

# aquatics

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# Aquatics

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Looking back to my June 1979 issue of *Aquatics*, a question was asked of the membership: "What are the major problems you encounter in your aquatic plant control programs?" The number one answer: Dealing with the public.

Ask any management agency or private business today what their number one problem is and you'll probably get the same response. Have we made any headway in public education or community involvement? Or, are we just spinning our wheels? It may feel like we are spinning our wheels, but public education must be a constant effort. As the population of Florida continues to rapidly grow, and as more people utilize our public waters, the organizations responsible for their management will continue to receive public comment and criticism. However, I feel we (the aquatic plant management industry) have made some positive efforts in the P.R. business.

Example: Recently, at an outdoor writers conference some questions came up about hydrilla management, half of the answers, knowledgeable answers I might add, came from the audience. In the last year or so, several outdoor writers from newspapers around the state have written about aquatic plant control in a positive vein, WOW!

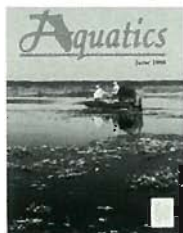
Example: A member of the Lake Santa Fe Homeowners Association became so interested in lake management and the role the homeowner should play, that she took a leave of absence from her teaching appointment to work part-time at the Center for Aquatic Plants coordinating homeowners around the state.

These examples are reflections of our increasing emphasis on getting more information to the public via public meetings, extension materials, and personal contact.

Keep up the good work!!

Dan Thayer

## ABOUT THE COVER



Bruce Tarr and Jesse Griffen spraying water hyacinth on Lake Okeechobee.

Photo by:  
Terry Peters

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# "Giant" *Lyngbya*

By

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Exceptionally large-celled, "giant" species of the filamentous blue-green alga, *Lyngbya*, form undesirable floating mats in some southeastern lakes and ponds (Figure 1). Unlike the smaller *Lyngbya* species which produce an occasional patch of mucilaginous surface mat, the floating mats of "giant" *Lyngbya* are thick, robust and may extend across entire coves and small ponds. Mats are composed of entangled filaments, with the size and consistency of long strands of coarse human hair. Wind action, as well as intrinsic growth, forms mats which may extend several feet in depth. These mats seriously impede navigation, limit recreational use, and introduce clogging problems at water intakes. As if to compound the insult to local residents, mats of "giant" *Lyngbya* emit a strong earthy or musk-like odor that permeates households surrounding infested water. It is with this negative background that we began our studies of "giant" *Lyngbya*.

## Classification and Description

Depending upon the characteristics emphasized, *Lyngbya* may be classified as a member of either the Blue-Green Algae (Class Cyanophyceae) or the photosynthetic bacterial group called the Cyanobacteria. The ambiguous classification portends the unusual nature of these organisms. *Lyngbya* is clearly a prokaryote because, like bacteria, it lacks nuclei and other membrane-bound organelles, but it also possesses a number of features associated with algae. For example, the size, shape, pigments and photosynthetic oxygen generation system are all characteristic of algae. An individual disc-shaped cell of a "giant" *Lyngbya* is huge compared

to most bacterial cells. A typical *Lyngbya* cell, having a cell diameter of 30-70 micrometers, and a length of 4-7 micrometers, could be packed with more than ten thousand bacterial cells. In addition, the coarse, hair-like *Lyngbya* filaments reach lengths in excess of tens of centimeters as they intertwine within a healthy mat.

The structure and properties of an individual *Lyngbya* filament is characteristic of the algal family, Oscillatoriaceae. Filaments contain only large, discoid cells, and no specialized cells, stacked within a firm, polysaccharide sheath, much as pennies are stacked within a roll of coins (Figure 2). These stacks of cells are called trichomes and a sheath-encased trichome is a filament (Figure 4). Filament growth occurs when any cell of

the trichome undergoes a fission type of cell division. Meanwhile, sheath development keeps pace with expansion as every cell of the trichome continuously secretes new sheath material. As a consequence, older regions of the sheath become markedly layered and reach thicknesses of 2-7 micrometers, whereas new sheath, formed around actively growing protruding tips of the filament, is very thin (0.3-2 micrometers).

Filaments do not easily split, tear or divide, due to the resistant character of the sheath. Instead, the internal trichomes break into fragments called hormogonia (Figure 4), which are slowly ejected from the sheath and form new filaments. Hormogonia are the only disseminules. They form as cells die of natural or chemi-



Figure 1. Surface mats of "giant" *Lyngbya* in a Georgia lake.



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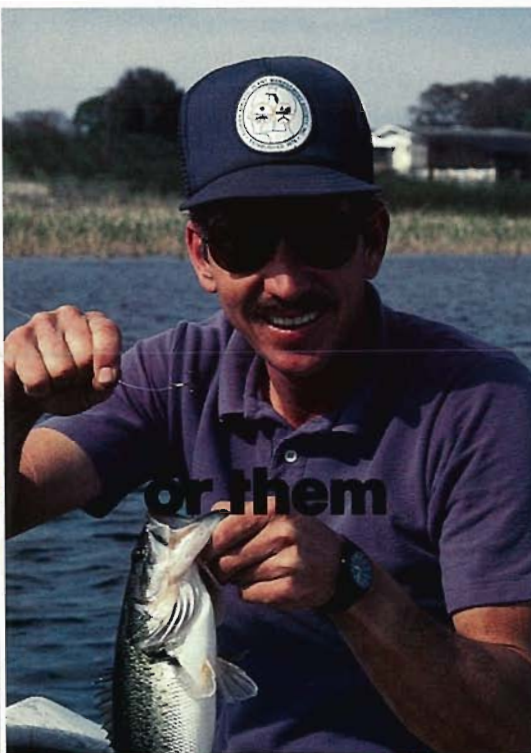
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cally-induced causes, such as some herbicide applications (Aurora and Gupta 1983), or when cells sustain physical breakage. The latter is easily induced by physical actions such as mechanical harvesters, the raking of mats by homeowners or disruption of mats by motor boats. *Lyngbya* cell structure encourages this easy breakage; cells are encircled by orderly "breakaway rings" of microscopic pores.

An array of photosynthetic pigments permits *Lyngbya* to exhibit several colors. Fundamental to all oxygen-evolving photosynthetic organisms is the green chlorophyll *a* pigment. In addition, *Lyngbya* possesses some orange and yellow-colored carotenes and xanthophylls, some of which are unique to the blue-green algae. The most important accessory pigments in *Lyngbya* are the red and blue colored, water soluble phycobilins: phycoerythrin; phycocyanin; and allophycocyanin. Relative concentrations of these pigments allow *Lyngbya* species to appear red, green, blue-green or black.

The color of *Lyngbya* filaments and their maximum photosynthetic rates vary in response to available light (Figure 3). Benthic mats are extraordinarily black, due to an abundance of phycobilins which harvest low intensity light for use in photosynthesis. Thus the term, "black algae" is often used to describe *Lyngbya* species. At the mat surface, where light intensity is maximum, chlorophylls and phycobilins are bleached (photo-oxidized); therefore, photosynthesis is minimal (Figure 3). Blue-green filaments characteristically trail down into the water from the underside of the surface mats. These "streamers," which are shaded by the surface mats so as to receive only 1-2% of sunlight, exhibit maximum rates of photosynthesis.

## Field Identification

*Lyngbya* can be distinguished

from other filamentous nuisance algae by its dark color, unbranched, entangled filaments, and characteristic "earthy" odor. All of these features can be observed in the field, without need for a microscope. Mat color ranges from black in benthic and newly-recruited surface mats to yellow-orange tones in photo-oxidized surface mats. This contrasts with the distinct green shades of *Cladophora*, *Pithophora*, or *Spirogyra*. In addition, *Lyngbya* is neither as "slimy" as *Spirogyra*, nor as coarse-textured as *Pithophora*. *Lyngbya* and *Pithophora* are also distinguished by branching patterns. *Lyngbya* is unbranched and resembles coarse hair, whereas *Pithophora* is highly branched and distinctly tufted (Lembi, et al. 1985).

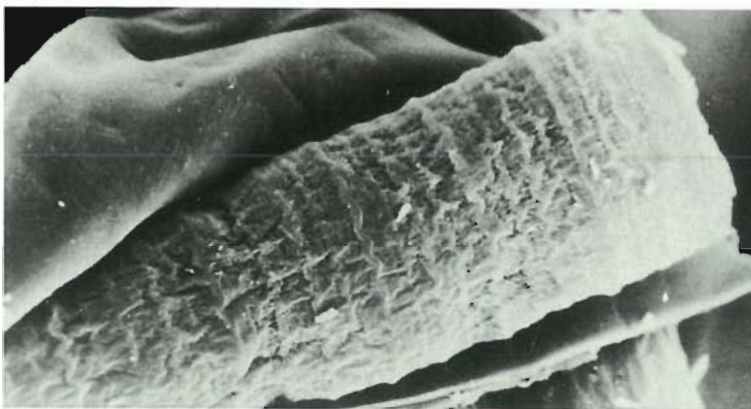


Figure 2. A Scanning Electron Micrograph of a "giant" *Lyngbya* filament. The sheath has been split to reveal the stacks of discoid cells within.

## Taxonomy

"Giant" *Lyngbya* forming nuisance growths have been variously identified as: *Lyngbya magnifica* Gardner; *Lyngbya majuscula* Harvey ex Gomont; and *Lyngbya Birgei* G.M. Smith. *L. Birgei* was originally described, from the plankton of a Wisconsin lake, as having trichomes 18-22 micrometers in width. In contrast, trichomes of both *L. majuscula* and *L. magnifica* are considerably larger, encompassing the size range from 32-80 micrometers in width. The species, *L. majuscula*, includes many marine representatives, a fact which encourages speculation as to a marine origin for the mat-forming taxa. This species also is implicated in outbreaks of "swimmer's itch" and has potential uses as an antileukemic agent

(Mynderse et al. 1977). *L. magnifica*, in contrast, was originally described from a water reservoir in Puerto Rico and has no documented toxic or beneficial effects. The *Lyngbya* forming noxious surface mats may belong to any or all of these species.

The thick, firm sheath encasing *Lyngbya* cells is characteristic of the "giant" members of the genus, and may be a key feature in generic assignment, mat formation, dessication resistance, herbicide tolerance and the very slow decay of dead filaments. The firm sheaths of various specimens, collected during all phases of growth, measured 0.3-9 micrometers in thickness. These are extraordinarily thick sheaths, especially when compared to those of the smaller-celled *Lyngbya* species.

Sheath morphology is an important feature in traditional taxonomy, though recent investigations (Droet 1968; Foerster 1964; Rippka et al. 1979) determined it to be unreliable. Droet (1968) discarded most sheath characteristics and classified the various "giant" *Lyngbya* within the species, *Oscillatoria princeps* Vaucher and *Microcoleus lyngbyaceus* (Kutzing) Crouan. Despite these

studies, much field identification of blue-green algae uses genus and species names from standard physiological references (Desikachary (1959); Prescott (1962); Smith (1950); Whitford and Schumacher (1973)). Since new species are invariably described from field populations, these names are useful in that they denote environmentally-induced variants, but confusing when comparing collections from various locations.

Environmental factors such as habitat, nutrient supply and age of the filaments all affect sheath morphology and thus bias sheath-based identifications. Several purported *Lyngbya* specimens collected in North Carolina and Florida were identified, after microscopic examination in the laboratory, to be *Plectonema Wollei* Farlow ex Gomont. *Plectonema* is



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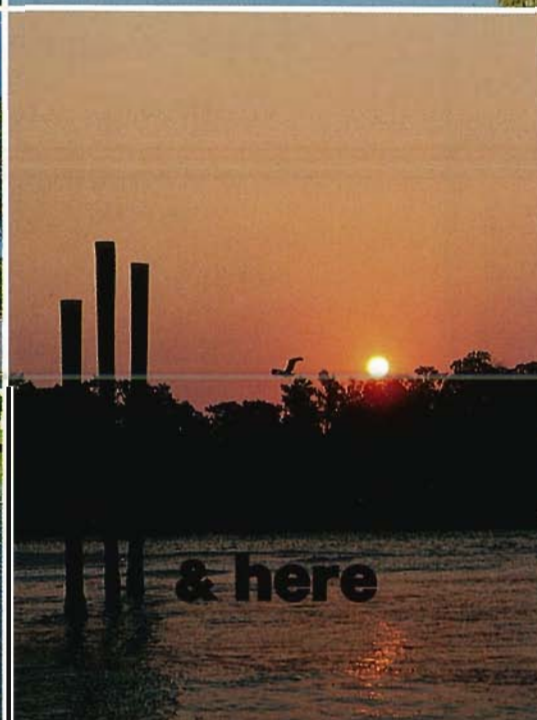
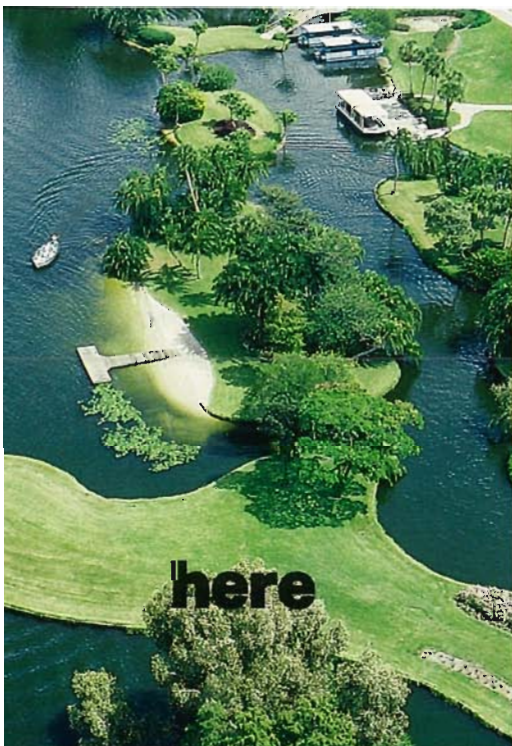
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distinguished from *Lyngbya* solely by the presence of "false branches" on *Plectonema*. A false branch is created when a hormogonium extends through a lateral break in the sheath, and elongates (Figure 4). However, false branching may be extremely rare in many situations which support growth of healthy filaments (Rippka et al. 1979). In fact, distinguishing these two species may be impossible and always requires microscopic observation. The striking overlap among taxa designated as *Lyngbya*, *Plectonema*, and *Phormidium* caused Rippka and her co-workers (1981) to unify all into a common "LPP-Group."

A taxonomic and biogeographical study currently underway at Clemson University may resolve these problems. Examination of *Lyngbya* mats from diverse locations has been made possible by the kind efforts of field workers throughout the southeast who have provided us with material. However, completion of our study, especially its geographical extension outside of the southeast, necessitates obtaining additional specimens. Anyone able to assist is asked to send specimens of *Lyngbya* (a handful sealed in a plastic bag is easily mailed), accompanied by a description of the site and any habitat information (such as known nutrient inputs or water management practices). Samples are preserved and permanently housed within the Clemson University Herbarium.

#### Distribution and Habitat

Our field and laboratory studies indicate that *Lyngbya* infestations in the southeastern United States are associated with eutrophic, alkaline water of moderate calcium concentrations. Beer et al. (1981) demonstrated the ability of *Lyngbya birgei* to utilize bicarbonate ions, and thus photosynthesize independent of the availability of aqueous carbon dioxide. This characteristic renders *Lyngbya* an efficient competitor in environments where dissolved carbon dioxide is limited, such as the high pH levels in warm, shallow, productive water bodies during the summer. Laboratory nutritional studies, as well as chemical analyses of *Lyngbya* — infested

lakes, indicate the positive relationship between elevated phosphorus and calcium levels and *Lyngbya* growth. Thus the common fish pond management practice of adding lime in conjunction with nitrogen and phosphorus fertilizers may encourage mat development.

#### Seasonal Cycles

*Lyngbya* tolerates a broad range

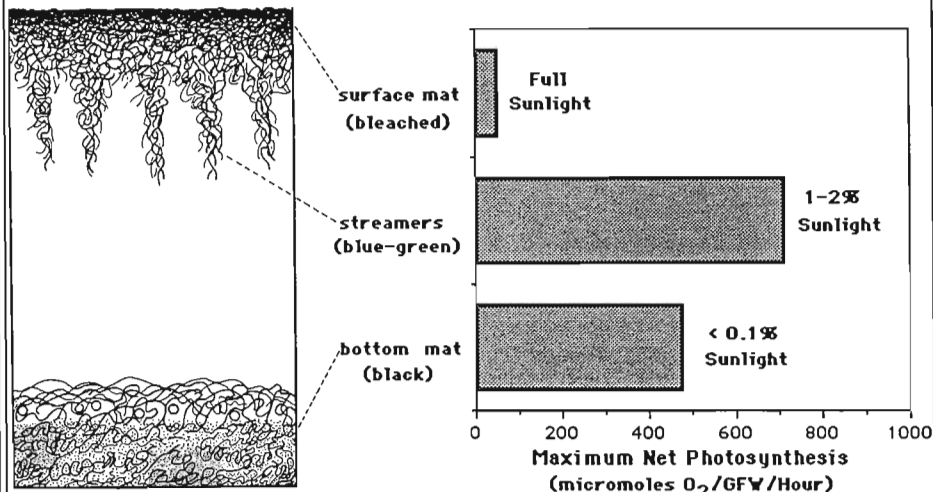


Figure 3. Diagrammatic representation of midsummer surface and benthic *Lyngbya* mats (collected from Marten's pond, Elloree, SC, July 1987) and associated maximum net photosynthetic rates.



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from the previous season, associated with considerable quantities of non-viable, but still entangled, empty sheaths. Layers of fine silt and sediment enshroud winter mats, until water temperature increases (to 18 C or 65 F, in our studies) and photosynthetically-generated oxygen bubbles accumulate in the upper layers of the mat, eventually buoying great masses of entangled filaments to the surface.

Photosynthesis increases, for a brief time, as these mats reach the surface, but quickly decreases as the uppermost surface layers are bleached (photo-oxidized). These photosynthetically inactive surface layers provide important protective shading to subsurface filaments. During periods of active growth, the underside of the surface mat is composed of long, trailing streamers which exhibit maximum photosynthetic rates (Figure 3). Mats persist at the surface until agitation, as by a thunderstorm or airboat, dislodges the accumulated air bubbles, causing the mats to sink (temporarily) or wind pushes the mats to

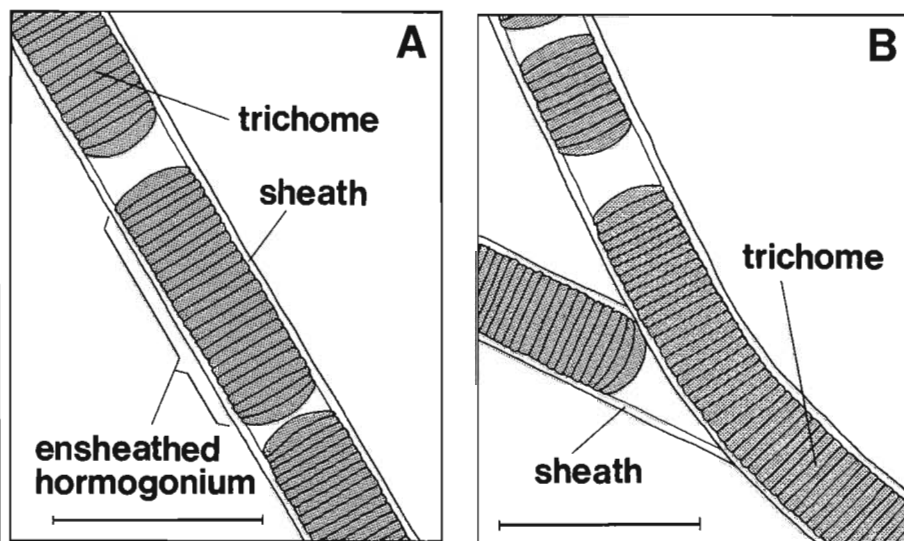


Figure 4. An unbranched *Lyngbya* filament (A) and a *Plectonema* false branch (B). The bar in the lower left-hand corner of each diagram denotes 100 micrometers.

a new location. Wind or current-induced movement not only introduces nuisance mats to new areas, but also clears the previous surface for recruitment of additional mats from the more slowly growing benthos. This cycle of mat expansion and relocation continues until reduced water temperatures preclude photosynthetic generation of

air bubbles and most mat material is again confined to the bottom sediments.

#### Control Techniques

Control of nuisance filamentous algae is usually attempted by means of: lake and watershed management practices; biological control agents; mechanical removal; or application of herbicides. Decreased nutrient levels characteristically diminishes growth of blue-green algae, but such management practices are neither possible nor desirable for all *Lyngbya*-infested water bodies. White amur (*Ctenopharyngodon idella*) successfully controlled *Lyngbya* in an Alabama fishing lake (Zolcynski and Smith 1980), reducing the infested lake area by 87.7% over a four year period. Mechanical harvesters are used to remove surface mats in Griffith Lake, Delaware (Ritter 1982). Diquat and copper compounds, alone and in combination, successfully control *Lyngbya*, at least for short periods of time. In addition, several commercial shading compounds appear to have secondary, toxic effects on *Lyngbya* due to generation of singlet oxygen (Martin et al. 1987).

The biphasic distribution of *Lyngbya* complicates control efforts. Spraying of surface mats causes them to sink to the bottom, only to be replaced, within a few weeks, as healthy benthic mats rise to the surface, often carrying

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with them substantial amounts of dead material. Mechanical harvesting similarly removes only surface mats, though it does lessen the total algal biomass, and thus the nutrient load, contained within a lake. Biological agents may control, but not eliminate, mats; SCUBA observation of a lake stocked with grass carp, and free of surface *Lyngbya* mats, revealed extensive, photosynthetically-active benthic mats.

Effective, long-lasting control measures should be targeted at the bottom mats. However, bottom application of herbicides is complicated by the absorption of some, such as diquat, to the overlying sediments, and the need for strong light to achieve optimal activity using copper compounds. Our preliminary, laboratory observations demonstrate the ability of diquat to selectively inhibit *Lyngbya* photosynthesis in reduced light or respiration in darkness. The improvement of diquat efficiency through use of novel sinking agents to carry the herbicide into bottom mats at the start of the metabolically active

period in early spring is among the topics currently under investigation at Clemson University.

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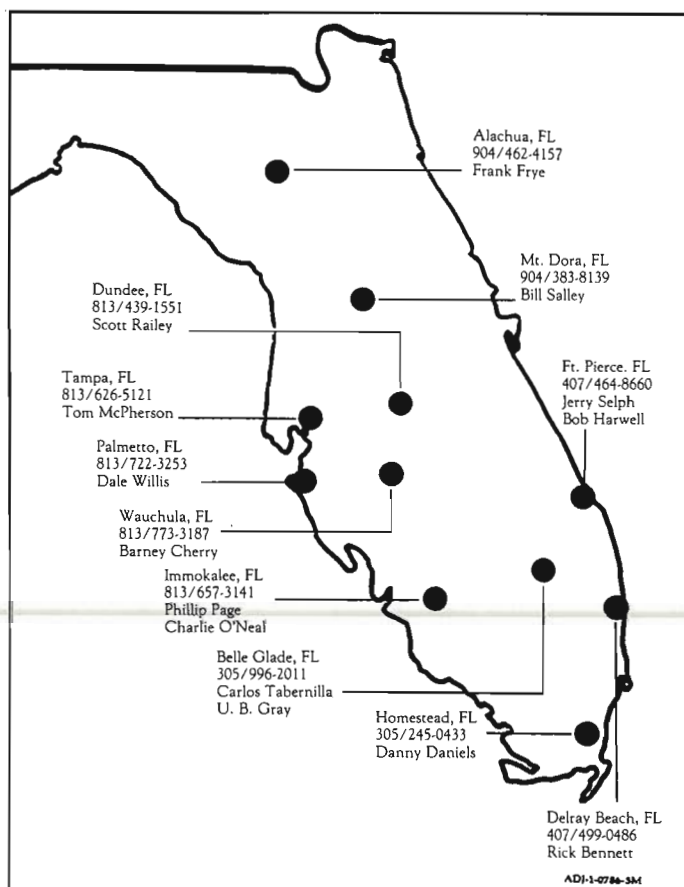
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ADJ-1-0786-3M



# Pesticide Screening in Fish and Sediment from Lake Alice, University of Florida Campus, Gainesville<sup>1</sup>

By  
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## Introduction

The use of pesticides to eliminate nuisance plants and insects is widespread. These compounds can enter aquatic ecosystems by many possible routes, including direct application, point source effluent, leaching into groundwater supplies, and agricultural runoff. Unfortunately, some of these pesticides may be highly toxic, non-selective, and affect other than targeted organisms.

Pesticide contamination has been reported in fish and other aquatic organisms from Canada to Florida, and across the United States (Ferguson 1967; Frank *et al.* 1974; Frank *et al.* 1978; Elder and Matraw 1984; Schmitt *et al.* 1985; Carlberg *et al.* 1986). Once in the environment, pesticides not intended for aquatic use may accumulate as they move up the food chain (Muirhead-Thompson 1971). In aquatic ecosystems, bioaccumulation reaches its maximum in the top predator in the system, usually fish. Fish, however, are not the end of the chain. Fish eating birds, and predatory birds which feed on them also bioaccumulate pesticides (Hickey and Anderson 1968; Johnson *et al.* 1975).

This paper presents results of a pilot study, the objective of which was to determine the levels, if any, of potentially toxic pesticides in the sediment or fish of a small lake receiving wastewater from a

secondary treatment plant, agricultural runoff, and, urban storm drainage.

## Methods

### Study Site

The fish and sediment analyzed in this study came from Lake Alice, a 12 hectare (30 acre) lake situated on the University of Florida campus in Gainesville. The lake is connected to a shallow, 21 hectare (52 acre) marsh containing water hyacinth, (*Eichhornia crassipes*), water pennywort (*Hydrocotyle spp.*), giant cutgrass (*Zizaniopsis miliacea*), alligator weed (*Alternanthera philoxeroides*), elephant ear (*Colocasia esculenta*), and other aquatic plants. The marsh and lake receive secondary treatment plant effluent and once-through condenser water from the campus heating plant. Current flow through the wastewater treatment plant is approximately 2.5 million gallons per day (university treatment plant Engineer, personal communication). Water flow through the lake is generally westward, with inflow first going through the marsh, then into the lake, and finally into the Floridian Aquifer by means of two dispersal wells at the western edge of the lake (Mitsch 1975).

Lake Alice is hypereutrophic and supports high standing stocks of fish, including largemouth bass (*Micropterus salmoides*), bluegill sunfish (*Lepomis macrochirus*), and blue tilapia (*Tilapia aurea*) (Canfield,

unpublished data). Many species of birds, including great blue herons (*Ardea herodias*), anhingas (*Anhinga anhinga*), and ospreys (*Pandion haliaetus*) are permanent residents around the lake. Lake Alice serves as an Audubon Society/University of Florida wildlife sanctuary with hunting and fishing prohibited.

### Sample Collection

I collected fish and surficial sediment samples (upper 5-6 inches of sediment) on September 22nd, 1987, using a boat mounted variable voltage electrofishing system to collect the fish, and a Ponar dredge to collect the sediment samples. Each fish sample included two individually wrapped and labelled components: a) muscle tissue, and b) abdominal fat and visceral tissue. I transferred the sediment samples from the dredge to one quart mason jars with foil lined lids. Freezing preserved all samples until analysis. In processing the samples, I used the extraction, cleanup, and analysis methods developed by Marble and Delfino (1987).

## Results

I analyzed eight fish samples (visceral and muscle tissue from each of four fish collected), and one of five sediment samples.

<sup>1</sup> Submitted in partial fulfillment of the requirements of EES 5245 — A course in water and wastewater analysis.



Two of the sediment samples contained all sand, two others contained sand/gytta mixture, and one sample contained mostly gytta. I only analyzed the mostly gytta sample, because based on its location in the lake, and compared to sand or sand/gytta samples, the gytta sediment type is the one most likely to accumulate whatever pesticides, if any, were present (Joseph Delfino — University of Florida, personal communication).

Gas chromatographic analysis revealed the presence of compounds containing electronegative atoms that captured beta particles as the compounds pass through the detector at the end of the column. For the most part, all the samples produced similar traces, suggesting similar compounds were present in all the samples. Gas chromatography mass spectrophotometric analysis inferred that traces from the gas chromatograph were caused by naturally occurring, long chain organic molecules. A library search for matches of the GC-MS traces suggested that the molecules probably came from natural products or related vegetative sources. A synthetic phthalate compound which does not naturally occur in the environment was present in all the samples. This compound, however, could have been an artifact of my methodology. None of the samples contained detectable levels of organochlorine pesticides, and selected ion monitoring for 4,4'-DDE did not indicate the presence of this compound at detectable levels.

### Discussion

The fish and sediment samples analyzed in this investigation were found to be free of detectable levels of organochlorine pesticides. Specific searches for DDE, a common metabolite of DDT found in areas formerly contaminated with DDT did not detect the presence of this compound. The samples contained mostly naturally occurring organic compounds. A synthetic phthalate compound not naturally found in the environ-



Some of the fish samples taken for pesticide analysis.

ment but present in the samples, could have been introduced during laboratory analysis. The absence of detectable levels of organochlorine pesticides in the samples from the lake suggest that: a) there are no current or recent significant sources of organochlorine pesticides in Lake Alice's watershed, or b) if Lake Alice's watershed does contain detectable levels of pesticides, they are removed by physical or biological processes before they enter the lake.

The University of Florida campus covers some 2,000 acres, many of which are extensively landscaped. The landscaped acreage is periodically treated with herbicides and insecticides to control unwanted plants and insects. The campus also includes experimental agricultural fields which are probably treated periodically with herbicides and insecticides. Because the campus is part of Lake Alice's watershed, the assumption can be made that some of these pesticides find their way into Lake Alice's drainage basin. Therefore, the next logical question involves the fate of the pesticides in this ecosystem.

As was noted earlier, waterflow into the lake is through a 21 hectare (52 acre) marsh containing

water hyacinth. The presence of the hyacinth may explain the absence of detectable levels of pesticides in the samples from the lake. During the active growth phase, water hyacinth are capable of absorbing heavy metals, pesticides, and other organic contaminants from water (Middlebrook *et al.* 1982). Other factors which might also reduce the bioavailability of micropollutants are naturally occurring microbes (Wood 1974) and aquatic humus from decaying plant material (Carlberg *et al.* 1986). The combination of low source levels of pesticides, coupled with water hyacinth, aquatic humus, and microbial activity may be responsible for the lack of detectable levels of organochlorine pesticides in fish and sediments collected from Lake Alice.

These findings, while encouraging, are the result of one sampling event with small sample size and should be treated as such. Larger sample sizes collected over a longer period and wider range might better represent what role, if any, pesticides play in the ecology of Lake Alice. However, until such samples are collected and analyzed, the apparent lack of detectable organochlorine pesticides in fish and sediment from Lake Alice should be considered "good news" about that ecosystem.

### Acknowledgments

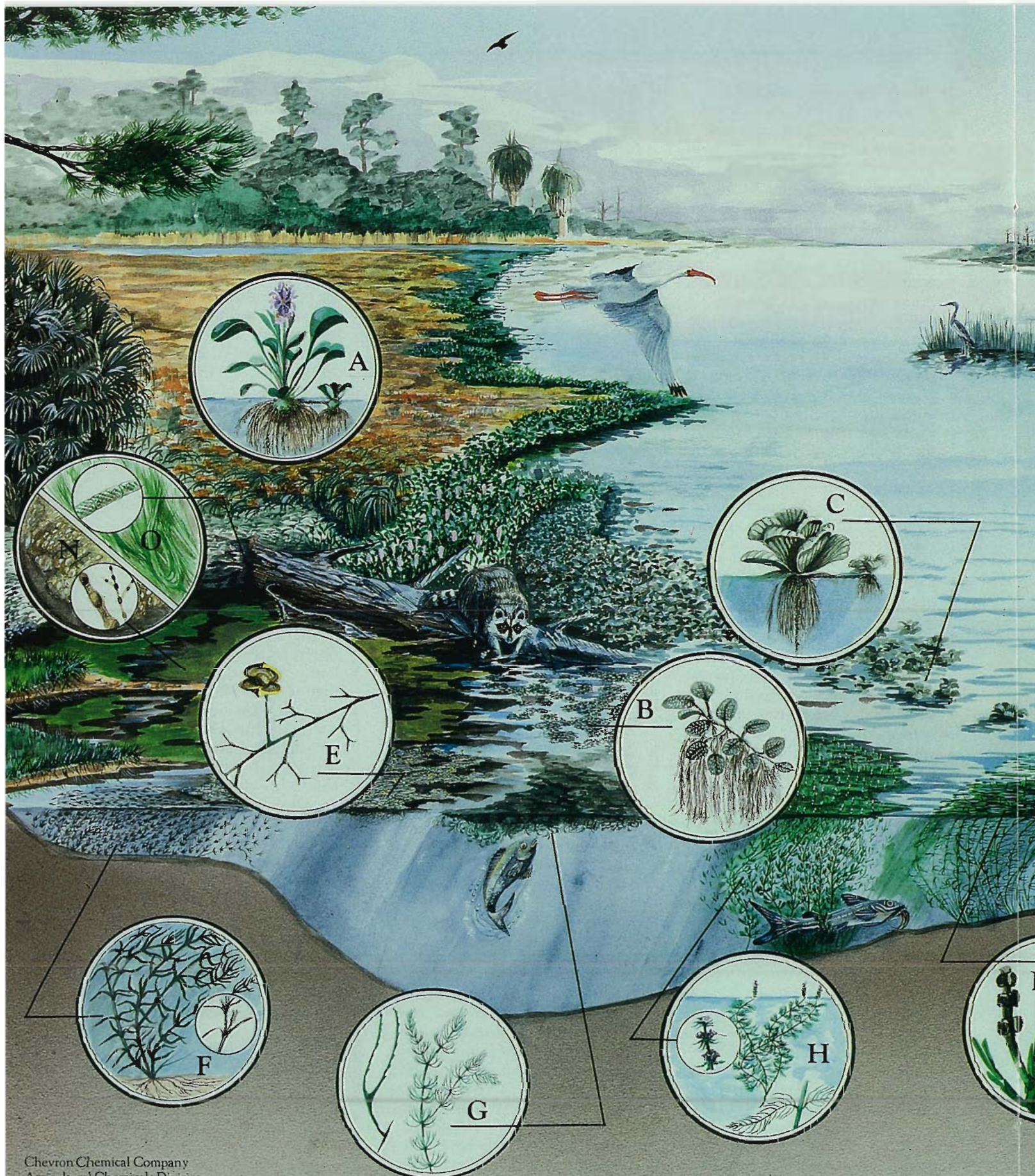
I would like to express my gratitude to Dr. J. Delfino for assistance in collecting the field samples, and his guidance and instructions in the lab. I am also grateful to B. Davis for his assistance in processing and interpreting the samples analyzed on the GC — mass spectrometer.

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Continued on page 23





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Pondweed	I	Pennywort	M
Hydrilla	J	Filamentous Algae	N
Elodea	K	( <i>Pithophora</i> spp.)	
Cattail	L	Filamentous Algae	O
		( <i>Spirogyra</i> spp.)	



# The First State's Experiences Controlling the Northern Monoecious Form of Hydrilla

By  
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Delaware, known as the first State by virtue of being the first to adopt the U.S. Constitution, also became the first northeastern state to recognize that it had a problem with *Hydrilla verticillata* and to initiate efforts at its control. The presence of hydrilla in three southern Delaware ponds was confirmed by Dr. Joseph C. Joyce, now Director of the Center for Aquatic Weeds, University of Florida at Gainesville and Wade West of the U.S. Army Corps of Engineers during a trip to Delaware in August 1981. One of these three ponds, Ingrams Pond, a 24.2-acre impoundment in Eastern Sussex County (Table 1) contained hydrilla at least as far back as 1976 when it had been misidentified as *Elodea* during treatments for control of *Cabomba* sp. (fanwort), which, at the time, was the most abundant of the two weeds.

Delaware's hydrilla produced male and female flowers when cultured in Florida in 1983 (Steward et al. 1984). These authors stated that the Delaware hydrilla had the same isoelectric enzyme patterns as the monoecious hydrilla from the Kenilworth Gardens and the Potomac River in Washington D.C. and from Lilyponds Water Gardens in Lilyponds, MD. It is likely that Delaware's hydrilla resulted from aquarium releases of stock originally imported by Lilyponds.

By 1983, hydrilla was found in 11 Delaware ponds having a combined surface acreage of 598 acres. By 1986, the list of Delaware

ponds known to contain hydrilla had grown to sixteen, with all of them located in the southern half of the state. One interesting observation is the presence of the plant in a small isolated pond on a waterfowl management area in Kent County. Waterfowl appear to be the only possible vehicle for transmission of the weed to this pond, in spite of the low probability attributed to this mode of transmission by Joyce, Haller and Colle (1980).

## Life History Aspects in Delaware

In order to document hydrilla life cycles in Delaware ponds, I studied the plant in 1985 in a 42-acre impoundment, Betts Pond, in southeastern Delaware that had never been treated for hydrilla control. In Delaware, as in North Carolina, no standing hydrilla persisted through the winter, with only tubers and turions present in February and March bottom samples. Core samples taken from Betts Pond in March had averages of 67.4 tubers/ft<sup>2</sup> and 58.3 turions/ft<sup>2</sup>. Sprouting from tubers and turions was evident by mid-April at water temperatures of 57° F. Hydrilla dry weight/ft<sup>2</sup> of sample bottom reached a maximum of 0.66 oz/ft<sup>2</sup> by August 2, and had attained 89% of this maximum biomass by July 3. By July 3, the stems had reached the water surface in sample locations ranging up to 38 inches deep. Although tubers attached to stems were noted throughout the growing season, small or newly formed tubers were most abundant in early October. The abundance of

newly formed turions increased steadily in the fall until the termination of sampling in December. Pistillate flowers were first noted early in September and persisted through October. Staminate flowers were much less abundant and inconspicuous, but their presence was noted in September and October. The Delaware monoecious hydrilla does not produce mats of detached, floating male flowers as observed in North Carolina populations by Hodson, Davis, and Langeland (1984).

## Control Efforts

Because hydrilla coexisted with fanwort in a number of Delaware lakes, plus the fact that winter pond drawdowns had proven effective for control of fanwort in



Wade West of the Army Corps of Engineers and Joe Joyce, University of Florida, discovering Hydrilla in a Delaware pond in 1981.



previous years, I was able to observe the effects of winter draw-downs on hydrilla during efforts to control fanwort. As could be predicted by experiences in Florida and elsewhere, winter drawdowns allowed hydrilla to completely colonize Delaware ponds to the exclusion of fanwort. Although an attempt was made on an 88-acre pond to do spring and fall draw-downs as detailed in Haller (1978), this proved undesirable for two reasons. One, the lake in question partially refilled with each heavy rain, thus negating the effect of the drawdowns; two, the subsequent disruption of public fishing was poorly received on this popular State Park pond, and enforcement problems resulted from the forced closure of the lake.

An attempt to harvest hydrilla was made on this same pond in 1983 using an Altosar H6-400 (6-ft cutting width) mechanical weed harvester, but this effort was severely hampered by the numerous stumps and cypress knees encountered, a condition common in several southern Delaware ponds, all of which are shallow (maximum depth around 9 feet).

By far, the greatest amount of effort went into controlling hydrilla with herbicides. A variety of chemicals and combinations of treatment rates, plot sizes, and time and method of application were attempted over the years. All of this variability complicated interpretation of results. Some of the commonly employed assessment methods included aerial reconnaissance, fathometer tracings, standing crop estimates, or in most cases visual observation supplemented by hand rake samples behind a boat. The latter criteria of success or failure was not quantitative but was characterized in descriptive terms such as excellent control (resulting in an almost completed elimination of leaves and stems), partial control, or no control. The category of partial control included good to excellent control in some areas treated but little or no control in others, or appreciable die-back or defoliation of plant stems with subsequent regrowth from these stems.

Rather than detail every treat-

ment of hydrilla in Delaware (nine lakes have received some treatment), I have selected four representative ponds that illustrate successes and failures (see Table 1 for a summary). Total water hardness values in these ponds ranged from 17 to 34 ppm. Figure 1 illustrates typical water temperatures during Delaware's growing season.

#### Ingrams Pond

As mentioned earlier, Ingrams Pond was treated for hydrilla (thought to be *Elodea* at the time) as early as 1976. An Aquathol Plus treatment at 2 ppm in June 1976 resulted in 90% control of the hydrilla. A treatment with 1.4 gallons/acre of Diquat in August 1978 also was effective. By the early 1980s, drawdowns and competition with hydrilla had all but eliminated fanwort. In 1982, two test plots of 2.8 and 1.4 acres each were treated in the lake in late August. One plot received 2-gallons of Diquat and 4-gallons of Cutrine Plus per acre with a polymer while the other plot was treated with 2-gallons of Diquat

with polymer per acre. The Diquat and Cutrine Plus treatment resulted in excellent control through the remainder of the fall, while the Diquat only plot resulted in partial control with only the tips of the plants being damaged. The next year, 4 acres were treated in late May and 16 acres in July with Diquat, Cutrine Plus (2 and 4 gallons/acre respectively) and polymer. Partial control was achieved in the areas treated, with shallower areas experiencing better control than deeper areas.

In 1984, four treatment plots were established (2.8, 1.4, 1.4 and 1.7 acres each). In June, the two larger plots received Diquat (2 gallons/acre), Koplex (4 gallons per acre) and a polymer, while the two smaller plots were treated with 8 gallons of Aquathol K/acre and polymer. The Diquat and Koplex treatments were repeated early in August and the Aquathol K treatments done again on August 23. The early summer

*Continued on page 20*

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Continued from page 17

Diquat and Koplex treatments resulted in better control than the Aquathol K plots, but none of the treatments achieved more than partial control. The late summer Aquathol K treatments were more successful than the Diquat and Koplex treatments, but the dead and broken off stems persisted into Autumn in floating mats, thus negating the benefit of the treatment to fishermen.

The following year Sonar 5P was applied in early June at a rate of 30 lbs. per acre to a 3.90-acre plot. In

addition, 5.3-acres were treated with Diquat, Koplex and a polymer in July. Unintentionally, these two treatments resulted in whole lake control in the area downstream of the treatments. The use of Sonar resulted in control well beyond the treatment area, as opposed to previous efforts with contact herbicides combined with a polymer.

#### Records Pond

Prior to treatment, Records Pond was choked with fanwort and hydrilla, with fanwort being

more common in the upper third of the pond. An early September 1982 treatment of a 1-acre boat access area with 10 gallons of Aquathol K and polymer resulted in damaged plants but little control. The following July, a 2.5-acre plot was treated with 12 gallons of Koplex/acre and polymer. Control was excellent and no stems were visible in the treatment plot two weeks later. However, the control was temporary in nature and within 6 weeks, the treatment area was almost completely revegetated. A mid-September treatment

Table 1. Summary of hydrilla treatment results on selected Delaware ponds.

Pond	Size (acres)	Depth in feet		Area treated (acres)	Herbicide <sup>1</sup>	Month/year	Effectiveness			Control duration
		Mean	Max				Limited or none	Partial control	Excellent control	
Ingrams	24.4	4.2	10.0	24.4	A+	6/76			X	season
				12.2	D	7/76				
				24.2	D	8/78			X	season
				2.8	DCP	8/82			X	season
				1.4	DP	8/82	X			none
				4.0	DCP	5/83		X		indeterminate
				6.0	DCP	7/83		X		indeterminate
				4.5	DKP	6/84		X		indeterminate
				2.9	AKP	6/84		X		indeterminate
				2.8	DCP	8/84		X		indeterminate
				1.7	DKP	8/84		X		indeterminate
				2.9	AKP	8/84		X		indeterminate
				3.9	S	6/85			X	season
				5.3	DKP	7/85				
Records	91.9	4.0-10.0		1.0	AKP	9/82	X			indeterminate
				2.5	KP	7/83			X	1 month
				1.0	DKP	9/83			X	1 month
				57.0	DK	7/84			X	indeterminate
				18.0	DK	7/84		X		indeterminate
				18.6	S	5/85				season
				80.0	DK	6/85			X	
				20.0	DK	8/85		X		
				36.7	S	5/86			X	season
				9.0	S	6/86				
Trap	88.0	4.1	8.0	38.0	K	7/84		X		indeterminate
				20.0	K	8/84				
				20.0	K	9/84				
				70.0	DK	6/85			X	season
				27.3	S	5/86			X	season
Waples	50.6	1.7	4.0	8.5	S	7/84			X	season
				4.0	S	8/84		X		
				12.0	S	5/85			X	2 seasons

<sup>1</sup>Herbicide abbreviations:

A+ - Aquathol Plus  
A - Aquathol K

C - Cutrine Plus  
D - Diquat

K - Koplex  
S - Sonar

P - Polymer  
(see text for dosages)



of the 1-acre boat launch area with Diquat (2 gallons), Koplex (4 gallons) and polymer resulted in excellent control in the launch area for the remainder of the Fall.

On 31 July, 1984, nearly the entire pond was treated with two gallons of Diquat and two gallons of Koplex per acre (no polymer). The result was a heavy dieoff and a floating mass of detached stems within eight days and excellent control within three weeks in all areas except the points furthest upstream where there was noticeable water flow. In 1985 these treatments were repeated in late June except with two gallons of Diquat, four gallons of Koplex and no polymer. In addition, the upper 18.6 acres were treated with 30 lbs per acre of Sonar 5P. Control was excellent in all areas treated except the uppermost portion of the lake where there was appreciable water flow. In early May 1986, the upper third of the 18-acre pond was treated with two applications each of 30 lbs/acre Sonar. A repeat treatment was made in June on the nine uppermost acres to control Fan-

wort. Control was excellent all summer and no hydrilla stems were visible in the lake. Fanwort control was less complete, but satisfactory nonetheless except where there was noticeable water flow. Since the flouridone active ingredient in Sonar works more slowly, there were no floating mats of decaying vegetation after treatment nor any temporary depressions in dissolved oxygen as had been the case with contact herbicides in prior years.

#### **Trap Pond**

Trap Pond had a history of problems with fanwort which eventually was eliminated in the late 1970s with winter drawdowns. Within a few years, hydrilla had replaced the fanwort. The first hydrilla treatment was a whole lake treatment in late July 1984 with eight gallons/acre of Koplex without polymer. This treatment only killed the top 1-2 feet of stems in the deeper areas and regrowth was rapid. By the end of August, retreatment was warranted but couldn't be scheduled until the fall.

On June 17, 1985, 70 acres of Trap Pond were treated at a rate of two gallons of Diquat and four gallons of Koplex (no polymer) per acre using weighted hoses in deeper areas. This treatment resulted in excellent control through the summer, although regrowth was evident in the fall. In 1986, a total of 27.3 acres were treated at the upper end of the pond with 30 lbs/acre of Sonar the first two weeks of May (one week between treatments). This treatment resulted in excellent control of hydrilla by mid-June, and when last checked on September 3, no hydrilla was in evidence.

#### **Waples Pond**

The shallow, stump-filled bottom of this pond precluded treatment except on the lowermost 13 acres. This area was subdivided into two and treated with Sonar 5P in July of 1984. Excellent control was achieved within a month except near the uppermost portion of the treatment area which was retreated in August. The same area on Waples Pond

*Continued on page 22*

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Continued from page 21

was treated again with Sonar in May 1985. No further treatments were required in 1985 nor in 1986. As of Fall 1986, the treatment area remained relatively free of hydrilla except near the confluence of the untreated portion of the pond.

## Conclusions and Recommendations

Over winter drawdowns seemed to stimulate the spread and eventual dominance of hydrilla in Delaware ponds that had both fanwort and hydrilla. Spring and fall drawdowns require further evaluation as to their effectiveness, but are socially very unacceptable in Dela-

ware public ponds in comparison to control methods that do not require pond closure to recreational use.

Herbicides have been shown to be effective for controlling hydrilla in Delaware. For spot treatments, I would recommend using contact herbicides such as Diquat and a copper complex with a polymer at label dosages or Koplex at 12 gallons/acre with a polymer. For sustained, whole growing-season control, I recommend Sonar. It has proven very effective when applied to 30% of the pond bottom at 30

lbs/acre in May (shortly after sprouting). Such a treatment has provided control in one instance for two growing seasons. Sonar 5P does not appear to be appropriate for spot treatments as plants will be killed beyond the treatment site. Second choice for whole lake control would be contact herbicides such as Diquat and Koplex or Aquathol K, especially when an immediate kill is desired. Some retreatment later in the summer may be necessary with contact herbicides.

Yet to be tested in Delaware are

## AVERAGE SUSSEX COUNTY POND TEMPERATURE (5-YEAR COMPOSITE) DEGREES F

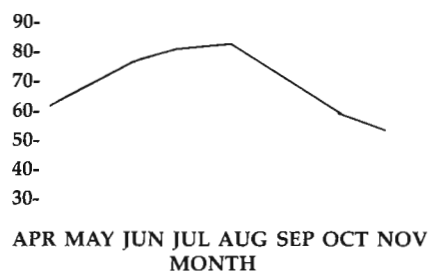


Figure 1. Composite average surface temperatures in Sussex County ponds measured at odd intervals from 1980-1985.



Applying Koplex to control Hydrilla in Trap Pond, DE.

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biological methods of control. In 1987, triploid grass carp will be stocked in Ingrams Pond to be evaluated for their effectiveness in controlling hydrilla.

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### Acknowledgments

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# Are Water Weeds a serious problem?



Yes! If water weeds are allowed to grow, they threaten our health and the health of aquatic life, not to mention spoiling the joys of swimming, boating and fishing.

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# Airboat Safety Examination

By  
Jess Van Dyke

*As a follow-up to the December 1987 article on learning airboat safety, Jess developed this comprehensive examination to test your personal judgment to the 10 most commonly asked questions.*

1. How long does it take for an airboat to sink?
  - a. Today's modern airboats are equipped with special flotation chambers. Even if completely "swamped," these boats will float for days.
  - b. .032 nannoseconds.
2. Even if the airboat were to sink, by some stretch of the imagination, as long as I have my flotation devices on board, everything is cool. Right?
  - a. Absolutely.
  - b. If the airboat sinks like a rock and your lifevest is stowed, you're in deep \_\_\_\_\_."
3. Big deal. So I'll have to swim a little. Flotation devices are for "candy \_\_\_\_\_." I was raised on the water and can swim like a fish. I'm still in great shape. Right?
  - a. No problem. You're immortal.
  - b. In your dreams, you pathetic slob. That was 20 years and 2,000 cases of beer ago! Jump in thick hydrilla wearing heavy clothing and see how long you last.
4. Hearing protection for an airboat operator is unnecessary. Besides, white ears really detract from a nice tan. Right?
  - a. Sure thing, George Hamilton.
  - b. Huh?
5. If you can't hear the thunder, lightning can't hurt you. Ain't that so?
  - a. No sweat, Slick. You can out-run any storm.
  - b. More people "fry" in Florida than anywhere else in the nation. If you don't turn off the airboat periodically on

summer afternoons, thunder storms can sneak up on you.

6. All airboats are essentially the same. If I can handle one I can drive the hell out of any airboat. Right?
  - a. Nothing wrong with confidence. Let 'er rip!
  - b. Each airboat is different and is just about to wreck if you don't know its special quirks.
7. I have launched and towed airboats a million times. It's such a routine I don't even have to think about it anymore. Right?
  - a. That's right, Einstein!
  - b. Tell that to the widows and orphans when you forget about the safety chains or trailer ball clamp. The new polymer hulls are so slick that airboats can launch themselves, anywhere and anytime.
8. Racing down a river in an airboat is a thrill a minute. Right?
  - a. Nothing's better. Go for it!"

- b. Well, it's fun, but even the best airboat driver can't predict what's around the next curve, like ten canoes full of kiddies. Running into the trees with an airboat is every bit as bad as a car wreck (without a seat belt).
9. With an aluminum hull on your airboat, running through stumps ain't no big thing. Right?
  - a. Sure, Ace. You can't punch a hole through that stuff.
  - b. Tell you what, wild man (woman), drive over a big stump that's just below the surface of the water or slide sideways into one and see what happens.
10. The cage on an airboat reduces top speed by at least 25%. Let's get rid of them or at least increase the mesh size.
  - a. Right on! Speed is everything.
  - b. Anything going through an airboat prop is mincemeat. Don't get in an airboat with a flimsy cage.





# HALLER'S HISTORICAL HIGHLIGHTS

## St. Johns River, Fall 1898.

The largest and most powerful passenger/cargo steamer on the river, *The City of Jacksonville*, was forced aground near Green Cove by a floating island of water hyacinth. Ship's officials reported that a strong westerly wind accompanying a thunderstorm dislodged about a mile square hyacinth island from the east bank. Despite the efforts of a full head of steam and the ship's crew and passengers, the wind driven island moved across the channel, trapping the ship and forcing it aground on the west bank of the river. Nearly 12 hours later, the rising tide moved the blockage upstream and *The City of Jacksonville* was able to make way to the city docks in Green Cove for repairs. Shipping officials are gravely concerned for the future navigation on the river and scheduled a meeting with the Army Engineers to discuss the hyacinth problems on the river.

## New Orleans, Fall 1902.

Shipping officials in Louisiana and Florida are praising Congress

for authorizing the Army Engineers to exterminate the troublesome water hyacinth from navigable rivers by any means possible. The 1899 River and Harbor Act was followed by a 3 year mechanical battle against the problem. Despite these removal efforts, the hyacinths have become much worse following rapid growth and mild winters. Corps officials now have authority to use agricultural chemicals or any other means which might be effective at solving this problem. Corps officials are testing several compounds for hyacinth control including sea salt, blue-stone, quick-lime, sodium arsenite, sodium chlorate, ammonium thiocyanate and other chemicals.

## St. Johns River, Fall 1903.

This reporter risked life and limb in a 12-foot skiff to transit the masses of floating islands to meet the new Corps spray steamer in mid-river. The captain explained that the new 60-foot steam boat is the first such boat to be used in the hyacinth eradication program in the river.

He went on to explain that the chemicals being sprayed are mixed on board, and although toxic to man, no problems have occurred with the crew and few fish kills have been noted because the spray stays mostly on the plants. The crew then proceeded to make up a 10,000 gallon batch of sodium arsenite according to the following formula:

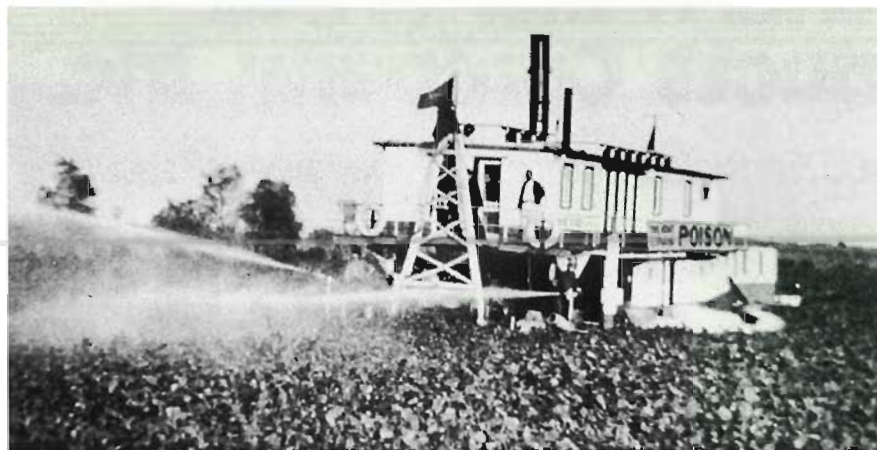
"Combine 600 lbs. of white arsenic (arsenious oxide) and 600 lbs. of washing soda (sodium carbonate) in a tank with about 600 gallons of water. Fuel the boilers with wood, and bring this solution to a boil and keep boiling for approximately 2 hours. Drain the solution off into the larger tank and add 9,600 to 12,000 gallons of water, depending upon the strength of mixture desired.

After mixing, spray the solution over the hyacinths at 50 psi in a 1-inch steam hose with a Fuller nozzle. This nozzle is used to create a very fine spray which helps avoid wasting material. On warm sunny days use 1 gallon of solution to spray 10 square yards of hyacinths."

The captain explained further that although the spray program is effective at killing hyacinth, the crew has to be very careful because of reports of damage to crops. Cattle are drawn to the salty tasting spray and several head of livestock have been killed. Reportedly, a spray boat captain in Louisiana has succumbed to arsenic poisoning, and 12 members of his crew became sick recently, although all the details are unknown at this time.

In researching this article one recognizes the seriousness of the hyacinth problem to the development of early Florida and Louisiana. Spray crews literally risked their lives in this eradication effort. In 1905 the Corps ceased using sodium arsenite in Florida and again turned to mechanical methods. The State Game and Fish Commission, however, used sodium arsenite into the 1940s. More on that at another date.

■ Bill Haller



Spraying sodium arsenite and marked with "Poison" signs, this steamboat crew attempts eradication of water hyacinth from the St. Johns River (1903).



## AQUAVINE



### EDUCATION FIRST

The Department of Natural Resources, in cooperation with the Center for Aquatic Plants and the Florida Aquatic Plant Management Society, have developed a slide program entitled "Managing Florida's Aquatic Plants." The show consists of 80, 35mm slides and a cassette tape for narration.

The slide presentation is intended as an educational tool for the general public regarding the management of aquatic plants in Florida waterways. A general history is discussed, as well as the who, how, and whys of plant management.

If you or your management agency would benefit from this program, you can purchase a copy for \$15.00. Send a check or money order, made out to the University of Florida, to the following address. Please be sure to include program title in your request.

Instructional Materials Service  
101 Rolfs Hall  
University of Florida  
Gainesville, FL 32611

### BOOTH SPACE

As you may recall from last

year's annual FAPMS meeting, display area was at a premium for industry and agency booth space. If you or your company plan on having a display at the 1988 annual meeting, contact local arrangements committee chairman Larry Maddox, at 2133 Wickham Rd., Melbourne, FL 32935, ASAP.

### PLAN EARLY

If you plan to attend the 1988 annual FAPMS meeting October 25-27, begin making your plans NOW! Start by making hotel reservations at the Holiday Inn Surfside in Daytona Beach. Next, call Ken Langeland and give him the title for your talk, especially if you're an applicator. Then select your favorite "Operations" and "Aquatic Scenes" photographs, get 8x10s made and send them to Nancy Allen. Don't forget to take the form provided in the last FAPMS newsletter and nominate your favorite applicator. Finally, bring lots of money, because shirts, hats, pins, and donations to the scholarship fund are always appreciated.

Oh yeah, one more thing. If you're a musician, or just think you are (like me), be sure to bring your instrument. We plan to get an impromptu band together for some pickin' and grinnin'. See you there.

### FLMS

We have recently become aware of the formation of a Florida

Chapter of the North American Lake Management Society. This new organization has been named "The Florida Lake Management Society." FLMS intends to promote better understanding and comprehensive management of lake and watershed ecosystems by facilitating communication between lake users and scientists, government agencies and industries involved in lake management. In addition, FLMS hopes to provide a forum to accommodate citizen action in areas of lake protection and restoration. Interested persons should contact Richard Coleman, Chairman, at 203 Lake Pansy Dr., Winter Haven, FL 33880.

### RECENT TREND?

This year, two of the five state water management districts decided that aquatic plant management was not in their best interest. Consequently, the Department of Natural Resources has contracted out plant management to private applicators. The two districts are the Northwest WMD and the Suwannee River WMD.

### SHORT COURSE

Don't forget, this is the year of the IFAS Aquatic Weed Management Short Course. The first round of speakers begins June 20, at the UF TREEO Center. If you have not made plans to attend, and want more information, call Ken Langeland at (904) 392-9613.



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