



# Aquatics

September 1989

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## **RODEO. EMERGED AQUATIC WEED AND BRUSH CONTROL.**



**EDITORIAL**

In the last issue of *Agrichemical Age*, Editor Len Richardson promotes consensus-building as opposed to debate when challenged in regards to your pesticide practices. When he asked his readers to call or write with opinions, the response came from only two people. Well, I called Len and expressed my support for his "consensus-building" approach. In my opinion, this approach to dealing with potentially controversial subjects has merit.

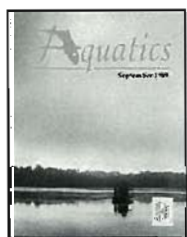
Recently, I was chatting with Sam Edwards who manages one of the local drainage districts, and a resident of the District stopped in to discuss the aquatic weed control program with him. She was concerned that there was too much reliance on the use of herbicides and that there "had to be a better way." Rather than defending the program and establishing the debate posture with the woman, Sam said "You're right. There may be a better way. Do you have any suggestions?" The atmosphere soon changed from challenge to information gathering and the woman left satisfied that the District had explored all avenues.

Here at the SFWMD, two interagency groups have been established that represent all of the agencies directly or indirectly involved with our Aquatic Plant Management Program. These groups meet regularly to discuss the program and to comment on our operations. This informal exchange gives everyone the chance for criticism and/or comment and to have input into our daily activities. Again, this consensus-building approach paid off recently at a public meeting sponsored by the CoE, when all the agencies that were represented at the meeting could address the public concerns with confidence and homogeneity.

The "bottom line": people like to be heard, especially when we manage public resources. It's easier to spend half a day in "give-n-take" meetings than two days in "us vs. them, I can win" name bashing.

by Dan Thayer

**ABOUT THE COVER**



St. Johns River Water Management District crew tanking up as the fog lifts off Lochloosa Lake in Alachua County, Florida.

Photo by Wayne Corbin

*Aquatics*

September 1989 / Vol. 11, No. 3



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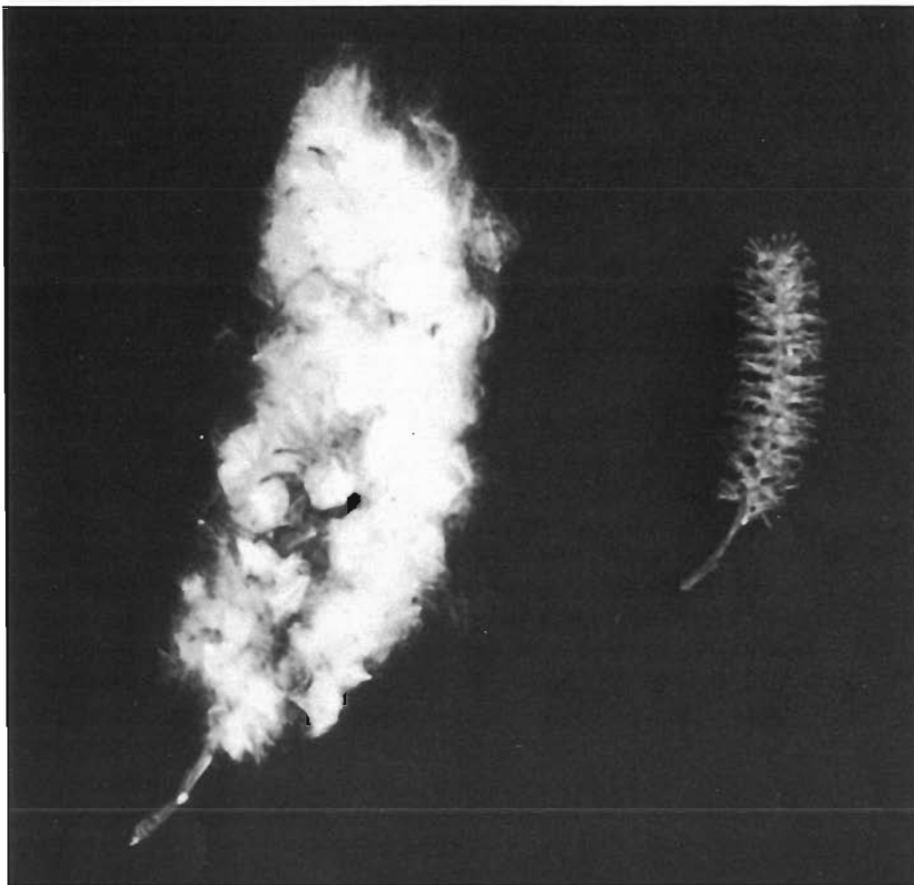
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EDITORIAL: Address all correspondence regarding editorial matter to Daniel Thayer, Editor, "Aquatics" Magazine, P.O. Box 24680, West Palm Beach, FL 33416.



The female and male flowers of willows are formed on catkin-type inflorescences which developed on separate plants

grows in the arctic regions of the world and is only an inch tall, to the black willow, which attains heights to 40 m tall. The leaf blades are lanceolate shaped, 10-16 cm long, with finely serrated margins. A single trunk or several trunks may be present bearing bark which is dark brown to black, heavily furrowed and aromatic.

The male and female flowers are borne on different plants. Small individual clusters of flowers are attached to inflorescence spikes called catkins. The staminate flowers are attached to cylindrical, erect catkins while the pistillate flowers are attached to drooping cylindrical catkins. There are no perianths or showy petals present and the catkins usually appear before or soon after the leaves start to emerge each spring. The fruit is a 1 cm long capsule containing numerous, minute, cottony or silky-haired seeds. Cross pollination often occurs producing

many intermediate forms. In some species, diploid chromosome numbers of 38,76,114, and 152 are found, thus constituting a polyploid series.

A taxonomic key to willows found in Florida is as follows:

1. Mature leaves are lanceolate.
  2. Leaf margins are toothed or finely serrated.
    3. Leaves are green beneath.
 

*S. Nigra*
    3. Leaves are whitish beneath.
 

*S. caroliniana*
  2. Leaf margins entire or smooth.
    1. Mature leaves broadly oval or oblong.
 

*S. floridana*

Willows can be found established in and along swamps, river and canal banks, sand bars, lake shorelines, boggy swales and floodplains. All species root easily and frequently form dense thickets. Willows are strictly found in fresh water areas but can not withstand continual

flooding. They have been extensively killed by high water levels in Conservation Area 3 in South Florida. Although willows are intolerant of salt water, coastal plain willow may occur in association with red mangroves. Willow heads are quite common being circular or oval shaped and sometimes atoll-like with a small central pond.

Reproduction of willows is by seed which can spread to new areas either by wind dispersion or water dissemination. Optimum germination occurs immediately after a drawdown or during draining. Willows can rapidly colonize an area, especially disturbed soils or areas recently burned. In the Shark River Slough of the Everglades, willows have taken over much of the area formerly supporting sawgrass and have replaced other swamp tree species in surrounding bay heads.

The tender twigs, buds, and foliage are fed upon by grouse, deer, elk and moose in its northern range.

Muskrats, beavers, rabbits, and squirrels utilize the bark, buds and woody portions. Willow heads are one of the favored habitats of alligators which in turn maintain depressions that fill with water and soon become abundant with fishes. The foliage of small trees provide protective shelter and roosting sites for several species of marsh birds such as the black and yellow-crowned night heron, great blue heron and the common snowy egret. Willow edges in upland areas also account for a large number of wrens, warblers and sparrows. In addition, during early spring, bees obtain nectar from the blossoms.

A stem borer, *Prionoxystus robinata*, frequently causes the breakage of willows by tunneling into the trunk. The larvae weakens the tree such that heavy winds are able to knock down the plant. The tree is usually not killed with the base soon putting out new shoots.

In the lower Mississippi Valley, black willow attains commercial timber size reaching 40 m in height and

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1 m in diameter. Its wood had been used to make boxes, furniture, cricket bats, doors, barrels, caskets and artificial limbs. Destructive distillation of the wood also makes a fine grade of charcoal and black powder, a component of black gun powder. The bark yields a tannic acid called tannin which is used in tanning leather. In addition, the bark produces salicin, a bitter white crystalline glucoside, used in biochemical tests and as a medicine (salicylic acid). In many parts of the world the branchlets are used in making baskets. The catkins are commonly called "pussy willows" and used in flower arrangements. Because of their rapid growth and a root system that forms a network which holds soil tightly together, willows have been planted along river and canal banks to prevent soil erosion from high waters. Willows can also be planted along fields to provide shade and as windbreaks.

A species of special concern is the Florida willow. This willow is usually not over 4 m tall and characterized by its very brittle branches. It grows only in very wet soils of dense swamp woods, especially along the edges of clear springs or rivers such as the Ichetucknee River. This species is endemic to two counties in Georgia and several counties scattered in Central and North Florida. Although the Florida willow is not classified as an endangered or threatened species, it is categorized as rare. There are only 12 to 15 known sites where the Florida willow can be found in the United States.

Pussy willow (*S. discolor*) is not found in Florida, but nevertheless is a plant with wide notoriety. This multistemmed small tree or shrub forms an open rounded crown and inhabits wet swamp soils and the shoreline of streams and lakes. The range of this species of willow is throughout southern Canada and northeast United States. During spring, the large catkins buds burst

and release numerous small seeds with white, soft, silky hairs commonly called "pussy fur". In winter, pussy willows can be used in flower arrangements with the twigs producing pretty golden stamens or slender greenish pistils. The species name *discolor* refers to the contrasting colors of the willow leaves which are very shiny green above and whitish below.

The weeping willow, (*S. babylonica*) is a nonaquatic willow native to China. It is frequently planted within cities worldwide as a small ornamental tree in landscape planning. Weeping willows are aesthetically pleasing trees, but sometimes they are used because of their tolerance to smoke and grime. The common name "weeping" is not derived from its long drooping branches, as many would assume. This species of willow is believed to have grown along the Euphrates River and the network of canals throughout the city of

Babylon (capital of the Old Babylonian Empire). For years the harp was a musical instrument played by the Jewish people to accompany the singing of joyful songs. But after the Jews were taken captive and forcefully moved to Babylon around 610 B.C., they didn't want to play their harps any more. They then hung their harps on the nearby willow trees and wept, thus the name weeping willow.

Willows occasionally cause water flow problems in canals or invade low water lakes during drawdowns and thus need to be controlled. Mechanical cutting of willows causes new shoots to appear at the base and therefore, control is not achieved. In nonaquatic sites, foliar spray of Arsenal, Roundup, 2, 4-D Amine, Velpar or Spike will eradicate willows. In aquatic sites, using Rodeo, 2,4-D Amine or Banvel 720 will effectively control willows.



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# Fish Kills Commonplace

by

**Tom Champeau, Fisheries Biologist**  
**Florida Game and Fresh Water Fish Commission**  
**Lakeland, Florida**

**T**he sometimes sudden appearance of thousands of dead fish is cause for considerable concern and alarm to most, but is normally a natural and commonplace occurrence.

Almost all fish kills occur as direct results from natural causes, though man's adverse influence may aggravate the frequency.

Conditions often exist in our lakes and ponds that could trigger a fish kill. If one or even several of these conditions are present, it probably isn't enough to kill fish. The right, or in this case the wrong, conditions must combine for fish to die.

Weather, the type of algae present, water temperature, water depth, water quality, presence of viruses and the types and number of fish in the system are all factors that figure into the making of a fish kill.

The most frequent cause of fish kills in Florida is the direct result of too little oxygen in the water. Seldom, however, is the lack of oxygen the direct cause of death.

We rarely see a fish kill where the lack of oxygen, suffocation, is the sole cause. More often than not, lack of oxygen precipitates stress which weakens the fish making them susceptible to virus or bacterial infection. The infection is actually what kills the fish.

Dissolved oxygen, or DO, is what fish breathe. It is produced through photosynthesis by microscopic plants such as algae.

As long as these plants have sunlight, they produce oxygen. During periods of low light, however, algae respire or uses oxygen. The results are low DO levels.

Low DO levels can occur anytime

of the year, but it's during the warmer months when other conditions are prevalent that they occur most frequently and with more adverse results.

Cloudy days, periods of low light, are almost an every day occurrence during the summer rainy season and the wind may lay calm for days. The cloudy days cause the abundant algae to respire oxygen. Oxygen that is left is not mixed by the action of the wind.

When combined with the presence of bacteria, viruses, poor water quality and high numbers of more susceptible fish, a DO or DO-related kill is likely to take place.

Concentrated fish, limited food and less oxygen will severely stress fish, making them more likely to succumb to virus or bacterial infection which also proliferates in crowded conditions. Drought related fish kills are often much more intense.

Though the apparent loss of fish may seem devastating, it is very seldom that there is a total loss of all fish and, a kill will actually do more long term good than bad.

The positive end of a fish kill is that it will stimulate production and eliminate over populated species such as shad and bluegill. The ultimate result is a much more balanced fishery.

Most fish kills, regardless of cause, occur on small ponds, retention areas and canals – particularly in urban or residential areas – because conditions necessary frequently exist.

It's also because they are common in these systems that GFC receives

hundreds of calls each year, concerning fish kills, in the south region alone.

The majority of fish kills are naturally occurring so there is really nothing that can be done to prevent them or stop one once it starts.

Kills resulting exclusively from inadequate oxygen are almost immediate, occurring in one day. During DO related kills, the most common, one generally finds fish dying over a three or four day period.

Pollution related kills also occur rapidly but there are other indications, such as film on the water, odor, or the presence of all types of dead or dying animals.

Should anyone suspect that a fish kill is the result of unnatural causes, they should call GFC's Regional Office in Lakeland at 813-644-9577.

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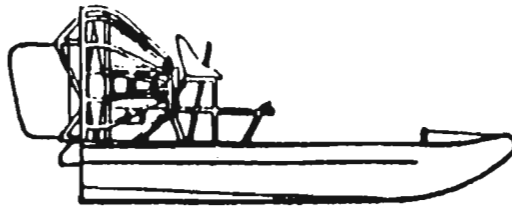
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# ENEMY MINE AN APPLICATOR'S VIEW

By  
**A.J. Nigels**  
**Lead Aquatic Plant Technician**  
**Citrus County, Aquatic Services**

You cause so much trouble in our rivers and streams  
to be rid of you is an applicator's dream.

Once thought a benefit to a variety of fish  
to be rid of you is an applicator's wish.

Though folks try to fish, to ski and to swim,  
with you in our waters, this looks rather slim.

You grow in places that is of seldom heard  
I'll be rid of you, you just take my word.

I've tried every method from above to below  
But you just defeat me, as you continue to grow.

Though not here too long,  
I see that in time  
you could turn all our waters to goo and to slime.

There are people that hate me, as I work through the day  
some say that they like you, even want you to stay.

This I'll agree, some plants have their place  
then there are those that take up their space.

So take my advice, as I'm out here each day  
you plants pack your bags, and be on your way...

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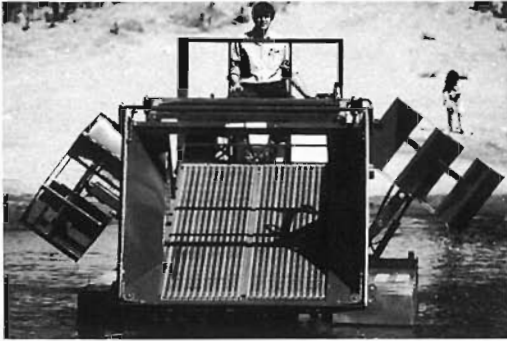
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## You Know It's Going to be a Bad Day When:

By

Citrus County Aquatic Services

1) You skip out on part of a F.A.P.M.S. Meeting to buy a new fishing pole and your ticket number is drawn for the new fishing pole.

2) Bill Haller tells you to pour this red dye into your mix tank and says "no problem"!

3) You attempt to step out onto a large rock in the canal and it turns out to be just a chunk of styrofoam.

4) After being reprimanded for losing too many staple guns, your

new partner drops another one overboard.

5) You take your wife to Daytona Beach for the first time and too many people know you.

6) You demonstrate how to safely operate an airboat and sink it in the process.

7) You attempt to snatch a stuck harvester off a sandbar with the rope tied to the cage of your airboat and chunks of varnished wood, tubing and wire start falling from the sky.

8) You allow your airboat, which is overloaded with people and the heaviest man is on the bow, to come down off a plane too fast in an alligator infested area and the rescue team is chanting "Let'em feed!"

9) You finally get your trailer out of a bad boat ramp and your axle is gone.

10) Dan Thayer wants a new "You know it's going to be a bad day when!" list.

ACTUAL RISKS	NUMBER OF DEATHS
1 Smoking	150,000
2 Alcoholic Beverages	100,000
3 Motor Vehicles	50,000
4 Handguns	17,000
5 Electric power	14,000
6 Motorcycles	3,000
7 Swimming	3,000
8 Surgery	2,800
9 X-rays	2,300
10 Railroads	1,950
11 General Aviation	1,300
12 Large construction	1,000
13 Bicycles	1,000
14 Hunting	800
15 House appliances	200
16 Fire fighting	195
17 Police work	160
18 Contraceptives	150
19 Commercial aviation	130
20 Nuclear power	100
21 Mountain climbing	30
22 Power mowers	24
23 Scholastic football	23
24 Skiing	18
25 Vaccinations	10
26 Food coloring	
27 Food preservatives	
28 PESTICIDES	
29 Prescription antibiotics	
30 Spray cans	

NOTE:

These data are ranked according to reported annual U.S. deaths. Numbers 26 thru 30 had no reported deaths and are thus listed alphabetically.

# Perception vs. Fact

Where do you rank pesticides in the list of the 30 risks to our health and mortality? In the survey reported by *Scientific American* in February 1982, business and professional people ranked them number 15. The League of Women Voters ranked them ninth, and college students ranked them fourth, ahead of alcoholic beverages and motor vehicles.

What many people perceive to have the greatest risk often does not correspond to the facts. According to *Scientific American*, pesticides ranked less than 25 out of 30. The accompanying chart ranks the number of deaths annually due to these 30 causes as they have been determined by actuarial estimates. (*The Bottom Line*, Spring 1989)

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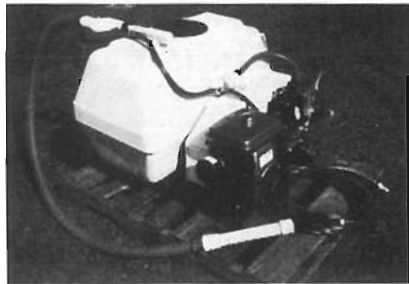
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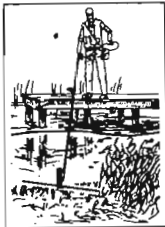
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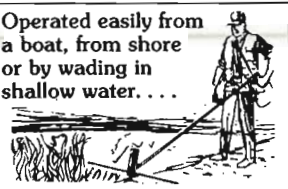
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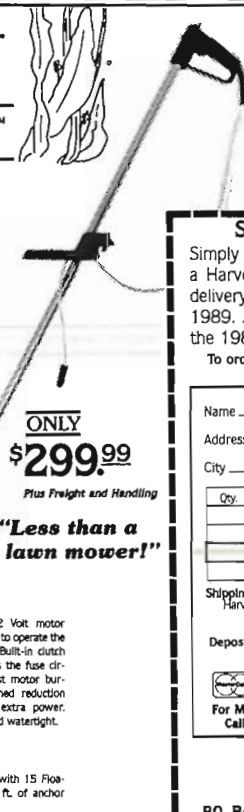
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# The Everglade Kite

by

Jesse Griffen

Herbicide Applicator

South Florida Water Management District

Okeechobee, Florida

The Everglade kite is a dark colored, 17 inch long, hawk-like bird. When fully extended, its broad wings span 45 inches, and lend themselves well to the bird's airborne hunting techniques. Unlike ospreys and terns which dive into the water for their prey, the kite hovers and only reaches into the water with its talons to grab its food. The sharply hooked beak is adapted for extracting its principal food, the Apple Snail, from its shell. The adult male is slate gray, with a distinct white patch at the base of its squarish tail, and the legs are reddish in color. The female and juveniles also bear this white patch, but are mottled brown in color.

This species declined dramatically in numbers principally due to loss of habitat by drainage activities in central and south Florida. In 1973 the U.S. Congress passed the Endangered Species Act, which provided for the classification of wildlife species as "Endangered" or "Threatened", and mandated legal protection for species so listed. In justification for such protection, the act states that various species of fish, wildlife, and plants have aesthetic, ecological, educational, historical, and scientific values.

Endangered is defined as: a species, subspecies, or isolated population, that is or soon may be, in immediate danger of extinction unless the species or its habitat is fully protected and managed for its survival.

#### *Distribution and Habitat*

The Everglade kite, or as it is sometimes called, the Snail kite, is unique to the State of Florida, it is one of the rarest birds in the United States.

Until the early 1920s the Everglade kite was common in the fresh water marshes throughout peninsula



*Extracted Apple Snail*

Florida. However, a census in 1950 revealed a population of less than 100 Everglade kite in existence. There is a subspecies located in Cuba.

During the winter of 1986-1987, a survey was completed that showed a total kite population of 563 birds.

The winter survey of 1987-1988 showed a total bird population of 326 birds, a 42% decrease from the number of kites observed in the field the previous year. Although the 1988-1989 report has not yet been released, there is once again a decrease in the number from the previous year, especially in Lake Okeechobee which is almost entirely due

to the low water levels.

Of the 326 birds surveyed in 1987-1988, 94 birds were located in Lake Okeechobee. Last year's nest count on Lake Okeechobee was 34 nests with at least one egg. Additionally, 5 more nests were started but never completed. In 1986 there were 90 nest sites. This year there were only 2 nest sites located.

The main nesting area on Lake Okeechobee for the Everglade kite is on the northwestern side in the area located between Indian Prairie Canal, north to the access canal to Buckhead Ridge. The main concentration of birds is in the area north of Indian Prairie to Tin House Cove, which is approximately halfway to Buckhead Ridge. In February of this year, a total of 28 birds were counted in the air at one time in this area. Some kites have been observed in the area south of Indian Prairie Canal to Harney Pond Canal, and on the eastern side of Observation Shoal. It has been reported that two kites nested this year on the northeastern shore of Lake Okeechobee in the Henry Creek area.

The Everglade kite's diet consists of the Apple Snail. He will glide over open water areas with submerged vegetation where the snails are feeding, drop down with his talons and catch the snail. The snails must be within five or six inches of the top of the water. He will then fly to a perch where with his specialized hooked beak remove the snail from the shell. The perch areas are very easy to find because the kite will use the same perch several times and the empty shells will be laying all around the site. Perches are located along the heavy cattail line or in clumps of cattails in the open water areas. The nest is usually built deeper into heavy cattails.

Starting in July of 1987, a series of



Typical Kite foraging habitat.

monthly meetings were held between the U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, Florida Department of Natural Resources, Florida Game and Fresh Water Fish Commission, and the South Florida Water Management District, to come up with a plan to control water hyacinth and water lettuce in the kite nesting areas.

Large mats of hyacinth were being

moved by the wind and wave action into the bulrush and cattail areas. Thus destroying breeding areas for Apple Snails and nesting sites of the kites. These large mats of hyacinth were also covering up open water areas of submerged plants where the snails and the kite feed.

In the past, the areas on the north-western shore of Lake Okeechobee were sprayed on a year round basis.

At an interagency meeting it was decided that the spraying would be done November through February, because the kite's nesting season runs from March through July.

It was agreed that:

(1) Prior to the initiation of nesting activities, an intensive spray program should be conducted using diquat and 2,4-D to minimize floating vegetation impacts to potential nesting areas.

(2) No spraying will occur in the areas identified as having active kite nesting between March 1 through July 7 (plus 14 days, if suggested by site assessment). A buffer zone of 100 yards from the colony's definable perimeter will be established. Isolated nest sites should have a buffer zone of approximately 25 to 50 yards.

(3) Cooperative site assessment to define areas to be protected with buffer zones will be conducted by the U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, Florida Game and Fresh Water Fish Commission, Florida Department of Natural Resources, and South Florida Water Management District.

## United Marine Weed Harvesters

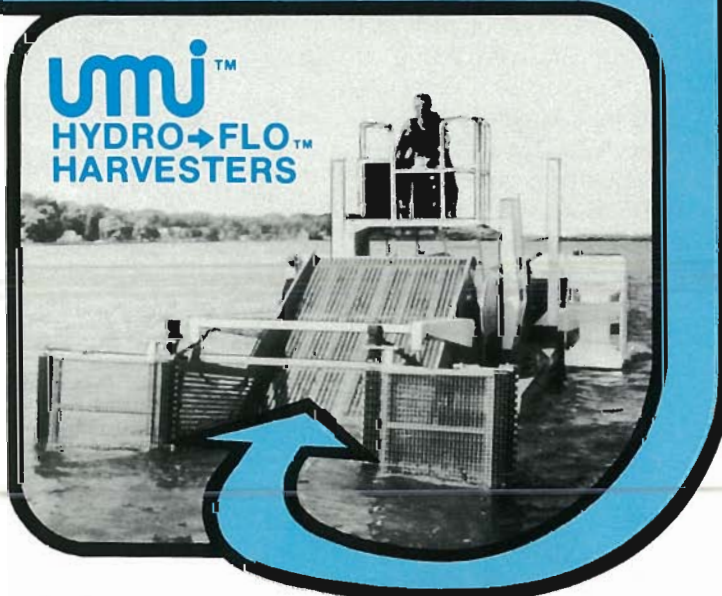
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(4) There will be assignment of designated South Florida Water Management Aquatic Weed Control crews to conduct herbicide applications in windowed buffer zone areas.

(5) Resume normal nuisance vegetation control efforts after July.

Spraying began on November 10, 1987 in the area from Indian Prairie to Buckhead Ridge. The work was concentrated from the outside edge of the bulrush, through the bulrush and cattails, to the heavy cattail line.

We used diquat at 1/2 gallon per acre, Nal-Control or Nal-Control II at 1/2 gallon per acre, and X-77 at 1 pint per acre, an airboat, and a hand held spray gun. Aquatic vegetation sprayed was 90% water hyacinth and 10% water lettuce. Using the spray to wet method, and holding the gun low and spraying through the bulrush and cattails, minimum damage was done to the native vegetation with good control on the hyacinth and lettuce.

One of the problems that we had in the area where we started was that between the bulrush line and the heavy cattail line there was a lot of open water that was packed with

hyacinth. We would spray a section and a week later a new batch of hyacinth would be blown into the area and we would have to go back into the area and start all over again.

After a few weeks of spraying we began to notice that the kites always seemed to be feeding ahead of us, choosing not to feed in treated areas. Bruce Tarr and I started to ask each other some questions. Was the diquat having some effect that we didn't know about? Were we getting too much diquat in the water column and making the snails feed at a depth where the kites could not reach them? Were the snails moving from the sprayed areas? We talked all of this over with our supervisors, Terry Peters and Lloyd Mitchum.

It was decided that we would skip an area and begin spraying and see what the kites did then. As soon as we skipped an area, we observed that after a week or so the kites appeared to be feeding in all areas. The only conclusion we could come up with was that the kites no longer felt threatened by the airboats.

As one of the agencies that planned, and implemented this project, we

feel that the effort was a complete success. During the 1988 and the 1989 kite breeding season on Lake Okeechobee, no active nests were disturbed by floating vegetation control activities. Through a combined cooperative effort between various resource management agencies, an integrated management plan was developed and implemented to control nuisance floating vegetation before it could cover kite foraging habitat, or possibly impact kite feeding areas. Furthermore, the plan limited the extent to which soft, emergent vegetation supporting kite nests was exposed to herbicide, thereby eliminating the possibility of collapse of the nesting substrate.

Continued efforts such as this can only benefit the species. We look forward to further integrating the Aquatic Plant Management Program in the District with this and other associated Wildlife and Fisheries Management Programs.

A special thanks to Hank Smith, Florida Department of Natural Resources, for reviewing this article.

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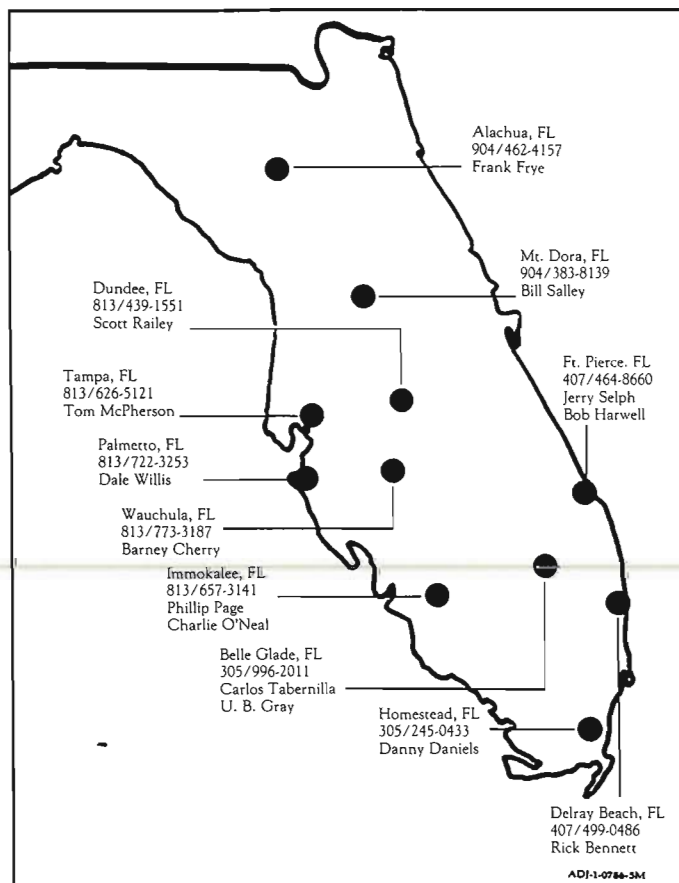
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Water lettuce pond in Pasco County.  
Photo by: Monica Dear, Pasco  
County Mosquito Control.

# The Phytogeography and Paleofloistics of *Pistia stratiotes* L.

by  
A.A. Stoddard III

Department of Agronomy  
University of Florida  
Gainesville, Florida

## Introduction

*Pistia stratiotes* L. or 'water lettuce' is a free floating aquatic species of the family Araceae. The proliferation of the plant in fresh water aquatic ecosystems throughout the tropical and subtropical regions of both hemispheres, and the subsequent weedy problems which result, are perhaps its most recognizable characteristic. The species seems most adapted to ponds, lakes and slow running rivers and streams and does not tolerate salinity or frost (30).

*Pistia* is characterized by its grey-green rosette of arenchymous obovate ribbed hirsute leaves, which are reproduced vegetatively through stolons or sexually through seed. The flowers of *Pistia* are perfect and are borne on a minute axillary spadix, subtended by a spathe. The resulting fruit possesses numerous seed which are approximately two millimeters in length and may germinate on the water surface (22, 32).

Historical references to *Pistia* are numerous. The ancient Egyptians incorporated into their written language a hieroglyphic symbol, which resembled a diagram of *Pistia* and meant purification. Apparently, nobility used the plant to cleanse the water in their private bathing pools (25). The Greek botanists Dioscorides and Theophrastus described the plant in floating mats on the Nile. Others noted its presence on the Nile to 13 degrees North, above which little more was found (25). This phenomena was most likely due to frost.

Medicinal and other uses of *Pistia* are also numerous. Ancient Egyptians employed the plant for treatment of fractures and kidney hemorrhages (25). The peoples of China, Southeast Asia, Malaysia, India, Africa, South America and Middle America all employed the plant for the treatment of afflictions such as venereal disease, boils and skin con-

ditions, diabetes, cough and asthma, dysentery, constipation, and ringworm. The plant has also been used as a aphrodesiac in China and as famine fare in India (when cooked) (24, 25, 26, 28).

## Floristics and Paleofloristics

The present distribution of *Pistia* is pantropical (ie. throughout the tropical regions of the earth) (9, 10, 11, 16, 30, 32). In Florida, William Bartram noticed *Pistia* in the St. Johns River, Dexter Lake, Lake Beresford, Salt Springs Run and the Suwannee River. (17). In North America, *Pistia* is found in a strip along the Gulf Coastal Plain to Texas and Arizona (30, 32). Various floras, texts and papers note locations throughout Central America (6, 31), the Antilles (6, 18, 28), South America (2, 6, 10, 23), Africa (2, 6, 10), Madagascar (6), India (10), southern and eastern Asia (6, 10, 24, 26) and Malaysia (6, 10, 24, 26).

Numerous fossil floras indicate

that the genus *Pistia* may have had a cosmopolitan distribution. It is important to mention that botanists consider the present-day genus to contain only one species, and it is therefore monotypic (10, 16). However, it may be disputed as to the existence of this trend in geological time. Fossil evidence reveals plants (both leaves and seeds) which show many similarities and few morphological differences from the present species (6,13).

The earliest finds of *Pistia* are from Upper Cretaceous strata in present-day Wyoming (20, 21), North Carolina (4), and southern France (29). This evidence indicates that the genus existed on two continents between 65 and 103 million years ago (MYA). Angiosperms are believed to have evolved in the Lower Cretaceous (approximately 120 MYA). Floras from the Wilcox formation of the Eocene epoch (35-54 MYA) indicate that the genus existed near present-day Nabornton, Louisiana (3, 5) and Grovetown, Georgia (6). Surprisingly, a fossil species of *Pistia* has been described in Oligocene (26-38 MYA) and Miocene (7-26 MYA) strata from western Siberia (8), indicating the striking changes in the earth's climate over the millenia. More recently, a fossil *Pistia* was described from Miocene strata in Denmark (13). Other finds include Miocene *Pistia* from West Germany (13).

This evidence indicates that the genus may have been widespread over the Northern hemisphere throughout the Cenozoic (65-2.5 MYA) Era and widespread over North America in the Upper Cretaceous Period. A widely accepted axiom of paleoecology states that environmental adaptations of species do not change. Through combination of this rule with geological evidence it is possible to describe the environmental conditions which may have existed at this time. Paleobotanists and geologists describe the climate of the Cretaceous and most of the Tertiary period as mild temperate and subtropical climates sup-

ported by vast inundations of seas upon the continents. This climatic trend has been theorized to have climaxed during the Eocene Epoch which is marked by subtropical climates, melted polar ice caps and heavy rainfall. Such a climate would indeed have supported habitats conducive to the growth of *Pistia* in much higher latitudes compared to present-day climate, as evidenced by the fossil records. Theories on plate tectonics have also raised the possibility that the shapes of the continents, and connections between them, were markedly different than today. Considering the flooding which occurred during the millions of years of these geological time frames, the spread of *Pistia* over the continents is more than a remote possibility.

An alternative means of migration should also be considered in *Pistia*. Most of the seeds of the family Araceae are eaten by birds (12). If the berries are eaten by birds and can float and germinate on water (22), an additional explanation is available for its past and present distribution. Engler (10) attributes the dispersal of *Pistia* seed to waterfowl. Ridley (27) mentions that the seed are contained in a berry which may attach to the legs of birds that walk on *Pistia* mats or on damp shores on which the seeds are known to germinate. He also noted that the plant can become established in isolated ponds in Africa and Asia which are not frequented by man. From such evidence, north-south migratory routes for the plant between continents in each hemisphere may be established.

Man may also play a role in the dispersal and migration of *Pistia*. The widespread and varied medicinal reputation of the plant and its use as pig feed (27) may provide an indirect means of establishment in new areas, through man. The use of the plant, with travelling Chinese men, has been reported in Singapore (27).

The center of origin of *Pistia*, despite the fossil record, is not clearly established. Presently, no one partic-

ular fossil predates all others, and the earliest finds are on two different continents. However, the Black Creek Formation in North Carolina (4) shows an unusual abundance of *Pistia* as compared with other fossil floras, but this evidence is inconclusive. The lack of additional finds in the southern hemisphere add to this quandry. In addition, the genus is monotypic, ruling out location of the center of diversity, which in turn could indicate the center of origin.

In view of these restrictions, several theories have been forwarded as to the location of the center of origin for *Pistia*. Bennett (2) reported that the greatest diversity of insects which feed on *Pistia* is in South America. From this observation, he concluded that South America is the likely origin of the genus. Holm et. al. (19) reported that the greatest production of seed per plant and, thus, the center of origin was in Africa. Others have postulated that North America cannot contain the center of origin because of a lack of insect pollinators (32). Although these theories have solid evolutionary foundation, a search of the literature provides for little widespread acceptance. An alternative way of narrowing down a center of origin could be through chromosome counts ( $2n=28$ ) (22) or karyotyping, however, this is contingent upon the existence of polyploidy in the gene pool. Presently, it appears that the best potential for the location of the center of origin for *Pistia* is a thorough search in the fossil flora.

The present pantropical range of *Pistia* seems to be stable or slightly decreasing. Occasionally the plant proliferates becoming a pest. Herbicide application probably has no effect on the overall range because man is simply managing problem populations. A greater danger to the range of *Pistia* is indirectly due to man. The introduction of *Eichornia crassipes* or 'Water Hyacinth' to lakes and waterways around the world, which are native to *Pistia* populations, usually results in displacement

of latter. Recent studies show that at an initial 50%-50% population ratio of each species results in 5 times more biomass of *Eichornia* vs. *Pistia* in nine weeks (1).

**Summary and Conclusions**

A review of the available fossil floras indicate that throughout the Tertiary and perhaps the Upper Cretaceous periods of geological history, the genus *Pistia* was widespread throughout aquatic habitats of the warmer regions of the earth. Climatic conditions of the time and the dispersal potential from birds (which had developed considerably by the time in question) may help to support this claim. As time progressed to the colder climates of the Pleistocene Epoch (2.5 MYA), a retreat of the genus equatorward undoubtedly occurred. This may have put considerable survival pressure on the genus, perhaps eliminating species which may have existed. The distribution of the genus may have been forced into isolated refugiums, elimi-

nating the genus from large areas. Retreat of the last glaciers (5,000 years) provided for migration of the genus into higher latitudes on a worldwide or continental basis through water flow, bird dispersal or man.

Recently, questions have been forwarded as to whether *Pistia* is native to North America. On a geological time scale, through fossil evidence, *Pistia* seems to be native to both hemispheres, at least since Eocene times. On a human time scale, the absolute question still remains – native or exotic? It should be noted, however, that bird dispersal and medicinal folklore of Cuba and South America indicate a widespread distribution of the genus since antiquity in the Western Hemisphere.

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# AQUAVINE



## ANNUAL MEETING NOTES

The theme for this year's banquet will be a luau, so bring your favorite Hawaiian dress for this festive feast. (Can you picture Corbin in a grass skirt?)

Don't forget to bring your favorite 8x10 color photo to the meeting for the annual photo contest and give them to Terry Peters, Awards Committee Chairman. Photos must be 8x10 to qualify.

If you have equipment to display, especially antiques, contact "Tex" Ivy ASAP.

Bring plenty of extra money for raffle tickets, because you will want to purchase from the raffle team of Haller and Cummings.

## MORE MIMOSA

The exotic *Mimosa pigra*, has once again reared its ugly claws. This time Mimosa was found on the North Fork of the St. Lucie River in St. Lucie County, Florida. The DNR is currently investigating the extent of the problem and a control program is being formulated.

## COLOMBIAN SCIENTISTS VISIT USA

Two water resource managers from Bogota, Colombia recently visited California, Arizona, and Florida in hopes of learning more about aquatic plant management in the States. The tour started in Phoenix, at the annual meeting of the Aquatic Plant Management Society and ended with a weed control demonstration in Miami area canals on August 4.

## DNR

Long time DNR biologist Larry Nall, has moved into another bureau within the Department. Larry will now be involved in marine research

for the Marine Sanctuary and Estuarine Reserves Bureau, a discipline closely related to his formal training. Good luck, the water weed world will miss you.

## FLMS

The first annual meeting of the Florida Lake Management Society will take place October 13 and 14 at Rollins College, in Winter Park, Florida. For more information, contact Mr. Kay Yeuell, at 407-644-7458.

## DNR-AGAIN

On July 27, the DNR held a public meeting in West Palm Beach regarding a proposal to add *Melaleuca quinquenervia* to the prohibited aquatic plant list. There was overwhelming support for this proposal from those who attended. The only opposition came from bee keepers, who were concerned the state would initiate an eradication program on a tree they claim in worth 12 million dollars to the honey production industry.



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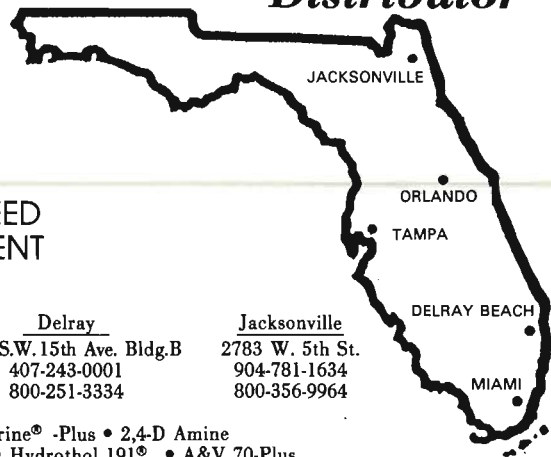
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