
Aquatics
Winter 2007

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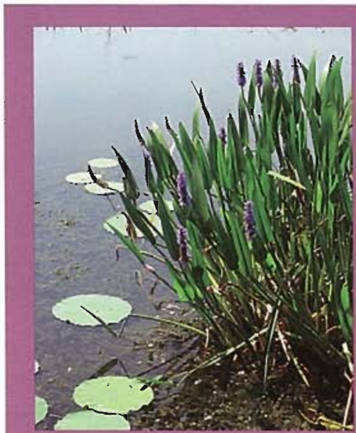
Errata: The cover photograph published in Aquatics magazine, Fall 2007 (Vol 29, No. 3) incorrectly listed the submersed aquatic plant as Eurasian watermilfoil (*Myriophyllum spicatum*). The aquatic plant was in fact a species of Pondweed (*Potamogeton sp.*). We apologize for this error. Ed.



Pickerelweed, hydrilla, and water lilies at Southport Park on Lake Tohopekaliga, Kissimmee, FL. Pink egg masses of the invasive Channeled Apple Snail cling to the stems of the Pickerelweed. Cover photograph by Tina Bond.

Aquatics

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Contents

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Activity of FOUR Herbicides on Watermeal

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Introduction

Watermeals (*Wolffia* spp.) are rootless floating aquatic plants that are the smallest (<1.5 mm in any direction) flowering angiosperms in the world. Five species of watermeal have been identified in the continental United States. Distribution of these watermeals varies by species; for example, northern or dotted watermeal (*W. borealis*) is found in the northern regions of the country, while spotless watermeal (*W. arrhiza*) is present only in California. Brazilian and Columbian watermeals (*W. brasiliensis* and *W. columbiana*, respectively) are widely distributed throughout the country, but Asian watermeal (*W. globosa*) has only been reported in California and Florida. Despite the common names associated with these watermeals, all five species are considered native to the United States and three, *W. brasiliensis, W. columbiana*, and *W. globosa*, are found in Florida

Watermeal has become a problem in many water bodies throughout the southeastern U.S. due to its explosive growth, ability to shade out submersed aquatic plants, and oxygen depletions that can kill fish. Many herbicide applicators consider watermeal one of the most difficult aquatic plants to control, since herbicide efficacy is unpredictable – sometimes they work well, but other times they have little or no effect. Little research has been focused on the control of watermeal, since the species are difficult to grow in the lab and often grow associated with algae; also, identification to the species level is extremely challenging since individual plants are tiny. The variable response of watermeal to herbicides may be due in part to differential tolerance depending on which species is being treated. Previous research reported that watermeal plants divide asexually to form new plants and during this "budding" stage, plants are much less susceptible to diquat (and likely other herbicides). Herbicides are also generally less effective in the field compared to susceptibility in the lab; field plants are often protected in sediments on the bottom of the pond and along the shoreline, so they can rapidly re-infest the pond. Previous research has evaluated aquatic herbicides such as carfentrazone, diquat, fluridone, and glyphosate in greenhouse and field trials as foliar and submersed applications for efficacy on watermeal. Diquat has been widely used as a contact herbicide for watermeal, and early spring treatments with fluridone AS and SP at 80 to 100 $\mu g\ L^{-1}$ may provide watermeal control by mid to late summer if there is no water exchange. Although diquat and fluridone often provide effective control of watermeal, failures with these treatments are common. Often, contact herbicides quickly injure and reduce the population of floating plants such as watermeal; however, single herbicide applications are typically ineffective and more than one treatment per season is required for control.

Flumioxazin and imazamox are currently being evaluated under an Experimental Use Permit (EUP) and Section 24C label, respectively, as potential aquatic herbicides for control of hydrilla and other invasive plants. Flumioxazin is a protoporphyrinogen oxidase (PPO) inhibiting herbicide that causes production of toxic singlet oxygen radicals (similar to hydrogen peroxide in the plant cells) which lead to destruction of plant cells. Imazamox inhibits the acetolactate synthase (ALS) or acetohydroxyacid synthase (AHAS) enzyme, which are important enzymes used in the production of the plant amino acids valine, leucine, and isoleucine. Both herbicides are desirable because they have low toxicity to humans and animals since they target specific plant enzymes. Therefore, the objective of this research was to compare the efficacy of flumioxazin and imazamox on watermeal with other herbicides in a greenhouse experiment.

Materials and Methods

Watermeal (suspect *W. brasiliensis*) was collected from 900 L concrete tanks established under a shade house (30% shade) at the Center for Aquatic and Invasive Plants in Gainesville, Florida and transferred to a greenhouse in August 2007. Watermeal was added to completely cover the surface (201 cm^2) of 473 mL plastic cups filled with 330 mL of water from the stock tanks (pH 7.5). The plants were allowed to acclimate for 2 d prior to herbicide treatment. Water was supplemented with Miracle-Gro® (25 $mg\ L^{-1}$) 3, 10, and 17 d after treatment (DAT). Water from the stock tanks was added to the cups as needed to account for evaporation. Watermeal was treated with a submersed application of diquat, carfentrazone, flumioxazin, or imazamox at 0, 25, 50, 100, 200,

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and 400 μg L^{-1}. This study was randomized with 4 replicates. Plants were visually evaluated at 21 DAT on a scale of 0 to 100%, where 0 = no chlorosis or reduction in biomass and 100% = no living biomass or complete control. Data are presented as means ± 95% confidence interval.

Results and Discussion

None of the herbicide treatments resulted in injury before 7 DAT (data not shown). All herbicides applied at 25 μg L^{-1} provided no control 21 DAT, but as the concentration of all herbicides increased above 25 μg L^{-1}, the level of control increased. There were minimal differences in control among all herbicides at 50 μg L^{-1}; however, diquat and flumioxazin caused more injury than carfentrazone or imazamox when applied at 100 μg L^{-1}. Diquat and flumioxazin resulted in 84 and 94% control, respectively, at 200 μg L^{-1} compared to 28 and 14% control with carfentrazone and imazamox, respectively, at the same rate. Both flumioxazin and diquat provided 94% control 21 DAT at 400 μg L^{-1}.

These results indicate that flumioxazin applied as a submersed treatment provided control of watermeal similar to diquat. These results are not surprising since flumioxazin has been proven effective on duckweed and water lettuce as a submersed treatment, but research into its efficacy and selectivity is continuing. Further research needs to be conducted to determine if flumioxazin may be applied in ponds and other water bodies to control watermeal where control has been difficult in the past. In this research, diquat was effective as a submersed treatment; this is in contrast to previous research that has shown that many aquatic herbicides are more effective when applied as foliar treatments. Imazamox and carfentrazone failed to provide more than 34% control of watermeal as a submersed treatment. The highest rates applied in this study are similar to the maximum label rate for diquat (370 μg L^{-1}) and carfentrazone (200 μg L^{-1}) and the proposed maximum label rates of the experimental herbicides flumioxazin (400 μg L^{-1}) and imazamox (500 μg L^{-1}).

Three of the herbicides tested are considered fast-acting contact herbicides (cafentrazone, diquat and flumioxazin), while imazamox is a much slower acting enzyme inhibitor somewhat similar to fluridone and glyphosate. Additional long term studies should be undertaken to evaluate efficacy of these slower acting compounds on watermeal. Also, the efficacy of foliar applications of flumioxazin and imazamox needs to be determined.

CAUTION: Diquat has a special local need label (24C) in Florida for application up to 370 μg L^{-1} and may not be labeled in other states. Applicators must have in their possession a copy of the 24C label when applying more than 2 gallons of diquat per acre. Flumioxazin currently has an EUP for scientists to conduct research with this product. It is not available to aquatic applicators in the U.S. at this time. **Always have a label and read instructions before any pesticide application.** A list of the literature used in the preparation of this article is available from Chris Mudge.

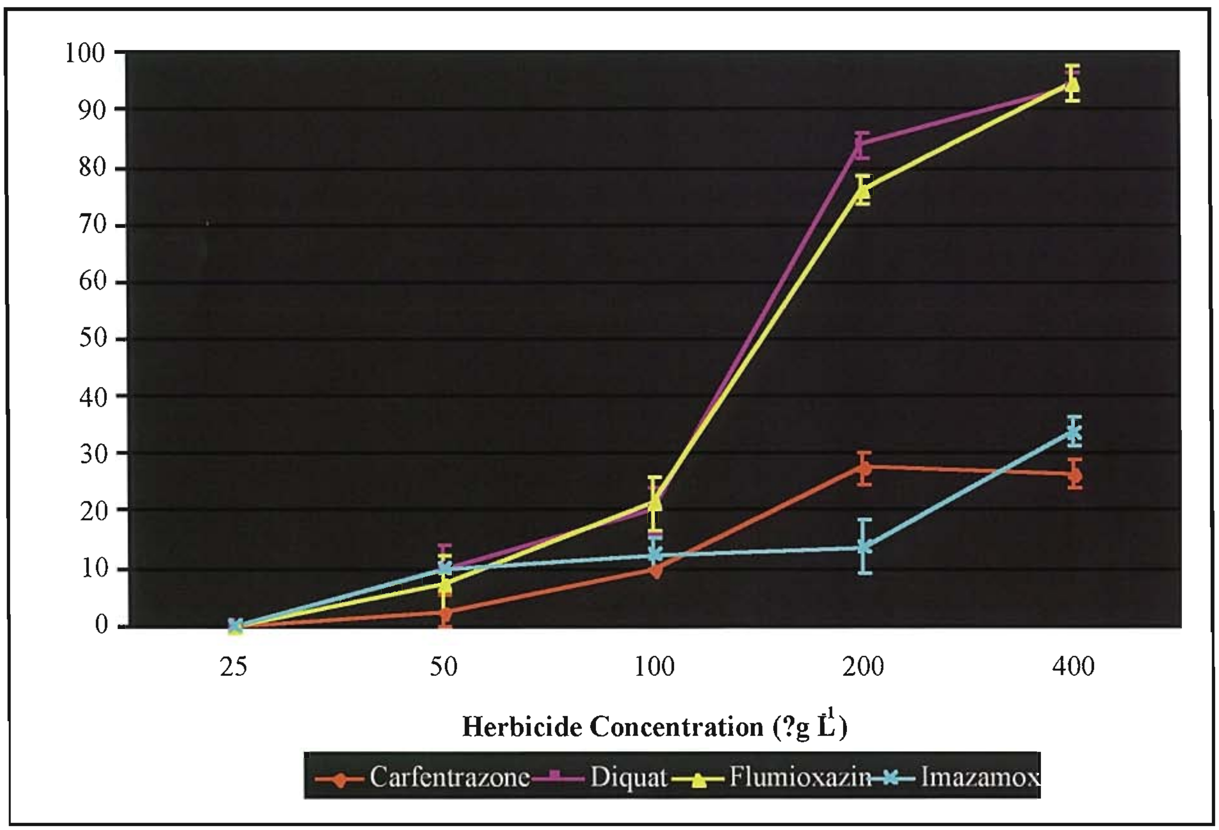

Figure 1. Effect of a submersed application of herbicides on watermeal 21 DAT. Data presented as means ± 95% confidence interval. Overlapping CI bars indicate no significant difference.


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Professional Vegetation Management

How to Build Weighted Trailing Hoses

Bill Haller[1], Lyn Gettys[1], Margaret Glenn[1] and Greg Reynolds[2]

[1]University of Florida Center for Aquatic and Invasive Plants – Gainesville, FL
[2]Syngenta Professional Products – Greensboro, NC

Back in the 70s (that's 1970s for the younger reader), when Elvis and disco were king and before iPods, PCs, HDTV, cell phones and whole-lake treatments with slow-acting enzyme-inhibiting herbicides like fluridone, most aquatic herbicide applicators were using weighted trailing hoses to treat the bottom acre-foot to control hydrilla and other submersed plants.

Say what?!? Yes, bottom acre-foot and weighted hoses! Read on...

Let's say you had early-season hydrilla that was 3 to 4 feet tall and growing in water 7 to 10 feet deep. Back in the day, you could inject contact herbicides such as diquat, copper and endothall through hoses so that the herbicide was delivered into the plant bed at the bottom of the water column, resulting in less herbicide applied and less money spent (Figure 1). The term "bottom acre-foot" may not be entirely correct, but that was what the method was commonly called. Bill McClintock (Director of Winter Park's Aquatic Weed Control program at the time) had a pontoon boat loaded with a 500-gallon sprayer equipped with four 20-foot trailing weighted hoses spaced about 10 feet apart. Bill would tank-mix 500 gallons of water with the appropriate herbicide and treat 5 acres along the shorelines with an output of 100 gallons per acre (GPA) in the 30-foot wide swath, being careful to miss docks and diving boards. This type of system was not unique to Winter

Figure 1. Bottom acre-foot treatment, with trailing weighted hoses. This system delivers the herbicide directly into the weedbed for maximum efficiency and lower cost. Line illustration drawn by Lyn Gettys and colored by Josh Huey.

Figure 2. Whole water column treatment, with trailing weighted hoses of various lengths. While this figure shows herbicide discharging from the ends of the hoses, it is actually discharged approximately 18 inches above the hose ends (see text). Line illustration drawn by Lyn Gettys and colored by Josh Huey.

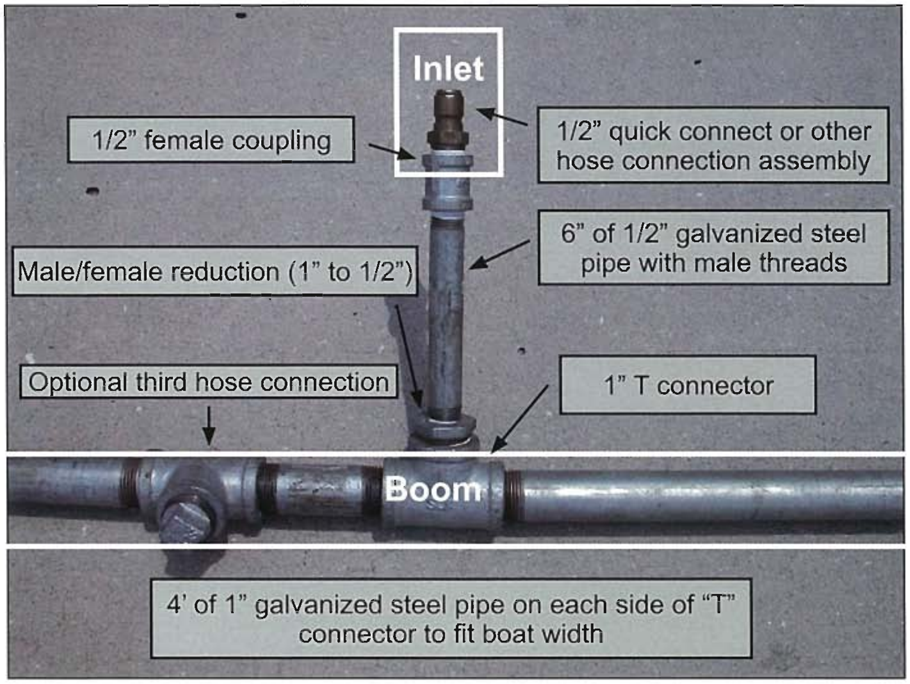


Figure 3. Inlet setup from the spray tank to the boom. Photo by Greg Reynolds.

Park – everyone used some variant of this setup to increase efficiency and reduce costs (after all, diquat was $26/gallon, endothall was $20/gallon and copper sulfate was 15¢/pound).

The main goal of the bottom acre-foot treatment was to place the herbicide where the weeds were growing – in other words, why treat the upper half of the water column when the weeds were in the lower half? This philosophy explains why granular versions of several products have been developed – to facilitate the placement of herbicide directly in target weed-beds. The use of weighted hoses also allows contact herbicides to be placed below the thermocline, the area that separates the warm upper and cool lower "layers" of the water (ever stood in a pond and noticed that the water around your feet was much cooler than the water near the surface?). Temperatures above the thermocline can get downright toasty, especially on hot, still, summer days, and herbicides applied at or just below the surface of the water don't mix with the cooler water below the thermocline. Surface-applied herbicides only come into contact with the upper 1 to 2 feet of topped-out hydrilla and don't reach the lower portions of weeds, so regrowth occurs quickly. The use of weighted hoses allows applicators to ensure that contact herbicides are delivered to the lower portions of weeds below the thermocline; this system may be slightly more time-consuming than regular surface application, but provides much better, longer-term control of weeds.

If weeds are distributed throughout the water column (say, 8 foot tall weeds in 10 feet of water), you should apply most contact herbicides (such as diquat at 370 ppb or endothall at 3 ppm) uniformly throughout the water column. We frequently use weighted hoses for uniform application of herbicides, dyes and even alum treatments to the entire water column of experimental plots (see Figure 2). We typically treat ponds that are 8 to 10 feet deep; our setup uses three hoses (one each of 4, 8 and 12 feet in length) attached to a single boom that is the same width as the boat (8 feet) so we can avoid damage to diving boards and docks.

We use a standard Hypro pump with a 100-gallon tank set to pump about 5 gallons per minute (GPM). The inlet to the 1-inch galvanized manifold (or boom) is shown in Figure 3. We use 1-inch galvanized because it is much stronger than smaller diameter pipes; after all, when a trailing hose snags on a stump or you turn too tightly and twist the hose around 2 tons of hydrilla, you want the manifold to remain intact (our motto: "Sink the boat, save the boom!"). The 1-inch boom is reduced to ½ inch at each hose (Figure 4). The hydraulic hose connector is a key component and must be used – note there is no hose clamp or metal connection where the hose attaches to the brass connector (the yellow band is simply a washer). The hose and brass connector (sold as Parker Push Lok 250 psi, 5/8") is designed so that the hose locks into the connector without any clamps; once locked, the hose will not come off. All hydraulic shops should have this or a similar product in stock. The shop where we purchased our materials also inserted the connectors for us. The spring (hose protector coil) in Figure 4 prevents the hose from rubbing on the bow. The loose lower end of the hose is connected to a lead-filled weighted ¾" pipe

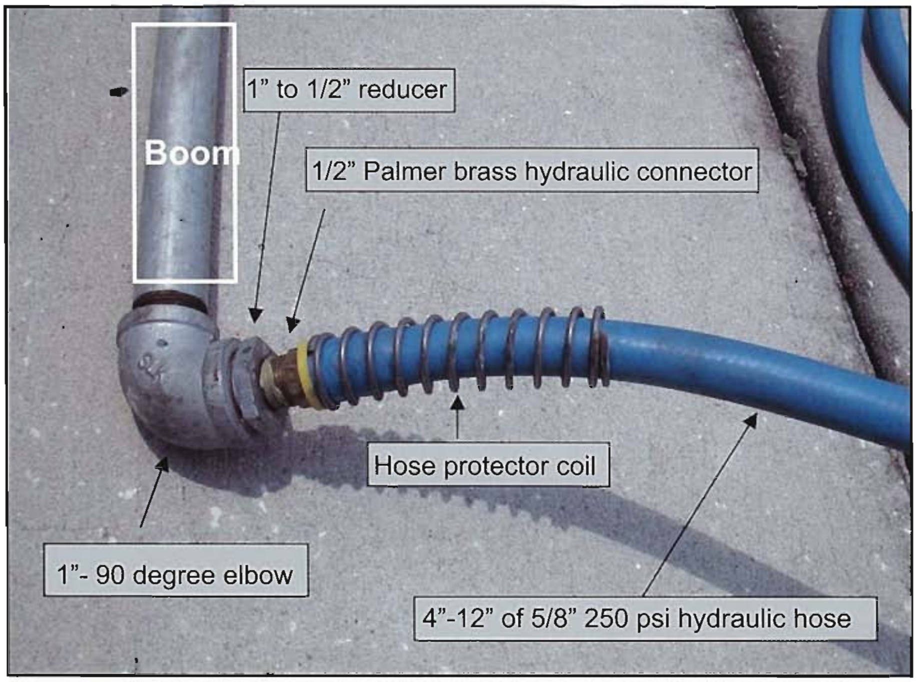


Figure 4. One-inch galvanized boom reduced to ½" for attachment of the 5/8" trailing hoses. Trailing hoses can be any length and we use two sets for our 3-hose setup. We use three 12 foot hoses to cover the bottom acre-foot and one each of 4, 8 and 12 foot hoses to treat the total water column. If you typically treat water that is 12 to 16 feet deep, you should use hoses that are 20 to 24 feet in length. Photo by Greg Reynolds.

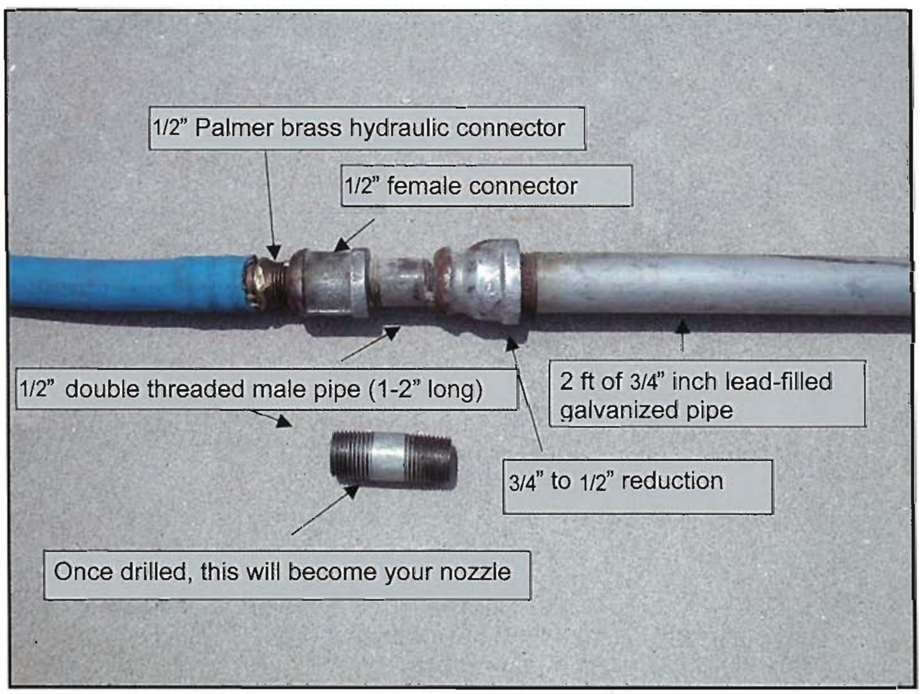


Figure 5. Trailing hose attached to the ¾" drilled nozzle and followed by 2 feet of ¾" lead-filled pipe. Photo by Greg Reynolds.

as shown in Figure 5. Make sure there are no ridges or hose clamps in this area to avoid snagging the hose on weeds. We also ground the edges from the brass connector, the female connector and the enlarging connector to prevent hydrilla and other weeds from getting caught on

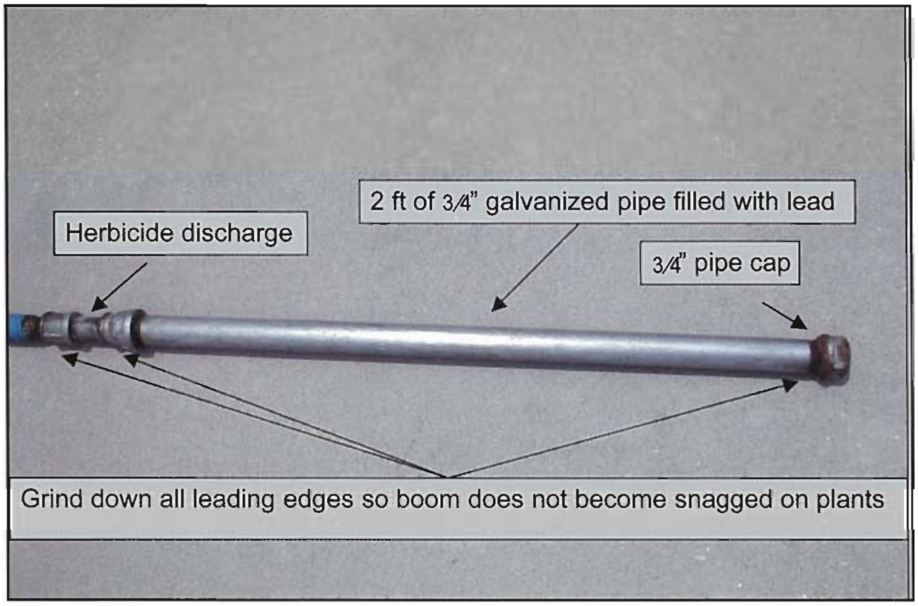
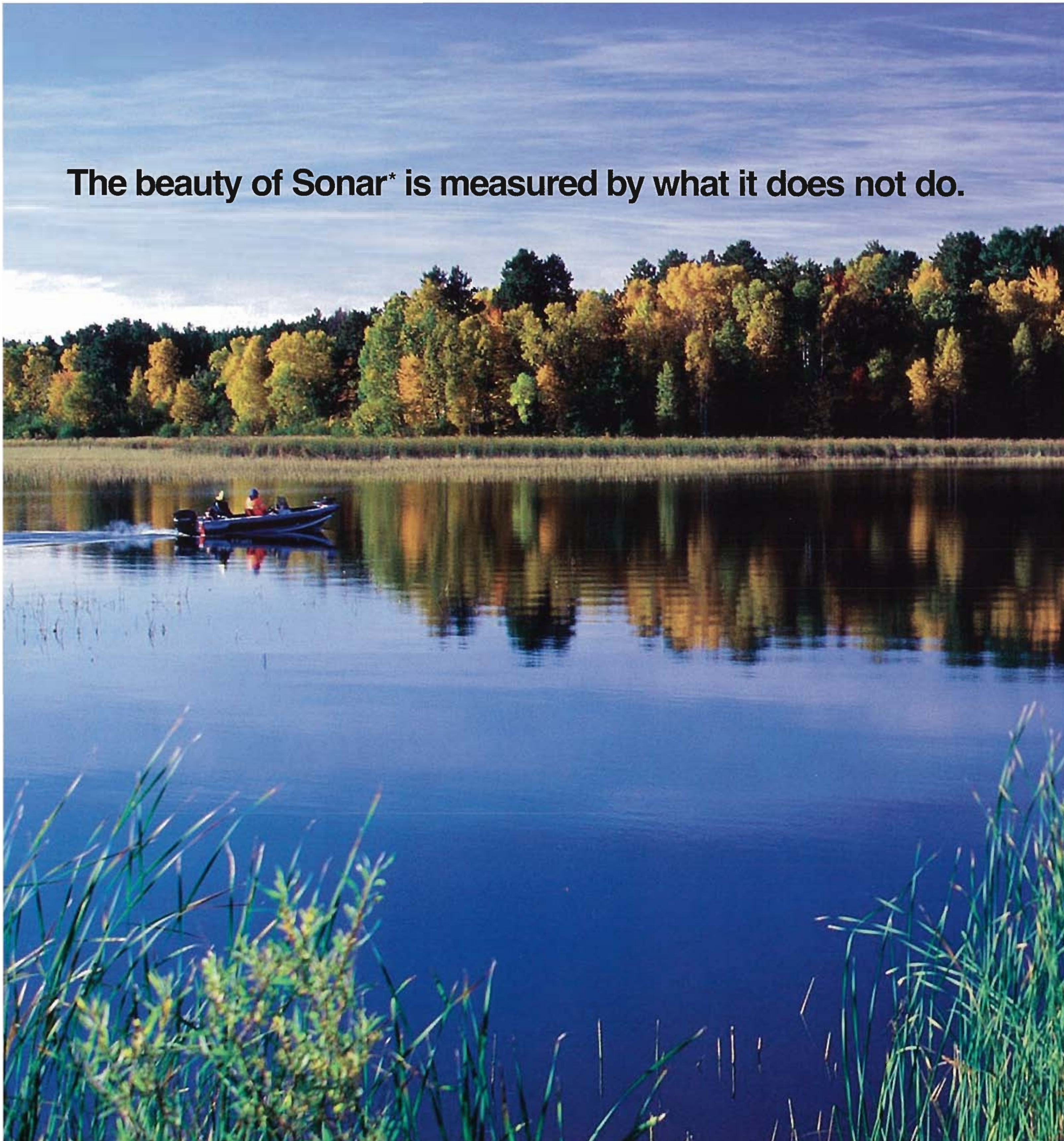


Figure 6. Lead-filled pipe at the end of the trailing hose. The depth of the lead-filled pipe will depend on the water depth and hose length and is greatly influenced by speed and weed density. Bill McClintock used a pontoon boat with a 30 foot swath (spray) width because he could treat almost 4 acres in an hour if he traveled at 1 mph (8 feet wide x 1 mile = 1 acre so 30 feet wide x 1 mile = 3.75 acres). Photo by Greg Reynolds.

the weighted hose. Check the edges on the left side of the connectors in Figure 5; that's the direction the hose pulls the weighted pipe through the weeds. You may still collect some weeds, but a quick yank on the trailing hose usually frees them from the discharge end.

The weighted end of the hose is shown in Figure 6. The ¾" pipe is 2 feet long and filled with molten lead. Molten lead is dangerous stuff to handle and we are not very brave, so we had our pipes filled with molten lead at a plumbing shop; it cost $50 to fill three pipes with lead, which seems like a good investment. We have found that a 2-foot-long, ¾" pipe is about right for our treatments based on boat speed and the weeds we treat; ½" pipe was not heavy enough and 3-foot-long pieces of pipe got unwieldy. A lower cap may not be necessary if the lead remains in the pipe; if you do need a cap, be sure that the edges are ground off to prevent snagging weeds. The nozzle ain't fancy, but it works just fine. The ground edges of the pipe fittings and the nozzle (hole) where the herbicide is discharged into the water are visible in Figure 7. Herbicide would be discharged into sediment or mud if the hole was on the bottom of the lead-filled pipe, so remember that the goal of this setup is to place the herbicide in the weeds or water column instead of on the bottom of the pond. If the pipe were vertical, the herbicide



A beautiful lake can turn ugly once invasive aquatic weeds like hydrilla or Eurasian watermilfoil take over. But before you introduce non-selective grass carp or launch a mechanical harvesting program, consider what Sonar Aquatic Herbicide does not do.

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would discharge 2 feet from the bottom; however, when the pipe is dragging, it is not vertical and the herbicide usually discharges around 12 inches from the bottom (Perfect! The bottom acre-foot?!?).

It's likely that the engineers among the aquatic applicators will find ways to improve on this design. A few cautions to keep in mind… first, you can't drag hoses when the boat is on a plane! Second, you must go slowly to keep the hoses on the bottom of the pond (this is probably why Winter Park had a 30' boom – to increase the acres treated per hour). Finally, avoid tight corners or the long hoses will collect lots of weeds. A good way to reduce the chances of this happening is to pull on the hoses every couple of minutes to shake loose any clinging weeds. Experience will be your best guide when working with weighted hoses – once you get the hang of it, you'll appreciate how effective this system is!

So now you know what a bottom acre-foot treatment is and how to build a high-tech boom and weighted hose system. In fact, it's so high-tech that if you apply copper, the money you save using this method will leave you with enough cash to build a new system each year (probably a good thing, since younger readers may not know that copper sulfate eats galvanized pipe!). We guarantee you'll get more effective weed control and use less chemical if you switch to this system – don't forget, this was proven way back in the 70s! For a bit of history, go to the APMS webpage at www.apms.org and click on the Online Publications link. Go to 1974, Volume 12, which provides the Table of Contents, then scroll down to page 46 and click on the title (or just type in http://www.apms.org/japm/vol12/v12p46.pdf to go directly to the article). Now that's old, but interesting, and yes, diquat was $25.85/gallon. Ah yes, back in the day… when we only had contact herbicides for submersed weed control.

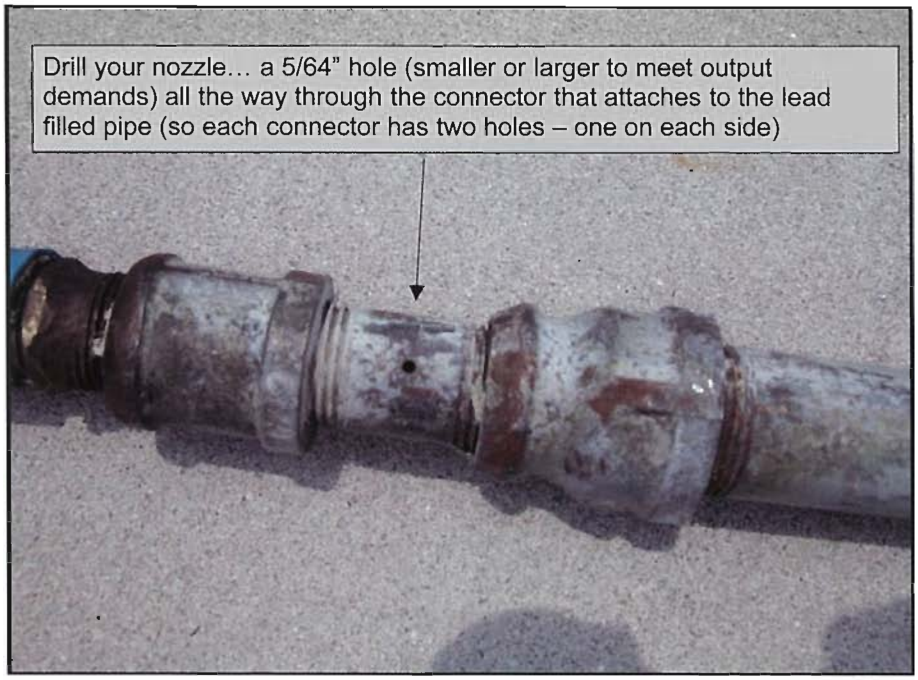

Figure 7. The nozzle for herbicide discharge can be drilled to any appropriate size. Note that the leading edges of the fitting are ground down to minimize snagging on submersed weeds. Photo by Greg Reynolds.

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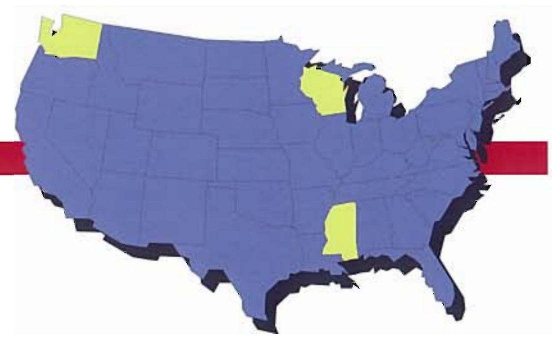
State Updates on Aquatic Plant Management Activities:



Washington, Wisconsin, and Mississippi

Introduction

Michael D. Netherland
US Army Engineer Research and Development Center
Gainesville, FL 32653

As noted in the last issue of Aquatics Magazine, we plan to feature state updates on various aquatic plant problems and management activities to give our readers a better understanding of both regional issues as well as different perspectives on management. We plan to continue running this feature until we run out of states with aquatic plant problems or willing contributors. Based on the three state contributions from the last issue of Aquatics, as well as the contributions for this issue, there are similarities and differences in both the types of water bodies, plant problems, and management philosophies. The recognition that a coordinated effort is key to addressing aquatic invasive species at a statewide level is becoming more common as many states look to develop new programs.

This issue includes updates from the states of Washington, Wisconsin, and Mississippi. While Washington and Wisconsin have had aquatic invasive species programs in place for some time, Mississippi is in the process of forming an Aquatic Nuisance Species Task Force. It is interesting to note that all three states have ongoing hydrilla (*Hydrilla verticillata*) eradication projects that are in various stages of implementation. Hydrilla's recent move into the Midwest has long been thought inevitable based on the ability of this plant to grow to nuisance levels in the colder climates of the Northeast. In addition to the movement of exotic species such as hydrilla, the reports of plants native to other areas of the U.S. moving into Washington (e.g. variable watermilfoil (*Myriophyllum heterophyllum*) and grassleaf arrowhead (*Sagittaria graminea*) demonstrates that the term "native" does not always denote a plant that is benign in nature. Moreover, the report from Washington also illustrates that taxonomy of aquatic species can be a challenge for even those highly trained in distinguishing morphological characteristics. The report from Wisconsin reflects the state's focus on protection of native plant species and the focus on prevention as a pillar of the state program. The increasing funding levels from the Wisconsin legislature for the Aquatic Invasive Species control cost share grant program certainly indicates that elected officials in this state recognize the problems associated with uncontrolled growth of non-native aquatic plants. Lastly, the report from Mississippi illustrates a state that is in the early stages of pulling together a coordinated statewide strategy for addressing aquatic invasive plant issues. Concerned individuals often drive such efforts, and the author of this update has played a significant role in initiating this effort. Due to the southern geography, Mississippi can lay claim to hosting several of the world's worst exotic aquatic weeds such as hydrilla, water hyacinth (*Eichhornia crassipes*) and giant salvinia (*Salvinia molesta*). Lastly, the example of the reduced efficacy of the alligatorweed flea beetle for control of alligatorweed (*Alternanthera philloxeroides*) in the northern parts of the state illustrates the need for aquatic resource managers to develop integrated plans for addressing each aquatic invasive species.

Washington: Invasive Aquatic Plant Management Activities

Jenifer Parsons
Aquatic Plant Specialist
Washington Dept. of Ecology

Since the early 1990's Washington State has had an active aquatic plant monitoring and grant program supported by boat trailer tab fees. The grant program funds local organizations to tackle aquatic weeds listed on the state's noxious weed list (see www.nwcb.wa.gov/ for the complete list). About $500,000 in grant funding is awarded each year. As part of the monitoring program we do aquatic plant inventories on as many of the state's public access lakes as possible, and also conduct selected projects tracking the effectiveness of control methods initiated with grant money.

We also monitor selected aquatic weed control methods as time allows.

With this update, I will highlight some of the more interesting things going on in the realm of aquatic weed management in the last couple of years.

Increasing complexity with milfoil identification

With the help of DNA analysis (many thanks to Dr. Michael Moody, Dr. Ryan Thumb and Dr. Cort Anderson) I have decided I no longer know much about the field identification of milfoil (*Myriophyllum*) species. With the DNA analysis we have learned that a few populations of what seemed to be the native western milfoil (*M. hippuroides*) on steroids, actually are the non-native and apparently invasive variable leaf milfoil (*M. heterophyllum*). Through extensive sampling and DNA analysis over the past year, we learned that variable leaf milfoil is present in five western Washington lakes. We also had milfoil from pet stores analyzed, and the majority, not surprisingly, was variable leaf milfoil. At the writing of this article, this species is currently proposed as an addition to the state noxious weed list as a class A weed. This would require eradication of the 5 established populations. It would also provide strong incentive to add the species to the state quarantine list making it illegal to sell, transport or posses.

In the last several years we have also had the presence of milfoil hybrids (between Eurasian (*M. spicatum*) and northern milfoil (*M. sibiricum*)) confirmed by DNA analysis in four lakes. Thus far these hybrid populations have not received a great deal of attention from the state, more from a lack of time than a lack of interest. In one lake where we suspect the hybrid has been present for at least 15 years it is the dominant plant. The other lakes so far are not dominated by the hybrid, but they also seem to be relatively new populations, or else are under management. So far, all of the confirmed hybrid populations occur in the eastern part of the state.

New species to the state

In addition to the unhappy discovery that we have yet another invasive *Myriophyllum* species, we have found new populations of several other aquatic and riparian species that are causing us varying levels of concern.

This year our field crew found a small population of arrow arum (*Peltandra virginica*) on a lake shore in northwest Washington. This may have been brought in from California or Oregon by waterfowl, as the lake is an undeveloped wildlife area and waterfowl eat the fruit and disperse the seeds.

Last year we found an escaped population of swamp rose-mallow (*Hibiscus moscheutos*) on a lake in central Washington. This appears to be an escaped ornamental. We are keeping an eye on it to see if it takes over.

Several non-native arrowhead (*Sagittaria*) species are causing varying degrees of problems. The worst is grass-leaf arrowhead (*S. graminea*) which is established in a handful of lakes in western Washington. A control program in one, Mason Lake, is meeting with limited success due to the submersed nature of plants growing in deeper water. Another, flat-leaf arrowhead (*S. platyphyla*), is established and thriving in one lake. It is being managed but so far has proven difficult to control. The third, bur arrowhead (*S. rigida*), persists at low levels in one lake.

European frog-bit (*Hydrocharis morsus-ranae*) was confirmed in one lake in 2003. Unfortunately the European frog-bit is dispersed throughout a high quality emergent wetland surrounding the lake. We cannot figure out a way to kill the frog-bit without severely impacting the wetland, so we keep an eye on nearby lakes and hope it doesn't spread.

A cattail new to the state, southern cattail (*Typha domingensis*), is present and persisting in several lakes in eastern Washington. It may have come in with wildlife, and so far we consider it a range expansion. We monitor it, but aren't doing anything to control it.

Some success!

On a brighter note, Washington's one population of hydrilla (*Hydrilla verticillata*) is finally firmly on the road to eradication. This was the first year that diver surveys found no hydrilla plants in the two connected lakes where we have battled this plant since 1995. Last year the divers only found two plants. The lakes will continue to receive herbicide treatments for an additional three years, with intensive diver inventories for at least five years (assuming they continue to find no plants; if they do, the clock starts over).

Although Eurasian milfoil is abundant and widespread in the state, we have successfully eradicated it from seven individual lakes. Most of these were well established populations that were treated with herbicide then followed up with intensive monitoring and localized control of surviving plants with bottom barriers or hand pulling. Another 38 lakes are being successfully managed to maintain low levels of this weed. We continue to do work with the biocontrol weevil *Euhrychiopsis lecontei* in the hopes of adding biocontrol to the tools used against this pervasive pest.

For more information

Please see our websites for information about the grant program, the aquatic weeds we track and control, and the monitoring program www.ecy.wa.gov/programs/wq/links/plants.html and www.ecy.wa.gov/programs/eap/lakes/aquaticplants/index.html or e-mail me jenp461@ecy.wa.gov, Kathy Hamel kham461@ecy.wa.gov, or Joan Clark jcla461@ecy.wa.gov.

Wisconsin: Invasive Aquatic Plant Management Overview and Update

Tim Asplund
Wisconsin DNR

Overview

A balanced aquatic plant community is a vital and necessary component of a healthy aquatic ecosystem. Native aquatic plants are the principal habitat feature of lakes and they help maintain clean water and provide the oxygen that fish and other organisms need to survive. The Wisconsin Department of Natural Resources is charged through state law to protect and develop diverse and stable communities of aquatic plants and regulate how they are managed.

At the same time, there is an acknowledgement of the threat that non-native, invasive aquatic plants have on maintaining balanced ecosystems. Currently, three aquatic plants are recognized in state code as being invasive species: Eurasian water milfoil, curly-leaf pondweed, and purple loosestrife. Aquatic plant management activities that are directed at control of aquatic invasive species are given greater priority and less oversight than activities directed at native species. For example, a permit is not required for manual removal of invasive aquatic plants along a riparian shoreline.

The department uses a three-tiered strategy for controlling aquatic invasive species:

1) Prevention through education and planning
2) Detecting and controlling new or "pioneer" infestations
3) Controlling established infestations

Research has indicated that *prevention* is the most cost-effective measure. Once an invasive species is established, it becomes very difficult and expensive to control the spread, and may be impossible to eradicate completely. Thus the state's priority is to prevent or at least significantly slow the spread of harmful invasions. Elements of this strategy include educating boaters, lake users and the general public to recognize invasive species, understand the harm they pose to our waters and practice prevention behaviors that will reduce their spread. The Clean

Boats Clean Waters program (www.uwsp.edu/cnr/uwexlakes/CBCW/default.asp) has been an effective tool to equip volunteers to monitor boat landings and ensure that plants are not being introduced inadvertently to public waters. Another key element of this strategy is working with lake groups and local government to develop aquatic plant management plans to implement all three tiers of the strategy (www.uwsp.edu/cnr/uwexlakes/ecology/APMguide.asp).

The second element of the strategy is to *detect the presence of new or pioneer stands of invasive plants* and work to bring them under control and prevent their establishment and spread. The state's baseline monitoring efforts have expanded in recent years to conduct lake-wide aquatic plant surveys on new lakes, increasing our capacity to detect new invasions. Rapid response grants and strategies are being developed to assist local governments and lake organizations with containing the spread of new invasions. This approach requires careful consideration; disturbing an invasive species that is not a nuisance or conducting incomplete management measures may actually stimulate its growth and spread.

The third element is to *control well established infestations* and restore healthy aquatic communities. This involves implementing long-term, integrated management plans that employ the latest research and control techniques at multiple levels and that includes enough monitoring to accurately measure results to be used to adjust and "tune" future management actions. Often these projects evolve into comprehensive lake management projects, which include watershed management, in-lake water quality, and fish community goals and objectives.

AIS grants

A key asset in enabling Wisconsin to implement its AIS strategy is through the Aquatic Invasive Species Control cost share grant program (http://dnr.wi.gov/org/caer/cfa/grants/Lakes/invasivespecies.html). The legislature established this program in 2004, with an initial allocation of $500,000 per year and a 50% cost share level. The recently enacted biennial budget increased the funding for this grant program to $2.8 million this fiscal year (through June, 2008) and $4.3 million in the following year, and increased the state's share to 75%.

Eligible sponsors include lake associations, river management organizations, nonprofit conservation organizations as well as any unit of local government, including tribes and lake protection and rehabilitation districts. Grants are available to conduct projects on all waters of the state, including lakes, rivers, streams, wetlands and the Great Lakes. Priorities are set on a statewide basis and emphasize activities that seek to prevent the spread or control new infestations of AIS over projects that attempt control on large established infestations.

Allocation of these grant resources reflects the three priorities listed above:

Grants up to $75,000 for education, monitoring, planning and prevention efforts like local boat landing inspections programs to **slow the spread** and develop strategies for tracking and control.

Grants up to $10,000 for rapid response projects to identify and **remove new, pioneer infestations** as soon as they are discovered and before they can become established.

Grants up to $75,000 for projects to **control or eradicate established infestations.**

Since 2004 we have:

Cost-shared over $2 million in 148 prevention and planning projects for the development of integrated management plans, boating inspection and education projects. This also includes 14 countywide projects supporting part-time AIS coordinator positions.

Cost-shared $188,500 in 36 projects to immediately chemically and manually treat new pioneer infestations of AIS and provide follow up monitoring, planning and prevention.

Cost-shared approximately $1.5 million in mostly herbicide treatments for AIS in 43 different projects where there is a well designed, long term, integrated management plan in place that targets native plant restoration and includes sufficient monitoring information so that we can learn, develop and adapt the best strategies for controlling AIS.

Hydrilla in Wisconsin

The invasive species *Hydrilla verticillata* was documented for the first time in Wisconsin in summer 2007. The identified population is in a 1.5 acre private pond in Marinette County in the northeastern part of the state. Since the discovery state, federal and county officials have been working together with the landowner to develop a containment and control plan for this invasive plant. (See October 4, 2007 news release: www.datcp.state.wi.us/press_release/result.jsp?prid=2029).

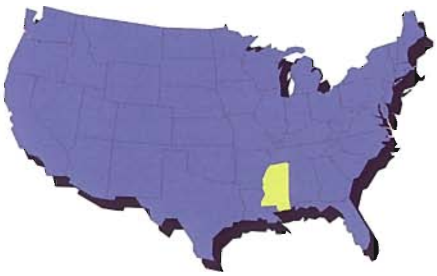
Wisconsin's Department of Agriculture, Trade and Consumer Protection (WDATCP) is taking the lead in responding to the incident because the pond is registered with that agency as a Type 1 fish farm, and thus exempt from aquatic plant management provisions that apply to public waters.

In late August an aquatic herbicide, Aquathol® K, was applied to the pond to kill off existing biomass and limit the potential for spread to nearby waters. This treatment was followed by a late fall drawdown of the pond to expose tubers and remaining plants to winter freezing. Additional steps will be taken in 2008 as needed and as agreed upon by all parties.

Agency staff suspect that source of the hydrilla, which has been present in the pond since 2005, was a shipment of aquatic plants from out of state. WDATCP staff are currently reviewing plant nursery records to identify the source of the hydrilla and track whether other orders from that source came into Wisconsin.

At this time the hydrilla population is believed to be an isolated incident. The pond is not connected to any natural water bodies, but staff from the WDNR and Marinette County are monitoring surrounding natural and artificial ponds and lakes for hydrilla to ensure that it has not spread.

Questions about aquatic invasive plants in Wisconsin can be directed to Tim Asplund, WDNR limnologist (608-267-7602 or email tim.asplund@wisconsin.gov).



Mississippi: Invasive Aquatic Plant Management Activities

John D. Madsen
Assistant Extension/Research Professor
Mississippi State University, GeoResources Institute

Mississippi has a wide range of aquatic environments, all of which are impacted to some extent by aquatic weed problems. Rivers, streams, oxbow lakes, reservoirs, and farm ponds punctuate the landscape. While there is not a focused statewide program dealing with aquatic plants, several government agencies have been active in management. Also, the state is in the process of developing a statewide Aquatic Nuisance Species Plan, through the auspices of the Mississippi Aquatic Nuisance Species Task Force. This, along with the interest in terrestrial weeds as indicated by the statewide Cogongrass Task Force and interest in forming the state's first Cooperative Weed Management District, indicate that Mississippi is on the verge of coordinated statewide activity on invasive plants.

Five species in particular cause the bulk of nuisance problems in the state: alligatorweed, Cuban bulrush, hydrilla, giant salvinia, and waterhyacinth.

Alligatorweed. Alligatorweed (*Alternanthera philoxeroides*) is a major nuisance problem in ditches, streams, bayous and wetlands across the state. The main control technique employed has been the alligatorweed flea beetle (*Agasicles philoxeroides*), which has been particularly effective in the southern third of the state, south of I-20. In the northern two-thirds of the state, the flea beetle has not been effective in alleviating aquatic nuisance growth of alligatorweed. Herbicides, including imazapyr and 2,4-D, have also been effective. Alligatorweed problems have been particularly significant in the bayous of the Delta in the past few years. These bayous conduct runoff water to the Mississippi River, reducing flooding to this significant agricultural area. While biocontrol augmentation has been used in one reservoir, herbicides have been more widely used in this region. While no government agencies have been conspicuously active in managing alligatorweed in the Delta, the Delta Council and the Delta Wildlife Federation have taken a lead in addressing the issue.

Cuban Bulrush. Cuban bulrush (*Scirpus cubensis*) has spread rapidly throughout the Tennessee-Tombigbee waterway in the past few years. The Tenn-Tom runs from the TVA reservoirs in the north to Mobile Bay to the south. Cuban bulrush has been spreading northwards, overgrowing mats of waterhyacinth. At the moment, no controls have been implemented in the Mississippi segment of the Tenn-Tom on this recent invader, though the Alabama Department of Conservation and Natural Resources has attempted to control Cuban bulrush in their segment of the Tenn-Tom using 2,4-D.

Giant salvinia. Giant salvinia (*Salvinia molesta*) has been found in several locations in the southern part of the state. The infestation in the Leaf River near Petal, MS continues to persist and spread, despite several herbicide treatments and the release of the salvinia weevil (*Cyrtobagous salviniae*). To date, the weevil populations have persisted, but have not controlled the growth of giant salvinia. The Mississippi Department of Agriculture and Commerce, Bureau of Plant Industry has attempted control of giant salvinia at the Leaf River locations using herbicides and releases of the weevil, in cooperation with the Mississippi Wildlife, Fisheries, and Parks Department. Funds for these activities largely came from the USDA-APHIS CAPS program, which unfortunately has discontinued active management funds. The giant salvinia population in the Pascagoula River estuary was decimated by Hurricane Katrina, and has apparently been eradicated by follow-up herbicide treatments by the Mississippi Department of Marine Resources. More details on these populations are available in GeoResources Institute Report #5012, available at www.gri.msstate.edu.

Hydrilla. Hydrilla (*Hydrilla verticillata*) has been found in several reservoirs in Mississippi. Ross Barnett Reservoir, a 20,0000 acre reservoir near Jackson, has approximately 150 acres of hydrilla, which is under active management by the Pearl River Valley Water Supply District. The Pearl River Valley Water Supply District (hereafter PRVWSD) has been very proactive in managing the hydrilla using spring and summer fluridone treatments combined with endothall contact herbicide treatments in the fall. Surveys have thus far found only small populations, so eradication of the hydrilla populations is still the goal.

PRVWSD has been proactive in managing invasive aquatic plants. Since a widespread infestation of waterhyacinth in the early 1990's, the PRVWSD has been active in controlling waterhyacinth, alligatorweed, and now hydrilla. Because of these efforts, the Ross Barnett Reservoir does not have significant nuisance growths of these plants, and its waters are available for recreation.

Several reservoirs in the Tennessee-Tombigbee waterway, including Lakes Aberdeen and Columbus, have populations of hydrilla, which are not under management. Further discussion of hydrilla populations in the state is available in More details on these populations are available in GeoResources Institute Report #5012, available at www.gri.msstate.edu.

Waterhyacinth. Waterhyacinth

(*Eichhornia crassipes*) is found throughout the state, causing problems in numerous systems. Waterhyacinth is being actively managed by the US Army Corps of Engineers in the Tennessee-Tombigbee waterway using herbicides, on an intermittent basis. The Pearl River Valley Water Supply District has been using a maintenance management approach for managing waterhyacinth in the Ross Barnett Reservoir since the early 1990's, mostly using 2,4-D.

These and other plants will be documented using a new web-based database under development at the GeoResources Institute. The Invasive Plant Atlas of the Mid-South (IPAMS) will track the locations of these and other aquatic plant species, as well as terrestrial invasive plants. IPAMS, which can be viewed at www.gri.msstate.edu/ipams , will launch in the near future. This information will be shared with national databases, including the USGS Aquatic Nuisance Species website and the National Institute for Invasive Species Science.

Finally, it is worth mentioning that a number of native plant species including duckweed, watermeal, southern naiad, and others cause problems in the numerous farm ponds throughout the state. Most of the nuisances caused by algal blooms and free-floating plants are self-inflicted problems that are the result of the practice of pond fertilization. Fisheries departments and agencies in the south recommend that landowners fertilize their ponds to maximize fish production. While this does enhance fish growth, the ponds are often oxygen deficient, and support noxious algal growths. This practice also enhances the growth of duckweed and watermeal. While this practice seems either counterintuitive or sacrilegious in northern states, it is considered a dearly held rite in the south only surpassed by the right to bear arms or eat fried chitlins (chitterlings to you Yankees). Nuisance native plant and algae problems constitute the bulk of the requests for assistance from small lake and pond owners in Mississippi.

Demonstration Project on Hydrilla and Hygrophila in the Upper Kissimmee Chain of Lakes (Excerpt from the EPA Work Plan)

Dr. Tina Bond, UF/IFAS Osceola County Extension

Osceola County, Florida was awarded a $2.881 million dollar grant by the Environmental Protection Agency (EPA) to find new and alternative ways to manage hydrilla and hygrophila in the Upper Kissimmee Chain of Lakes. The objectives of the project are:

1. To evaluate the effectiveness of Experimental Use Permit (EUP) herbicides and biological controls in the treatment of hydrilla and hygrophila;
2. To evaluate new technology processes or practices, or a new combination or uses of technologies, processes or practices for the control of hydrilla and hygrophila using small-scale field work;
3. To implement and monitor successful practices and processes identified in objectives 1 and 2 using large-scale field demonstrations; and
4. To demonstrate the project efforts in alternative technologies to manage hydrilla and hygrophila and disseminate to the public the results of this project.

"Where hydrilla occurs, it causes substantial economic hardships, interferes with various water uses, displaces native aquatic plant communities, and adversely impacts freshwater habitats. Management techniques have been developed, but sufficient funding is not available to stop the spread of the plant or implement optimum management programs. Educational efforts to increase public and political awareness of problems associated with this weed and the need for adequate funding to manage it are necessary" (Langeland, 1996).

The primary targeted species are Hydrilla (*Hydrilla verticillata*) and Hygrophila (*Hygrophila polysperma*).

Hygrophila is still a popular and widely distributed aquarium plant, but, because of its potential as a weed, the Department of Environmental Protection prohibited its sale in Florida. Hygrophila seems to grow more robustly in enriched waters (Schmitz and Nall 1984) and in flowing waters (Van Dijk et al. 1986). Control of hygrophila is difficult. Harvesters fragment plants and increase distribution, and grass carp have a low preference for hygrophila. Incidental targeted species may include: Water lettuce (*Pistia stratiotes*), Water Hyacinth (*Eichhornia crassipes*), Torpedo grass (*Panicum repens*), Para grass (*Urochloa mutica*), Alligator weed (*Alternanthera philoxeroides*), Wild taro (*Colocasia esculenta*), and Parrots feather (*Myriophyllum aquaticum*).

This project will not only benefit the waterways in Osceola County, but may have potential applications for other high-flow sites in the State of Florida such as Lake Rousseau, Lake Seminole, and Lake Istokpoga.

Since the early 1900's, there have been numerous drainage projects to alleviate flooding or to drain the land for agricultural use. The Central and South Florida (C&SF) Flood Control Project of the 1960's completely

"Registered herbicides including diquat, endothall, and fluridone, provide marginal control"–of Hygrophila (McCann et al.1996).

changed the natural system in Osceola County as well as other parts of the state. Projects like the C&SF Project have altered the natural hydrologic processes to such an extent that historical high and low stages are no longer recognizable. High water levels in the summer months during the rainy season and low water levels in the winter months during the dry season were the normal hydrologic processes that occurred. In the past, water levels fluctuated naturally between five and ten feet. Currently, structures like weirs, locks and levees maintain water levels high in the winter and low in the summer, with little fluctuation in water levels, the exact opposite of the normal processes. Introduction of non-native species increases in runoff, nutrient loading, and discharge, and ideal conditions for plant growth in Florida have encouraged the growth of exotics plants.

Aquatic invasive plants have been able to thrive in Florida because of the lack of normal fluctuation within the lake system coupled with the lack of severe freezes that could help reduce the impacts of these exotic plants. Water quality and overall health of the lakes in Osceola County have been in decline because of increases in nutrient loading, invasive plant introductions, and the stabilization of water levels. These activities are further degrading the natural system as well as decreasing the level of service flood control provides, which was the primary reason for altering the system to what it is today. Biological diversity decreases as invasive exotics spread out of control, forming dense monocultures in which none of the native species can thrive. This not only includes plants but also affects prime aquatic habitat, which supports numerous species of fish, waterfowl, wading birds, and wildlife (Dooris, 1976). The demonstration project is needed because the aquatic ecosystems in Osceola County have been deeply impacted by drainage projects that have occurred over the years. As a result of drainage projects, there has been a tremendous increase in the amount of aquatic invasive plants throughout the County and State.

There are four elements of the project headed by leading researchers in Aquatic Plant Management that will accomplish the goals and objectives of the project:

Element 1: Development and Testing of New Aquatic Herbicides

Dr. William Haller, well-known aquatic plant researcher at the University of Florida and Director of the Center for Aquatic and Invasive Plants, will be evaluating EUP (Experimental Use Permit) herbicides for effectiveness on hydrilla and hygrophila.

Agrichemical companies have a renewed interest in developing herbicides for use in aquatic environments. Many of the new products coming to market are reduced-risk pesticides, meaning that these products have low risk or impacts to human health and non-target organisms such as fish, birds, and plants. Reduced risk pesticides also have very low potential for groundwater contamination, lower use rates and low resistance potential, something of utmost importance to aquatic plant managers.

The two main tasks include: Determining field selectivity, efficacy and water residues of new aquatic herbicides and laboratory / greenhouse screening; and Preliminary evaluation of potential new aquatic herbicides. Researchers will learn how to determine water residues and impacts of new herbicides on target and non-target species in ponds and lakes. Researchers will also investigate the time: rate relationships, selectivity and phyto-toxicity of potential new aquatic herbicides to determine feasibility of further registration.

Element 2: Evaluation of Currently Registered Herbicides for Control of Hydrilla and Hygrophila, coordinated by Dr. Michael Netherland with the U.S. Army Corps of Engineers.

Of the nine active ingredients currently registered for aquatic use, only four of these compounds (fluridone, endothall, diquat, copper) have been proven effective for hydrilla (*Hydrilla verticillata*) control. The products that form the backbone of most state-funded hydrilla control programs include fluridone and endothall.

Due to the limited number of registered products, work on hydrilla control will be focused in the following areas:

- Evaluations of endothall in high flow areas of the Kissimmee Chain of Lakes or in other Osceola County Lakes where drip applications can be evaluated.
- Evaluations of endothall use in the fall and winter for control of hydrilla.
- Evaluations of endothall in shallow-water environments, with an emphasis on initial efficacy and longevity of control.

The proposed projects will generally include initial laboratory (replicated trials inside) or mesocosm (replicated trials outside) validation work, followed by field-scale demonstrations using the most promising techniques. While fluridone does represent an existing and important technology, knowledge on use patterns for both fluridone-resistant and fluridone-sensitive strains of hydrilla is extensive within Osceola County. There is a greater need to focus attention on developing information on the other existing molecules to help us reduce reliance on fluridone.

Element 3: Biological Control on Hydrilla and Hygrophila

Classical insect biological control can be particularly successful at controlling invasive pests of foreign origin. The underlying principal of classical biological control is that pests are kept in equilibrium in their native ranges by a complex of biological checks and balances such as insects, diseases, nematodes and other biological organisms. When introduced into another geographical location, away from these natural checks, the organism proliferates and becomes a serious pest. Thus, classical biocontrol of weeds consists of determining the native range of an exotic plant and searching that range for natural checks and balances with the goal of determining safety of the

AQUAVINE

Call for Papers and Student Contest: 2008 Midwest-APMS Conference

The 2008 Midwest Aquatic Plant Management Society is seeking potential speakers for the annual conference scheduled March 1-3rd, 2008 in Sandusky Ohio. Please contact Jason Broekstra (jason@prolakemgmt.com - Phone: 616-891-1294, if you are interested. In addition, a student paper contest will be coordinated by Tyler Koschnick (tylerk@sepro.com).

Calendar

February 19-21, 2008
28th Annual Meeting and Symposium of FL Chapter American Fisheries Society.
Ocala, FL. www.sdafs.org/flafs/

May 5-8, 2008
Aquatic Weed Control Short Course.
Coral Springs Marriott Hotel, Coral Springs, Florida.
http://conference.ifas.ufl.edu/aw/

May 15-18, 2008
Florida Native Plant Society 28th Annual Conference.
Estuaries to Uplands: Celebrating Florida's Native Plant Heritage.
Manatee Convention Center, Palmetto, FL.
www.fnps.org/

May 20-22, 2008
10th Annual Southeast EPPC Conference.
Imperial Palace Casinos, Biloxi, Mississippi
www.se-eppc.org

March1-3rd
28th Annual Midwest APMS conference
Kalahari Waterpark Convention Center, Sandusky, OH
www.mapms.org

March 3-6th, 2008
Western Aquatic Plant Management Society (WAPMS) Annual Conference. Granlibakken Conference Center & Lodge, Lake Tahoe, CA.
www.wapms.org/

controlling organism and introducing it into the area where the weed is a pest.

Task 1: Demonstration of Hydrilla Control in Osceola County, Florida using Mycoleptodiscus terrestris (Mt), a New Contact Bioherbicide, for Aquatic Plant Management (Project Ongoing), coordinated by Dr. Mark Heilman with SePRO Corporation.

Task 2: Foreign Exploration for Natural Enemies of Hygrophila, coordinated by Dr. James Cuda of the University of Florida, Entomology/Nematology Department.

Task 3: Collaborative Effort to Search for Natural Enemies of Hydrilla in East Africa (Project Ongoing), coordinated by Dr. William Overholt of the University of Florida, Biological Control Research and Containment Laboratory.

Element 4: Demonstration and Outreach coordinated by Dr. Tina Bond with UF/IFAS Osceola County Extension Services.

The main goal to demonstrate the results of this project to the local applicators, non-scientific public; as well as to federal, state and local government partners, will be coordinated by Dr. Tina Bond. Dr. Bond will develop a series of demonstration and outreach strategies in cooperation with the UF Center for Invasive and Aquatic Plants (CAIP) Information Office. The demonstration and outreach portion of this project features a variety of methods to demonstrate progress on the project and implementation of new alternative management strategies.

Although we have been struggling with invasive plant problems for more than a century in this state, most people are unaware of the severity of the situation. The most effective, long-term method for preventing the spread of aquatic invasive plants is an informed citizenry. A concerted public information campaign in Osceola County will go a long way in getting the word out to lake residents and other user groups who can help us stem the flow of invasive species by being aware of the problem and on the lookout for existing infestations or potential ones. This will ultimately benefit all Floridians, whose tax dollars are being spent each year to mitigate the damage being inflicted by a number of highly invasive species. The information developed in this project can then be used as a template for similar public outreach efforts throughout the state.

The most important benefit realized as a result of performing the following demonstration project will be the dissemination of information to the general public from the various experiments and trials we perform. It is our goal to incorporate graduate students, student interns and professors into many elements of the proposed project, such that one result will be research papers created for conference presentations and/or publishing, graduate student theses, as well as reports prepared for publishing in scientific journals. The Hydrilla and Hygrophila Demonstration Project interactive website provides specific project details and research results. It will be updated as the project progresses and will be available to all Internet users worldwide.

For more information and the complete Work Plan, please visit the website at: http://plants.ifas.ufl.edu/osceola