CLEAN LAKES INC.
Aquatic Ecosystem Restoration & Maintenance

November 14, 2011

Lahontan Regional Water Quality Control Board
C/O Daniel Sussman or Mary Wagner
2501 Lake Tahoe Blvd.
South Lake Tahoe, CA 96150

Subject: Clean Lakes, Inc.'s Comments to the **"REQUEST FOR PUBLIC COMMENT ON PROPOSED AMENDMENTS TO THE WATER QUALITY CONTROL PLAN FOR THE LAHONTAN REGION: PESTICIDE PROHIBITION WITH EXEMPTION CRITERIA, REVISED DRAFT"**

Dear Mr. Sussman or Ms. Wagner:

Clean Lakes, Inc. (CLI) appreciates the opportunity to provide comments for the Draft Pesticide Basin Plan Amendment for the Lahontan Region (6) Basin Plan. CLI staff support the proposed amendments and recognizes the effort of Lahontan Board staff required in developing an approach that facilitates pesticide applications for beneficial purposes.

We have the following comments from the related documents for your consideration:

Staff Report – Page 6, Issue 1: "Examples of such activities include vector control by local agencies, restoration or protection of threatened or endangered species, and control of aquatic weeds or algae to protect navigation, water conveyances, or public water supplies". Wording for the control of aquatic weeds and algae should include wording to prevent the spread of nuisance invasive species (i.e. Eurasian Watermilfoil and Curlyleaf Pondweed), or general Ecological Preservation - Aquatic Invasive Species (AIS).

Staff Report – Page 17, Paragraph 2: Projects that may be allowed under this Basin Plan Amendment should also include projects implemented for purposes of Ecological Preservation - Aquatic Invasive Species (AIS).

Staff Report – Page 18, Paragraph 4. The statement, "The aquatic pesticide application will temporarily preclude the continued beneficial use supported within the treatment area", does not agree with the statement in sentence two of this same paragraph. It is not clear what beneficial use(s) will be temporarily precluded. This sentence should be deleted.

Staff Report – 38 7 (a): II. Environmental Impacts: Page 53, Paragraph 1, Greenhouse Gas Emissions: The statement **"**Some greenhouse gas emissions, namely methane release, may result from the decay of vegetation treated with aquatic herbicides". Any potential greenhouses gasses that result from the decay of vegetation treated with aquatic herbicides would generally be the same gasses created on a seasonal basis when the plants decay each fall. Through the control of aquatic vegetation with herbicides, it would be expected that control would be initiated when the plants are in the early growth stage, and thus less decayed biomass would be present, and thus any greenhouse gases produced would be less than if the vegetation was allowed to grow and increase in biomass prior to fall dye back. This section should be modified as the vegetation decays on an annual basis, and no additional impact from greenhouse gas production would result from aquatic herbicide treatments.

Staff Report –Page 38, 7 a) and Page 53, Paragraph 1. The statement that, "The proposed project requires that dead biomass, a potential emission source, must be removed from the project area and disposed of at an appropriate location", is unreasonable for all aquatic plant control programs. In some circumstances, such as in the control of emergent or floating vegetation, removal of dying or dead biomass is feasible. However, in the case of submersed aquatic plant control projects (i.e. Eurasian watermilfoil) collecting dead biomass is not feasible or practical since plants will fragment into small uncollectable pieces. The only practical way that dead biomass might be collected is through a dredging related activity that would likely cause greater impacts to native vegetation and higher levels of green house gases through the required use of combustion engine equipment. Selective control of invasive aquatic plants through use of aquatic herbicide applications would reduce long term organic material accumulation, as well as potential production of greenhouse gases, by eradicating or greatly reducing the invasive plant species. (See attached articles, Maintenance Control of Aquatic Plants by Bill Haller, Aquatics - Summer 1981; Benefits of Maintenance Control of Water Hyacinth by James Joyce. Aquatics – Winter 1985; Understanding Organic Accumulation of Selected Aquatic Plants in Florida by Dana Bigham. Aquatics – Fall 2009). This Eurasian watermilfoil biomass removal recommendation should be modified or deleted.

Attachment 2, Revised Draft Waste Discharge prohibition and Exemption Criteria. Page 8, 1 c. states the need for, "The chemical composition of the pesticide to be used, including inert ingredients." Inert ingredients are thought to be considered proprietary or intellectual property. Board staff should clarify with pesticide manufacturers their ability to provide this information prior to finalizing this BPA.

Attachment 2, Revised Draft Waste Discharge prohibition and Exemption Criteria. Page 10, section 2. Under this paragraph which falls under Exemption criteria for controlling aquatic invasive species and other harmful species, time sensitive projects, it appears that the statement, "(Removal of biomass may not be necessary in situations where recovering the dead biomass creates greater potential impact to water quality)" is inconsistent with Staff Report Pages 18, 38, and 53 outlined above.

Thank you for the opportunity to provide comments on the proposed Amendments.

Should you have any questions or require clarification regarding this letter, please contact Thomas Moorhouse via cell phone at 818-201-5982 or via email at tmoorhouse@cleanlake.com.

Sincerely,

CLEAN LAKES, INC.

Thomas G. Moorhouse
Aquatic Pest Control Advisor

Attachments:

- Maintenance Control of Aquatic Plants by Bill Haller, Aquatics - Summer 1981
- Benefits of Maintenance Control of Water Hyacinth by James Joyce. Aquatics – Winter 1985
- Understanding Organic Accumulation of Selected Aquatic Plants in Florida by Dana Bigham. Aquatics – Fall 2009

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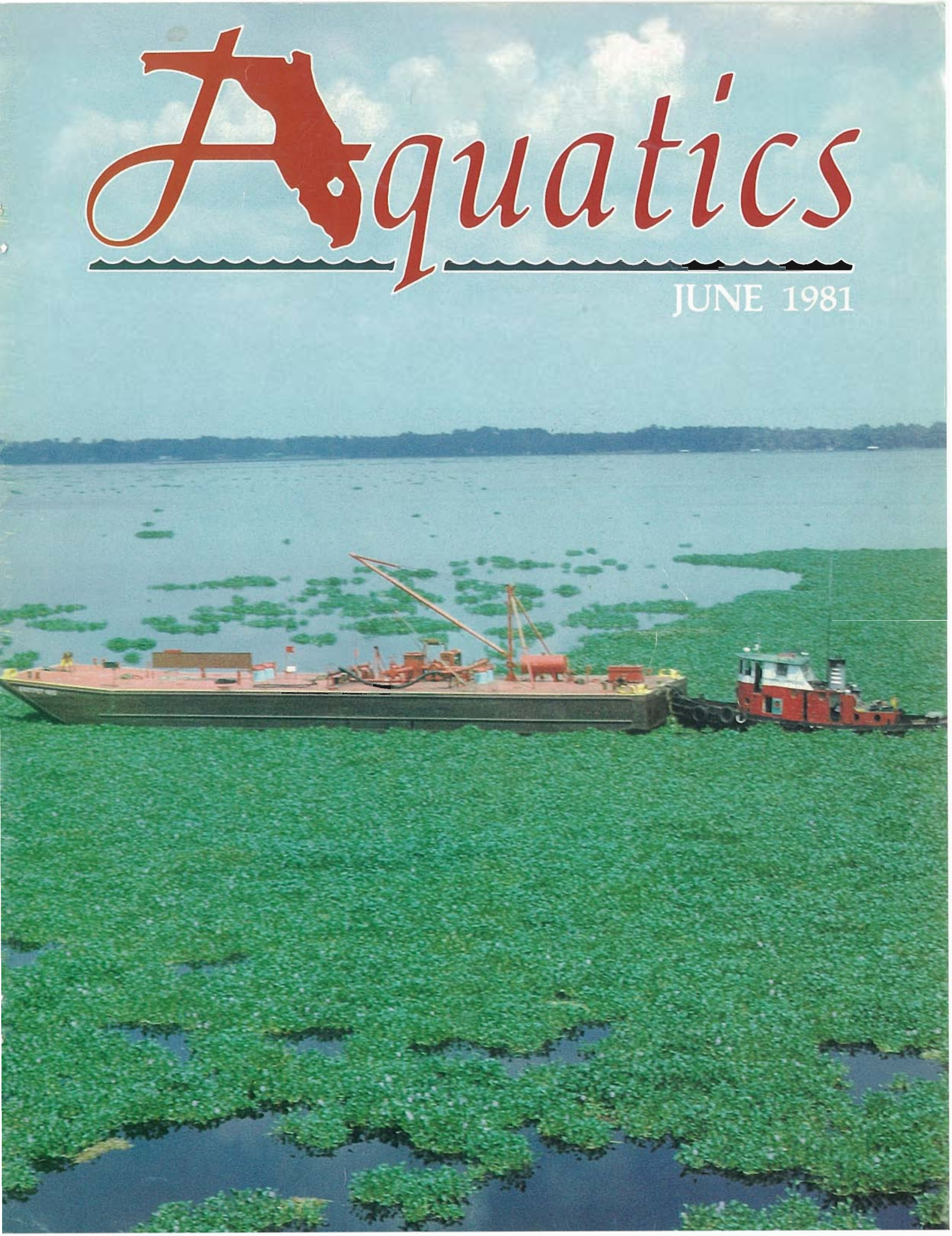
Aquatics

JUNE 1981



Aquatics

JUNE 1981 VOLUME 3 • NUMBER 2

Editorial

Paul C. Myers

The present ongoing turmoil in aquatic weed control permitting has brought to light, once again, the need for professionalism in aquatic weed control. Due in part to isolated instances of poor judgment, misuse, or neglect, it appears we are to be saddled with regulations which are more restrictive than we have known to date.

The cooperative working relationship most have had with the Bureau of Aquatic Plant Research and Control, within the Department of Natural Resources, is in a state of flux. Philosophy exhibited in the draft permitting rule is cause for apprehension and reflects a staunch regulatory approach.

The multiple agency responsibility in waters of this state has and will continue to overlap under the present state structure. By mandate of law and through interagency agreements the interest of each agency can be served while giving the public maximum benefit for multiple or designated water usage.

Aquatic weed control applicators, as a whole, are aware of the many ramifications which must be addressed in making treatment decisions. Through knowledge, technology and experience, aquatic weed control must proceed in the most effective, least damaging mode. This cannot be totally mandated by rules, which many times hinge on interpretation. Rather, due to the diversity of waters and circumstances encountered, local managers must be relied upon to make sound decisions.

The Aqua-Vine Section of "Aquatics" has been added to provide information on current events and recent publications from industry and government to increase the dissemination of aquatic plant control techniques and regulatory changes. Complete copies of reports mentioned in this section can be obtained on request to the respective authors or the Editor of "Aquatics."

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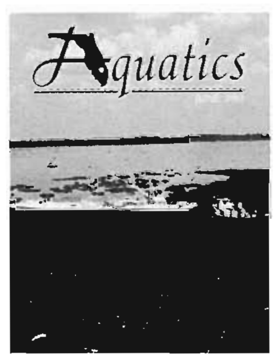
CALENDAR NOTES

July 10	FAPMS Board Meeting, Melbourne
July 12-15	Aquatic Plant Management Society's Annual Meeting, Coliseum Ramada Inn, Jackson, Mississippi
Oct. 21-23	FAPMS Annual Meeting, Orlando



COVER

Water hyacinths have blocked traffic in the St. Johns River many times in the past ninety years. Photo compliments of U.S. Army Corps of Engineers.

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

CORRESPONDENCE: Address all correspondence regarding editorial matter to Paul C. Myers, Editor, "AQUATICS" Magazine, 310 E. Thelma St., Lake Alfred, Fla. 33850.

MAINTENANCE CONTROL OF WATER HYACINTH

By Bill Haller*

A recent issue of *Aquatics* contained the statement, "Aquatic plant pest number one no more, water hyacinth maintenance control is a success story." Most everyone knowledgeable of aquatic weed control agrees and also recognizes the vigilance and effort required to keep water hyacinths under control. Certainly, there are farm ponds, canals and little-used ditches that are bank to bank water hyacinths. But the major waters in the state are essentially hyacinth free, so the once serious aquatic weed problem in Florida is solved. Or is it? Now that the water hyacinth is being managed at low populations, the priorities in the public's mind have changed. Influx of new residents, human forgetfulness, and the current lack of hyacinth problems add up to "why waste time on our lake treating 50 to 100 square foot patches of hyacinths, when they aren't bothering anyone?"

*Past President, Florida Aquatic Plant Management Society

Was it that long ago that the St. Johns River was bank to bank hyacinths at Astor, Palatka, and even in Jacksonville? Was it that long ago that many lakes and flood control canals contained 30, 50, 75 percent or even greater cover age of water hyacinths? Ask Vernon Myers, Bob Gates, Clayton Phillippy, Frank Wilson or others if killing water hyacinth was ever number one in the public viewpoint! Times have changed, and it's important to understand and be able to assure the public that hyacinths can be a serious problem, and that maintenance control programs are safe environmental and economic necessities.

There are individuals who can never be assured of the safety and use of aquatic herbicides. They should understand that maintenance hyacinth control programs result in a dramatic reduction in the amounts of herbicides being applied in the environment. Studies in ponds, canals, and even records of the hyacinth control program on the St. Johns River illustrate this fact. Prior to initiation of maintenance hyacinth control programs on the St. Johns River in the mid-1970s, the Corps and GFWFC spray crews used up to 10,000 gallons of 2,4-D per year. In FY 1976, for example, 6,312 gallons of 2,4-D were used. Now the hyacinths are under control and in FY 1980 the Corps used 4,350 gallons of 2,4-D or diquat on the 300 mile long river and its tributaries. (J. Joyce Per. Comm.: J. Aquat. Plant Manage. Vol 15, 1977.)

Data from ponds or lakes more dramatically illustrates the reduction in chemical use in a maintenance control program. In 1975 we initially treated a four-acre hyacinth infested pond, recorded 2,4-D use, and monitored water quality for four years. (W. Brower, Ph.D. Dissertation, University of Florida, 1980.) The pond, located in a citrus grove in Marion County, was totally covered with water hyacinth. Game Commission crews treated the pond on May 15, 1975 with 2,4-D at a rate of 3 lbs./acre. Regrowth and areas run over by the airboat dictated another treatment of the total area on July 15, 1975, again with 3 lbs./acre. After this treatment, the mats began to decay rapidly and by November, 1975, wind and wave action produced approximately 3 acres of open water. The remaining floating islands and hyacinths (1 acre) were retreated on November 19, 1975 with 2,4-D (3 lbs./acre). This was the final treatment required during the 1975 growing season. Total chemical used in the pond was 27 lbs., or 6.75 lbs./acre, in 1975. In the spring of 1976, the pond was essentially open water and only a fringe of plants remained which required treatment (0.5 acre at 3.0 lbs./acre. In 1976, the pond received only 1.5 lbs. of 2,4-D. Since 1976, the pond has not required chemical treatment, an occasional hyacinth is hand removed when it occurs, and the pond currently produces excellent bass and bream fishing (pond was stocked in 1976).

These two examples, obviously at both extremes of size, demonstrate the reduction in the amounts of chemical required under a good, vigilant control program.

Also important in your public relations is a good working knowledge of the plants, chemical, and spray systems you are using. Does the general public know that the spray from the handgun is not pure chemical, but is 2 or 3 lbs. of herbicide diluted with 50 to 100 gallons of water? You, in fact, are using only a 2 to 6% solution of chemical! Studies have also shown that 60 to 80% of the spray solution remains on the plants and never reaches the water. The lower dilution (50 gallons/acre) obviously causes less runoff, and higher amounts of chemical stay on the plants. There is a trade-off here between adequate coverage and greater runoff resulting in more chemical in the water column. Higher dilutions favor better coverage, but also increase runoff. Inverts, polymers, and aerial application probably result in less runoff than traditional water-chemical sprays, but I know of no published research on this subject.

If median values are assumed (3 lbs./acre, 30% runoff), the chemical application may result in approximately 1 lb. of chemical actually entering the water in the hyacinth mat. Assuming 5 ft. of water depth, the 2,4-D concentration in the water will be approximately 0.07 ppm, far below the levels which are known to adversely affect fish, insects, and other non-target organisms.

Any currently labelled herbicide used in water hyacinth control dissipates or is biologically degraded rapidly. In closed ponds such as the four acre pond described earlier, residues are often nonexistent in the water within a week after spraying. Certainly one important criterion for registration of most aquatic herbicides is a short half-life in water. All the registered products used in Florida for water hyacinth control comply with this important parameter. Another point with which to reassure the public is that hyacinth control and all other legal aquatic plant management programs utilize federally approved herbicides. Industry spends millions of dollars on toxicology, carcinogenicity and other sophisticated laboratory and field testing under Federal supervision before a product is labelled, and even then testing continues.

There is considerable literature available on the growth, control and reproduction of water hyacinth. After several years experience I have concluded that the water hyacinth is an organic polluter. The plant is the prime aquatic candidate for use in methane or energy production and for use in nutrient removal in sewage systems. Why? Because the plant grows so fast, producing over 60 tons of dry weight per acre per year. Standing crop biomass, the weight of a mat of water hyacinth, is commonly 250 to 300 tons/acre fresh weight (25 to 30 tons/acre dry weight), which makes it understandable why mechanically harvesting hyacinths is so slow and costly.

This high productivity results in deposition of organic detritus on the bottoms of our waterways. Measurements over a growing season indicate that natural turnover of leaf litter and root sloughing of water hyacinths result in deposition of approximately 1.7 tons of detritus per acre per year (dry weight). It was also noted that when a severe frost occurred the roots of the hyacinths naturally dropped off the plant at or just below the water surface. Obviously, this is an adaptation to keep the plant (meristem) afloat after the air filled leaves are destroyed by frost and they lose their bouyancy. Chemical control of hyacinths also produces detritus. The chemical control program resulted in deposition of 4.8 tons of detritus per acre per year in experimentally treated ponds. Considering the standing crop when sprayed, it appears that about 20 to 30% of the sprayed hyacinths end up forming detritus and the rest of the detritus oxidizes and decays at the water surface. Therefore, there should be no real hurry in causing a dropout to occur after spraying, as rotting on the surface results in less detritus on the bottom.

Obviously chemical control of water hyacinth silts the bottoms and therefore should not be done. WRONG! Back to the treated and untreated ponds since 1975. The untreated pond has in the past 6 years deposited 1.7 tons per acre per year for a total of 10.2 tons of organic

Water Hyacinth *continued on page 11*

Water Hyacinths *continued from page 7*

detritus per acre. The chemically treated ponds incurred a deposition of 4.8 tons per acre in 1975-76 and no hyacinths have grown in the pond since. So in the long run (6 years), the hyacinth control program has reduced organic detritus by 5.4 tons per acre!

When you consider the many lakes in Florida with heavy organic bottoms one wonders what role the hyacinth has played in the formation of these heavy silt loads. This is why I often jokingly refer to the theory that the only good hyacinth is a dead hyacinth.

The growth of hyacinths is a function of their reproductive capability. Often one hears that the plant reproduces itself by forming daughter plants every 7 to 10 days. This is true, but not in all waters at all times of the year. Under ideal conditions of high temperature, high humidity, high light, high nutrients and low plant densities, hyacinths will double in about 7 days. Several times we have heard a farmer say that he removed almost all the hyacinths from his pond and they didn't come back for a few weeks, and then the thing was darn near covered again. A square yard of water hyacinths contains about 100 plants. If that square yard is dispersed a little, it could grow to an acre in about three months. Hyacinths produce flowers throughout the growing season and seed production occurs sporadically. The flower only lasts for a couple of days, after which the stem forms a crook neck, forcing the flower spike into the water. The seeds (if the flower is fertilized) continue developing under the water for about a week, then, as the flower decays, the seeds fall to the hydrosoil. Seeds are apparently not important to hyacinth management programs except where drawdown or drought conditions lower the water level and seeds germinate along the shoreline. For the most part, however, the seeds are of little concern.

The economic savings of hyacinth maintenance programs are evident from the previous discussion. Savings in herbicide costs alone would vary from 30% in major systems to 100% on small lake situations, where hyacinths can actually be eradicated from the system. Labor savings and related operational costs are also reduced.

Simply looking at detritus formation, maintenance programs are obviously of greater environmental benefit than letting the plants get out of hand. Studies have shown reduced oxygen levels under large hyacinth infestations, and no fish survive under a 100% infestation. Minimal short-term environmental impact occurs when small areas are treated over a longer period of time. Everyone with aquatic experience will agree that there is less impact on a lake if 1% of the lake area is treated three times a year rather than 30% of the lake once every two years. That is the bottom line between treating aquatic weeds and aquatic plant management!

This article has certainly been negative to the water hyacinth, and, I believe, rightly so. Hyacinths serve useful purposes, but on the balance sheet, this exotic plant has done more harm than good. I recognize that hyacinth roots harbor many aquatic insects and minnows on which game fish feed. Hyacinths produce shade and bass like to lay under the mats. Fishermen in many tropical and underdeveloped countries construct a large frame in lakes or rivers and fill it with water hyacinths. After 5 to 7 days, they encircle the hyacinths with a fine mesh net and toss the frame and plants out of the net. Then the net is slowly pursed and all the fish which were attracted to the hyacinths for feed and shade are captured.

Thus, some Florida fishermen have objections to reducing hyacinths to minimal populations. In waters with no structure, a patch of water hyacinths, brush piles or old tires very effectively act as fish attractors. The problem, as has been pointed out, is that hyacinths can rapidly get out of hand. Also, hyacinths shade the bottom and crowd out native species such as lotus, lilies, maidencane, eelgrass, and other emergent and submersed plants. Rather than having a single type of plant predominate, wouldn't a diverse mixture of emergent, floating and submersed plants benefit the fisheries of our lakes and rivers? There is no documented answer to this question at this time.

Another controversial fishing topic is the effect of chemicals, particularly 2,4-D, on the feeding habits of bass. We have begun some studies and surveys in this area with bass clubs. It turns out that there are almost as many opinions on this topic as there are fishermen. The two major lines of thought are that bass will not feed in an area treated with 2,4-D, or they leave the treated area. Also, bass are believed by some to not feed on wild shiners caught in a chemically treated area and fished in another nontreated area. The other major opinion is that bass and other fishes are attracted to treated water hyacinths because, as the hyacinths decay, they release insects, minnows, and other food

Water Hyacinths *continued on page 12*

Water Hyacinths *continued from page 11*
organisms that attract larger sportfish. This appears to be an easily researchable problem and data collection will be conducted over the next several months.

Agreement exists that extensive infestations and growth of water hyacinths are detrimental to everyone concerned. Aquatic weed control programs have successfully and safely reduced hyacinths from the number one weed problem to a manageable maintenance program in most areas. The introduction and establishment of biological organisms, such as insects and diseases, are further assisting the maintenance control programs.

Public priorities have changed and a public relations program is essential in most large control programs. The public at large is not aware of potential growth and capabilities that hyacinths possess for producing problem infestations. Legislators and state regulatory agencies also change over time and many of them are like the public at large, ignorant of the potential problems of hyacinth growth. Control or management of any pest, insect, weed, or disease is most effectively handled in a timely manner. In the projected time it takes to get a permit reviewed by state agencies, that square yard of hyacinth can become an acre!

AQUA-VINE

FAPMS
Annual Meeting Update

Call for Papers

Time is speeding by and before you know it you'll be packing your bags to attend the October, 1981, FAPMS meeting in Orlando. Unless you wish to sit in silence for 2½ days, we are going to need participation from the membership.

Share your experiences, research projects, wonder techniques, energy saving tips, and other words of wisdom with us. Last year's program was an excellent one with a good diversity of papers. **Become active and participate!** This is the year for those of you who have never presented a paper to be heard.

Please send the title of your paper to be presented to me.

David P. Tarver
2416 McWest Street
Tallahassee, Florida 32303

Products Display

Exhibit space at the Annual Meeting, October 21-23, will be $100. We would like to encourage those displaying their wares to contact Larry Maddox, Local Arrangements Chairman, 305/254-1761.

Equipment Demonstration

Be thinking about participation in the equipment demonstration. Every operation has similarities and differences to be shared. Plan to bring along, for display or demonstration, a spray boat, mechanical harvester, truck rig, lazor destroyer or whatever you use in your aquatic weed control program. For more information and detail, contact Herb Cummings, 305/592-5680.

Books Available — *Aquatic and Wetland Plants of Florida*

At last, reprinting of *Aquatic and Wetland Plants of Florida* has been completed. This color plated identification text is now available free of charge to those involved with Florida's aquatic ecology. Please hold your request to one per person, as the supply is limited. There have been no major changes in this new edition; therefore, if you received the 1978 text, please do not request the latest edition.

Address your request to:

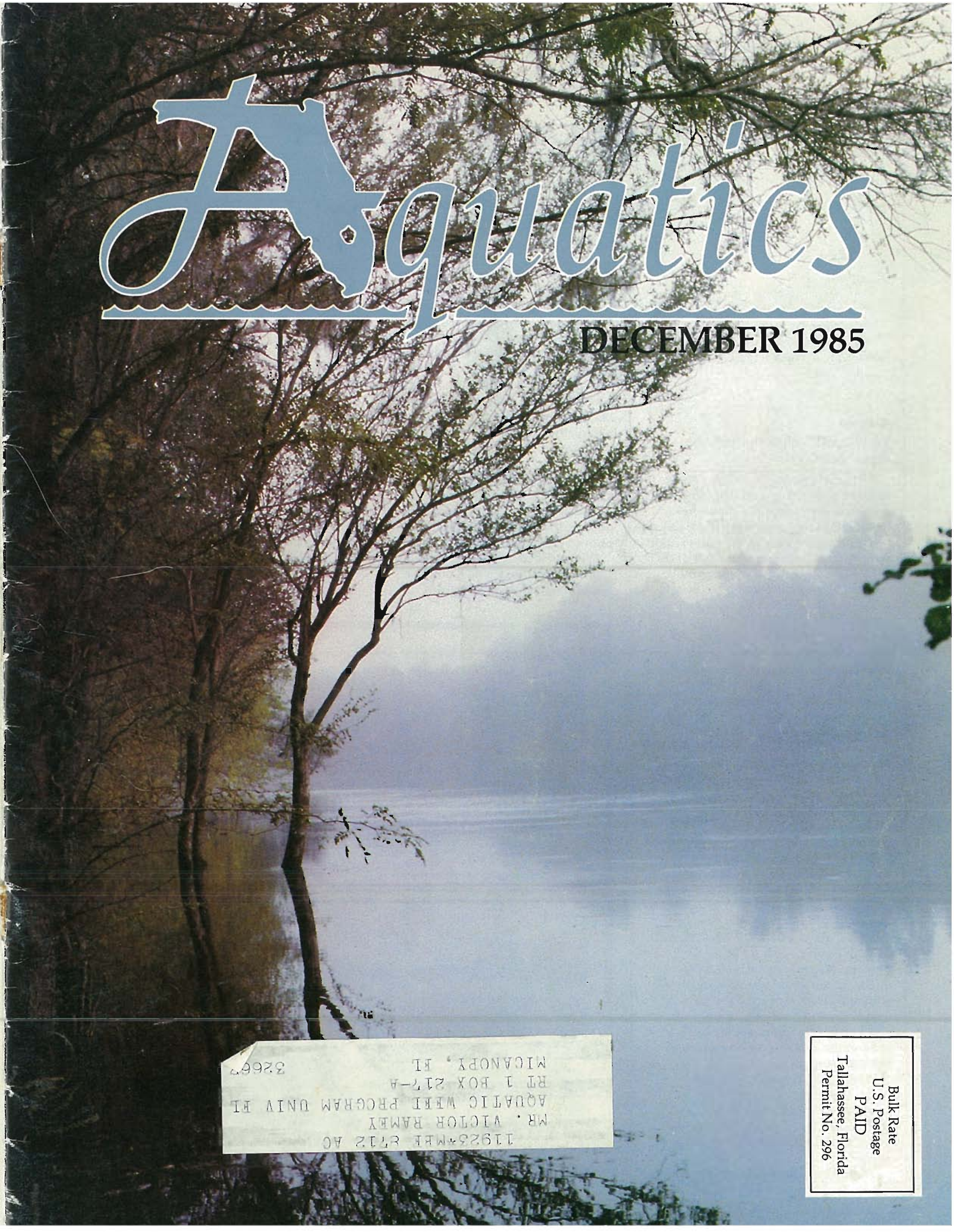
Bureau of Aquatic Plant Research and Control
Florida Department of Natural Resources
3900 Commonwealth Blvd.
Tallahassee, Florida 32303

PEOPLE ON THE MOVE

Dr. Batterson Joins IFAS Faculty at AREC Ft. Lauderdale

Dr. Ted R. Batterson has recently joined the faculty as an Assistant Professor at the University of Florida Agricultural Research and Education Center in Fort Lauderdale, Florida. The

People on the Move *continued on page 15*



Aquatics
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EDITORIAL

During the past ten years aquatic plant management personnel in Florida achieved what was once thought to be an unattainable goal, i.e. the maintenance control of waterhyacinths. The rivers and lakes are no longer perpetually covered with rafts and jams of waterhyacinths which restrict navigation, cover recreational beaches, impede water flow, and adversely impact native vegetation, fish and wildlife habitats. This has been achieved through the prudent use of aquatic herbicides and the spread of biological control agents into waterhyacinth nursery areas. Unfortunately, as Florida's population has grown, the percentage of water users who remember the "good ole days" of waterhyacinth control (pre-1975), have decreased rapidly. As such, the public's and governmental administrative perception of the priority of maintaining a low level of waterhyacinths has also decreased. The "squeaky wheel" of the waterhyacinth jam has been well greased. It is now the responsibility of the professional aquatic applicators and the research community to exert a conscious effort towards educating the public on the need for aquatic plant management.

Joe Joyce

ABOUT THE COVER

Early morning fog lifting off of the Santa Fe River. First place award in the photo contest at the 9th annual meeting of the FAPMS.
Photo by: Joe Hinkle, DNR, Lake City.

Aquatics

FLORIDA AQUATIC PLANT MANAGEMENT SOCIETY, INC. ESTABLISHED 1976

DECEMBER 1985/Volume 7, NO. 4

CONTENTS

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

EDITORIAL: Address all correspondence regarding editorial matter to Daniel Thayer, Editor, "Aquatics" Magazine, 7922 N.W. 71st Street, Gainesville, FL 32606.

Benefits of Maintenance Control of Waterhyacinth

by
Joseph C. Joyce
Director, Center for Aquatic Weeds
Institute of Food and Agricultural Sciences
University of Florida

Three of the main criticisms of the public concerning the use of herbicides to control waterhyacinths are: (a) the quantity of chemical used to control the plants, (b) the amount of organic material deposited on the lake or river bottom by the dead waterhyacinths and (c) the increased oxygen demand and lower dissolved oxygen (D.O.) levels created by the decaying plant material. Management personnel have implemented waterhyacinth maintenance programs designed to address these three issues (3), however no quantitative data have been collected to document the predicted benefits of maintaining low levels of waterhyacinths. Numerous studies have been conducted to correlate the growth of waterhyacinths with dissolved oxygen levels (4,6,7) and detritial accumulation (1,2,5,6). However, no studies have been conducted to correlate the maintenance control of waterhyacinths with the D.O. levels, amount of organic sedimentation, and quantity of herbicide utilized on an annual basis. In order to test this relationship, ten waterhyacinth plants were planted in each of 18 concrete vaults at the Center for Aquatic Weeds in Gainesville, Florida. The plants were maintained at six maximum levels of coverage (3) replicates each) i.e. zero, 5%, 25%, 50%, 100% and 100% unsprayed. For example, when the waterhyacinths increased to 25 plants (equivalent to 5% coverage) in the three 5% tanks they were chemically treated with 2,4-D to the original 10 plants; when the plants reached 25, 50, or 100% coverage in other predetermined tanks they were sprayed back to 5% coverage. In the tanks labeled 100% unsprayed, the plants were allowed to completely cover the water surface and no herbicide control was conducted. Records were maintained on the number of times each tank was treated with 2,4-D and the quantity of herbicide solution utilized over the one-year study period. Once spraying operations were initiated, biweekly D.O. measurements were made. At the end of one year, the live plants remaining after the winter freeze were removed, the tanks were drained, and the organic sediments were dried and weighed.

The amount of herbicide used under the six different treatment levels is shown in Table 1. In the most intensely managed tanks (5% coverage), eight separate treatments were required throughout the year. This was twice the number required at the 50% level and four times more than at the 100% level of coverage. However, at the 5% level only 17 milliliters of spray solution was required during each spraying, whereas four times that amount was required at 50% and ten times (175 mls) more herbicide solution was required for each spraying at the 100% level of coverage. Calculations of the total amount used throughout the one year study period and extrapolation of the data to a per acre base's indicates that 1.7 lbs of herbicide (less than one half gallon*) would be required to maintain the plants at the 5% maintenance level, whereas 3.3 lbs (.83 gallon*) would be required at the 50% coverage level and 4.5 lbs. (1.13 gallons*) of herbicide would be required at the 100% coverage level. This latter amount is 2.65 times more than that required to maintain the plants at the 5% maintenance level.

The annual amount of detrital material deposited by the six levels of waterhyacinth management is shown in Table 2. At the 5% coverage level only 0.39 inches of drained sediment accumulated in the tanks. This amount is essentially the same as the 0% coverage level. These amounts were almost doubled at the 25 and 50% coverage levels. The 100% coverage level deposited almost two inches or four times more sediment than the 5% maintenance level. The unsprayed waterhyacinth produced almost four inches of sediments or ten times more than the 5% level. The higher amount in the 100% unsprayed tanks is due to the deposition of large quantities of frost killed waterhyacinths and the lack of organic decomposition of these plants prior to sediment measurement. This fact is also evident in the average

*4.0 lbs 2,4-D acid per gallon of concentrate

Table 1. Annual Herbicide Useage Under Various Waterhyacinth Management Schedules

Percent of Area Covered Prior to Control	Number of Times Sprayed	Average Volume 2,4-D solution per treatment (ml)	Average Total Volume 2,4-D solution per tank (ml)	Total Amount 2,4-D assuming 1 Acre Pond (lbs)
0	0	0	0	0
5	8	17	136	1.7
25	7	34	238	3.1
50	4	63	252	3.3
100	2	175	350	4.5
100 (Unsprayed)	0	0	0	0

Table 2. Annual Organic Sedimentation Caused by Various Waterhyacinth Management Schedules

Percent of Area Covered Prior to Control	Average Sediment Depth (inches)	Average Percent Organic Content	Sediment Deposition (Tons/acre, dry weight)	
			Total	Organic
0	0.35	35	2.4	0.9
5	0.39	54	2.5	1.3
25	0.67	59	2.5	1.5
50	0.71	59	3.2	1.9
100	1.90	70	4.2	2.9
100 (unsprayed)	4.02	80	6.5	5.2

percentage organic content and appearance of the sediments. In the 5, 25, and 50 coverage tanks, the sediments were unconsolidated, finely divided with few plant parts identifiable, and ranged between 54 to 59% organic matter. In the 100% and 100% unsprayed tanks, the sediments were more consolidated and plant parts more easily identifiable. These sediments had undergone less decomposition and averaged between 70 and 80% organic content, respectively. In terms of total amount of sediment deposited per acre on an annual basis the unsprayed waterhyacinths deposited 6.5 tons/acre (dry weight) which is approximately 2.7 times more than the 5% maintenance level. The organic portion of these sediments was 5.2 tons/acre in the unsprayed tanks which was four times the amount (1.3 tons/acre) in the 5% coverage tanks. It is interesting to note that the amount of sediments deposited in the 100% tanks is exactly equal to that reported (4.2 tons/acre) for the renovation of a citrus pond completely covered with waterhyacinths (1).

Biweekly D.O. levels associated with the various treatment levels are shown in Table 3. As expected the D.O. levels are higher in the tanks with fewer waterhyacinths. This is due to a higher percentage of open water which allowed disfusion of oxygen from the atmosphere, and less oxygen demand created by decaying waterhyacinths, more solar radiation entering the water column which allowed greater production of D.O. by phytoplankton. In a similar study which evaluated the effects of various levels of waterhyacinths on fish production (4), it was observed that reductions in phytoplankton growth in ponds with 10 and 25% waterhyacinth coverage resulted in much lower fish production due to a reduction in the food base. However, the presence of 5% cover by waterhyacinth did not significantly affect fish production (4).

An additional observation made during the study was the amount of live waterhyacinths which survived the severe freeze during January, 1985. During this freeze approximately 3-4 inches of ice was observed on the surface of most of the tanks. Two weeks following the freeze waterhyacinths in all the tanks appeared brown and completely killed, however two months later when the experiment was ended the 100% coverage unsprayed tanks contained an average of 90 live plants (only ten plants were stocked in each tank initially. No live plants remained in the 5 or 25% coverage tanks. This is caused by the insulating nature of the waterhyacinth which reduces the heat loss from the water surface and the insulation of the plant meristem by the high amounts of plant material in the large "bull" hyacinths (2,6).

In summary, it is evident that maintenance of waterhyacinths at low levels (less than 5% coverage) can (a) reduce annual herbicide useage by a factor as great as 2.6, (b) reduce organic

Table 3. Effects of various levels of waterhyacinth management schedules on dissolved oxygen concentration

Percent of Area Covered Prior to Control	Average Dissolved Oxygen Concentration mg/1
0	10.3
5	9.3
25	4.0
50	1.6
100	1.3
100 (unsprayed)	2.0

deposition by a factor of 4.0., (c) prevent the depression of dissolved oxygen concentrations, and (d) accentuate the killing effects of winter freezes on the waterhyacinth. Data such as these can be extremely useful in explaining the benefits of the maintenance of waterhyacinth control to the concerned public.

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Herbivorous Fish Permitting Update

by
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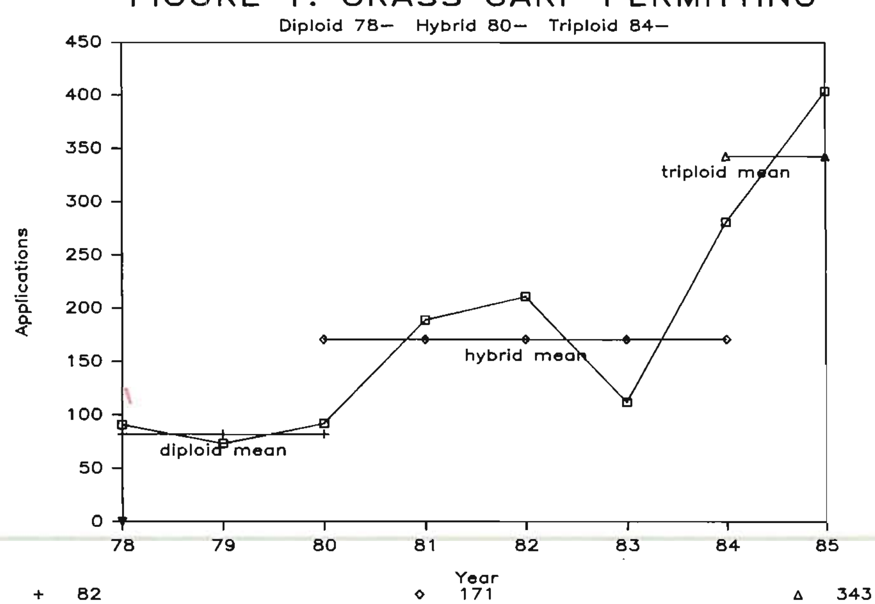
An average of 82 applications for (diploid) grass carp were received annually by the DNR between permitting years 1978 and 1979 (Figure 1). Grass carp use within the DNR permitting system, however, was restricted to sites of 25 surface acres maximum for control of non-indigenous species only. The increase in applications for hybrid carp (209% averaged annually) is therefore not unexpected, since the surface acreage and exotic plant restrictions were eliminated.

Although permitting (as expressed in numbers of applications processed) increased from 92 to 211 within a 2 year period following introduction of the triploid hybrid grass carp in 1980, a decrease was observed in 1983. It is probable that the decrease reflected inadequacies observed with use of hybrid carp to manage aquatic vegetation.

Since inception of triploid grass carp permitting in 1984, applications received by the Commission for herbivorous fish have significantly increased. Compared to an average 171 applications received annually between 1981 and 1983, 281 were handled in 1984 and 303 just in the first three quarters of 1985 (projected annual mean of 343). This would indicate a 164% increase in 1983 and 177% in 1984.

FIGURE 1. GRASS CARP PERMITTING



Although greater numbers of sites were stocked annually for hybrid carp than for diploid grass carp on the average (52 versus 48), there was a progressive decrease in numbers of sites stocked with the hybrid annually after 1981, as shown in Figure 2a. The number of hybrid sites stocked each year decreased 23% between 1981 and 1982 (70 to 54), and 39% between 1982 and 1983 (54 to 33).

Numbers of fish stocked annually is

Aquatics

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Hydrilla Control by American Coots

Observations Suggest the Possibility

Muck Accumulation Rates of Three Plants

Organic Muck Production of Water Hyacinth, Cattails, & Hydrilla

Water Hyacinths in Thailand

A Unique Approach to an Aquatic Infestation

Striving to Thrive

Aquatic Plant Survival in the Highly Acidic Lakes of The Ocala National Forest

Aquatics
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Cover photo: Small flock of American Coot feeding on topped out hydrilla found in the Kissimmee Chain of Lake, Kissimmee, FL. page 7
Photo by Keshav Setaram, SFWMD.

Emergent and river bottom vegetation page 9

Thai waterhyacinth baskets page 13

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Understanding Organic Accumulation of Selected Aquatic Plants in Florida

By Dana L. Bigham
University of Florida-IFAS

Most aquatic applicators and plant management programs are accused by the public of creating "muck-filled lakes." How many times have you heard "this lake had a sand bottom before those control programs started?" The best way to counter these claims is by increasing your understanding of the role of organic matter in lake biology.

Florida lakes are generally shallow and highly productive, because climate conditions and naturally occurring nutrients allow aquatic and wetland plants to rapidly grow in rivers, floodplains, and littoral areas which create large amounts of organic matter. The natural production of organic matter is essential for healthy, productive ecosystems and is the natural basis of lake aging and secession. The organic matter is also the base of the food chain supporting large populations of fish and wildlife in Florida aquatic ecosystems.

Dead Plant Material Drives the Food Chain

Organic compounds contain carbon molecules and are produced primarily through photosynthesis. Decomposition is the breakdown of these formerly living organisms and is driven primarily by microflora, such as fungi, bacteria, and invertebrates. Deposited organic material that remains in a system is called detritus. Detritus accumulation on lake and river bottoms occurs over time and is typically a very slow process.

Annual and perennial plants, trees, and submersed aquatic plants differ from one another in productivity. Productivity is a measure used to compare growth per unit area over time. The productivity of a particular plant plays a role in how much organic matter the plant is capable of depositing in a system. Production can be expressed in many ways, but for the purpose of this paper we will define productivity as the amount of dry weight produced per acre per year.

The standing crop of biomass is usually measured by collecting the plants in a specific area (square foot, square yard, etc.), drying the plants, and calculating a value that is converted to pounds per acre. This is a one-time measurement that can be repeated periodically to measure the change in biomass within a given system. The standing crop of biomass can then be used to estimate productivity.

Some Plants Produce Too Much

Organic detritus is the portion of decomposing plant material that accumulates over time. This portion is usually much less than the plant's total production due to organisms that consume detritus, including microbes, detritivores, insects, some fish, worms, etc... Plants require sunlight for growth, but they need nutrition as well. The cycle of organic production and decomposition replenishes the essential nutrients in the aquatic system and supplies energy in the form of carbon to plants and a host of microorganisms. Lakes with higher nutrient levels generally have greater biological productivity. Lakes with higher biological productivity are able to support a greater number of macrophytes, macroinvertebrates, fish, wildlife, and algae.

Nothing lives forever, and plants grow at different rates, so natural organic accu-

Emergent and river bottom vegetation such as cattails and cypress trees product large amounts of organic matter, which contributes significantly to the detritus in Florida waterways. This photo was taken by Lyn Gettys on Lake Ocklawaha in March 2009. Note the dead cattail leaves from last year's growth and the new leaves on the Cypress trees.

mulation due to plant productivity varies from site to site. Organic deposition from macrophytes occurs mostly in autumn and winter in temperate locations, whereas this process is almost continuous in tropical and subtropical areas. Balanced ecosystems typically lose organic matter at about the same rate new organic matter is produced. Less balanced systems, however, may accumulate excessive organic detritus and nutrients. High nutrient levels can cause algal blooms, which often reduce water clarity and limit light penetration to aquatic plants. Also, decomposers use oxygen to break down organic material in a system. Therefore, when large amounts of organic matter are produced by algae or plants, oxygen in the water column is depleted by decomposers and becomes unavailable to the flora and fauna that require oxygen for growth.

Water hyacinth, hydrilla, and cattails behave like annual plants in both the northern states and most of Florida. Most of the plant material produced by waterhyacinth and hydrilla throughout the year dies back in the winter, and in the spring, new growth arises from a few buds, stems, and tubers. The aboveground growth of cattail also dies back each year, and the plants regrow in the spring from underground rhizomes. During the fall, the production of new growth ceases, and dead tissue is decomposed by microfauna. Some of this dead tissue, however, is deposited on the bottom of the system.

There is a season-long balance between production of new growth and senescence of old growth. The annual productivity of undisturbed hydrilla ranges from 1 to 3 tons of dry weight per acre per year, whereas undistributed populations of waterhyacinth and cattail typically produce as much as 10 to 20 tons of dry weight per acre per year. Annual organic matter accumulated in tanks with undisturbed populations of hydrilla, waterhyacinth, and cattails are shown in Table 1. Accumulated organic matter attributable to these plants varies from 1 to 5 tons of dry weight per acre per year, which is about 1/4 to 1/3 of the total annual production of the plants.

Untreated Water Hyacinth Doubles Muck Production

The use of herbicides in aquatics is a contentious issue. Some people fail to consider the amount of organic matter produced by uncontrolled plant populations. Instead some people focus on the organic matter deposited to lake bottoms or aquatic ecosystems when herbicide-treated plants die. Any management activity, mechanical harvesting, or herbicide treatment that reduces growth will reduce organic production and detritus accumulation in the long run. For example, Dr. Haller at the Center for Aquatic and Invasive Plants (IFA) treated a pond in 1981 to control waterhyacinth and practiced maintenance control for six years. A total of 4.8 tons per acre of organic matter accumulated in the first year of treatment. In subsequent years, there was essentially no hyacinth growth and no additional accumulation of organic matter. An adjacent control pond with untreated water hyacinth accumulated 1.7 tons or organic matter per acre per year, for a total of 10.2 tons per acre over the six-year period. Therefore, maintenance control of waterhyacinth reduced organic matter accumulation by 5.4 tons over the six-year period.

A number of studies have examined the effect of litter fall in river forests and mangroves on organic cycling in aquatic systems, but little research has been conducted to study the role of aquatic plants in these systems. It may not be possible to directly compare data regarding these different sources of organic matter, but together, these data can provide a general understanding of the value and magnitude of organic matter production and cycling. It is important to recognize that organic deposition from undisturbed populations of macrophytes is a natural occurrence, and that emergent aquatic plants and river forests likely add significant amounts of organic matter to Florida waterways, although annual deposition of organic detritus varies greatly between water bodies. Organic matter cycling plays an important role in the ecological health of water bodies. The control of waterhyacinth and other invasive aquatic plants reduces their productivity and also reduces organic detritus accumulation over time.

The organic matter contribution of river forests and mangroves to aquatic systems is different in many ways from the contributions of true aquatic plants. Most trees that colonize the fringes of rivers and other bodies of water are long-lived perennial species, with much of their annual productivity stored as wood, above-ground branches, leaves, and below-ground roots. These species contribute organic matter mostly in the form of cellulose-rich, slowly decaying twigs and leaves. These cellulose-rich forms are very important to nutrient cycling and the support of aquatic and marine fauna. Leaf and litter fall in river forests is highly variable, and the amount of organic matter contributed to rivers and lakes is largely dependent on the area of the floodplain. The annual organic matter contribution of these ecosystems is similar to that of floating and emergent plants, ranging from 1.5 to more than 5 tons of dry weight per acre per year.

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ORGANIC MATTER PRODUCTION RATES	ANNUAL TONS DW/ ACRE/ YEAR	REFERENCE
WATER HYACINTH	5.3	MOORHEAD ET AL., 1988
	5.2	JOYCE, 1985
CATTAIL	3	KIRSCHNER ET AL. 2001
	4.2	ALVAREZ AND BÉCARES, 2006
HYDRILLA	1.3	JOYCE ET AL., 1992
FLORIDA CYPRESS (FLOODPLAIN)	3.2	DUEVER ET AL., 1984; CARTER ET AL., 1974
FLORIDA CYPRESS (STILL-WATER)	1.6	BURNS, 1978; CARTER ET AL. 1974
FLORIDA CYPRESS DRAINED (FLOODPLAIN)	1.4	BURNS, 1978

Annual organic matter production (tons dry weight per acre per year) from undisturbed plant populations of cattails, water hyacinths, and hydrilla compared to leaf-litter production of cypress river bottoms and mangroves.