prior experience in South Carolina lakes and the experience of stocking efforts in other states. The stocking plan targets the upper lake area and provides for the release of only sterile grass carp of at least 10 inches in length at a rate of 25 fish per vegetated acre. Based on an estimated 12,000 acres of hydrilla and Brazilian elodea in



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upper Lake Marion, a total of 300,000 fish will be required. Due to limitations on funding and availability of sterile grass carp, the stockings will be conducted incrementally with 100,000 fish released each year for three consecutive years (Figure 2). Stocking areas were selected based on the abundance of and access to hydrilla infestations and by identifying coves and other restricted areas where fish movement might be limited, therefore providing the possibility of located control from each year's release. Subsequent stockings will depend on the extent of aquatic plant control resulting from the first three years' effort.

Operational costs for the entire stocking project will total about \$1.2 million with funding provided by the U.S. Army Corps of Engineers (50%), S.C. Water Resources Commission (32%), and Santee Cooper (18%). In conjunction with the stocking effort, about \$600,000 in associated studies are planned to monitor 1) the abundance and distribution of aquatic plants (aerial photography); 2) lakewide movement of the grass

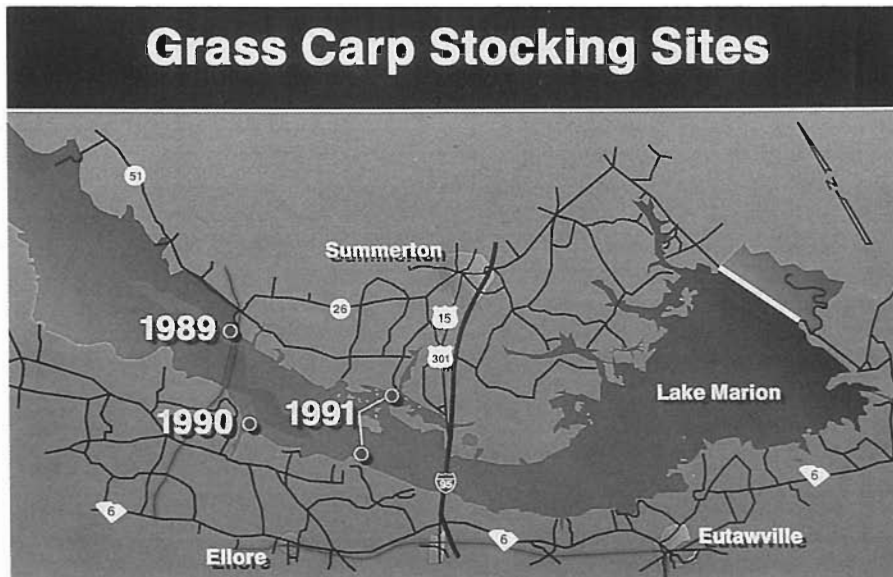


Figure 2. Location of sterile grass carp stocking sites.

carp (radio telemetry); and 3) changes in native fish populations. Because of the national significance of this project, these studies are being funded and coordinated by the U.S. Army Corps of Engineers' Waterways Experiment Station in Vicksburg, Mississippi. Santee Cooper is also monitoring water quality conditions in the upper lake

area as part of their routine monitoring program.

The stocking project is being coordinated by the S.C. Water Resources Commission. All the fish are being purchased from a consortium of three suppliers located near Lonoke, Arkansas—J. M. Malone and Son Enterprises, Hill's Farms

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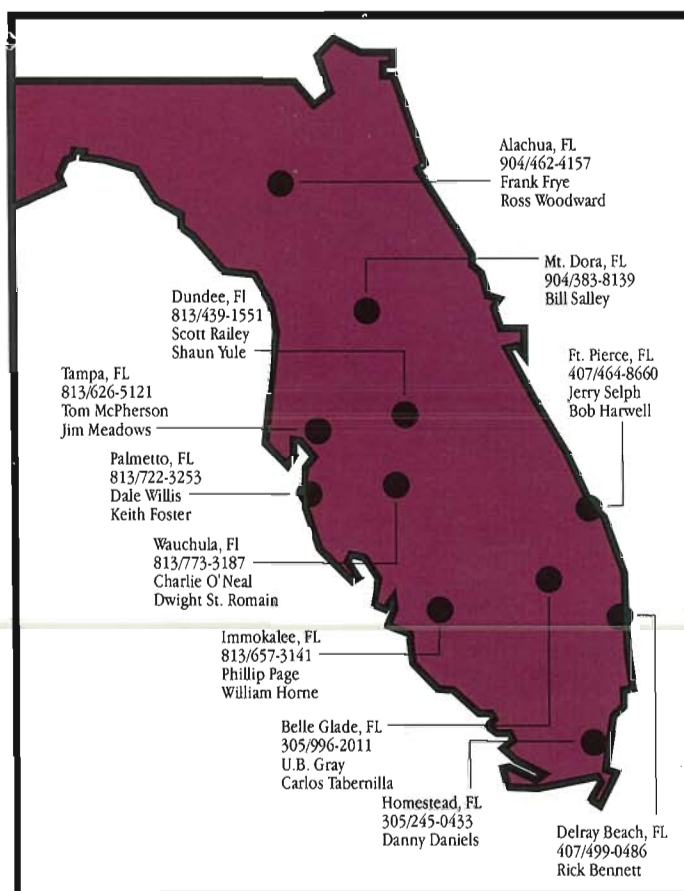
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Carolina. In addition, the fish are carefully inspected by the S.C. Water Resources Commission to insure that they are a minimum of 10 inches in length.

The project is now in its second year and, except for some unexpected setbacks and minor adjust-

ments, is being carried out as originally planned. While it is too early to expect any significant results, unofficial reports of localized weed control by the fish have been noted. Furthermore, preliminary results from the radio tracking studies indicate that the grass carp are remaining in the general target area of upper Lake Marion and that most of the fish appear to prefer the open water areas near the release sites.

Unfortunately, any project of this size is bound to encounter some unforeseen problems. Extremely hot weather in late April and May 1989 created high water temperatures and low dissolved oxygen conditions resulting in two separate fish kill events in the upper lake area, killing an undetermined number of stocked grass carp. Furthermore, on September 22, 1989, Hurricane Hugo, the largest storm ever recorded in South Carolina, hit the coast near Charleston and plowed a path of destruction directly over Lake Marion on its way inland. The result was the state's largest, most widespread fish kill ever documented. Unfortunately, an accurate assessment of the storm's impact on the grass carp stocked in 1989 is not available, and reports provide conflicting results. The official fish kill report indicates that no grass carp died from Hugo; however, only one of the six radio tagged grass carp apparently survived the storm. Because of the uncertainty of grass carp survival during 1989, the stocking plan has been modified to allow for a fourth year of stocking, if needed, to replace fish possibly lost due to Hurricane Hugo and the spring fish kill events.

Despite the setbacks, the grass carp stocking project in Lake Marion is progressing as planned with continued support and commitment from state and federal agencies, and most importantly from the public. Sterile grass carp have proven to be an effective tool for long-term control of nuisance submersed aquatic plants in small lake systems, and we are hopeful that they will prove just as effective in much larger lake systems like Lake Marion.



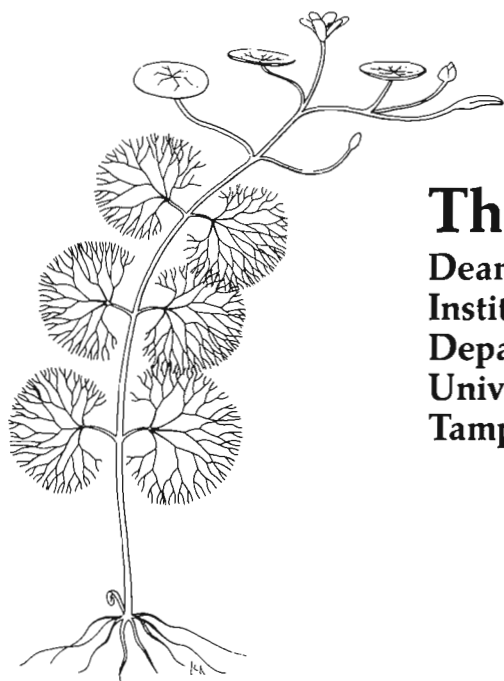
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## The Cabomba Color Problem

Dean F. Martin and Richard P. Wain<sup>1</sup>  
 Institute for Environmental Studies,  
 Department of Chemistry,  
 University of South Florida,  
 Tampa, Florida

Hanlon (1990) summarized some of the characteristics of *Cabomba* (fanwort): the distribution in the United States, the popularity as an aquarium plant, the spread due to careless dumping of aquaria, methods of reproduction, the increasing abundance in Florida, though it is not yet regarded as a nuisance plant. It provides fish habitat, but no wildlife value has been reported.

He also described green-cabomba (*Cabomba caroliniana*) and *C. pulcherrima* (purple cabomba). He added, "There is some question whether green-cabomba and red-cabomba are the same or separate species."

This distinction is what might be called the cabomba color problem, the genetic relationships between at least three taxa of cabomba, but it is a problem that seems to have been solved.

Three taxa are commonly reported in the literature for United States distribution: *Cabomba caroliniana* var. *caroliniana* Gray (fanwort), *C. caroliniana* var. *multipartita* (green fanwort), and *C. pulcherrima* (Harper) Fass. (purple fanwort) (cf., Wain et al., 1983). Variety *multipartita* was thought to be a cultivar form of *C. caroliniana* because of

its association with the aquarium industry. And *C. pulcherrima* is a purple colored segregate of *C. caroliniana* (Fassett, 1953).

A previous study was concerned with determining the genetic relationship among the three taxa (Wain et al., 1983). Genetic differentiation can be detected electrophoretically as differences in allele frequencies, or in the most extreme case as a fixation of alternate alleles (Wain et al., 1985). Genetically differentiated populations often differ physiologically, and thus, they may have notable impacts on biological and chemical control programs.

The sample of genetic markers that we examined indicated that the three taxa of cabomba were genetically indistinguishable (Wain et al., 1985). This means that *C. caroliniana* and *C. pulcherrima* are most likely part of a common gene pool, and that the apparent differences are probably best explained in terms of environmentally induced variation. Godfrey and Wooten (1981), for example, noted that cabomba with high levels of purple pigmentation was commonly found in very warm waters, whereas plants with little or no purple pigmentation inhabited cooler water.

As we noted previously (Wain et al., 1983), morphologically plastic

traits (different colors, different sizes) are well documented in aquatic plants (Sculthrope, 1967; Hutchinson, 1975), and we believe that the morphological differences found among the three taxa of cabomba are best explained in terms of environmentally induced differences. We also believe that electrophoresis can be a very useful tool for providing the basis of making this judgment or related ones.

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<sup>1</sup>Professor and Computer Project Analyst Manager



# The Effect of 2,4-D Amine on the Growth of Spatterdock

by

Chuck Hanlon and Bill Haller<sup>1</sup>

University of Florida - IFAS Center for Aquatic Plants  
Gainesville, FL

Spatterdock (*Nuphar luteum*) is a native emergent aquatic plant distributed throughout the United States. It commonly grows in one to three meters of water, rarely requires control, is considered beneficial habitat for fish and wildlife and is a dominant plant in many Florida lakes such as Orange and Kissimmee.

Waterhyacinths and hydrilla are frequently found in many of the same lakes as spatterdock and responsible agencies within the state are attempting to control these exotic hydrophytes under maintenance control programs. In lakes where exotics are frequently sprayed, fishermen, lake residents and fish camp operators often complain that spray crews are "destroying the pads." However, maintenance control of waterhyacinths and hydrilla has been used for the past three years in Orange Lake and visual inspection of the spatterdock community in the lake indicates that despite the use of 2,4-D and sonar, there has not been a decrease of spatterdock, in fact spatterdock may have actually increased in coverage as water levels in the lake have decreased during this time.

In the March 1990 issue of *AQUATICS* we described our initial research project concerning 2,4-D and spatterdock. Two months after spatterdock was treated with single applications of 0, 1, 2, 3, and 4 lbs/A 2,4-D amine, we found it was recovering from any initial injury, and the numbers of leaves in the treated plots were not significantly different from the check plot. The average weight per leaf in the treatment plots was however, somewhat lower than in the check plot, probably due to the regrowth of young

leaves from the spatterdock rhizome. As described in the previous *AQUATICS* (March 1990) article, a second study was set up in Orange Lake to examine what long term effect 2,4-D has on spatterdock since little quantitative data has been published on these interactions thus far. A large uniform stand of spatterdock was located in Orange Lake, Florida and four 0.25 acre plots with an average depth ranging from two to three ft were established on September 28, 1989. Three of the four plots were randomly treated with either 2.0, 3.0, or 4.0 lbs per acre of 2,4-D amine. The fourth plot was left untreated and served as a control.

One day prior to treatment, a one-by-three meter PVC floating frame was positioned in five different areas inside each plot. All emerged leaves inside the frame were counted and the leaf stems were cut just below the point of attachment to the leaf. Leaves were then placed in mesh bags, oven dried for a minimum of 72 hours at 80 C and dry weights were determined. Two additional harvests, similar to the first, were conducted at 44 and 235 days after treatment (DAT).

After two weeks, the effects of 2,4-D were visible, (Figure 1) however, no rate dependent effect

was observed since the degree of epinasty and leaf chlorosis was similar in all treated plots. During this time it would be easy for an individual to look at the treated pads and conclude that the spatterdock was damaged by the treatment.

Forty-four days after treatment, the number of leaves/m<sup>2</sup> in the control plot was similar to the treated plots, however the total biomass and the average weight per leaf in the control plot was greater. By 235 DAT water levels in the lake had dropped considerably. Portions of the control, two and three lbs/A plots were either dry or in very shallow water while there was approximately one ft of water covering the four lbs/A plot. There was no difference in the number of leaves/m<sup>2</sup> in the control plot and the plots treated with two and three lbs/A 2,4-D. Fewer leaves were harvested from the four lbs/A plot. Since this plot was in deeper water, more newly-formed young leaves were still submersed and therefore not included in the harvest. All plots had a similar total biomass (Table 1), however, the average individual weight per leaf in the four lbs/A plot was heavier than the control but similar to the plot treated with two lbs/A 2,4-D. From these data, it appears a single ap-



Figure 1. *Spatterdock untreated control (left), and treated plants (right).*  
Photo by C. Hanlon

<sup>1</sup>Assistant in Aquatic Weeds and Professor, Agronomy Department.

plication of 2,4-D amine at rates of two to four lbs/A may initially reduce the vigor of the spatterdock stand, but long term results show there is no significant impact on the number of leaves/m<sup>2</sup> or leaf biomass.

During the course of this study, we have observed mats of waterhyacinths invading and crowding out spatterdock stands creating conditions unfavorable for spatterdock growth. When dense waterhyacinths mats are sprayed inside these spatterdock stands, the waterhyacinths die and large holes in what was once a uniform stand of spatterdock are created as the waterhyacinths decay (Figure 2). While decomposing underwater, anoxic conditions may occur in the hydrosol. Although rhizomes can actively grow under low oxygen conditions (zero to one percent oxygen), oxygen benefits new leaf growth (Laing 1940). Therefore, new leaf development from underground spatterdock rhizomes may be inhibited during low oxygen conditions, but eventually lateral development of new spatterdock

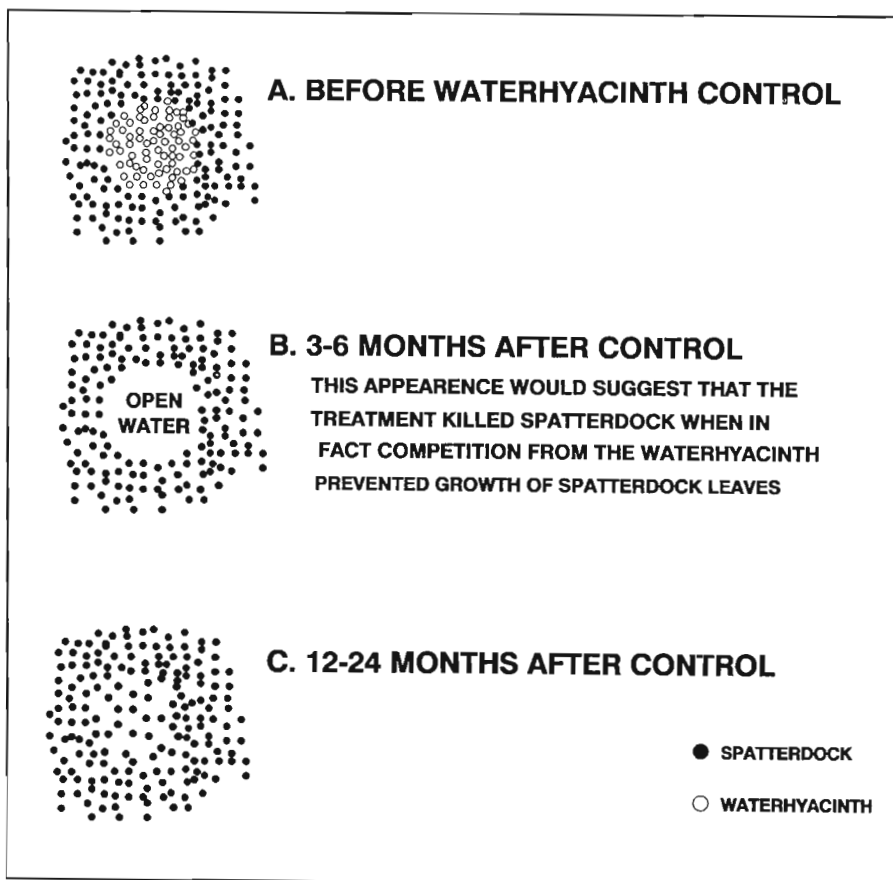


Figure 2. Time series showing the effect of spraying in spatterdock beds.

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plants will occur and refill the holes created by competition from waterhyacinths (Figure 2).

It has been impossible for us to find anything other than short term impacts of single applications of 2,4-D on spatterdock. These results agree with clipping and spraying studies conducted in England (Barrett 1974). As a result, our future research will address the issue of multiple applications of 2,4-D and its effect on the survival of this plant.

**Conclusions**

When mats of waterhyacinths, growing inside spatterdock stands, are sprayed with 2,4-D they die and are responsible for the large holes people often observe inside these spatterdock stands. Also, in the first 2 to 8 weeks after spraying, spatterdock plants often look damaged and appear to be dying. Based on these observations it is easily concluded by the public that "you are killing the pads" but in fact you are not.

Table 1. *The effect of 2,4-D on the number of spatterdock leaves and biomass (grams dry wt.) 44 and 235 days after treatment (DAT). Values in a column followed by the same letter are not significantly different (p < 0.05).*

LBS/A	HARVEST	
	44 DAT	235 DAT
<b>AVERAGE LEAF NUMBER / m<sup>2</sup></b>		
0	14 (a)	30 (a)
2	11 (b)	31 (a)
3	14 (a)	28 (a)
4	17 (a)	24 (b)
<b>AVERAGE WEIGHT / m<sup>2</sup></b>		
0	50 (a)	84 (ab)
2	26 (b)	102 (a)
3	35 (b)	73 (b)
4	42 (a)	90 (a)
<b>AVERAGE WEIGHT / LEAF</b>		
0	3.4 (a)	2.8 (a)
2	2.5 (b)	3.3 (ab)
3	2.5 (b)	2.6 (a)
4	2.6 (b)	3.8 (b)

**Acknowledgements**

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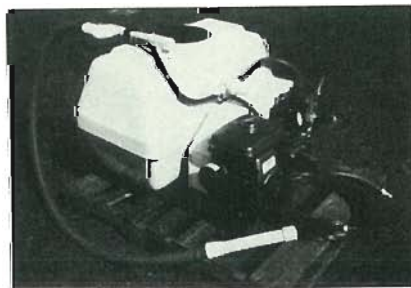
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October may seem a ways off, but it's never too early to prepare for the FAPMS annual meeting. We'll be back in Daytona Beach this year and should all be thinking about Applicator of the Year nominations and toting our cameras everywhere to snap award-winning shots. Somebody's got to challenge multi-year winner Wendy Andrew in the photo contest!

## DNR AQUATIC PLANT BUREAU NO LONGER FACING AXE

In early January, incoming Florida Governor Lawton Chiles asked all state department heads to identify programs amounting to five percent of their respective budgets which could be eliminated. Executive Director Tom Gardner, at the Department of Natural Resources, pinpointed the Bureau of Aquatic Plant Management, and its associated programs, for elimination. In late January, however, Gov. Chiles contacted Gardner to say that the Bureau of Aquatic Plant Management would not be listed among the state programs to be eliminated. Certainly the work of this Bureau has shown itself to be necessary and effective. All of the Bureau employees, along with the rest of us, can breathe a sigh of relief, at least for the time being.

## 1989 FLORIDA DNR AQUATIC PLANT SURVEY AVAILABLE

The 1989 Florida DNR aquatic plant survey has been published and is available from the Bureau of Aquatic Plant Management, Tallahassee. The 1989 survey has data for all species encountered in public waters statewide. The 1990 survey should be published within the next two months. The 1990 survey has

data for exotic species only. The 1990 data show new record lows for water hyacinth and waterlettuce populations, less than 1200 and 1500 acres statewide, respectively!

Hydrilla's another story, however. Insufficient funding has led to an increase in hydrilla in Florida. In 1989, 44,000 acres of hydrilla were found. In 1990, this figure increased to over 57,000 acres. Let's hope that discussions with legislators will lead to funding that will be sufficient to protect Florida's waters!

## ANOTHER AQUATIC PLANT VIDEO AVAILABLE

"Clear Waters — Managing South Florida's Aquatic Plants," a 1990 video production of the South Florida Water Management District, is available. The 23-minute program details how and why exotic plants are managed in southern Florida. Aquatic and terrestrial (i.e., melaleuca) exotics are included along with current control methods and management philosophy. The program was developed with the legislative, technical and regulatory communities as its "target"

audiences, along with the general public. Copies are available from Mike Bodle, SFWMD, P.O. Box 24680, West Palm Beach, FL 33416-4680.

## UPCOMING MEETINGS

March 12-13  
Florida Aquatic Plant Review and Short Course, TREEO Center, University of Florida, Gainesville. Registration \$15.00 (\$20.00 after 3/1/91), Center for Aquatic Plants, Gainesville.

March 14-15  
Western Aquatic Plant Management Society annual meeting, Stouffer Madison Hotel, Seattle, Washington.

March 17-18  
Midwest Aquatic Plant Management Society annual meeting, University Place Holiday Inn, East Lansing, Michigan.

July 14-17  
Aquatic Plant Management Society annual meeting, Hyatt Regency Dearborn, Dearborn, Michigan.

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**IFAS, CENTER FOR AQUATIC PLANTS REGIONAL CERTIFICATION TRAINING WORKSHOPS**

In response to many requesting and increasing budget problems at the state, county, and local level, IFAS will conduct three regional certification training workshops. By bringing training to various parts of the state we hope to make training available to individuals whose budgets do not permit traveling to shortcourses in Gainesville. Local arrangements will be provided by faculty in Cooperative Extension Service Offices. Information presented will be at the basic level to prepare people for taking the certified pesticide applicator examination for Category Number 6 - Aquatic Pest Control. Attendees should pass the Core exam and study training material prior to the workshop. Tests will not be administered the day of the workshop but can be scheduled at a later date by contacting the appropriate Cooperative Extension Service Office. Continuing Education Units (CEUs) will also be available for certified applicators who wish to use one of these workshops as a refresher course. **SPACE MAY BE LIMITED, SO PLEASE CONTACT US IN ADVANCE IF YOU PLAN TO ATTEND.**

**TENTATIVE PROGRAM**

- 8:00-8:30 Registration
- 8:30-10:00 Overview of Aquatic Plant Management - Ken Langeland
  - History
  - Herbicides
  - Non-herbicide methods of aquatic weed control
  - Environmental considerations
- 10:00-12:00 Aquatic Plant Identification Vernon Vandiver
- 12:00-1:00 LUNCH
- 1:00-4:00 Applying the Right Amount of Herbicide - Richard Cromwell

Locations, dates, and local contacts are as follows:

West Palm Beach, Clayton Hutcheson Agricultural Services Center, April 9, 1991, Contact: Scott Charbo 407/996-1655.

Stuart (Martin Co.), Levi Johnson Agricultural Center April 11, 1991, Contact: Jack Hebb (St. Lucie Co.) 407/468-1660 or Bob Whitty (Martin Co.) 407/288-5654.

Sarasota/Bradenton, Airport Authority, May 7, 1991, Contact: Phyllis Gilreath (Manatee Co.) 813/722-4524 or Mike Holsinger (Sarasota Co.) 813/951-4240.

**FAPMS MEMORABILIA MEMBERSHIP SURVEY**

The preference of the FAPMS membership is needed concerning whether the Society logo should be changed and what items are wanted for future Society memorabilia. Please complete the following survey and send to: Nancy Allen, P.O. Box 188, Inglis, FL 32649.

Indicate whether you'd buy any of the suggested items with a "yes" or "no." Be sure to suggest any items that are not listed.

Do we need new Society memorabilia this year? \_\_\_\_\_(Y/N)

Would you buy Society memorabilia this year? \_\_\_\_\_(Y/N)

Should Society logo (see p. 3) be re-drawn? \_\_\_\_\_(Y/N)

Do you prefer:

T-shirts \_\_\_\_\_(Y/N) \_\_\_\_\_(Sizes) \_\_\_\_\_(Colors)

Golf shirts \_\_\_\_\_(Y/N) \_\_\_\_\_(Sizes) \_\_\_\_\_(Colors)

Patches \_\_\_\_\_(Y/N) Pins \_\_\_\_\_(Y/N)

Stickers \_\_\_\_\_(Y/N) Pens \_\_\_\_\_(Y/N)

Hats \_\_\_\_\_(Y/N) Other(s) \_\_\_\_\_



**Agent Contacts**

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**Snake River Chemicals, Inc.**  
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**Van Waters & Rogers**  
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Houston, TX 77061  
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